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Analysis of the Relationship between Adolescent Anemia and Micronutrient Intake

Najma Millaty, Nurul Shofia, Ika Mustika*, Niken Aurelia, Nisrina Azzah Umamah,Septiana Safitri, Yuliana Safitri, Wildan Maulana

Faculty of Psychology and Health, Islamic State University of Sunan Ampel, Surabaya, Indonesia
*ikamustika@uinsa.co.id

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Abstract: According to the World Health Organization (WHO), anemia cases in adolescent girls reached 53.7%. RISKESDAS data in 2018 also showed an increase in anemia cases in adolescents aged 15-24 years by 18.4% to 48.9%. Anemia is a health disorder that is prone to occur in adolescent girls due to lack of hemoglobin in the body. This study aims to determine and analyze the relationship between anemia in adolescent girls and micronutrient intake. The method used was a literature review, critically reviewing previously published findings from Pubmed and Science Direct with certain inclusion criteria. The results showed that the intake of certain micronutrients such as iron, zinc, vitamin B12, vitamin B6, and copper had a significant association with the incidence of anemia in adolescent girls. The association between one or more micronutrients related to iron formation and absorption can lead to anemia. Iron, as the main component in the formation of hemoglobin, can interfere with the absorption of hemoglobin if it does not occur properly.In conclusion, micronutrient intake affects the incidence of anemia in adolescent girls. Impaired absorption and formation between nutrients can interfere with hemoglobin formation, causing anemia.

1   INTRODUCTION

Anemia is a condition where the blood has a decreased ability to transport oxygen due to low hemoglobin concentration in the blood. Anemia can be caused by various factors, such as nutrition, genetics, and cellular abnormalities. Based on nutritional problems, anemia is classified into several types, one of which is iron deficiency anemia. Such anemia can occur when the body does not have enough iron to produce hemoglobin. Iron deficiency anemia is one of the anemia that is often found in adolescents, especially adolescent girls.

Adolescence is a transitional phase from children to adulthood which involves the processof growth and development, both in terms of physical, psychological, and emotional. Based on the Nutrition Adequacy Table (AKG) states that the iron requirement of female adolescentswith an age range of 13-29 years is 26 mg per day. Where this figure is a higher value for its needs compared to the iron needs of adolescent boys of the same age. In adolescent girls, iron intake is not only used for growth and development, but also used to replace iron lost through blood loss during menstruation. Therefore, the high need for iron in girls will ultimately havea greater risk of anemia.

According to the *World Health Organization* (WHO), cases of anemia in adolescent girls in 2019 were around 29.9%. Meanwhile, based on data from the Ministry of Health's Basic Health Research (Riskesdas), cases of anemia in adolescents aged 15-24 years have increased from 2013 to 2018 from 18.4% to 32%.

2   METHODS

This research method uses a literature review method that focuses on analyzing the relationship between adolescent girls' anemia and micronutrient intake. This research was conducted by collecting data from

various sources, including relevant journals and research reports. The data collected was then systematically analyzed to find the relationship between anemia of adolescent girls and micronutrient intake. Data collection techniques in this study include collecting data in the form of relevant literature sourced from journals and research reports related to this topic. Data were analyzed using descriptive analysis techniques to get an overview and quantitative analysis to find relationships between variables. This study was conducted with the aim of knowing the relationship between anemia of adolescent girls and micronutrient intake and providing recommendations to improve the nutritional quality of adolescent girls.

Figure 1: Journal Search Prism

3 RESULTS

Table 1: Journal Analysis Table

No	Research Title	Name/ Year	Research Methods	Research Results
1	Relationship between Iron Intake and Anemia Status of Adolescent Girls in Bogor City	Tyas Permatasari, Dodik Briawan, Siti Madanijah / (2020)	This study was conducted using a cross sectional research design. Data collected included food consumption using the semi-quantitative Food	Based on the results of the study, it was found that the incidence of anemia in adolescent girls in Bogor City was 20.9% of 172 subjects, namely there were 36 adolescents who experienced anemia. There were two incidences of anemia, namely mild anemia as

No	Research Title	Name/ Year	Research Methods	Research Results
			Frequency Questionnare (FFQ) method, hemoglobin levels analyzed using the cyanmethemoglobin method, and anemia status which was divided into 2 namely anemia and not anemia.	many as 32 subjects (88.8%) and moderate anemia as many as 4 subjects (11.1%). In this study, anemia status was determined using hemoglobin indicators. Based on the results of hemoglobin levels, it can be determined that the classification of mild anemia is 10-11.9 g/dl, moderate anemia is 7-9.9 g/dl, and severe anemia is <7 g/dl. Subjects with moderate category can have an impact on their immune status and ognitive function. The most dominant factor of the problem of anemia in adolescents is related to food patterns of iron sources. Total consumption of animal side dishes in adolescent girls in Bogor City is still relatively low. The average consumption of animal side dishes in the subjects of this study still reached 39%. As for the consumption of vegetable side dishes, it only reached 31.2%, and the consumption of vegetables and fruits was still relatively low, namely vegetables 30.95 ± 1.91 and fruits 39.65 ± 30.17.
2	Iron Intake, Vitamin C and Blood Addition Tablet Consumption Associated with the Incidence of Anemia among Adolescent Girls of SMPIT Majmaul Bahrain Bogor	Sarah Alfiah, Nunung Cipta Dainy	The results of the study were then analyzed univariately to determine the frequency distribution and characteristics of each variable. Bivariate analysis using the Chi-Square test to determine the relationship between iron intake, vitamin C, compliance with TTD consumption and knowledge about anemia with the incidence of anemia in adolescent girls.	Based on the results of the study, it can be found that the prevalence of anemia among adolescent girls at Majmaul Bahrain IT Junior High School is 54.7%. Most respondents had iron intake in the deficient category (54.7%), vitamin C intake in the deficient category (51.6%), there were 62.3% of respondents who were not compliant in consuming TTD (Blood Additive Tablets), and 61.1% of respondents with poor knowledge. Based on the results of the level of compliance and low knowledge of respondents, it is due to the lack of educational efforts to students related to anemia by schools and local health centers. Most of the adolescent girls at Majmaul Bahrain IT Junior High School were found to be anemic. There are several factors that can cause anemia, namely food intake, knowledge, and compliance with taking blood supplement tablets. This can be seen from the results of the study which prove that most respondents on all variables are included in the less category. This proves that there is a significant correlation between iron intake, vitamin C with the incidence of anemia in adolescent girls at Majmaul Bahrain IT Junior High School.
3	The relationship of Fe tablet administration to increased hemoglobin levels in adolescent girls at risk of anemia	Asriullah Jabbar, et al (2024)	Quantitative with cross sectional. The cross sectional research method will study the relationship between independent factors and dependent factors with measurements made with instantaneous observation at the same time. The bivariate data analysis using Pearson ChiSquare	Based on the analysis conducted from 91 respondents, the highest respondent data for bivariate analysis of Fe tablet administration with increased hemoglobin levels is the category of increased hemoglobin levels with complete Fe tablet administration. The results of respondents who experienced an increase in hemoglobin levels with complete Fe tablet administration were 52 people, and with incomplete Fe tablet administration were 4 people. In respondents who did not experience an increase in hemoglobin levels with

No	Research Title	Name/ Year	Research Methods	Research Results
				complete Fe tablet administration as many as 7 people and incomplete Fe tablet administration as many as 5 people.
4	Adolescent girls' knowledge about taking FE tablets during menstruation with anemia	Catur Setyorini, Durrotun Nafisah, Fitria Kurniastuti (2023)	quantitative with a cross sectional approach and data analysis using Pearson ChiSquare	Based on the results of the study, 64 respondents (59.3%) who had knowledge about Fe tablet consumption during menstruation in the good category, 60 people (55.6%) of them did not suffer from anemia. While from 39 respondents (36.1%) who had knowledge about Fe tablet consumption during menstruation with sufficient category, 29 people (26.9%) of them did not suffer from anemia. Based on the results of chi-square analysis, the results of P Value < α (0.001 < 0.05) indicate a significant relationship between the two variables.
5	The Relationship between Intake of Iron, Zinc and Folic Acid with the Incidence of Anemia in Adolescent Girls at SMAN 1 North Kampar in 2021	Puspita Sari (2022)	The analysis used was univariate analysis and bivariate analysis. Univariate analysis was used to explain and describe each characteristic of each variable using iron, zinc, folic acid intake, and the incidence of anemia. While bivariate analysis was used to see the relationship between independent variables and dependent variables with the chi-square test.	Based on the analysis conducted on 81 students, it was found that more than 50% of students had insufficient iron intake (50 students), zinc intake (53 students), and folic acid intake (58 students). 53 students experienced anemia and less than 50% of students experienced pale skin (41 students), pale eyelids (35 students), lethargic body (36 students), and easily broken nails (9 students). In the bivariate analysis, it was found that 50% of students had anemia with insufficient iron intake, 22% of students did not have anemia with sufficient iron intake, more than 50% of students had anemia with sufficient zinc intake, and 50% of students had anemia with sufficient folic acid intake.
6	Relationship between Vitamin C and Vitamin B12 Intake and the Incidence of Suspected Anemia in Adolescent Girls in Sukoharjo Regency	Sunarti Hanapi, et al (2019)	The analysis used was univariate analysis and bivariate analysis. Univariate analysis was conducted to describe the variables of vitamin C intake, vitamin B12 intake, and the incidence of suspected anemia.	Based on the analysis conducted on 110 adolescent girls, it was found that 57.3% of vitamin C intake was in the deficient category where respondents consumed the most sources of vitamin C from spinach and 61.8% of vitamin B12 intake was in the deficient category with the most sources of vitamin B12 in domestic chicken eggs. In this study, the non-suspect anemia category was 65.5%.
7	Relationship between nutritional status and the incidence of anemia in adolescent girls	Gusman Virgo (2020)	In the study, two analyses were carried out, namely data analysis of subject data (univariate) which was used to identify subject age, weight, height, z score based on IMT / U, hemoglobin levels, protein intake, iron, vitamin C, vitamin B12 and folate. And the second analysis is bivariate analysis with the Chi Square test to determine the relationship between nutritional status and the incidence of anemia in adolescent girls	Based on the results of the study based on IMT/U, the average z-score value was 0.97 ± 1.18 SD, with the lowest value of -3.03 and the highest value of 2.64. The z-score value shows the nutritional status of the subjects: very thin 1 person (1.1%), thin 3 people (3.3%), normal 66 people (73.3%), obese 14 people (15.6%), and 6 people (6.7%). Hemoglobin levels showed that the lowest was 9.9 grams/dL and the highest was 14.9 grams/dL, with a mean of 12.6 ± 1.29 SD, and 24 of them (26.7%) were anemic. The calculated intake of protein, iron, vitamin C, vitamin B12, and folate showed that 63.3% of the girls had iron intake that was less than the requirement, while most of the girls had adequate intake of protein, vitamin C, vitamin B12, and folate. There was no significant relationship between nutritional

No	Research Title	Name/ Year	Research Methods	Research Results
			aged 12-14 years then continued multivariate analysis with logistic regression test.	status and the incidence of anemia in adolescent girls; one person (25%) was underweight and three people (50%) were obese.
8	Relationship between Nutritional Status and Anemia in Adolescent Girls at SMA PGRI 4 Banjarmasin	Hutari Puji Astuti, Christiani Bumi Pangesti (2022)	This study uses a non-parametric statistical test, namely the chi square test to see the relationship between nutritional status variables and the incidence of anemia in adolescent girls at PGRI 4 Banjarmasin High School. The aim is to determine whether or not there is a relationship between nutritional status and the incidence of anemia in adolescent girls at PGRI 4 Banjarmasin High School.	The results of the research in this journal have 2 tables containing that adolescent girls with normal nutritional status have the highest number, namely 80.6%. While the least amount is thin nutritional status 9%. And fat nutritional status at a percentatse of 10.4%.In table 2 explains that most of the research respondents experienced anemia, namely 62.7%. With the number of students around 42 people. And 25 children did not suffer from anemia, namely 37.3%.
9	Relationship between intake of zinc, copper, and vitamin B6 with the incidence of anemia in students at SMA Muhammadiyah 10 GKB	Fithria Nurul Azizah, et al (2023)	The data collected from the research results were then processed using the SPSS statistical program with several stages including coding, entry, cleaning, and analyzing. Furthermore, data analysis was carried out and presented in tabular form with the pearson correlation test.	The results of this study showed there was a significant relationship between zinc intake (sig = 0.002), copper (sig = 0.539), and vitamin B6 (sig = 0.001) with hemoglobin levels in adolescent girls at SMA Muhammadiyah 10 GKB.
10	Vitamins A administration factor	Puspita Adriani (2019)	Relationship between Iron Source Consumption and Anemia Among Junior and Senior High School Adolescent Girls in Bantul.	Judging from the average iron intake of adolescent girls as much as 22.88 mg/ day which means it meets the needs that should be. However, from the results of data collection most of the adolescent girls as many as 110 people (55.56%) have iron intake that is still lacking (<15mg / day) this is influenced by the frequency of iron intake of adolescent girls who are mostly only 1-2x a week and the amount of consumption is also low and the types of food consumed are less diverse.

4 DISCUSSIONS

Adolescence is a transition period from childhood to adulthood with an age range of 10 - 19 years. Based on research from Riskesdas in 2018, the prevalence of anemia in adolescents was 32%. This shows that 3-4 out of 10 adolescents suffer from anemia. Anemia can occur due to factors of eating habits that are not optimal so that they do not meet nutritional intake. In addition, physical activity is also one of the factors causing anemia. This is because, the habit of adolescents who lack exercise so that the intake of nutrients is not balanced with the energy expended. One of the main causes of anemia in adolescents is a lack of nutritional intake from food which includes iron, vitamin C, protein, vitamin B12, zinc, and folic acid.

Anemia

Anemia is one of the health problems that often occurs in children around the world, especially in developing countries, namely Indonesia. Anemia is caused by iron deficiency in the patient's body. It is known that 30% of the world's population is anemic and most of them are found in developing countries. Anemia is a condition where the body lacks hemoglobin. Hemoglobin is a metalloprotein, a protein that contains iron in red blood cells. The iron is responsible for transporting oxygen from the lungs to the rest of the body. Anemia is one of the conditions that often occur in adolescent girls. This can be caused by various factors, namely nutritional status, menstruation, and socioeconomics. Anemia can have an impact on reducing endurance, resulting in the body being susceptible to health problems.

Epidemiologically, the highest incidence of anemia is found in late infancy and early childhood. This is due to iron deficiency during pregnancy and accelerated childhood growth accompanied by low iron intake from food. In addition, anemia also occurs in adolescence due to rapid growth and development, inadequate iron intake and aggravated by blood loss due to menstruation in adolescent girls. In general, adolescent girls will experience menstruation every month. During menstruation, adolescent girls are more at risk of anemia. In addition, poor dietary habits in adolescent girls can also be a factor in anemia. Iron deficiency occurs because the body needs more than is available in food. When a person is born, the body has only a small amount of iron, but as an adult, the amount becomes more. To keep the amount in balance, children need to absorb about 0.8 mg of iron every day until the age of 15. But since only a small amount is absorbed by the body, a person needs foods that contain about 8-10 mg of iron every day.

The World Health Organization (WHO) in the world health statistics in 2021 shows that the prevalence of anemia in women of reproductive age (15-49 years) in the world is around 29.9%. Meanwhile, the prevalence of anemia in non-pregnant women aged 15-49 years is 29.6%, which includes the adolescent age category. Based on the results of the 2018 Riskesdas report, it shows that anemia is a major health problem that often occurs in adolescents, especially adolescent girls. This can be influenced by non-optimal nutritional intake habits and lack of physical activity.

Anemia is a condition where the Hemoglobin (Hb) level in the blood is lower than the normal level for groups of people based on age and gender. In adolescent women the normal Hb level is 12-15 gr/dl. Based on WHO in 2017 anemia is a condition of the body in which the number of red blood cells and their oxygen lifting capacity are insufficient to meet the physiological needs of the body. The physiological needs of a person's body vary depending on age, gender, place of residence, smoking behavior, and stage of pregnancy. In general, anemia occurs due to lack of knowledge about anemia, iron, folic acid, vitamin B12, and vitamin A deficiency. Some other causes are acute and chronic inflammation, parasite infection, congenital disorders that affect hemoglobin synthesis, and lack of red cell production.

The incidence of anemia in adolescent girls can cause fatigue, decreased learning concentration, so that it can affect learning achievement and can reduce work productivity. The high prevalence of anemia in adolescents if not handled properly, it will continue into adulthood and will contribute greatly to maternal mortality, premature birth and low birth rate. One of the interventions conducted by the government to reduce the prevalence of anemia in adolescent girls is the use of tablets containing iron and folic acid supplements through the provision of blood supplement tablets (TTD). Other sources of TTD include health facilities, schools, and individual initiatives. The target objective of the TTD program at the school level is to reach the upper grades of junior high school, high school, and equivalent, as well as women outside school as a strategic initiative to solve the nutrition cycle problem. Blood supplement tablets are included in the government program, namely the Prevention and Control of Anemia in Adolescent Girls and Women of Childbearing Age (WUS) Program, one of the specific objectives is to increase the fulfillment of TTD consumption in adolescent girls, so as to reduce the prevalence of anemia in adolescent girls. The preliminary study conducted by the researcher was to interview five main informants, namely adolescent girls regarding anemia and some of the related symptoms identified. Of the five adolescent girls, four of them experienced the five Ls (weak, lethargic, tired, and lunglai), while one adolescent girl only occasionally had difficulty coping with them, even though she had enough sleep (6-8 hours/day). The researchers also conducted conjunctival examinations on five primary reports and found that four of the adolescents had conjunctival warning signs. Five primary reports and found that four out of five adolescents had warning signs of pallor

Micronutrient Intake of Adolescent Girls

Folic Acid

Folic acid, also known as vitamin B9, is one of the eight water-soluble B vitamins that the body does not store in large amounts and requires a regular supply through food or supplements to maintain normal levels. Folic acid plays a role in red blood cell formation and growth which can be obtained by eating green vegetables and liver. Folic acid also plays a role in the process of nucleo protein synthesis which is key to the formation and production of normal red blood grains in the bone marrow, (Besuni et al., 2013). The substances needed by the bone marrow for hemoglobin formation are metals (such as iron, manganese, cobalt, zinc, copper), vitamin B12, vitamin B6, vitamin C, vitamin E, folic acid, thiamine, riboflavin, pantothenic acid, protein, hormones such as erythropoetin, androgens, and thyroxine. Red blood cell production can be disrupted if digestion does not function properly (malabsorption) or stomach disorders so that nutrients are not absorbed, (Saptyasih et al., 2016).

Folic acid also plays a role in DNA synthesis and amino acid metabolism where in this case the work of folic acid is related to the work of vitamin B12. Vitamin B12 works to convert folic acid into an active form, in normal function folic acid plays a role in the metabolism of all cells including cells of the gastrointestinal tract, bone marrow, and nerve tissue, (Marissa, 2021). Folic acid is needed in biochemical reactions involving the removal of one carbon unit in amino acid interconversions such as the conversion of homocysteine to methionine and serine to glycine in the synthesis of purine DNA precursors. In the process of DNA formation, folic acid plays an important role in nucleotide synthesis, (Besuni et al., 2013). The final maturation of red blood cells requires folic acid, the more and the longer the intake of folic acid will further increase hemoglobin levels.

The average intake of folic acid in pregnant women and fertile women aged 10-19 years according to the standard Nutritional Adequacy Score is 400 micrograms / day or the same as two glasses of milk. Folic acid plays an important role during pregnancy, but before pregnancy, consuming folic acid is highly recommended in order to prevent anemia and reduce the risk of NTD (Neural Tube Defects), as well as an antidepressant. Folic acid deficiency in girls, as adults will not experience menstruation. Whereas in pregnant women, it can increase the risk of anemia so that the mother is easily tired, tired, lethargic, pale,

and can cause miscarriage. In fetuses with pregnant women, folic acid deficiency can cause disability in babies who are born. Babies will experience defects in the brain and spinal cord, babies are born with cleft lip, down syndrome, babies are born with low body weight, babies experience blood coagulation disorders, and so on, (Devianty, 2013). Folic acid deficiency over a long period of time can also cause a decrease in the formation of hemoglobin levels will interfere with the process of cell division and tissue growth which can cause serious health problems.

Folic acid sources are found in green vegetables, fruits, nuts, eggs, wheat and milk, and beef liver. Green vegetables have a high folic acid content of around 100-200 micrograms such as kangkong, spinach, broccoli, cassava leaves, and so on. Beans are a source of protein and rich in fiber which contains 8-17% protein, 100 grams of iron, 100 grams of calcium, and rich in folic acid as much as 700- 100 micrograms. Fruits that are rich in folic acid are avocados, oranges, bananas, and strawberries.

Iron

Average- Iron is an essential microelement needed by the body. Iron is a mineral that plays a role in the formation of red blood cells (synthesizes hemoglobin) and as a component to form myoglobin, a protein that carries oxygen to the muscles, forms collagen, a protein found in bones, connective tissue, and cartilage, and plays a role in the formation of enzymes. Iron also plays a role in the body's defense system, (Besuni et al., 2013). Substances play a role in the synthesis of hormones and nuerotransmitters in the body including dopamine, serotonin, and norepinephrine. In thyroid hormone synthesis, iron plays a role as part of the enzyme thyroid peroxidase as a co-factor in catalyzing the activity of the enzyme thryoperoxidase (TPO). The TPO enzyme is involved in catalyzing the first two reactions of thyroid hormone biosynthesis, (Mulyantoro et al., 2017).

Individual iron requirements differ depending on various factors including age, gender, level of physical activity, and health status. Children, adolescents, and pregnant women require higher iron intake due to rapid growth and development. Adolescent girls require increased iron intake due to menstruation, (Sintya Purnayanti, 2019). The average iron intake in accordance with the standard Nutrient Adequacy Rate (AKG) for women aged 10-19 years is 20 micrograms / day or about 15-18 milligrams. Insufficient iron intake will not directly affect hemoglobin levels because the body has iron reserves

stored in the liver. In addition, adequate vitamin C intake helps the absorption of iron more optimally. Hemoglobin formation is influenced by iron levels as a constituent of heme and is influenced by protein, (Pinasti et al., 2020). Iron storage in several organs can fulfill the need for red blood cell formation in the bone marrow. If iron storage is reduced and the intake of iron consumed is low, the balance of iron in the body is disturbed, resulting in decreased hemoglobin levels which cause iron nutritional anemia. The condition of iron anemia is indicated by a decrease in hemoglobin and ferritin levels in plasma. (Alamsyah, 2018).

Iron deficiency causes the body to be unable to produce hemoglobin effectively, leading to disruptions in oxygen and carbon dioxide transportation that can interfere with normal cellular function. Iron deficiency leads to anemia because the need for iron intake does not match the need to synthesize and produce erythrocytes. Iron deficiency anemia is characterized by inappropriate hemoglobin synthesis due to a lack of iron that plays an important role in the body, resulting in a lack of erythrocyte capacity that transports oxygen to body cells and tissues. One of the causes of iron deficiency anemia is characterized by businesslike symptoms such as shortness of breath, lethargy, dizziness, and pale conjunctiva, (Azizah, 2020). Iron deficiency in adolescent girls has an impact on neurodevelopment and behavior such as decreased motor activity, impaired cognitive function, and decreased social interaction. Iron deficiency can also reduce fitness levels, concentration power, memory, and immunity which results in low learning ability and impacts learning achievement, (Arima et al., 2019).

Food sources that are rich in iron are green vegetables such as spinach, mustard greens, kale, green beans, peanuts and their preparations, seafood such as shrimp and shellfish, eggs, and grain products. Iron from animal sources is more easily absorbed by the body compared to iron from plant sources. In increasing iron absorption, it is recommended to consume food sources rich in vitamin C, (Nabilla et al., 2022). Iron absorption can be influenced by several factors including caffeine, calcium, and polyphenols in the and coffee.

Vitamin B12

Vitamin B12 or cobalamin is a water-soluble vitamin that plays an important role in DNA synthesis, erythrocyte formation, carbohydrate, protein, and fat metabolism, and plays a role in nerve maintenance.

This vitamin is synthesized by bacteria and is found in animal protein sources but not in vegetables. Vitamin B12 cannot be synthesized by humans, therefore vitamin B12 intake is obtained through food, especially food sources from animals. Vitamin B12 plays an important role in nerve myelination, brain development, and cognitive function, (Salsabila, 2020). Vitamin B12 is needed in the synthesis of hemoglobin, a protein in red blood cells that transports oxygen from the lungs to the rest of the body. Without sufficient vitamin B12, the formation of red blood cells is disrupted where the red blood cells are immature and accumulate in the spinal cord, which can cause pernicious anemia. Pernicious anemia is another form of nutritional anemia where the digestive tract is unable to absorb vitamin B12, (Sa'Adah, 2018). Adequate intake of vitamin B12 will increase hemoglobin levels in the blood through the metabolism of protein, fat, and folic acid which requires the role of vitamin B12 by synthesizing hemoglobin and red blood cells. Hemoglobin synthesis requires succinyl-CoA. Vitamin B12 acts as a cofactor in the synthesis of hemoglobin in the formation of energy derived from the breakdown of fat and protein, (Pinasti et al., 2020).

The need for vitamin B12 in each individual differs according to several factors such as age, gender, physical activity, and health status. The daily requirement of vitamin B12 is about 2.4-2.8 micrograms for adults and adolescent girls. However, the need for vitamin B12 will increase in pregnant and lactating women as well as someone with media conditions that interfere with the absorption or metabolism of vitamin B12. In adolescents, vitamin B12 helps in the conversion of carbohydrates, proteins, and fats into energy needed for daily activities and growth. In this sense, vitamin B12 plays an important role in maintaining balanced energy levels during adolescent growth and development. Vitamin B12 deficiency is not very common as the body still stores this vitamin for a long period of time, about five years. Commonly used investigations are low serum vitamin B12 levels or megaloblastic bone marrow. To determine vitamin B12 deficiency can be assessed by assessing homocysteine and methylmalonic acid, (Salsabila, 2020).

The main sources of vitamin B12 are poultry meat, fish, eggs, cheese, shrimp, shellfish, and dairy products. Sources of vitamin B12 are found naturally in animal products and are produced by microorganisms present in the animal's body. Plant-based sources of vitamin B12 are found in cereal products. Vitamin sources also come from

supplements because many elderly people cannot naturally absorb vitamin B12, so vitamin B12 needs are obtained from fortified foods or supplements, (Lestari & Ambarwati, 2023).

Zinc

Zinc is the main mineral in the formation of more than 300 enzymes needed in wound healing, helps cell reproduction, maintains vision, maintains adult fertility and child growth processes, stimulates immunity, and can prevent free radicals. Zinc is also a key component in maintaining healthy skin and preventing skin diseases. Zinc is involved in cell division, cell differentiation, and regulation of DNA synthesis, playing an important role during the growth and development of children, adolescents, and pregnant and lactating women. Zinc also plays a role in the formation of red blood cells and in the synthesis and degradation of carbohydrates, proteins, fats, and nucleic acids. Zinc affects iron metabolism by assisting carbonic anhydrase, which stimulates gastric HCL production, thereby increasing hemoglobin levels. Zinc transportation in the body is albumin, the more zinc content the more the amount of albumin increases. Increasing the amount of albumin can accelerate the production of fibrin mesh as blood clotting. The body absorbs zinc by combining blood elements such as antibodies, plasma proteins, electrolytes, complement, and water into the vascular space, (Jamhariyah, 2019).

Zinc also plays a role in heme synthesis because zinc is related to the activity of the enzyme alpha-aminolevulinic acid dehydratase (ALAD), which catalyzes heme synthesis. Zinc supplementation can increase Fe and hemoglobin levels, but also reduce parasitemia, (Hutasoit & Kurniati, 2020). Zinc requirements vary depending on age, body weight, level of physical activity, and health conditions. In general, the daily zinc requirement for adolescent girls is around 8-9 milligrams. Food sources that are rich in zinc are animal foods such as beef, fish, chicken liver, eggs, oysters, nuts, spinach, milk and its products, and dark chocolate, (Prastia, 2022). Zinc needs can also be met with zinc supplementation as an addition to the zinc content for daily needs. Supplements that are absorbed in digestion require the help of a conveyance (albumin) and occur in the upper part of the small intestine, more precisely the duodenum.

Zinc deficiency results in growth failure and the most affected organs are gastrointestinal, epidermal system, immune, central nervous, skeletal, and reproductive. Lack of zinc intake can affect iron metabolism because zinc acts as a cofactor in the retinol oxidation reaction. Low plasma retinol concentration is associated with decreased iron and hemoglobin. Not only that, zinc deficiency also affects IGF-1, growth factor, and GH binding protein RNA. These hormones will gradually decrease growth leading to weight gain. During growth, rapid tissue synthesis occurs which can result in low serum and plasma zinc. Zinc deficiency inhibits bone formation and bone mineralization. In addition, it can inhibit growth hormone metabolism, resulting in decreased IGF-1, (Prastia, 2022). Insufficient intake occurs due to insufficient zinc supply which can be caused by factors such as dislike of eating foods rich in zinc, impaired absorption, and increased zinc demand and secretion.

Vitamin B6

Vitamin B6 or pyridoxine is one of the water-soluble B-complex vitamins and has an important role in body functions. Vitamin B6 plays a role in several metabolic processes including carbohydrate, protein, and fat metabolism. The body requires this vitamin for the reaction of more than 100 enzymes, immune function, and brain development during pregnancy. In addition, vitamin B6 acts as a cofactor in essential enzymatic reactions of the body. The body uses vitamin B6 to convert nutrients into energy, for the formation of red blood cells, the formation of DNA and RNA, and to prevent excess amino acids that can increase the risk of cardiovascular disease, (Nasution, 2024).

Vitamin B6 also plays an important role in the synthesis of neurotransmitters, chemicals used by the nervous system to send signals between nerve cells including serotonin, dopamine, and norepinephrine which play a role in mood regulation, sleep, and stress response. Vitamin B6 acts as a catalyst in the synthesis of heme in the hemoglobin molecule. Adolescent girls who experience menstruation need to pay attention to iron intake, because blood loss during menstruation can increase the need for vitamin B6 because this nutrient plays a role in iron absorption, so it is important to ensure adequate intake to maintain blood health and prevent anemia, (Astuti & Kulsum, 2020). According to the Institute of Medicine (Rachmawati & Haristiani, 2021)the recommended daily intake (RDA) of vitamin B6 in adolescent girls is about 1.2-1.3 milligrams/day. This requirement depends on age, level of physical activity, and overall health.

Vitamin B6 deficiency leads to impaired production of neurotransmitters that contribute to mental health issues such as depression, anxiety, and sleep disorders. Vitamin B6 deficiency will also interfere with protein metabolism and hemoglobin formation. In this case, it is necessary to overcome the deficiency by consuming food sources rich in vitamin B6. Food sources rich in vitamin B6 are wheat/oats, chicken meat, nuts, eggs, seeds, fresh fruits, and green vegetables, (Mafaza et al., 2023).

Copper

Copper is one of the minerals needed by the body for metabolic processes at the cellular level. Copper plays a role in bone health, preventing infection, iron metabolism, immune function, cellular respiration, and defense against free radicals. Copper and iron metabolism are linked, so copper deficiency causes disturbances in the iron mobilization process, leading to anemia. Even though it is needed in small amounts, copper intake is very important for the health of the body. Copper plays a role in preventing anemia because it helps in iron absorption, releases iron stores from ferritiles in the liver, and stimulates hemoglobin synthesis, (Ransun et al., 2021).

Copper plays a role in the absorption of iron, another essential mineral required for the formation of hemoglobin. A lack of copper intake can impair the body's ability to absorb and use iron effectively, which can also contribute to the occurrence of anemia. Copper intake requirements for adolescent girls vary depending on age, physical activity level, and overall health condition. In general, the daily intake for adolescent girls is around 0.7 to 1.3 milligrams/day, according to the nutritional guidelines issued by health agencies.

Copper deficiency can affect the body's ability to form hemoglobin effectively, which in turn can lead to anemia. Without enough copper, the human body cannot produce an adequate amount of hemoglobin to transport oxygen throughout the body. Over time, this can lead to anemia symptoms such as fatigue, dizziness, and shortness of breath. Copper deficiency can occur simultaneously with iron deficiency. The combination of copper and iron deficiency can make the anemia condition more severe and difficult to overcome.

Relationship of Micronutrients with Anemia in Adolescent Girls

The study showed a significant relationship between micronutrient intake and the incidence of anemia. This occurs due to disturbances in the absorption and formation of iron, which is the main component in the formation of red blood cells (hemoglobin). Anemia is a condition of reduced hemoglobin levels. Adolescent girls are particularly at risk of anemia because they experience menstruation and are likely to lose iron. Food sources of iron consist of heme iron from animal foods and non- heme iron from plant foods. Micronutrients, especially iron, can have a significant impact on hemoglobin production in the body. the amount of iron that is still lacking in the diet occurs because most Indonesians still consume vegetables which are sources of non-heme iron. Hemoglobin is needed to carry oxygen throughout the body, if hemoglobin is insufficient there will be a decrease in the capacity of the blood to carry oxygen throughout the body.

Known inhibitors of iron absorption in foods are tannins, phytates, polyphenolic compounds and calcium. Cereals are one of the phytate compounds that can be found. This compound is a major inhibitor of iron absorption because there is phytic acid content that can bind iron so that the bioavailability of iron absorption decreases in the human body. tannin can form complex bonds chemically because tannin can bind iron, aluminum, and calcium. If iron is bound, the iron contained in food will be difficult to absorb. The body will experience anemia when iron deficiency can interfere with the process of red blood cell formation.

According to the Ministry of Health of the Republic of Indonesia No. HK. 03.03/0595/2016 regarding the provision of Blood Addition Tablets to adolescent girls in junior and senior high school educational institutions through UKS. Adolescents are required to consume Blood Addition Tablets because every month they experience menstruation. The provision of Blood Addition Tablets serves to replace iron lost during the menstrual period and increase iron intake from food intake.

5 CONCLUSIONS

In conclusion, the study showed that knowledge and iron consumption are very important in preventing and managing iron nutritional anemia in adolescent

girls. Insufficient iron consumption can increase the likelihood of anemia. Another cause of the onset of nutritional anemia in adolescent girls is the lack of knowledge and attitude towards anemia. And knowledge about iron nutritional anemia is very important to prevent and overcome anemia. Good knowledge about anemia can help adolescent girls choose foods with high nutrition and high iron. For now, most adolescent girls have sufficient knowledge about iron nutritional anemia, but still need to be improved. As a form of prevention and overcoming iron nutritional anemia in adolescent girls, it is necessary to improve the knowledge and attitudes of adolescent girls about anemia. As well as the consumption of iron tablets that can help prevent and overcome iron nutritional anemia in adolescent girls.

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Food Safety Analysis Based on Halal Food with The Use of Water as a Food Need in Indonesia

Abdillah Akmal Karami, Sarita Oktorina*

Environmental Engineering Department, Islamic State University of Sunan Ampel, Surabaya, Indonesia

**sarita@uinsa.ac.id*

Keywords: Drinking Water, Food Need, Food Safety, Water.

Abstract: Halal food security in Indonesia is a complex issue viewed from a religious perspective, especially in water processing. This article examines the public's understanding of the water treatment process, whether halal or non-halal. This research also examines the risks from the views of people with this understanding. The method used uses a literature study consisting of several pieces of literature that are reviewed and analyzed descriptively to understand the existing problems properly. The results of this research answered this understanding with an analysis of environmental, technical, social, financial, security, and institutional risks, as well as a comparison with regulations and hadith. The water treatment process carried out by water management institutions follows the rules and is considered to duplicate natural processes, namely the water cycle. This perspective is also supported by several regulations in Indonesia, which indicate that food safety, especially water, can be adequately implemented. This study shows that there is always involvement between officeholders, service providers, and the community in maintaining the safety of water sources.

1 INTRODUCTION

Food safety in the context of halal food in Indonesia is a complex issue involving religious beliefs. As the country with the largest Muslim population, Indonesia is experiencing increasing demand for halal products, which has strongly emphasized halal certification to ensure compliance with Islamic food laws (Anggarkasih and Resma, 2022). This focus on halal certification is essential to meet domestic demand and expand export opportunities, especially to Organization of Islamic Cooperation countries that mandate halal guarantees for imported goods (Anggarkasih and Resma, 2022). The importance of halal certification is increasingly highlighted by the close relationship between halal and haram food choices and the sense of comfort and security it provides to Muslim consumers in Indonesia (Mutmainah et al., 2022). Water is vital in ensuring food safety and security and is essential in food production. Reviewing water resource management policies, especially those related to irrigation for sustainable agriculture, is very important to support food security efforts in Indonesia (Pambudi, 2021). Additionally, ensuring the authenticity of food products, including consideration of halal compliance, is critical to upholding consumer trust and confidence, particularly in Muslim communities (Guntarti et al., 2020). Aspects such as food safety, halal certification, and compliance with quality standards such as the Indonesian National Standard (SNI) label significantly influence consumers' food purchasing decisions (Catur Nugroho et al., 2023).

Water treatment in Indonesia involves various aspects, such as reusing water and community habits regarding water treatment. Conventional water treatment plants (IPA) in Indonesia generally apply coagulation processes (Salsabila et al., 2023), flocculation (Barakwan et al., 2019), membrane bioreactors, reverse osmosis, and filtration (Yudhantoro et al., 2020) to treat surface water. Turbid and produces clean and safe water. In addition, community habits such as boiling drinking water often occur in urban areas such as Kampung Salo District in Kendari, Indonesia, driven by concerns about microbiological contaminants in drinking water (Prasetya et al., 2019). This means that

people's perceptions of river water quality and related risks significantly shape their behavior toward water management (Tarannum et al., 2018). Concerns regarding pollution originating from municipal and industrial waste disposal and water runoff from indirect sources such as agricultural land have raised significant concerns among the public (Ray, 2011).

Studies on halal products show that religiosity and adherence to halal principles have a significant effect on consumer attitudes and behavior (Sudarsono et al., 2024). Perceptions of halal certification and haram (forbidden) ingredients in products can influence consumer decisions, reflecting the importance of religious beliefs in product choices (Ahmad, 2022). Individuals prioritizing halal practices may also be more concerned about water sources (Loussaief et al., 2024). Suppose someone considers river water treatment inconsistent with halal principles due to contamination, pollution, or other factors. In that case, their attitude towards the use of that water may be influenced by religious considerations. The presence of impurities or substances considered haram in water processing can cause reluctance to use river water for various purposes (Hussain et al., 2024).

For this reason, it is essential to carry out literature research to analyze the subjectivity of people's views on water use for daily purposes. However, they still need to decide whether what they do is halal or non-halal. This aims to provide an understanding of a new perspective in facing the challenges of food security in Indonesia, especially in using water for daily life (Pusparani, 2021). Therefore, the convergence of halal food, water requirements in food production, and food safety in Indonesia underscores the balance between religious principles and regulations. By addressing these interconnected aspects, Indonesia can further strengthen its position as a global leader in the halal food industry while maintaining the security and integrity of its food supply chain, especially in water processing.

2 METHODS

The library research method, also known as literature study or literature review, is a systematic approach to reviewing and synthesizing existing knowledge, theories, and findings regarding a particular topic or research question. This method involves reviewing and analyzing various academic sources, including books, journal articles, conference papers, reports, theories, laws, postulates, principles, or ideas to understand the subject matter comprehensively. The nature of library research methods is characterized by its emphasis on critical evaluation and synthesis of existing literature to identify trends, gaps, and inconsistencies in the current body of knowledge. This research uses descriptive analysis, namely the regular breakdown of the data obtained, and then understanding and explanation are provided so the reader can understand it well (Wakimoto, 2013)

3 RESULTS

Drinking Water in Indonesia

Figure 1 shows that as many as 41% of households in Indonesia use bottled water to meet their drinking water needs. This figure is higher than other drinking water sources such as pumps, pipes, springs, wells, and surface water. Half of households in Indonesia still use natural sources without processing. This includes 33% of the original groundwater and 26% using the help of piped equipment. Figure 1 is also related to Figure 2. Indonesia has adequate drinking water sources based on household usage, namely 91.72% in 2023. This figure has continued to rise since 2021, which aligns with the data shown in Figure 1

Figure 1: Percentage Distribution of Households According to Drinking Water
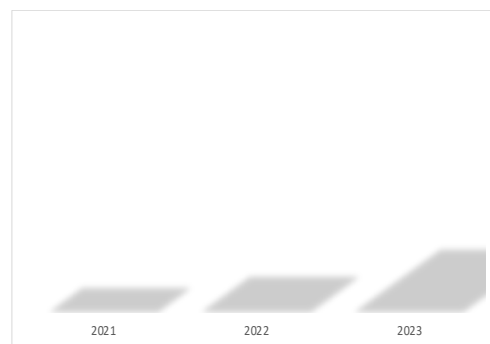

Figure 2: Percentage of Households that have an Improper Source of Drinking Water in 2021-2023.

Source: Indonesian Central Statistics Agency (BPS, 2024)

Literature Review

This research used database searches to analyze ten articles. Table 1 shows the results of the literature review.

Table 1: Literature Review Summary

No	Author	Summary
1	(Ikhsan et al., 2022)	Consumption of bottled drinking water in Indonesia increased by 1.24% every year from 2000 to 2020. By 2026, 50% of Indonesia's population is estimated to consume bottled water. Increased use of bottled water is linked to the country's economic growth, as shown by gross domestic product and urban population figures. Factors influencing household consumption of bottled water include the age of the head of household, education level of both parents, index wealth, type of residence, region, and type of toilet facilities. The young generation in urban areas is predicted to be Indonesia's primary bottled drinking water consumers. Previous studies have highlighted that bottled drinking water in Indonesia is often contaminated, emphasizing the importance of improving quality and safety to reduce negative impacts on health.
2	(Kurniawan et al., 2024)	Indonesia faces significant water quality challenges due to increasing pollution, population growth, and industrial activity, with only 35% of water economically viable for reuse and 67% of water needs met by 2021. The country's water supply deficit is estimated at 5,5 hm3/year, which shows a gap between water demand and supply that cannot be closed simply by increasing water supply. Only 10% of rainfall seeps into groundwater, and around 70% of Indonesia's rivers are polluted by domestic waste, indicating severe water quality problems.
3	(Ramadhan et al., 2024)	36.4% of Refill Drinking Water samples did not meet total coliform standards. 93.9% of Refill Drinking Water Depot operators know hygiene measures well. 69.7% of operators have good personal hygiene practices. There is a significant relationship between operator cleanliness and the quality of total coliform refill drinking water ($p=0.016$; $OR=8.4$). The study concluded that operator hygiene is essential in meeting the bacteriological quality standards of Refillable Drinking Water. This research recommends increasing awareness among Refill Drinking Water Depot operators to maintain cleanliness while working consistently.
4	(Katili et al., 2023)	The research found that biological parameters showed contamination by Escherichia coli and coliform bacteria with a specific average score. The quality of drinking water is relatively good in terms of temperature, turbidity, aroma, taste, colour, arsenic, fluoride, nitrite, nitrate, iron, pH, and manganese. Total Dissolved Solids (TDS) were found to be high at 1,525 mg/L, and chromium and cadmium levels were recorded to be above standard limits, which is a cause for concern. This study highlights the need for interventions to improve drinking water quality and control water pollution in Lekobalo Village, Gorontalo City, Indonesia.
5	(Daniel et al., 2023)	Although most households regularly treat their drinking water in rural Indonesia, only some are treated. Psychological factors such as risk, attitudes, norms, abilities, and self-regulation are high in society, indicating that these factors influence routine water treatment. The study revealed that action planning, a sub-factor of psychological factors, had the most significant relationship with the frequency of drinking treated water. Even though most drinking water is stored safely, the environment around where the water is stored is less hygienic. Overall, this research highlights the importance of always promoting treated drinking water and ensuring that it is stored in a safe and hygienic environment to maximize the health benefits of household water treatment in regions where this is commonplace.
6	(Irianti et al., 2023)	Drinking water that is managed safely is essential for maintaining public health. This study looked at drinking water quality monitoring and household water management practices in four provinces in Indonesia. Drinking water quality monitoring needs to fully comply with Minister of Health Decree No. 736/2010 due to issues such as sample size and comprehensive reporting. Household drinking water sources vary, most commonly piped water, followed by protected dug wells, boreholes, and rechargeable water. Only around 43% of household water sources are free of dangerous Escherichia coli bacteria. Most households meet chemical quality standards for water. About 36% of households manage drinking water safely, a higher percentage than the national average. This study highlights the need to improve drinking water monitoring by implementing water safety plans.
7	(Priadi et al., 2024)	This research identified that existing regulations must be implemented and enforced effectively, resulting in uncertainty in monitoring the quality of self-supplied drinking water. It has been observed that local government agencies responsible for water supply need help in coordinating and managing independent water supply systems efficiently. There is a need for better coordination between stakeholders, improved communication strategies, and empowerment of local communities

No	Author	Summary
		in effectively managing independent drinking water systems. Other findings indicate a clear need for capacity-building programs to improve individuals' technical skills and knowledge in self-sufficient drinking water management. This study emphasizes the importance of establishing clear guidelines, standard practices, and effective monitoring systems to mitigate the risks associated with self-sufficient drinking water services in urban areas in Indonesia.
8	(Sadidan et al., 2024)	Research revealed that many water samples exceeded class 1 standards for chemical parameters. The pH level is within acceptable limits. Factors such as Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and dissolved iron (Fe) were observed to be higher than class 1 standards at several sample points. The Citarum River in West Java, known as one of the most polluted rivers globally, is an essential agricultural and drinking water source. The study identified that the river faces pollution challenges due to industrial and population growth in the area. This pollution affects water quality with visible changes in color and odor, indicating direct discharge of chemical waste into rivers.
9	(Yudied Agung Mirasa et al., 2024)	This research analyzes the risk quotient of exposure to hazardous chemicals in drinking water in 25 cities in East Java Province. Parameters such as NO3, NO2, and Mg were found to have risk quotient values greater than 1, indicating unsafe levels for human consumption. The highest concentrations of specific parameters were identified in drinking water samples, such as NO3, NO2, Fe, Mg, and Zn. The risk quotient values for NO3, NO2, and Mg indicate that these substances pose health risks to individuals consuming the water. These findings indicate that immediate action is needed to address and control NO3, NO2, and Mg levels in drinking water to ensure public safety.
10	(Corsita et al., 2024)	This study highlights that community involvement is critical to the success and sustainability of projects, ensuring that the solutions implemented align with community needs. Overall, the research results show that the PAR method is effective in fostering cooperation between various parties and creating solutions that impact increasing the drinking water supply in the village. The positive results in Kameyakha Village suggest that PAR can be a valuable approach to address similar challenges in other indigenous communities, encouraging community-based development and sustainable solutions to water supply problems. The findings of this research support the idea that involving local communities in decision-making processes can produce more effective and long-term solutions to improve essential services such as the drinking water supply.

4   DISCUSSIONS

In many countries, including Indonesia, there are problems with people's concerns about processing water as a daily need (Katili et al., 2023). This problem makes it difficult to provide safe drinking water for the community. When good drinking water treatment is insufficient, and no one is monitoring it, it will create various risks in distributing clean water to homes (Foster et al., 2021). This is a big problem because many people rely on this way of getting water. All these risks must be discussed carefully by looking at the findings in other studies. This helps show where we need to focus our attention to make things better in the future.

Environmental Risks (Surface water and Groundwater Resources)

Groundwater and surface water are essential water sources that people in Indonesia widely use for drinking and other daily activities. There are risks to groundwater, such as water quality worsening because of too much water withdrawal or pollution (Irianti et al., 2022). In addition, around 70% of rivers in Indonesia are polluted by domestic and industrial waste, indicating severe water quality problems (Kurniawan et al., 2024). These risks can make the water unhealthy to drink. In some areas, people dig deeper wells and use more substantial pumps to get more water (Irianti et al., 2022) (Sadidan et al., 2024). This may seem beneficial, but it can worsen groundwater quality long-term and increase environmental risks. Other problems, such as saltwater intrusion, where salt water enters groundwater, and water shortages during the dry season, can affect the quality and availability of groundwater (UNESCO, 2022).

To better manage these risks, reasonable regulations and plans need to be in place to protect groundwater and surface water resources and ensure everyone has access to safe drinking water. By applying existing regulations and involving everyone who uses water sources, we can work together to reduce risks and protect these important water sources for the future (Priadi et al., 2024).

Technical Risk

Service providers such as PDAMs, well diggers, and pump technicians can be trained and certified to build better water treatment facilities that protect water sources. This helps ensure that the water remains clean and safe to use daily. Having regulations, certifications, and permits for these service providers is essential. This ensures they follow regulations and build water treatment facilities correctly, as in Tanzania (Sutton and Butterworth, 2021) and Tangerang, as shown in Figure 3 (Ramadhan et al., 2019). Apart from that, the government can also monitor water sources. They can

check records to ensure everything is done correctly, as in Queensland, Australia (Queensland Government, 2020).

Having good standards and regulations for building water treatment facilities is very important. This can help avoid problems such as the location of water sources too close to dirty water sources, making the water unsafe to use for daily needs. By implementing regulations and carrying out apparent supervision, we can improve the quality of drinking water supplied by ourselves and the public. This is important because it can increase the security and reliability of water supply for communities that depend on independent and public water supply systems (Priadi et al., 2024).
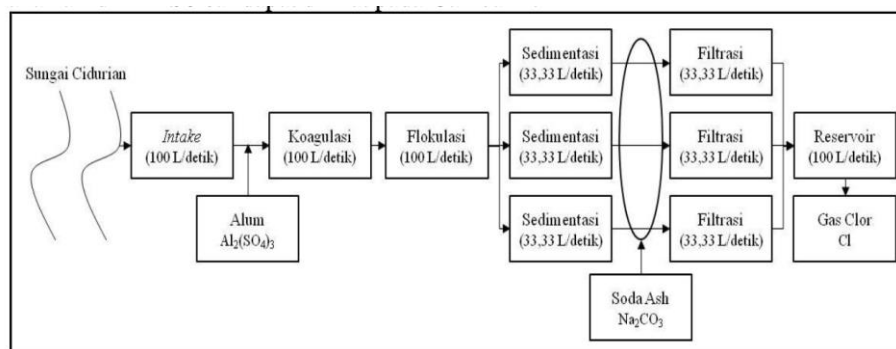
Figure 3: Water Treatment Process at The Solear IPA, Tangerang Regency
Source: Ramadhan et al, 2019

Social and Financial Risks

Many people who manage their water supplies face social risks, such as contamination, due to not knowing how to treat or store water safely (Irianti et al., 2022). This lack of knowledge can lead to health problems and possibly non-compliance with local regulations (Daniel et al., 2023). This makes many people prefer bottled drinking water and refillable drinking water to meet their needs, per Figure 1. Sometimes bottled and refillable drinking water is still contaminated with certain substances, making many people worried about their contents (Ikhsan et al., 2022)(Ramadhan et al., 2024).

Financial risks also arise for users who rely on self-supplied water. Some households need bottled or refillable water in addition to the water they purchase, which can be expensive and increase financial vulnerability. Households with low incomes are vulnerable to the economic impact of using self-supplied water because they are more dependent on additional water sources and face increased financial risks (Corsita et al., 2024).

To address these risks, government intervention is needed to reduce water access and affordability disparities. This can help reduce the financial burden on vulnerable groups and improve overall water security (Priadi et al., 2024). Education and behavior change initiatives are critical in mitigating social risks among independent households. By increasing awareness and promoting safe water treatment practices, we can improve the quality of our drinking water and reduce health risks (Corsita et al., 2024).

Health and Water Security Risks

Drinking water from unprotected wells or boreholes can produce more impurities than piped water. It can make people sick if they drink it. When the rainy season arrives, the risk of contracting disease due to contaminated water increases (Kurniawan et al., 2024). This happens because more bad ingredients may be mixed into the water during that time. Parameters such as NO3, NO2, and Mg were found in drinking water at levels above the threshold, indicating unsafe levels for human consumption (Mirasa et al., 2024). Communities with their water

sources may face health risks because their groundwater may need to be cleaner. This can happen if too many people use the water if wells are not built properly, or if people need to be careful (Irianti et al., 2022).

Monitoring water quality is essential to keep everyone safe. We need to check the water regularly and also ensure that the place where the water comes from is clean. This way, we can find out if there are risks and manage them so that the water remains safe to drink. By improving how we monitor water quality, inspecting wells, and ensuring everyone knows how to keep our water clean, we can reduce the risk of illness from drinking water. This will help ensure that everyone can access safe and healthy drinking water.

Institutional Risk

The government must decide who can use water sources when many people need them. This is important to avoid conflict and ensure everyone has enough clean water. Managing sanitation and water resources is essential in places where many people live close together (Fischer et al., 2020). Proper construction and monitoring of these facilities are necessary to keep the water safe. The government must identify areas at high risk of pollution and water scarcity (Priadi et al., 2024).

More people can access safe drinking water by prioritizing these areas for expanded piped water services. Government agencies play an important role in managing the use of water resources among various users (Ardhianie et al., 2022). These institutions must regulate water withdrawals, prioritize water for basic human needs, and ensure equitable distribution of water. By strengthening institutional functions related to water source management, the risk of contamination and depletion of water sources can be better addressed.

Implementation

The Indonesian State's efforts to treat water as a human need have been deemed fulfilled based on Figure 2. Nearly 91.72% of households in Indonesia have adequate drinking water. This also requires support from the community, government, and water management institutions (PDAM). People often still feel worried about the results of water treatment by PDAM. With a majority Muslim community, this problem is often linked to whether PDAM-processed products are categorized as halal or non-halal. Based

on MUI Fatwa No.02 of 2010 concerning Recycled Water, recycled water is water that is processed (technologically engineered) from water that has been used, has been unclean, or has changed one of its properties, namely taste, color, and smell so that it can be utilized. Then there are provisions for this, namely:

1. Drain the water affected by contaminants so that what remains is water that is safe from contaminants.
2. Adding holy water purifies the water affected by contaminants until it reaches a volume of at least two qullah; the contaminant elements and all the properties that cause the water to change are lost.
3. Change water that is contaminated or has changed its properties by using tools that can restore the water's original properties to make it pure and purifying, provided that the volume of water is two kullah and the tools used must be pure.

This provision is in line with the principles of water management institutions (PDAM), namely that the results of recycled water must comply with the Republic of Indonesia Government Regulation No. 21 of 2021 concerning the Implementation of Environmental Protection and Management in Appendix VI concerning National Water Quality Standards. This regulation states that the water content must be managed under applicable regulations. Apart from that, there are also regulations for halal guarantees, namely in the Decree of the Head of the Halal Product Guarantee Organizing Agency Number 20 of 2023 concerning Criteria for the Halal Product Guarantee System, Sanitation Standard Operating Procedure (SSOP) by BPOM, and Regulation of the Minister of Industry of the Republic of Indonesia No. 75/M-IND/PER/7/2010 Concerning Guidelines for Good Manufacturing Practices, it has guidelines on how to process raw materials for daily needs so that they are guaranteed halal and healthy.

Community concerns can also be explained by the water cycle in Figure 4. This image shows the journey of the water that we use every day. Interestingly, there are similarities in the process between Figure 3 and Figure 4, where each image depicts the process of recycling water. The only difference is how to process water sources. Figure 3 Processing water sources using technology. Then, Figure 4 processes water sources using natural compositions naturally and comprehensively. The recycling process used by PDAM is a form of implication of natural processes with the help of existing technology. Therefore, PDAM's processed products can be used for daily

needs without worrying about the process they go through. There may need to be thorough monitoring of the content of the recycled water until it reaches people's homes. As long as the water does not change, namely the taste, smell, and color, based on the

Hadith of the Prophet, "Water is holy, unless its smell, taste or color changes due to unclean objects that come into contact with it" (HR al-Baihaqi) then the water can be used properly.
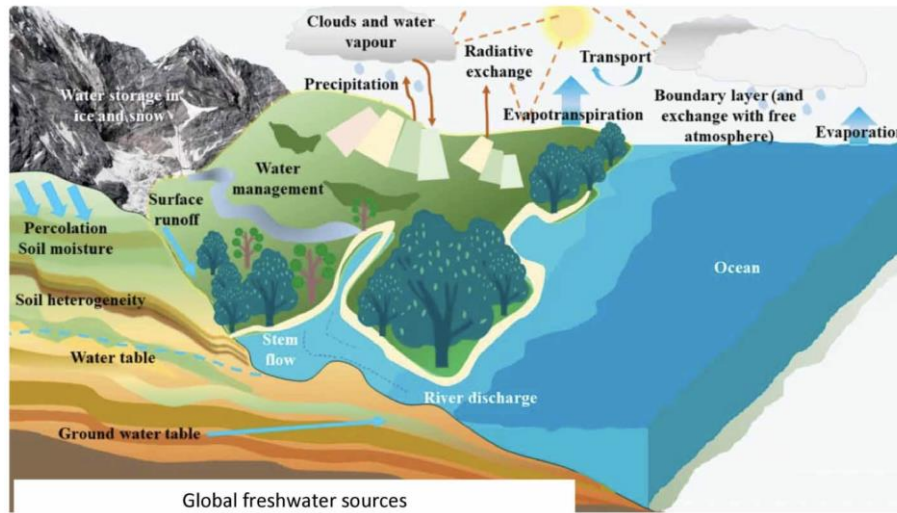
Figure 4. Water Cycle
Source: Ramadhan et al, 2024

Implications and Limitation of This Work: Future Research

This research is based on a single case study in Indonesia, so it cannot necessarily represent other regions with different conditions. It does not provide a detailed quantitative assessment of the impacts of climate change on water quality and sanitation metrics. Interactions between water quality and other sectors, such as energy or agriculture, have not been fully explored, which could impact the resilience of water systems.

The scientific evidence obtained can assist policymakers in reducing urban and rural water pollution in Indonesia through better water management practices. By understanding the consequences of changing societal conditions, this research can contribute to formulating national adaptation plans to address local impacts effectively. Collaboration among water professionals can produce innovative solutions to address future water risks and improve water technology globally.

Future research could involve multiple case studies to provide a more comprehensive understanding of the global impact of changing societal attitudes on water quality and sanitation. Incorporating quantitative

assessments and considering the linkages between water quality and other sectors will strengthen research results. Encouraging ongoing collaboration among stakeholders and professionals will encourage the development of effective and sustainable solutions to address water challenges in the face of significant changes in societal attitudes.

5   CONCLUSIONS

Food safety in Indonesia, especially in water processing, has been described in depth and comprehensively using literature studies from previous research. The provision of drinking water by water management institutions (PDAM) as a daily need for the community is a concern so that the quality of the processed water can be maintained in terms of halalness and safety. People often think that PDAM products are categorized as halal or non-halal. This perception was finally answered through this research by combining several environmental, technical, social, financial, security, and institutional risk aspects, which resulted in a new perspective that all water recycling processes from water sources have the same conditions as natural conditions, namely the water cycle. This underlines the need to always care

for and maintain water sources so no contaminants enter them. There is a need to transform Indonesia's water self-sufficiency system to manage the risks associated with water services effectively. This emphasizes that all parties involved in providing drinking water, both independent and commercial, have rights and responsibilities towards sustainability and risk reduction.

The provision of drinking water through water sources in Indonesia is currently adequately regulated, so there needs to be clear roles and responsibilities for the government, community, and service providers. These findings also show that although infrastructure design standards already exist, their implementation still needs improvement, potentially creating risks of non-standard construction and contamination. In addition, without proper governance and application of regulations, there are increased risks in terms of decreasing the quality and quantity of water sources, inadequate infrastructure, low awareness of water treatment and storage, additional costs for water sources, health and water safety problems, and fragmentation of water resources.

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Phenolic Content and Functional Groups of Green Tea Kombucha, Telang Flower Kombucha, Rosella Flower Kombucha, Chamomile Flower Kombucha and Lavender Flower Kombucha

Eva Agustina*, Raihana Frika Nafisah, Fadila Ayu Puspitasari, Nurfadilah Puspitasari, Yanuar Bakhrul Alam, Noviana Budianti Kartikasari, Yolanda Safira Virginia, Windi Indra Alfiyanti

Faculty of Science and Technology, Islamic State University of Sunan Ampel, Surabaya, Indonesia
*eva_agustina@uinsby.ac.id

Abstract: Kombucha is a fermentation product between green tea and microorganisms. The basic ingredients for kombucha can be obtained from plants that contain high antioxidants, such as green tea, butterfly pea flowers, rosella flowers, chamomile flowers and lavender flowers. The aim of this research was to determine the phenolic content and functional groups in green tea kombucha, telang flower kombucha, rosella flower kombucha, chamomile flower kombucha and lavender flower kombucha. This research uses experimental research by testing phenolic content using a UV-Vis Spectrophotometer instrument and functional group analysis using Fourier Transform Infrared (FTIR). The results showed that the phenolic content of green tea kombucha was 162.35 mg/L GAE, butterfly pea flower kombucha was 124.46 mg/L GAE, rosella flower kombucha was 101.30 mg/L GAE, chamomile flower kombucha was 35.41 mg/L GAE and lavender flower kombucha was 136.43 mg/L GAE. The highest phenolic content is found in green tea kombucha. The spectra resulting from the identification of telang flower kombucha tea samples contain alcohol functional groups, amines, nitro compounds, and the broad peaks indicate the stretching vibration of OH monometric alcohol. In green tea kombucha, alkenes, alkynes and monometric alcohol groups are found. In rosella flower kombucha, the functional groups alcohol, alkene, alkyne, nitrile and phenol are found. In chamomile flower kombucha, the functional groups ether, amine, alkene, alkyne, ester and alcohol are found. In lavender flower kombucha, the functional groups alcohol, alkene, alkyne and alkane are found. It can be concluded that kombucha contains secondary metabolite compounds including flavonoids, phenolics, saponins, tannins, steroids and triterpenoids.

1 INTRODUCTION

Green tea (*Camellia sinensis*) is a drink that is often consumed by the wider community. Green tea has many beneficial ingredients such as water, minerals, vitamins, polyphenols and antioxidants (Hassmy, 2017). Green tea has a high polyphenol content with the main compound being catechin which really supports its antioxidant activity to capture free radicals so that it can reduce cell damage (Evitasari and Susanti, 2021). Based on research by Nugraheni et al., (2022), green tea has a total content of phenolic compounds in both sample sizes (fine and coarse) showing optimum results at a temperature variation of 80 °C and a stirring time of 10 minutes

respectively, namely 44.487 ± 0.483 µg. AGE/g dry green tea leaves (fine samples) and 22.676 ± 0.483 µg AGE/g dry green tea leaves (coarse samples). One form of innovative green tea drink is kombucha.

Kombucha is a refreshing and beneficial drink for health, with a slightly sweet and sour taste produced through the fermentation process. The fermentation process for kombucha tea lasts 4-12 days (Falahuddin *et al.,* 2017). Fermentation occurs in a solution of tea and sugar using various types of bacterial cultures (such as *Acetobacter xylinum, A. xylinoides, Bacterium gluconicum*) and fungi (such as *Saccharomyces cerevisiae, S. ludwigii,*

Zygosaccharomyces bailii, Z. rouxii, Schizosaccharomyces pombe, Torulaspora delbrueckii, Brettanomyces bruxellensis , B. lambicus, B. custersii, Candida sp., or *Pichia membranaefaciens*) which is known as SCOBY (Symbiotic Culture of Bacteria and Yeast) (Kaewkod *et al.,* 2019; Priyono and Riswanto, 2021). Kombucha is made through a fermentation process involving a symbiosis of microorganisms from a group of acetic acid bacteria and yeast (Majidah *et al.,* 2022).

The acetic acid bacteria that is generally used is *Acetobacter xylinum*, while the yeast used is *Saccharomyces cerevisiae* (Majidah *et al.,* 2022). *Acetobacter xylinum* bacteria are known to have a liquid surface that can produce a cellulose layer. This layer is on the surface of the tea like a thin sheet which can form a mass of bacterial and yeast cells. This layer can be called "kombu mushroom" or SCOBY (Symbiotic Culture of Bacteria Yeast). SCOBYs will be arranged in layers following the breeding site and can grow successively (Ardheniati *et al.,* 2009). The metabolic activities of yeast and bacteria influence differences in substrate use. The invertase enzyme content in yeast can hydrolyze sucrose into glucose and fructose. The fructose substrate in the yeast glycolysis pathway can produce ethanol. Acetic acid bacteria such as *Acetobacter xylinum* can produce gluconic acid from glucose and acetic acid from ethanol (Karyantina dan Sumarmi, 2019).

Apart from green tea, the basic ingredients for making kombucha can also come from plants that are rich in antioxidants, such as rosella flowers, telang flowers, lavender flowers and chamomile. Rosella contains flavonoid anthocyanins as antioxidants, vitamin C, vitamin D and vitamin A which can help restore damaged or dead skin cells, as well as vitamins B1 and B2 to prevent dry skin, resulting in beautiful and healthy skin (Tungadi *et al.*, 2022). Based on research conducted by Formagio et al., (2015), it shows that rosella has a phenolic content in its petals of 382.04 ± 4.22. Butterfly pea flowers (*Clitoria ternatea* L.) are known to contain anthocyanins, flavonoids, flavonol glycosides such as routine, delfinidin, kaempferol, quercetin, malvidin, polyphenols contributing to antidiabetic qualities (Andriani dan Murtisiwi, 2020). Based on research conducted by (Siregar *et al.,* 2023), telang flowers have a phenol content of 515.48 mg/100g, this value is in the high category.

Lavender contains the main ingredients linalyl-acetate and linalool which can have a relaxing effect so that currently in Indonesia, lavender aroma is widely used as a mixture of herbal tea, kombucha tea, bath soap, beauty products and even aromatherapy oil. Lavender also has anti-inflammatory properties to reduce inflammation (Salsabila *et al.,* 2022). Based on research conducted by Dobros et al., (2022), it shows that lavender flowers have phenolic compound levels varying from 14.88 to 32.82 mg/L GAE. Chamomile contains a flavonoid compound, namely apigenin, which binds to benzodiazepine receptors in the brain so that it can treat anxiety disorders, depression and sleep quality disorders (Suciwati *et al.,* 2023). Based on research conducted by Putrid and Astuti, (2023), it shows that chamomile has a phenolic content of 67.4 mg/GAE dry extract.

Phenolic compounds are secondary metabolite compounds originating from plants. Phenolic compounds are aromatic compounds with a structure derived from benzene so they have an aromatic ring and the presence of one or more hydroxyl (OH) groups (Mahardani dan Yuanita, 2021). Phenolic compounds have many benefits for human health, such as antioxidants, antidiabetic, antifilarial, anticancer, cardioprotective and anti-inflammatory which are good for health. Functional groups are groups that determine the properties of organic compounds because they are able to show distinctive properties when the compound content of the sample is detected (Setiawan, 2022). The instruments used to determine the levels of phenolic compounds are a UV Vis and FTIR spectrophotometer. Based on this explanation, research was conducted to determine the phenolic content and functional groups in green tea kombucha, telang flower kombucha, rosella flower kombucha, chamomile flower kombucha and lavender flower kombucha.

2 METHODS

Tools and Materials

Tools

The tools used in this research are measuring cups, beakers, measuring flasks, Erlenmeyer flasks, glass jars, stirrers, dropper pipettes, volume pipettes, spoons, analytical scales, stoves, ovens, vortexes, aluminum foil, pH meters, spectrophotometer UV-VIS, Fourier Transform Infrared (FTIR).

Materials

The ingredients used in this research were green tea, telang flowers, rosella flowers, chamomile flowers,

lavender flowers, water, kombucha starter culture, distilled water, granulated sugar, methanol p.a, Na_2CO_3, gallic acid, Folin-ciocalteu.

Kombucha Starter Preparation

Boil 1000 ml of water until it boils and add 100 grams of sugar (10% w/v) from the amount of water used and add 5 grams of 0.5% (w/v) tea. Then filter and cover the filtrate with aluminum foil and let sit until the tea has room temperature. After that, add 100 ml of kombucha starter culture (10% w/v) to the brewed tea and then close the container tightly. Propagation of the kombucha starter culture was left for 14 days.

Kombucha Starter Preparation

Boil 1000 ml of water until it boils and add 100 grams of sugar (10% w/v) from the amount of water used and add 5 grams of 0.5% (w/v) tea. Then filter and cover the filtrate with aluminum foil and let sit until the tea has room temperature. After that, add 100 ml of kombucha starter culture (10% w/v) to the brewed tea and then close the container tightly. Propagation of the kombucha starter culture was left for 14 days.

Making Green Tea Kombucha

5 grams of green tea is brewed using 200 ml of boiling water. Then add sugar with a concentration of 50 grams and stir. Cover the brewed green tea tightly with a cloth and let it sit until room temperature. 20 ml of liquid kombucha starter is added and fermented for approximately 12 days in a closed container

Making Flower Kombucha

5 grams of telang flower, rosella, lavender and chamomile each are brewed using 200 ml of boiling water. Then add sugar with a concentration of 50 grams and stir. Cover the steeping flower tea with a cloth and let it sit until room temperature. 20 ml of liquid kombucha starter is added and fermented for approximately 12 days in a closed container.

Test pH Levels

pH measurements are measured using a pH meter. Green tea kombucha, telang flower kombucha, rosella flower kombucha, lavender flower kombucha and chamomile flower kombucha were put into a glass beaker and then dipped into a pH meter.

Phenolic Content Test

Standard Curve of Gallic Acid Standard Solution

The standard gallic acid solution was made in varying concentrations of 10, 20, 30, 40, 50 ppm. Take 1 ml of the standard solution of gallic acid of each concentration and put it into a test tube and add 0.5 ml of Folin-ciocalteu then let it sit for 8 minutes while shaking. To the solution was added 4 ml of 7% Na_2CO_3 solution and vortexed for 1 minute. Measurements were carried out at a wavelength of 760 nm.

Sample Absorption Measurement

Take 1 ml of kombucha from each sample and add 0.5 ml of Folin-ciocalteu, let stand for 8 minutes while shaking. 4 ml of 7% Na2CO3 solution was added and vortexed for 1 minute. Absorbance was calculated with a wavelength of 760 nm. Measurements were carried out at a wavelength of 760 nm. The total phenol content can be calculated using the following formula:

$$TPC = c \cdot v \cdot fp$$

Information:

TPC : total phenolic content (mg/L GAE)

c   : concentration (x value) (ppm)

v   : sample volume (ml)

fp   : dilution factor

FTIR Test

In the FTIR test the sample is analyzed by wetting the instrument in the sample holder with alcohol and cleaning with a tissue. Then, each kombucha sample was taken using a dropper pipette and dropped alternately one by one onto a sample buffer that had been cleaned with alcohol. After that, the wave spectrum results were compared with literature frequency data to determine the functional groups in the sample.

3   RESULTS and DISCUSSIONS

Kombucha is a fermented drink that originated in Manchuria in the Tsin Dynasty around 220 SM, used as a detox and energy drink. In 414 M, it was brought

to Japan to treat Emperor Inkyo's digestive problems. Along with the development of trade routes, kombucha spread to Russia (known as *Cainiigrib, Cainii kvass, Japonskigrib, Kambucha, Jsakvasska*), then to Germany (known as *Heldenpilz, Kombuchaschwamm*) until the 20th century (Jayabalan *et al.,* 2014; Priyono and Riswanto, 2021). From an organoleptic perspective, kombucha has a sour taste. The sour taste is caused by the increase in organic acid compounds, such as acetic acid and so on during the fermentation process. Acetic acid bacteria in the kombucha fermentation process will convert glucose into various types of acids, vitamins and alcohol which are beneficial for the body's health. These types of acids include organic acids such as acetic acid, citric acid, malic acid, glucuronic acid, lactic acid, caprylic acid, carbonic acid, folic acid, gluconic acid, chondroitin sulfate acid, hyaluronic acid, usnic acid, and there are also amino acids. (Nasution and Nasution, 2022). The pH value of kombucha for each sample can be seen in table 1.

Table 1: pH value

No	Sample	pH Value
1	Green Tea Kombucha	3.32
2	Telang Flower Kombucha	2.86
3	Rosella Flower Kombucha	2.62
4	Lavender Flower Kombucha	2.9
5	Chamomile Flower Kombucha	2.78

The longer the fermentation time, the greater the total acid (Wistiana and Zubaidah, 2015). The degree of acidity (pH) is one of the parameters resulting from processed fermented food or drinks. The low pH value in the two kombucha samples is caused by the metabolic process of yeast and bacteria towards sucrose which produces a number of organic acids such as acetic acid, gluconic acid and glucuronic acid (Wistiana and Zubaidah, 2015). The decrease in the pH of kombucha tea also occurs because during the fermentation process, yeast will synthesize sugar into ethanol and by bacteria the acetate is broken down into organic acids, such as acetic acid and gluconic acid and several concentrations of organic acids. This results in a decrease in the pH of the fermentation medium (Puspitasari et al., 2017).

The activity of lactic acid bacteria is to break down carbohydrates into lactic acid. The lactic acid that is formed will be secreted out of the cells and accumulate in the fermentation medium so that the longer the fermentation time, the total amount of accumulated acid will increase and reduce the pH. The pH value will decrease if there is enough acidification due to the activity of lactic acid bacteria

(Kinteki et al., 2019). Glucose in acetic acid bacteria is obtained from yeast through a sucrose inversion process. In the process of making ethanol by the yeast Saccharomyces cerevisiae and cellulose by the acetic acid bacteria Acetobacter xylinum, the acetic acid bacteria will convert glucose into gluconic acid via the pentose phosphate pathway. Most of the fructose is metabolized into acetic acid and a small amount of gluconic acid (Ardheniati et al., 2009).

In this process, glucose functions as a substrate for cell growth and the formation of a product in the form of acetic acid (Ardheniati et al., 2009). The glucose in the fermentation medium is converted into lactic acid with the help of enzymes produced by lactic acid bacteria. Production of lactic acid for heterofermentation is produced from glucose via the pentose-phosphate pathway. Apart from producing lactic acid, ethanol and carbon dioxide are also produced as by-products of fermentation (Ferdaus et al., 2008).

Table 2: Data for Determining the Standard Standard Curve for Gallic Acid

Consentration (ppm)	Absorbance
10	0.331
20	0.52
30	0.804
40	1.159
50	1.315

Solutions of varying concentrations (10 ppm, 20 ppm, 30 ppm, 40 ppm, 50 ppm) were searched for absorbance using a UV-Visible spectrophotometer instrument. The absorbance of each concentration can be seen in table 1. After obtaining the absorbance of each concentration, the next step is to create a standard standard curve for gallic acid which is used to find equations and linear regression. The standard standard curve for gallic acid can be seen in Figure 1.
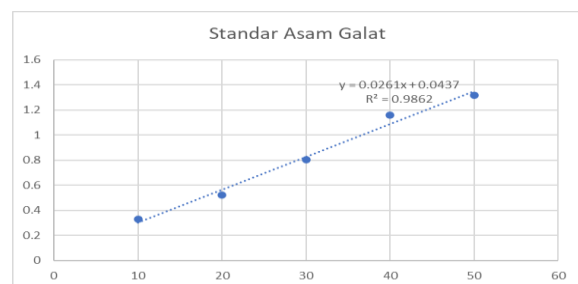
Figure 1: Gallic Acid Standard Calibration Curve

The standard standard curve for gallic acid has a regression equation y (absorbance) = 0.0261x (concentration) + 0.0437 with a coefficient of

determination R2 = 0.9862. The curve can be said to be linear because the coefficient of determination (R2) is 0.9862 or close to one. The phenolic concentration can be determined by substituting the absorbance of the sample into Y in the equation. The size of the X indicates the concentration of phenolics in the sample.

After knowing the phenolic concentration, then calculate the TPC. Determination of TPC is part of the analysis which is related to phenolic content and antioxidant activity. Samples that have a relatively high content of phenolic secondary metabolite compounds usually have high antioxidant activity (Handayani *et al.,* 2022). The total phenolic content in each kombucha sample was expressed as gallic acid equivalent (GAE). GAE is a general reference for measuring the number of phenolic compounds contained in a material. Based on the existing phenolic concentration, the TPC value of kombucha for each sample was obtained. The TPC value of each sample can be seen in table 3.

Table 3: TPC Value of Kombucha Green Tea, Telang, Rosella, Lavender and Chamomile

Sampel	Absorbansi	Konsentrasi Fenolik	TPC (mg/L GAE)
Green Tea Kombucha	4.281	162.348659	162.35
Telang Flower Kombucha	3.292	124.4559387	124.46
Rosella Kombucha	2.688	101.3141762	101.31
Lavender Kombucha	3.561	134.7624521	134.76
Chamomile Kombucha	0.968	35.4137931	35.41

The TPC value of green tea kombucha was 162.35 mg/L GAE, butterfly pea flower kombucha was 124.46 mg/L GAE, rosella flower kombucha was 101.31 mg/L GAE, lavender flower kombucha was 134.76 mg/L GAE, and chamomile flower kombucha was 35.41 mg/L L GAE. Based on the data obtained, it can be seen that the TPC value in green tea kombucha is higher than the TPC value in other samples.

Table 4: Compound Content of Green Tea, Telang, Rosella, Lavender and Chamomile

No	Aspect	Green Tea	Telang Flower	Rosella	Lavender	Chamomile
1	Flavonoid	Catechin (-) epicatechin (EC) (-) epigallocationchin (EGC) (-) epicatechin gallate (ECG) (-) epigallocationchin gallate (EGCG) (Fadhlurrohman dan Susanto, 2024)	Kaempferol glycosides, quercetin glycosides, mirisetin (Andiarni dan Murtisiwi, 2018).	Kaempferol, Quercetin, Myricetin (Ramahani *et al.,* 2024)	Luteolin, Apigenin, quercetin (Stanciu *et al.,* 2014)	Luteolin, Apigenin, quercetin, patuletin (Putri dan Astuti, 2023)
2	Anthocyanin	-	Delphinidin-3,5-glucoside (Putri dan Baharza, 2023) Cyanidin-3-O-Glucoside, Cn-3-(6"-p-coumaroylgluc-oside) (Saputri *et al.,* 2023).	Cyanidin Peonidin Delfinidine Malvidin Petunidin (Gamgulu, 2023)	-	-
3	Polyphenols	Epigalocatechin Gallate (EGCG), Epigalocatechin (EGC), Epicatechin Gallate (ECG), and Epicatechin (EC) (Fadhlurrohman dan Susanto, 2024)	Phenolic Acids and Flavonoids (Fadhlurrohman dan Susanto, 2024)	Citric Acid, Malic Acid, Ascorbic Acid (Nugroho *et al.,* 2018)	Linalool linalyl asetat (Sihite, 2022)	Apigenin, quersetin, patuletin, luteolin, coumarin, asam fenolat (Putri and Astuti, 2023)

| 4 | Phenolic | Catechins, Epicatechin, Epigalocatechin, and Epigalocatechin Gallate (Galati, 2006) | Phenolic acids (gallic acid, chlorogenic acid) (Marpaung, 2020) | Citric Acid, Hydroxycitric Acid, Hibiscus Acid, Protocatechuic Acid (Boras-Linares, 2014) | Asam rosmarinic, linalool, luteolin, kemferol, quersetin (Sihite, 2022) | Apigenin, quersetin, patuletin, luteolin, coumarin, asam kafeat (Putri dan Astuti, 2023) |
| 5 | Steroid | Beta-sitosterol (Helilusiatiningsih, 2021) | Kaempferol glycosides, quercetin glycosides, mirisetin (Andiarni dan Murtisiwi, 2018). | - | - | - |

Green tea contains more phenolic compounds or compounds with OH groups. This can be seen in table 4. Data on compound content in green tea samples is comparable to the TPC value obtained. The highest TPC value was the kombucha tea sample from green tea, namely 162.35.

The fermentation process is very important to change a molecule or compound and the effectiveness of the active compound. Biochemical transformation processes during fermentation not only adjust the balance between nutrients and antinutrients, but also influence product properties, such as increasing the levels of biologically active phenolic compounds and their antioxidant capacity. The fermentation process can also increase antioxidant properties by increasing free flavonoid levels. The fermentation process will promote cell wall damage, facilitating the release or even production of certain bioactive components. Through fermentation, microbial enzymes will also be released, so that active plant compounds can be released such as flavonoids, tannins and alkaloids (Rahmi *et al.,* 2016).

An increase in total phenolic content after the fermentation process can occur due to the enzymatic activity of microorganisms in the substrate, causing a higher release of phenolic compounds (Laela et al., 2023). The presence of microorganisms in the fermentation process is an important factor in increasing the phenolic content of kombucha tea. During the process, microorganisms play a role in damaging the cell wall structure so that plants (flowers) or green tea can release various bioactive compounds contained therein (Mahardani and Yuanita, 2021). Throughout the fermentation process,

these microorganisms can produce specific enzymes that promote the conversion of non-phenolic compounds into phenolic compounds (Ansory *et al.,* 2023).

Enzymes in the fermentation process play an important role in breaking down the structure of complex organic compounds into simple phenolic compounds, which are easier to obtain and measure. The metabolic activity of microorganisms results in the production of various secondary metabolites. Some of these secondary metabolites may exhibit phenolic characteristics or may be converted into phenolic compounds by these microorganisms. As a result, the overall phenolic content in kombucha will increase. The increase in phenolic compound levels during the fermentation process may be influenced by factors such as the type of microorganisms used, fermentation conditions, as well as the composition and chemical properties of the fermentation substrate (Ansory *et al.,* 2023).

Functional groups are groups that determine the properties of organic compounds because they are able to show distinctive properties when the compound content of the sample is detected (Setiawan, 2022). Fourier Transform Infrared (FTIR) analysis was carried out to identify the functional groups contained in green tea kombucha, telang, rosella, lavender and chamomile. The results of FTIR analysis provide information regarding the chemical structure and active components contained in each type of kombucha. FTIR data from various types of kombucha are presented in table 5 below:

Table 5. FTIR Data for Kombucha Green Tea, Telang, Rosella, Lavender and Chamomile

No	Sample	The Obtained Wavenumber Values (cm^{-1})	Type of Bond
1	Green Tea Kombucha	1136,84	C-O (Alcohol, ethers, carboxylic acids, esters)

No	Sample	The Obtained Wavenumber Values (cm⁻¹)	Type of Bond
2	Telang Flower Kombucha	1638,16	C-C aromatic or C=C (alkenes)
		3267,01	O-H (Hydrogen-bonded, alcohols, phenols)
		1261,7	C-N (amida, amina)
		1142,43	C-O
		3199,91	O-H
		1628,49	C-C aromatic or C=C (alkenes)
3	Rosella Flower Kombucha	3201,78	O-H
		1638,85	C-C aromatic or C=C (alkenes)
		1142,92	C-O
		1265,79	C-N (amida, amina)
4	Lavender Flower Kombucha	1628,84663	C-C aromatic or C=C (alkenes)
		2569,99944	O-H (Hydrogen-bonded, carboxylic acids)
		2689,27425	O-H (Hydrogen-bonded, carboxylic acids)
		2879,36848	C-H (Alkanes)
		3207,37421	O-H (Hydrogen-bonded, alcohols, phenols)
5	Chamomile Flower Kombucha	1140,56538	C-O (Alcohols, ethers, carboxylic acids, esters)
		1267,29486	C-O (Alcohols, ethers, carboxylic acids, esters)
		1628,84663	C-C aromatic or C=C (alkenes)
		3229,73824	O-H (Hydrogen-bonded, alcohols, phenols)

FTIR (Fourier Transform Infrared Spectroscopy) analysis is a spectroscopic technique used to identify functional groups in a compound based on the molecular vibrations produced when the compound absorbs infrared radiation (Dachriyanus, 2004). Each functional group has a characteristic vibrational frequency, so it can be used to identify the type of compound contained in the sample (Silverstein *et al.,* 2005). The wave number absorption results in the kombucha green tea sample were at wave numbers 3201.78 cm-1 with wide intensity, 1638.85 cm-1 with sharp intensity, 1142.92 cm-1 and 1265.79 cm-1 with medium intensity (Table 5). The wave absorption at 3201.78 cm-1 with a wide intensity indicates the presence of the O-H functional group, while the wave absorption at 1638.85 cm-1 with a sharp intensity indicates the presence of the aromatic C-C functional group. The results of FTIR analysis on kombucha tea, telang, rosella, chamomile, and lavender contain almost the same functional groups as green tea.

Green tea kombucha with telang, rosella, lavender and chamomille kombucha tea both contain OH groups. However, the transmittance band stretch in telang, rosella, lavender, and chamomille kombucha teas was wider than that of green tea kombucha (Figure 2). Basically, tea samples contain aromatic OH and C=C groups which are characteristic of flavonoid compounds (catechins) in green tea leaves (Sukaesih, 2021). According to Abriyani et al., (2023) the standard for flavonoids is OH (hydroxyl) wave absorption at 3372 cm-1. In general, catechins are found in young tea leaves, and the concentration of catechins in tea leaves will decrease as the age of the tea leaves increases (Nugraheni *et al.,* 2022).
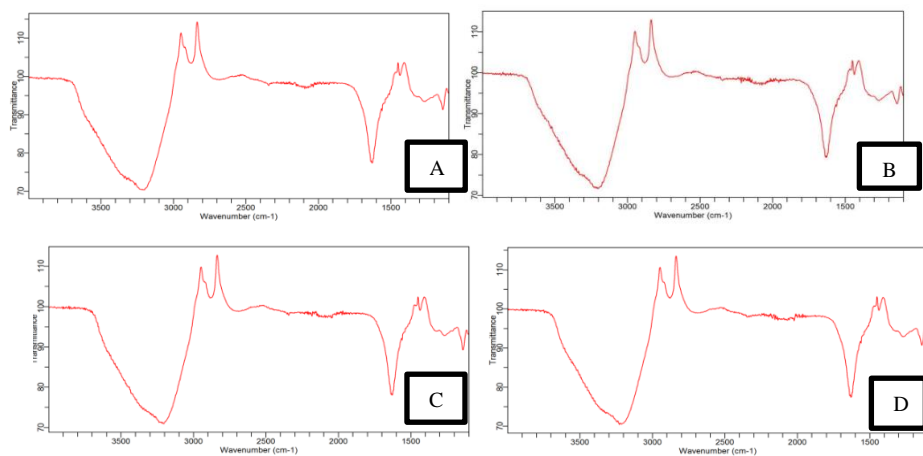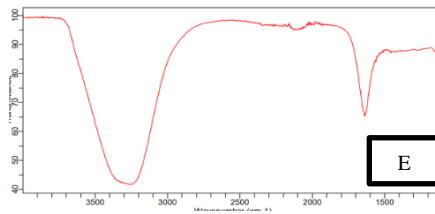
Figure 2: FTIR Spectra of Kombucha Tea Telang (A), Rosella (B), Lavender (C), Chamomille (D), and Green Tea (E)

The spectral stretch in the wave number range of 3000-3700 cm-1 is also influenced by the flavonoid and phenolic content in telang, rosella, lavender and chamomile flowers, as well as microbiological activity in the manufacturing process. The process of making kombucha tea uses a 7-21 day fermentation process with the help of microbes, one of which uses the yeast Saccharomyces cerevisiae (Priyono and Riswanto, 2021), which produces the alcohol content in kombucha tea from several sources (Table 3). Phenolic compounds are compounds in plants that have the most hydroxyl (OH) groups (Diniyah and Lee, 2020). According to Marpaung (2020), telang flowers contain relatively high levels of polyphenols, which can provide benefits for human health, including as antioxidants, antidiabetic, antiobesity, antihyperlipidemia, and cholesterol regulation. The content of phenolic compounds is widely known to destroy free radicals and in general the content of phenolic compounds is positively correlated with antioxidant activity (Febriana *et al.*, 2019). Polyphenol content is also found in lavender flowers (Dobros *et al.,* 2022) and chamomile leaves (Dai *et al*., 2022). Derivatives of polyphenols are phenolics, which are polyphenolic compounds that dissolve in water (Arifin *et al.,* 2018). The flavonoid content in roselle is 0.23 mg/g (Mahadevan *et al.,* 2009; Nurnasari and Khuluq, 2017). The basic content of tea which contains OH groups (catechins) plus the alcohol content of polyphenols from each sample makes the FTIR spectrum stretch wider in the wave number range of 3000-3700 cm-1.

Telang flowers contain phytochemical compounds including flavonoids, saponins, terpenoids and tannins (Cahyaningsih *et al.,* 2019). Rosella flowers have been confirmed to contain 0.23 mg/g flavonoids, 0.125 mg/g phenolics, 0.13 mg/g saponins, 0.12 mg/g alkaloids, and 0.17 mg/g tannins. Flavonoid content was also identified in lavender flowers (Mahadevan *et al.,* 2009). The alkaloid content in roselle can be seen at the absorption wave of 1142.92 cm-1. The C-N group detected at the absorption wave of 1142.92 cm-1 is possibly an alkaloid compound with a piperidine base structure as in research conducted by

Fachriyah et al. (2018). Kareru et al., (2008) stated that saponin has absorption of the infrared functional groups OH, CH, C=C, C=O, and C-O-C. It can be seen in Figure 2 that the OH group absorption of rosella kombucha tea is more stretched compared to green tea, this is also caused by the saponin content in rosella kombucha tea. Uptake of saponin oligosaccharides with saponin. Likewise, other samples contain the same phytochemical compounds so that the spectral absorption in each sample is almost the same. The wide peak that appears in the spectrum indicates the stretching vibration of the monometric OH group of alcohol. These groups are characteristic of secondary metabolite compounds in the flavonoid, phenolic and saponin groups (Harborne, 1987).

The results of FTIR analysis on the five kombucha tea samples showed that there were differences in the identified functional groups. In butterfly pea flower kombucha tea, functional groups of alcohol, amines and nitro compounds were detected. The wide peak that appears in the spectrum indicates the stretching vibration of the alcohol's monometric O-H group. These groups are characteristic of secondary metabolite compounds in the flavonoid, phenolic and saponin groups (Harborne, 1987). Green tea kombucha has alkene, alkyne and alcohol functional groups, which indicate the presence of flavonoid and phenolic compounds. These compounds are known to have high antioxidant activity and play a role in maintaining body health (Cabrera *et al.,* 2006). In rosella flower kombucha, the functional groups alcohol, alkene, alkyne, nitrile and phenol were identified. These groups are characteristic of flavonoid, phenolic, tannin and steroid compounds. These compounds have various bioactivities, such as antioxidant, antimicrobial and anti-inflammatory (Riaz and Chopra, 2018).

Chamomile flower kombucha contains ether, amine, alkene, alkyne, ester and alcohol functional groups, which indicate the presence of flavonoid, phenolic, saponin and triterpenoid compounds. These compounds are known to have calming, anti-

inflammatory and antimicrobial effects (Singh *et al.,* 2011). Meanwhile, in lavender flower kombucha, the functional groups alcohol, alkene, alkyne and alkane were detected. This indicates the presence of flavonoid, phenolic and steroid compounds in the sample. These compounds contribute to the relaxing, antioxidant and antimicrobial effects of lavender flowers (Cavanagh and Wilkinson, 2002).

4   CONCLUSIONS

Based on research that has been carried out, it can be seen that the TPC value of green tea kombucha is 162.35 mg/L GAE, telang kombucha is 124.46 mg/L GAE, rosella kombucha is 101.31 mg/L GAE, chamomile kombucha is 35, 41 mg/L GAE, lavender kombucha is 134.76 mg/L GAE, so it can be concluded that the highest phenolic content is found in green tea kombucha. Based on FTIR analysis, it can be concluded that each type of kombucha tea contains different secondary metabolite compounds. Telang flower kombucha tea contains flavonoids, phenolics, saponins and nitro compounds, while green tea contains flavonoids and phenolics. Rosella flower kombucha tea is rich in flavonoids, phenolics, tannins, steroids and alkaloids, meanwhile, chamomile flower kombucha tea contains flavonoids, phenolics, saponins, triterpenoids and lavender flower kombucha tea contains flavonoids, phenolics and steroids.

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Dietary Sodium-Potassium Intake and Risk of Hypertension

Nafiisa Febrina Putri Sunardi[1], Najha Ayis Zahirah[1], Najwa Laska Halqi[1], Nanda Dwi Aprilia[1], Natalia Putri Ayunda Soepratno[1], Tia Nurmala Putri[1] and Linda Prasetyaning Widayanti[2]*

[1]*Nutrition Study Program, Islamic State University of Sunan Ampel, Surabaya, Indonesia*
[2]*Psychology Study Program, Islamic State University of Sunan Ampel, Surabaya, Indonesia*
linda.pw@uinsa.ac.id

Abstract: Hypertension is a disease with a high mortality rate in Indonesia. Hypertension is an increase in systolic blood pressure >140 mmHg and diastolic blood pressure >90 mmHg. The prevalence of hypertension has increased significantly in patients aged 60 years and over. Many factors cause hypertension, one of which is a poor diet. The purpose of this study was to determine the effect of sodium and potassium intake on the incidence of hypertension in the elderly. The data or sources related to the relationship between potassium and potassium intake with hypertension in the elderly was used as a method in this research. The influence of sodium and potassium intake on the incidence of hypertension in the elderly is the result of research

1 INTRODUCTION

Hypertension is a disease that is often experienced by elderly people, both men and women. However, this does not rule out the possibility that teenagers or adults will not experience it. Hypertension is an early disease that can lead to chronic diseases such as heart disease, stroke and kidney disease. It is said to be hypertension if both distolic and systolic blood pressure exceeds the normal limit, namely 130/80 mmHg. The occurrence of hypertension in the body has many causal factors, most importantly an imbalance in the body's nutritional intake. Nutritional intake that can directly cause hypertension is sodium and potassium intake. Even though both are micronutrients, they are very important to pay attention to. Sodium intake itself is mostly found in ready-to-eat foods.

Every year the prevalence of hypertension according to WHO always increases, in 2011 it reached 1 billion people in the world. One of them is Indonesia. Apart from that, WHO also estimates that prevalence will continue to increase and predicts that as many as 29% of adults worldwide will experience hypertension by 2025. In 2020 there will be around 1.56 billion adults living with hypertension. Hypertension kills almost 8 billion people every year in the world and almost 1.5

million people every year in the East-South Asia region. About one third of adults in East-South Asia suffer from hypertension (WHO, 2018).

Excessive sodium consumption causes the body to retain fluid which can increase blood volume. Excessive sodium intake can reduce the diameter of the arteries, causing the heart to have to pump hard to push the blood volume through an increasingly narrow space, so that blood pressure rises resulting in hypertension. Hypertension needs to be prevented, prevention of hypertension can be done by always checking blood pressure regularly. If it cannot be prevented, then at least reduce it by reducing consumption of ready-to-eat food and reducing sodium and potassium consumption. Apart from the methods already mentioned, treating hypertension to avoid complications can be done through pharmacology or non-pharmacology

2 METHODS

This research is a review based on literature sourced from literature sources from the Google Scholar database. In the process of writing this literature, the keywords used are Hypertension, Sodium Intake, and

Potassium. The journals or articles used are limited, namely for approximately the last 5 years starting from 2019 to 2024. A total of 5,280 study articles and journals were found in the Google Scholar database. These studies were analyzed to obtain research results, namely a type of quantitative research conducted over approximately the last 5 years, with a minimum of 27 respondents and a maximum of 191 respondents consisting of elderly people with hypertension. According to existing criteria, the number of journal studies and articles obtained was 15 studies, the majority of which were scientific journals and articles. We present the article screening process in the PRISMA diagram as follow
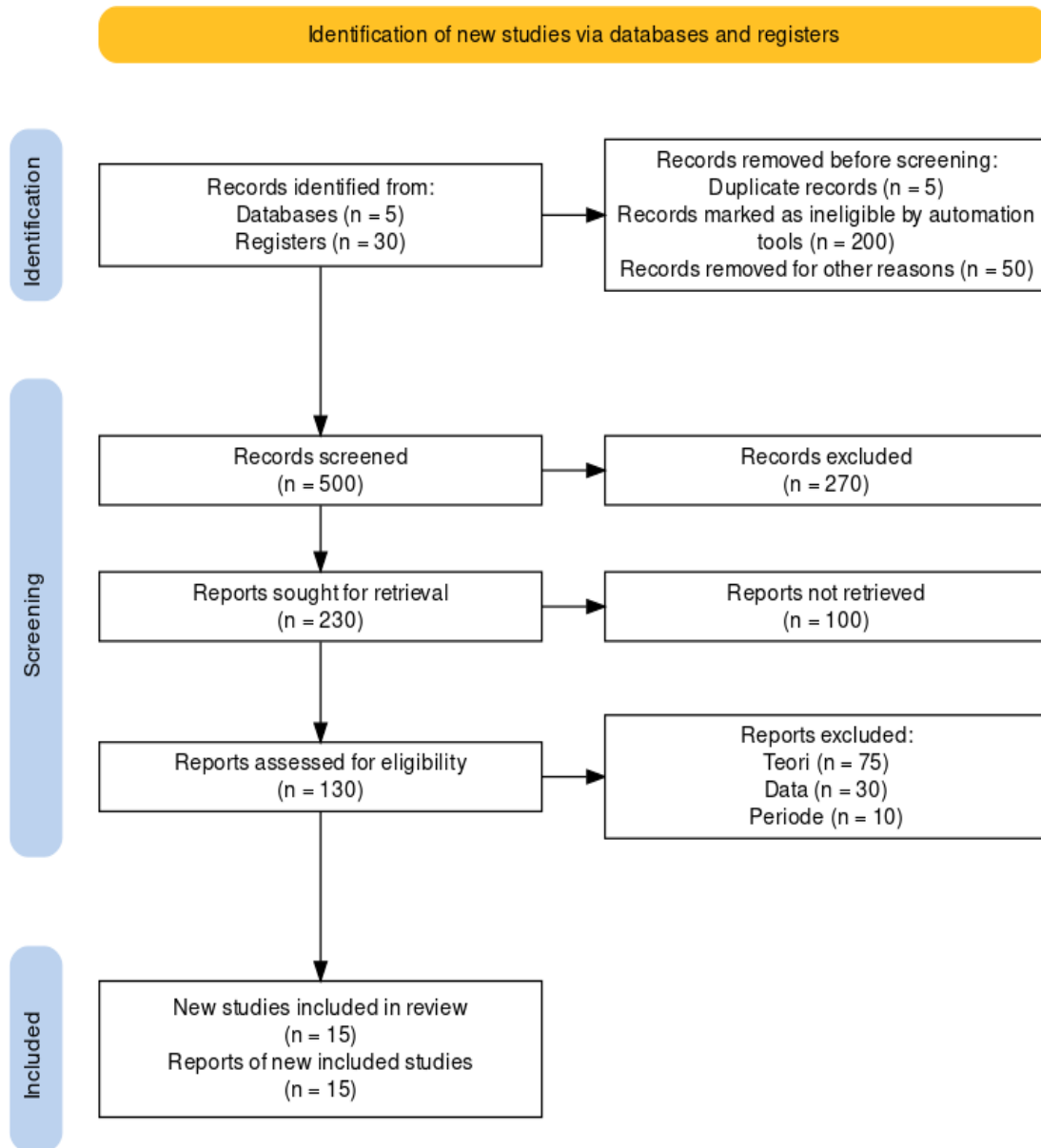
Figure 1: Prisma

3   RESULTS

A total of 15 articles that met the inclusion criteria and met the aims of the literature review were analyzed in more detail to obtain information regarding potassium and sodium intake in relation to the risk of hypertension in the elderly. The two articles analyzed focused more on nutritional status in relation to hypertension. Five articles focused more on diet on the risk of hypertension. Meanwhile, other articles specifically discuss sodium and potassium intake on the risk of hypertension.

Table 1. Literature Review Summary

No	Author: Year	Topic	Method	Results
1.	M. Zulfikar Al – Fariqi: 2021	The relationship between nutritional status and the incidence of hypertension in the elderly at the Narmada Community Health Center, West Lombok	Descriptive analytical research with an approach *cross sectional.*	Study This proves that the nutritional status of the elderly is related Which significant with Incidence of hypertension experienced by the elderly at the Narmada Lombok Community Health Center West.
2.	Atin Rohatin and Cahyani Wira Prayuda: 2020	Relationship between sodium and potassium intake and hypertension in the elderly in the internal medicine clinic	Analytical descriptive research approach *cross sectional.*	Study This proves that excessive sodium intake and insufficient potassium intake can cause hypertension in the elderly in internal medicine clinics Hospital Majalengka
3.	Harleni Harleni, Siska Ratu Miranda: 2019	Connection Nutritional status, Intake Nutrition And Family History With Genesis Hypertension in the Elderly at the Community Health Center Lubuk Buaya Padang	Analytical descriptive research approach *cross sectional.*	Study this proves that no. There is a relationship between nutritional status and potassium consumption patterns with the incidence of hypertension. There is a relationship between fat and sodium consumption patterns and incident hypertension.
4	Meters Hamidah Haris Alhamidi, Sona Utari, Desti Ambar Wati, Riska Nur Suci Ayu Alifiyanti Muharramah: 2021	Connection Adequacy Level Sodium and Potassium with Hypertension in the Elderly Implementation Unit Technical Area Service Tresna Werdha Elderly Social Lampung in 2021	Quantitative survey research analytics with design cross sectional	Study this proves that no be found relationship between adequate levels of sodium and potassium with incidence of hypertension in the elderly, Regional Technical Implementation Unit Tresna Elderly Social Services Werdha Lampung in 2021.
5	Yulia Fitri, Rusmikawati, Siti Zulfah, Nurbaiti: 2018	Sodium and Calcium Intake As a Factor Causing Hypertension in Age Carry on (Sodium And Potassium Intake As A Factor Causing Hypertension In The Elderly)	Analytical research with approaches Cross Sectional	Study it proves that higher sodium intake could have an impact To happen hypertension on elderly, while intake potassium no impact against hypertension in this age group in region community health center work Darul Imarah Regency Aceh Big.
6	Asrinawaty, Norfai: 2014	Relationship between nutritional status and the incidence of hypertension Elderly at Posyandu for the Elderly Cockatoos in Pelambuan Community Health Center Working Area	Observational research approach Cross Sectional	Study This proves that there is a meaningful relationship between nutritional status and incident hypertension, where elderly people with higher nutritional status are more at risk of experiencing mild, moderate or severe hypertension than those with normal and poor nutritional status in the work area Public health center Sealing.
7	Janu Purwono, Rita Sari,	Salt Consumption Patterns with Incident	Study Correlation analytics with	Study This prove that There is a relationship between salt consumption

No	Author: Year	Topic	Method	Results
	Wehad Ratnasari, April Budianto: 2020	Hypertension In the Elderly	approach Cross sectional	patterns and the incidence of hypertension in the elderly in the Puskesmas work area Gadingrejo.
8	Arifatul Hidayah, Ari Yuniastuti, Sri Ratna Rahayu: 2020	The Analysis of Saturated Fat, Sodium, Protein Intake and Body Mass Index on the Occurrence of Hypertension in the Elderly in Semarang Regency	The research used a case control approach	Study This proves that the intake of saturated fat, sodium, protein and Body Mass Index is Several factors influence the incidence of hypertension in the district Semarang.
9	Khikmats Sangadah: 2022	Relationship between Micronutrient Intake (Sodium, Potassium, Calcium, Magnesium) and Physical Activity with the Incident of Hypertension	Analytical observational research with case control design.	Study it proves that there is a relationship between sodium intake, intake potassium, and physical activity with events hypertension. There isn't any connection between calcium intake and magnesium intake With incidence of hypertension.
10	Irma Handayani, Aryanti Setyaningsih, Arwin Muhlis: 2024	Relationship between nutritional status and Knowledge level Balanced Nutrition Against Events Elderly Hypertension in Bulu District Sukoharjo Regency	Observational research with Cross Sectional research design	Study This proves that there is a relationship Between level of knowledge about balanced nutrition on the incidence of hypertension in the elderly in the District Hair Sukoharjo Regency.
11	Julwansa Saragih, Eva Anita Yunia: 2023	Connection Lifestyle With the incidence of hypertension in the elderly at the Pematang Siantar Army Hospital Year 2023	Quantitative research approach cross sectional.	Study This proves that there is a relationship between lifestyle and the incidence of hypertension in the elderly in army hospitals Year 2023.
12	Agus Nurika Nugroho, Antok Nurwidi Antara, Siti Uswatun Chasanah: 2016	Relationship between nutritional status and the incidence of hypertension For the Elderly in Girisekar Village, Panggang Health Center Working Area Ii Regency Gunungkidul	Analytical survey research approach cross sectional	Study This proves that there is a relationship between nutritional status and incidence of hypertension in the elderly in Girisekar Village
13	Asnia Zainuddin, Irma Yunawati: 2019	Sodium Intake And Fat Associated With Incident Hypertension In the Elderly in the Poasia Region Kendari City	Analytical research observational approach cross sectional.	Study it proves that sodium and fat intake of each individual is related to the incidence of hypertension in the elderly in the region Poasia Kendari City.
14	Atin Rohatin, Cahyani Wira Prayuda: 2020	Connection Sodium Intake, Potassium With Hypertension In Elderly At the Polyclinic Internal Diseases	The research uses an approach cross sectional	Study This proves that there is a relationship between sodium intake and hypertension in the elderly in the Internal Medicine clinic HOSPITAL Majalengka year 2017.
15	Chouk Norist Hasiando, M. Ikhsan Amar, Iin Fatmawati: 2018	Relationship Between Sodium Consumption Habits, Fat and Sleep Duration With Hypertension in the Elderly at the Cimanggis Health Center, Depok City 2018	The research uses an approach cross sectional	Study This proves that there is a relationship between habit sodium consumption, fat and duration sleep with hypertension in Cimanggis Community Health Center City Depok.

4   DISCUSSIONS

The Relationship of Potassium Intake on Hypertension

Hypertension sufferers generally have several influencing factors, starting from gender, sodium consumption, and age. There is research that there is no relationship between sodium intake and hypertension, because high blood pressure occurs not only due to high sodium intake at the moment, but also the buildup due to long-term sodium intake (Mitha et al, 2021). In other research, it was stated that sodium intake has a greater impact on the occurrence of hypertension in old age (Yulia et al, 2018), so that routine use of excessive amounts of sodium is one of the factors causing hypertension in old age. Apart from sodium intake, the nutritional status of the elderly has a significant relationship with the risk of hypertension (Zulfikar, 2021). Hypertension can occur as a result of the subject's long-term habit of consuming foods high in sodium and is supported by internal factors carried out as a form of lifestyle (Annisa Yuri, 2021). In other research, it is stated that the factors that influence an increase in blood pressure are factors that cannot be changed and can be changed. Sodium is included in the factors that can be changed in the influence of hypertension (Arifatul et al, 2020). Subjects who have a sodium intake of more than the 2013 RDA are more susceptible or even suffer from hypertension than subjects who have a sodium intake of less than the 2013 RDA who have a lower level of susceptibility to hypertension or even do not suffer from hypertension (Rahma et al, 2019).

The recommended sodium intake according to the 2013 AKG for men and women aged 30-49 years is 1500 mg. If intake exceeds the 2013 AKG recommendations, it can increase the risk of hypertension (Rahma et al, 2019). The majority of hypertension sufferers consume sodium in amounts greater than daily nutritional requirements, with 3557.40 mg with a minimum sodium intake of 1103 mg and a maximum of 8578 mg (Dyah and Rani, 2021). Excessive salt intake causes sodium retention in the kidneys, causing an increase in fluid volume which causes hypertension to occur (Martha et al, 2022). Food sources of sodium that are often consumed by hypertension sufferers are salted fish, pindang fish, soy sauce, sauces, biscuits, white bread and instant noodles (Rahma et al, 2019).

Besides The sodium for hypertension sufferers comes from table salt which is used daily as a spice in cooking, plus side dishes that exceed the minimum consumption limit (Wati et al, 2023). Looking at the conditions of previous research regarding the influence of sodium on the risk of hypertension in each person, it is not a definite factor, where when the subject consumes sodium, the subject does not directly develop hypertension (Chouk, 2018). Lifestyle is the main factor that triggers the highest hypertension, seeing that currently the consumption of fast food with uncontrolled sodium content, as well as the distribution of snacks and drinks containing sodium means that humans cannot regulate sodium intake according to the 2013 RDA limits (Atin, 2020). So, in the current conditions, it is most appropriate to control the intake of both food and drinks consumed daily, which should be regulated as best as possible, because the risk of hypertension increases if humans consume sodium in excess of the limit continuously.

Currently, the majority of people with hypertension are elderly (Atin, 2020), where their lifestyle when they were young did not control their food and drink intake. Looking at the current lifestyle where people do not look at the number of servings in food and drink packaging in circulation, so daily sodium intake can be excessive, resulting in hypertension. Therefore, there are several ways to prevent hypertension. Starting from reducing the use of table salt when cooking food. Table salt can also be replaced with Himalayan salt which has a lower sodium content than table salt. Apart from that, reducing consumption of fast food can also help reduce the risk of hypertension in old age. Apart from that, buying food and beverage products by looking at the number of measurements per serving in the packaging can prevent hypertension because it controls excessive sodium consumption in one day continuously (Mitha et al, 2021).

The Relationship of Potassium Intake on Hypertension

Potassium is a positively charged ion found in cells. Potassium is absorbed in the small intestine and excreted through urine as much as 80-90%, then the remainder is excreted through feces, sweat and gastric juices (Palmer and Clegg, 2016). Potassium plays an important role in maintaining fluid and electrolyte balance, acid-base balance in the body, muscle relaxation, and nerve transmission (Staruschenko,

2018). Potassium or potassium in the body functions by restoring the vasodilation effect, which reduces total peripheral pressure and reduces the heart's workload in pumping blood (Staruschenko, 2018). Low potassium intake can lead to increased blood pressure and renal vascular remodeling, which is an indication of vascular resistance in the kidneys. Efforts to reduce the incidence of hypertension include meeting the body's potassium intake needs (Ekmekcioglu et al., 2016).

Low potassium intake has adverse effects on health, especially in relation to hypertension. Potassium plays an important role in balancing sodium levels in the body. Potassium is the main ion in intracellular fluid. Consuming large amounts of potassium can lower blood pressure by increasing the concentration of potassium inside the cells, which attracts fluid from outside the cells. Potassium lowers blood pressure through a vasodilation mechanism, which reduces total peripheral resistance and increases cardiac output. In addition, potassium has a diuretic effect that helps lower blood pressure. Potassium can also influence the activity of the renin-angiotensin system (Ekmekcioglu et al., 2016).

Potassium's role in regulating peripheral and central nerves that influence blood pressure is also important. In addition, potassium helps maintain the elasticity of artery walls and optimizes their function, so that it can prevent narrowing of blood vessels (atherosclerosis) and reduce the risk of coronary heart disease and stroke (Adrogué and Madias, 2014).

Studies show that low potassium consumption is associated with an increased risk of hypertension. Research in various areas, such as in Pajang Village and the Ambal II Community Health Center working area, shows a negative relationship between potassium intake and blood pressure. Individuals with low potassium intake have a higher risk of developing hypertension than those with adequate potassium intake.

In research at the Ambal II Community Health Center, for example, respondents with insufficient potassium intake had a 2.68 times higher risk of developing hypertension (p=0.035, OR=2.68). However, based on the results of statistical tests in this study, it shows that there is no significant relationship between calcium intake and the incidence of hypertension in the Ambal II Community Health Center working area (p=0.163). This research is the same as Sinarti's research, et al (2017) obtained results that there was no significant relationship between potassium intake and the

incidence of hypertension (Mulyasari, Pontang and others, 2017), in line with research by Amelia Eka Putri (2020) that there was no significant relationship between potassium intake and hypertension (Putri, 2022). The majority of respondents, both in the low potassium intake category and the sufficient potassium intake category, suffered from hypertension. This could be caused by other factors, one of which is cultural factors that influence people's eating patterns.

However, scientifically, potassium deficiency can weaken heart muscle contractions, affecting blood pressure. When potassium intake is insufficient, parathyroid hormone stimulates the release of calcium from the bones into the blood to maintain balance. Blood calcium will bind to free fatty acids, causing blood vessels to harden and thicken, reducing the elasticity of the heart, which ultimately increases blood pressure (Liu et al., 2018). Overall, the literature underscores the importance of increasing potassium intake as part of a dietary strategy for the prevention and management of hypertension, contributing to better cardiovascular health in general.

5 CONCLUSIONS

Based on the research results, it can be concluded that many studies state that excessive salt intake can cause sodium retention in the kidneys, causing an increase in fluid volume which causes hypertension to occur. Food sources of sodium that are often consumed by hypertension sufferers are salted fish, pindang fish, soy sauce, sauces, biscuits, white bread and instant noodles. Lifestyle is the main factor that triggers the highest hypertension, seeing that currently the consumption of fast food with uncontrolled sodium content, as well as the distribution of snacks and drinks containing sodium means that humans cannot regulate sodium intake according to the 2013 RDA limits. And as for the relationship between potassium intake low levels can lead to increased blood pressure and renal vascular remodeling, which is an indication of vascular resistance in the kidneys. Efforts to reduce the incidence of hypertension include meeting the body's potassium intake needs. Low potassium intake has adverse effects on health, especially in relation to hypertension.

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Analysis Total Phenolic Content of Chamomile Flower (Matricaria chamomilla) and Green Tea (Camellia sinensis) Kombucha with Spectrophotometry UV-Vis Method

Noviana Budianti Kartikasari[1], Windi Indra Alfiyanti[1], R. M. Pradikalisatryo R[1], Alisa Afkarani[1], Nova Lusiana[2], Irul Hidayati[1], Eva Agustina[1]*

[1]*Faculty of Science and Technology, Sunan Ampel State Islamic University Surabaya, Indonesia*
[2]*Faculty of Psychology and Health, Sunan Ampel State Islamic University Surabaya, Indonesia*
eva_agustina@uinsby.ac.id

Keywords: Kombucha, Chamomile flower, Green tea, Phenolic.

Abstract: Kombucha is a probiotic drink made from fermented tea. The basic ingredients for making kombucha can come from organic ingredients, such as chamomile flowers & green tea. Chamomile flowers (Matricaria chamomilla) and green tea (Camellia sinensis) are one type of plant that has phenolic content and is beneficial for the health of the body. Phenolic compounds are compounds that are found in many plants and play a role in producing natural plant antioxidants. This study aims to determine the phenolic content contained in chamomile kombucha and green tea. The method used is a quantitative test with UV-Visible spectrophotometry to determine phenolic levels. The results showed that the total phenolic content of chamomile flower kombucha was 35.41 mg/L GAE and green tea kombucha was 162.35 mg/L GAE. It can be concluded that the phenolic content of green tea kombucha is higher than chamomile flower kombucha.

1 INTRODUCTION

Chamomile is one of the most well-known plants in the West and has been used medicinally since ancient times. Chamomile is often used in herbal teas due to its calming, carminative, and spasmolytic properties. Chamomile has daisy-like flowers with a yellow center and white petals. Chamomile's fresh and dried flower parts can be used to make infusions, liquid extracts, and essential oils. Chamomile has two main species from the *Asteraceae/Compositae* family that are often used in traditional herbal medicine. These species are *Matricaria chamomilla* (German chamomile) and *Chamaemelum nobile* (Roman chamomile) (Zadeh *et al*., 2022).

Camellia sinensis is a plant that originated in Southeast China and spread to India, Sri Lanka, and other tropical and subtropical countries. The plant grows with sufficient rainfall, good drainage, and acidic soil. *Camellia sinensis* is known as the basic ingredient for making tea. The main types of tea plants often used are *Camellia sinensis* var. sinensis

(Chinese tea), which is widely grown in China, Japan, and Taiwan, and *C. assamica* var. assamica (Sour tea), which is dominant in South and Southeast Asia, including Malaysia and Australia. *Camellia sinensis* is one of the plants that has phenolic and antioxidant content that is beneficial to the health of the body (Felicia et al., 2016).

Chamomile flowers and green tea are types of plants that can be used as basic ingredients for making kombucha. Kombucha is a microbial fermented beverage that utilizes bioprocess technology, with bacteria and yeast as starter cultures (Oktavia *et al*., 2021). Kombucha is produced from the fermentation process by *Acetobacter xylinum* bacteria and several other types of yeast that convert sugar into essential amino acids that are beneficial to the body. In addition, there are several other microbes that play a role in the kombucha fermentation process, including *Bacterium* sp, *Gluconobacter gluconicum*, *Acetobacter aceti*, *Acetobacter ketogenum*,

Saccharomyces cerevisiae, and *Phicia fermentan* (Jayabalan, 2007).

Microorganisms in the kombucha fermentation process will produce several acidic compounds, such as acetic acid, glucoronic acid, lactic acid, carbonic acid, folic acid, gluconic acid, chondroitin sulfate, hyaluronic acid and usnat acid through the process of converting tea and sugar. In addition, it also produces several kinds of vitamins, such as B1, B2, B3, B6, B12, B15, and C) and polyphenolics that play an important role in the antioxidant process (Naland, 2008; Setyaningrum *et al*., 2023). Kombucha has various properties, one of which is to increase endurance. In addition, kombucha is also able to prevent cell aging, and also prevent cancer which is usually found in the gastrointestinal tract and can be used as anti-aging because it is rich in antioxidant content (Oktavia *et al*., 2021).

The use of chamomile flowers and green tea as basic ingredients for making kombucha because they contain high phenolic compounds. Phenolic is a secondary metabolite that is spread in plants (Lerebulan *et al*., 2018). Phenolic compounds are known to have antioxidant activity (Onkar *et al*., 2012). The structure of this compound includes phenolic quinones, flavonoids, phenylpropanoids, simple monocyclic phenols, and polyphenols such as tannins, lignin, melanin, and phenolic quinones (Marjoni & Afrinaldi, 2015; Pamungkas *et al*., 2016). Phenolic compounds contain conjugated double bonds and chromophore groups.

Fadhilah *et al* (2022) said that chamomile contains phenolic compounds such as flavonoids and tannins that have strong antioxidant activity and function to fight free radicals and protect the body from various diseases. Putri & Astuti (2017) explains that chamomile flowers contain total phenolic content of 67.4 mg/GAE per gram of dry extract. One of the compounds contained in chamomile flowers is apigenin. Apigenin can act as an antioxidant, anti-inflammatory, and anxiolytic and supports the therapeutic effects of chamomile in improving sleep quality and reducing anxiety.

Leslie and Gunawan (2019) stated that phenolic compounds were found as the main secondary metabolites in *Camellia sinensis* with the results of phytochemical tests showing very high strength (+4). In addition, Hunandra (2017) revealed that green tea-based kombucha contains phenolic compounds with total phenol levels in green tea reaching 1003.8 ppm. Kombucha made through fermentation of green tea using kombu mushrooms and granulated sugar will produce phenolic compounds that have benefits as antioxidants.

The levels of chemical compounds that have conjugated double bonds and chromophore groups can be measured by UV-Visible spectrophotometric methods (Sari & Ayuchecaria, 2017). UV-Vis spectrophotometry is an analytical method that utilizes ultraviolet (UV) and visible light wavelengths to detect compounds. Compounds that can generally be identified by this method are compounds that have chromophore and auxochrome groups. Testing using a UV-Vis Spectrophotometer is fast and simple when compared to other methods (Sahumena *et al*., 2020).

This study aims to determine the phenolic content contained in chamomile kombucha and green tea. The method used is a quantitative test with UV-Visible spectrophotometry to determine phenolic level.

2 METHODS

Time and Location of Research

This research was conducted at the Instrumentation Laboratory Campus II Sunan Ampel State Islamic University Surabaya in May 2024.

Tools and Materials

The tools used in this research are measuring cup, beaker glass, measuring flask, erlenmeyer, glass jar, stirrer, drop pipette, volume pipette, spoon, analytical balance, stove, oven, vortex, aluminum foil, pH meter, UV-VIS spectrophotometer. The materials used in this study are chamomile flowers, green tea, water, tea, kombucha culture starter, distilled water, sugar, methanol p.a, Na2CO3, gallic acid, *Folin-ciocalteu*.

Kombucha Starter Preparation

1000 ml of water is brought to a boil and 100 grams of sugar (10% b/v) of the amount of water used and 5 grams of 0.5% (b/v) tea is added. Then filtered and the filtrate is covered with aluminum foil and let stand until the tea has room temperature. After that, 100 ml of kombucha culture starter (10% b/v) was added to the steeped tea and the container was tightly closed. The kombucha culture starter propagation was left for 14 days.

Kombucha Starter Preparation

Boil 1000 ml of water until it boils and add 100 grams of sugar (10% w/v) from the amount of water used and add 5 grams of 0.5% (w/v) tea. Then filter and cover the filtrate with aluminum foil and let sit until the tea has room temperature. After that, add 100 ml of kombucha starter culture (10% w/v) to the brewed tea and then close the container tightly. Propagation of the kombucha starter culture was left for 14 days.

Preparation of Green Tea Kombucha

5 grams of green tea is brewed using 200 ml of boiling water. Then added sugar with a concentration of 50 grams stirred. Green tea brew is covered tightly with a cloth and allowed to stand until room temperature. Liquid kombucha starter as much as 20 ml is added and fermented for approximately 12 days in a closed container.

Preparation of Chamomile Kombucha

5 grams of chamomile flowers are brewed using 200 ml of boiling water. Then added sugar with a concentration of 50 grams stirred. Chamomile tea was covered tightly with a cloth and allowed to stand until room temperature. Liquid kombucha starter of 20 ml was added and fermented for approximately 12 days in a closed container.

pH Level Test

The pH measurement was measured using a pH meter. Green tea kombucha and chamomile flower kombucha were put in a beaker glass and then dipped in a pH meter.

Phenolic Content Test

Standard Curve of Gallic Acid Standard Solution

Gallic acid standard solution was made concentration variations of 10, 20, 30, 40, 50 ppm. Gallic acid standard solution of each concentration was taken 1 ml put into a test tube and added 0.5 ml of *Folin-ciocalteu* then allowed to stand 8 minutes while shaking. Into the solution was added 4 ml of 7% Na2CO3 solution and homogenized using a vortex for 1 minute. Measurements were taken at a wavelength of 760 nm.

Sample Absorbency Measurement

Kombucha each sample was taken as much as 1 ml and added 0.5 ml of Folin-ciocalteu, allowed to stand for 8 minutes while shaking. 4 ml of 7% Na2CO3 solution was added and homogenized using a vortex for 1 minute. Absorbance was calculated with a wavelength of 760 nm. Measurements were made at a wavelength of 760 nm. Total phenol content can be calculated using the following formula:

$$TPC = c. \, v. \, Fp \qquad (1)$$

Information:

TPC : total phenolic content (mg/L GAE)

c : concentration (x value) (ppm)

v : sample volume (ml)

fp : dilution factor

3 RESULTS

Kombucha of chamomile flowers and green tea is a fermented beverage made from a decoction of chamomile flowers, green tea, and sugar with a sweet taste and distinctive sour aroma. Kombucha fermentation is carried out through symbiotic culture between acetic acid bacteria and yeast. Chamomile flower kombucha fermentation produces a cream color, while green tea kombucha produces a brownish red color. The results of chamomile flower kombucha fermentation are presented in Figure 1.

Figure 1: Apperarance of Chamomile Flower Kombucha & Green Tea Kombucha

The pH value is one of the parameters used to determine the quality of kombucha through the fermentation process. The pH measurement aims to identify the acidity level of kombucha and the level of decomposition of raw materials required during the fermentation process. The pH value of each sample can be seen in table 1.

Table 1: pH value Data

No	Sample	pH Value
1	Kombucha Green Tea	3.32
2	Kombucha Chamomile Flower	2.78

The phenolic compound levels of chamomile flower kombucha and green tea were analyzed a uv-vis spectrophotometric instrument. The first step in determining phenolic content is the preparation of a standard standard curve of gallic acid with absorbance values of each concentration. The absorbance value data for determining the standard curve of gallic acid can be seen in table 2.

Table 2: Absorbance Value Data of Gallic Acid Standard Curve Determination

Consentration (ppm)	Absorbance
10	0.331
20	0.52
30	0.804
40	1.159
50	1.315

Measurement of total phenolic content determination was carried out at a wavelength of 760 nm. The standard curve of gallic acid obtained for the measurement of total phenolic content is $y=0.0261x+0.0437$ with a correlation coefficient (R^2) of 0.9862. The measurement results of gallic acid standard solution can be seen in Figure 2.
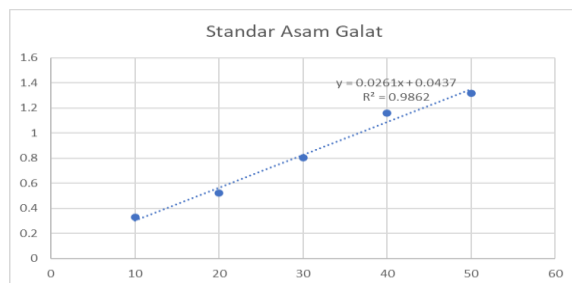
Figure 2: Gallic Acid Standard Calibration Curve

Phenolic concentration can be known by substituting the sample absorbance into Y in the equation. The amount of X shows the amount of phenolic concentration in the sample. The calculation stage of the TPC (Total Phenolic Content) value is carried out after the phenolic concentration is known. TPC determination is part of the analysis that has to do with phenolic content and antioxidant activity. Samples with high phenolic secondary metabolite compounds usually have high antioxidant activity (Handayani et al., 2022). The total phenolic content in each sample was expressed as Gallic Acid Equivalent (GAE). GAE is a general reference used in measuring phenolic compounds contained in a material (Wibisino et al., 2020).

Based on the concentration of phenolics present, the TPC value of green tea and chamomile kombucha was obtained. The TPC value of each sample can be seen in table 3.

Table 3: TPC Value of Kombucha Green Tea, Telang, Rosella, Lavender and Chamomile

Sampel	Absorbance	Phenolic Concentration	TPC (mg/L GAE)
Kombucha Green Tea	4.281	162.348659	162.35
Kombucha Chamomile	0.968	35.4137931	35.41

The TPC value of green tea kombucha is 162.35 mg/L GAE, while chamomile kombucha is 35.41 mg/L GAE. Based on the data obtained, it is known that the highest phenolic content is found in green tea kombucha. Green tea contains more phenolic compounds or compounds with OH groups. This can be seen in table 4. Data on compound content in green tea samples is comparable to the TPC value obtained. The highest TPC value was the kombucha tea sample from green tea, namely 162.35.

4 DISCUSSIONS

Kombucha is a fermented beverage made from a solution of tea and sucrose sugar (as nutrients) fermented by *Acetobacter xylinum* bacteria as well as several other types of yeast. This fermentation process converts the sugar into essential amino acids (Jayabalan, 2007). These essential amino acids have various benefits for the body, such as improving the immune system, kombucha can then prevent cell aging and cancer, especially in the digestive tract (Oktaviani *et al.*, 2021). This efficacy is due to the content of phenolic compounds that have antioxidant activity (Khaerah & Akbar, 2019).

Phenolic compounds are compounds that have antioxidant activity. Antioxidants are indispensable for the healing and treatment of degenerative diseases such as diabetes, liver damage, inflammation, cancer, cardiovascular, neurological disorders and the aging process. Antioxidants are very useful because they can inhibit free radicals (Sari & Ayuchecaria, 2017). Phenolic compounds have varied structures such as phenolic quinones, flavonoids, phenylpropanoids,

simple monocyclic phenols, polyphenols (including tannins, lignin, and melanin), and phenolic quinones (Pamungkas *et al*., 2016). Phenolic compound levels can also affect antioxidant activity. The higher the total phenolic content in a sample, the higher the antioxidant activity (Faidah *et al*., 2024).

Fermentation in kombucha tea drinks can increase phenolic compounds and antioxidants (Martinez Leal, et al. 2018). The fermentation process of kombucha tea is known to produce four isomers of epicatechin including epigalocatechin gallate, epicatechin gallate, epigalocatein, and epicatechin which have an effect on increasing phenolic compounds (Karsidin *et al*., 2022). These isomers will cause an increase in polyphenols during the fermentation process due to the biotransformation process by enzymes produced from the metabolism of microorganisms such as epigalocatechin gallate into epigalocatein, while epicatein gallate into epicatein (Suhardini & Zubaidah, 2016).

Quantitative analysis in this study was carried out by measuring the amount of total phenolics in kombucha using the *Folin-ciocalteu* method, which is a common technique for determining phenolic content in plants. *Folin-ciocalteu* reagent is used because phenolic compounds can react with Folin to form a solution whose absorbance can be measured (Chun *et al*., 2003). The reaction oxidizes phenolics and phenolic-hydroxy groups that will reduce the heteropoly acid in the *Folin-ciocalteu* reagent into a blue molybdenum-tungsten complex compound that can be measured absorbance on a spectrophotometer with a maximum wavelength of 765 nm (Alfian & Susanti, 2012).

Measurement of absorbance of phenolic content requires a standard solution, namely gallic acid as a comparison solution. Gallic acid is used as a comparator because the compound has a phenol group with good stability and is relatively affordable compared to other standard solutions (Syarif *et al*., 2016). In addition, gallic acid has high purity so that it can increase accuracy in the process of analyzing a compound (Waterhouse, 1999). Na_2CO_3 compound is needed in the process of making gallic acid standard solution. Na_2CO_3 or what is called sodium carbonate is an organic compound that is included in the salt group. The use of Na_2CO_3 is because sodium carbonate is composed of strong base compounds (NaOH) and weak acids (H_2CO_3). The basic salt in which if this salt is dissolved it will react and produce OH- ions. The weak acid H_2CO_3 will increase the yield of hydrophobic properties of alginate (Tambunan & Rudiyansyah, 2023).

Food ingredients commonly used for herbal products through the fermentation process have the aim of increasing the content of compounds present in the sample. The samples used in this study were chamomile flower kombucha (*Matricaria chamomilla*) and green tea (*Camellia sinensis*). According to research by Prasetyadi *et al* (2024) stated that the crown of chamomile flowers (*Matricaria chamomile* L.) contains several active compounds including essential oils, phenolics, flavonoids (*Matricaria chamomile* L.) such as apigenin, quercetin, patuletin, and luteolin), and glucosides. Phenolic compounds found in chamomile flowers are known to play a role in antibacterial and anti-inflammatory activities.

Alim & Hayuningtyas (2023) also mentioned that chamomile (*Matricaria chamomile* L.) contains various phytochemical compounds including flavonoids, alkaloids, saponins, terpenoids, tannins/phenols, steroids, and chamazulene. Meanwhile, green tea (*Camellia sinensis*) contains flavonoid compounds, phenolic acids, and carotenoids that have an effect on increasing antioxidant activity (Vu & Alvarez, 2021). Increased antioxidant activity can also be influenced by antioxidant activity in the basic ingredients processed into kombucha (Khaerah & Akbar 2019).

Chamomile flowers are known to contain several kinds of compounds, including organic acid compounds, flavonoids, coumarins, essential oils, and so on. Organic acid compounds found in chamomile flowers are isobutyric acid ($C_4H_8O_2$), tiglic acid ($C_5H_8O_2$), 4-hydroxybenzoic acid ($C_7H_6O_3$), galacturonic acid ($C_6H_{10}O_7$), chlorogenic acid ($C_{16}H_{18}O_9$), and so on. These organic acid compounds are known to have the potential to handle the treatment of immune system diseases, cancer, and cardiovascular diseases (Tvrzicka *et al*., 2011).

Flavonoid class compounds in chamomile flowers include apigenin ($C_{15}H_{10}O_5$), quercetin ($C_{15}H_{10}O_7$), luteolin ($C_{15}H_{10}O_6$), rutin ($C_{27}H_{30}O_{16}$), and so on. These compounds act as anti-inflammatory, antibacterial, antioxidant, anticancer, and so on (Dai *et al*., 2023). Coumarin ($C_9H_6O_2$), esculatin ($C_9H_6O_4$), skimmin ($C_{15}H_{16}O_8$), daphnin ($C_{15}H_{16}O_9$), 7-methoxycumarin ($C_{10}H_8O_3$) re coumarin class compounds found in chamomile flowers. According to Pratiwi *et al* (2021) coumarin class compounds act as anti-inflammatory, antioxidant, antiallergic, antiviral, antioxidant, antithrombotic, and anticancer.

Essential oils are oxygenated hydrocarbon compounds that contain a lot of oxygen. Essential oils

are mostly used as aromatherapy products because they have a distinctive aroma. In addition, essential oils also have potential as antibacterial, antifungal, antiviral, antioxidant, anti-parasitic, anticancer, and anti-inflammatory (Eiska, 2021). The compounds of the essential oil group contained in chamomile flowers include benzaldehyde (C_7H_6O), isobutyl phenylacetate ($C_{12}H_{16}O_2$), benzyl acetate ($C_9H_{10}O_2$), and so on (Dai *et al*., 2023).

Green tea (*Camellia sinensis*) contains several active compounds from the polyphenol group, organic acids, methylcanthine, minerals, and so on. Active compounds that mostly dominate come from the polyphenol group, namely catechins. According to research by Purwanto *et al* (2022) the catechin content in green tea brew is known to reach 30-42%. Catechins are polyphenol group compounds that have high antioxidant activity. The main catechin compounds found in green tea are EC (*Epicatechin*), ECG (*Epicatechin-3-gallate*), EGC (*Epigallocatechin*), and EGCG (*Epigallocatechin-3-gallate*) (Trivana et al., 2023). The chemical structure of catechin compounds can be seen in Figure 3.
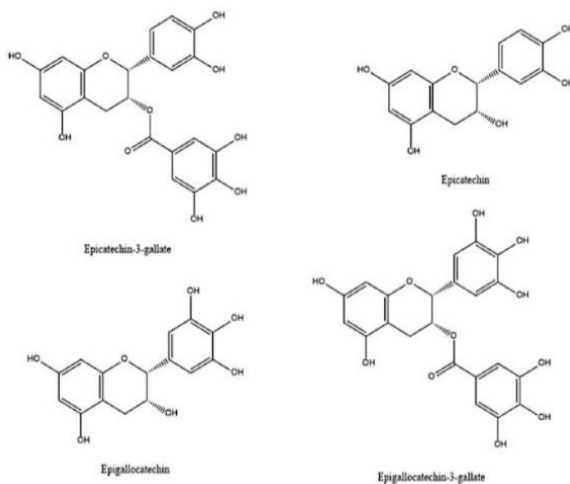
Figure 3. Chemical Structure of Catechin Compounds (Purwanto *et al*., 2022)

EC (*Epicatechin*) catechin compounds have potential as anti-cancer substances with good toxicity levels that are anti-hepatotoxic, anti-carcinogenic, anti-mutagenic, and have a safe LD50 (Sururi *et al*., 2023). Meanwhile, the catechin compound ECG (*Epicatechin-3-gallate*) acts as a mediator of inhibitory effects on cancer cells. In addition to regulating intracellular signals, ECG is also able to inhibit the enzymatic activity of RNase A and matrix metalloproteinase through metal chelators (copper and zinc) in cancer cells (Li *et al*., 2022). The catechin compound EGC (*Epigallocatechin*) functions to reduce oxidative stress that triggers neurodegenerative diseases, and has antioxidant, anticancer, and antiallergic effects (Leslie & Gunawan, 2019).

The catechin compound EGCG (*Epigallocatechin-3-gallate*) is a polyphenol found in green tea and has been shown to have anti-inflammatory, anti-apoptotic, anti-edema effects, as well as properties that stimulate regeneration or reduce the presence of inhibitory molecules in the environment (Errachid *et al*., 2021). EGCG is a catechin compound used as a quality indicator because it is the most active with a large amount (Ananingsih *et al*., 2013; Purwanto *et al*., 2022). According to Albuquerque *et al* (2016), these catechin compounds act as antioxidants, antiobesity, anti-inflammatory, anticancer, antitumor, and so on. In addition, there are also other compounds contained in green tea such as kaempferol, quercetin, gallic acid, glycosides, and mirisetin.

The pH value plays an important role in determining total phenolic content. Changes in pH value in the fermentation process can increase antioxidant activity by changing the content and structure of phenolic compounds (Martínez Leal *et al*., 2018). The pH value affects the kombucha fermentation process because several acidic compounds, such as acetate and gluconate are formed. Kombucha drinks that are suitable for consumption have a pH value ranging from 2.5-4.6 (Hapsari *et al*., 2021). Based on the pH value data, it is known that green tea kombucha has a pH of 3.32, while chamomile flower kombucha has a pH of 2.78. The acid value in Kombucha Green Tea brew increases and the pH of the Kombucha Green Tea solution decreases, this is because during the fermentation process the yeast and *Acetobacter xylinum* bacteria contained in the starter or kombucha fungus metabolize the sucrose or sugar contained in the green tea brew solution and produce a number of organic acids, the high sugar content in the tea solution causes an increase in microorganism activity and organic acids. The higher the organic acids contained in kombucha, the higher the total acid produced, thus lowering the pH of the tea solution. The decrease in pH value in fermentation will support the life of *Acetobacter xylinum* bacteria in kombucha culture to carry out its metabolic activities. The dissolved acid will dissociate to release free protons which reduce the pH of the solution in Kombucha Green Tea (Hassmy *et al*., 2017).

5 CONCLUSIONS

The results showed that the total phenolic content of green tea kombucha was 162.35 mg/L GAE, while chamomile kombucha was 35.41 mg/L GAE. The total phenolic content of green tea kombucha is higher than chamomile flowers. This is due to the presence of phenolic compounds found in green tea. Polyphenol class compounds in the form of catechins are one of the phenolic compounds in green tea with high antioxidant activity.

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Analysis of Gastritis Prevention with Halal Food Consumption

Zendy Indah Permatasari, Virina Dwi Sabilla, Athifah Hasna Azzahra, Muhammad Chabibur R,
Netta Kusumawardhani, Aulia Rizkinanda, Esti Novi Andyarini*

Faculty of Psychology and Health, Universitas Islam Negeri Sunan Ampel, Surabaya, Indonesia

* *estinoviandyarini@gmail.com*

Keywords: Gastritis, Digestive System, Halal Food.

Abstract: Gastritis is an inflammation of the stomach lining that can be acute, chronic, diffuse or localized. When the defense mechanisms of the gastric mucosa are overwhelmed with bacteria and other irritants, localized inflammation occurs in the gastric mucosa. Common symptoms of gastritis include abdominal discomfort, bloating, headache, nausea, and vomiting, as well as discomfort or burning in the upper abdomen, nausea, and vomiting. and become bloated. Chills and fever may interfere with daily life. Because of the high incidence of gastritis, it is necessary for everyone, especially in productive age, to change a bad diet, such as consuming spicy foods, acidic foods or drinks, irregular meal times, and excessive portions of food, into a good lifestyle with healthier food consumption and of course halal. Diet and eating habits are the main components that affect a person's health and nutrition, therefore, as a Muslim, consuming halal and thoyyib food is an obligation. One must pay careful attention to the halal and health aspects. This research was conducted with a strategy of searching for journals used in the literature review. Some journals mentioned that consuming a balanced diet can help prevent gastritis. The study also found that consuming a variety of fruits and vegetables, such as papaya, apples, bananas and strawberries can help reduce gastritis. In addition, plenty of fish, seafood, such as salmon, sardines, tuna and seafood products rich in vitamin D can help prevent gastritis. There is also aloe vera extract shows that it effectively reduces indigestion and does not aggravate it. Research conducted on the relationship between halal food consumption and gastritis showed a significant relationship between food choices and gastritis.

1   INTRODUCTION

Over time, epidemiology, which previously focused on infectious diseases, has shifted to broader health issues. This situation arises due to changes in disease patterns in society, lifestyle changes, social and economic improvements, and the widespread impact on society. In addition, non-communicable degenerative diseases are due to changes in human lifestyle and bacterial transmission. One of them is ulcer disease or gastritis. (Diliyana & Utami, 2020)

Gastritis is an inflammation of the stomach lining that can be acute, chronic, diffuse or localized. When the defense mechanisms of the gastric mucosa are overwhelmed with bacteria and other irritants, localized inflammation occurs in the gastric mucosa. Peptic ulcers are known as gastritis. Irregular diet and consumption of foods that increase stomach acid production are the main causes of gastritis.

Ulcers can also be caused by several microorganism infections. (Uwa & Milwati, 2019)

It is undeniable that the lifestyle of modern humans is far from healthy due to bad habits such as frequent consumption of junk food, eating at inappropriate times, and eating without maintaining environmental hygiene. The nutritional value of food consumed by humans. These habits pose a significant risk of developing ulcers. (Pratama et al., 2022)

Common symptoms of ulcer disease include abdominal discomfort, bloating, headache, nausea, and vomiting, as well as discomfort or burning in the upper abdomen, nausea, and vomiting. and become bloated. Chills and fever can interfere with daily life. Although most cases of ulcers do not cause permanent damage to the stomach lining, people with

ulcers often experience recurrent attacks that cause pain in the solar plexus (Sartika et al., 2020).

Basically, the causes of ulcers can be divided into two main parts, namely internal factors and external factors. Internal factors are conditions that cause excessive discharge of stomach acid, and various external substances that cause infection and inflammation of the stomach. Risk factors for ulcers include taking aspirin or non-steroidal anti-inflammatory drugs, drinking alcoholic or carbonated drinks, smoking, and poor dietary habits.(Firdausy et al., 2022)

According to WHO, it is 40.8%. And some regions in Indonesia are quite high with a prevalence of 274,396 cases out of 238,452,952 population. The prevalence of gastritis in East Java reached 31.2% with a total of 30,154 cases. (Muna & Kurniawati, 2023). In a study, it was found that 47% of respondents aged 19 to 29 years suffered from gastritis, which is in line with the idea that the disease affects young adults to the elderly. This can be seen from the frequency distribution of respondents by age. People of all ages belong to the productive age class, which indicates a greater chance of developing gastritis in productive age. Age, as students are in the productive age range, is one of the factors that cause gastritis in students (Astuti et al., 2022).

Due to the large number of incidents of gastritis, it is necessary for everyone, especially those of productive age, to change bad eating patterns, such as consuming spicy food, sour food or drinks, irregular meal times, and excessive portion sizes, into a good lifestyle by consuming Food is healthier and of course halal. (Tussakinah & Burhan, nd 2018)

Diet and eating habits are the main components that influence a person's health and nutrition, therefore, as a Muslim, consuming halal food and thoyyib is an obligation. (Widiyati, W. 2023). Based on the definition, halal food and toyyib means something that can be eaten whether from the sea or land that is good and clean. (Hasanah, AI, Fauziah, R., & Kurniawan, RR 2021). With so many food products available around us, someone should be more selective in choosing what they buy. One must pay careful attention to halal and health aspects. (Satria, AD 2021). Based on the existing background, we realize that the relevance of this research is very important in the context of human life. It is hoped that this research will provide a better understanding of the types of toyyibah halal food and their correlation with body health.

2 METHODS

This research was conducted with a strategy to search for journals used in the literature review, the search strategy used was PICO (P: Patient, population, problem, I: intervention, prognostic, exposure, C: comparison control, O: outcome) The journals used in the literature review were obtained through the journal provider database, Google Schooler. The researcher opened www.Google.Schooler.com. Researchers wrote keywords namely "prevention, diet, halal food, and gastritis" 4,620 results appeared, then selected based on the last 6 years 3,460 results appeared, then narrowed down according to sort by relevance found 276 results, then the results will be processed again as many as 30 journals relevant to the research.

3 RESULTS

Emphasizing The Problems That Researchers Take

In the research of Nasution, E. M., & Nasution, U. A. H. (2023) regarding Halal and Haram Food Consumption in the Perspective of Al-Qur'an and Hadith. Their research is in line with the research of Permana, R. F. F., & Bandiyah, S. U. (2021) regarding the Concept of Blessing in Halal Food Consumption, described in their research that in Q.S. An-Nahl: 115 and Q.S. Al-Baqarah: 173, Allah explicitly forbids carrion, blood, pork and animals slaughtered without mentioning the name of Allah. According to the Hadith, only two types of blood are allowed: heart and spleen. As for pigs they are forbidden, because pigs contain parasites that are harmful to the human body. In Syaiful's research (2023), it is explained that the consumption of halal food and drinks has an impact on health. In addition, it explains in more detail the command to eat halal and tayyib food which can be defined as good and pure food and drink that applies generally to all types of food, such as grains, fruits, and meat. The study of Rojabiah et al (2023) also emphasizes that Allah commands Muslims to eat halal and healthy food. Halal and healthy foods contain proteins, carbohydrates, fats, minerals, water, and vitamins, which help maintain mental balance, maintain the body's hormones, and maintain the digestive system.

The results of research by Khairina (2023), a Public Health student at Lambung Mangkurat University, show that there is a high level of compliance with

halal food habits. This compliance is positively correlated with physical health, in accordance with the principles of nutrition and holistic health. However, the results of the journal Adila, N. A., & Filsahani, N. K. (2023) identified that the benefits of consuming halal food and beverages are not only limited to physical health, but also include mental, spiritual, and social aspects. By understanding these benefits, consuming halal food and beverages is not only a religious obligation, but also a sustainable choice to support a healthier and more balanced lifestyle. Mulyati, S., Abubakar, A., & Hadade, H. (2023) emphasized that food considered halal by Muslims must meet two conditions: Halal, which means that it can be consumed without being prohibited by shara' law, and good or Thayyib, which means that the food is nutritious and good for health. In line with Widiyati, W. (2023) explains that the right food according to Islam is Halalan Tayyiban food, which means that halal and nutritious both cannot be separated because they affect the development of the body and protect against disease. Then it is also explained, that if eating too much can cause poor digestion and inadequate absorption of nutrients or eating too small portions, it can also slow down movement.

Firdausy et al (2022) showed that diet and stress have a relationship with the incidence of gastritis in students of the Faculty of Health Sciences, Ibn Khaldun University. Then elaborated that gastritis is a digestive disease associated with diet. The results of research by Laily et al., (2022) show that an unhealthy diet increases the likelihood of suffering from gastritis. In line with Aritonang's research (2021) shows that an irregular eating schedule is also a major factor that can affect gastritis recurrence. Researchers Gunawan et al., (2024) said whether there are factors that cause gastritis associated with diet. Simbolon, P., & Simbolon, N. (2022) describe recurrence can be prevented with medication, but reducing causative factors can reduce the likelihood of recurrence. This shows that the preventive measure for gastritis is to maintain a good and regular diet.

Meanwhile, research conducted by Rimbawati & Wulandari (2022) shows that there is a relationship between three other things, namely physical activity, stress, and diet, which can cause gastritis. This is because physical activity and stress prevent a person from eating, causing an empty stomach and increasing stomach acid. Susanti, M. M., & Fitriani, F. (2018). analyzing the Effect of Diet on the Incidence of Gastritis at Puskesmas Purwodadi I Grobogan Regency. It was found that gastritis disease is more easily diagnosed in individuals who have an irregular diet. When the stomach should be filled, but left empty or delayed, stomach acid will digest the gastric mucosal layer. This is because when the stomach is empty, the peristalsis of the stomach becomes stronger, which causes more stomach acid to be consumed, which in turn causes heartburn. With this problem, researchers Muriyatmoko et al (2022) then made a decision support system that would later help students in determining nutritionally balanced and healthy foods to consume for people with stomach acid/gastritis.

The results of research by Kusyati, E. & Fauzi'ah, N. (2018) show that aloe vera is effective as a companion therapy for gastritis pain. Herbalife concentrated aloe vera products have ingredients that can accelerate the decrease in gastric acid secretion. However, based on the research findings of Khotimah et al. (2019) showed that consuming papaya juice can also reduce pain caused by gastritis. This is because papaya contains the enzyme papain, which can accelerate the breakdown of proteins, which in turn accelerates the regeneration of damaged gastric cells. These researchers then also emphasized their results that the administration of papaya juice and aloe vera extract was different, with the papaya juice group mean of 12.88 and the aloe vera extract mean of 20.12, indicating that aloe vera extract was more effective. In addition, the results of research by Prihashinta, A. W., & Putriana, D. (2022). which looked at the relationship between vitamin D intake and meal frequency with complaints of gastritis symptoms in students of the Faculty of Law, Universitas Muhammadiyah Surakarta (UMS) showed that consumption of foods containing high vitamin D can reduce complaints of gastritis symptoms. Fish oil, liver, marine fish such as mackerel, salmon, sardines, and tuna are high sources of vitamin D. In addition, many foods that have been fortified with vitamin D can reduce gastritis symptoms. In addition, many foods have been fortified with vitamin D, especially dairy products and cereals. (Ajjah et al., 2020) in their research concluded that poor diet, such as meal irregularities, suboptimal meal frequency, and consumption of unhealthy foods or foods that are not halal can trigger excessive GERD or become a source of digestive disease.

Research Methods Used

Nasution, E. M., & Nasution, U. A. H. (2023) analyzed the concept and effects of consuming halal and haram food from an Islamic perspective. By using the literature research method and analysis of the

most important Islamic sources, such as the Al-Quran, and Hadith, as well as the opinions of leading researchers. The research of Permana, R. F., & Bandiyah, S. U. (2021) using qualitative research methods that emphasize aspects of in-depth understanding of a problem. Researchers use a literature approach by considering past research, and understanding the problem to be studied. Syaiful, M., Azkiyah, N. A., & Hakim, M. L. (2022) use qualitative methods or data analysis using several books and journals that contain discussions about the effect of halal food and drinks on the health of the human body and several verses in the Al-Quran and Hadith. The research of Rojabiah, N., Suryani, S., & Budiyanto, S. (2023) is a qualitative study that uses library research techniques and analyzes data using descriptive analysis by applying the content analysis method. Using two data sources, namely primary data on Al-Quran verses related to halal and tayyib and Tafsir Al-Mishbah, and secondary data using books or writings related to halal and tayyib food on health.

Khairina, D. (2023) combined a qualitative approach with the interview method as the main strategy to gain an understanding of halal food habits and their impact on the health of Muslim communities within the Public Health Study Program, Faculty of Medicine, Lambung Mangkurat University. It is based on the concept of nutrition as the main foundation and emphasizes the importance of balanced food intake in maintaining physical health. Encouraging interview questions to understand the extent to which halal food pickers can fulfill the body's nutritional needs optimally. In addition, it includes a holistic health approach, considering spiritual and mental aspects as integral elements of well-being. In line with Adila, N. A., & Filsahani, N. K. (2023) using library research techniques with secondary data sources derived from books and journals related to halal food on health. Mulyati, S., Abubakar, A., & Hadade, H. (2023) used an analytical descriptive method, which is a method that examines the ideas of human thought products contained in print media, both in the form of primary texts such as books on Islamic thought and secondary texts by conducting critical studies. Widiyati, W. (2023) used the literature review method by conducting a series of studies involving various kinds of information derived from literature such as books, encyclopedias, documents, and so on.

Firdausy et al's research (2021) uses cross-sectional, which is a research approach used to investigate how risk factors and effects are caused. This approach is done by collecting data or looking at things at once at a certain time or approach. Laily et al (2023) used

quantitative methods with a descriptive correlation design using a cross-sectional approach. Aritonang, M. (2021) used a descriptive research design to find out about the effect of stress and diet on the frequency of disease recurrence in patients with gastritis. Gunawan et al (2024) used quantitative research with descriptive research design. Describing or describing what is experienced by respondents and conducted research taken at one time which ultimately uses a cross-sectional approach.

Simbolon, P. & Simbolon, N. (2022) used descriptive analytic research with a cross-sectional approach. The research instrument was a knowledge questionnaire and gastritis prevention behavior. Analyzing data using the Chi-Square test. Rimbawati, Y., Wulandari, R., & Mustakim. (2022) used a quantitative research type analytic survey with Cross Sectional approach. Analyzing data using univariate analysis and bivariate analysis. Susanti, M. M. & Fitriani, F. (2018) The type of research used in this study is analytical survey research. The research design used in this study was case-control using a retrospective approach. The sampling technique used in this study was non-probability sampling with a saturated sampling technique. Samples who became respondents in this study were patients who experienced gastritis and did not experience gastritis who visited the Purwodadi I Health Center. Muriyatmoko et al (2022) This research model uses several methods, namely waterfall or what is often called the waterfall approach, which needs analysis, design, programming, testing, and maintenance or maintenance. The Waterfall model is one of the most commonly used SDLC models when developing information systems or software. The system approach used in software development is a systematic and sequential approach. At the needs analysis stage, researchers identify the problems that occur and then find a solution in the form of a decision support system. At the design stage, the design is made based on the analysis of the application requirements that have been designed. At the programming stage, coding is carried out from the system design that has been designed at the previous stage. At the testing stage, through 2 stages of testing, namely black box testing and user testing. At the maintenance stage, application improvements are made based on criticism and suggestions from the parties participating in the test.

Kusyati, E. & Fauzi'ah, N. (2018) used quantitative research with Quasy Experiment Design. This research design uses one group pretest posttest, using one group given aloe vera concentrate. Just like

Khotimah et al (2019) who used the Quasy Experiment with a non-equivalent approach with control group design. The sampling technique used is total sampling with the Simple Random Sampling method and data collection using observation. Prihashinta, A. W., & Putriana, D. (2022) used an observational analytic method with a cross-sectional research approach. The sampling technique used simple random sampling method. Data collection on vitamin D intake using the Semi Quantitative Food Frequency Questionnaire (SQ-FFQ). Data analysis using the Nutrisurvey program and expressed in grams per day. Food frequency data using food frequency questionnaire. The parameters used were scoring with the mean as a cut-off point and into 2 categories, namely poor (< mean) and good (≥ mean). Ajjah et al's research (2020) used an observational analytic descriptive method with a cross-sectional design. Subjects were taken using the prbability sampling technique with stratified random sampling method, selecting subjects randomly in each batch. Data was collected through filling out a questionnaire by the subject.

Table 1: Journal Review

No	Author	Language	Source	Objective	Method	Findings
1	Astrid Wahyu Prihashinta, Dittasari Putriana (2022) Vitamin D Intake, Frequency of Eating and Complaints of Gastritis Symptoms on Students	Indonesia	Google shcolar	Analysis of the relationship between vitamin D intake and meal frequency with complaints of stomach ulcers among students at the Faculty of Law, Muhammadiyah University, Surakarta.	Observational analytical research with cross sectional design. The sampling technique uses a simple random sampling method	More than half of the subjects had insufficient vitamin D intake (64%), and complained of gastritis symptoms routine (58%). As many as 40% of subjects had poor eating frequency. There is a relationship between vitamin D intake (p<0.001, r= -0.651) and eating frequency (p<0.001, r= -0.743) with complaints of gastritis symptoms in UMS FH student.
2	Yudha Fika Diliyana, Yeni Utami The Relationship of Diet with The Incident of Gastritis in Adolescents in The Working Area of Balowerti City Health Center Kediri	Indonesia	Google schoolar	The relationship between diet and the incidence of gastritis in the working area of the Balowerti Community Health Center, Kediri City.	Bivariate analysis is analysis what is done to find out if there is whether there is a relationship between the independent variables and bound by using the test statistics	Analysis of this research using Chisquare analysis shows the statistical test results obtained value of $\rho = 0.048 < = 0.05$, so statistics H0 is rejected H1 is accepted, that there is a relationship between diet and incidence of gastritis in working area Public health centern Balowerti City Kediri with value coefficient contingency of 0.231 which is interpreted as strength relationships between variables at levels low.
3	Mellina Siswati Siagian, (2021) Literature Review: Pattern Relationships Deep Dining Occurrence of Gastritis in Youth 2021	Indonesin	Google shcoolar	Relationship between Patterns Deep Dining Occurrence of Gastritis in Youth 2021	Study descriptive with design literature review	Of the 10 articles conducted literature review study, states that it still exists articles that don't happen gastritis. However (80%) are the majority of gastritis. There still is Adolescents do not maintain patterns Eat. So that being in the majority is a pattern not eating well gastritis as many as 7 articles (70%)
4	Ivan Saladin and Udin Rosidin, (2018) Pattern Relationships Eat	Indonesin	Google scholar	Pattern Relationships Eat with Gastritis on Teenagers at	Descriptive correlation with design study cross sectional	Research Results about type characteristics the respondent's gender is obtained data from the most respondents with

	with Gastritis on Teenagers at School Intermediate YBKP3 Vocational Garut			School Intermediate YBKP3 Vocational Garut		genderwomen as many as 101respondents (72.1%).
5	Siskawati Amri (2020) The Relationship Between Diet and Gastritis in Adolescents at Napsi'ah Stabat Health Vocational School, Langkat Regency	Indonesin	Google shcoolar	The Relationship between Diet and Gastritis in Adolescents at the Napsi'ah Stabat Health Vocational School, Langkat Regency	The method used in this research is analytical observational with a cross sectional study approach	Based on the results of the chi square test of the relationship between diet and gastritis in young women at Napsi'ah Stabat Health Vocational School in 2018 with a degree of significance $(\alpha) = 0.05$ and $df = 1$, the calculation results were obtained, namely Sig (2tailed) $0.001< (\alpha) = 0 .05$, then Ho is rejected and Ha is accepted.
6	Fita Kusnul Khotimah, Sutrisno, Fitriani (2019) Effectiveness Of Papaya Juice and Aloe Vera Extract on Decreasing Dyspepsia in Gastritis Patients at Purwodadi Health Center Grobogan District	Indonesia	Google schoolar	Effectiveness Of Papaya Juice and Aloe Vera Extract on Decreasing Dyspepsia in Gastritis Patients at Purwodadi Health Center 1 Grobogan District	This research uses a *Quasi Experimental* method with a non-equivalent control group design	Based on the results of the Wilcoxon test, it shows a p value <0.005 (0.000 and 0.000). The Mann Withney test has a sig value of 0.018 because aloe vera has a mean value of 20.12 ± 4.06 while papaya has a mean value of 12.88 ± 3.38. In research conducted by researchers, aloe vera extract was found to be more effective than papaya juice in reducing digestive disorders in ulcer patients.

4 DISCUSSIONS

According to research by Tusakinah et al (2018) in line with Susanti's research (2018) Gastritis usually starts with an unhealthy and irregular diet, a poor diet that can result in stomach acid digesting the stomach mucosa layer, but is left empty or delayed. This is because when the stomach is empty, the peristalsis of the stomach becomes stronger, which causes more stomach acid to be produced, which causes heartburn. If irritating substances enter the stomach, they will irritate the gastric mucosa. Acidic foods trigger acid reflux, which increases the level of stomach acid in the stomach. As stomach acid increases, the stomach becomes sensitive, and if this increase in stomach acid is left unchecked, damage to the stomach lining or ulcer disease will worsen. The term "eating habits" is used to describe habits and behaviors related to dietary management. Diet is the arrangement of the types and amounts of food consumed by a person or group of people at a given time, including the frequency of eating, types of food, and portions.

Digestive diseases can be caused by an irregular and unhealthy diet.

The balance of the body is destroyed by humans themselves, as happens with the digestive tract due to eating food carelessly or other habits such as smoking and working without rest. Most foreign substances (chemicals) enter the body through food.Eat food that is still hot and do not blow on it. Forced entry of hot food can cause damage to the oral mucosa and the underlying digestive tract. Food moves through the gastrointestinal tract from top to bottom. It starts in the mouth and ends in the esophagus, where food forms into spheres. After reaching the stomach, food mixes with digestive enzymes such as amylase, trypsin, lipase, and stomach acid, thus increasing its acid level (Khairani, M. D.2020). Gastritis disease if not treated without prevention of recurrence can cause stomach cancer and death (Jelita V. 2023).

Factors that can cause gastritis are poor diet, including irregular, less than the body's needs, not varied, and unhealthy. The habit of eating food that is too spicy, cold or hot and eating in a hurry (Mahaji 2020). Consumption of caffeine-containing beverages such as coffee and tea. Foods that have a

hard texture and are eaten hot. Consumption of spicy and sour foods (Rahman et al. 2022). Long-term use of pain relievers with excessive consumption of junk food (Simbolon, P., & Simbolon, N. 2022). Consumption of foods containing gas such as sweet potatoes, beans, cabbage, etc. Imbalance of gastric aggressive and defensive factors, which can be caused by diet, smoking, and consumption of NSAIDs. Lack of food hygiene and eating utensils contaminated with helicobacter pylori which causes gastritis (Sari & wulandari 2023). And in research (Aritonang, M.2021). Gastritis is caused by dietary irregularities, such as eating too much, too fast, too much seasoning, or foods that contain disease-causing bacteria. Gastritis can be caused by factors such as alcohol, aspirin, bile reflux, or radiation therapy. Starting with an irregular diet, gastritis usually causes inflammation of the stomach due to increased stomach acid. A diet consists of the schedule, type, and amount of food consumed.

In the Islamic view, eating right gives the body the strength to move and protects it from disease. However, eating too much can lead to poor digestion and inadequate absorption of nutrients, which can cause cells to become damaged and ruptured or eating too small a portion, which can slow down movement. According to Islam, people should not just eat food according to their taste without paying attention to the rules. Food outlined in the Qur'an is considered halal and good (tayyib) if consumed in proportionate amounts, not too much or too little, and has a positive effect on the body and is safe (Permana, R. & Bandiyah, S., 2021).

Diet and eating habits are the main components that affect a person's health and nutrition. Halalan Tayyiban, which means halal and nutritious, is found in the Quran (Akin E. 2021). According to Islam, halal and nutritious are inseparable as both affect human physical and mental development. If the food consumed by humans does not heed this call of Allah, then there will be an impending danger, both in this world and in the hereafter, namely hell. Eating a diverse diet is an important part of balanced nutrition guidelines. The body needs nutrients such as carbohydrates, proteins, fats, vitamins, and minerals to move, develop, and stay healthy (Widiyawati, 2023).

Linguistically, the word "food" can be interpreted with the words "tha'am", "aklun", and "ghidha'un", each of which means to fill something and or to put something into the stomach through the mouth. In Indonesian, the word "ghidza" also means nutrient uptake. In terms of terms, food can be defined as

anything that can be eaten, whether sea or land. Halal food is food that is permitted by Islamic law to be eaten, based on the Qur'an and Hadith of the Prophet (SAW). According to the commentators, the word "thayyib" comes from the Arabic word thaba, which means good, delicious, pleasant, tasty, and delicious, and means clean or pure. In addition, this word can also be interpreted as food that is not dirty in terms of substance or damaged (expired) or mixed with unclean objects. Eating halal and tayyib food is an obligation of every Muslim. The food and drinks consumed by Muslims are not free so that it requires Muslims to choose food selectively, namely halal food in accordance with the instructions of Allah SWT in the Qur'an and the explanation of the Prophet Muhammad SAW in the hadith. The food eaten must come from a clear source, halal and good and healthy. The Qur'anic perspective on the recommendation to choose food that is "halal" and "tayyib" is mentioned in the words of Allah SWT. Allah SWT created humans as the most perfect creatures equipped with knowledge and manners and regulates their lives in detail, including in terms of food and drink. As a creature of Allah, humans will not be separated from the need for food and drink to support the survival process (Hasanah et al. 2021). Without food and drink, living things will not be able to survive to live their daily lives, because the energy obtained through food is used to maintain the body's mechanism processes in growth and development and replace damaged body tissues, regulate metabolism, and other body fluids, and act as a defense mechanism against the attack of various diseases. Food also affects the health and immunity of the human body. The physical condition of individuals who consume food will always be healthy and avoid various diseases if the food is healthy, with complete and balanced nutrition. But on the contrary, food will cause various kinds of diseases, if what is consumed is excessive and unhealthy. Many studies have analyzed the impact of food on human health. Errors in food selection are the main risk factor that causes the emergence of degenerative diseases (Syaiful et al. 2022).

The Prophet said in a hadith: 'The source of disease is the stomach, the stomach is a storehouse of disease, and fasting is the cure (HR Muslim). ' Poor personal hygiene, sleeping too late, and lack of exercise cause a person to contract various diseases, so the Prophet said in a hadith. "Wash your hands three times. Because there are those among you who do not know where their hands spent the night (HR. Sunan Nasai) The increasing number of non-infectious diseases that appear in society is evidence of the lack of attention

to a healthy lifestyle. Avoid eating or blowing on hot food. Forcing hot food into the mouth can damage the mucous membranes of the mouth and the underlying digestive tract. The Prophet forbade cooling food as long-term consumption can lead to impaired taste, permanent damage to the oral mucosa, and problems with the oral mucosa. From a medical point of view, blowing on food can increase the acidity of the food. This can be explained by the relationship between the CO_2 content of respiratory exhaust gas and water vapor (H_2O), which in turn forms acidic H_2CO_3. Increased acidity in the blood, intake of acidic foods cause fatigue, drowsiness, and fatigue. Difficulty concentrating and confusion (khairani 2020)

According to Adila & Fisahani (2023), Food and drink consumed by humans basically come from nature, sourced from plants and animals. The Qur'an teaches that humans and animals on earth have access to food, but they must try before eating it. According to the Ulama, there are several criteria to determine whether a food or drink is considered halal. halal food standards can be divided into two aspects. One is halal in terms of material and the other is halal in terms of its acquisition. In general, all plants are considered halal for consumption by Muslims, unless they contain poisons that can adversely affect health and harm the human body. Hygiene in the processing and preparation of halal food can also reduce the risk of foodborne illness. Consuming safe and hygienic food can optimize public health. By avoiding ingredients that can cause food allergies and intolerances, eating halal food can help maintain digestive health and reduce the risk of chronic diseases. In addition, halal food and beverages are often more natural and contain fewer synthetic additives. This can provide additional health benefits, including Boosting the immune system and reducing the risk of developing degenerative diseases. Therefore, further research and dissemination of information on the health benefits of halal food and beverages is essential to increase public awareness of the close relationship between food and beverage intake and overall health.

Theoretical research on the benefits of consuming halal food and beverages for physical health can be based on Islamic teachings and scientific health research principles. Religiously, Muslims are taught in Islamic teachings to consume halal and clean foods and avoid haram foods.

This is explained in the Qur'an Surah Al-Baqarah verse 168 which reads, ``O people, eat what is halal and good from what is on earth.'' Furthermore, it is mentioned in the hadith that it is halal and nutritious

to eat from what is on earth. In terms of health, consuming halal food and drinks is believed to provide benefits for physical health. The benefits of consuming halal food and drink for physical health have been a topic of interesting debate. Halal Toybar or halal, healthy and nutritious food is certainly very helpful for us, both for physical and spiritual needs. Eating halal food and beverages provides several benefits to the human body. First, consuming halal food and drink helps avoid moral poisons and evil deeds that can damage faith and affect a person's dignity. Second, consuming halal food and drink helps keep the body away from the causes of diseases that can weaken the body and even make you one of the people loved by Allah SWT and His Messenger.

Healthy eating refers to consuming the right amount of food from all food groups in the correct order for one's body to function and function properly depending on lifestyle and activity levels. A balanced diet can be considered a healthy diet for the body. Balanced foods that meet human needs are called nutritious foods. These foods contain several nutrients such as carbohydrates, proteins, fats, vitamins and minerals that can ensure the health of the human body. Healthy food acts as a source of energy, and the substances contained in food can produce power or energy for human activities. Carbohydrates and fats are substances found in food that function as a source of energy for the body. Bodybuilders, substances that work on cell regeneration or replacement of damaged cells and support the growth process. Food substances that act as building blocks for the body, namely proteins and minerals, in the metabolic process of the body function as homeostatic agents in charge of regulating the functions of certain body parts: heart, bones, nerves, and hormones. The components of food that protect the body are protein, vitamins, minerals, and water. (Rojabiah et al., 2023)

Given the important role food plays in shaping human physical and mental development, religions urge everyone to eat good food. Healthy eating actually means a balanced and nutritious diet. Nutritious foods contain various nutrients such as carbohydrates, proteins, fats, vitamins, and minerals that the human body needs to stay healthy and function properly. The right combination of these different types of foods ensures that your body receives the nutrients it needs for optimal growth, cell repair, and organ function. It is important to remember that tasty, luxurious, and delicious foods are not necessarily an indicator of health. They can actually have a negative impact on health, especially if they contain potentially harmful

additives or are consumed in excess. Therefore, evaluating healthy food requires a comprehensive understanding of its nutritional content and its impact on the body's health. The concept of healthy food is becoming increasingly important in relation to the physical health benefits of consuming halal food and beverages. Halal food and beverages that are processed and processed in accordance with hygiene and halal principles can ensure that consumers obtain nutrients that are beneficial to their health. Therefore, an understanding of healthy food includes not only nutritional aspects, but also ethical and hygienic considerations in food selection and preparation (Nasution, E. M., & Nasution, U. A. H. 2023).

The research of Khotimah et al. (2019) showed the effect of giving papaya juice with aloe vera juice, with papaya 200 grm and aloe vera extract with 15 ml added with 120 ml of water which was carried out for 4 days. on the decrease in gastritis before and after because papaya contains papain enzymes that can accelerate the breakdown of proteins which will accelerate the regeneration of damaged stomach cells. Weak base minerals in the form of magnesium, potassium, and calcium are able to neutralize increased stomach acid and can reduce and repair stomach damage. Papain enzyme is a proteolytic enzyme that promotes the proteolytic process in the stomach, thus promoting the regeneration of damaged stomach cells. Papain enzyme contains 11.6% potassium benzylglucosinolate. Therefore, since papain acts on the digestive tract, it helps to treat the symptoms of indigestion and chronic ulcers. Weak alkaline minerals such as magnesium, potassium, and calcium are able to neutralize the increase in stomach acid, thus keeping the acidity of stomach acid in a normal state. These minerals are known to be used in various types of acid neutralizers (antacids). Antacids are generally slightly alkaline minerals. Ions from the mineral can combine with CL ions and react with HCL to form salts, which neutralize stomach acid. By neutralizing stomach acid, it helps reduce the pain caused by stomach ulcers.

And in line with the research of Kusyati & Fauzi'ah (2018) reinforced by the research of Retiu et. all. (2021). the administration of aloe vera extract shows that it effectively reduces indigestion and does not make it worse. The substances bradykinase, carboxypeptidase and salicylate are able to reduce abdominal discomfort or pain due to inflammation. Aloe vera extract contains lectins, which suppress gastric acid secretion. Lectins are proteins/glycoproteins that can recognize and bind to carbohydrate groups. Lectins directly inhibit gastric

acid production from gastric acid-producing parietal cells. Aloe vera also contains bradykinase, carboxypeptidase, and salicylate substances that can reduce symptoms due to inflammation, such as nausea, bloating, vomiting, and abdominal pain. Saponins and tannins found in aloe vera reduce inflammation and prevent it from getting worse. and saponins, flavonoids, tannins, and polyphenols 16 are antioxidants that play a role in preventing damage due to oxidative reactions and act as free radical binders in the destruction of metal ions. By preventing damage to the mucosa due to oxidative reactions, preventing further damage to the gastric mucosa, and accelerating healing.

But in the research of Prihashinta, A. W., & Putriana, D. (2022). Stating that lack of vitamin D intake can cause gastritis. Vitamin D intake has not met the needs of the Nutrition Adequacy Rate (AKG) recommended by the Indonesian Ministry of Health, which is 15 mcg/day. Lack of vitamin D intake occurs due to low consumption of foodstuffs rich in vitamin D such as fish oil, liver, marine fish such as mackerel, salmon, sardines, tuna, and can now also be found in dairy products and cereals. Vitamin D plays an important role in regulating the immune system by inhibiting adaptive immunity. Therefore, chronic vitamin D deficiency may increase the incidence of autoimmune diseases, including gastritis. Vitamin D regulates chemokine production, fights inflammation caused by autoimmune diseases such as gastritis, and induces differentiation of immune cells that play a role in self-tolerance. Other mechanisms include strengthening the innate immune system and inhibiting the adaptive immune system by modulating the interaction between lymphoid cells and antigen-presenting cells (APCs), increasing the number of helper 2 lymphocytes, cells that are resistant by inducing dendritic cell proliferation. In this way, vitamin D exerts anti-inflammatory and immunomodulatory effects.

By eating on time, eating balanced and sufficient food, eating healthy and nutritious fruits and vegetables, and choosing boiled food over fried food, reducing fast food, snacks, and carbonated drinks can prevent acid reflux (Amri, S. W. 2020). Vegetables and natural products are also rich in various vitamins, such as vitamin C and vitamin E. They have antioxidant and anti-inflammatory effects, which help protect the gastric mucosa from damage. Insufficient intake of vegetables and natural products can lead to vitamin deficiencies and weaken the work of mucosal obstruction, thereby increasing the risk of gastric infections. Marine fish and shellfish are known for

their high content of omega-3 fatty acids, while dairy These products provide sufficient amounts of calcium and vitamin D. Omega-3 fatty acids exhibit anti-inflammatory and antimicrobial effects, which help reduce gastric

mucosal inflammation and maintain digestive health. In addition, direct fat intake is essential for defense. gastric mucosa and protects the sharpness of the mucosal boundary. Fat plays an important role as a carrier of fat-soluble vitamins, supporting the absorption of these vitamins and maintaining the normal function of the mucosal barrier. Some other examples are bananas because they are easy to process and have soluble properties, which can help neutralize stomach acid. In addition, bananas are rich in pectin fibers that make a difference in intestinal development, and contain compounds that can coat the stomach barrier, in this way providing extra security from abrasions to the stomach. Bananas also contain potassium, which makes a difference to regulating fluid levels in the body and reducing the danger of dryness. Yogurt contains probiotics, specifically good microbes that help maintain the balance of microflora in the stomach and the interior of the body. Probiotics can reduce the development of the microbe H. pylori, which is one of the main causes of gastritis. In addition, yogurt can also help reduce the side effects of nausea and speed up the healing process of stomach wounds. Choose yogurt without sugar to get the most benefits. In addition, broccoli can be a green vegetable that is rich in fiber, vitamin C, vitamin K, and sulforaphane, a compound that has anti-bacterial and anti-cancer properties. Sulforaphane is particularly effective against the microbe H. pylori. The fiber in broccoli also makes a difference in smoothing assimilation and avoiding blockages that can aggravate gastritis indications. And cereals are a superb source of solvent fiber, especially beta-glucan, which can help moderate the assimilation and retention of supplements, thereby reducing the workload on the stomach. Wheat can also help reduce gastric corrosive levels and keep you feeling fuller for longer, avoiding the inappropriate use of foods that can decrease gastritis. Wheat also contains B vitamins and antioxidants that are excellent for general health. In anticipation of gastritis, eat small meals regularly to avoid over-stomaching. Maintain a strategic distance from hot, spicy, sour and ready-to-eat foods that can injure the stomach. Limit the use of caffeine and keep a strategic distance from alcoholic beverages. Do not smoke, as smoking can reduce stomach irritation. Manage stress well through relaxation procedures such as reflexology or yoga. And drink enough water

daily to maintain body hydration. (Li, P., Zhu, W., Ding, J., & Lei, F. 2024).

This compliance has a positive correlation with physical health conditions, in accordance with the principles of nutrition and holistic health approaches. This suggests that halal food consumption is not only a religious observance but also has a positive impact on the health of the Muslim community, especially in academic settings. Thus, halal food habits are considered an important factor that supports the holistic health and well-being of Muslims, especially in educational settings such as universities. The relationship between halal food and public health can be understood through several aspects, compliance with halal food consumption ensures that Muslims consume food that is in accordance with their religious teachings. Halal food is usually prepared with high standards of hygiene and safety, to reduce the risk of developing diseases caused by contamination or unhealthy ingredients. Consumption of halal food can also affect physical health, as foods that are allowed to be consumed in Islam tend to be healthier, such as meat that is slaughtered the right way and without blood. In addition, awareness of food sourcing and production ethics in halal food can contribute positively to the overall well-being of society (Khairina 2023).

5 CONCLUSIONS

From the results of the research we reviewed, it can be concluded that diet and eating habits are the main components that influence a person's health and nutrition, therefore, as a Muslim, consuming halal food and toyyib is an obligation. Gastritis is inflammation of the stomach lining which can occur acutely, chronically, diffusely, or locally. When the defense mechanisms of the gastric mucosa are filled with bacteria and other irritants, local inflammation occurs in the gastric mucosa. Which later causes stomach ulcers or known as gastritis and occurs due to excessive release of stomach acid. Symptoms include abdominal discomfort, bloating, headaches, nausea, and vomiting, as well as burning in the upper abdomen. Ulcer sufferers often experience repeated attacks that cause pain in the pit of the stomach. Risk factors for ulcers include taking aspirin or non-steroidal anti-inflammatory drugs, drinking alcoholic or carbonated drinks, smoking habits, and poor eating habits, such as consuming spicy food, acidic foods or drinks, irregular meal times, and large portion sizes. excessive. In addition, physical activity, stress, and

food intake also play a role in gastritis. Halal food is food that is permitted by Islamic law to be eaten, based on the Koran and the Hadith of the Prophet SAW. "Thayyib" comes from the Arabic thaba, which means good, delicious, pleasant, delicious, and delicious, and means clean or holy. Apart from that, this word can be interpreted as food that is not dirty in terms of substance or damaged (expired) or mixed with unclean objects.

The results of the literature review recommend that consuming a balanced diet can help prevent gastritis. This study also found that consuming various fruits and vegetables, such as papaya, apples, bananas, and strawberries can help reduce gastritis. In addition, many fish, seafood, such as salmon, sardines, tuna and seafood products that are rich in vitamin D can help prevent gastritis. There is also aloe vera extract shown to be effective in reducing digestive disorders and not making them worse. The substances bradykinase, carboxypeptidase, and salicylates help reduce stomach discomfort or pain due to inflammation. The saponins and tenin found in aloe vera reduce inflammation and prevent it from getting worse. Saponins, flavonoids, tannins and polyphenols 16 are antioxidants which play a role in preventing reactionary damage and act as free radical scavengers in the destruction of metal ions. And oats can help reduce the risk of gastritis because they contain B vitamins and antioxidants which are beneficial for overall health. To prevent gastritis, it is recommended to consume a variety of foods, including healthy, balanced and low-calorie food choices.

Research conducted on the relationship between halal food consumption and gastritis shows that there is a significant relationship between food choices and gastritis. The results showed that 80% of the articles did not suffer from gastritis, but 70% of the respondents suffered from gastritis. The majority of respondents were poor eaters, with 70% of them suffering from gastritis. The study also found that most had a high risk of gastritis, with 7 articles reporting a high risk of gastritis. In conclusion, consuming halal food can contribute positively to the overall health and well-being of Muslims.

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Analysis of Functional Groups of Green Tea Kombucha (*Camellia sinensis*) and Telang Flower Kombucha (*Clitoria ternatea* L.) Using FTIR (*Fourier Transform Infrared*)

Yanuar Bakhrul Alam, Nasywa Sayyida Amaliyah, Rizqiyatul Maulidina Billah, Eva Agustina, Risa Purnamasari*

Faculty of Science and Technology, Sunan Ampel State Islamic University Surabaya, Indonesia
**risap1989@gmail.com*

Abstract: Kombucha is a fermented drink that has many health benefits. The basic ingredients that can be used to make kombucha are antioxidant-rich plants, such as green tea and butterfly pea flowers. The aim of this research is to determine the functional groups contained in green tea kombucha and butterfly pea flower kombucha. Kombucha functional group analysis was carried out using a Fourier Transform Infrared (FTIR) instrument. Analysis with FTIR provides a spectrum in the form of characteristic absorption bands for certain functional groups in the sample being measured. The results of the spectra on the analysis of the functional groups of telang flower kombucha using FTIR produce absorptions in the wave number region 1500 cm-1 to 3500 cm-1. The spectra generated from the identification of telang flower kombucha tea samples contain functional groups of alcohol, amines, nitro compounds, and the wide peak shows the presence of stretching vibrations of OH monometric alcohol. As for the results of the analysis on green tea kombucha, alkenes, alkynes, and monometric alcohol groups were obtained. Based on the results of FTIR analysis, that all functional groups contained in the spectrum show the characterization of functional groups in general contained in flavonoid compounds (catechins).

1   INTRODUCTION

Tea is one of the plant commodities that is a source of state income in the non-oil and gas sector (Ginanjar *et al.,* 2019). Tea plants are also basic materials that can be processed into consumer materials in the industrial sector, (Radifan *et al.,* 2017) such as in the fields of cosmetics, beverages, and food (Insanu *et al.,* 2017). One type of tea that thrives in Indonesia is green tea (*Camellia sinensis*). Green tea is one type of herbal tea originating from China. This plant is widely cultivated in Southeast Asia as a raw material for making traditional medicine (herbal medicine). Green tea is very beneficial for human health because it contains secondary metabolite compounds such as saponins, tannins, alkaloids, flavonoids, and glycosides. Secondary metabolites in tea can inhibit enzyme activity, such as angiotensin-I enzyme, amylase, sucrase, maltase, glucosyl enzyme which is an HIV-triggering enzyme, and tyrosinase enzyme. In addition to the content of secondary metabolites, green tea also contains high amounts of polyphenol active compounds, namely 30-40%, higher than black

tea which contains 3-10% polyphenols (Shobri and Rohdiana, 2016).

The habit of drinking tea is a long-standing one in Indonesian society. Tea fermented using microorganisms, or kombucha, has more nutrients and health benefits than regular tea. The definition of kombucha itself is one of the healthy drinks made by fermenting sweet tea for 8-10 days (Filippis *et al.,* 2018). The process of making kombucha is basically influenced by the concentration of substrate (sugar) in inhibiting the growth of pathogenic bacteria (Marwati and Handria, 2013). Generally, kombucha is produced by utilizing black tea or green tea by symbiotic bacterial culture, which consists of acetic acid bacteria and yeast (Villareal-Soto *et al.,* 2019). The presence of acetic acid bacterial culture in kombucha produces alcohol as a metabolite compound and also CO_2 compounds (Filippis *et al.,* 2018). The low level of alcohol that has been produced during the kombucha fermentation process

causes the probiotic drink to have high nutritional value and halal consumption (Rezaldi *et al.,* 2022).

Kombucha culture is a gelatinoid and clay layer like nata with a disk shape (Rinihapsari and Richter, 2019). When viewed from its appearance kombucha is composed of two components, namely the top layer which is cellulose and kombucha liquid at the bottom. Kombucha tea drink has many beneficial compounds for health, including several organic acids, vitamins, minerals, polyphenols, and bioactive compounds (Leal *et al.,* 2018). The concentration of metabolite compounds is influenced by several factors, including the quality of the microorganism culture (Nguyen *et al.,* 2015), the concentration of tea and sugar used (Fu *et al.,* 2014), and the time used for the fermentation process (Jayabalan *et al.,* 2008).

The body will get many benefits from kombucha if you consume it, especially to help stabilize the body's metabolism which prevents fat from accumulating. Kombucha contains chemical metabolites, including B vitamins of both types B1 (thiamine), B2 (riboflavin), B3 (niacin), B6 (pyridoxine), B12 (cyanocobalamin), vitamin C, and polyphenols. One of its metabolites is niacin, which has the potential to control lipid metabolism and lower LDL, triglycerides, and HDL. Catechin-type polyphenols are another ingredient in kombucha that helps control lipid metabolism. These polyphenols function as antihypertensives, reduce the amount of lipids deposited in the body, accelerate cholesterol excretion through waste matter, and protect the body from free radicals. Therefore, catechins can also reduce the risk of cardiovascular disease. Niacin has a significant role in lowering cholesterol and vasolidating the surface of blood vessels (Rezaldi *et al.,* 2022). The results of research by Nasution & Nasution, 2022) also stated that the increase in phenolic compounds was higher during kombucha fermentation, and thus the higher the antioxidant activity.

Kombucha can basically be produced from other plant materials besides tea, which have high bioactive components in producing metabolites. Another material that has the potential to be developed as a raw material for kombucha fermentation is telang flowers (Rezaldi *et al.,* 2022). Telang flower with the scientific name Clitoria ternatea is a flower that has a high content of antioxidants. Telang flowers can often be found in forests, garden edges, and even in home yards. Telang flowers are often referred to as medicinal plants by the community because they are high in antioxidants (Sumartini, 2020). Telang flowers are legumes that belong to the Fabaceae

family. Telang flowers spread to grow in tropical and subtropical parts of the world on the continents of Asia and the Pacific, America and the Caribbean, Australia, and Africa. All parts of the telang flower from the roots to the flowers have the effect of treating and strengthening organ performance (Marpaung, 2020). Generally, telang flowers are used as a fever-reducing medicine, eye medicine, bladder and urinary tract irritation, and even as a medicine to remove phlegm in chronic bronchitis. The majority of Indonesians use telang flowers as food coloring (Jeyaraj *et al.,* 2011).

The nature of kombucha and telang flowers, which have high antioxidant content, opens up opportunities to be developed as functional drinks, active ingredients, or medicinal raw materials (Fadillah *et al.,* 2022). According to the results of research on kombucha of telang flowers by Rezaldi *et al* (2021), that kombucha of telang flowers has the potential as an antibacterial both gram-positive and gram-negative because the 40% sugar concentration used is the best sugar concentration in inhibiting the growth of pathogenic bacteria. The various roles of telang flower extract include anti-diabetes, anti-obesity, anti-inflammatory, anti-microorganism, hepatoprotector, and rich in antioxidants which are useful for warding off free radicals (Marpaung, 2020).

Antibacterials in kombucha come from the content of organic acids in the form of acetic acid. The fermentation of acetic acid itself produces various antioxidant compounds that are beneficial to the body, including acetic acid, ethanol, lactic acid, glucose, fructose, and others (Widianto *et al.,* 2013). The purpose of this research is to see the difference in the content of antioxidant compounds contained in green tea kombucha and telang flower kombucha by analyzing their functional groups using FTIR (Fourier Transform Infra Red) instrument. FTIR is one of the instruments that uses spectroscopic principles. Spectroscopy is equipped with fourier transformation for detection and analysis of spectrum results (Baharuddindkk., 2023). Infrared spectroscopy is used for the identification of organic compounds because it has a complex spectrum, which consists of many peaks. The number of peaks indicates that there are functional groups characterized by wave numbers. In addition, each functional group absorbs infrared light at a certain frequency.

2 METHODS

Tools and Materials

The tools and materials used in this research are green tea kombucha, bay flower kombucha, dropper pipette, alcohol standard solution as a blank, and Fourier Transform Infrared (FTIR) tool.

Research Procedure

Analysis of bayang flower kombucha and green tea kombucha was carried out using FTIR (Fourier Transform Infrared) spectrophotometry, which is by knowing information related to chemical bonds in the sample through its wave number, so that it can show what functional groups are present in the sample. The way FTIR works is as follows: The sample to be tested is placed on the sample holder after the FTIR tester is turned on. Each infrared ray will pass through the sample and comparator. Then successively passes through the chopper, and proceeds to convert it into an electrical signal which is then recorded by the recorder into a spectrum with different peaks.

3 RESULTS and DISCUSSIONS

Green Tea and Telang

The results of the analysis of green tea functional groups using an infrared spectrophotometer (FTIR) provide absorption in the wavenumber region (cm-1) which can be seen in Figure 1.
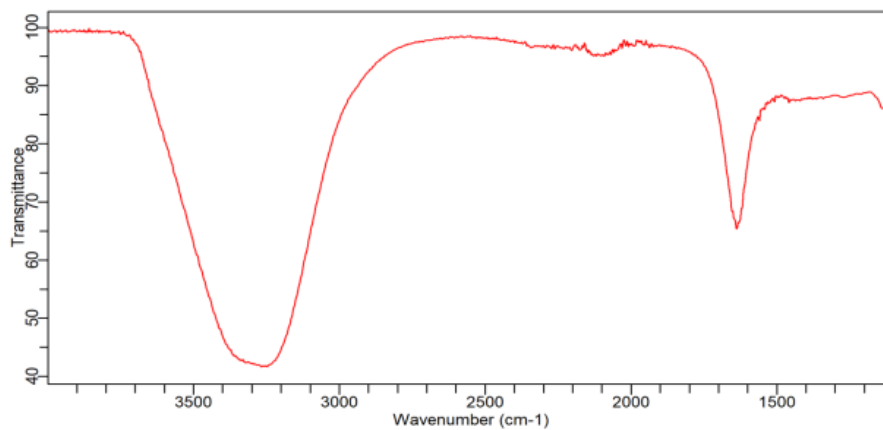
Figure 1: Green Tea Analysis Results

The results of the wave number absorptions using FTIR are then interpreted in Table 1 below.

Table 1: Interpretation of FTIR Spectra of Green Tea

Wafenumber (cm⁻¹)		Intensity	Functional Groups
Theoretical	FTIR Result		
3000-3700	3267,01	Width	O-H
1500-1675	1638,16	Sharp	C-C aromatic

The absorption results indicate the presence of certain functional groups in the green tea sample. Analysis of functional groups using FTIR with a wave number limit of 1000-4000 cm-1. The results of wave number absorption in this green tea sample are at wave number 3267.01 cm-1 with wide intensity and 1638.16 cm-1 with sharp intensity. The absorption at 3267.01 cm-1 with wide intensity indicates the presence of O-H functional groups, while the absorption at 1638.16 cm-1 with sharp intensity indicates the presence of C-C aromatic functional groups.

The results of the analysis of functional groups in rosella samples can be seen in Figure 2 and their interpretation in Table 2.
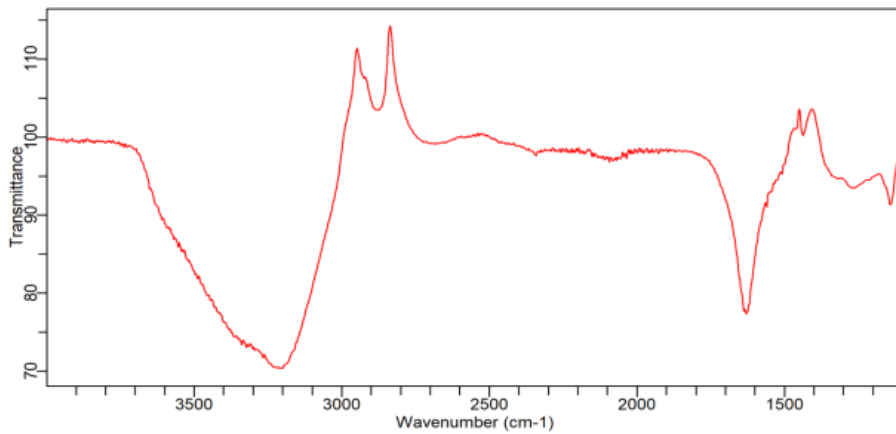
Figure 2: Analysis Results of Telang Kombucha Tea

Table 2: Interpretation of FTIR Spectra of Telang Kombucha Tea

Wafenumber (cm^{-1})		Intensity	Functional Groups
Theoretical	FTIR Result		
3000-3700	3201,78	Width	O-H
1500-1675	1628,85	Sharp	C-C aromatic

The results of wave number absorption in the green kombucha telang sample are found at wave number 3201.78 cm-1 with wide intensity and 1638.85cm-1 with sharp intensity. The absorption wave at 3201.78 cm-1 with wide intensity indicates the presence of O-H functional groups, while the absorption wave at 1638.85 cm-1 with sharp intensity indicates the presence of C-C aromatic functional groups. The results of FTIR analysis on telang kombucha tea have almost the same functional group content as green tea.

Green tea with telang kombucha tea both contain OH groups. However, the stretching of the transmittance band in telang kombucha tea is wider than that of green tea. Basically, the tea sample already contains OH groups and C = C aromatic which characterizes flavonoid compounds (catechins) in green tea (Sukaesih, 2021). According to Abriyani et al. (2023) that the flavonoid standard is the absorption of the OH (hydroxyl) wave at 3372 cm-1. In general, catechins are found in young tea leaf shoots. The concentration of catechins in tea leaf shoots will decrease as the tea leaves get older. (Nugraheni *et al.,* 2022).

In the telang kombucha tea sample, the stretching of the OH group is wider due to the influence of microbiological activity in the manufacturing process. The process of making kombucha tea using a 7-21 day fermentation process using microbial

assistance, one of which is using the Saccharomyces cerevisiae yeast (Priyono & Riswanto, 2021). The alcohol content of kombucha tea from several sources can be seen in Table 3. Basic tea content that already contains OH groups (catechins) coupled with alcohol content as an effect of the fermentation process, makes the FTIR spectrum stretch wider in the 3000-3700 cm-1 wave number range.

Kombucha beverage products are tea solution beverages by fermentation using microbes as fermentation agents. The pH value of kombucha tea ranges from 3.0-5.5 depending on the length of fermentation. The pH value in kombucha tea is influenced by the accumulation of acids formed during fermentation (Saputra *et al.,* 2017). The results obtained in this study show that there is a difference in pH between green tea and telang kombucha tea. The pH value of telang flower kombucha tea drops can be caused by the sugar substart that turns into alcohol and organic acid products during the fermentation process. The metabolic activity of bacteria and yeast also causes a decrease in pH (Siregar *et al.,* 2023).

Table 3: Alcohol Content of Kombucha Tea from Several Sources

Alcohol Content	Source
0,297-0,621%	(Pratiwi et al., 2012)
1,61-5,12%	(Simanjuntak et al., 2016)
0,7-1,3%	(Kapp & Sumner, 2019)
0,2-3,5%	(Jakubczyk et al., 2020)
0,06-1,95%	(Tan et al., 2020)

4   CONCLUSIONS

Based on the results and discussion, it can be concluded that FTIR analysis of green tea and telang kombucha tea shows the presence of O-H and C-C aromatic functional groups. The analysis showed that rosella kombucha tea has a wider OH group content compared to green tea, which is due to the influence of microbiological activity in the process of making kombucha tea. The fermentation process used in making kombucha tea using microbes such as Saccharomyces cerevisiae, produces alcohol content which contributes to the stretching of the FTIR spectrum. The content of OH and C-C aromatic groups in telang kombucha tea indicates the presence of catechins, which are flavonoid compounds present in green tea.

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Comparison of Total Phenolic Content in Green Tea Kombucha (Camellia sinensis) and Lavender Flower Kombucha (Lavandula angustifolia) Using UV-VIS Spectrophotometry

Windi Indra Alfiyanti[1], Tafdila Faza Rusyda[1], Dea Ma'rifatul Zahro[1], Funsu Andiarna[2], Risa Purnamasari[1]*

[1]*Faculty of Science and Technology, Sunan Ampel State Islamic University Surabaya, Indonesia*
[2]*Faculty of Psychology and Health, Sunan Ampel State Islamic University Surabaya, Indonesia*
Risap1989@gmail.com

Keywords: Green Tea, Kombucha, Lavender Flower, Phenolic, UV-Vis Spectrophotometry.

Abstract: Kombucha is a fermented beverage produced through the fermentation of tea and sugar by a Symbiotic Culture of Bacteria and Yeast (SCOBY). The substrates used in kombucha production can include ingredients high in phenolic compounds, such as green tea leaves and lavender flowers. This study aims to compare the total phenolic content between green tea kombucha and lavender flower kombucha. The analysis method utilized UV-Visible spectrophotometry with the Folin-Ciocalteu method and gallic acid standard with results expressed in mg gallic acid equivalents (GAE) per gram of simplicia. The analysis results indicated that kombucha made from green tea leaves had a total phenolic content of 162.35 mg GAE/g, whereas kombucha made from lavender flowers had a total phenolic content of 136.43 mg GAE/g. These findings show that the total phenolic content in green tea kombucha is higher compared to lavender flower kombucha, with a ratio of 5:4.

1 INTRODUCTION

Tea is a beverage product that has benefits for the human body. Tea is made from tea shoots (Camellia sinensis) which contain chemical compounds, namely catechins, vitamin E, vitamin C, tannins, flavonoids, theophylline, polyphenols and minerals such as Mg, Ge, Mo, Se and Zn (Arisudin et al., 2021) . Tea can be fermented using microorganisms which provides a variety of ways to consume the tea such as kombucha. Kombucha tea is a traditional tea that is known to be interesting because it is the result of fermentation carried out by a symbiotic culture (De Filippis et al., 2018). Kombucha is a fermented drink produced through the fermentation process of tea and sugar by SCOBY (Symbiotic Culture of Bacteria and Yeast). Kombucha is known to have quite high levels of antioxidants (Pebiningrum et al., 2023).

The substrate used in making kombucha can come from materials that contain high phenolic compounds, such as green tea leaves and lavender flowers (Sulistiawaty and Solihat, 2022). Green tea is a type of non-fermented or unfermented tea that contains a lot of catechins, one of the components of flavonoids (Kusnan, 2022). In the research results of Kusmiyati et al. (2015) reported that green tea has antioxidant activity and high total phenol compounds of $334.68 + 0.89$ mg/L GAE. Lavender flowers are native to Switzerland which have anti-aging antioxidants (Sayuti, 2017). The results of research by Dobros et et al. (2022) reported that the value of total phenolic content in Lavandula angustifolia extract varied from 14.88 to 32.82 mg/L GAE.

This study aims to determine the comparison of total phenolic levels in green tea kombucha (Camellia sinensis) and lavender kombucha (Lavandula angustifolia) using the spectrophotometric method. Phenolic compounds are compounds that contain hydroxyl groups and are found in many plants. Phenolic compounds are aromatic compounds with benzene-derived structures that have aromatic rings and one or more hydroxyl groups (OH) (Kurang and

Malaipada, 2021). The method used to determine the phenolic content of kombucha in green tea and lavender flowers is UV-Vis spectrophotometry.

UV-Vis spectrophotometry is a compound analysis method using UV and Visible wavelengths as absorption areas (Zurweni and Sanova, 2023). UV-Vis spectrophotometry is an instrument to identify compounds that have chromophore groups and auxochrome groups (Sahumena et al., 2020). Auxochrome groups are functional groups that have free electrolyte pairs. Chromophore groups are organic compounds with conjugated double bonds that are responsible for electrical absorption (Krisdiyanto and Sa'ad, 2023).

2   METHODS

Time and Location of Research

This research was conducted at the Instrumentation Laboratory Campus II Sunan Ampel State Islamic University Surabaya in May 2024.

Tools and Materials

The tools used in the research are measuring flask, measuring pipette, bulb, vortex, centrifuge, cuvette, test tube, beaker glass, and UV-vis spectrophotometer. While the materials used are green tea kombucha, lavender flowers, water, kombucha culture starter, distilled water, granulated sugar, gallic acid, methanol p.a, Folin-ciocalteu, Na2CO3.

Kombucha Starter Preparation

100 ml of water was brought to a boil, 100 grams of sugar (10% b/v) was added and 5 grams of 0.5% tea (b/v) was added. Filtered and covered with aluminum foil then allowed to stand at room temperature. Next, 100 ml of kombucha culture starter (10% b/v) was added to the tea and then sealed. Left for 14 days to propagate the kombucha culture starter.

Green Tea Kombucha Preparation

Brewed 5 grams of green tea with 200 ml of boiling water, then added 50 grams of sugar and stirred. The brewed green tea was covered tightly with a cloth and allowed to stand at room temperature. Added 20 ml of liquid kombucha starter and fermented for 12 days in a tightly closed container.

Lavender Flower Kombucha Preparation

Brewed 5 grams of lavender flowers with 200 ml of boiling water, then added 50 grams of sugar and stirred. The lavender flower brew was covered tightly with a cloth and allowed to stand at room temperature. Added 20 ml of liquid kombucha starter and fermented for 12 days in a tightly closed container.

pH Level Test

The pH measurement was measured using a pH meter. Green tea kombucha and chamomile flower kombucha were put in a beaker glass and then dipped in a pH meter.

Phenolic Content Test

Determination of Maximum Wavelength

Determination of the maximum wavelength of gallic acid was done by measuring gallic acid solution with a concentration of 10 ppm at a wavelength of 400-800 nm using a uv-vis spectrophotometer instrument. The maximum wavelength can be known based on the highest absorbance of the measurement results using a uv-vis spectrophotometer instrument (Tetha and Sugiarso, 2016).

Standard Curve of Gallic Acid Standard Solution

The standard solution in this study uses gallic acid standard. Gallic acid standard solution was made with concentration variations of 10, 20, 30, 40, 50 ppm. Taken each standard concentration of gallic acid as much as 1 ml and put into a test tube. The solution was reacted with Folin-ciocalteu as much as 0.5 ml then shaken and left for 8 minutes. Added 7% Na2CO3 solution as much as 4 ml then homogenized using a vortex for 1 minute. The solution was put in a 500 rpm centrifuge for 3 minutes. Measurements were made using a uv-vis spectrophotometer instrument at a wavelength of 760 nm. The absorbance measurement results of gallic acid standard solution were used to make a calibration curve where gallic acid concentration as the X-axis and absorbance as the Y-axis. The regression equation of the curve was used to determine the concentration of the sample

Determination of Phenolic Content of Samples

Samples of green tea kombucha and lavender flower kombucha were each taken as much as 1 ml and reacted with 0.5 ml of Folin-ciocalteu then shaken and left for 8 minutes. The sample solution was added with 4 ml of 7% Na2CO3 solution and then homogenized for 1 minute. Then the absorbance of the sample was measured using a uv-vis spectrophotometer instrument at a wavelength of 760 nm. The blank solution used was methanol p.a.. Phenolic content in green tea kombucha and lavender flower kombucha samples was calculated using the formula:

$$TPC = c.\ v.\ fp$$

Description:

TPC : total phenolic content (mg/L GAE)

c   : concentration (x value) (ppm)

v   : volume of extract (ml)

fp   : dilution factor

g   : sample weight (gram)

3   RESULTS

Kombucha from lavender flowers is a fermented beverage processed from a decoction of lavender flowers. green tea, and sugar which is then fermented with SCOBY. This kombucha drink has a distinctive flavor and aroma. Its sour and sweet taste creates a fresh sensation. The new flavor is created by acetic acid bacteria collaborating with yeast. The result of lavender flower kombucha fermentation is shown in Figure 1.

Figure 1: Apperarance of Lavender Flower Kombucha

The results of lavender flower kombucha fermentation will be analyzed for total phenolics using a UV-Vis speltrophotometer. Before that, it is necessary to measure gallic acid standard solution first. Variations of ppm concentrations used are 10 ppm, 20 ppm, 30 ppm, 40 ppm, and 50 ppm. The wave used in the measurement of gallic acid standard is 760 nm. Here are the absorbance results of gallic acid standard solution.

Table 1: Concentration Data of Gallic Acid Standardizers

Consentration (ppm)	Absorbance
10	0.331
20	0.52
30	0.804
40	1.159
50	1.315

The concentration variation solutions used were 10 ppm, 20 ppm, 30 ppm, 40 ppm, and 50 ppm. Absorbance was obtained using UV-VIS instrument. Variations of concentration and absorbance are made curves to get regression results. The results of the gallic acid standard curve can be seen below.
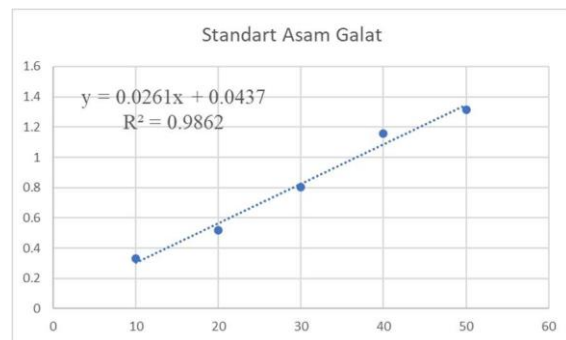
Figure 2: Gallic Acid Standard Calibration Curve

Based on the results of the calibration curve, the regression equation obtained is y (Absorbance) = 0.261x (concentration) + 0.0437. The coefficient of determination R2 = 0.9862. Determination (R2) has a value of 0.9862 can be said to be linear because it is close to the number one. Phenolic concentration will be known if substituting absorbance in equation Y. The amount of phenolic concentration in the sample is indicated by X.

The known concentration results are continued with the calculation of TPC. TPC determination is one of the data analysis to determine the relationship between phenolic and antioxidant in the sample. Phenolic compounds have a role to prevent oxidation. Total phenol activity testing is carried out with the aim of knowing antioxidant activity. The higher the

total phenol content, the higher the antioxidant because antioxidants are mostly composed by phenol compounds (Djapiala, et al. 2013). Gallic acid equivalents are determined from the total phenolic content of the sample. Based on the concentration and absorbance of phenolic, the TPC value is obtained as follows.

Table 2: TPC value of green tea and lavender flower kombucha

Sampel	Absorbance	Phenolic Concentration	TPC (mg/L GAE)
Green Tea Kombucha	4.281	162.348659	162.35
Lavender Kombucha	3.561	134.762452	134.76

Phenolic concentration can be known by substituting the sample absorbance into Y in the equation. The amount of X shows the amount of phenolic concentration in the sample. The calculation stage of the TPC (Total Phenolic Content) value is carried out after the phenolic concentration is known. TPC determination is part of the analysis that has to do with phenolic content and antioxidant activity. Samples with high phenolic secondary metabolite compounds usually have high antioxidant activity (Handayani et al., 2022). The total phenolic content in each sample was expressed as Gallic Acid Equivalent (GAE). GAE is a general reference used in measuring phenolic compounds contained in a material (Wibisino et al., 2020).

Based on the concentration of phenolics present, the TPC value of green tea and chamomile kombucha was obtained. The TPC value of each sample can be seen in table 3.

Table 3: TPC Value of Kombucha Green Tea, Telang, Rosella, Lavender and Chamomile

Sampel	Absorbance	Phenolic Concentration	TPC (mg/L GAE)
Kombucha Green Tea	4.281	162.348659	162.35
Kombucha Chamomile	0.968	35.4137931	35.41

The TPC value obtained by green tea kombucha has a value of 162.35 mg/L GAE, while the lavender flower kombucha has a value of 134.76. Based on these two values, it can be seen that green tea kombucha has higher phenolic content compared to lavender flower kombucha. The next test continued

with pH testing on green tea kombucha and lavender flower kombucha. The pH test results are shown in Figures 3 and 4.

Figure 3: Green tea kombucha pH test results

Figure 4: Lavender flower kombucha pH test results

The results of the pH value are shown in the table below.

Table 1: TPC value of green tea and chamomile kombucha

Sample	pH Value
Green Tea Kombucha	3.32
Lavender Kombucha	2.9

The pH test on green tea and lavender flower kombucha was carried out using a pH meter. The pH level in green tea kombucha is 3.32, while in lavender flower kombucha is 2.9. Based on the above results, it can be seen that green tea kombucha has higher wetness than lavender flower kombucha.

4 DISCUSSIONS

Kombucha is a fermented beverage from tea and sugar fermented by Acetobacter xylinum bacteria and several other yeasts that convert sugar content into essential amino acids that can benefit the body (Saputra et al., 2017). The main ingredients of kombucha that are often used are green tea, black tea, can also be made with several ingredients such as fruits or flowers. Kombucha has properties that are good for the body. According to Khaerah and Akbar (2019), these properties are due to the presence of phenolic content which has high antioxidant activity. The higher the content of phenolic compounds, the

higher the antioxidant activity. The fermentation process of tea will increase the amount of phenolics in tea thus increasing antioxidant activity as well.

Lavender flowers contain Phenolic compounds of lavender flowers include hydroxybenzoic acid (p-hydroxybenzoic acid, protocatechuic acid, vanillic acid, gentisic acid, gallic acid), hydroxycinnamic acid (rosmarinic acid, caffeic acid, p- cumaric acid, ferulic acid, chlorogenic acid, sinapic acid, cinnamic acid, 4-O- caffeoylquinic, 5-O-caffeoylquinic) and flavonoids (apigenin and luteolin glycosides, catechins, naringenin, vanillin) (Dobros, et al. 2022). Antioxidant and polyphenol contents are also found in green tea.

Antioxidant activity and polyphenols have a role in counteracting free radicals. Free radicals come from outside the body that can have a harmful impact on the body. Free radicals have molecules that contain more than one unpaired electron. Electrons that do not have a pair can cause free radicals because they have reactive properties and are easily attracted to magnets (Yuslianti, 2018). The content of chemical compounds in green tea contains catechins and polyphenols. Catechins are composed of epicatechin, epigalotekin, epitecin, epitecin gallate, catechin gallate, and epigalatocatechin gallate. Flavonols are composed of kaemfenol, quecetin, minicertin. Catechins are the main compounds with flavan-3-ol skeleton that determine the quality of tea leaves (Hasanah et al., 2012). About 42% of dried tea leaves contain catechin polyphenol compounds (Rabbani et al., 2019). The following is a picture of the molecular compounds of catechin derivatives.
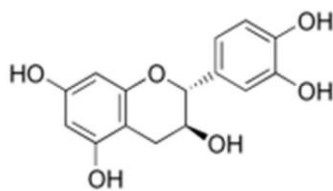
Figure 5: Molecular Structure of Catechins
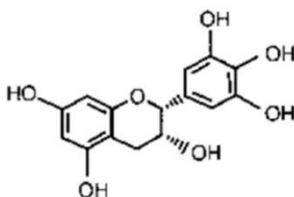
Figure 6. Molecular Structure of Epigalocatechin
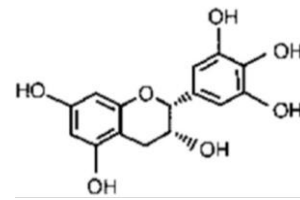
Figure 7. Molecular Structure of epicatechin
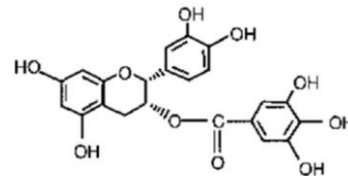
Figure 8. Molecular Structure of Epigalocatechin Galate
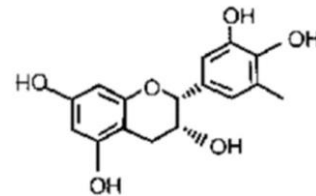
Figure 9. Molecular Structure of Epicatechin (Anesini et al., 2008)

Suoeroxide anion radicals such as reactive oxygen species (ROS) that are formed can cause oxidative stress that triggers disease to death in cells. The formation of antioxidants can inhibit oxidative damage caused by free radicals (Anand et al., 2017) Antioxidants become compounds that can inhibit free radicals because they have electron donor properties. Epigalotekin is one of the compounds that has high antioxidant activity (Du et al., 2012). The following is the mechanism of free radical capture carried out by epigalocatechin.
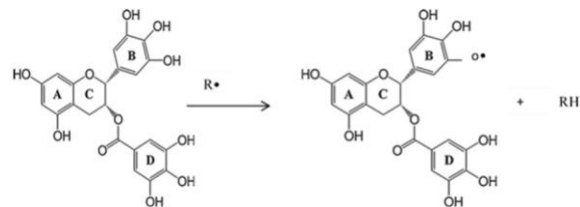
Figure 9. Mechanism of Free Radical Capture by Epigalocatechin (Sajilata *et al.*, 2008)

The compound epicalocatechin gallate is a compound that belongs to the hydroxyl group of rings B and D. This compound has antioxidant properties that work

by transferring single electrons to free radicals. Free radical compounds that have a pair because they have received an electron donor from epigalocatechin gallate turn into non-free radicals. The antioxidant activity of epigalocatechin gallate also has metal chelating properties and can inhibit the formation of ROS. This compound can increase superoxide dismutase activity and gluation levels so that oxidative damage can be minimized (Fadhila et al., 2021).

Absorbance testing on gallic acid is used as a standard solution because it is one of the natural, stable and cheap phenols. Gallic acid is a phenolic compound derived from hydroxybenzoic acid which is classified as a simple phenolic acid (Ahmad et al., 2015). Gallic acid has O-H groups and conjugated double bonds on each benzene ring, it can form complex compounds with Folin-ciocalteu reagent (Supriningrum et al., 2020). Folin-ciocalteu oxidizes phenolic- hydroxy or phenolic groups to reduce heteropoly acid (phosphomolybdate- phosphotungstate) to a bluish-green molybedenum-tungsten complex (Martono et al., 2020). The sample solution is added with Na_2CO_3 solution which aims to create an alkaline atmosphere so that phenolic compounds undergo proton dissociation into phenolic ions (Safitri and Herdyastuti, 2021). The phenolic ion will react with Folin- ciocalteu reagent to produce a blue color.pH testing is done to determine the level of acidity or wetness in the sample. pH measurement uses the concept of loharithm with the aim of getting the right ion concentration. pH is a quantity measured from a scale of 0 to 14 (Astria, 2014). pH is said to have acidic properties if it is less than 7 and is said to have alkaline properties if it is more than 7, while a pH with a value of 7 is said to be neutral (Ihsanto, 2009). pH can decrease due to the fermentation process which produces organic acetic acid, lactic acid, and so on. Fermentation itself can increase antioxidant compounds. The more organic acids, the higher the phenolic content and the higher the antioxidant activity. The higher the phenolic content and antioxidant activity, the lower the pH value (Novita and Dyah, 2011).

5   CONCLUSIONS

The results of this study showed that the phenolic content in green tea kombucha was 162.35 mg/L GAE, while in lavender flower kombucha it was 134.76 mg/L GAE. The total phenolic content of green tea kombucha is higher than lavender flower

kombucha. This is because the basic ingredients of green tea already contain high phenolic compounds. The polyphenol group that dominates in green tea is catechin which has several derivatives. Derivatives of these catechins can have the ability to ward off free radicals because of their reactive nature. The pH value of green tea kombucha is 3.32, while the pH value of lavender flowers is 2.9. Both samples are said to be acidic because they have a low pH of less than 7.

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Analysis of the Effect of Knowledge Level and Nutritional Status Related to the Concept of Healthy Snacks

Filda Ilfi Yana, Ayu Rosyidah P, Dziyauu Qoulin N, Hendryanto Maulana G, Kholifah Dian K, Ria Qadariah Arief*, Nova Lusiana

Nutrition Departement, Faculty of Physicology and Heath, Universitas Islam Negeri Sunan Ampel, Surabaya
ria.qadariah@gmail.com

Abstract: The importance of understanding the concept of healthy food has raised awareness about choosing healthy snacks for school children. This study aims to analyze the effect of knowledge level and nutritional status related to the concept of healthy snacks. This research uses a cross-sectional method, which is a way of approaching or collecting data with pre-tests and post-tests, anthropometric measurements, and student data analysis. The sample consists of 37 students from SDN I Tambaksari Surabaya aged 12-13 years. The results show no significant relationship between nutritional status and knowledge of healthy snacks (p-value = 0.162 > α = 0.05) and between gender and increased knowledge of healthy snack concepts (p-value = 0.131 > α = 0.05). The conclusion of this study indicates that the respondents' knowledge and gender do not affect their behavior in choosing healthy snacks.

1   INTRODUCTION

Children are the most valuable long-term investment. Amid daily busy activities, snacks become an essential part of children's diet. Children often buy food outside without considering its cleanliness and content. The importance of maintaining a healthy diet has increased awareness of the need for healthy snacks. Healthy snacks not only satisfy hunger but also provide good nutritional benefits for the body.

Awareness of the importance of healthy snacks for children needs to be instilled not only at home but also at school and in their play environment. Lack of knowledge is one of the reasons children continue to consume unhealthy snacks. Parents, teachers, and caregivers play key roles in providing and educating children about good food choices. Initiatives such as nutrition education programs in schools, promoting healthy food in canteens, and providing healthy snack options at home can help form good eating habits from an early age (Sumarni et al., 2020).

In addition to education, innovation in creating attractive and delicious snacks is also very important. Healthy snacks must be able to compete with less healthy snacks in terms of taste and visual appeal.

Serving food becomes an attraction because the first thing a person does in choosing food is looking at the presentation and decoration. Using natural ingredients, reducing unnecessary additives, and creative presentation can make healthy snacks more appealing to children (Hartatik, 2022).

Thus, encouraging healthy snack consumption among children is not just about providing better options but also about building a strong foundation for the future generation's health. This is an essential step in preventing future health problems and ensuring children grow up healthy and strong.

2   METHODS

In this study, the researchers used the likelihood test, a statistical approach used to make inferences about model parameters based on observed data. This activity was carried out directly through the provision of education on healthy snacks in the school environment and filling out community service information. This method is implemented to interact

directly with the target as an effort to promote healthy snacks consumption for school children. The activities were carried out in several stages, including.

Anthropometric Measurements

In this stage, height and weight measurements were carried out with the target, namely school children aged 12-13 years. Anthropometric measurements were carried out directly by two coordinators. The first coordinator measured height, while the second coordinator measured weight.

Figure 1: Anthropometric Measurements

Community Service Information Filling

After the anthropometric measurements, the community service team requested permission from the class teacher to collect data through this information filling. Before filling out the community service information, the team provided instructions on how to fill out the information.

Pre-Test Question Filling

In this stage, pre-test filling was used to measure students' knowledge about healthy snacks before being given education. Students were asked to fill out questionnaires individually in a conducive classroom atmosphere. The community service team gave 30 minutes for filling out the pre-test questionnaires. The researchers ensured that the students understood the instructions clearly and well.

Figure 2: Pre-Test Question Filling

Providing Education on The Importance of Consuming Healthy Snacks for School Children

After filling out the pre-test questionnaires, students were given education related to healthy snack consumption using lecture, discussion methods, and a session closed by a volunteer from one of the sixth-grade students to deliver the material obtained for 30 minutes.

Post-Test Questions Filling

In this stage, post-test filling was used to measure students' knowledge about healthy snacks after being given education. Students were asked to fill out questionnaires individually in a conducive classroom atmosphere. The community service team gave 30 minutes for filling out the post-test questionnaires. The researchers ensured that the students understood the instructions clearly and well.

Figure 3: Post-Test Question Filling

Data Analysis of Students

Researchers collected data from the pre-test and post-test answers that had been collected and analyzed to measure students' knowledge levels about healthy snack consumption. Data were taken through a statistical approach by comparing pre-test and post-test results to assess the relationship between knowledge level and nutritional status of school children regarding healthy snacks.

Time of implementation

This activity was carried out for one day at SDN Tambaksari I Surabaya, Jl. Mundu No.35, Tambaksari, Tambaksari, Surabaya, East Java, 60136. The stages included coordination between the community service team and the school, permission from the class teacher, anthropometric measurements, community service information filling, pre-test questionnaire filling, education intervention, post-test questionnaire filling, and closing.

3   RESULTS

Table 1: Sample Distribution by Gender

Nutritional Status	Gender				total		p*
	Male		Female				
	n	%	n	%	n	%	
Less	3	33.3	5	62.5	9	100	
Normal	8	42.1	11	57.9	19	100	0,131
More	5	55.5	4	44.5	9	100	
total	16		20		36		

* p-value from likelihood test

Effect of Nutritional Status Based on Respondent Gender on Knowledge Improvement in Healthy Snack Concepts

Based on the data analysis using the likelihood test, a p-value of 0.131 > α = 0.05 was obtained, meaning Ha is rejected, and Ho is accepted. Thus, it can be concluded that there is no relationship between gender and the improvement of healthy snack concepts knowledge among students at SDN 1 Tambaksari Surabaya, meaning the respondents' gender does not affect the improvement of healthy snack concepts knowledge.

Table 2: Distribution Based on Nutritional Status

Nutritional Status	Knowledge of Healthy Snack Concepts						p*
	Adequate		High				
	n	%	n	%	n	%	
Less	1	12.5	7	87.5	8	100	
Normal	2	10.52	17	89.48	19	100	0,162
More	1	11.11	8	88.89	9	100	
total	4		32		36		

* p-value from likelihood test

Effect of Nutritional Status Based on Knowledge of Healthy Snack Concepts on Knowledge Improvement in Healthy Snack Concepts

Based on the data analysis using the likelihood test, a p-value of 0.162 > α = 0.05 was obtained, meaning Ha is rejected, and Ho is accepted. Thus, it can be concluded that there is no relationship between nutritional status and the knowledge level of healthy snack concepts among students at SDN 1 Tambaksari Surabaya, meaning the respondents' knowledge does not affect their behavior in choosing snacks.

4   DISCUSSIONS

Snacks are foods consumed between main meals and are one of the sources of calorie intake. Snacks

contribute about 20% of the total daily calories consumed by school students. It is essential to choose snacks not only based on the students' interests and preferences but also on their nutritional needs. Additionally, snacks should not reduce their appetite for main meals. Examples of healthy snacks that can be chosen include fresh fruits and vegetables and their processed forms like fruit juices, nuts such as walnuts, hazelnuts, and almonds, and simple biscuits (Bastami et al., 2019).

In this study, we conducted assistance to improve the knowledge concept of healthy snacks. During the community service to the students at SDN 1 Tambaksari, we observed that the students were very active in gaining knowledge about healthy snacks concepts. During the material presentation session, they paid attention, and during the question session about healthy snacks, they were eager to answer and explain their conclusions about the concept of healthy snacks. The results of the post-test averages show that their knowledge about healthy snacks was very good.

This research aims to understand the knowledge about healthy snacks and nutritional status among 6A grade students at SDN 1 Tambaksari Surabaya, and to determine the relationship between gender and nutritional status with increased knowledge about healthy snacks. An individual's nutritional status reflects the balance between the nutritional intake received and the body's nutritional needs. To achieve good nutritional status, the body must be able to utilize these nutrients to maintain energy reserves and replace lost nutrients. Good nutritional status is an important indicator to assess the development and growth of children, while knowledge about healthy snacks can influence the food choices that might be consumed daily.

The Relationship Between Gender and Knowledge About Healthy Snacks at SDN Tambaksari I Surabaya

This study was conducted to test the hypothesis that there is a significant relationship between nutritional status and knowledge of healthy snacks using the likelihood test in statistics because the Pearson chi-square test was not met. The results in Table 1 show that there is no significant relationship between gender and the increase in knowledge of the healthy snack concept in elementary school children. The results of the likelihood ratio test yielded a p-value of more than 0.05, namely 0.131, indicating that there is no significant relationship between the gender of the

respondents and the increase in knowledge of the healthy snack concept.

These research results are similar to those of a study conducted on elementary school students in the Bukit Bestari District, Tanjung Pinang City, Riau Islands Province by (Pitriyanti et al., 2023). In their study, it was found that there was no relationship between gender and knowledge about healthy snacks in elementary school children. This explains that both male and female respondents have a good level of knowledge about healthy snacks. This is because our respondents were 6th-grade students, who already have a sufficient understanding of the concept of healthy snacks

The Relationship Between Children's Nutritional Status and Knowledge About Healthy Snacks at SDN Tambaksari I Surabaya

In the study on the relationship between knowledge about healthy snacks and nutritional status among students of SDN I Tambaksari Surabaya, the statistical likelihood test results from the SPSS 26 for Windows calculation were 0.162, which means that the P-value > α, namely 0.162 > 0.05, thus, Ha is rejected and H0 is accepted. There is no correlation between knowledge about healthy snacks and the nutritional status of children at SDN I Tambaksari Surabaya. This is indicated by the majority of respondents achieving maximum scores on both the pre-test and post-test questions. Based on these results, the level of knowledge and nutritional status of students at SDN I Tambaksari Surabaya does not have a significant relationship with the concept of healthy snacks. This shows that the level of knowledge about healthy snacks does not directly influence the nutritional status of children.

This is not in line with the research conducted by (Puspita et al., 2024) which states that there is a correlation between knowledge and the nutritional status of children. In their study, nutritional status has a very close relationship with the development of gross motor skills in children, meaning that the lower the nutritional status of the child, the lower the child's motor development and vice versa. Whereas in our study, knowledge does not affect the nutritional status of children. This could be due to other factors such as eating patterns, meal frequency, and physical activity which have a greater influence on the nutritional status of the students. Therefore, these two studies have different results.

Thus, it is hoped that students can choose healthy snacks that are not only delicious but also nutritious. Because students who have good nutritional status, consumption patterns, and behavior in choosing snacks will have a healthier body and an ideal physique.

5 CONCLUSIONS

The conclusion of this study is that, based on data analysis using the Likelihood test, no significant relationship was found between nutritional status and the level of knowledge about healthy snacks (p-value = 0.162 > α = 0.05), and there is no significant relationship between gender and the increase in knowledge of the concept of healthy snacks (p-value = 0.131 > α = 0.05) among grade VI A students of SDN I Tambaksari, Surabaya. This indicates that the knowledge and gender of the respondents do not influence their behavior in choosing healthy snacks. Other factors such as dietary patterns and physical activity may have a greater impact on the nutritional status of the students. Therefore, it is hoped that students can choose snacks that are not only tasty and attractive but also nutritious to maintain health and achieve optimal nutritional status.

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Comparison Of Functional Groups in Green Tea Kombucha (Camellia sinensis) and Lavender Flower Kombucha (Lavandula angustifolia L) Using Fourier Transform Infrared Spectroscopy (FTIR)

N Yolanda Safira Virginia[1], Fadila Ayu Puspitasari[1], Aini Lutfi Nur Aida[1], Gischa Putri Anggraini[1], Eva Agustina[1]*, Irul Hidayati[1], Funsu Andrina[2]

[1]*Faculty of Science and Technology, Sunan Ampel State Islamic University, Surabaya, Indonesia*
[2]*Faculty of Psychology and Health, Sunan Ampel State Islamic University, Surabaya, Indonesia*
**eva_agustina@uinsby.ac.id*

Abstract: Kombucha is a fermented beverage produced through the fermentation process of tea and sugar by SCOBY (Symbiotic Culture of Bacteria and Yeast). Kombucha can be produced from various raw materials such as green tea (*Camellia sinensis*) and lavender (*Lavandula angustifolia* L.), which have different chemical compositions. The aim of this study is to compare the functional groups of green tea kombucha and lavender kombucha. The method used is Fourier Transform Infrared Spectroscopy (FTIR). The results of this study indicate that both green tea kombucha and lavender kombucha show the presence of phenolic and flavonoid compounds. Additionally, both have the same functional groups, namely O-H (alcohol), C=C (alkena), and C≡C (alkuna). The FTIR results of lavender kombucha also show the presence of C-H (alkana) groups, indicating the presence of nonpolar compounds such as terpenoids and steroids.

1 INTRODUCTION

Kombucha is a traditional beverage produced from the fermentation of tea and sugar solution using kombucha microbial starter which is a symbiosis between bacteria and yeast. The fermentation process of kombucha tea lasts for 4-12 days (Falahuddin et al., 2017). Various types of bacterial and yeast cultures used during the fermentation process include *Acetobacter xylinum, Acetobacter aceti, Brettanomyces* sp., *Pichia* sp., *Saccharomyces* sp., *Zygosaccharomyces kombuchaensis, Torulopsis* sp., *Zygosaccharomyces bailii; Schizosaccharomyces, Saccharomycodes, Torulaspora*, and *Candida* (Khamidah & Antarlina, 2020).

Kombucha is often referred to as tea with 1001 benefits or longevity tea because it has various health properties. This drink contains several organic acid compounds as well as a number of other compounds such as acetic acid, lactic acid, glucoronic acid, phenolic acid, ethanol, B vitamins, and enzymes (Rosada et al., 2022). Organic acids in kombucha are the main compounds that have potential as active ingredients in providing health benefits such as antioxidants (Purnami et al., 2018). Therefore, consuming kombucha tea can provide positive benefits for the health of the stomach, intestines, glands, and can help treat various problems such as aging, diabetes, rheumatic joints, and hemorrhoids (Goh et al., 2012).

Green tea (*Camellia sinensis*) can be used as an ingredient for making kombucha. Green tea contains secondary metabolite compounds such as saponins, tannins, alkaloids, flavonoids and glycosides (Nugraheni et al., 2022). Apart from green tea, lavender flowers (*Lavandula angustifolia*) are also known to be used for making kombucha. This flower is often used as an ingredient in kombucha tea because it has a pleasant aroma and a soft taste when drunk. Lavender also has antimicrobial properties that can help in the fermentation process and maintain the quality of kombucha (Tapias et al., 2022).

An organic compound is a compound composed of atoms of carbon (C), hydrogen (H), oxygen (O), and nitrogen (N), arranged in various unique conformations. These molecules form compounds with specific properties and functions. A functional group is the position of chemical reactivity in a molecule, which is a specific group of atoms that give the compound special properties (Toar et al., 2021). The content of compounds in green tea kombucha and lavender flower kombucha can be analyzed with various tools, one of which is by using a Fourier transformed infrared (FTIR) Spectrophotometer instrument.

FTIR is a method for compound identification through infrared spectroscopy, where infrared radiation will be passed through the sample. Some of the radiation will be absorbed by the sample and some will be passed (Satriawan & Illing, 2018). The working principle of FTIR is to recognize the functional group of a compound from the results of infrared absorbance carried out on a compound in the sample. The absorbance pattern absorbed by each compound will be different so that the content of the compounds in the sample can be distinguished (Sjahfirdi et al., 2015). The advantages of FTIR, which has an interferometer, are that information about the structure can be obtained precisely and accurately because of its high resolution; can be used to analyze samples in solid, liquid and gas phases; and is fast in the process of analyzing samples. In addition, FTIR can analyze samples qualitatively and quantitatively compared to dispersion IR which can only be used for qualitative analysis. Analysis of functional groups with FTIR spectroscopy is certainly the first step in predicting the structure of a compound in a sample through its functional groups. Functional group analysis is also expected to be the basis for identifying a product or material using existing functional group data (Marselia et al., 2021). The purpose of this study was to determine the difference in the content of compounds contained in green tea kombucha and lavender flower kombucha by analyzing their functional groups using FTIR (Fourier Transform Infra Red) instrument.

2 METHODS

Location

The practicum entitled Comparison of Function Groups of Green Tea Kombucha and Lavender Flower Kombucha Using FTIR (Fourier Transform Infrared) Spectroscopy was conducted on Saturday, May 13, 2024 at the Instrumentation Laboratory of Sunan Ampel State Islamic University Surabaya, Kec. Gunung Anyar, Surabaya.

Tools and Materials

The tools used in this practicum are drop pipettes and an FTIR Spectrophotometer connected via a computer. Meanwhile, the materials used were ethanol, tissue, green tea kombucha and lavender flower kombucha.

This research uses a qualitative analysis method. The subjects in this study used 2 samples, namely green tea kombucha samples and lavender flower kombucha samples. The tool used in this research is the FTIR (Fourier Transform Infrared) tool. Qualitative data processing and analysis methods are carried out by analyzing data through FTIR tests to detect the presence or absence of functional groups in the content of green tea kombucha samples and lavender flower kombucha samples.

Work Procedure

pH Level Test

The pH measurement was measured using a pH meter. Green tea kombucha and rosella flower kombucha were put in a beaker glass and then dipped in a pH meter.

Qualitative Test of Function Groups Using IR Spectrophotometer

The work method carried out is to turn on all equipment both FTIR instruments and computers, then when the computer is on, click the microlab menu on the computer, enter the password on the menu, then click start, method, new, click data collect only, after that click instrument (click full on spectral range), then click save as. The next step is to create a folder by clicking check and activate, then click start then the next step is to wet the instrument in the sample holder with alcohol and clean it with a tissue, then the green tea Kombucha sample is taken using a drop pipette and dripped on a sample holder that has been cleaned with alcohol, then click next on the computer and Spektra will appear on the computer screen, after that click data handling, then export, CPS and rename. The last step is to print the spectra data of green tea and lavender flower kombucha samples in the form of word or pdf, then save the file.

Repeat the same treatment on the Lavender flower kombucha sample.

3 RESULTS and DISCUSSIONS

The results of qualitative tests of compounds contained in green tea kombucha samples using Infrared spectrophotometer (FTIR) are presented in Figure 1. This wave number data is then matched with literature frequency data. The functional groups obtained from the matching results for each wave number are presented in Table 1.
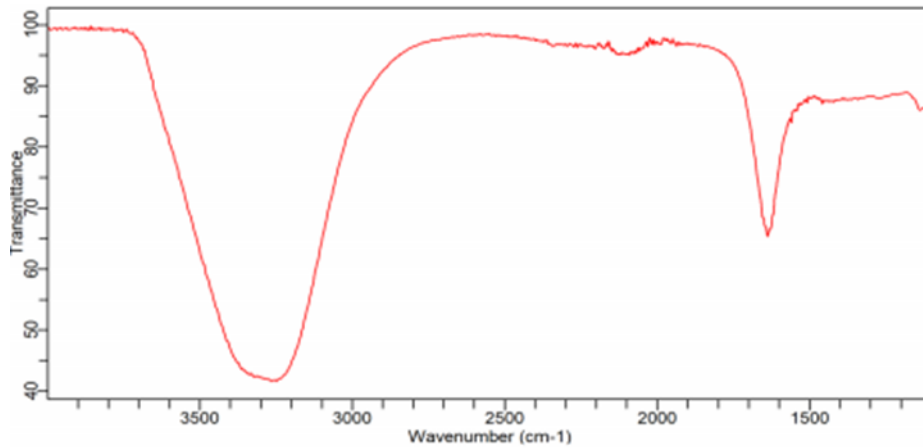
Figure 1: FTIR Spectrum of Green Tea Kombucha

Table 1: FTIR Data of Green Tea Kombucha

Wave number value obtained (cm)-1	Literature	Bond type
1136,83804	1050-1300	C-O (Alcohol, ethers, carboxylic acids, esters)
1638,16498	1610-1680	C=C (alkenes)
2118,99156	2100-2260	C≡C (Alkynes)
3267,01161	3200-3600	O-H (Hydrogen-bonded, alcohols, phenols)

Based on the data analysis of the FTIR spectrum results on the green tea kombucha sample, there are four functional groups detected, namely, there is a wide absorption at a wavelength of 3267.01161 cm-1 which indicates the stretching vibrations of the O-H (hydroxyl) group, also detected the C = C group at a wave of 1610.31 cm1. C-O group at wave number 1136.83 cm-1 and the presence of C-O group stretching vibrations at a wavelength of 1136 cm-1.

The results of the analysis of functional groups in lavender samples can be seen in Figure 2 and Table 2.
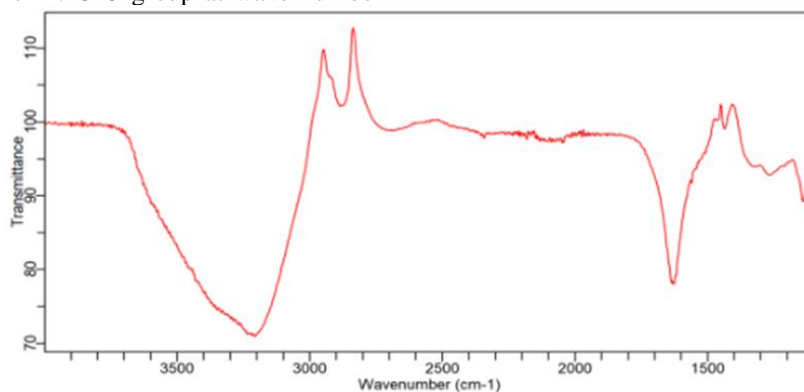
Figure 2: FTIR spectrum of Lavender Flower kombucha

Table 2: FTIR Data of Lavender Flower Kombucha

Wave number value obtained (cm)-1	Literature	Bond type
1628,84663	1610-1680	C=C (alkenes)
2569,99944	2500-2700	O-H (Hydrogen-bonded, carboxylic acids)
2689,27425	2500-2700	O-H (Hydrogen-bonded, carboxylic acids)
2879,36848	2850-2970	C-H (Alkanes)
3207,37421	3200-3600	O-H (Hydrogen-bonded, alcohols, phenols)

FTIR spectrum analysis of lavender kombucha showed several wave numbers associated with various types of bonds. At a wave number of 1628.84663 cm-1, C=C bonds were detected, stretching vibrations of hydrogen-bonded O-H groups at wave numbers 2569.99944 cm-1 and 2689.27425 cm, stretching vibrations of C-H bonds at a wavelength of 2879.36848 cm-1, and absorption indicating the stretching vibrations of O-H groups at a wave number of 3207.37421 cm-1. The results of FTIR analysis on lavender kombucha tea have almost the same functional group content as green tea.

Green tea kombucha and lavender kombucha were detected to have some of the same groups, namely O-H groups and C=C groups. The widened bands in these two samples are caused by the presence of intermolecular hydrogen bonds. The hydroxyl group band can come from phenol (Ar-OH) groups, and is corroborated by the presence of C=C groups in the sample. Based on the presence of these two groups, it can be analyzed that green tea kombucha and lavender kombucha contain phenolic or polyphenolic compounds (Mahardika et al., 2020). In green tea kombucha, C-O groups and C≡C groups were indicated which were not detected in the lavender kombucha sample. Both groups can strengthen that green tea contains polar compounds (Sunardi, 2023). One of the flavonoid compounds found in green tea is catechin.

Green tea is known to have high antioxidant activity. This antioxidant activity is caused by the compounds contained therein, including catechin compounds. Catechins are secondary metabolite compounds from the flavonoid group that have a flavon-3-ol structural framework (Fadhilah et al., 2021). Catechin has the chemical formula C15H14O6, which has 15 carbon atoms arranged in the C6-C3-C6 configuration and its carbon skeleton consists of two C6 groups (substituted benzene rings) and is connected to three aliphatic carbon atoms (Figure 3) (Katja et al., 2021).
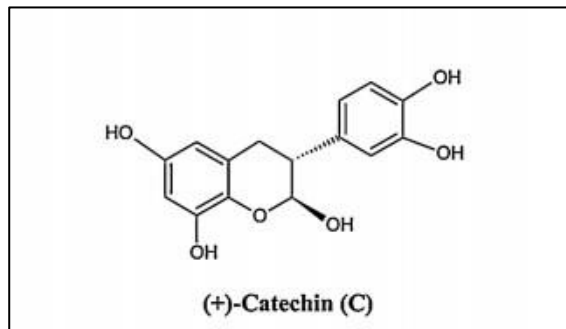
Figure 3: Catechin compounds (Katja et al., 2021).

Catechins have two aromatic rings and several hydroxyl groups, because they have more than one hydroxyl group this compound is referred to as a polyphenolic compound or a compound that acts as an antioxidant, apart from antioxidants catechins also have greater antibacterial activity against gram positive than gram negative bacteria. The main sources of catechins are found in fruits such as grapes, apples, pears, cherries, green tea and gambier (Fadhilah et al., 2021). While the kombucha sample indicated the stretching vibrations of the hydrogen-bonded O-H group at wave numbers 2569.99944 cm-1 and 2689.27425 cm-1 which indicated the presence of carboxylic acids in the sample, as well as at wave number 2879.36848 cm-1 there were stretching vibrations of C-H alkanes bonds which were not detected in the green tea kombucha sample. These functional groups indicate the presence of nonpolar compounds such as terpenoids and steroids contained in lavender kombucha samples (Susanti and Nurman, 2022).

The results of this FTIR spectrum analysis show that lavender tea kombucha contains compounds with various functional groups, reflecting its complex and rich chemical composition. However, this instrument only functions to determine molecular vibrations which are used to predict the structure of chemical compounds contained in the sample (Sulistiyani & Huda, 2018). This instrument cannot directly determine what compounds are contained in the sample, but only predicts compounds by looking at the results of the functional groups produced.

In addition to the differences in functional groups analyzed using FTIR, the two kombucha samples also have different PH levels. The pH of green tea kombucha is 3.32 while the pH of lavender flower kombucha is 2.90. pH is one of the important parameters affecting kombucha fermentation due to the formation of several acids formed such as acetic and gluconic acids. It is also closely related to microbial growth and changes in the structure of phytochemical compounds that can affect antioxidant activity (Hafsari and Farida, 2021).

4   CONCLUSIONS

The conclusion of this study shows that green tea kombucha and lavender flower kombucha have differences in chemical composition that are reflected in the pattern of functional groups detected in FTIR analysis. Although both contain phenolic compounds, green tea kombucha contains polar compounds such as catechins that act as antioxidants, while lavender kombucha contains nonpolar compounds such as terpenoids and steroids. In addition, differences in pH levels can also affect the fermentation process and antioxidant activity of both types of kombucha.

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Analysis of the Effect of Knowledge Level and Nutritional Status Related to the Concept of Healthy Snacks

Filda Ilfi Yana, Ayu Rosyidah P, Dziyauu Qoulin N, Hendryanto Maulana G, Kholifah Dian K, Ria Qodariah Arief*, Nova Lusiana

Nutrition Departement, Faculty of Physiology and Heath, Universitas Islam Negeri Sunan Ampel, Surabaya
ria.qadariah@gmail.com

Abstract: The importance of understanding the concept of healthy food has raised awareness about choosing healthy snacks for school children. This study aims to analyze the effect of knowledge level and nutritional status related to the concept of healthy snacks. This research uses a cross-sectional method, which is a way of approaching or collecting data with pre-tests and post-tests, anthropometric measurements, and student data analysis. The sample consists of 37 students from SDN I Tambaksari Surabaya aged 12-13 years. The results show no significant relationship between nutritional status and knowledge of healthy snacks (p-value = 0.162 > α = 0.05) and between gender and increased knowledge of healthy snack concepts (p-value = 0.131 > α = 0.05). The conclusion of this study indicates that the respondents' knowledge and gender do not affect their behavior in choosing healthy snacks.

1   INTRODUCTION

Children are the most valuable long-term investment. Amid daily busy activities, snacks become an essential part of children's diet. Children often buy food outside without considering its cleanliness and content. The importance of maintaining a healthy diet has increased awareness of the need for healthy snacks. Healthy snacks not only satisfy hunger but also provide good nutritional benefits for the body.

Awareness of the importance of healthy snacks for children needs to be instilled not only at home but also at school and in their play environment. Lack of knowledge is one of the reasons children continue to consume unhealthy snacks. Parents, teachers, and caregivers play key roles in providing and educating children about good food choices. Initiatives such as nutrition education programs in schools, promoting healthy food in canteens, and providing healthy snack options at home can help form good eating habits from an early age (Sumarni et al., 2020).

In addition to education, innovation in creating attractive and delicious snacks is also very important. Healthy snacks must be able to compete with less healthy snacks in terms of taste and visual appeal.

Serving food becomes an attraction because the first thing a person does in choosing food is looking at the presentation and decoration. Using natural ingredients, reducing unnecessary additives, and creative presentation can make healthy snacks more appealing to children (Hartatik, 2022).

Thus, encouraging healthy snack consumption among children is not just about providing better options but also about building a strong foundation for the future generation's health. This is an essential step in preventing future health problems and ensuring children grow up healthy and strong.

2   METHODS

In this study, the researchers used the likelihood test, a statistical approach used to make inferences about model parameters based on observed data. This activity was carried out directly through the provision of education on healthy snacks in the school environment and filling out community service information. This method is implemented to interact

directly with the target as an effort to promote healthy snacks consumption for school children. The activities were carried out in several stages, including.

Anthropometric Measurements

In this stage, height and weight measurements were carried out with the target, namely school children aged 12-13 years. Anthropometric measurements were carried out directly by two coordinators. The first coordinator measured height, while the second coordinator measured weight.

Figure 1: Anthropometric Measurements

Community Service Information Filling

After the anthropometric measurements, the community service team requested permission from the class teacher to collect data through this information filling. Before filling out the community service information, the team provided instructions on how to fill out the information.

Pre-Test Question Filling

In this stage, pre-test filling was used to measure students' knowledge about healthy snacks before being given education. Students were asked to fill out questionnaires individually in a conducive classroom atmosphere. The community service team gave 30 minutes for filling out the pre-test questionnaires. The researchers ensured that the students understood the instructions clearly and well.

Figure 2: Pre-Test Question Filling

Providing Education on The Importance of Consuming Healthy Snacks for School Children

After filling out the pre-test questionnaires, students were given education related to healthy snack consumption using lecture, discussion methods, and a session closed by a volunteer from one of the sixth-grade students to deliver the material obtained for 30 minutes.

Post-Test Questions Filling

In this stage, post-test filling was used to measure students' knowledge about healthy snacks after being given education. Students were asked to fill out questionnaires individually in a conducive classroom atmosphere. The community service team gave 30 minutes for filling out the post-test questionnaires. The researchers ensured that the students understood the instructions clearly and well.

Figure 3: Post-Test Question Filling

Data Analysis of Students

Researchers collected data from the pre-test and post-test answers that had been collected and analyzed to measure students' knowledge levels about healthy snack consumption. Data were taken through a statistical approach by comparing pre-test and post-test results to assess the relationship between knowledge level and nutritional status of school children regarding healthy snacks.

Time of implementation

This activity was carried out for one day at SDN Tambaksari I Surabaya, Jl. Mundu No.35, Tambaksari, Tambaksari, Surabaya, East Java, 60136. The stages included coordination between the community service team and the school, permission from the class teacher, anthropometric measurements, community service information filling, pre-test questionnaire filling, education intervention, post-test questionnaire filling, and closing.

3 RESULTS

Table 1: Sample Distribution by Gender

| Nutritional Status | Gender | | | | total | | p* |
| | Male | | Female | | | | |
	n	%	n	%	n	%	
Less	3	33.3	5	62.5	9	100	
Normal	8	42.1	11	57.9	19	100	0,131
More	5	55.5	4	44.5	9	100	
total	16		20		36		

* p-value from likelihood test

Effect of Nutritional Status Based on Respondent Gender on Knowledge Improvement in Healthy Snack Concepts

Based on the data analysis using the likelihood test, a p-value of 0.131 > α = 0.05 was obtained, meaning Ha is rejected, and Ho is accepted. Thus, it can be concluded that there is no relationship between gender and the improvement of healthy snack concepts knowledge among students at SDN 1 Tambaksari Surabaya, meaning the respondents' gender does not affect the improvement of healthy snack concepts knowledge.

Table 2: Distribution Based on Nutritional Status

| Nutritional Status | Knowledge of Healthy Snack Concepts | | | | | | p* |
| | Adequate | | High | | | | |
	n	%	n	%	n	%	
Less	1	12.5	7	87.5	8	100	
Normal	2	10.52	17	89.48	19	100	0,162
More	1	11.11	8	88.89	9	100	
total	4		32		36		

* p-value from likelihood test

Effect of Nutritional Status Based on Knowledge of Healthy Snack Concepts on Knowledge Improvement in Healthy Snack Concepts

Based on the data analysis using the likelihood test, a p-value of 0.162 > α = 0.05 was obtained, meaning Ha is rejected, and Ho is accepted. Thus, it can be concluded that there is no relationship between nutritional status and the knowledge level of healthy snack concepts among students at SDN 1 Tambaksari Surabaya, meaning the respondents' knowledge does not affect their behavior in choosing snacks.

4 DISCUSSIONS

Snacks are foods consumed between main meals and are one of the sources of calorie intake. Snacks

contribute about 20% of the total daily calories consumed by school students. It is essential to choose snacks not only based on the students' interests and preferences but also on their nutritional needs. Additionally, snacks should not reduce their appetite for main meals. Examples of healthy snacks that can be chosen include fresh fruits and vegetables and their processed forms like fruit juices, nuts such as walnuts, hazelnuts, and almonds, and simple biscuits (Bastami et al., 2019).

In this study, we conducted assistance to improve the knowledge concept of healthy snacks. During the community service to the students at SDN 1 Tambaksari, we observed that the students were very active in gaining knowledge about healthy snacks concepts. During the material presentation session, they paid attention, and during the question session about healthy snacks, they were eager to answer and explain their conclusions about the concept of healthy snacks. The results of the post-test averages show that their knowledge about healthy snacks was very good.

This research aims to understand the knowledge about healthy snacks and nutritional status among 6A grade students at SDN 1 Tambaksari Surabaya, and to determine the relationship between gender and nutritional status with increased knowledge about healthy snacks. An individual's nutritional status reflects the balance between the nutritional intake received and the body's nutritional needs. To achieve good nutritional status, the body must be able to utilize these nutrients to maintain energy reserves and replace lost nutrients. Good nutritional status is an important indicator to assess the development and growth of children, while knowledge about healthy snacks can influence the food choices that might be consumed daily.

The Relationship Between Gender and Knowledge About Healthy Snacks at SDN Tambaksari I Surabaya

This study was conducted to test the hypothesis that there is a significant relationship between nutritional status and knowledge of healthy snacks using the likelihood test in statistics because the Pearson chi-square test was not met. The results in Table 1 show that there is no significant relationship between gender and the increase in knowledge of the healthy snack concept in elementary school children. The results of the likelihood ratio test yielded a p-value of more than 0.05, namely 0.131, indicating that there is no significant relationship between the gender of the respondents and the increase in knowledge of the healthy snack concept.

These research results are similar to those of a study conducted on elementary school students in the Bukit Bestari District, Tanjung Pinang City, Riau Islands Province by (Pitriyanti et al., 2023). In their study, it was found that there was no relationship between gender and knowledge about healthy snacks in elementary school children. This explains that both male and female respondents have a good level of knowledge about healthy snacks. This is because our respondents were 6th-grade students, who already have a sufficient understanding of the concept of healthy snacks

The Relationship Between Children's Nutritional Status and Knowledge About Healthy Snacks at SDN Tambaksari I Surabaya

In the study on the relationship between knowledge about healthy snacks and nutritional status among students of SDN I Tambaksari Surabaya, the statistical likelihood test results from the SPSS 26 for Windows calculation were 0.162, which means that the P-value $> \alpha$, namely $0.162 > 0.05$, thus, Ha is rejected and H0 is accepted. There is no correlation between knowledge about healthy snacks and the nutritional status of children at SDN I Tambaksari Surabaya. This is indicated by the majority of respondents achieving maximum scores on both the pre-test and post-test questions. Based on these results, the level of knowledge and nutritional status of students at SDN I Tambaksari Surabaya does not have a significant relationship with the concept of healthy snacks. This shows that the level of knowledge about healthy snacks does not directly influence the nutritional status of children.

This is not in line with the research conducted by (Puspita et al., 2024) which states that there is a correlation between knowledge and the nutritional status of children. In their study, nutritional status has a very close relationship with the development of gross motor skills in children, meaning that the lower the nutritional status of the child, the lower the child's motor development and vice versa. Whereas in our study, knowledge does not affect the nutritional status of children. This could be due to other factors such as eating patterns, meal frequency, and physical activity which have a greater influence on the nutritional status of the students. Therefore, these two studies have different results.

Thus, it is hoped that students can choose healthy snacks that are not only delicious but also nutritious. Because students who have good nutritional status, consumption patterns, and behavior in choosing snacks will have a healthier body and an ideal physique.

5   CONCLUSIONS

The conclusion of this study is that, based on data analysis using the Likelihood test, no significant relationship was found between nutritional status and the level of knowledge about healthy snacks (p-value = $0.162 > \alpha = 0.05$), and there is no significant relationship between gender and the increase in knowledge of the concept of healthy snacks (p-value = $0.131 > \alpha = 0.05$) among grade VI A students of SDN I Tambaksari, Surabaya. This indicates that the knowledge and gender of the respondents do not influence their behavior in choosing healthy snacks. Other factors such as dietary patterns and physical activity may have a greater impact on the nutritional status of the students. Therefore, it is hoped that students can choose snacks that are not only tasty and attractive but also nutritious to maintain health and achieve optimal nutritional status.

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Comparison of Functional Groups in Green Tea Kombucha (Camellia sinensis) and Chamomile Flower Kombucha (Matricaria chamomilla) Using Fourier Transform Infrared Spectroscopy (FTIR)

Yolanda Safira Virginia[1], Amanda Ameliya[1], Syafa Putri Nabila[1], Risa Purnamasari[1], Eva Agustina[1], Nova Lusiana[2]*

[1]*Faculty of Science and Technology, Sunan Ampel State Islamic University, Surabaya, Indonesia*
[2]*Faculty of Psychology and Health, Sunan Ampel State Islamic University, Surabaya, Indonesia*
* *novalusiana@uinsa.ac.id*

Keywords: Kombucha, Chamomile flowers, Green tea, FTIR.

Abstract: Kombucha is a fermented beverage made by SCOBY (*Symbiotic Culture of Bacteria and Yeast*). Substrates in making kombucha drinks can use ingredients that contain high phenolic compounds, such as green tea and chamomile flowers. Green tea is a type of tea that is not fermented or non-fermented and contains more catechins (one of the flavonoid components) and is beneficial for health. Chamomile flower preparations in the form of tea are believed to reduce pain, because they contain flavonoid compounds that can reduce pain, can cure canker sores, overcome sleep problems, digestion, anxiety. This study aims to determine the functional groups contained in chamomile flower kombucha and green tea. The method used is the analysis of functional groups using *Fourier Transform InfraRed*, then comparisons are made on the resulting functional groups. The results showed that the functional groups contained in chamomile flower kombucha are C-O ether, C-N amine, C=C alkene, C≡C alkyne, C=O ester, and O-H alcohol. While the functional groups found in green tea are C-N amine, C=C alkene, C≡C alkyne, and O-H alcohol. Thus, chamomile flower kombucha and green tea are known to contain secondary metabolite compounds of flavonoids, phenolics, saponins, and tannins.

1 INTRODUCTION

Tea is the most popular drink in society, because tea is the type of drink most consumed by adult humans. Drinking tea is often done by some people in the morning before starting activities, drinking tea is very delicious when it is still warm because it can refresh the body and mind (Anggraini et al., 2018). Green Tea is one type of herbal tea originating from China. This plant is widely cultivated in Southeast Asia as a raw material for making traditional medicine (herbal medicine) This is because green tea contains high amounts of polyphenols, namely 30-40%, higher than black tea which contains 3-10% polyphenols (Amalia et al., 2016).

Green tea is a type of tea that is not fermented or non-fermented and contains more catechins (one of the flavonoid components). Green tea is obtained by drying fresh leaves, has several good effects on

health, one of which is to reduce the risk of cardiovascular disease such as blood cholesterol levels and blood pressure. Catechin compounds are secondary metabolite compounds naturally produced by plants and belong to the flavonoid group, catechins in tea leaves are very complex compounds consisting of 6 components, namely Epicatechin (EC), Epicatechin 3-Gallate (ECG), Epigallocatechin (EGC), Epigallocatechin 3-Gallate (EGCG), Catechin (C), Gallocatechin (GC). Tea has the main efficacy derived from the polyphenols contained in it (Kusnan, 2022).

Chamomile is native to Europe and Western Asia, but is currently considered a cosmopolitan species. Since its presence in Mexico in the 16th century, this species has been used mainly to treat diseases related to the gastrointestinal system such as diarrhea. In

other countries, the flowers of this species are often used in tea form to treat spasmolytics and as a sedative (Putra & Septa, 2018). Chamomile or also called chamomile is a plant in the Asteraceae family that grows throughout Europe and Asian regions that have 4 seasons. This plant is also widespread because it is cultivated by humans in North America and Australia, which has many benefits in medicinal herbs. The Latin name of the chamomile plant is Matricaria chamomilla L. This plant can grow as high as 15-60 cm with long and small leaves in groups of three leaves on a stalk. The flowers look like daisy flowers, with white petals with a yellow center. Matricaria chamomilla is used as a traditional medicine to treat wounds, mouth ulcers, inflammations, bacterial infections and other diseases. M. chamomilla in the form of water extracts is often used as a mild sedative.4 Some studies say that this M. chamomilla has functions as anti-inflammatory, anticancer, antioxidant, and antibacterial (Alim & Hayuningtyas, 2023).

Chamomile tea has the property of relaxing tense nerves, this plant contains about 120 chemical compounds including flavonoids, 3% glycosides, azolines, apigenin, and methoxycoumarin. The content of chamomile, especially bisabolol and karmasolen, has anti-inflammatory effects, chamomile is also an analgesic, antipyretic, antirheumatic, anti-inflammatory, carminative and sedative properties known to reduce menstrual pain (Yuliyanti, 2021). M. chamomilla has many benefits for medicinal herbs due to its phytochemical content, including flavonoids, alkaloids, saponins, terpenoids, tannins / phenols, steroids, and chamazulene. Flavonoids can be divided into several parts, the first being flavones (apigenin, luteolin), flavonols (quercetin), flavanols (hesperetin), anthocyanins, and proanthocyanidins or tannins. Flavonoids are proven to improve health, prevent disease, and have antioxidant, cardiovascular disease prevention, anti-inflammatory, anticancer activities, besides that they are very safe and have low toxicity. One of the compounds found in chamomile is flavonoid compounds. Flavonoids contained in this plant have a function as anti-inflammatory. Flavonoids can stimulate the immune system by increasing the activity of macrophages and lymphocytes. Most of the anti-inflammatory effects of flavonoids are on the biosynthesis of cytokine proteins that separate the adhesion of circulating leukocytes to the site of injury (Alim & Hayuningtyas, 2023).

A preliminary study found that 82% of people given chamomile extract reported "complete" pain reduction. This plant has a soothing effect on mucous membranes, and ingredients that have a healing effect. Tea from concentrated chamomile can be used as a mouthwash; three or four times a day for the treatment of aphthae (Putri, 2015). Chamomile is widely used in the form of aromatherapy oil or drunk as tea. Chamomile flowers are often used in tea form to treat spasmolytics and as a sedative. Both fresh and dried chamomile flowers have aromatic, flavoring and coloring properties. They are used in a number of commercial products including soaps, detergents, perfumes, lotions, ointments, hair products, alcoholic beverages and herbal teas. The use of chamomile as an herbal remedy dates back to ancient Greek and Roman times. Chamomile has been used as a traditional herbal medicine because of its calming effect (Putra & Septa, 2018).

The mechanism of chamomile therapy in reducing pain is related to the mechanism of anti-inflammatory effects and arome therapy where nerve fibers in the nose carry sensory input in the brain which is the center of instinct, memory, and various vital functions are formed. Chamomile is most commonly used to treat sleep disorders, digestive problems, pain relief, and many others (Putri et al., 2018). Chamomile tea has a soothing effect on mucous membranes, and the ingredients have a healing effect. Tea from concentrated chamomile can be used as a mouthwash; three or four times a day for the treatment of aphthae (Putri, 2015). The mechanism of flavonoids in inhibiting the inflammatory process in burn wounds through various ways, namely inhibiting capillary permeability, inhibiting the release of serotonin and histamine to the site of inflammation, arachidonic acid metabolism by inhibiting the work of cyclogenase, and the secretion of lysosomal enzymes which are inflammatory mediators inhibition of these inflammatory mediators can inhibit the proliferation of the inflammatory process, neutrophil cells, and endothelial cells (Anisa et al., 2019).

The advantage of kombucha tea over regular tea liquid is the content of organic acids and several compounds such as vitamins and amino acids. The results of research conducted by Purwaning (2010) and Rahayu (2005) using kombucha tea on white rats showed a decrease in cholesterol levels. Making kombucha tea made from a variety of leaves, namely bay leaves, guava leaves, betel leaves, soursop leaves, coffee leaves, and tea leaves, states that the best kombucha tea is made from tea leaves, because the tannin contained in tea leaves is the highest so that it affects the antioxidant level of kombucha mushroom growth media (Purnami et al., 2018).

Fourier Transformed Infrared (FTIR) is one of the tools or instruments that can be used to detect functional groups, identify compounds and analyze mixtures of analyzed samples without damaging the sample. The working principle of FTIR spectrophotometry is the interaction between energy and matter. Infrared that passes through the gap to the sample, where the gap serves to control the amount of energy delivered to the sample. Then some infrared is absorbed by the sample and the other is transmitted through the sample surface so that the infrared rays pass to the detector and the measured signal is then sent to the computer, then recorded in the form of peaks from the sample tested (Sari et al., 2018). The advantage of using chemometric techniques for IR spectrum interpretation is its ability to link the spectrum profile with hidden information contained by the plant. The resulting FTIR spectrum is a very complex data information that will thoroughly describe the chemical characteristics of a material. Changes that occur in band position and intensity in the FTIR spectrum will be related to changes in the chemical composition of a material. Therefore, FTIR spectra can be used to distinguish plants from one another even though the composition of the chemical compounds is not known with certainty (Purwakusumah et al., 2014).

2 METHODS

Tools and Materials

The tools used in this research include drop pipettes, tissues, and IR spectroscopy. While the materials used are chamomile Kombucha, green tea Kombucha, and alcohol as a blank.

Preparation of Kombucha

2000 ml of water is boiled until boiling and 200 grams of sugar (10% b/v) is added from the amount of water used and 10 grams of 0.5% (b/v) tea is added. Then filtered and the filtrate is covered with aluminum foil and let stand until the tea has room temperature. After that, 200 ml of kombucha culture starter (10% b/v) was added to the steeping tea and the container was tightly closed. Propagation of kombucha culture starter was left for 14 days.

pH test

Before conducting the test, the pH meter must be calibrated using Buffer 4.0 and 7.0 solutions before continuing the measurement. After that, the sample is measured by attaching the pH meter electrode to it and waiting for a while until a stable value is read.

Function Group Analysis

Chamomile kombucha and green tea that have been made are analyzed using IR spectroscopy.

3 RESULTS and DISCUSSIONS

The results of qualitative tests of compounds present in green tea kombucha samples using an Infrared spectrophotometer (FTIR) are shown in Figure 1. From the spectrum, it can be seen that there are several peaks showing absorption at wavelengths of 1136.83804 cm-1, 1638.16498 cm-1, 2118.99156 cm-1 and 3267.01161 cm-1. This wavelength data was then compared with the frequency data available in the literature. The functional groups identified from this comparison for each wavelength are presented in.

Figure 1: Apperarance of Chamomile Flower Kombucha & Green Tea Kombucha

Table 1: FTIR Data of Green Tea Kombucha

Wave number value obtained (cm)-1	Literature	Bond type
1136,83804	1050-1300	C-O (Alcohol, ethers, carboxylic acids, esters)
1638,16498	1610-1680	C=C (alkenes)
2118,99156	2100-2260	C≡C (Alkynes)
3267,01161	3200-3600	O-H (Hydrogen-bonded, alcohols, phenols)

Based on the data analysis of the FTIR spectrum of the chamomile flower kombucha sample, it shows several wave numbers associated with various types of bonds. At wave number 1628.84663 cm-1, the C=C bond was detected. Strain vibrations from alcohol-bound C-O groups at wave numbers 1140.56538 cm-1 and 1267.29486. Strain vibrations of C≡C bonds at wavelengths of 2154.40127 cm-1, 2173.03796 cm-1, and 2249.44838. As well as absorption that shows the stretching vibrations of the O-H group at a wave number of 3229.73824 cm-1.
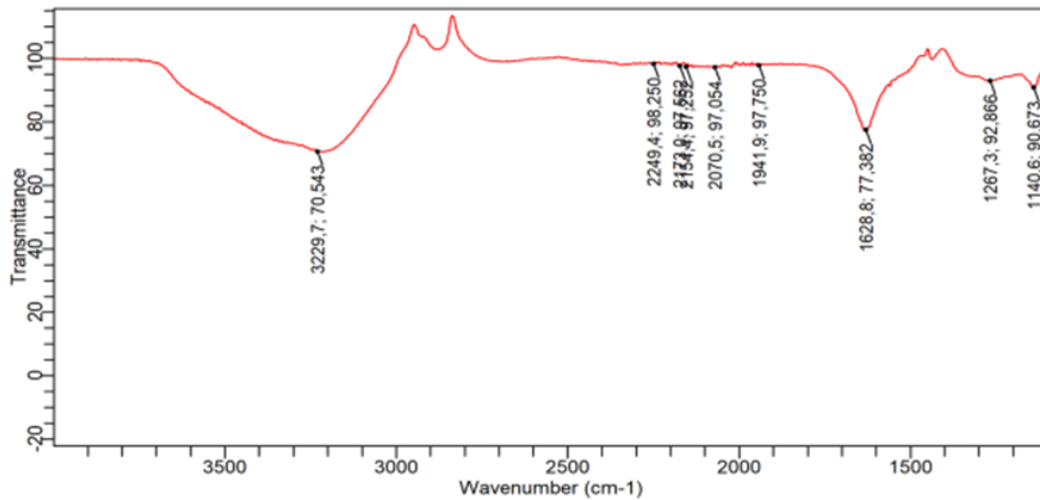
Figure 2. FTIR spectrum of chamomile flower kombucha

Table 2: FTIR Data of Chamomile Flower Kombucha

Wave number value obtained (cm)-1	Literature	Bond type
1140,56538	1050-1300	C-O (Alcohols, ethers, carboxylic acids, esters)
1267,29486	1050-1300	C-O (Alcohols, ethers, carboxylic acids, esters)
1628,84663	1610-1680	C=C (alkenes)
2154,40127	2100-2260	C≡C (Alkynes)
2173,03796	2100-2260	C≡C (Alkynes)
2249,44838	2100-2260	C≡C (Alkynes)
3229,73824	3200-3600	O-H (Hydrogen-bonded, alcohols, phenols)

Phytochemical compounds contained in green tea based on table 1. include flavonoids, tannins, saponins, and phenolic compounds. According to research by (Kusmiyati et al., 2015) green tea has high flavonoid levels, which are around 20-30% of dry weight, especially in the catechin group. It was also stated by Lindawati and Anggraini, 2020 that green tea contains polyphenolic compounds including flavanols, flavonoids, flavandiols, and phenolic acids where the total amount can reach 30% of the weight of dry tea. Apart from the four antioxidant compounds, green tea also contains tannins, alkaloids, triterpenoids, and saponins. The content is detected in the form of functional groups C-O (Alcohol, ethers, carboxylic acids, esters), C=C (Alkenes), C≡C (Alkynes), and O-H (Hydrogen-bonded, alcohols, phenols). The presence of aromatic rings is indicated by the absorption in the wave number region 1638,16498 cm-1 which is the absorption of the aromatic C=C ring stretch as a typical chromophore group of flavonoids in conjugated bond systems. Tannin compounds were detected by the presence of O-H, C=C, and C-O groups which are characteristic functional groups in tannin and saponin compounds.

The functional groups that can be detected in chamomile kombucha are alcohol or ether groups (C-O), alkenes (C=C), alkynes (C≡C), and hydroxyls (O-H). Therefore, the content of Chamomile flowers is not much different from the content in green tea. In the study said that the content of secondary metabolites in chamomile includes flavonoids, alkaloids, saponins, terpenoids, tannins / phenols, steroids, and chamazulene. Flavonoids can be divided into several parts, the first being flavones (apigenin, luteolin), flavonols (quercetin), flavanols (hesperetin), anthocyanins, and proanthocyanidins or tannins. Flavonoids are proven to improve health, prevent disease, and have antioxidant, cardiovascular disease prevention, anti-inflammatory, anticancer activities, besides that they are very safe and have low toxicity. One of the compounds found in chamomile is flavonoid compounds. Flavonoids contained in this plant have a function as anti-inflammatory. Flavonoids can stimulate the immune system by increasing the activity of macrophages and lymphocytes. Most of the anti-inflammatory effects of flavonoids are on the biosynthesis of cytokine proteins that separate the adhesion of circulating leukocytes to the site of injury (Alim & Hayuningtyas, 2023).

Chamomile flowers have long been used as an ingredient in traditional medicine, especially in traditional Iranian medicine where it is often used as an anti-inflammatory, antioxidant, remedy for skin problems, remedy for respiratory problems, sedative tranquilizer, and so on. Previous studies have shown that chamomile tea has anti-inflammatory and woundhealing properties. Ingredients such as bisabolol in chamomile can help reduce inflammation and speed up the healing process of burn wounds. In addition, flavonoids contained in chamomile extract have an important role in plant biochemistry and physiology, which functions as an antioxidant, antibacterial and anti-inflammatory. Flavonoids can accelerate the wound healing process by increasing the rate of wound contraction, decreasing the epithelialization period, increasing collagen deposition, and forming granulation tissue (Hakim et al., 2021).

The difference in the content of secondary metabolites in plants is influenced by the age of the sample and the environmental conditions in which the plant grows, although qualitatively the content of secondary metabolites is almost the same. The content of secondary metabolites in plants can vary depending on environmental factors and factors in the plant itself. The age and maturity level of a plant

affects the content of secondary metabolites that are maximally active in the plant. Strengthened by the statement The growth of a biota is influenced by external and inner factors. External factors are territory, season, water temperature, type of food available and other environmental factors, while internal factors are age, size, and other biological factors (Supriatna et al., 2019).

Table 3: pH Test Results

Types of kombucha	pH
Green Tea Kombucha	2.78
Chamomile kombucha	3.32

After analyzing the functional groups on the graph, the pH test was continued to determine the acidity level of each kombucha. The pH test on chamomile kombucha and green tea kombucha is shown in Table 3. It can be observed that the difference is quite far, namely 2.78 in chamomile kombucha and 3.32 in green tea kombucha. pH shows the success rate of the fermentation process in making kombucha tea. pH is one of the most important environmental parameters that affect kombucha fermentation due to the formation of several acids formed such as acetic and gluconic acids. It is also closely related to microbial growth and changes in the structure of phytochemical compounds that can affect antioxidant activity (Hafsari et al., 2021).

4 CONCLUSIONS

The study demonstrates that Fourier Transform Infrared Spectroscopy (FTIR) effectively identifies functional groups in both green tea kombucha and chamomile flower kombucha. The results indicate that the fermentation process in both kombucha types influences the chemical composition, leading to similar functional groups despite the different sources. This suggests that the fermentation process plays a pivotal role in defining the chemical properties of kombucha, potentially affecting its health benefits and flavor profiles. Future research could explore the impact of varying fermentation durations on these properties.

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Halal Food Development Strategy: Preliminary Study

Sri Herliana[1]*, Inayati Fadhilah Zulfa[1]

Institut Teknologi Bandung, Bandung, Indonesia

**sri.herliana@sbm-itb.ac.id*

Keywords: Halal, Food, Development, Strategy, SWOT.

Abstract: Indonesia is the country with the largest Muslim population in the world and is ranked first for consumers of food and beverage products halal. The large Muslim population with the value of food and drink consumption The largest halal food in the world has not been able to become a driving force for Indonesia to increasing the production of halal food and drinks. The country's large Muslim population provides a market for halal products, creating strong domestic demand that can drive growth and innovation in the industry. Indonesia's commitment to halal certification and regulations also makes Indonesia a leader in ensuring the integrity and authenticity of halal products, thereby further enhancing its reputation in the global market. The aim of this research is to identify strengths, weaknesses, opportunities and threats facing the large-scale halal food and beverage industry Indonesian small and medium enterprises and formulate industrial development strategies Indonesian halal food and drinks. To identify strategies for developing halal food products in Indonesia using SWOT analysis. The approach taken is a desk study approach where secondary data is obtained from various journal articles, statistical report data, reports from government agencies related to food, electronic news and other secondary data.

1 INTRODUCTION

The development of the halal industry is a transformation of the Indonesian economy towards a sustainable economy in the development of a new industrialization paradigm in Indonesia now and in the future. The development of the sharia economy and halal lifestyle is an important element for developing new sources of growth, in order to support a sustainable economy. This high growth potential can be seen from the 2022 State of the Global Islamic Economy Report (SGIER) data which shows that Muslim spending globally in 2022 will grow by 9.1% for sharia economic sectors (excluding the sharia financial sector Then, in 2025 it is estimated that Muslim spending will reach USD 2.8 trillion with a Compound Annual Growth Rate (CAGR) in four years of 7.5%. Based on the KNKS survey in the study of the National Strategy for Halal Industrial Development (2019), halal is something that It is very important for producers to produce products for society. Therefore, the processing industry needs to pay attention to processes when procuring materials, designing products, producing, storing and distributing products. According to Law no. 33 of 2014 concerning Halal Product Guarantee, halal products are produced through a halal product process, namely a series of activities (processes) to guarantee the halalness of the product, including providing materials, processing, storage, packaging, distribution, sales and product presentation (Master Plan Industri Halal Indonesia 2023-2029).

Indonesia is the country with the largest Muslim population in the world, become a target market with enormous potential for the product to enter international halal products. Based on data from Indonesia Halal Economy and Strategy Roadmap, Indonesia's position as an importer of halal food and drinks is in second place in the world with total expenditure of USD 16.88 billion in 2017. This data shows that Indonesia has not able to manage the advantages it has. High demand will be Indonesian halal food and drinks are not matched by adequate supply adequate (Rosadi, 2020).

A development strategy for the halal food and beverage industry is needed to boost the national economy. Industrial development efforts Halal food

and drinks need to be done with good strategy so that goals and development are more focused. Therefore, this research aims to identify internal and external factors Indonesian halal food and beverage industry to meet the demand for halal food and drinks.

2 LITERATURE REVIEW

SWOT Analysis

SWOT analysis is a strategic planning tool to identify and analyze the strengths, weaknesses, opportunities and threats of an organization. In the SWOT analysis, internal and external factors will be analyzed. The results of evaluating internal and external factors will produce valuable data or information regarding their current position in the market and develop strategies to exploit strengths, overcome weaknesses, take advantage of opportunities and mitigate threats. SWOT analysis helps organizations make decisions and plan for future success. (Mauno et al., 2001; David, 2015; Leigh 2009).

Figure 1: SWOT Matrix

By conducting a SWOT analysis you can better understand their competitive advantages and areas that need improvement and can be used as a tool to identify potential risks and challenges that may impact the company's operations. By assessing weaknesses and threats you can develop emergency plans and mitigation strategies to overcome potential obstacles. Additionally, SWOT analysis can provide valuable insights for identifying growth and expansion opportunities. By taking advantage of strengths and opportunities can take advantage of market trends and new technologies to drive innovation and achieve competitive advantage. A comprehensive SWOT analysis can serve as a roadmap for strategic planning and decision making, guiding a business towards sustainable growth and success. (Chao & Miguel, 2009; David, 2015).

By creating solutions based on the weaknesses and threats identified in the analysis can develop strategies to mitigate risks and improve their overall performance. The TOWS Matrix is a strategic management tool that can be used to develop an effective project risk management strategy by identifying internal strengths to address threats. caused by risk categories observed in international projects (Rahul et al., 2019).

Development of halal food and drinks in Indonesia

A key factor in the success of developing halal food in Indonesia is the increasing demand for halal products both domestically and internationally. With a large Muslim population and increasing consumer awareness of halal certification, there is a huge opportunity for businesses to enter this market. By developing halal food products that meet the strict standards set by Islamic law, companies can not only meet the needs of Muslim consumers but also appeal to a wider audience that prioritizes ethical and sustainable food choices. In addition, by investing in the development of halal food production facilities and distribution networks, businesses can position themselves as leaders in the industry and gain a competitive advantage in the global market (Nurrachmi, 2016).

The shift towards halal products reflects a larger trend towards conscious consumerism, where individuals increasingly seek products that align with their religious beliefs and values. Research shows that Muslim consumers, especially in countries such as India and Indonesia, are driving demand for halal products. halal products, including cosmetics and food. Factors such as religiosity, awareness about halal products, and halal certification play an important role in influencing consumer purchasing decisions. (Faheem & Uzma, 2018; Usman et al., 2022).

Indonesia's commitment to providing high quality halal products not only improves its economy but also strengthens its position as a center for halal trade in the region. With continued support from the government and ongoing efforts to promote the halal industry, Indonesia is poised to further expand its market share and influence in the global halal market. As consumer demand for halal products continues to increase around the world, Indonesia's strategic approach to halal certification and production will undoubtedly drive its success in the years to come. (Firdaus et al., 2012; Bagas, 2020)

By focusing on innovation and sustainability in halal production, Indonesia is preparing itself to achieve long-term success in the halal market. The country's dedication to meeting the needs of Muslim consumers while ensuring the highest standards of quality and authenticity has earned the country a reputation as a trusted source for halal products. With cooperation between government and industry to promote and develop the halal sector, Indonesia is well positioned to capitalize on the increasing global demand for halal goods and services. As a result, Indonesia's influence in the halal industry is expected to grow stronger in the coming years (Fernando et al., 2021).

Through continuous innovation and dedication to quality, Indonesia can further establish itself as a leader in the halal food sector. By investing in research and development, the country can create unique, best-selling products that will attract consumers from all over the world. In addition, by encouraging transparency and compliance with strict halal standards, Indonesia can build trust and credibility among consumers, thereby further strengthening its position in the global market. Ultimately, with a strategic approach to growth and a commitment to excellence, Indonesia has the potential to become a force in the halal food industry in the years to come. "Indonesia can further establish itself as a leader in the halal food sector by investing in research and development of halal food products. Analysis of halal food products in Indonesia focuses on the study and implementation of policies to develop competitiveness in Southeast Asia, stimulate economic development with strategies to optimize the export and import potential of halal food products (Imsar & Budi, 2023).

3 METHODS

To identify strategies for developing halal food products in Indonesia using SWOT analysis. The approach taken is a desk study approach where secondary data is obtained from various journal articles, statistical report data, reports from government agencies related to food, electronic news and other secondary data.

4 RESULTS and DISCUSSIONS

Strength

Largest Muslim population

In 2020, the Muslim population in the world reached 1.9 billion people, and it is estimated that it will continue to grow to 2.2 billion people or 26.5 percent of the total world population in 2030. This increase in numbers will be accompanied by increasing demand for products. and halal services. In 2020, Indonesia exported a total of USD46.7 billion for halal products in the form of food, fashion, pharmaceuticals and cosmetics globally. For exports of Indonesian halal products to member countries of the Organization of Islamic Cooperation (OIC), it was recorded that it reached USD48.3 billion in 2021, and is projected to increase to USD53.8 billion in 2022. Population provides a market for halal products, creating strong domestic demand that can drive growth and innovation in the industry. Indonesia's commitment to halal certification and regulations also makes Indonesia a leader in ensuring the integrity and authenticity of halal products, thereby further enhancing its reputation in the global market (Kemenperin, 2023).

The halal food industry in Indonesia is currently experiencing significant growth and development. With a large Muslim population and increasing demand for halal products both domestically and internationally, Indonesia has become a key player in the global halal market. The country has implemented strict halal certification standards to ensure the authenticity and quality of halal products, further strengthening its reputation as a trusted source of halal goods. This has attracted investment from both local and international companies who want to take advantage of the growth of the halal industry in Indonesia. As a result, the country has experienced a surge in halal food production, distribution and exports, thereby contributing to economic growth and positioning it as a leader in the halal industry (Ilmi & Khintan, 2019).

Natural Resources

Indonesia's comparative advantage is in the form of natural resource potential the fourth largest population globally and the number one largest Muslim population in the world is fundamental economy that needs to be utilized through economic development so that it becomes a competitive

advantage and can be developed into a motorbike driving the national economy. Combining rich natural resources with The largest Muslim population in the world can be comprehensively realized through concept of halal agro-industry development. This is a form appropriate to utilize the potential it has so that it becomes a producer value-added products, highly competitive and in order to fulfill potential needs for domestic and international halal markets. Halal agroindustry is expected to be able to answer comparative advantage into excellence competition (Purnomo, 2011).

Weaknesses

Lack of Awareness of The Importance of Halal Certification

There are still many producers who pay little attention to halal products and there is still a lack of knowledge about halal products among small businesses, a lack of promotion about halal and a lack of socialization, education and information about halal (Widiastuti et al., 2011).

By overcoming these challenges and pursuing a more transparent and reliable certification system, Indonesia's halal food industry can continue to grow and gain recognition on the global stage. Regulations do provide challenges for the Indonesian halal food industry, causing inconsistencies in the quality and authenticity of halal products. The lack of clarity and integration of food safety regulations in halal standards has been widely discussed by academics. The use of pork derivative products in food products is a serious problem from a religious perspective, because some religions prohibit their followers from consuming these products (Wahyuni, 2024; Hamzah et al., 2022).

Limited Access to The Global Halal Market

Limited access to the global halal market is a challenge for Indonesian food producers, but with the right strategy and investment, they can overcome these obstacles and enter profitable markets. Collaborating with international halal certification bodies and participating in trade shows can help Indonesian companies showcase their products to a wider audience. In addition, establishing partnerships with foreign distributors and retailers can expand their reach and increase their market share in key regions. By utilizing technology and digital platforms, Indonesian food producers can also increase their visibility and accessibility to global

consumers looking for halal products. Overall, the key to unlocking the full potential of Indonesia's halal food industry lies in strategic partnerships, innovation, and commitment to quality and compliance. With the right approach, Indonesia can solidify its position as a leading player in the global halal food market and benefit from increased trade and economic growth. Challenges faced by Indonesian food producers include a lack of regulatory consultation, land acquisition issues, minimum wage setting, and excessive licensing processes. The new Food Security Agency aims to manage the supply and demand of food products, but there are concerns about the reliability of the data and the potential negative impact on the food industry if it is not well prepared. Government policy in the agricultural sector focuses on output and input subsidies, but there are limitations on foreign ownership in this sector. The goal of self-sufficiency with other goals is still a challenge (Bima et al., 2014)

By collaborating with international companies and organizations, Indonesian food producers can access new distribution channels and enter emerging markets. Innovation in product development and packaging can also help differentiate Indonesian halal products in the global market, thereby attracting a wider customer base. By maintaining high quality standards and compliance with halal regulations, Indonesia can build a strong reputation as a reliable source of halal food products, thereby further increasing its competitiveness on the world stage. Through these strategic efforts, Indonesia has the opportunity not only to increase its market share but also contribute to the growth of the global halal food industry as a whole (Pratono, 2020).

Lack of Skilled Labor in Halal Food Production

Companies in Indonesia face challenges such as difficulty accessing credit, lack of clarity on business concepts, low managerial capabilities, and excessive design simplification by copying internet trends. The government does not provide adequate training, and entrepreneurs lack the confidence to compete globally. Apart from that, there are problems with uneven distribution of raw materials, changing trends, and differences in tax rates between local and foreign products . Lack of collaboration between stakeholders in the fashion industry, lack of branding, and understanding of global customers are also inhibiting factors (Togar et al., 2011; Wie 2006).

Lack of skilled labor in halal food production provides challenges for Indonesian companies who want to expand their presence in the global market. To overcome these obstacles, investment in training programs and educational initiatives will be essential to develop a skilled workforce capable of meeting the demands of the halal industry. By prioritizing human resource development, Indonesia can ensure sustainable growth and success in the competitive halal food market. Additionally, collaboration with international partners and organizations can provide valuable insights and resources to further enhance the country's position as a leading producer of halal food.

By fostering partnerships with other countries and organizations, Indonesia can access new markets and technologies that will help them stay competitive. Foreign direct investment (FDI) plays an important role in increasing productivity in Indonesia and spurring innovation by providing the necessary innovation capital, especially in the areas of technology and management processes. FDI can encourage technology diffusion through direct technology transfer, technical licensing, and research and development facilities, which leads to the transfer of knowledge and technology that can increase Indonesia's competitiveness. value chain, can drive more innovation and knowledge diffusion by meeting higher technical standards and facing intense global competition (Yose et al., 2018).

Innovation and dedication to quality can further establish Indonesia as a leader in the halal food sector. By investing in research and development, the country can create unique, best-selling products that will attract consumers from all over the world. In addition, by encouraging transparency and compliance with strict halal standards, Indonesia can build trust and credibility among consumers, thereby further strengthening its position in the global market. Ultimately, with a strategic approach to growth and a commitment to excellence, Indonesia has the potential to become a force in the halal food industry in the years to come. (Imsar & Budi, 2023).

Opportunities

Increasing Demand For Halal Products

Market expansion and diversification are increasingly abundant, along with the increasing demand for halal products throughout the world. By leveraging its resources and expertise, Indonesia can leverage new markets and partnerships to increase its presence on the global stage. Additionally, with advances in technology and distribution channels, the country can simplify its supply chain and reach a wider audience, thereby driving further growth and success in the halal food sector. As the industry continues to develop and adapt to changing consumer preferences, Indonesia has the opportunity to innovate and lead in providing high-quality, ethically sourced halal products to meet the needs of a diverse and discerning market. The increasing demand for halal products worldwide presents opportunities for market expansion and diversification. However, Brunei faces weaknesses such as a lack of dedicated halal logistics infrastructure and weak private sector demand for halal logistics. Leveraging IT, the development of the halal industry, and cooperation with the OIC and ASEAN can help Brunei's halal logistics sector develop (Ab et al., 2021).

Increasing consumer awareness and interest in halal products has also created opportunities for Indonesian companies to expand their reach beyond traditional markets. By utilizing digital marketing strategies and e-commerce platforms, businesses can target and interact with a global audience of halal consumers. Additionally, partnerships with international retailers and distributors can help Indonesian brands gain access to new markets and increase their market share. As demand for halal products increases, Indonesia is well positioned to capitalize on this trend and strengthen its position as a key player in the global halal food industry. The integration of technology and innovation in marketing strategies, particularly through AI and data analysis, has enabled companies to understand consumer behavior and expand their reach through digital marketing channels. Companies are encouraged to adopt a customer-centric approach and utilize technological innovation to remain competitive in the market. By focusing on creating customer value, driving differentiation, and increasing brand value, businesses can attract and retain customers in a highly competitive environment (Mustika & Nur, 2024; Scott & Venkatesh, 2009).

With a variety of halal products and a strong reputation for quality, Indonesian companies have the potential to become leaders in the global halal market. By focusing on innovation and meeting the needs of Muslim consumers around the world, Indonesian brands can differentiate themselves and build a strong presence in the industry. With the right strategies and partnerships, Indonesia has the opportunity to not only meet the growing demand for halal products, but also shape the future of the global halal food industry. "Indonesian companies have the potential to become

leaders in the global halal market due to the high demand for halal products and strong reputation for quality in the industry (Wanda, 2019).

By investing in research and development, Indonesian companies can create unique, high-quality halal products that attract many consumers. Additionally, forming strategic partnerships with retailers and distributors around the world will help Indonesian brands expand their reach and increase their market share. By leveraging its strengths and remaining at the forefront of industry trends, Indonesia can solidify its position as a key player in the global halal food market in the years to come (Nasrullah, 2019).

Government Support

The Indonesian government has taken strategic steps to strengthen its position in the global halal industry. This includes developing regulations that support the halal sector and establishing the Halal Product Guarantee Organizing Agency (BPJPH). BPJPH is tasked with coordinating halal certification, which is an important step in ensuring the authenticity and credibility of halal products. However, the government's role is not limited to regulation and certification; he is also active in raising public awareness about the importance of a halal lifestyle. On the other hand, private institutions play a crucial role in innovation and marketing of halal products. These companies, from MSMEs to multinational corporations, are adopting halal standards as part of their commitment to quality and social responsibility. Through effective marketing and consumer education, they help the public understand the benefits of halal products, not only in religious contexts but also health, sustainability and ethics. Collaboration between the government and the private sector is key in educating the public. Partnership programs, such as halal exhibitions, seminars and workshops, have proven effective in spreading knowledge about halal to the wider public (Kurniawan, 2023).

The Indonesian government has implemented various initiatives to promote halal certification of food products, as well as supporting the expansion of halal food businesses both domestically and internationally. This support has helped raise the profile of Indonesian halal cuisine on the global stage, attracting more food enthusiasts and tourists looking for authentic and diverse dining experiences. Additionally, government efforts to standardize and regulate the halal food industry have instilled

confidence in consumers, ensuring that they can trust the authenticity and quality of halal products.

Collaborations with International Halal Food Companies

One potential way for Indonesian companies to further expand their presence in the global halal food market is through collaboration with international halal food companies. By partnering with established players in key markets, Indonesian brands can leverage their expertise, distribution networks and brand recognition to gain access to new customers and increase their market share. It can also provide valuable opportunities for knowledge exchange and technology transfer, allowing Indonesian companies to improve their product offerings and remain competitive in an increasingly crowded market. Additionally, collaboration with international halal food companies can help Indonesian brands navigate the complex regulatory environment and ensure compliance with international standards, further strengthening their position as trusted providers of halal products. "Imported technology can make a significant contribution to the technological capabilities of Indonesian companies by providing access to new knowledge and skills, which can improve their product offerings. The acquisition of mature technology can increase production capacity and improve product quality, but may not make a significant contribution to the development of technological capabilities (Thevarkalathil et al., 2004).

These partnerships can also facilitate the exchange of best practices and innovative ideas, leading to improved efficiency and quality across the supply chain. By leveraging the expertise and resources of international halal food companies, Indonesian brands can simplify their operations and expand their reach into new global markets. Ultimately, this collaboration can help Indonesian companies establish themselves as leaders in the halal food industry, demonstrating their commitment to quality and authenticity to consumers around the world. Collaboration with other countries can help Indonesian companies become leaders in the halal food industry by improving bilateral relations and resolving obstacles related to the recognition and acceptance of halal products. This can also provide benefits for entrepreneurs and national business actors. as well as encouraging the export of halal products from Indonesia. In addition, government support is very important to ensure the smooth supply chain of halal products, especially for small and micro

industries. Research on non-halal substitute ingredients for cosmetic products or medicines is still open for development, which can further support the industry (Kolkman, 2014; Safri et al., 2021).

Increasing Trend of Healthy and Organic Halal Food Choices

The increasing trend of healthy and organic halal food options presents a great opportunity for Indonesian brands to expand their offerings and attract a new segment of health-conscious consumers. By incorporating natural and sustainably sourced ingredients into their products, these brands can differentiate themselves in the market and attract a growing number of consumers looking for healthy food options. Additionally, by emphasizing ethical and environmentally friendly aspects of their products, Indonesian brands can further enhance their reputation and attract a global audience that values sustainability and social responsibility. In this way, the trend towards healthy and organic halal food options presents a unique opportunity for Indonesian brands to not only meet growing consumer needs but also position themselves as leaders in the industry. (Hassan, 2023; Elasra, 2016).

By investing in sustainable practices and purchasing high-quality ingredients, Indonesian brands can solidify their position in the market as pioneers in the halal healthy food sector. This will not only attract more health-conscious consumers but also align them with the values of socially responsible individuals around the world. Overall, by capitalizing on this trend, Indonesian brands have the potential to not only grow in the market but also have a positive impact on people and the planet. Indonesian brands can utilize social media marketing activities, especially Instagram, to increase brand awareness and build brand equity, which ultimately influences consumer purchase intentions. Understanding the impact of social media marketing in Indonesia, especially Instagram, is critical for companies to reach Indonesian Consumers effectively and strengthen their brand presence in the market. However, there are challenges such as a lack of collaboration between stakeholders in the fashion industry and a lack of branding and understanding of global customers by local entrepreneurs (Vanessa & Lim, 2020; Togar et al., 2011).

This commitment to sustainability and quality will not only drive sales but also create a loyal customer base that values ethical practices. With more consumers prioritizing health and ethical

considerations in their purchasing decisions, Indonesian brands have a unique opportunity to lead the global halal food market. By staying at the forefront and continuing to innovate, these brands can continue to grow and succeed while making a positive contribution to the environment and society.

Threats

Competition with other countries that produce halal food

There are many competing countries in the halal industrial sector. Not only Muslim countries such as Malaysia, Turkey and the United Arab Emirates, even countries with a majority non-Muslim population such as Thailand, China, Japan and South Korea are also involved in the halal industry. China has become the largest exporter of Muslim clothing. Meanwhile, South Korea has become the largest producer of halal cosmetics, accompanied by the development of halal tourism. Japan is also developing the halal industry and halal tourism. Apart from that, neighboring countries such as Thailand have a vision to become the world's halal kitchen (KNEKS, 2021).

The success of Indonesian brands in the global halal food market may be influenced by increasing competition from other countries and potential problems in supply chain management. Halal Supply Chain Management plays an important role in ensuring the availability of goods and customer satisfaction in the halal industry. Implementing Halal Supply Chain Management involves cooperation between organizations and meeting consumer demand, which is an important factor for success in the market. The halal supply chain includes procurement, manufacturing, distribution, and logistics, all of which must comply with halal standards in order to function effectively. Cooperation and synergy between industry players, government and supervisors are needed to overcome challenges and realize opportunities in the halal industry for the Indonesian economy. and the importance of adhering to halal standards throughout the process is critical for success in the global market (Ikar, 2021; Ilmi & Khintan, 2019).

The global halal food market is dynamic and continues to grow, presenting opportunities and challenges for Indonesian brands. By closely monitoring market trends, adapting strategies, and staying ahead of geopolitical and regulatory changes, Indonesian brands can position themselves for success in an increasingly competitive landscape. It is

important for these brands to remain agile and proactive to meet the demands of changing consumer preferences and maintain their relevance in the global marketplace. With the right approach, Indonesian brands have the potential to not only survive but also thrive in the global halal food market. Agility is critical for brands to stay relevant by adapting to changing consumer preferences. Companies can choose from three basic types of agility strategies: rapid, responsive, and proactive, based on market and competitive characteristics. Aligning manufacturing tasks and choices with rapidly changing business environments is the key to good performance (Zhang, 2011).

Increasing competition in the market encourages Indonesian brands to innovate and differentiate themselves from their competitors. This has led to the development of new technologies and processes to simplify the halal certification process and reduce costs. Additionally, Indonesian brands are exploring new markets and distribution channels to reach a wider audience and increase their market share. Overall, the challenges faced by Indonesian brands in the halal food industry have sparked a wave of innovation and creativity, pushing the industry forward and strengthening Indonesia's position as a leader in the global halal food market.

International Halal Standards

There is no halal certificate that is valid globally. Matter This is due to the lack of consensus by countries in the world regarding the standardization of international halal certificates. Every country has its own criteria for determining halal certification. these criteria not necessarily accepted by other countries. Thus, internal irregularities are created halal certification. Of course, this can impact trust consumers when the product is exported to other countries (Randeree 2019). For this reason, it is necessary to hold meetings between countries in the world to discuss the standardization of halal certification. At least, this step could be initiated by the Organization of Islamic Cooperation (OIC) (Madjid, 2022).

Indonesian brands continuously strive to ensure that their products meet the strict halal standards set by Islamic law, thereby providing consumers with a sense of confidence and reliability. Through strategic marketing efforts and investments in research and development, these brands have been able to expand their reach and capture a larger share of the global halal food market. Overall, Indonesia's commitment

to excellence in halal food production has positioned the country as a key player in this industry, with a promising future.

5 CONCLUSIONS

Indonesian halal food and beverages have the potential to become leaders in the industry. Innovation and expansion, Indonesian halal food and beverages Indonesia can set new standards of excellence and inspire other countries to prioritize ethical and high-quality products in the halal food market. The success of Indonesian halal food and drinks not only provides benefits to the Indonesian economy but also contributes to the growth and development of the halal food industry throughout the world.

With an emphasis on ethical practices and the best ingredients, Indonesian halal food and beverages have the opportunity to make a significant impact on the halal food market. As consumers become increasingly aware of where their food comes from and how it is produced, Indonesian halal food and beverages have the opportunity to lead the way in setting new standards for excellence in the industry. This not only benefits the local economy but also increases the positive image of Indonesian halal food in the world.

By focusing on the factors that influence development, Indonesian halal food and beverages can continue to grow and develop in the global market, attracting a larger customer base and strengthening their reputation as an industry leader. Additionally, establishing partnerships with other halal food manufacturers and organizations can help expand distribution channels and increase market reach, ultimately driving success and further growth for the halal food industry in Indonesia.

By collaborating with other halal food producers, Indonesian halal food and beverages can leverage their respective strengths and resources to enter new markets and consumer segments. This collaborative approach not only fosters a sense of unity within the industry but also enables the exchange of best practices and innovations that can drive continuous improvement and competitiveness. Ultimately, by prioritizing collaboration and strategic partnerships, Indonesian halal food brands can position themselves as key players in the global halal food market and ensure sustainable growth and success in the long term.

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Analysis of Differences in Functional Groups in Green Tea Kombucha (Camellia sinensis) and Rosella Flower Kombucha (Hibiscus sabdariffa) Using FTIR Spectrophotometer Instrument

Yanuar Bakhrul Alam, Della Putri Yuansari Fatmadi, Nurul Faiza, Eva Agustina, Risa Purnamasari

Faculty of Science and Technology, Universitas Islam Negeri Sunan Ampel, Surabaya, Indonesia

*risap1989@gmail.com

Keywords: Kombucha, Green Tea, Rosella Flower, FTIR, Functional Groups.

Abstract: Functional groups are groups that determine the properties of organic compounds. Kombucha is a fermented drink made from tea and sugar to which a symbiotic culture of bacteria and yeast (SCOBY) is added. The aim of this study was to analyze the differences in functional groups found in green tea kombucha and rosella flower kombucha (*Hibiscus sabdariffa*). This research includes experimental research by analyzing functional groups in test samples using the FTIR (*Fourier Transform Infrared Spectroscopy*) instrument. The results of the study showed that green tea kombucha has functional groups C-N amine, C=C alkene, C≡C (triple) alkyne, and O-H alcohol, while the functional groups of rosella kombucha tea are produced as many as 5 functional groups, including the functional group C - O (Alcohol, ether, carboxylic acid, ester).

1 INTRODUCTION

Tea is a beverage product that has many benefits for the human body. Tea plants grow in tropical and subtropical regions such as Indonesia. The chemical compounds contained in tea are catechins, vitamin E, vitamin C, tannins, flavonoids, theophylline, polyphenols, and a number of minerals such as Mg, Ge, Mo, Se and Zn. Although from the same plant. What distinguishes all these types of tea is the manufacturing process (Arisudin *et al.,* 2021). Tea has many health benefits so it is developed into various derivative products, one of which is kombucha.

Kombucha comes from a mixture of sweet tea fermented by a number of microorganisms, especially yeast and acetic acid bacteria (Toeh *et al,* 2004). This type of tea has advantages when compared to the usual type of tea because kombucha tea contains organic acids and several organic compounds and amino acids. Because these contents are effective as antioxidants and antibacterials to improve digestive tract function and increase body resistance and are also able to lower cholesterol levels, blood pressure

and improve liver function and reduce the spread of cancer (Sumanto *et al.,* 2023).

Tea has several types, one of which is green tea, which can be turned into kombucha for research because kombucha is a fermented drink that has various health benefits that are different from ordinary green tea. Fermenting green tea with kombucha produces probiotics, enzymes, and organic acids that are not present in pure green tea. Kombucha research allows scientists to explore these additional benefits, such as improved digestive health, detoxification, and potentially more powerful antimicrobial and antioxidant properties. In other words, converting green tea into kombucha enriches the beverage with bioactive components that can provide broader health effects (Villarrral *et al,* 2018). Several methods are required to make kombucha tea.

The main ingredients needed to make kombucha include tea, sugar, and an initial liquid containing kombucha starter culture (Toeh *et al,* 2004). Green tea kombucha has a variety of widely recognized health benefits, including antioxidant, antimicrobial, and digestive health-promoting activities. Green tea

kombucha, a fermented green tea with microbes, offers the added benefit of containing a variety of organic acids, vitamins, and other bioactive compounds. This study used samples of kombucha tea from rosella flowers because rosella flowers contain several secondary metabolic compounds that are beneficial for body health. To utilize the functional properties of rosella and the ability of microbes in fermenting kombucha which produces compounds that are beneficial for the body, rosella flowers are transformed into kombucha tea products which are expected to provide greater benefits for the general public.

The rosella plant (*Hibiscus sabdariffa*) comes from the Malvaceae family or fiber-producing plants. Rosella is one of the plants that is familiar to the public, because almost all parts of this plant can be used, especially for health (Baniu & Olii, 2024). This rosella plant contains calcium, vitamins C, D, B1, B2, magnesium, omega-3, beta-carotene, and 18 essential amino acids, including lysine and agrin. Vitamin C in rosella flowers is three times more than in black grapes, nine times more than in citrus fruits, and ten times more than in fruit (Wijayanti & Retnaningsih, 2023). However, there are several research gaps that require the latest innovations to deepen understanding and maximize the benefits of green tea kombucha. In the research of Arisudin *et al* (2021), further research is also needed to understand how green tea kombucha affects body cells and tissues at the molecular level and studies are needed that compare the health effects of kombucha from various types of tea to determine the specific advantages of green tea. Meanwhile, in the research of Sumanto *et al* (2023), further research is needed to determine the optimal fermentation conditions that produce maximum health benefits. A different study was also conducted by Inggrid *et al* (2019). This study did not explore the interaction between green tea and additional ingredients such as rosella flowers in kombucha fermentation, so further research is needed to understand how this combination affects the chemical profile and health benefits of kombucha.

From several research results that have been conducted, many show that one of the plants that has antibacterial activity is the rosella plant. Rosella (*Hibiscus sabdariffa L.*) is a plant that has antimicrobial, antioxidant, anti-inflammatory, antidiabetic, antihypertensive and antifungal activities. The antimicrobial properties of rosella flowers are indicated by polyphenol compounds such as flavonoids, namely anthocyanins and gosypetin, phenolics, tannins and saponins. Research conducted by Mukani (2014) also stated that giving rosella flower kombucha increased erythrocyte levels and hemoglobin levels in the blood of mice. To determine the compound content in rosella flower kombucha and green tea, functional group analysis was carried out on rosella flowers and green tea using the *Fourier Transformed Infrared* (FTIR) Spectrophotometry instrument method.

Fourier Transformed Infrared (FTIR) spectrophotometer is an instrument used to detect, identify, and analyze a type of functional group from the sample being tested without damaging the sample (Abriyani *et al.,* 2024). FTIR spectroscopy can analyze the presence of mixtures in samples without damaging the sample to be analyzed. Infrared spectrophotometer (FTIR) is generally used to identify organic bioactive compounds, especially in plant extracts. Bioactive compounds contained in plant extracts have their own advantages, where almost all of the compounds show absorption power against infrared radiation and FTIR has non-destructive properties, meaning properties that do not easily damage samples so that it is possible to carry out measurements in situ (Nurhamidah *et al.,* 2024).

Through FTIR testing on green tea kombucha and rosella flower kombucha, we can gain a deeper understanding of the chemical composition and molecular structure of the two types of kombucha, to determine the contents therein, such as polyphenols, organic acids, and vitamins. By comparing the composition between the two types of kombucha we can find out about the contribution of additional ingredients, such as rosella flowers, to the chemical profile of kombucha. In addition, through molecular structure analysis, we can explore the interactions of compounds in both types of kombucha during the fermentation process. Thus we can know the overall properties and health benefits of kombucha (Jati & Cahyanto, 2020).

The basic principle of IR spectrophotometric analysis is through the absorption of electromagnetic radiation by certain functional groups, from the absorption process a readable absorption spectrum is formed, from this spectrum it can be used to determine the functional groups contained in a compound (Pristiwani & Ridwanto, 2023). The infrared region of the electromagnetic wave spectrum starts from a wavelength of 14000 cm- to 10^{-1}. Infrared spectroscopy analysis includes several methods based on the absorption or reflection of electromagnetic radiation. When a compound is placed in an infrared beam, the absorbed energy causes changes in bond vibrations. The resulting infrared spectrum is

complex data information, so it can comprehensively describe the chemical characteristics of a sample (Abriyani *et al.,* 2024).

The working mechanism of FTIR is that the light coming from the light source will be transmitted, then split by the beam splitter into 2 perpendicular rays. In a spectrophotometer there are 2 types of mirrors, namely a stationary mirror and a moving mirror which function to reflect light. The resulting light from the reflection of the two mirrors will be reflected back to the beam splitter to react again. The 2 rays that were divided earlier will be partly directed towards the sample and partly towards the source. The back and forth movement of the mirror causes the incoming light to reach the detector and fluctuate. The back and forth movement of the mirror causes the incoming light to reach the detector and fluctuate. The fluctuation of light that reaches this detector will produce a signal on the detector called an interferometer. This interferometer will be converted into an IR spectra with the help of a computer based on mathematical operations (Abriyani *et al.,* 2024).

The FTIR measurement technique is a standard method for characterizing the molecular structure of organic materials. From this characterization, an absorption spectrum is obtained which describes the interaction between electromagnetic electric field radiation (IR radiation) and the electric dipole moment of the molecule. Each absorption peak in the spectrum is related to the excitation of the vibrational mode of the molecule concerned, which consists of stretching and bending vibrations such as out-of-plane bending (twisting, wagging) and in-plane bending (rocking) (Raturandang *et al.,* 2022).

2   METHODS

Study Location

The practicum entitled Analysis of differences in functional groups in green tea kombucha (*Camellia sinensis*) and rosella flower kombucha (*Hibiscus sabdariffa*) using an FTIR spectrophotometer instrument was carried out at the Instrumentation and Measurement Laboratory of Sunan Ampel State Islamic University, Surabaya, District. Gunung Anyar, Surabaya.

Tools and materials

The tools used in this practicum are a drop pipete and FTIR spectrophotometer which are connected via computer. Meanwhile, the materials used are tissue, green tea, and rosella flower kombucha tea.

Ways of working

This research uses qualitative analysis methods. The subjects of this research used 2 samples, namely green tea and rosella flower kombucha tea. The tool used in this research is FTIR (*Fourier Transform Infrared*). The qualitative data processing and analysis method was carried out by analyzing the data through the FTIR test to detect the presence or absence of functional groups in the contents of green tea samples and rosella flower kombucha samples.

The way it works is to turn on all the equipment, both the FTIR instrument and the computer, then when the computer is on, click the microlab menu on the computer, enter the password in the menu, then click start, method, new, click data collect only, then click instrument (click full in the spectral range), then click save as. The next step is to create a folder by clicking check and activate, then click start then the next step is to wet the instrument on the sample holder with alcohol and clean it with a tissue, then samples of rosella flower kombucha tea and green tea are taken using a dropper and dropped on the sample holder. Which has been cleaned with alcohol, then click next on the computer and the spectra will appear on the computer screen, after that click data handling, then export, CPS and change the name. The final step is to print the spectra data for samples of rosella flower kombucha tea and green tea in the form of word or PDF, then save the file.

3   RESULTS and DISCUSSIONS

The results of the analysis of green tea functional groups using an infrared spectrophotometer (FTIR) provide absorptions in the wave number area (cm-1) which can be seen in Figure 1.
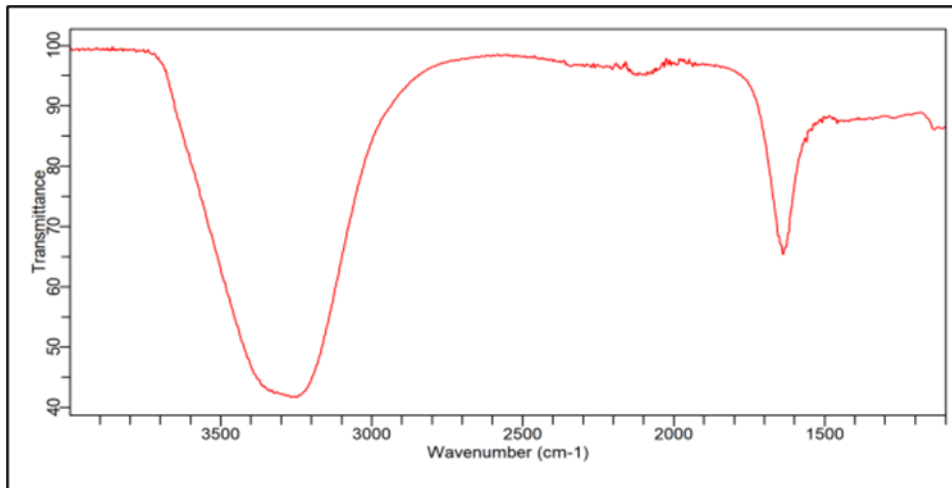
Figure 1: Green Tea Analysis Results

The results of the wave number absorptions using FTIR are then interpreted in Table 1 below

Wave Number (cm⁻¹)		Intensity	Functional groups
Theoretical	Results FTIR		
3000-3700	3267,01	Wide	O-H
1500-1675	1638,16	Sharp	C-C aromatic
1000-1300	1136,83	Currently	C-O

The absorption results showed the presence of certain functional groups in the green tea samples. Functional group analysis uses FTIR with a wave number limit of 1000-4000 cm-1. The wave number absorption results in this green tea sample are at a wave number of 3267.01 cm-1 with a wide intensity and 1638.16 cm-1 with a sharp intensity. The wave absorption at 3267.01 cm-1 with a wide intensity indicates the presence of the O-H functional group, while the wave absorption at 1638.16 cm-1 with a sharp intensity indicates the presence of the aromatic C-C functional group.

The results of functional group analysis on rosella samples can be seen in Figure 2 and the interpretation in Table 2.
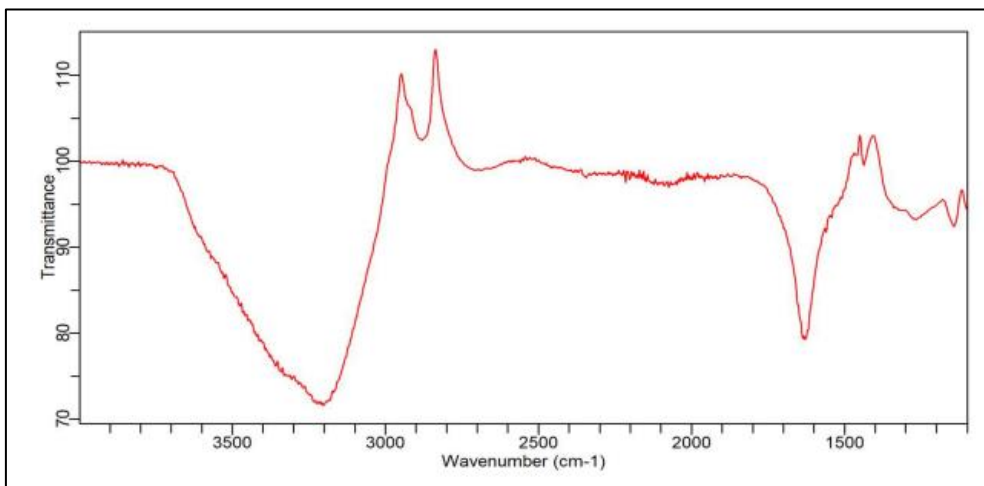
Figure 2: Results of Rosella Kombucha Tea Analysis

Table 2: Interpretation of FTIR Spectra of Rosella Kombucha Tea

| Wave Number (cm⁻¹) | | Intensity | Functional groups |
Theoretical	Results FTIR		
3000-3700	3201,78	Wide	O-H
1500-1675	1638,85	Sharp	C-C aromatic
1000-1300	1142,92	Currently	C-O
1180-1360	1265,79	Currently	C-N (amida, amina)

The wave number absorption results in the green kombucha rosella tea sample were at wave numbers 3201.78 cm⁻¹ with wide intensity, 1638.85 cm⁻¹ with sharp intensity, 1142.92 cm⁻¹ and 1265.79 cm⁻¹ with medium intensity, The wave absorption at 3201.78 cm⁻¹ with a wide intensity indicates the presence of the O-H functional group, while the wave absorption at 1638.85 cm⁻¹ with a sharp intensity indicates the presence of the aromatic C-C functional group. The results of FTIR analysis on rosella kombucha tea contain almost the same functional groups as green tea.

Green kombucha tea and rosella kombucha tea both contain OH groups. However, the stretch of the transmittance band in rosella kombucha tea was wider than in green tea kombucha. Basically, tea samples contain aromatic OH and C=C groups which are characteristic of flavonoid compounds (catechins) in green tea leaves (Sukaesih, 2021). According to Abriyani *et al.,* (2023) the standard for flavonoids is OH (hydroxyl) wave absorption at 3372 cm⁻¹. In general, catechins are found in young tea leaves. The concentration of catechins in tea leaves will decrease as the age of the tea leaves increases. (Nugraheni *et al.,* 2022).

In the Rosella kombucha sample, the stretch in the OH group is wider because the content is influenced by microbiological activity in the manufacturing process. The process of making kombucha uses a 7-21 day fermentation process using the help of microbes, one of which uses the yeast *Saccharomyces cerevisiae* (Priyono & Riswanto, 2021). The alcohol content in kombucha from several sources can be seen in Table 3. The basic content of tea which already contains OH groups (catechins) is added to the alcohol content as an effect of the fermentation process, making the FTIR spectrum stretch wider in the wave number range of 3000-3700 cm⁻¹. The spectral stretch at 3201.78 cm⁻¹ is also influenced by the flavonoid and phenolic content in rosella leaves. Phenolic compounds are compounds in plants that have the most hydroxyl (OH) groups (Diniyah & Lee, 2020).

Table 3. Alcohol content of Kombucha tea from several sources

Alcohol Level	Source
0,297-0,621%	(Pratiwi et al., 2012)
1,61-5,12%	(Simanjuntak et al., 2016)
0,7-1,3%	(Kapp & Sumner, 2019)
0,2-3,5%	(Jakubczyk et al., 2020)
0,06-1,95%	(Tan et al., 2020)

Rosella leaves contain several phytochemical contents. The contents of rosella leaves include 0.23 mg/g flavonoids, 0.125 mg/g phenolics, 0.13 mg/g saponins, 0.12 mg/g alkaloids, and 0.17 mg/g tannins. Apart from that, the nutritional content of herbal roselle leaves is 86.2% water content, 1.7–3.2% protein, 1.1% fat, 10% fiber, 0.18% calcium, 54 mg/100 g ascorbic acid (Mahadevan *et al.,* 2009; Nurnasari & Khuluq, 2017). The alkaloid content in roselle can be seen at the absorption wave of 1142.92 cm-1. The C-N group detected at an absorption wave of 1142.92 cm⁻¹ is possibly an alkaloid compound with a piperidine base structure as in research conducted by Fachriyah *et al.* (2018). Kareru *et al.,* (2008) stated that saponin has absorption of the infrared functional groups OH, CH, C=C, C=O, and C-O-C. It can be seen in Figure 2 that the absorption of the OH group of rosella kombucha tea is more stretched compared to green tea, this is also caused by the saponin content in rosella kombucha tea. Uptake of saponin oligosaccharides with saponins.

Kombucha drink products are fermented tea drink products using microbes as fermentation agents. Nile pH in kombucha ranges between 3. 0 - 5. 5 depending on the fermentation time. The pH value of kombucha is influenced by the accumulation of acids formed during fermentation (Saputra *et al.,* 2017). The results obtained in this research were that there was a pH difference between green tea and rosella kombucha. The pH value of the rosella kombucha is 2.63 while the green kombucha is 3.32. The pH value in rosella kombucha is lower because the ascorbic acid content in rosella is 54 mg/100 g (Mahadevan et al., 2009; Nurnasari & Khuluq, 2017).

4   CONCLUSIONS

In FTIR analysis, green tea and rosella kombucha showed absorption at wave numbers indicating the presence of certain functional groups. The difference in stretching of the O-H groups between the two is caused by the influence of microbiological activity during fermentation. Rosella also provides additional bioactive compounds, such as flavonoids and phenolics, which enrich the chemical profile of rosella kombucha. The pH value is lower in rosella kombucha because of the high ascorbic acid content in rosella. Both contain alcohol as a result of fermentation. This shows the potential of rosella kombucha as a functional drink rich in bioactive compounds with broader health benefits, but requires further studies for more in-depth exploration. The research results show that green tea kombucha has the functional groups C-N amine, C=C alkene, C=C (3-fold) alkyne, and O-H alcohol, while the functional groups from rosella kombucha tea produce 5 functional groups, including the C - O functional group (Alcohols, ethers, carboxylic acids, esters).

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Analysis of Phenolic Content of Green Tea Kombucha and Butterfly Pea (*Clitoria Ternatea L.*) Flower Kombucha Using Spectrophotometer Uv-Vis

Raihana Frika Nafisah, Diana Rahma Wati, Sistani Huzainiyah, Eva Agustina, Risa Purnamasari
Faculty of Science and Technology, Sunan Ampel State Islamic University, Surabaya, Indonesia
**risap1989@gmail.com*

Keywords: Kombucha, Green Tea, Butterfly Pea Flower, Phenolic Content, Spectrophotometer Uv-vis.

Abstract: Kombucha is a health drink that comes from fermented green tea and microorganisms such as *Acetobacter xylinum*. Kombucha is believed to have high antioxidant content. Butterfly pea flowers (*Clitoria ternatea L.*) can be used as a basic ingredient for making kombucha because they are believed to have high phenolic content. Phenolics are compounds that have hydroxyl groups (-OH) and contribute most to antioxidant activity. The aim of this research was to determine the levels of phenolic compounds in green tea kombucha and butterfly pea flower kombucha. This research used experimental research by testing phenolic levels using a spectrophotometer uv-vis instrument. The results showed that the phenolic content of green tea kombucha was 162.35 mg/L GAE and butterfly pea flower kombucha was 124.46 mg/L GAE. Thus, the highest phenolic content is found in green tea kombucha.

1   INTRODUCTION

Green tea is a drink that is popular among people and is very popular in Asian countries, especially in Japan (Tamon *et al*., 2021). Green tea has many health benefits, such as preventing and lowering high blood pressure, reducing bad cholesterol levels, reducing the risk of stroke, and smoothing the skin. All types of tea contain catechin compounds, but green tea is currently more popular because its catechin content is higher than black tea. Therefore, green tea is known to help prevent cancer growth (Lelita *et al*., 2019). Research conducted by Wang *et al*. (2022) showed that green tea has a very strong antioxidant activity value, with an IC50 value (50% inhibitory concentration) of 8.45 ± 0.41 μg/mL in the DPPH (2,2-diphenyl-1-picrylhydrazyl) test.

Green tea can be used as a fermented drink, namely kombucha. Kombucha is a fermented drink between tea and sugar made by a kombucha starter culture called SCOBY (Symbiotic Culture of Bacteria and Yeast). Kombucha has the form of a gelatinous mass or resembles a white gelatinous biofilm which is similar to nata de coco but the medium is different. The activity of microorganisms during fermentation produces various compounds that are beneficial for health such as vitamins, minerals, enzymes and

phenolic compounds (Khamidah and Antarlina, 2020). Apart from green tea, the raw materials for making kombucha can be obtained from plants high in antioxidants such as butterfly pea flowers.

Butterfly pea flower (*Clitoria ternatea*) is a compound flower that is identical to the purple color on its petals. Butterfly pea flower is a plant that can be found in home gardens, plantations and the edges of rice fields. This plant functions as an ornamental plant which is used as a traditional eye medicine and food coloring. Apart from that, this plant produces green beans which are legumes (Angriani, 2019). Based on several studies collected by Jeyaraj *et al*. In 2021, butterfly pea flowers are known to contain quite a variety of bioactive compounds. The bioactive compounds contained in it include kaempferol, quercetin, and myrisetin. Apart from that, telang flowers are also known to contain several other compounds such as fatty acids, phytosterols and tocopherols. Several compounds contained in telang flowers are known to have good antioxidant properties. In research conducted by Saha *et al*. (2021), butterfly pea flower extract showed a total phenol value of 271.4 ± 12.7 mg GAE/g (gallic acid equivalent per gram) and a DPPH radical scavenging

activity value of 89.2 ± 3.4%. Based on these data, it can be seen that butterfly pea flowers can be used as kombucha because they have good phenolic compound value.

Phenolic compounds are the result of secondary metabolites from plants with a combination of mono and polysaccharides linked to one or more phenolic groups, or as ester or methyl ester derivatives. This compound is an aromatic compound whose structure is derived from benzene so that it has an aromatic ring and the presence of one or more hydroxyl groups (-OH). Phenolic compounds tend to dissolve in water, generally bind to sugar as glycosides and are located in cell vacuoles (Mahardani and Yuanita, 2021). There are around eight thousand types of plants that contain compounds belonging to the group of phenolic compounds, where the structures of these compounds are known. These phenolic compounds include flavonoids, phenyl propanoids, phenolic quinones, polyphenols (such as lignin, melanin and tannin), as well as simple monocyclic phenols (Sundu *et al*., 2022). One of the instruments used to determine the levels of phenolic compounds is a spectrophotometer uv-vis. This study aims to determine the phenolic content of green tea kombucha and butterfly pea flower kombucha using a spectrophotometer uv-vis.

2   METHODS

Tools and Materials

Tools

The tools used in this research were glass jars, spoons, stoves, measuring glasses, beakers, measuring flasks, Erlenmeyer flasks, dropper pipettes, volume pipettes, bulbs, analytical scales, vortexes, pH meters, spectrophotometer uv-vis.

Materials

The ingredients used in this research were green tea, butterfly pea flowers, water, kombucha starter culture, distilled water, sugar, methanol p.a, Na_2CO_3, gallic acid, Folin-ciocalteu.

Kombucha Tea Preparation

Kombucha Strater Preparation

1000 ml of water is boiled until it boils and 100 grams of sugar (10% w/v) is added to the amount of water used and 5 grams of 0.5% (w/v) tea is added. Then filter and cover the filtrate with aluminum foil and let sit until the tea has room temperature. After that, add 100 ml of kombucha starter culture (10% w/v) to the brewed tea and then close the container tightly. Propagation of the kombucha starter culture was left for 14 days.

Making Green Tea Kombucha

5 grams of green tea is brewed using 200 ml of boiling water. Then add sugar with a concentration of 50 grams and stir. Cover the brewed green tea tightly with a cloth and let it sit until room temperature. 20 ml of liquid kombucha starter is added and fermented for approximately 12 days in a closed container.

Making Telang Kombucha

5 grams of butterfly pea flowers are brewed using 200 ml of boiling water. Then add sugar with a concentration of 50 grams and stir. Cover the steeping telang tea with a cloth and let it sit until room temperature. 20 ml of liquid kombucha starter is added and fermented for approximately 12 days in a closed container.

pH Level Test

pH measurements are measured using a pH meter. Green tea kombucha and butterfly pea flower kombucha were put in a glass beaker and then dipped into a pH meter

Phenolic Content Test

Standard Curve of Gallic Acid Standard Solution

The standard gallic acid solution was made in varying concentrations of 10, 20, 30, 40, 50 ppm. Take 1 ml of the standard solution of gallic acid of each concentration and put it into a test tube and add 0.5 ml of Folin-ciocalteu then leave it for 8 minutes while shaking. To the solution was added 4 ml of 7% Na_2CO_3 solution and vortexed for 1 minute. Measurements were carried out at a wavelength of 760 nm.

Sample Absorption Measurement

1 ml of kombucha from each sample and add 0.5 ml of Folin-ciocalteu, leave it for 8 minutes while shaking. 4 ml of 7% Na2CO3 solution was added and vortexed for 1 minute. Absorbance was calculated with a wavelength of 760 nm. Measurements were carried out at a wavelength of 760 nm. The total phenol content can be calculated using the following formula:

$$TPC = c \cdot v \cdot fp$$

Explanation:

TPC : total phenolic content (mg/L GAE)

c   : concentration (x value) (ppm)

v   : sample volume (ml)

fp   : dilution factor

3   RESULTS and DISCUSSIONS

Kombucha is a health drink that has many benefits for the body. Kombucha is believed to contain phenolics and antioxidants. Kombucha has a sour taste caused by the increase in organic acid compounds during the fermentation process. The pH value of each sample can be seen in table 1.

Table 1: pH Value

No	Sample	pH Value
1	Kombucha Teh Hijau	3.32
2	Kombucha Telang	2.86

Kombucha is a fermented drink that is high in secondary metabolite compounds so it is considered to have good antioxidant activity. Kombucha has a sour taste due to the increase in organic acid compounds during the fermentation process. This results in a decrease in the pH of the kombucha. The longer the fermentation time, the greater the total acid (Wistiana and Zubaidah, 2015). In general, the degree of acidity of a material is indicated by the pH value. The pH value of green tea kombucha and butterfly pea kombucha can be seen in table 1. The low pH value in the two kombucha samples is caused by the metabolic process of yeast and bacteria towards sucrose which produces organic acids such as acetic acid, gluconic acid, and glucuronic acid (Wistiana and Zubaidah, 2015). The decrease in the pH of kombucha tea also occurs because during the

fermentation process, yeast will synthesize sugar into ethanol. Then it will be broken down into organic acids by acetic bacteria into acetic acid and gluconic acid and several concentrations of organic acids (Puspitasari *et al.*, 2017).

Kombucha is believed to have good antioxidant content. This antioxidant potential is obtained from the phenolic compounds contained in kombucha (Nafisah *et al.*, 2023). Phenolic compounds are a type of organic compound that has one or more hydroxyl groups (-OH). The group is attached to an aromatic ring called phenol. This hydroxyl group gives reactive properties and unique characteristics to phenolic compounds. This compound can be found naturally in various types of plants. In the food and beverage industry, phenolic compounds play a role in providing a distinctive aroma, as natural colorants, and as antioxidant agents in food and beverage products (Christalina *et al.*, 2018). The way phenolic compounds work involves denaturing proteins in bacteria. These compounds can be absorbed into bacterial cells because they have hydrogen bonds. If phenolic levels are low, phenolic compounds will form protein complexes with weak bonds, then decompose, followed by penetration of phenolic compounds into bacterial cells, which causes protein deposition and denaturation (Novita, 2016).

In this study, the levels of phenolic compounds in green tea kombucha and butterfly pea flower kombucha were analyzed using a spectrophotometer uv-vis instrument. Spectrophotometer uv-vis is an instrument used to quantitatively determine the compound content in a sample which is measured in the ultraviolet-visible light region with a wavelength of 200-700 nm. The first step in calculating phenolic content is to create a standard curve for gallic acid. In making a standard curve, the absorbance of each concentration is needed. This data can be seen in table 2.

Table 2: Data for Determining the Standard Standard Curve for Gallic Acid

Concentration (ppm)	Absorbance
10	0.331
20	0.52
30	0.804
40	1.159
50	1.315

Solutions of varying concentrations (10 ppm, 20 ppm, 30 ppm, 40 ppm, 50 ppm) were searched for absorbance using a spectrophotometer uv-vis instrument. The absorbance of each concentration can be seen in table 2. After obtaining the absorbance of

each concentration, the next step is to create a standard standard curve for gallic acid which is used to find equations and linear regression. The standard standard curve for gallic acid can be seen in Figure 1.

Figure 1: This caption has one line so it is centered

The measurement results from this instrument are in the form of absorbance based on the Lambert-Beer law from several concentrations of standard solutions or samples. The absorbance was analyzed to obtain a standard curve. The standard curve provides an illustration of the correlation coefficient (r) and the linear regression equation, y = ax + b. This equation is used to determine the compound content of a sample being analyzed (Wahyuni and Marpaung, 2020). The standard standard curve for gallic acid has the regression equation y (absorbance) = 0.0261x (concentration) + 0.0437 with a coefficient of determination R^2 = 0.9862. The curve can be said to be linear because the determination coefficient (R^2) is 0.9862 or close to one. The phenolic concentration can be determined by substituting the absorbance of the sample into Y in the equation. The size of the X indicates the concentration of phenolics in the sample.

The standard phenolic compound used is gallic acid or 3,4,5-trihydroxybenzoic acid ($C_6H_2(OH)_3CO_2H$). Gallic acid is used as a standard solution because gallic acid has a hydroxyl group and a conjugated double bond on each benzene ring so that this compound easily reacts to form a complex with the Folin-Ciocalteu reagent which is a constituent unit of phenolic compounds (Adawiah *et al*., 2015). In addition, gallic acid is the choice as a standard due to the availability of a stable and pure substance (Niwele *et al*., 2020). The reagents used are Folin Ciocalteu and Na_2CO_3. Folin Ciocalteu is a polymeric ion complex solution made from phosphomolybdic acid and heteropoly phosphotungstic acid consisting of water, sodium tungstate, sodium molybdate, phosphoric acid, hydrochloric acid, lithium sulfate and bromine. The principle of the Folin Ciocalteu method is a colorimetric oxidation and reduction reaction to measure all phenolic compounds in the sample. Phenolic compounds react with gallic acid to produce phenolic compounds and a blue molybdenum-tungsten complex. The high intensity of the blue color contained means that there are a lot of phenolic compounds in the sample. Another reagent is Na_2CO_3, which is a chemical compound that functions as a chemical aid in the neutralization process. Gallic acid is reacted with Folin-Ciocalteu reagent to produce a yellow color, after which it is added with Na_2CO_3 solution to produce a blue color.

After knowing the phenolic concentration, then calculate the total phenolic content (TPC). Determination of TPC is part of the analysis which is related to phenolic content and antioxidant activity. Samples that have a relatively high content of phenolic secondary metabolite compounds usually have high antioxidant activity (Handayani *et al*., 2022). The total phenolic content in each extract is expressed as gallic acid equivalent (GAE). GAE is a general reference for measuring the number of phenolic compounds contained in a material. Based on the existing phenolic concentration, the TPC value of kombucha for each sample was obtained. The TPC value of each sample can be seen in table 3.

Table 3: TPC Value of Green Tea Kombucha and Telang Flower Kombucha

Sample	Absorbance	Phenolic Concentration	TPC (mg/L GAE)
Green Tea Kombucha	4.281	162.348659	162.35
Telang Kombucha	3.292	124.4559387	124.46

The TPC value of green tea kombucha is 162.35 mg/L GAE, while the TPC value of rosella flower kombucha is 124.46 mg/L GAE. Based on the data obtained, it can be seen that the TPC value for green tea kombucha is higher than the TPC value for butterfly pea flower kombucha. In this research, the sample used was kombucha made from green tea leaves and butterfly pea flowers. This sample selection was based on previous studies which showed that both samples contained secondary abolite, proven in table 4.

Table 4: Compound Content of Green Tea and Butterfly Pea Flower

No	Aspect	Green Tea	Butterfly Pea Flower
1	Flavonoids	Catechin, epicatechin, epigalocatechin, and epigalocatechin gallate.	Kaempferol glycosides, quercetin glycosides, and mirisetin (Andiarni & Murtisiwi, 2018).
2	Anthocyanin	-	Delphinidin-3,5-glucoside (Putri & Baharza, 2023) cyanidin-3-O-glucoside, Cn-3-(6"-p-coumaroylgluc-oside) (Saputri et al., 2023).
3	Polyphenols	epigalocatechin gallate (EGCG), epigalocatechin (EGC), epicatechin gallate (ECG), and epicatechin (EC)	phenolic acids and flavonoids
4	Phenolic	catechins, epicatechin, epigalocatechin, and epigalocatechin gallate.	Phenolic acids (gallic acid, chlorogenic acid) (Marpaung, 2020).

Based on the results table 4, aspects of the compounds in green tea and butterfly pea flowers were obtained. The flavonoids in green tea contain the compounds catechin, epicatechin, epigalocatechin and epigalocatechin gallate. Meanwhile, in butterfly pea flowers the compounds are kaempferol, quercetin and myricetin. Green tea does not have anthocyanins, while telang contains anthocyanins whose compounds are delphinidin, cyanidin and peonin. The compounds contained in polyphenols in hiau tea are epigalocatechin gallate (EGCG), epigalocatechin (EGC), epicatechin gallate (ECG), and epicatechin (EC). Meanwhile, the polyphenol compound contained in telang is phenolic acid (gallic acid, chlorogenic acid). Furthermore, phenolic compounds in green tea contain catechin, epicatechin, epigalocatechin and epigalocatechin gallate. Meanwhile, in telang the phenolic compounds are phenolic acid (gallic acid, chlorogenic acid) and

flavonoids (kaempferol, quercetin, myrisetin). There are no steroid compounds in green tea and telang.

Butterfly pea flower (*Clitoria ternatea* L.) is a herb that has many benefits for human health. Butterfly flower petals contain high amounts of flavonoids (Putri and Baharza, 2023). This plant also contains various active compounds or phytochemicals which have pharmacological potential, such as antioxidants, anti-inflammatory, antidiabetic, anticancer, antihistamine and immunomodulatory. Apart from that, the compounds in Telang Flower can also affect the central nervous system. Based on these contents, butterfly pea flowers have the potential to be an innovative ingredient in making kombucha tea (Siregar *et al*., 2023). Butterfly pea flowers can be used as a drink, either by using fresh flowers that have just been picked or by using flowers that have been dried first, then blended with warm water (Ikhwan *et al*., 2022).

(Juniaty, 2013)

(Lumingkewas *et al*., 2019)
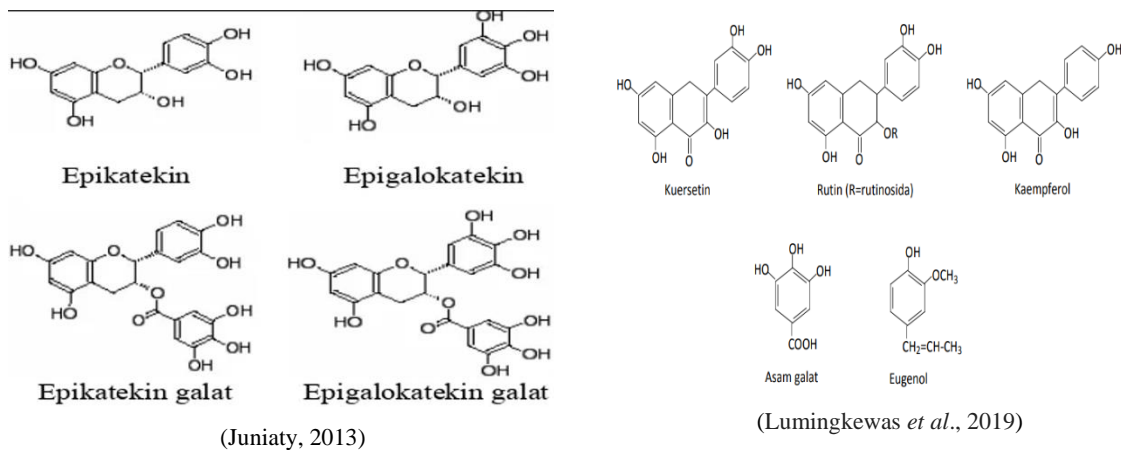
Figure 2: Green tea phenolic compounds (left) and Telang phenolic compounds (right)

Green tea and telang flowers contain compounds that provide many health benefits. Based on Table 4, it can seen that green tea and telang flowers have differences in compound content. The content of

phenol compounds is more found in green tea than bayang flowers. However, green tea does not contain anthocyanin compounds. This can be proven by the results of the study, where the TPC value of green tea

kombucha is higher when compared to telang flower kombucha.

The total phenolic content is related to the metabolic activity of microbes during fermentation. These microbes can modify bioactive components such as polyphenols, tannins, and flavonoids. The activity of microorganisms during fermentation produces compounds that are beneficial to health, including various vitamins, minerals, enzymes, and phenolic compounds. The higher the level of phenolic compounds produced, the higher their antioxidant activity (Khamidah & Antarlina, 2020). Lactic acid bacteria in kombucha can produce phenolic compounds because they metabolize ferulic acid and cinnamic acid into 4-vinyl phenol and 4-vinyl guaiacol, thus increasing the amount of phenolic compounds (Winarsi et al., 2019).

The fermentation process plays a crucial role in altering the components and bioactivity of active compounds. Biochemical changes occurring during fermentation also alter the ratio of nutrient and antinutrient components, which in turn affect product characteristics, such as increasing the content of biologically active phenolic components as well as their antioxidant activity. Fermentation also enhances antioxidant properties by increasing the content of free flavonoids. Furthermore, fermentation stimulates cell wall degradation, which ultimately releases or even induces the synthesis of some bioactive components. The fermentation process also triggers the release of microbial enzymes that liberate free forms of plant chemical components such as flavonoids, tannins, and alkaloids (Rahmi et al., 2016).

4 CONCLUSIONS

The results showed that the TPC value of green tea kombucha was 162.35 mg/L GAE and rosella flower kombucha was 101.30 mg/L GAE. Thus, green tea kombucha has a higher phenolic content compared to rosella flower kombucha. This shows that green tea has a greater opportunity as the main ingredient in making kombucha which can provide better health benefits.

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Analysis of Phenolic Content in Green Tea Kombucha and Rosella (*Hibiscus sabdariffa*) Kombucha Using Spectrophotometer Uv-Vis

Raihana Frika Nafisah[1], Nafiatul Nuriyah[1], Fathma Cantika Putri[1], Funsu Andiarna[1], Irul Hidayati[1]*

Faculty of Science and Technology, Universitas Islam Negeri Sunan Ampel, Surabaya, Indonesia
*irulhidayati.alfatawi@gmail.com

Keywords: Kombucha, Rosella, Green Tea, Phenolics, Spectrophotometry UV-Vis.

Abstract: Phenolic compounds are compounds that have hydroxyl groups and are most abundant in plants. Green tea and rosella flowers are types of plants that contain phenolic compounds and can be used as ingredients to make kombucha tea drinks. Kombucha is a fermented drink made from tea and sugar which is fermented by a colony of bacteria and yeast. The aim of this research was to determine the levels of phenolic compounds in green tea kombucha and rosella flowers through experimental tests using spectrophotometry uv-vis. The results showed that the phenolic content of green tea kombucha was 162.35 mg/L GAE, while rosella kombucha had a level of 101.30 mg/L GAE. Thus, the phenolic content of green tea kombucha is higher compared to rosella kombucha.

1 INTRODUCTION

Green tea (*Camelia sinensis*. L) is a type of herbal plant originating from China. This plant is widely cultivated as a raw material for making traditional medicines (Anindita *et al*., 2012). Tea is a drink that is popular with the general public because it is believed to have many health benefits. The content of bioactive compounds in tea can function as anticancer, antimicrobial, lowering blood cholesterol, reducing blood sugar, antibacterial and what is popular is antioxidant (Sasmito and Dearta, 2020). Based on research conducted by Priani *et al*., (2024) green tea has very strong antioxidant activity with an IC50 value of 6,435 ppm. Green tea extract was also developed into a nanoemulsion preparation using Tween80 surfactant and PEG400 cosurfactant. The research results showed that green tea ethanol extract had very strong antioxidant activity with an IC50 value of 2.14 ± 0.01 ppm.

One of the fermented foods made from green tea is kombucha. Kombucha is a drink made from fermented tea with a *SCOBY* (*Symbiotic Consortium of Bacteria and Yeast*) which is rich in beneficial compounds such as organic acids, minerals, vitamins, amino acids and active polyphenols (Kapp and Sumner, 2019). The advantage of kombucha tea compared to green tea usually lies in its higher content of organic acids, vitamins and amino acids. The antioxidant properties of kombucha tea have been proven to increase during the fermentation process due to the free phenolics produced, where the higher the phenolic content, the higher the antioxidant activity (Bishop *et al*., 2022). Apart from green tea, the basic ingredients for making kombucha can be obtained from plants that are rich in antioxidants such as rosella flowers.

The roselle plant (*Hibiscus sabdariff*a) also known as marsh acid, beetle acid, or susur acid, originates from the African continent. Apart from being used as an ornamental plant, roselle also has medicinal properties as a tea, and the leaves can be used as a vegetable. This plant is known for its many beneficial properties for humans, such as lowering cholesterol levels, treating hypertension, preventing osteoporosis and premature aging, reducing throat phlegm, and treating canker sores (Astuti and Fadilla, 2020). The use of rosella flowers (*Hibiscus sabdariffa* L.) is believed to have antioxidant activity related to the phenolic content in them (Pangaribuan, 2016). This is proven by research conducted by Sitanggang *et al*., (2023) which shows that rosella flowers have high

antioxidant activity, with an IC50 of 10.74 ± 0.14 mg/g and an IC50 of 202.47 μL/mL. The flower petals are rich in antioxidants which play a role in binding free radicals and are often used as natural dyes.

Green tea and rosella both contain secondary metabolite compounds which are included in the type of antioxidant, namely phenolic compounds. Phenolics have one or more aromatic benzene rings and are considered one of the most abundant types of antioxidants (Wardani *et al*., 2020). Phenolic compounds are bioactive secondary metabolites that are widely distributed in plants, mainly produced through the cicamic acid, pentose phosphate and phenylpropanoid pathways. Structurally, phenolic compounds include a variety of compounds that have aromatic rings with one or more hydroxyl groups, and can vary from simple molecules to complex polymers (Haminiuk *et al*., 2012). Phenolic compounds are chemical compounds that have conjugated double bonds and chromophore groups. Chemical compounds that have conjugated double bonds and chromophore groups can be determined using the spectrophotometric uv-vis method (Sari and Ayuchecaria, 2017). This research was conducted to determine the phenolic content of green tea kombucha and rosella kombucha using a UV-vis spectrophotometer.

2 METHODS

Tools and Materials

Tools

The tools used in this research were glass jars, spoons, stoves, measuring glasses, beakers, measuring flasks, Erlenmeyer flasks, dropper pipettes, volume pipettes, bulbs, analytical scales, vortexes, pH meters, UV-VIS spectrophotometers.

Materials

The ingredients used in this research were green tea, rosella flowers, water, kombucha starter culture, distilled water, granulated sugar, methanol p.a, Na_2CO_3, gallic acid, Folin-ciocalteu.

Kombucha Tea Preparation

Kombucha Starter Preparation

1000 ml of water is boiled until it boils and 100 grams of sugar (10% w/v) is added to the amount of water used and 5 grams of 0.5% (w/v) tea is added. Then filter and cover the filtrate with aluminum foil and let sit until the tea has room temperature. After that, add 100 ml of kombucha starter culture (10% w/v) to the brewed tea and then close the container tightly. Propagation of the kombucha starter culture was left for 14 days.

Making Green Tea Kombucha

5 grams of green tea is brewed using 200 ml of boiling water. Then add sugar with a concentration of 50 grams and stir. Cover the brewed green tea tightly with a cloth and let it sit until room temperature. 20 ml of liquid kombucha starter is added and fermented for approximately 12 days in a closed container.

Making Rosella Kombucha

5 grams of rosella flowers are brewed using 200 ml of boiling water. Then add sugar with a concentration of 50 grams and stir. Cover the steep rosella tea with a cloth and let it sit until room temperature. 20 ml of liquid kombucha starter is added and fermented for approximately 12 days in a closed container.

pH Level Test

pH measurements are measured using a pH meter. Green tea kombucha and rosella flower kombucha were put in a glass beaker and then dipped into a pH meter.

Phenolic Content Test

Standard Curve of Gallic Acid Standard Solution

The standard gallic acid solution was made in varying concentrations of 10, 20, 30, 40, 50 ppm. Take 1 ml of the standard solution of gallic acid of each concentration and put it into a test tube and add 0.5 ml of Folin-ciocalteu then leave it for 8 minutes while shaking. To the solution was added 4 ml of 7% Na_2CO_3 solution and vortexed for 1 minute. Measurements were carried out at a wavelength of 760 nm.

Sample Absorption Measurement

1 ml of kombucha from each sample and add 0.5 ml of Folin-ciocalteu, leave it for 8 minutes while shaking. 4 ml of 7% Na2CO3 solution was added and vortexed for 1 minute. Absorbance was calculated with a wavelength of 760 nm. Measurements were carried out at a wavelength of 760 nm. The total phenol content can be calculated using the following formula:

$$TPC = c \cdot v \cdot fp$$

Explanation:

TPC : total phenolic content (mg/L GAE)

c   : concentration (x value) (ppm)

v   : sample volume (ml)

fp   : dilution factor

3 RESULTS and DISCUSSIONS

Kombucha is a health drink that has many benefits for the body. Kombucha is believed to contain phenolics and antioxidants. Kombucha has a sour taste caused by the increase in organic acid compounds during the fermentation process, and resulting in a decrease in the pH of the kombucha. The longer the fermentation time, then the total acid will increase (Wistiana & Zubaidah, 2015). Generally, the degree of acidity of a material is indicated by the pH value. The pH value of green tea kombucha and rosella kombucha can be seen in table 1. The low pH value in the two kombucha samples is caused by the metabolic process of yeast and bacteria towards sucrose which produces a number of organic acids such as acetic acid, gluconic acid and glucuronic acid (Wistiana & Zubaidah, 2015).

Table 1: pH value

No	Sample	pH Value
1	Kombucha Teh Hijau	3.32
2	Kombucha Rosella	2.62

The decrease in the pH of kombucha tea also occurs because during the fermentation process, yeast will synthesize sugar into ethanol and by bacteria the acetate is broken down into organic acids, such as acetic acid and gluconic acid and several concentrations of organic acids. This results in a decrease in the pH of the fermentation medium

(Puspitasari et al., 2017). As fermentation progresses, the pH decreases, becoming more acidic. *Lactobacillus bulgaricus* is a lactic acid bacterium with the ability to convert carbohydrates into organic acids, primarily lactic acid. The accumulation of lactic acid in the fermentation medium causes a gradual decrease in pH. This influence is associated with an increase in medium acidity due to the release of organic acids (Ansory et al., 2023).

Kombucha is believed to have good antioxidant content. This antioxidant potential is obtained from the phenolic compounds contained in kombucha (Nafisah et al., 2023). Phenolic compounds are a type of organic compound that has one or more hydroxyl groups (-OH) attached to an aromatic ring called phenol. The basic structure of phenolic compounds is an aromatic ring which has hydroxyl groups scattered around the ring. This hydroxyl group gives reactive properties and unique characteristics to phenolic compounds. This compound can be found naturally in various types of plants. In the food and beverage industry, phenolic compounds play a role in providing a distinctive aroma, as natural colorants, and as antioxidant agents in food and beverage products (Christalina et al., 2018). The way phenolic compounds work involves denaturing proteins in bacteria. These compounds can be absorbed into bacterial cells because they have hydrogen bonds. If phenolic levels are low, phenolic compounds will form protein complexes with weak bonds, then decompose, followed by penetration of phenolic compounds into bacterial cells, which causes protein deposition and denaturation (Novita, 2016).

In this study, the levels of phenolic compounds in green tea kombucha and rosella flower kombucha were analyzed using a spectrophotometer uv-vis. A spectrophotometer uv-vis is a tool used quantitatively to identify the compound content in a sample by measuring absorbance in the wavelength range 200-700 nm. The first step in calculating phenolic content is to create a standard curve for gallic acid. In making a standard curve, the absorbance of each concentration is needed. The measurement results are in the form of absorbance, which is analyzed according to the Lambert-Beer law from the concentration of the standard solution or sample. Absorbance data are used to create a standard curve, which provides information about the correlation coefficient (r) and the linear regression equation ($y = ax + b$). This regression equation is then used to determine the compound content in the analyzed samples (Wahyuni and Marpaung, 2020). This data can be seen in table 1.

Table 2: Data for Determining the Standard Curve for Gallic Acid

Consentration (ppm)	Absorbance
10	0.331
20	0.52
30	0.804
40	1.159
50	1.315

Solutions of variation concentrations (10 ppm, 20 ppm, 30 ppm, 40 ppm, 50 ppm) were searched for absorbance using a spectrophotometer uv-vis instrument. The absorbance of each concentration can be seen in table 2. After obtaining the absorbance of each concentration, the next step is to create a standard standard curve for gallic acid which is used to find equations and linear regression. The standard curve for gallic acid can be seen in Figure 1.
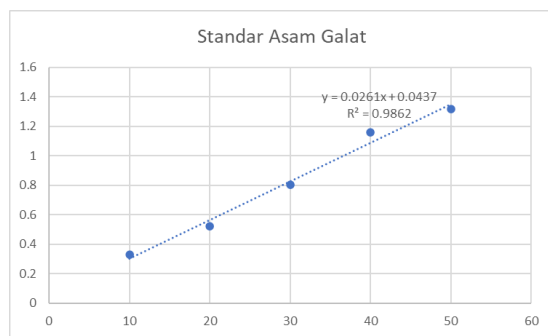
Figure 1: Standart Curve for Gallic Acid

The standard curve for gallic acid has the regression equation y (absorbance) = 0.0261x (concentration) + 0.0437 with a coefficient of determination $R2$ = 0.9862. The curve can be said to be linear because the determination coefficient ($R2$) is 0.9862 or close to one. The phenolic concentration can be determined by substituting the absorbance of the sample into Y in

the equation. The size of the X indicates the concentration of phenolics in the sample.

The standard phenolic compound used is gallic acid or 3,4,5 - trihydroxybenzoic acid ($C6H2(OH)3CO2H$). Gallic acid is a derivative of hydroxybenzoic acid which is included in the category of simple phenolic acids (Ansory et al., 2023). In the process of testing phenolic content, kombucha was added with Folin Ciocalteu reagent and 7% $Na2CO3$. The oxidation reaction of Folin with phenolic compounds or phenolic hydroxyl groups will reduce the phosphomolybdate-phostungstate present in the Folin-Ciocalteu reagent. The Folin-Ciocalteu reagent will react with the hydroxyl group and form a molybdenum-tungsten blue complex which can be detected using a spectrophotometer. The addition of $Na2CO3$ aims to achieve alkaline conditions in the Folin reaction, which causes the dissociation of phenolic compound protons into phenolic ions. $Na2CO3$ can form an alkaline environment, so that the higher the phenolic content in the extract, the stronger the intensity of the blue color produced (Gemati et al., 2013).

After knowing the phenolic concentration, then calculate the TPC. Determination of TPC is part of the analysis which is related to phenolic content and antioxidant activity. Samples with a relatively high content of phenolic secondary metabolite compounds generally have high antioxidant activity (Handayani et al., 2022). The total phenolic content in each extract is expressed as gallic acid equivalent (GAE). GAE is a general reference for measuring the number of phenolic compounds contained in a material. Based on the existing phenolic concentration, the TPC value of kombucha for each sample was obtained. The TPC value of each sample can be seen in table 3.

Table 3: TPC Value of Green Tea Kombucha and Rosella Flower Kombucha

Sample	Absorbance	Phenolic Concentration	TPC (mg/L GAE)
Green Tea Kombucha	4.281	162.348659	162.35
Rosella Kombucha	2.688	101.3141762	101.31

The TPC value of green tea kombucha is 162.35 mg/L GAE, while the TPC value of rosella flower kombucha is 101.31 mg/L GAE. Based on the data obtained, it can be seen that the TPC value for green tea kombucha is higher than the TPC value for rosella flower kombucha. The samples used in this research

were green tea kombucha and rosella flower kombucha. The use of samples in this study was based on previous literature which showed the presence of compounds contained in green tea and rosella flowers. The compound content of each sample can be seen in table 4..

Table 4: Compound Content of Green Tea, Telang, Rosella, Lavender and Chamomile

No	Aspect	Green Tea	Rosella
1	Flavonoid	Catechin (-) epicatechin (EC) (-) epigallocationchin (EGC) (-) epicatechin gallate (ECG) (-) epigallocationchin gallate (EGCG). (Fadhlurrohman & Susanto, 2024)	Kaempferol Quercetin Myricetin (Ramahani et al., 2024)
2	Anthocyanin	-	Cyanidin Peonidin Delfinidine Malvidin Petunidin (Gamgulu, 2023)
3	Polyphenols	Epigallocatechin galat Epigallocatechin (Fadhlurrohman & Susanto, 2024)	Citric acid, malic acid, ascorbic acid (Nugroho et al., 2018)
4	Phenolic	simple hydroxybenzoic acids such as gallic acid and propyl gallate (Galati, 2006)	Citric acid Hydroxycitric acid Hibiscus acid Protocatechuic acid (Boras-Linares, 2014)
5	Steroid	Beta-sitosterol (Helilusiatiningsih, 2021)	Beta-sitosterol Stigmasterol (Khan et al., 2020)

Green tea and rosella are both rich in various compounds that provide health benefits. Based on table 4, it can be seen that green tea and rosella have differences in terms of their compound content. Green tea contains flavonoid compounds such as (-) epicatechin (EC), (-) epigallocatechin (EGC), (-) epicatechin gallate (ECG), (-) epigallocatechin gallate (EGCG). Rosella contains kaempferol, quercetin, and myrisetin, which have been shown to have antioxidant and anti-inflammatory properties that are important for body health. On the other hand, rosella contains anthocyanins such as cyanidin, peonidin, delphinidin, malvidin, and petunidin, which are also known for their antioxidant and anti-inflammatory properties. Additionally, polyphenols such as epigallocatechin gallate (EGCG) and epigallocatechin (EGC) are found in green tea. Rosella flowers contain citric acid, malic acid and ascorbic acid. Phenolic compounds such as simple hydroxybenzoic acids namely gallic acid and propyl gallate are present in green tea, while rosella is rich in citric acid, hydroxycitric acid, hibiscus acid and protocatechuic acid. Lastly, steroids such as beta-sitosterol and stigmasterol can be found in green tea, providing additional health benefits. With the combination of these compounds, green tea and rosella offer various health benefits for the body.

Based on table 4, it can be seen that green tea contains several catechin compounds including epicatechin (EC), epigallochantiochin (EGC), epicatechin gallate (ECG), epigallochantiochin gallate (EGCG), polyphenolic compounds in the form of epigallocatechin gallate and epigalocatechin. and contains steroids in the form of beta sitosterol. Based on the results of the catechin compound, the function of the epicatecin compound in green tea is as a strong antioxidant, which can reduce lipid peroxidation and also inhibit platelet aggregation (Praptiwi, et al, 2015). Furthermore, the compound epigallochantiochin (EGC) is a catechin class compound that can prevent the production of IL-8 in airway epithelial cells, thereby limiting the degree of inflammation of the respiratory tract. Furthermore, the compound epicatechin gallate (ECG) is a natural flavonoid compound found in green tea

(Juniaty, 2013)   (Jia dan Lui, 2013)
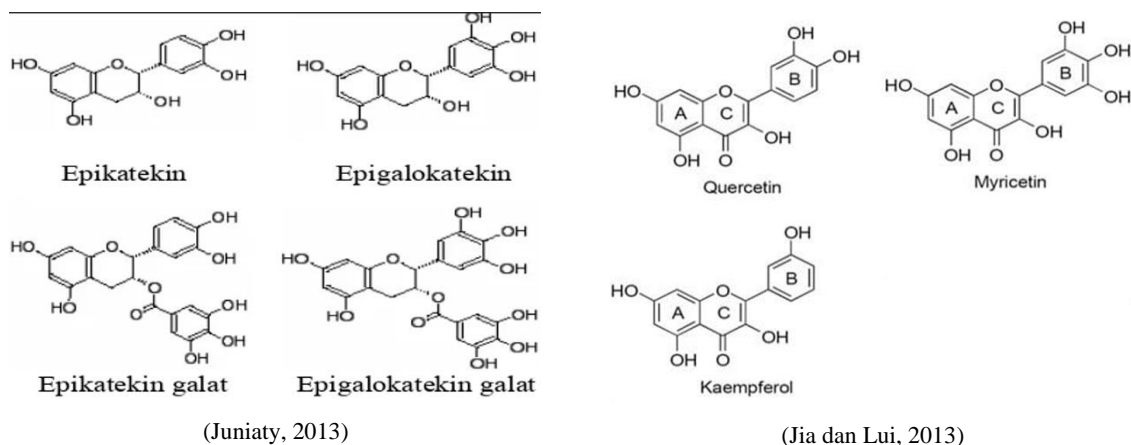
Figure 2: Phenolic Compounds of Green Tea (left) and Rosella (right)

Based on the results of phenolic content analysis research which can be seen in table 3, that the phenolic content in green tea kombucha is greater than in rosella kombucha. This is proven by table 4, that compounds containing the -OH group are more commonly found in green tea so that the TPC value in green tea kombucha is higher than rosella flower kombucha.

The microorganisms in the fermentation process provides a strong rationale for the increase in phenolic content. The activities of these microorganisms during fermentation can induce damage to cell wall structures, allowing various bioactive compounds contained within to be released (Mahardani & Yuanita, 2021). Throughout fermentation, microorganisms involved in the process can produce specific enzymes capable of converting non-phenolic compounds into phenolic compounds. These enzymes can transform the structure of complex organic compounds into simpler and more measurable phenolic compounds. Microorganism metabolism activities also result in various secondary metabolites. Some secondary metabolites produced during fermentation may possess phenolic properties or can be converted into phenolic compounds by these microorganisms. Consequently, the total phenolic content in kombucha will increase. Changes in phenolic content during fermentation may depend on the type of microorganism used, fermentation conditions, as well as the composition and chemical properties of the fermented substrate (Ansory et al., 2023).

4 CONCLUSIONS

The results showed that the TPC value of green tea kombucha was 162.35 mg/L GAE and rosella flower kombucha was 101.30 mg/L GAE. Thus, green tea kombucha has a higher phenolic content compared to rosella flower kombucha. This shows that green tea has a greater opportunity as the main ingredient in making kombucha which can provide better health benefits.

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The Influence of Awareness about Halal and Toyyib Food on Interest Consuming Korean Food Among Adolescent and Adult

Ika Mustika*, Sri Hidayati L.

Faculty of Psychology and Health, UIN Sunan Ampel Surabaya, Indonesia

*ikamustika@uinsa.ac.id

Keywords: Halal Awareness, Toyyib Food, Interest Cnsuming, Korean Food, Adolescent, Adult.

Abstract: The selection of halal and thoyyib foods is an obligation and a part of Muslim identity. The influence of foreign culture like the Korean Wave has impacted people's interest in Korean foods. Unfortunately, not all Korean foods are made with halal and thoyyib ingredients suitable for consumption by Muslims. The aim of this research is to understand how awareness of consuming halal and thoyyib foods affects the desire to purchase Korean cuisine among teenagers and adults. This quantitative study was conducted in East Java, focusing on 189 participants aged 12-30, both male and female, who are Muslims. Data was collected through Google Form questionnaires and analyzed using multiple linear regression. The results showed a positive significant influence of halal and thoyyib awareness on the interest in consuming Korean cuisine, with a regression coefficient significance value of $0.000 < 0.05$. In conclusion, it was found that halal and thoyyib foods have a significant impact both individually and collectively on the interest in consuming Korean foods.

1 INTRODUCTION

The demand for halal market is increasing and becoming a highly sensitive trend among Muslims worldwide(Alifianita,2023.). Southeast Asia is seen as having a large halal market opportunity due to its Muslim population reaching 230 million. Developing countries like Indonesia, Malaysia, and Thailand are the top consumers of halal products in the world (Setyaningsih, 2022). As the country with the largest Muslim population globally, Indonesia contributes 12.6% of the world's Muslim population (Divianjella, Muslichah and Ariff, 2020). With 87.2% of Indonesia's total population being Muslim, the halal certification of a product is crucial for Indonesia (Kusuma, 2021).

For Muslims, consuming halal and toyyib food is an obligation and a defining characteristic. This is stated in Surah Al-Baqarah verses 168 and 172. In Surah Al-Baqarah verse 168. : "*O humanity! Eat from what is lawful and good on the earth and do not follow Satan's footsteps. He is truly your sworn enemy.*". As for Surah Al Baqarah verse 172. : "*O believers! Eat from the good things We have provided for you. And give thanks to Allah if you ˹truly˺ worship Him*

˹*alone*˺.". Based on both verses, Muslims are commanded to consume food that is halal and good, as well as sourced from lawful provisions, demonstrating the obedience of Muslims to Allah SWT. (Kusuma, 2021).

According to the Indonesian Ulama Council (MUI), halal food is food that complies with Islamic law, does not contain pork; does not contain forbidden ingredients such as blood, human body organs, disgusting substances, animals must be slaughtered according to Islamic law, storage, sales, food transportation tools should not be used for pork or other impurities. (Kusuma, 2021). Thayyib essentially means "free from deficiencies in its field" and "free from all impurities". In addition to being commanded that the food should be halal and thayyib, it is also required that the food is beneficial for health. According to Kalamuddin Nurdin's perspective in the Syawarifiyyah dictionary, thayyib is understood as virtue, goodness, excellence, blessing, and pleasure. Al Raghib al-Ashfahani explains that the term thayyib is specifically used to describe something that gives delight to the senses and soul, such as food, clothing,

shelter, and so on. In the Qur'an, the word thayyib and its various derivatives are mentioned 46 times, dispersed throughout several chapters and verses. (Samsuddin, 2020.)

Buya Hamka expresses that "*And eat from what Allah SWT has provided for you, that which is lawful and good*". This is in accordance with QS. Al-Maidah verse 88 : "*Eat of the good, lawful things provided to you by Allah. And be mindful of Allah in Whom you believe*"

Word thayyibat is a plural form of the word "ath-thayyib". Linguistically, it can mean good, delicious, calming, excellent, and healthy. In the context of food, it refers to food that is not dirty in terms of its content, or spoiled (expired), or mixed with impurities. It can also be said that what is "thayyib" about food is that it is appetizing, does not harm one's physical and mental health. (Maftuhah, 2014)

The development of current technology and information has led to the emergence of foreign cultures in Indonesian society. One of them is the foreign culture from South Korea known as Hallyu or Korean Wave. (Lupitasari, Nurlaela and Miranti, 2020; Cindrakasih, 2021). In Indonesia, the popularity of the Korean Wave is very high, especially since access to entertainment from South Korea has become easier. The influence of Korean dramas and Korean music (K-Pop) has spread widely, attracting people to learn more about South Korea, including its distinctive cuisine. Korean food is often featured in Korean dramas, variety shows, reality shows, and more. The presence of Korean food on television sparks people's interest to try and discover the names of these dishes. Korean food is rapidly growing in Indonesia due to the high interest of Indonesian people in Korean cuisine. This has led to the emergence of Korean food sellers ranging from street vendors to restaurants. The food is presented with various unique flavors and tastes distinctive to Korea, but adjusted to suit Indonesian tastes. (Assa'adah, no date). (Tamara and Suyanto, 2019; Sari, Hulaify and Komarudin, 2023).

The demand for Korean food in Islamic markets continues to rise, including in Indonesia. However, not all Korean food in Indonesia has been certified Halal by MUI. Some Korean foods use pork oil, pork meat, and alcohol in their cooking process. Additionally, the processing of ingredients that do not comply with Islamic law renders the food unsuitable for consumption by Muslims.(Maria Oktavianingtias and Istyakara Muslichah, 2022). Consumers who are Muslim should pay close attention to the concept of halal and toyyib in various aspects of life, including food. (*Gelombang Korea dan Dampaknya pada Industri Makanan Korea Halal di Indonesia*, no date). However, the reality is that many people pay little attention to the spiritual dimension in the process of consuming food. Many people, especially the younger generation, consume food to follow trends without considering the principles of halal and toyyib in food. The excessive fondness for Korean culture is increasing the interest of the younger generation in buying Korean food while disregarding awareness of halal food.(Sari, Hulaify and Komarudin, 2023; Putra and Aliyanti, 2024).

2 METHODS

This research uses a quantitative research method with a survey technique using online questionnaires distributed through Google Form. The sampling technique used is accidental sampling obtained online through social media platforms, with the sample size determined based on specific considerations, including respondents aged 12-30 years old, interested in or have purchased or consumed Korean food at least once, and willing to participate in the study. The sample size for this research is 189 respondents.

Table 1: Scoring Questionnaire Evaluation

Score	Category
4	Strongly agree (SS)
3	Agree (S)
2	Disagree (TS)
1	Strongly disagree (STS)

Validity testing is conducted to determine the validity of each item in the questionnaire for each variable under study. There are 26 items for the halal food variable, 12 items for the wholesome food variable, and 20 items for the Korean food consumption interest variable.

Table 2: Validity testing results from questionnaire item

Variabel	Indikator	p value	α	Status
	X1.1	0,000	0,05	Valid
Halal Food (X1)	X1.2	0,000	0,05	Valid
	X1.3	0,000	0,05	Valid

Variabel	Indikator	p value	α	Status
	X1.4	0,000	0,05	Valid
	X1.5	0,000	0,05	Valid
	X1.6	0,000	0,05	Valid
	X1.7	0,000	0,05	Valid
	X1.8	0,000	0,05	Valid
	X1.9	0,000	0,05	Valid
	X1.10	0,001	0,05	Valid
	X1.11	0,000	0,05	Valid
	X1.12	0,000	0,05	Valid
	X2.1	0,000	0,05	Valid
	X2.2	0,000	0,05	Valid
	X2.3	0,000	0,05	Valid
	X2.4	0,000	0,05	Valid
	X2.5	0,000	0,05	Valid
Toyyib Food (X2)	X2.6	0,000	0,05	Valid
	X2.7	0,000	0,05	Valid
	X2.8	0,000	0,05	Valid
	X2.9	0,000	0,05	Valid
	X2.10	0,000	0,05	Valid
	X2.11	0,000	0,05	Valid
	X2.12	0,000	0,05	Valid
	Y.1	0,000	0,05	Valid
	Y.2	0,000	0,05	Valid
	Y.3	0,000	0,05	Valid
	Y.4	0,000	0,05	Valid
	Y.5	0,000	0,05	Valid
	Y.6	0,000	0,05	Valid
	Y.7	0,000	0,05	Valid
	Y.8	0,000	0,05	Valid
	Y.9	0,000	0,05	Valid
Interest in Comsuming Korean Food (Y)	Y.10	0,000	0,05	Valid
	Y.11	0,000	0,05	Valid
	Y.12	0,000	0,05	Valid
	Y.13	0,003	0,05	Valid
	Y.14	0,000	0,05	Valid
	Y.15	0,000	0,05	Valid
	Y.16	0,000	0,05	Valid
	Y.17	0,000	0,05	Valid
	Y.18	0,005	0,05	Valid
	Y.19	0,000	0,05	Valid
	Y.20	0,000	0,05	Valid

From the table above, the results of validity testing can be seen, with a questionnaire consisting of 44 items of questions filled out by 189 respondents. The significance value alpha is 0.05, with the conclusion that if the p value < α (0.05) the questionnaire is valid, while if the p value > α (0.05) it is not valid. The validity test results in the table show that all questionnaire items are valid.

Table 3: Reliability testing results of variables

Variabel	Cronbach's Alpha	N (items)	Status
Halal Food	0,889	12	Reliabel
Toyyib Food	0,887	12	Reliabel

Variabel	Cronbach's Alpha	N (items)	Status
Interest in consuming Korean Food	0,888	20	Reliabel

Reliability testing in research is carried out to measure the consistency of item questions in a questionnaire for the variables X1 and X2 towards Y. The basis for decision-making for reliability testing is if the value of α > 0.60, then the data can be considered reliable. If the value of α < 0.60, then the data is deemed unreliable.

Table 4: Reliability Statistics

Cronbach's Alpha	N of Items
.892	44

The number of questions in the questionnaire is 44. The questionnaire is considered reliable if the Cronbach Alpha value is > 0.6. Based on the above table, the reliability test result in this study is 0.892 > 0.6, indicating that the questions are reliable. The data analysis technique used in this study includes descriptive analysis and multiple linear regression analysis to analyze the characteristics of respondents such as gender, age, school background, and whether they have consumed Korean food. Multiple linear regression analysis is used to determine the influence between independent variables (respondents' awareness of halal and wholesome food) and the dependent variable (interest in consuming Korean food).

The technique used to answer the problem formulation for respondent characteristics is multiple correlation analysis with partial tests and simultaneous tests. Partial correlation analysis is used to prove the hypothesis between variables X1 and Y and X2 and Y. While simultaneous correlation analysis to prove the hypothesis between variables X1 and X2 with Y (Lupitasari, Nurlaela and Miranti, 2020b).

3 RESULTS

Sample testing using a questionnaire obtained 189 respondents with the criteria that respondents are 12¬-30 years old, interested or have bought or consumed at least once Korean food and are willing to be research samples.

Table 5: Respondent Identity

Respondent Identity		Number of Respondent	Persentase
Gender	Male	32	16,9
	Female	157	83,1
Age group	12-15 years old	2	0,01
	16-19 years old	73	38,6
	20-23 years old	93	49,2
	24-27 years old	19	0,10
	28-31 years old	2	0,01
School of origin	Madrasah Aliyah	56	29.6
	Pondok Pesantren	17	9.0
	SMA	87	46.0
	SMK	29	15.3
Ever/never consumed	ever	155	82
	never	34	18

Based on the table above, the distribution of respondents according to gender is dominated by women by 83.1%, which illustrates that Korean food is also very popular with women because Korean snacks are also shown in Korean dramas which are very attractive to women in Indonesia. In the age group, a very high age was found in the age range of 20-23 years at 49.2% and likewise in the age group 16-19 years at 38.6%. It can be seen that teenagers and adults have a high interest in consuming Korean snacks. The distribution of respondents based on school origin was more from SMA and MA, namely

46.0% and 29.6% and the respondents' statements in the decision to consume Korean food were dominated by statements of having consumed 155 respondents or 82%.

Normality test is a test that is done in knowing whether or not a dependent and independent variable is normal. The regression model is said to be good is a normal or near normal data distribution. To determine normality, you can see the results of the Kolmogorov Smirnov Test as follows:

Table 6: One-Sample Kolmogorov-Smirnov Test

		Unstandardized Residual
N		189
Normal Parameters[a]	Mean	.0000000
	Std. Deviation	7.13516219

		Unstandardized Residual
Most Extreme Differences	Absolute	.061
	Positive	.030
	Negative	-.061
Kolmogorov-Smirnov Z		.839
Asymp. Sig. (2-tailed)		.481

a. Test distribution is Normal.

Based on the test results in the table above, the p-value (Asymp.Sig. 2 tailed) is 0.481> 0.05 so it can be concluded that the regression model has fulfilled the Data Normality assumption (the data is normally distributed).

Table 7: Linieritas Test

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
Unstandardized Residual * Unstandardized Predicted Value	Between Groups	(Combined)	4692.250	105	44.688	.760	.908
		Linearity	.000	1	.000	.000	1.000
		Deviation from Linearity	4692.250	104	45.118	.768	.900
	Within Groups		4878.931	83	58.782		
	Total		9571.181	188			

Based on the test results of the table above, the linearity p-value (sig) is 1.000> 0.05 so it can be concluded that there is a linear relationship between the independent variable and the dependent variable.

Table 8: Multikolinieritas Test

Model		Collinearity Statistics	
		Tolerance	VIF
1	Makanan Halal	.705	1.418
	Makanan Toyyib	.705	1.418

Based on the test results in the table above, the VIF value for all independent variables is less than 10, which means that the independent variables are free from multicollinearity

Table 9: Autokorelasi Test

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.406ᵃ	.165	.156	7.173	2.032

a. Predictors: (Constant), Makanan_Toyyib, Makanan_Halal
b. Dependent Variable: Minat_Beli

Based on the Durbin Watson table, the dL value is 1.7406, the dU value is 1.7833 and the dW value is 2.032 where the 4-dl value is 4-1.7406 equal to 2.2594 or equal to $1.7833 < 2,032 < 2.2594$. In conclusion, according to the criteria dU < dW < (4-dL) is fulfilled, namely free of autocorrelation symptoms between independent variables.

Table 10. Heterokedastisitas Test

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.374	2.524		.544	.587
	Makanan Halal	.044	.094	.041	.471	.638
	Makanan Toyyib	.096	.070	.119	1.372	.172

a. Dependent Variable: ABS_RES1

Based on the table above, it can be seen that the p-value (Sig.) obtained for halal food is 0.638> 0.05 and toyyib food is 0.172> 0.05, which means that all independent variables are free from symptoms of Heteroscedasticity and can proceed to the REGRESSION TEST because it has met all the specified assumption tests.

Table 10. Multiple Linier Regression Test

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.406[a]	.165	.156	7.173	.165	18.390	2	186	.000	2.032

a. Predictors: (Constant), Makanan_Toyyib, Makanan_Halal

b. Dependent Variable: Minat_Beli

a. The correlation coefficient value of 0.406 indicates a moderate relationship or correlation between Halal and Toyyib Food and Interest in Consumption of Korean Specialties. With a positive regression coefficient value or in line, which means that there is a positive relationship between the dependent and independent variables.

b. The R Square value (coefficient of determination) of 0.165 means that simultaneously the halal food and toyyib food variables affect the interest in Korean specialty food consumption by 16.5%. While the remaining 83.5% of consumption is influenced by other unobserved variables.

c. The Adjusted R Square score shows the magnitude of the role of the independent variable in influencing the independent variable, which is 15.6%.

d. The standard error value of 7.173 indicates that the error with regression in predicting.

Table 11: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	11.882	4.162		2.855	.005
	Makanan Halal	.300	.155	.154	1.933	.005
	Makanan Toyyib	.436	.115	.301	3.778	.000

a. Dependent Variable: Minat_Beli

Based on the table above, the regression equation can be formulated as:

$$Y = 11{,}882 + 0{,}300X1 + 0{,}436X2$$

With this regression equation, we can estimate how much interest in consuming Korean specialties based on awareness of halal and toyyib food, namely:

a. Constant 11.882, meaning that with or without the influence of the halal food or toyyib food variable, the interest in consuming Korean food has occurred at 11.882.

b. Coefficient 0.300X1, meaning that with an increase of 1 unit of halal food value, the interest in Korean food consumption will also increase by 0.300 assuming other factors remain.

c. Coefficient 0.436X2, meaning that with an increase of 1 unit of toyyib food value, the interest in Korean food consumption will also increase by 0.436, assuming other factors remain constant.

d. And of the two independent variables, the most significant influence is on the toyyib food variable.

Decision making for hypotheses (partially)

a. Based on the table above, it is obtained that the p¬-value (sig.) for halal food is 0.005 <0.05, which means that H0 is rejected, indicating that there is an influence between halal food on the interest in consuming Korean specialties.

b. Based on the table above, it is obtained that the p¬-value (sig.) for halal food is 0.000 <0.05, which means that H0 is rejected, indicating that there is an influence between halal food on interest in consumption of Korean specialties.

Table 12: Anova[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1892.575	2	946.288	18.390	.000[a]
	Residual	9571.181	186	51.458		
	Total	**11463.757**	**188**			

a. Predictors: (Constant), Makanan_Toyyib, Makanan_Halal
b. Dependent Variable: Minat_Beli

Based on the results in the ANOVA table, the p¬-value (sig.) is 0.000 <0.05 so that H0 is rejected, which means that simultaneously the independent variables (Halal Food and Toyyib Food) affect the dependent variable (Interest in Consumption of Korean Specialties).

4   DISCUSSIONS

Based on the results of tests that have been carried out on the variables of awareness of halal food and toyyib food on interest in Korean food consumption among adolescents and adults, it is found that there is a significant influence both partially and simultaneously. The results of this study are in accordance with the research of Savitri, et al, namely that there is a partially significant effect of halal awareness on buying interest in Korean food. When teenagers begin to realize that consuming halal and toyyib food is important for themselves, especially for their health, it will have a positive impact on their interest in buying and consuming halal Korean food products. The greater the level of understanding of a teenager of the concept of halal, it will determine the attitude and the more positive the behavior of a teenager on issues related to halal and toyyib according to Islamic rules. (Hendradewi, Mustika and Darsiah, 2021)

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Awareness of the halalness of various products such as food and beverages and cosmetics is important, especially for Muslim teenagers. The knowledge of

Muslim teenagers in Indonesia about the halalness of Korean cosmetics and food products can be seen from their tendency to choose products that have been labeled and certified halal by MUI. The high percentage of interest in food from Korea and Japan indicates that halal labeling on these products is very important.   In addition, halal labeling on imported products is very important, especially for Muslim countries such as Indonesia due to the high demand for these products. (Ramadhani *et al.*, 2023).

This research is in line with research conducted by Nofianti & Rofiqoh (2019) dan Setyaningsih & Marwansyah (2019) that halal awareness has a significant effect on buying interest. This is in accordance with research Elen Surya Lupitasari,dkk (2020) is that Korean Wave and Korean food have a significant effect on interest in eating Korean dishes with a value of 96.959. (Lupitasari, Nurlaela and Miranti, 2020).

Different results were found in Putra and Aliyanti's research (2024), where halal awareness has no effect on buying interest in Korean food, because the younger generation is more likely to follow trends in buying food and pay less attention to the halalness of a product or food. In addition to awareness of halal food, buying interest in Korean food is also influenced by other factors such as the influence of korean wave, halal food literacy and religiosity. (Putra and Aliyanti, 2024).

According to previous research, there are several factors for individuals to choose halal food, including religious teachings and food safety. As many as 46% of research respondents choose halal food and stay away from haram food because it is in accordance with Islamic teachings. In addition, as many as 54% of respondents believe that halal food is clear about the safety of the food ingredients and is completely safe for consumption.(Dewi, 2020).

Islam is a religion that covers all aspects of life. Islam emphasizes the importance of maintaining one's health and well-being as a way of life. To attain optimal health, one must consider various factors, including food consumption, which directly impacts emotional, physical and spiritual well-being. In addition, Muslims are advised to pay special attention to their diet in order to maintain a pure heart and a healthy intellect as well as nurture a clean soul and a healthy body, a healthy body. Muslims are allowed to eat halal food, which is defined as food that is

allowed. In addition, Muslims are encouraged to eat good (toyyib) food, which includes the aspect of safety. As the most excellent example among all humans, our Prophet set many guidelines for Muslims to follow in order to achieve and maintain a healthy lifestyle, whether physically, emotionally or mentally. Many foods have been assessed in the Qur'an and Sunnah and have been confirmed to have some benefits (Elgharbawy and Azmi, 2022).

5 CONCLUSIONS

The findings of this study conclude that the halal and toyyib food variables have a significant effect both partially and simultaneously on interest in Korean food consumption.

Suggestions for the community, especially adolescent and adults, are to increase awareness of halal and toyyib food when consuming food and drinks by increasing literacy about halal food, paying more attention to the composition of food and food processing that will be consumed. In addition, for the Government, it is expected to pay more attention to food and beverages circulating in the community so that they comply with Islamic law and regulations. Food businesses are expected to be able to apply the principles of halal and toyyib in processing and serving food.

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Analysis of the Urgency of Vitamin A Consumption on the Growth and Development of Toddlers

Rezandy Alif Bima Luckyto[1], Siti Nur Zahrina Madiha[1], Marwah Nurul Ibrahiem[1], Nurul Aulia[1], Rahma Aulia Syahrani Ardita[1], Sabrina Nabila Auliasari[1], Nazwa Bilbina Dinda Atillah[1] , Dwi Rukma Santi[2]*

[1]Nutrition Study Program, Sunan Ampel State Islamic University Surabaya, Indonesia
[2]Psychology Study Program, Sunan Ampel State Islamic University Surabaya, Indonesia
*[*dwirukmasanti@uinsa.ac.id](mailto:dwirukmasanti@uinsa.ac.id)*

Keywords: Vitamin A, Growth and development, Toddlers.

Abstract: Vitamin A is an essential vitamin that plays an important role in the growth and development of toddlers. Vitamin A is the most important nutrient for restoring health and survival. Vitamin A deficiency increases morbidity and mortality, because it is susceptible to infections such as diarrhea and pneumonia. The method used is a literature review method with journals ranging from 2019 to 2024 with appropriate journals. This literature review aims to analyze the urgency of consuming vitamin A for optimal growth and development of toddlers. The results obtained show that consumption of vitamin A is very important for the growth and development of toddlers. Vitamin A plays an important role in maintaining eye health, the immune system, and cognitive function. The conclusion that can be drawn is that vitamin A consumption is very important for optimal growth and development of toddlers.

1 INTRODUCTION

The process of growth and development, which is the outcome of the combination of hereditary and environmental factors, can be used to assess a child's quality. Environmental factors encompass biological, physical, psychological, and social settings; genetic/hereditary factors are those relating to genes inherited from mother and father. Rapid growth and development begins in youth, specifically at age five. The term "Golden Age" is frequently used to describe this time period (Ningsih et al., 2022). Growth and development are essentially different but interrelated events that are difficult to separate: growth and development. Growth is defined as a change in the number, size, dimension, or level of cells, organs, or individuals and can be measured in numbers or grams. Development, on the other hand, is an attempt to add more complex capabilities, structures, and functions to the body in an orderly pattern (Eritiana et al., 2022).

The period of supplementary breastfeeding begins around 6 months of age, when breastmilk alone no longer provides adequate nutrition. Thereafter, the child should be fed a safe and nutritious diet of protein, energy, vitamins and minerals, and should be breastfed continuously until 23 months of age or beyond. Minimal dietary diversity in children during complementary feeding and between 6 and 23 months of age means that only 19% of children are fed a minimally acceptable diet at weaning. Vitamin A is essential for growth and immune function, and vitamin A deficiency makes children vulnerable to infections and death from decreased immune function (Yuniarti et al., 2024).

The high infant and child mortality rate in Indonesia has led to poor public health outcomes. This issue reflects the need for government involvement at the national level to support and maintain oversight of vaccination programs and vitamin A supply in Indonesia. Vitamin A helps reduce mortality and morbidity. Therefore, vitamin A can increase the body's resistance to infections such as measles,

diarrhea, and acute respiratory infections (ARI) (Andanawarih et al., 2020).

For survival and good health, vitamin A is essential. Vitamin A deficiency increases morbidity and mortality rates in children by increasing their susceptibility to potentially lethal illnesses such as pneumonia and diarrhea. Night blindness, a kind of xerophthalmia that can result in corneal damage and blindness, is one of the most serious consequences of vitamin A deficiency. Subclinical vitamin A insufficiency is still a major problem in some areas, impacting about 50 liters. Lowered disease resistance due to this deficit has a detrimental effect on child survival. In addition to preventing blindness, treating a vitamin A deficiency improves productivity, lowers infant mortality, and supports healthy child development (Adriani, 2019).

2 METHODS

Using sources from the Google Scholar database, this study reviews the literature. In the literature process, the keywords used were Vitamin A, Growth and Development and Toddlers. Literature is limited to studies of the last 5 years, starting from 2019 to 2024. 15,800 studies were found through Google Scholar database. The studies were analyzed to obtain studies that fit the criteria of the criteria, namely the type of quantitative research, conducted during the last 5 years, less than equal to 100 people as the sample. 100 people as the sample. According to these criteria, the number of studies obtained was 15 studies, which were conducted by Indonesian researchers. Most of the studies were articles in scientific journals. Our article screening process presented in the following PRISMA diagram.
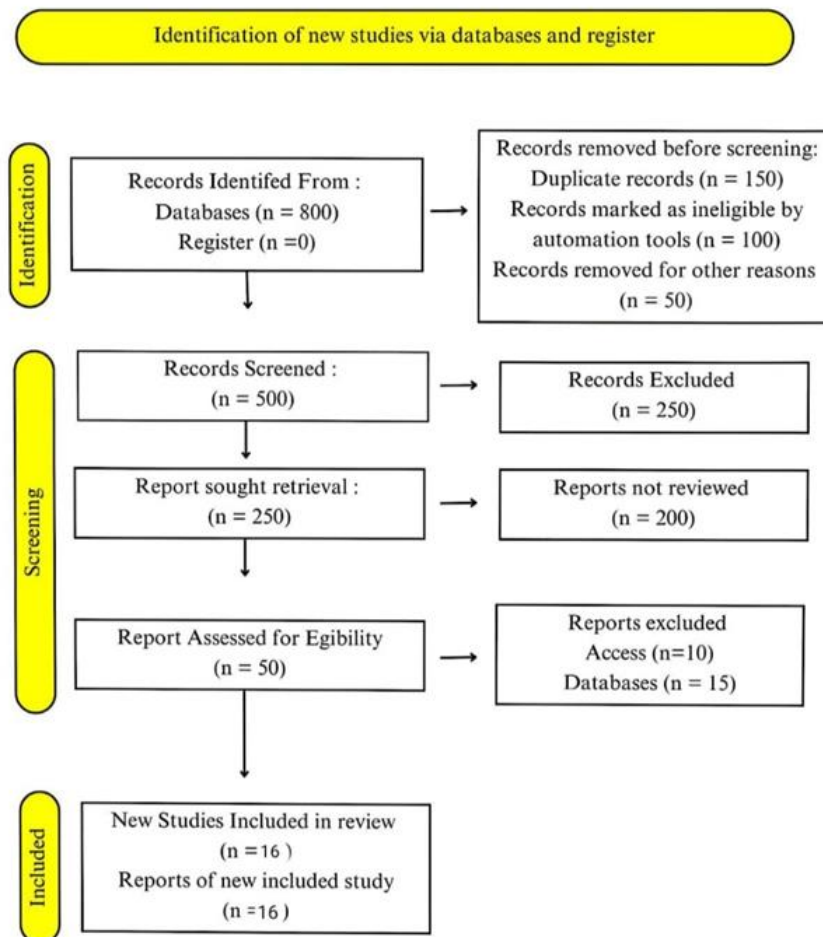

Figure 1: Journal Search Prism

3 RESULTS

Table 1: Journal Analysis Table

No	Research Title	Name/ Year Published Research	Research Methods	Research Results
1	Counseling on 'Growth and Development Monitoring' from Provision of Vitamin A to Toddlers at Posyandu Kenanga Village Mampie Kec. Cileungsi Kabupaten Bogor Year 2021	Nengsih. Yulita, and Imelda Diana Marsilia. (2021)	For this community service activity it is necessary to prepare with the aim of making a work plan based on counseling on monitoring growth and development and giving Vitamin A to toddlers. and the method of implementing the activities provided is in the form of counseling material on monitoring growth and development and giving Vitamin A.	The results of a series of community service activities for mothers who have toddlers are satisfactory, both mastery of the material and how to monitor the growth and development of toddlers who have been given. The understanding of the counseling participants was seen during discussions, questions and answers. It turned out that the participants were able to absorb and understand the material presented. From the results of questions asked in the discussion of participants after being given counseling material, it can be concluded that the counseling went smoothly. For the provision of Vitamin A toddlers who are present are given according to the dose of 52 toddlers, toddlers who do not come will be given directly to each toddler's home by cadres so that the target of giving Vitamin A is still achieved.
2	Socialization of the Benefits of Providing Vitamin A to Children in Wawatu Pantai Village, North Moramo Subdistrict, South Konawe Regency	Asriullah Jabbar, et al (2024)	This research uses the methods used in this activity are material presentation, question and answer between presenters and villagers, filling out pretests and posttests.	This service activity provides an understanding of the benefits of giving vitamin A to children as evidenced by the increase in knowledge after socialization and understanding of the community in Wawatu Pantai Village regarding Vitamin A in children.
3	Monitoring Infant Toddler Growth Through Posyandu Activities & Providing Vitamin A Capsules	Catur Setyorini, Durrotun Nafisah, Fitria Kurniastuti (2023)	This research uses community service activities. Community service was carried out by mothers and infants or toddlers totaling 130 respondents.	Most respondents were toddlers aged 12-59 months, totaling 107 individuals (82.3%), with a majority being male (56.2%) and having normal nutritional status (79.2%). The majority of mothers (96.9%) brought the MCH book to the posyandu. All infants aged 6 months and older, as well as toddlers, received Vitamin A capsules (100%).
4	The Correlation Between the Level of Knowledge of The Mother About The Provision of Vitamin A With Mother's Compliance with The Giving of Vitamin A to Infants Aged 6 - 11 Months At Posyandu Mekar Sari And Bakti Ibu	Puspita Sari (2022)	This study employed a cross-sectional design with a sample of thirty-two moms whose babies were between the ages of six and eleven months. by the use of the whole sample approach with primary data. Fisher Exact Test is used. According to a cross-tabulation study comparing the amount of maternal knowledge and compliance with administering vitamin	Based on 32 samples, the majority of mothers know enough to know up to 15 individuals (47%) and are obedient to up to 17 persons (53%). The bivariate results show a significant correlation (p ≤0.05) between maternal compliance in providing vitamin A to infants aged 6 to 11 months at Posyandu Mekar Sari and Bakti Ibu in the Baamang II Sampit Health Center Working Area in 2022 and her level of knowledge about doing so.

No	Research Title	Name/ Year Published Research	Research Methods	Research Results
	Work Area Baamang Ii Sampit Health Center In 2022		A across 32 samples, most mothers are sufficiently knowledgeable and obedient—up to 16 individuals, or 46.9%.	
5	Factors associated with vitamin A administration among children under five years of age	Sunarti Hanapi, et al (2019)	This research uses a cross sectional study. Sampling data with purposive sampling technique and data collection using a questionnaire, analysis using chi square test.	In this study, vitamin A was administered to 126 (48.1%) and not to 136 (51.9%) toddlers. 5.0% of toddler visits are active, 28.2% of cadres are active, and 63.4% of mothers have knowledge. Bivariate test results indicated that 67.7% of mothers had appropriate knowledge. When given vitamin A, children under five demonstrated knowledge with a chi square test p value of 0.000 and an active cadre role of 82.4% for toddlers to the health center / posyandu 100%. Vitamin A-treated toddlers with a p-value of 0.000 were linked to vitamin A administration in toddlers
6	Factors Associated with Vitamin A Administration in Children Toddlers at the Posyandu Beringin Lestari Village Work Area Puskesmas Tapung Hilir 1 Kampar Regency 2018	Gusman Virgo (2020)	Analytic research design with cross sectional design, measurement of independent variables (maternal knowledge, the role of cadres and the activeness of toddler visits to posyandu) and the dependent variable (vitamin administration). A in toddlers)	The variable associated with the provision of vitamin A in toddlers is the variable mother's knowledge value (p=0.015) and the variable activeness of toddlers in visiting the posyandu value (p=0.000), while the variable that is not associated is the role of cadres value (p=0.203), from these results there is a relationship between knowledge and mothers and the activeness of toddlers in visiting the posyandu, but there is no relationship between the role of cadres in the vitamin A provision factor in toddlers**.**
7	Efforts to Improve Toddler Health by Providing Vitamin A and Health Counseling About Stunting in Mothers of Toddlers at Pmb Sri Rejeki Dh Jabung Plupuh Sragen	Hutari Puji Astuti, Christiani Bumi Pangesti (2022)	This study used a sample of all mothers who have toddlers in Jabung RT 01 Plupuh Sragen Village, namely 23 mothers of toddlers. as an introduction to emphasize the understanding of stunting and vitamin A in toddlers and the question and answer method. The results obtained from counseling about stunting and giving Vitamin A to toddlers are all mothers who have toddlers there is an increase in knowledge with an average value of knowledge about stunting and vitamin A in toddlers of 90%.	Based on the outcomes of a one-day coaching and counseling program attended by twenty-three moms of toddlers, the community responded well to the initiative. Mothers of toddlers became more knowledgeable about several things related to stunting and vitamin A in toddlers. This can be seen from the results of the question and answer session, where before counseling on stunting and vitamin A in toddlers, mothers of toddlers did not understand about several things about stunting and vitamin A. But after counseling about stunting and vitamin A in toddlers, mothers of toddlers become more knowledgeable about stunting and vitamin A for toddlers with an average value of knowledge about stunting and vitamin A of 90%.
8	The relationship between nutritional status, vitamin A administration, immunization status, exclusive	Fithria Nurul Azizah, et al (2023)	This research is a quantitative study with a cross-sectional study which then the results will be analyzed using the *Chi Square* Test.	The results showed that most infants aged 0-59 months had a normal nutritional status of 87.0%, incomplete vitamin A administration 53.1%, incomplete immunization status 56.7%, not exclusively breastfed 55.9%, and most toddlers 0-59 months suffering from

No	Research Title	Name/ Year Published Research	Research Methods	Research Results
	breastfeeding with the incidence of ARI in children under five years of age.			ARI of 57.1%. Analysis of the relationship of these variables obtained a p value of 0.000 (p <0.05) so that statistically there is no significant relationship between nutritional status
9	Vitamin A administration factor	Puspita Adriani (2019)	This type of research is quantitative with a cross sectional approach. The research analysis used chi-square. The research instrument used a questionnaire.	There is a significant correlation between knowledge, education, and work when it comes to providing Vitamin A to toddlers (6-59 months) in the Kandai Health Center Working Area of Kendari City, according to the results of a bivariate analysis of the factors associated with this provision. The findings of the study on the association between knowledge and giving toddlers (6–59 months) vitamin A indicate that moms with higher levels of education will find it easier and more understandable to recognize the benefits of Posyandu activities for their children. Parental education is one of the key determinants in a child's growth and development, according to the results of the association between education and the administration of vitamin A to toddlers (6-59) months old. This is because with good education, Parents have access to all outside knowledge, particularly that which pertains to raising morally upright children and maintaining their health. According to research on the connection between employment and vitamin A provision in toddlers (6–59 months), working mothers find it difficult to make time for visits to the Posyandu. On the other hand, stay-at-home moms have more time for relaxation and can take their kids to Posyandu to acquire Vitamin A.
10	Socialization of the Importance of Vitamin A to Optimize Toddler Growth.	Muhatta, Fajar, Romli Gafur, Iwan Setiawan, Syamsul Ma'arip, Tb. Fiki Fahlaifi Musaffa, Rahmat Hidayat, Iwan Gunawan, Angga Sofyan Lutfi, Eva Muti'ah, Basrowi (2023)	The method used was information counseling on the importance of vitamin A to optimize child growth and development. The data collection process was carried out in two stages, namely pre-test and post-test. The pre-test was conducted to measure the initial ability that the target already had. While the post-test is to determine the extent of understanding of the training material that has been given.	The training activities were carried out in the mushola of the residents of Kp. Ranca Wiru Ds. Kemuning and attended by 50 people. 20 mothers of infants and 25 mothers of toddlers and 5 health cadres. Counseling was conducted for one day and divided into two sessions, the first counseling on the importance of vitamin A and the second session on vitamin A administration for infants and toddlers. It was proven that there were still 23 people who did not understand very well and 15 people who did not understand. After the counseling, the participants' understanding has started to improve. Out of 50 people, there were 20 people who understood very well, 20 understood and 7 people understood quite well. There were only two people who did not understand and there was still one person who did not understand very well. The mother of the toddler who really did not

No	Research Title	Name/ Year Published Research	Research Methods	Research Results
				understand was not present in the provision of training materials and returned when the post-test was conducted. Evidently there were still 28 people who were very poorly understood and 12 people who did not understand. After counseling, the participants' understanding has started to improve. Out of 60 people, there were 30 people who really understood, 11 understood and 7 people understood quite well. There was only 1 person who did not understand and there was still 1 person who did not understand very well. The baby's mother who did not understand very well was not present during the training and returned when the post-test was conducted.
11	Socialization of the Benefits of Providing Vitamin A to Toddlers in the Lubuk Begalung Health Center Working Area, Padang City	Fadhilatul Hasnah, Dian Paramitha Asyari, Gusrianti, Nailul Hikmi (2023)	Implemented in the form of counseling and socialization about Vitamin A and the month of Vitamin A administration. Tools and materials to be used in the form of counseling media such as questionnaires, infocus, laptops.	The results of the pretest questionnaire showed that of the 15 mothers of toddlers who attended, 9 had good knowledge about Vitamin A and the month of administration, while 6 more still did not know about the benefits of Vitamin A. Based on the results obtained, it shows that there is a significant relationship at the level between the level of maternal knowledge and the provision of Vitamin A. After the socialization and counseling activities are expected to provide clear information about Vitamin A and its schedule, the Posttest activities are carried out again using the same questionnaire. It was found that there was still 1 mother of toddlers who still did not know about the benefits of Vitamin A but all knew about the schedule of administration.
12	Counseling on Basic Immunization, Vitamin A and Growth and Development in Infants and Toddlers in the Pekalongan City Jenggot Health Center Area	Putri Andanawarih and Miftachul Jannah (2020)	The research used an observation method in the form of community service consisting of education and monitoring. Education uses pre and post-tests with prepared questionnaires.	The results showed an increase of 35% in maternal knowledge about basic immunization in the evaluation results conducted and the measurement of vitamin A showed the results of measuring maternal knowledge about Viamin A had a very good increase of 48%.
13	Association of vitamin A deficiency with early childhood stunting in Uganda: A population based cross-sectional study	Paddy Ssentongo, Djibril M. Ba, Anna E. Ssentongo, Claudio Fronterre, Andrew Whalen, Yanxu Yang, Jessica E. Ericson,	Data are from the most recent Uganda Demographic and Health Survey (UDHS) (2016). Data were collected between June 20, 2015 and December 16, 2016, data collection involved a multistage stratified sampling design.	The prevalence of vitamin A deficiency (VAD) was 8.9% (95% CI: 8.1%-9.6%, n = 424). Stunting affected 27% of the children (95% CI: 26.1%-28.6%, n = 1302), 4% were underweight (95% CI: 3.6%-4.7%, n = 196), and 17% were thin (95% CI: 16.0%-18.2%, n = 813). After accounting for household factors such as wealth index, parents' education and employment status, land ownership for agriculture, and livestock, as well as vitamin A supplementation and community factors like population density,

No	Research Title	Name/ Year Published Research	Research Methods	Research Results
		Vernon M. Chinchilli (2020)		growing season length, and place of residence, children with VAD had 43% higher odds of being stunted compared to those without VAD (adjusted odds ratio, 1.43; 95% CI: 1.08-1.89, p = 0.01). No significant association was found between VAD and being thin or underweight.
14	The level of maternal knowledge about vitamin A administration and maternal compliance in Vitamin A administration.	Febra Ayudiah and Taufiani Rossita (2023)	This study uses a quantitative design using a cross sectional design Analytical Survey	Based on this research on 102 respondents, most mothers have a good level of knowledge as many as 44 respondents. The level of maternal compliance in giving vitamin A there are 54 mothers who are not obedient in giving vitamin A.
15	Clinical vitamin A deficiency among preschool aged children in southwest Ethiopia	Abdil wahid, et al (2024)	In this study, data collection uses a questionnaire, the results of which will be analyzed using SPPS with logistic regression.	The study found that the overall prevalence of clinical vitamin A deficiency (VAD) in the area was 2.2% (ranging from 1.7% to 2.7%). This rate is considered a major public health issue based on the WHO threshold for public health significance in preschool-aged children, which is ≥1.56%.
16	Vitamin A supplementation coverage and its associated factors among children aged 6-59 months in West Azernet Berbere Woreda, South West Ethiopia	Bihon Berihun, et al (2023)	This study was conducted by collecting data using a questionnaire which was then analyzed using bivariate logistic regression and multivariate analysis.	The investigation's findings are: - The likelihood that a child will receive vitamin A supplementation was 2.5 times higher in families with monthly incomes over 2000 ETB. - Three times as many mothers who were informed about vitamin A supplementation were likely to take it. - The likelihood of mothers receiving vitamin A supplements was 67.6% lower when their husbands disapproved of them.

4 DISCUSSIONS

Definition of Vitamin A

Important fat-soluble vitamin A is stored in the liver and needs to be obtained externally because the body is unable to generate it. Children under five may have a weakened immune system and a higher chance of morbidity and death if they suffer from a vitamin A deficiency (VAD). Lack of vitamin A is a primary cause of blindness in children. Toddlers' access to vitamin A can be impacted by a number of variables. A mother's ability to provide vitamin A for her kid can be influenced by her educational background, as more education can facilitate a mother's ability to assimilate information and knowledge more readily.

Vitamin A is one of the most crucial elements for growth. All retinoids, provitamin A, and carotenoids with biological activity that are utilized as retinol are collectively referred to as vitamin A. Because dietary intake is still inadequate and vitamin A levels are still low, the body must obtain its vitamin A requirements from outside sources, making vitamin A an important nutrient. One of the fat-soluble nutrients, vitamin A is stored in the liver and needs to be obtained from outside the body because it cannot be generated by the body.

For toddlers between the ages of 6 and 59 months, vitamin A capsule supplementation serves as a preventative measure against blindness as well as a treatment for vitamin A deficiency (VAC), the primary cause of which is reduced vitamin A stores in the body leading to abnormalities in the eyes that typically affect children between the ages of 6 months

and 4 years. In children with disorders such as protein energy shortage or malnutrition, vitamin A insufficiency can typically be attributed to decreased absorption in the intestine. Beginning at age six months, vitamin A pills are administered twice a year in February and August.

Vitamin A Function in Toddlers

The body cannot create or make vitamin A, which means it must come from outside sources. Vitamin A is an essential ingredient that is stored in the liver and is a fat-soluble nutrient. In addition to being necessary for healthy growth and resistance to illnesses like measles, diarrhea, and other infectious diseases, vitamin A can lower mortality rates.

The function of vitamin A is to increase the immune system that can prevent complications in diseases, help in the process of vision, especially in adaptation from light to dark places, help growth in toddlers such as nail, tooth or hair growth, and help function in organs.

To prevent vitamin A deficiency in toddlers, vitamin A capsules are given in February and August. Vitamin A administration in infants 6-11 months is given once with a dose of 100,000 IU in blue color. while in children under five 12 - 59 months is given twice with a dose of 200,000 IU in red color

The Impact of Vitamin A on The Growth and Development of Toddlers

In addition to breast milk, baby's growth and development is also influenced by their food intake. Complementary feeding is a supplement to breastmilk that your baby needs after consuming exclusive breastmilk. Your baby's diet should be rich in energy, protein, and micronutrients (especially iron, azine, calcium, vitamin A, vitamin C, and folic acid), which can affect the baby's height and weight (Muklis., 2019). Another very serious consequence of vitamin A deficiency (VAD) is night blindness, which includes corneal damage and blindness, which can eventually lead to death. Vitamin A is involved in the formation, production, and growth of red blood cells, lymphoid cells, and antibodies, as well as the integrity of epithelial cells lining the body (Hertati et al., 2023).

Additionally, xerophthalmia, night blindness, corneal deterioration, and blindness are all prevented by vitamin A. One of the most vital nutrients that the body requires, particularly for a child's growth and development, is vitamin A. Since the body is unable to generate vitamin A, it must be received from the outside (essential). accountable for the body's resistance to illness, growth, enhanced energy, and vision (Hertati et al., 2023). Vitamin A contributes to a lower death and morbidity rate. As a result, vitamin A helps strengthen the body's defenses against illnesses like diarrhea, measles, and acute respiratory infections (ARI). Night blindness and other xerophthalmia symptoms, such as corneal damage and blindness, are additional extremely dangerous effects of VAC (Andanawarih & Jannah, 2020).

Vitamin A is important for healthy cell function throughout the baby's body. Vitamin A helps maintain healthy skin, hair and digestive system. Vitamin A deficiency can cause dry and rough skin, hair loss, and diarrhea. Vitamin A helps in the formation of red blood cells. Vitamin A deficiency can lead to anemia in young children which can cause fatigue, pallor, and shortness of breath. Vitamin A plays an important role in the growth and development of body cells and tissues in young children. Vitamin A helps form bones, teeth and other tissues. Vitamin A deficiency can cause growth problems such as stunting and wasting in young children (Andanawarih & Jannah., 2020).

Diseases Arising from Vitamin A Deficiency

Hypovitaminosis A is the condition that results from a vitamin A deficiency. Hypovitaminosis A can result in a number of illnesses, including ocular damage: Visual impairments include poor color vision, poor night vision, and poor eyesight due to vitamin A insufficiency. Skin damage: Dry, itchy, and greasy skin can result from a vitamin A deficiency. Immune system damage: A lack of vitamin A can affect the immune system's performance, increasing the body's susceptibility to diseases and harm to the neurological system Fatigue, headaches, and poor brain function are examples of nervous system illnesses that can be brought on by a vitamin A deficit.

Vitamin A deficiency can also cause impaired vision at twilight (night blindness), as well as damage to eye tissue, namely seroftalmia, which can lead to blindness. Vitamin A deficiency can also lead to keratinization of epithelial tissue and reduced mucus secretion. Night Blindness: Impaired vision at dusk caused by malfunction of various seller mechanisms in which retinoid compounds play a role. Vitamin A deficiency results in impaired vision at dusk (night

blindness). This occurs when vitamin A stores in the liver are depleted.

Blindness can result from Seroftalmia (Xerophthalmia), which is damage to the tissue surrounding the eyes. A vitamin A shortage causes night blindness, or blurred vision at sunset. When the liver's reserves of vitamin A are exhausted, this happens. Increased depletion results in keratinization of the gastrointestinal tract, genitourinary tract, eyes, and lungs' epithelial tissues, and with a decrease in mucus output. Damage to Epithelial Tissue: A lack of vitamin A can result in keratinization of the gastrointestinal system, genitourinary tract, eyes, and lungs. This condition is exacerbated by a decrease in mucus secretion (Muliah et al., 2019).

Prevention of Vitamin A Deficiency

(Rahmad & Wulandari, 2022) In his journal explained that giving vitamin A supplements to toddlers is needed to increase children's immunity from disease. Vitamin A deficiency in the body that lasts a long time can cause health problems that have an impact on increasing the risk of morbidity and mortality of toddlers. Vitamin A or retinol is involved in the formation of the production and growth of red blood cells, lymphocyte cells, antibodies as well as the integrity of the body's coating cells. Vitamin A also prevents night blindness, xerophthalmia, corneal damage and blindness and prevents anemia in postpartum women. Vitamin A deficiency can increase a child's risk of upper respiratory tract infections, measles and diarrhea.

Vitamin A deficiency (VAD) remains a significant global issue, particularly in developing nations, and can affect individuals of all ages, especially during growth periods. Studies from various countries indicate that biannual vitamin A supplementation for children aged 6-59 months can prevent VAD and night blindness, as well as enhance immunity. Children with VAD are more prone to infections such as upper respiratory tract infections, measles, and diarrhea.

In particular, children who are deficient in vitamin A should be the target of early intervention to increase their vitamin A status. Vitamin A capsules for infants 6–11 months old are blue and contain 100,000 IU of retinol (palmitate/acetate); vitamin A capsules for children under five years old, 12-59 months old, and mothers who have recently given birth are red and contain 200,000 IU of retinol (palmitate/acetate). According to the Vitamin A Supplementation Management Guidelines, infants and children under five are given vitamin A capsules at the same time each year in February and August. Infants from 6 to 11 months receive vitamin A injections once, and children under the age of five receive them twice between the ages of 12 and 59 months.

Then (Putri & Anggita, 2022) In his journal explains that vitamin A deficiency or deficiency can cause several disorders to the health of the body, including Hemeralopia or chicken blindness, night blindness, Frinoderma, the formation of the epithelium of the skin of the hands and feet is disturbed, so that the skin of the hands and / or feet looks scaly, bleeding in the intestinal membranes, kidneys and lungs, damage to the cornea by causing bitot spots, seroftalmi (cornea dries up) and eventually kerotit, seroftalmi (cornea of the eye is completely damaged), stopping the growth process, disruption of growth in infants.

Mothers who deprive their children of vitamin A are contributing factors to vitamin A insufficiency. This is due to a lack of understanding of the significance of vitamin A administration, which may negatively affect toddlers' health. Higher levels of knowledge also translate into greater awareness of the value of vitamin A supplementation. By offering health education, attempts can be made to increase mothers' understanding of the administration of vitamin A. The purpose of health education is to help people change their habits, attitudes, and knowledge in order to attain better health.

Foods to Help Toddler Growth and Development (Containing Vit A)

Vitamin A is an essential nutrient required for various aspects of human health. Based on the nutrients it contains, vitamin A is divided into 2 types, namely retinoids and carotenoids, which are obtained from various food sources. Vitamin A in the form of retinoids can be obtained from animal foods while in the form of carotenoids can be obtained from vegetables and fruits. Plant-based carotenoids, such as vitamin A, can be converted by the body. Provitamin A is the collective term for these carotenoids, which include beta- and alpha-carotene.

Animal food sources

1. Animal livers, such as beef, chicken and fish liver, are one of the richest sources of vitamin A. They contain retinol, a form of vitamin A that is readily utilized by the body. These foods contain retinol, a form of vitamin A that is readily utilized by the body.

2. eggs, especially in the yolk
3. Animal meat, especially red meat, contains vitamin A.
4. dairy products, such as milk, cheese, and yogurt contain vitamin A in the form of reticol

The best source of vitamin A for children under five is food derived from animal ingredients because it serves to optimize their growth and development. However, vegetables and fruits are still needed for antioxidant functions. Sources of vitamin A from animal foods include meat, beef or chicken liver, fish, milk, eggs, cheese, shark liver oil, cod liver oil, and colostrum in breast milk. Many fruits and vegetables are also rich in provitamin A and can help fulfill the body's vitamin A needs.

Among the plant foods that contain vitamin A include:

1. Sweet potato, Every 200 grams contains 1920 μg RAE
2. Pumpkin, very 205 grams contains 1140 μg RAE
3. Mango, Every 165 grams contains 89 μg RAE
4. Cantaloupe, Every 160 grams contains 270 μg RAE
5. Grapefruit, Every 154 grams contains 89 μg RAE
6. Watermelon, Every 155 grams contains 43 μg RAE
7. Papaya, Every 165 grams contains 78 μg RAE
8. Apricots, Every 70 grams contains 67 μg RAE
9. Guava, Every 110 grams contains 34 μg RAE
10. Kale, Every 118 grams contains 172 μg RAE
11. Green mustard, Every 190 grams contains 722 μg RAE
12. Radish, Every 144 grams contains 549 μg RAE
13. Carrots, Every 155 grams contains 1280 μg RAE
14. Red bell pepper, Every 164 grams contains 257 μg RAE
15. Spinach, Every 180 grams contains 943 μg RAE

5 CONCLUSIONS

As a fat-soluble vitamin that is stored in the liver and cannot be generated by the body, vitamin A is a necessary nutrient that must come from outside sources. Vitamin A has several functions, including boosting immunity, which can assist avoid health difficulties, aiding in vision, particularly in adjusting from light to dark, supporting toddler growth, including the development of teeth, hair, and nails, and supporting organ function. Vitamin A deficiency (VAD) causes night blindness, which can culminate in blindness and corneal damage, and can ultimately be fatal. The disease arising from vitamin A deficiency is hypovitaminosis A. Vitamin A capsule supplementation is given twice a year in February and August, from 6 months to 59 months of age. Vitamin A supplementation for infants 6-11 months is given once with a dose of 100,000 IU in blue, while children under five 12-59 months are given twice with a dose of 200,000 IU in red. MP-ASI is a breast milk supplement that babies need after consuming exclusive breast milk. Based on the nutrients it contains, vitamin A is divided into 2 types, namely retinoids and carotenoids obtained from various food sources. Vitamin A in the form of retinoids can be obtained from animal foods while in the form of carotenoids can be obtained from vegetables and fruits.

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Capturing The Effect of Iron Intake on The Incidence of Anemia in Pregnant Women

Syifa Ar Raihan[1], Mohammad Fadhito Firmansyah[1], Nabila Savitri Putri Martanto[1], Shofiyah Az Zahrawani[1], Tiara Putri Ferrynda[1], U'us Eka Maskhuriyah[1], Dwi Rukma Santi[2]*

[1]*Nutrition Study Program, Sunan Ampel State Islamic University Surabaya, Indonesia*
[2]*Psychology Study Program, Sunan Ampel State Islamic University Surabaya, Indonesia*
dwirukmasanty@uinsa.ac.id

Keywords: Iron, Anemia, Pregnant Women.

Abstract: Iron is one of the important components of hemoglobin. Hemoglobin carries oxygen in red blood cells from the lungs to all body tissues. The concentration of hemoglobin indicates the level of iron sufficiency or deficiency. Iron deficiency can cause anemia, resulting in reduced oxygen capacity in red blood cells for organs. In pregnant women, anemia is still a frequent nutritional problem. Anemia in pregnant women can increase the risk of complications in pregnancy and childbirth. The method used in writing this article is a literature review of journals from 2019 to 2024. The purpose of this literature review is to analyze the effect of iron intake on the incidence of anemia in pregnant women. The results of the articles reviewed show that there is an effect of iron intake on the incidence of anemia in pregnant women. Iron intake can increase hemoglobin levels to reach normal values. In maximizing iron absorption, vitamin C intake is also good to consume to help the iron absorption process. So it can be concluded that consuming food intake containing iron can increase hemoglobin production in pregnant women, which can reduce the risk of childbirth such as premature birth and low birth weight (LBW) in infants.

1 INTRODUCTION

A condition in which red blood cells are reduced in blood circulation so that they are unable to carry oxygen to the entire tissue is an anemia. Pregnant mothers in Indonesia have anemia prevalence of 70% or 7 out of 10 pregnant women with cases of anemia. One of the most susceptible groups to nutritional problems is iron deficiency anemia (Fe). Pregnant women are at higher risk of developing anemia (Kadir, 2019). Anemia during pregnancy is defined when the mother's hemoglobin levels are below 11 g/dL in the first and third trimesters or hemoglobins are below 10.5% g/dl in the second trimester. The risk of anemia in the pregnant mother is premature birth, antepartum bleeding, postpartum hemorrhage that may result in the death of the mother and child, and infectious diseases (Sulung et al., 2022).

In Indonesia, the prevalence of anemia has increased as a result of a person's deteriorating nutritional status. Inadequate nutrition is caused by factors of non-conformity of food intake with the required intake of the body. Based on the Nutritional Satisfaction Data. 2019, it shows that during pregnancy the pregnant mother requires an additional energy and protein. Where pregnant mothers in trimester I perform an additional calorie of 180 kcal and protein of 20 grams. In trimester II and III requires additional calories of 300 kkal and 20 gram of protein. The energy helps in the movement of the muscles of the gastrointestinal tract, thus facilitating the absorption of iron in the intestines. Pregnant mothers require about 800 mg of iron (Fe) where 300 mg is needed for the fetus and 500 mg is used for hemoglobin growth (Tarigan et al., 2021).

Pregnancy in the third trimester is the maturity of pregnancy, so high nutritional requirements, especially iron, are crucial to preventing anemia. Pregnant mother's anemia occurs in the third trimester, because at this time the fetus accumulates

iron reserves for its own supply as the supply of the first month after birth (Lestari et al., 2022). An effort can be made to prevent anemia is through increased intake of foods that have iron content. Just taking Fe tablets alone is less effective in meeting a person's iron needs, especially women and pregnant mothers. For that, we need other sources of food to meet our iron requirements. Consumption of vitamin C can also play a role in helping absorption of iron in the body. Thus, consuming a food source of iron along with a source of vitamin c is a good combination for increasing hemoglobin levels. One of the factors that a pregnant woman suffers from anemia is a lack of iron intake, therefore writing this article aims to find out a picture of the intake of iron with the incidence of anemia to the pregnant mother.

2 METHODS

This research is a literature review with literature sources from the Google Scholar database. In the literary process, the keywords used are iron intake, anemia and pregnant mothers. Literature is limited to research over the last five years, counting from 2019 to 2024. 20,800 studies were found through the Google Scholar database. These studies are analyzed to obtain research that meets the criteria of research, that is, the type of quantitative research, carried out over the last 5 years, less than equal to 100 people as a sample. According to this criterion, the number of studies obtained is 18 studies, conducted by Indonesian researchers. Most of his studies were articles in scientific journals. The filtering process of our article is presented in the following PRISMA diagram.
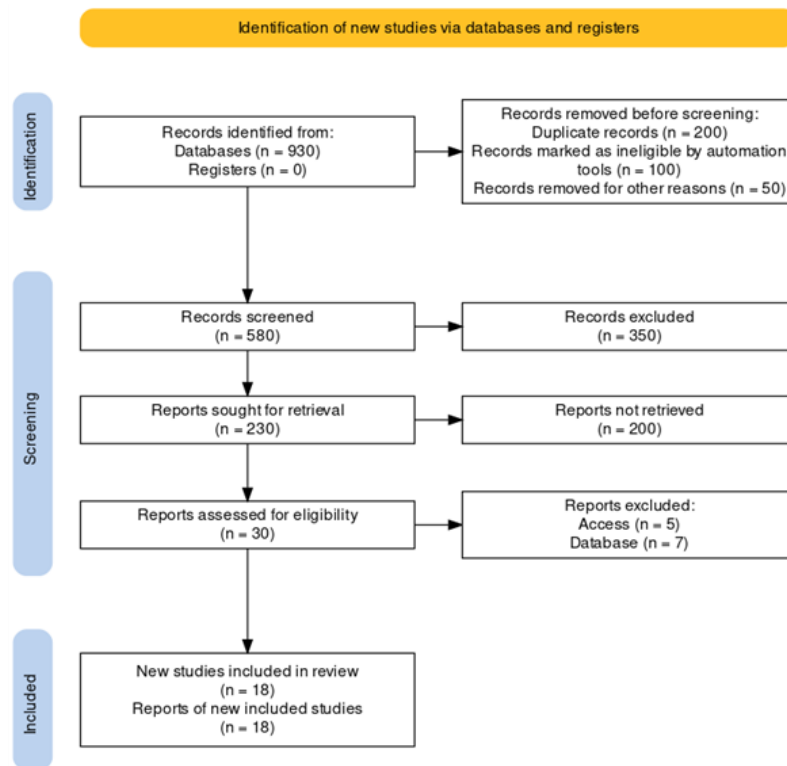
Figure 1: Literature Search

3 RESULTS

The literature search used the Google Scholar database with the keyword "Ineffects of iron intake on pregnant mothers". The first search resulted in 20,700 articles. The article was then given a special coverage for the last five years, namely 2019-2024, leaving 930 journal articles. Articles are then sorted by title, abstract, and keyword. The article must also meet the following inclusion criteria: (1) the article is not a literature review; (2) it is a non-paid article; (3) it is in full text form. Thus, 18 research journal articles have been obtained that can be re-examined.

Table 1: Overview of The Study on Nutrient Intake on The Incidence of Anemia in Pregnant Women

Researcher(s)	Year	Sample Quantity	Research Type and Desain	Instrument
Widowati et al., 2019	2019	11	*Quasi experimental*	Hemoglobin meter and observation sheet
Luthbis & Ratnasari, 2020	2020	30	*Quasi experimental*	Observation sheet and Hb meter (easy touch) GCHB
Lutfiasari et al., 2020	2020	15	*Pre experimental*	Observation sheet and Hb measuring stick
Sulaiman et al., 2022	2022	100	Kuantitatif-*Cross Sectional*	Interview, Hb measuring instrument
Lathifah & Susilawati, 2019	2019	40	*Pra experimental*	Questionnaire sheet and Hb meter
Lestari et al., 2022	2022	30	*Quasi experimental*	Easy Touch Hemoglobin
Agustina et al., 2022	2022	60	*Quasi experimental*	Hb measurement device
Choirunissa & Manurung, 2020	2020	30	*Quasi experimental*	Hemoglobin measurement tool
Olii, 2020	2020	60	*Pre experimental*	Hemoglobin measurement tool and food recall form
Marlina et al., 2022	2022	15	*Quasi experimental*	Digital hemoglobin meter
Harismayanti & Lihu, 2021	2021	34	*Quasi eksperimental*	Hb measurement questionnaire
Kundaryanti et al., 2019	2019	13	*Quasi experimental*	Digital Hb set and observation sheet
Fajrin, 2020	2020	19	Kuantitatif- *cross sectional*	Questionnaire and lab result of Hb level
Ariecha et al., 2020	2020	32	Observasional - cross sectional	Questionnaire sheet
Monica et al., 2021	2021	60	*Pretest-postest control group desain*	Measurement of hemoglobin level by cyanmethemo globin method
Liananiar et al., 2020	2020	24	*Pretest-postest control Group desain*	Measurement of Hb levels with Hb sahli measuring instrument
Ulfiana et al., 2019	2019	44	*Quasi experimental*	Mini screen digital Hb meter with Hospitex brand
Sugita & Kuswati, 2020	2020	30	*Quasi experimental*	Hb level measuring instrument

Table 1 shows an overview of studies on the impact of iron intake on the incidence of anaemia in pregnant women from 2019 to 2024. The sample used in the study is less than the same as 100 people. The studies mostly use the type and design of Quasi Experimental research.

4 DISCUSSIONS

Iron in The Body

Iron is a component that the body needs to build blood cells, such as hemoglobin, myoglobin (a protein that carries oxygen to the muscles), and collagen (a cartilage-forming protein), which also serves as the body's defence system. You can get iron by eating meat, eggs, grains, nuts, seeds, vegetables, and fruits. To meet your iron needs, the kind of iron that you often consume must also be taken into account. There are two types of iron in foods: the heme iron that is found in animal foods such as meat, and the non-heme iron found in vegetable foods like vegetables and grains. Research has shown that Heme iron is more easily absorbed into the lumen of the intestine than non-Heme iron, especially when combined with foods that contain vitamin A, vitamin C, and amino acids.

Iron Deficiency Anemia

Iron deficiency is a common anemia that interferes with the production of red blood cells, especially the synthesis of hemoglobin, and ultimately causes symptoms such as fatigue and growth disorders in

children. The main factor causing iron deficiency anemia is a lack of absorption of iron into the body. Other factors that are also relevant include family structure, nutritional consumption, menstrual patterns (for teenage girls), and the frequency of related infections. According to Nurbadriyah (2019), iron deficiency anemia can be influenced by various factors, including:

Increased Physiological Needs of Individuals

It is common in infants, where adaptation to the environment in the early stages of life increases red blood cells as a form of adaptation of the body to increased oxygen supply and growth causes changes in the reproductive system. Premature birth also means that babies are at higher risk of developing iron deficiency anemia. In addition, female teenagers are also prone to developing anemia due to the fact that adolescent girls have menstrual periods every month resulting in large amounts of blood loss, so the iron intake needs must be met in order to prevent anemia from occurring.

Lack of Iron Absorbed

The lack of absorption of iron from animal foods, the consumption of components that can produce iron, and the components which can inhibit its intake affect the risk of iron deficiency. This is due to a lack of gastric acid and the speed of food travel through the intestines.

Bleeding

Bleeding is a condition when blood comes out of a blood vessel and causes a person to lose blood in the body. Blood loss affects the iron balance. When you lose a lot of blood, you get severe iron deficiency and anemia.

Fetal-Mother Blood Transfusion

This condition is commonly referred to as fetomaternal transfusion, a condition in which blood from the fetus enters the mother's bloodstream through the placenta. Chronic blood leakage that occurs in the bloodstream of the mother can cause iron deficiency anemia at the end of the fetal life and early infancy.

Improvement of Health

Iron is needed to accelerate the growth process in infants, children, and adolescents, as well as with the

mother's pregnancy status, which requires the availability of large amounts of iron.

Iron deficiency anemia develops in three stages, the first phase begins with a decrease in the level of iron in the bone marrow, and a reduction in serum ferritin levels as a result of increased absorption of iron by the intestinal mucosa, which is accompanied by a decline in iron levels. The liver will synthesize transferins, producing an increase in TIBC. In the first stage, it shows no symptoms, and the status of red blood cells and red blood cell distribution is still normal. In addition, the second stage is a condition in which there is erythropoiesis deficiency of iron. This condition is manifested by a lack of hemoglobin (Hb) content within the reticulosis, although at this stage normal red blood Cells are still present when the blood circulates, clinically without symptoms. In the third stage, levels of Hb and hematocrit decrease due to lack of iron storage and transportation, so the production of iron in the bone marrow also decreases. Therefore, at this stage the patient develops symptoms of anemia (Kurniati, 2020).

Anemia in Pregnancy

Anemia is when a mother's hemoglobin (Hb) levels in her blood are below 12 grams. Anemia during pregnancy is when her hemoglobins are below 11 grams per cent in the first and third trimesters, or less than 10.5% in the second trimester. Iron deficiency anemia is an anemia caused by a lack of iron in the body, so the need for iron (Fe) for erythropoiesis is not satisfied, which is marked by the image of hypochrome-micrositer red blood cells, serum iron levels (Serum Iron = SI) as well as transferin decreases, total iron binding capacity (TIBC) increases also the iron reserves in the bone marrow and elsewhere very little or no. There are many factors that can lead to iron deficiency anemia, including a lack of iron and protein intake from food, intestinal absorption disorders, acute and chronic bleeding, and increased iron requirements such as in pregnant women, growth periods, and recovery periods of various diseases.

Iron Deficiency Anemia in Pregnancy

The World Health Organization (WHO) has that pregnant women suffer from iron deficiency with a prevalence of 35-75% which, with the age of pregnancy, is increasing. According to the WHO, 40% of pregnant women in developing countries who die are related to pregnancy anemia, and most of the

causes of pregnancies are lack of iron intake and acute bleeding, and the two factors rarely interact. Preventive efforts are carried out with the administration of iron supplements during pregnancy. But the results are unsatisfactory. Iron absorption and iron requirements increased during pregnancy, with total iron requirements of about 1000 mg. As the body's iron reserves were exhausted, high iron requirements could not be met with a daily iron diet or iron supplementation. According to theory, iron supplements should be given in the pre-pregnancy period to prevent a lack of iron storage in the body. This disorder can occur due to low or empty iron storage in the body during pre-conception, especially in developing countries. Therefore, iron supplementation during pregnancy alone is not sufficient to prevent iron deficiency anemia. In one study it was found that giving iron supplements before pregnancies may reduce the prevalence of anemia compared to giving iron in the early stages (0% versus 38.46%, p<0.05).

Impact of Iron Deficiency Anemia on Pregnant Mothers

Iron deficiency anemia can be fatal to pregnant mothers because it takes a lot of energy to give birth. Then during childbirth, there's usually heavy bleeding, and the condition of the pregnant mother gets worse due to anemia. Blood shortages and acute bleeding are the leading causes of pregnant mother death during childbirth. The main causes of maternal death include postpartum bleeding (associated with eclampsia and infection) and placenta previa, all caused by deficiency anemia. Pregnant mother suffering from iron deficiency anemia is unable to meet her nutritional needs and the fetus in her womb. Therefore, pregnant mothers suffering from iron deficiency anemia often experience miscarriages, dead births, low birth weight, or premature births.

Anemia in pregnant mothers is not without risk. Research has shown that high maternal mortality rates are closely linked to anemia. Anemia also causes a decrease in physical performance because the body cells do not receive enough oxygen. Anemia in pregnant mothers increases the incidence of complications during pregnancy and childbirth. Increased risk of maternal death, premature birth, low birth weight, and perinatal death. In addition, prenatal and postpartum bleeding is more common in women with anaemia, and women with anemia are more likely to die because they cannot tolerate blood loss. One consequence of iron deficiency anemia (ADB) is

premature birth, with additional problems such as low birth weight, inadequate immune response, and a tendency to experience psychological and growth problems. If this continues, it's linked to low IQ and decreased learning ability. All this leads to poor talent quality, reduced productivity, and economic impact. For treatment, one folate iron tablet containing 60 mg of iron and 250 µg of folic acid can be administered for 90 consecutive days during pregnancy.

The Effect of Iron Intake on Hemoglobin Levels of Pregnant Women with Anemia

An effort to control and prevent anemia is to supplement with Fe tablets and eliminate the cause. In addition, eating foods containing iron and changing dietary habits by eating fruits and vegetables can also prevent anemia. Non-pharmacological treatments can be done using simple and easily available vegetables and fruits. Some fruits that can increase the hemoglobin levels in pregnant women are chili, red seed rose, banana, red or green spinach vegetable beans, tomatoes, green nuts and others.

According to Widoyati et al., the year 2019 concerning the administration of turmeric syrup against the hemoglobin levels of pregnant women in the 2nd trimester with anemia. It is known that hemoglobin levels have increased by 1.0 gr/dl after consuming turmeric syrup. This is due to the content of iron 0.3 mg, vitamin C 3.6 mg per 100 grams. In the formation of red blood cells requires iron. Iron is an essential trace element for the body. The iron content in the spleen will later be absorbed by the intestine and then carried by the blood for blood formation (hematopoiesis). Iron is important for pregnant mothers to maintain and help the formation. Vitamin C inhibits the production of hepcidine (e.g., in HepG2 cells) that controls iron homeostasis, thus making vitamin C potentially helping reduce iron deficiency. The results are similar to the Sugita & Kuswati study (2020), which found that after eating turmeric, the hemoglobin level increased by 1.14 gr/dl.

According to a study by Lathifah & Susilawati, (2019) on the administration of red spinach juice mixed with honey against increased hemoglobin levels in pregnant women in the 3rd trimester. It is known that the overall increase in hemoglobin levels was the lowest of 0.4 points and the highest of 1.4 points. These differences are likely to be influenced by some factors such as the mother's age, or may also be that she consumes other foods that contain iron that

can't be controlled by the researchers. The increase in Hb levels after the administration of red spinach juice with honey is due to the fat content of 0.8 grams, 2.2 grams protein, 6.3 grams carbohydrates, 7 mg iron, 520 mg calcium, and Vit. C 62 mg per 100 grams. For that consumption of red spinach is perfectly suitable in everyday life and can prevent anemia. This research is similar to that conducted by Kurdayanti & Widowati (2019). With the kind of sponge that is green sponge. The administration of green spinach juice against increased hemoglobin levels has been shown to increase the Hb levels of pregnant women with anemia in the puskesmas work area of the southern Jakarta week market in 2018. The Hb level increased by 1.23 after giving green spinach juice. It is known that green spinach contains 3.9 mg of iron per 100 grams of spinach.

In addition to red and green spinach, iron is also found in other fruits such as beets and red seeds. In the study Harahap & Liesmayani, 2020 is an analysis of the influence of the consumption of strawberries on the increase in hemoglobin levels in pregnant women in trimester 3. Based on the results there was an increase in the levels of haemoglobin in the pregnant mothers by 11.5 mg/dl after consuming strawberry. A study by Agustina Dkk (2020) showed an increase in Hb levels after administering red seed juice. This administration is done by giving Fe tablets as well so that the improvement that occurs is more effective than just giving Fe Tablets alone. The chemical content of seed roses is amino acids (triptofan, lysine), phosphorus, iron, vitamin A, calcium, sulfur, vitamin B1, and vitamin C. Red seed rose contains minerals that can accelerate the process of synthesis of red blood cell hemoglobin so that it can help treat anemia or low red blood count. (Winarni et al., 2020).

Iron is one of the nutrients that cannot be obtained in adequate amounts from food consumed during pregnancy. For that, iron requires vitamin C to help maximize absorption. One of the fruits that has vitamin C and is good for health is orange. This is in line with a marlina study (2022) that states that giving Fe tablets with orange water can increase the Hb levels of pregnant women with mild category anemia. With an average increase of 0.77 gr/dl. Vitamin C helps in transferring iron from transferrin in plasma to ferritin in the liver, thus increasing non-heme iron absorption fourfold. Besides, tomatoes are a good source of vitamin C. Research by Lestari showed that pregnant women who consumed tomato juice showed higher hemoglobin levels. In this study, pregnant women with anemia in the third trimester in RSUD Ciawi were divided into two groups: one group received tomato juice, while the other group received only tablets Fe. The findings of the study showed that the group given tomato Juice had an average hemoglobin increase of 3,800 g / dL, while a group receiving only tablet Fe had an increase of 0.7133 g / dl.

The dragon fruit is rich in iron and vitamin C. The iron that is found in the dragon's fruit is useful to increase the amount of iron in the blood. According to Olii's research, 2020 shows that consumption of dragon juice affects the hemoglobin levels of pregnant mothers. The respondents were pregnant women in the second and third trimesters who suffered from anaemia and only took Fe tablets. The results of the study indicated that after taking dragon juice there was an increase in hemoglobin levels with an average increase of 11.17 gr/dl. This suggests that the consumption of tablets of Fe combined with the intake of other nutrients of iron was more effective in increasing the level of haemoglobin of the pregnant woman than taking just Fe tablet.

The best strategy in dealing with iron deficiency in the body is to increase the intake of nutritious food sources and consume 60-120 milligrams daily. Consuming foods that are rich in iron such as liver, meat, milk, green vegetable fish, as well as green beans, one of which, like green nuts, can prevent anemia. As in pregnant mothers in the area of work puskesmas Dungaliyo showed an improvement after taking Fe tablets along with the consumption of green beans. The iron content of green beans is mainly found in embryonic plants and seed skins. One good way in presenting green beans is when the water and ampas are filtered and the nutrients are separated which produces green bean syrup and makes it a nutritious drink. The iron content in 100 grams of green beans is 6.7 mg. (Harismayanti & Lihu, 2021).

Pregnant mothers' iron requirements are increasing, requiring an additional 700-800 mg. Of this, 500 mg are used to boost hematopoiesis, 300 mg to support fetal needs in the hematopoiesis process during pregnancy, and 200 mg as a reserve for blood loss during childbirth. Therefore, pregnant mothers are advised to take an extra iron of about 30-60 mg per day. Previous research has shown that iron supplements can increase hemoglobin levels in pregnant women. Where when pregnant mothers consume iron (Fe) tablets every day for a month, hemoglobin levels can rise by 1 g/dl. The results of the study conducted by Choirunissa and Spruce (2020) showed that the intervention group had an increase in hemoglobin levels from 9,993 to 11,287. The iron content in green beans is 2.25 mg in every

half cup of green bean. The use of green beans as a non-pharmacological treatment in the prevention of anemia by increasing hemoglobin levels in pregnant women.

5   CONCLUSIONS

Iron deficiency anemia in pregnant mothers is a common health problem experienced by many women around the world. The World Health Organization (WHO) reports that the prevalence of iron deficiency in pregnant women ranges between 35-75% and increases with the age of pregnancy. Iron is essential for pregnant mothers to maintain and assist in the formation of red blood cells, as well as support the development and growth of the fetus. Iron sources can be found in foods such as liver, meat, milk, fish, green vegetables and nuts such as green beans. Therefore, pregnant mothers are advised to consume enough iron to avoid anaemia and complications during childbirth.

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Analysis of Alcohol Content in Fruit Vinegars as a Halal Testing Method for Fermented Products

Hanik Faizah, Mufidur Rohman, Estri Kusumawati, Nirmala Fitria Firdhausi*

Department of Biology, Faculty of Science and Technology, Universitas Islam Negeri Sunan Ampel, Surabaya, Indonesia
nirmala_firdausi@uinsa.ac.id

Keywords: Persimmon Vinegar, Soursop Vinegar, Combined Vinegar, Alcohol Content, Halal Food Products.

Abstract: The significance of halal certification has experienced notable growth over time as a result of the escalating demand for halal food products. One of the critical points of halal certification for food and beverages is the alcohol content contained within them. Fermented products represent a category of food and beverages with a pivotal consideration in ensuring compliance with halal dietary restrictions, particularly in relation to alcohol content. This study aimed to determine the alcohol content in persimmon vinegar, soursop vinegar, and combined (mix of persimmon and soursop) vinegar. The study conducted experimental analyses to assess the alcohol concentration in fruit vinegars employing a specific gravity calculation method using a pycnometer. The study found that the combined fruit vinegar had the highest alcohol content at 0.195%, while persimmon vinegar had the lowest alcohol content at 0.15%. The results showed that persimmon vinegar, soursop fruit vinegar, and combined fruit vinegar contained alcohol content below 0.5%, aligning with the halal standards outlined in the MUI Fatwa No. 10 of 2018.

1   INTRODUCTION

Indonesia is widely acknowledged for its significant Muslim population, which places it within the category of a developing nation (Sultan, 2023). Islamic principles stipulate that follower must choose halal and thayyib (wholesome) products while avoiding those identified as haram, thereby promoting both physical and spiritual well-being. Halal products encompass a diverse array of items, including attire, beauty products, food such as beverages, and pharmaceuticals. Aligned with Islamic economic principles, the discourse surrounding halal has gained widespread global recognition as an economic phenomenon. Remarkably, Indonesia is among the top 10 countries worldwide in terms of consumption of halal goods, according to the 2017 Global Islamic Economy Indicator. The nation has been lauded as the largest global consumer of halal food and ranks sixth globally for halal cosmetics and pharmaceuticals. Notwithstanding these accomplishments, the Ministry of Religion of the Republic of Indonesia aims to establish itself as a leading global producer of halal goods across all sectors. The realization of this ambition necessitates seamless coordination and collaboration among all stakeholders involved (Ministry of Religion of the Republic of Indonesia, 2017).

The significance of halal certification has notably escalated due to the surging demand for halal food products. Halal certification has the pivotal role in fostering consumer trust and expanding the halal market. In Indonesia, halal certificates are issued through three designated institutions as stipulated in Law No. 33 of 2014. These institutions include The Halal Product Assurance Organizing Body (BPJPH), The Halal Inspection Agency (LPH), and the Indonesian Ulema Council (MUI). The BPJPH is responsible for policy formulation, application verification, certification issuance, and labelling of halal products. Conversely, the LPH is tasked with assessing and verifying the halal status of products, employing halal auditors for inspection purposes. The MUI serves as a third-party entity in the halal certification process, conducting halal fatwa proceedings to ascertain product compliance with

halal standards (Ministry of Religion of the Republic of Indonesia, 2022).

One of the critical points of halal certification for food and beverages is the alcohol content contained within them. According to Islamic law, the consumption of alcoholic beverages is strictly prohibited, and the inclusion of such drinks in food or other beverages renders them haram (forbidden). However, this prohibition does not extend to naturally produced ethanol in low quantities. Ethanol levels can be tolerated in food and beverages if they do not pose adverse effects on the human body. The halal status of food products containing ethanol is determined by the concept of Al Istihlak (assimilation). This concept indicates the permissible level of ethanol in food products if the substance is dissolved in another halal substance that is in greater quantity than the ethanol (Najiha et al., 2010). According to MUI Fatwa No. 10 of 2018 concerning Food and Beverage Products Containing Alcohol/Ethanol, the tolerance level for ethanol in beverages is set at 0.5%, and is not harmful to the body (MUI, 2018). Fermented products are the primary category of food and beverage items commonly associated with the presence of ethanol. (Destanoğlu & Ates, 2019). Among these fermented foodstuffs, fruit vinegar stands as a widely recognized product.

Fruit vinegar is a fruit-derived alimentary product that undergoes a dual process of fermentation, which includes alcoholic fermentation and acetic acid fermentation. During the initial stage of fermentation, yeast converts the sugar content present in the fruit into ethanol and carbon dioxide (Antoniewicz et al., 2021). The presence of ethanol, a byproduct of this fermentation process, is a critical component of fruit vinegar. Therefore, evaluating the ethanol content of fruit vinegar is essential in determining its halal status. Previous studies have investigated the alcohol content in various fermented products. For example, Ester et al. (2021) reported an alcohol content of 0.99% in mas banana fruit vinegar, while Agustina et al. (2023) found that starfruit leaf kombucha tea contained 0.43% alcohol. These findings underscore the significance of investigating assessing the ethanol content in persimmon, soursop, and combination fruit vinegars, which are less commonly produced, to ascertain their halal compliance.

2 METHODS

Research Methods

This research used an experimental method. The production of fruit vinegar uses persimmon, soursop as the basic ingredients and a combination of persimmon and soursop is also produced. The three fruit vinegars were tested for alcohol content.

Materials and Tools

The materials used in this study are persimmon fruit, soursop fruit, sugar, mineral water, distilled water, tissue, filter paper, and NaOH.

The tools used in this study are glass bottles, stirring spoons, measuring glass, beaker glass, volumetric flask, micropipettes, micropipette tips, digital scales, analytical balance, and pycnometers.

Procedure

Fruit Vinegar Production

For the vinegar production, fresh fruits are selected, thoroughly washed, and dried. For soursop, the peel and seeds are extracted from the pulp. As for persimmon, the fruit is cut, and its seeds and stems are removed. Subsequently, 120 grams of each fruit is pulverized using a blender. The blended fruit is then placed into a 500 ml glass bottle, and 42 grams of sugar and 400 ml of sterile water are added. The mixture is stirred and covered with cloth. The fermentation process is carried out at room temperature between 21-26 °C for 41 days without the addition of yeast and bacteria cultures. After 41 days, the vinegar is filtered and then transferred into sterile bottles.

The Analysis of Alcohol Content

The evaluation of alcohol content in soursop and persimmon fruit vinegars in this study adopted the methodology delineated by Skoog (1985). A 25 ml sample from each vinegar type was extracted, neutralized with 3 N sodium hydroxide, and processed through distillation to yield 25 ml of distillate. The distilled product was transferred to a pycnometer affixed with a 25 ml thermometer. The pycnometer, initially weighed, was then immersed in cold water until attaining 28°C. Following this, the exterior of the pycnometer was desiccated using absorbent paper and re-weighed to determine the

specific gravity of the alcohol. The alcohol content in the fruit vinegar sample was deduced by comparing the specific gravity obtained with the reference specific gravity values. The specific gravity was computed using the ensuing formula:

$$\frac{(\text{Pw} + \text{distillate}) - \text{Pw empty}}{(\text{Pw} + \text{distilled water}) - \text{Pw empty}}$$

Where:

Pw : picnometer weight

Data Analysis

The data obtained from this study were the alcohol content of persimmon fruit vinegar, soursop fruit vinegar and their combination. The data were analyzed descriptively and compared with MUI Fatwa Number 10 of 2018.

3 RESULTS

The alcohol content of the vinegar

To identify strategies for developing halal food products in Indonesia using SWOT analysis. The approach taken is a desk study approach where secondary data is obtained from various journal articles, statistical report data, reports from government agencies related to food, electronic news and other secondary data.

The results of alcohol content of the various fruit vinegar in our study can be seen in Table 1. Our study found that each type of fruit vinegar exhibits distinct levels of alcohol content, with persimmon vinegar containing 0.15% alcohol, soursop vinegar containing 0.165% alcohol, and the combined (mix of persimmon and soursop) vinegar containing 0.195% alcohol. The highest alcohol content was observed in the combined vinegar (0.195%), while the lowest was found in persimmon vinegar (0.15%). Based on table 1, the alcohol content of all the fruit vinegar in our study was below 0.5%.

Table 1: The Alcohol Content of The Vinegar

Fruit Vinegar Types	Alcohol Content (%)
persimmon vinegars	0,15
Soursop vinegars	0,165
Combined vinegar (mix of persimmon and Soursop)	0, 195

4 DISCUSSIONS

In this study, fruit vinegar was prepared utilizing persimmon and soursop as primary constituents. The fruits underwent an initial washing process to eliminate surface contaminants and mitigate any potential production inconsistencies. Subsequently, the fruit was diced and deposited into a sterile container with sugar solution. The introduction of liquid sugar serves to enhance the availability of carbon for the yeast, thereby optimizing the fermentation process (Jayus et al., 2019). The ensuing incubation period spanned 41 days, fostering the development of the fermented product in the form of fruit vinegar. Regular stirring during incubation played a pivotal role in ensuring the uniform distribution of nutrients and sugars. Upon completion of the incubation phase, the fruit vinegar underwent filtration to isolate residual fibers, which were then subject to assessment for ethanol levels.

The ethanol content in fruit vinegar cannot be separated from the role of microorganisms that carry out fermentation to produce new products as a result of this process. Among these microorganisms, Saccharomyces cerevisiae stands out as a prominent player in ethanol production. Notably, ethanol is derived from the conversion of glucose facilitated by S. cerevisiae. This transformative process relies on the enzymatic activity regulated by S. cerevisiae. Research indicates that approximately twelve enzymes are required for the conversion of glucose into CO_2 and ethanol. Of these enzymes, ten are involved in the conversion of glucose to pyruvate, generating ATP to fuel yeast proliferation, while the remaining two enzymes oversee the conversion of pyruvate into final fermentation byproducts to ensure redox equilibrium is maintained within the yeast. Therefore, the availability of metal ions in the fermentation medium can significantly impact the overall progression of fermentation and the efficacy of sugar-to-ethanol conversion. The reactions that occur during the glucose conversion process take place under anaerobic conditions. Pyruvic acid, which is the product of sugar catabolism, serves as an acceptor of NADH, a reduced coenzyme, in S. cerevisiae. Subsequently, acetaldehyde is utilized to transform pyruvic acid into ethanol, with alcohol dehydrogenase facilitating the final step by regenerating NAD+ to sustain glycolysis and ATP synthesis. The significant role of the final step reaction in ethanol production forms the cornerstone of the predominant fermentation industry (Walker & Walker, 2018).

Ethanol, an organic alcohol compound, features a hydroxyl functional group where the terminal end binds to a saturated carbon atom (CH3CH2OH). The presence of these compounds in food varies based on the storage process and specific type of food product (Alsaleem et al., 2022). According to Luzón-Quintana et al. (2021), alcohol contents in fruit vinegar are influenced by sugar additions during manufacturing or inherent sugar content in base ingredients, given the direct linkage between sugar and alcoholic fermentation processes. Ethanol, resulting from alcoholic fermentation, undergoes conversion back into acetic acid through the action of acetic acid bacteria in aerobic conditions (Vidra & Németh, 2018). Nonetheless, only approximately 95% of ethanol undergoes conversion to acetic acid by these bacteria (Aryanti, 2015). The alcohol content within the final fruit vinegar product depends on the abundance of Acetobacter aceti bacteria. An increased concentration of Acetobacter aceti inoculum leads to reduced alcohol content in fruit vinegar, whereas a lower inoculum concentration results in higher alcohol content in fruit vinegar. This is due to the pivotal role of Acetobacter aceti in the conversion of ethanol to acetic acid (Idayanti & Rosida, 2022).

The analysis of alcohol content in this study was conducted using the method of specific gravity calculation employing a pycnometer. A distilled vinegar sample was subjected to a one-hour distillation process to extract pure alcohol, isolating it from water and other components before specific gravity measurement. Subsequently, the weights of the obtained pure alcohol from distillation and distilled water, used for comparison, were measured utilizing a pycnometer. Through this procedure, the alcohol content of the vinegar sample was then derived by comparing its weight to that of distilled water which has been measured. The results of alcohol content analysis on various vinegar samples were summarized in Table 1.

Our study found that each type of fruit vinegar exhibits distinct levels of alcohol content, with persimmon vinegar containing 0.15% alcohol, soursop vinegar containing 0.165% alcohol, and the combined vinegar containing 0.195% alcohol. The highest alcohol content was observed in the combined vinegar, while the lowest was found in persimmon vinegar. These findings affirm that the fruit vinegar generated in this study is permissible for consumption, as it complies with the alcohol content threshold for food products stipulated by the Indonesian Council of Ulama (MUI) Fatwa No. 10 of 2018 regarding Food and Beverage Products Containing Alcohol/Ethanol, which stated that such products should not exceed 0.5% alcohol/ethanol. The findings of our study align with a study conducted by Nurismanto et al. (2014). In the study, the production of banana fruit vinegar with variations in fermentation time was carried out and tested for alcohol content. from the test, the alcohol content contained in banana fruit vinegar with a fermentation time of 10 days was 0.38%. In contrast, Idayanti and Rosida (2022) reported that the alcohol content in grape vinegar, kersen fruit vinegar, and starfruit vinegar in their study did not meet the MUI Standard No. 10 of 2018. Alcohol content of kersen fruit vinegar, starfruit and grape produced ranged from 1.83-2.43%.

Furthermore, the fruit vinegar in our study meets the quality criteria outlined in MUI Fatwa No. 10 of 2018, as alcohol generated through a spontaneous or traditional fermentation method devoid of any prohibited additives. This will be different case if the production process of vinegar subjected to non-spontaneous fermentation methods, which requires yeast or bacterial inoculum. Apart from alcohol levels, there are several critical halal points that need to be observed. The critical points include the source of the microbes and the source of the fermentation media (MUI, 2018). Several critical points must be considered when assessing the permissibility of fermented products within the context of Islamic dietary laws. Among these factors, the origin and alcohol content of the product stand out as vital elements that require careful examination.

5 CONCLUSIONS

Based on the alcohol content analysis, we found that the combined fruit vinegar exhibited the highest alcohol content (0.195%). Conversely, the lowest alcohol content was found in persimmon vinegar (0.15%). Our study revealed that persimmon, soursop and combined vinegar had an alcohol content below 0.5% which is in accordance with the halal standards of MUI Fatwa No. 10 of 2018.

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Ultra-Processed Food Consumption and Its Role in Obesity and Metabolic Syndrome Development

Romyun Alvy Khoiriyah*, Bunga Janviera Firnanda, Hilma Nahlah Faradisah, Fitri A

Nutrition Study Program, Sunan Ampel State Islamic University Surabaya, Indonesia

*romyunuinsa@gmail.com

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Abstract: This article examined the relationship between the consumption of ultra-processed foods (UPF) and obesity, as well as metabolic syndrome, through a systematic review approach. UPFs were known to contain salt, sugar, oils, fats, and other additives mimicking natural foods' sensory qualities. Research indicated that diets high in UPF were nutritionally unbalanced and promoted excessive consumption, which was detrimental to health. Data from various studies showed that increased UPF consumption was linked to a higher risk of obesity and related diseases, such as type 2 diabetes. Cross-sectional studies indicated that UPF consumption correlated with a higher risk of overweight in men compared to women. This research utilized diverse data sources that used methods such as semi-quantitative food frequency questionnaires and prospective analysis to evaluate this relationship. Results showed that high UPF consumption significantly contributed to obesity and metabolic disorders, affecting metabolic profiles and overall diet quality, highlighting the need for better dietary policies to mitigate the adverse impacts of ultra-processed foods.

1 INTRODUCTION

Obesity is a primary public health concern worldwide. More than 12.0% of the adult population (≥ 20 years old) suffers from obesity, and this figure is projected to continue rising, affecting 19.5% of the global adult population by 2025 (Lea Nash Castro et al., 2021). Obesity is categorized both as a disease and a risk factor for other non-communicable diseases (NCDs), such as cardiovascular diseases, diabetes, and several types of cancer (Haslam & James, 2005). In 2016, NCDs accounted for 71.0% of all deaths worldwide (Naghavi et al., 2017).

Ultra-processed foods (UPF) are industrial formulations that, in addition to containing salt, sugar, oils, and fats, also include substances (especially additives) used to mimic the sensory qualities of minimally processed foods and culinary preparations (Elizabeth et al., 2020). Diets high in UPF content tend to be nutritionally unbalanced, promoting passive and excessive consumption of food and beverages, thus detrimental to health (Martinez-Perez et al., 2021). The consumption of ultra-processed food products worldwide has

drastically increased. Based on data from the National Food Survey, UPF contributes between 25% to 60% of total daily energy intake (Pagliai et al., 2021).

Dependency on UPF as a substantial part of daily calorie intake can reduce the consumption of fresh and minimally processed foods, which indirectly may jeopardize health (Martinez-Perez et al., 2021). UPF consumption has a substantial impact on nutrient intake and overall diet quality, playing a crucial role in increasing the risk of weight gain and health conditions such as obesity (Monteles Nascimento et al., 2023). In a cross-sectional study, there is evidence indicating a gender-specific relationship between UPF intake and overweight conditions. The study suggests that UPF consumption may be associated with an increased risk of being overweight in men with higher body mass index (BMI), waist circumference (WC), and abdominal obesity, while no similar relationship was found in women (Marrón-Ponce et al., 2018). Furthermore, UPF is associated with a decrease in muscle mass markers, corrected arm muscle area, and arm circumference (Monteles

Nascimento et al., 2023). Additionally, in a sample of adults representing the entire country, food insecurity was found to be associated with increased UPF consumption (Leung et al., 2019). Based on these descriptions, this research aims to investigate how ultra-processed food consumption influences obesity and metabolic syndrome through a systematic review method. A better understanding of this relationship is expected to assist in the development of more effective policies and interventions to address obesity and metabolic health issues in the community.

2 METHODS

Research Type

This study employed a literature review method. This method was utilized to identify, evaluate, and interpret findings from research relevant to a specific topic or phenomenon that was the focus of the study.

This process involved systematically and systematically reviewing scholarly articles

Keywords for Article Search

The selection of articles for this research involved the use of specific keywords and Boolean operators (AND). This search was carried out in May 2024, utilizing various databases such as Pubmed.gov, Wiley Online Library, Cochrane Library, ProQuest, and ScienceDirect. Furthermore, articles were also sought through the Google search engine. The scope of the search encompassed publications from 2020 to 2024, with inclusion criteria limited to literature reporting research outcomes. The literature search process employed a combination of keywords including ultra-processed food, ultra-processed food and obesity, ultra-processed food and its metabolic implications, ultra-processed food consumption, and ultra-processed food and metabolic syndrome.
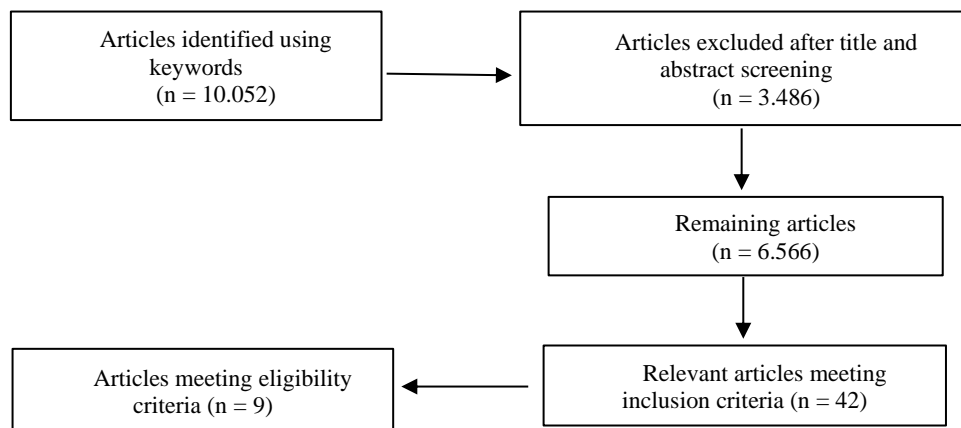
3 RESULTS and DISCUSSIONS

Figure 1: Article Selection Process

The search of articles in the designated databases yielded a total of 10,052 articles. Subsequently, a screening process based on titles and abstracts was conducted, resulting in the elimination of 3,486 articles and leaving 6,566 articles for further consideration. From these articles, those deemed relevant according to the established inclusion criteria and suitable for both qualitative and quantitative synthesis were selected, amounting to 42 articles. Following this, the full texts of the 42 relevant articles were carefully examined, leading to the identification

of 9 articles that met the criteria for relevance and acceptability. The process of article selection, from initial identification to the determination of the final chosen articles, is depicted in Figure 1.

Based on the literature review in this article, eligible articles are original research articles that are not literature reviews, with a study period within the last 5 years, specifically from 2020 to 2024. From the literature review, it was found that the consumption of ultra-processed food is associated with weight gain leading to obesity. Furthermore, several studies

related to ultra-processed food consumption are known to increase the risk of metabolic syndrome and its severity. A summary description of the data from the included studies can be seen in Table 1.

Table 1: Summary of Data Description from Included Studies

No	Titles	Researcher / Year	Methods	Results
1	Increase ultra-processed food consumption is associated with worsening of cardiometabolic risk factors in adults with metabolic syndrome: Longitudinal analysis from a randomized trial	(González-Palacios et al., 2023)	The research method employed was prospective, involving the collection of data for 12 months with a total of 618 participants aged 60-75 years old, without a history of cardiovascular disease at the beginning of the study, and with at least 3 metabolic syndrome risk factors. Information regarding dietary intake was obtained using the FFQ method at the beginning of the study, at 6 months, and 12 months during the follow-up period.	There is a correlation between changes in UPF consumption levels (according to quartiles in g/day) and Cardiometabolic Risk Factors from the beginning of the study to 6 and 12 months of follow-up. Compared to the lowest quartile, the highest quartile of UPF consumption is positively associated with body weight, BMI, waist circumference, diastolic blood pressure, fasting blood glucose, HbA1c, plasma triglycerides, and TyG index in multivariate analysis. All associations indicate a significant dose-response relationship (p-trend <0.05). No statistically significant relationship was found between the highest UPF consumption and systolic blood pressure as well as all types of cholesterol (total cholesterol, HDL, and LDL cholesterol). This study concludes that when adults with metabolic syndrome consume large amounts of ultra-processed foods (UPF), factors that can lead to heart and metabolic problems (CMR) tend to worsen after 12 months.
2	Ultra-processed Food Intake and Risk of Type 2 Diabetes in Korean Adults	(Cho et al., 2024)	The research method utilized in this study was experimental, with subjects obtained from the Ansang-Ansung Cohort, Korean Genome and Epidemiology Study (KoGES). The study included a total of 7,438 adult participants aged 40-69 years old who met the following inclusion criteria: diagnosed with type 2 diabetes mellitus (DM), taking diabetes medication, having fasting blood glucose concentration measured ≥126 mg/dL, or HbA1c concentration ≥6.5% at the beginning of the study. Dietary intake over the previous 12 months was assessed at the beginning of the study using a 103-item semi-quantitative food frequency questionnaire (FFQ).	During the study period from 2001 to 2019, which lasted on average for 15 years, there were 1,187 cases of type 2 diabetes recorded in the cohort study. The analysis results indicate that individuals who consumed the highest amounts of ultra-processed foods had a significantly higher risk of developing type 2 diabetes compared to those who consumed them in smaller quantities [risk ratio (HR) = 1.34, with a 95% confidence interval between 1.13 and 1.59, P-trend = 0.002]. This correlation remained significant even after adjusting for confounding factors such as dietary quality and body mass index (BMI). Further analysis of specific ultra-processed food consumption showed that a higher intake of foods such as ham/sausages, instant noodles, ice cream, and carbonated drinks was associated with a higher risk of type 2 diabetes. However, higher consumption of candy/chocolate was associated with a lower risk factor for type 2 diabetes.
3	The influence of ultra-processed food consumption on	(Rego et al., 2023)	The main objective of this study is to determine the influence of ultra-processed food (UPF) consumption on brain activity	The results of this study indicate that the diet chosen by participants on average consisted of 50% carbohydrates, 35% fat, and 15% protein (10% animal-based/5%

No	Titles	Researcher / Year	Methods	Results
	reward processing and energy intake: Background, design, and methods of a controlled feeding trial in adolescents and young adults		measured by Blood Oxygen Level-Dependent (BOLD) response, increased ad libitum energy intake, and negative effects on executive function (EF) and delay discounting in individuals aged 18–25 years. This study employs a crossover design with controlled feeding periods of 14 days each, followed by a four-week washout period. Participants will undergo two diet conditions in random order: a high-UPF diet (81% of calories from UPF) and a non-UPF diet (0% of calories from UPF).	plant-based), adjusted in terms of fiber, added sugars, saturated and unsaturated fats, sodium, glycemic index, and overall dietary quality. Some of the most commonly selected ultra-processed food groups included: 1) Buffet meal tray comprising Nature's Path Corn Flakes, Lucky Charms, Del Monte canned peaches in syrup, Pop Tart, Sunny Delight orange juice drink, Kroger whole milk yogurt with vanilla flavoring; 2) Snack tray consisting of Cape Cod chips, Pringles, Keebler sugar cookie, Welch's fruit snacks. These ultra-processed food types were chosen due to their palatability and texture preferences among the study subjects. The findings of this research suggest that ultra-processed food (UPF) consumption influences various physiological and behavioral aspects related to diet and health. UPF consumption is associated with increased ad libitum energy intake and changes in brain reward responses, as well as having negative impacts on executive function and cognitive control. These findings could aid in developing healthier dietary strategies and better nutrition policies.
4	Metabolic profiles of ultra-processed food consumption and their role in obesity risk in British children	(Handakas et al., 2022)	This study aims to understand the relationship between ultra-processed food (UPF) consumption and obesity risk in children in the UK, focusing on the underlying metabolic mechanisms for analysis. Data were obtained from the Avon Longitudinal Study of Parents and Children (ALSPAC) cohort. A cross-sectional research design was employed to investigate the relationship between UPF consumption and metabolic profiles at the age of 7 years, with a total of 4,528 children included in the study. Prospective testing was conducted to examine the relationship between UPF consumption at the age of 13 years and metabolic profiles at the age of 17 years, involving a total of 3,086 children in the study.	Metabolic characteristics influenced by UPF reveal that at the age of 7, UPF consumption is associated with 115 different metabolic characteristics. Significant changes include a decrease in branched-chain amino acids (BCAA) and aromatic amino acids, as well as an increase in citrate, glutamine, and monounsaturated fatty acids (MUFA). Furthermore, the association between UPF consumption and obesity involves identified metabolites (such as increased citrate and glutamine) associated with increased fat mass accumulation, indicating potential mechanisms by which UPF contributes to childhood obesity. Nutrient intake also mediates most of the relationships between UPF and metabolites, except for citrate. The effect of UPF intake on cardiometabolic risk is mediated by overall dietary quality, as poor dietary quality exacerbates the negative effects of UPF. In general, this study concludes that UPF consumption disrupts various metabolic pathways, significantly contributing to the risk of obesity in children.
5	The interaction between ultra-processed foods and genetic risk	(Gholami et al., 2024)	The research method employed in this study was cross-sectional. The study involved 376 female participants who were overweight	The study results comprised: 1) Descriptive characteristics of participants involving 376 women categorized as overweight or obese. The mean age of participants was

No	Titles	Researcher / Year	Methods	Results
	score on body adiposity index (BAI), appendicular skeletal muscle mass index (ASM), and lipid profile in overweight and obese women		or obese, recruited from 21 healthcare centers in Tehran, Iran, using a multi-stage random sampling method. The study took place from April 2023 to February 2024. The recruited participants were healthy women with a BMI between 25-40 kg/m² and aged over 18 years. The data observed included: 1) Biochemical parameter measurements, including fasting venous blood samples to measure total cholesterol as well as LDL and HDL cholesterol levels; 2) Anthropometric measurements and body composition assessment; 3) Assessment of dietary intake using FFQ and NOVA questionnaires; 4) Assessment of physical activity using the IPAQ questionnaire; 5) Genotyping and GRS testing by DNA extraction from blood using the salting-out method and PCR technique. Statistical tests included normality tests for quantitative variables using the Kolmogorov-Smirnov test. Categorical data were presented as absolute and relative frequencies, while quantitative data were presented as mean and standard deviation. ANOVA and chi-square tests were used to assess mean differences and distribution of categorical variables across UPF tertiles. Analysis of covariance (ANCOVA) was used to adjust for confounding factors. The analysis was conducted using SPSS v.26 software, with a significance level of $p < 0.05$ and a marginal significance level of $p < 0.07$. General linear regression models were used to analyze the interaction between GRS and UPFs, with adjustments for age, BMI, energy intake, physical activity, and education.	36.68 ± 9.23 years, with a weight of 80.59 ± 11.27 kg, height of 161.21 ± 5.78 cm, BMI of 31.02 ± 3.86 kg/m², and waist circumference of 99.21 ± 9.58 cm. 48.5% of participants had a bachelor's degree or higher, and the majority (71.7%) were married. The mean physical activity of participants was 993.26 (1098.67) MET/min/week; 2) Mean differences in variables based on NOVA score: Age: Participants in higher NOVA score tertiles were younger, with significant differences between tertile 3 (T3) and tertile 1 (T1) ($p = 0.03$), Weight: The mean weight was lower in participants with the lowest NOVA tertile. Significant differences were observed between T3 and tertile 2 (T2) ($p = 0.02$), Body Fat Percentage (BF %) was higher in participants in NOVA T3, indicating marginal significant variation ($p = 0.06$), Waist Circumference (WC): Significant differences between T3 and T2 in adjusted models; 3) Mean differences in variables based on GRS group: Height: Participants with GRS < 3 had higher height with significant differences in both crude ($p = 0.02$) and adjusted models ($p = 0.03$), BMI: Significant difference in crude model ($p = 0.01$) and remained marginally significant after adjustment ($p = 0.07$), Body Roundness Index (BRI): Higher in participants in GRS > 3 with significant difference in crude ($p = 0.01$) and adjusted models ($p = 0.02$), Skeletal Muscle Index (SMI): Significant difference in crude and adjusted models ($p = 0.02$). Participants in GRS > 3 groups had lower SMI compared to other GRS groups; 4) Food intake based on UPF consumption tertile: Non-Dairy Beverages, Cakes, Dairy Beverages, Potato Chips, Processed Meats, Oils & Sauces, and Sweets Intake: All showed significant variations among UPF consumption tertiles ($p = 0.00$), Energy Intake: Also showed significant differences among UPF consumption tertiles ($p = 0.00$). The conclusion of this study indicates that individuals with a higher genetic predisposition to obesity, as indicated by their genetic risk score (GRS), may be more vulnerable to the negative effects of ultra-processed food (UPF) consumption on skeletal muscle mass.
6	Consumption of a variety of plant foods, ultra-processed foods, and risk for	(Mitra et al., 2024)	This study was an experimental diet study using a quasi-experimental method over 18 weeks to analyze the impact of increased plant-based food intake	All 19 participants in this study were females. The average age of the participants was 28 years ($\pm$ 11.8). One participant had lactose intolerance, and another had a peanut allergy. Five

No	Titles	Researcher / Year	Methods	Results
	chronic disease: A dietary intervention		on the consumption of ultra-processed food (UPF) and chronic disease risk factors. The study consisted of a four-week control period followed by an eight-week diet intervention, during which participants were asked to increase their intake of unprocessed plant-based foods to 30 varieties per week. Follow-up was conducted six weeks after the intervention ended. Diet intake was assessed using the Automated Self-Administered 24-Hour Dietary Assessment Tool (ASA24). Participants completed a 24-hour recall once during the control and intervention periods, as well as a three-day diet record. Consumption of ultra-processed food was assessed from ASA24 data by calculating the amount of ultra-processed food consumed in each 24 hours. Participants also recorded the number of unprocessed plant-based food varieties consumed each week. Chronic disease risk was assessed through anthropometric and laboratory data. Paired t-tests were used to test the difference in mean plant-based food consumption between the control and intervention periods, as well as the difference in education assessment scores before and after the intervention. Differences in overall and individual HEI scores were assessed with the T-test. Laboratory data were analyzed using repeated measures ANOVA and Bonferroni post-hoc tests.	participants (26.3%) reported having chronic diseases: hypertension ($n = 1$), polycystic ovary syndrome ($n = 1$), diabetes ($n = 1$), Crohn's disease ($n = 1$), and thyroid disease ($n = 1$). All participants who completed the survey on determinants of ultra-processed food consumption ($n = 18$) reported consuming ultra-processed food. The three most common individual determinants were "I enjoy it," "It tastes good," "I am familiar with it," and "It is easy to prepare." The most common categories of determinants were habit, pleasure, and taste. The average number of plant-based food varieties per week was higher during the intervention period compared to the control period (34.7 ± 10.8 vs 23.1 ± 12.1; $p < 0.001$). The average amount of ultra-processed food consumed per day was significantly lower during the intervention period compared to the control period (5.32 ± 1.65 vs 6.54 ± 2.04; $p < 0.05$). There was no difference in mean HEI scores between the control and intervention periods. However, there was a significant increase in the total fruit consumption score. Anthropometric measurements mostly remained unchanged at the four-time points except for diastolic blood pressure. There was a significant difference in diastolic blood pressure at the four different time points; $F(3,14) = 3.70$, $p < 0.05$. Post-hoc analysis showed a significant difference in diastolic blood pressure between baseline (time point 1) and early intervention (time point 2). Diastolic blood pressure was significantly lower at time point 2 compared to time point 1 ($t = 3.95$, $df = 14$, $p < 0.01$). The percentage of blood pressure measurements in the normal category was higher after the intervention compared to before, but not statistically significant.
7	Association of normal weight obesity with lifestyle and dietary habits in young Thai women: A cross-sectional study	(Kobayashi et al., 2023)	The experimental method utilized in this study was cross-sectional. Data were obtained between 2017 and 2020, with the study subjects consisting of 507 female university students in Thailand residing around Thaniyaburi and Chiang Mai. A total of 113 underweight women (BMI <18.5 kg/m2) and 144 overweight women (BMI $\geq$ 25.0 kg/m2) were excluded from the analysis. The remaining 250 women fell within	A total of 46.8% of study participants with normal body type (BMI, 18.5–25.0 kg/m2) were detected to have Normal Weight Obesity (NOW). There were no differences in age or height between the NO-NWO and NWO groups. Weight, BMI, and BFR in the NWO group were significantly higher than those in the NO-NWO group (all $p < 0.001$). Muscle mass in the NWO group was lower than in the NO-NWO group, but this difference was not statistically significant ($p = 0.084$). There was no difference in basal metabolic rate between

No	Titles	Researcher / Year	Methods	Results
			the normal BMI range, as classified by the World Health Organization (18.5 ≤ BMI < 25.0 kg/m2). Height was measured using In Lab 550 (In Body Japan Inc., Tokyo, Japan), while weight, body fat ratio (BFR), basal metabolic rate, and muscle mass were measured using ACCUNIQ BC300 (Toyo Medic Co., Ltd., Tokyo, Japan), and BMI calculation was also performed. Surveys on lifestyle and dietary habits were conducted using self-administered questionnaires. Participants in this cross-sectional study were classified into NONWO and NWO groups (normal weight obesity), and physical measurements, lifestyle, and dietary habits were compared between the two groups. Qualitative variables were analyzed using the chi-square test or Fisher's exact test, and quantitative variables were analyzed using the Student's t-test.	the NWO and NO-NWO groups. The NWO group had a higher percentage of irregular menstrual cycles than the NO-NWO group, but this difference was not significant ($p = 0.079$). There were no differences in exercise habits, type of residence, duration of sleep, or smoking habits. Participants in the NWO group walked fewer steps per day than those in the NONWO group, but this difference was not significant ($p = 0.291$). Young Thai women in the NWO group were less likely than those in the NONWO group to answer "almost every day" to the item "eating oily foods" ($p = 0.047$). The NWO group was more likely than the NO-NWO group to answer "almost every day" to the item "eating UPF" ($p = 0.036$). Additionally, the NWO group was more likely than the NO-NWO group to answer "almost every day" to the item "drinking sugary drinks"; however, this difference was not significant ($p = 0.073$). Logistic analysis showed that frequent consumption of UPF was positively associated with NWO. The results of the multivariate analysis indicated similar patterns for physical activity, menstrual cycle, and typical stool softness, with a 2.04-fold higher risk for NWO in participants who consumed UPF "almost every day" compared to those who consumed it "rarely" ($p = 0.014$). The frequency of drinking additional sugary drinks was also associated with NWO.
8	Consumption of ultra-processed foods associated with weight gain and obesity in adults: A multi-national cohort study	(Cordova et al., 2023)	This study was a prospective cohort study conducted in 10 European countries: Denmark, France, Germany, Greece, Italy, the Netherlands, Norway, Spain, Sweden, and the United Kingdom (UK). Between 1992 and 2000, a total of 521,448 men and women were recruited as study subjects. Anthropometric measurements, including weight and height, were taken at the beginning of the study and after a median follow-up time of 5 years. Individual dietary patterns were assessed using validated diet questionnaires in each country. Consumption of ultra-processed foods (UPF) was estimated by integrating the NOVA food classification system into the EPIC database. Data on factors such as education level, physical activity, alcohol intake,	Participants in the highest quintile showed a greater increase in weight, were younger, and consumed more sugar/sweets and biscuits. Additionally, those in the highest quintile consumed more soft drinks and less alcohol compared to those in the lowest quintile. Observing weight between the start of the study and the second assessment about five years later, the average weight gain in the study population was 2.1 kg with significant variation among participants (SD 5.0 kg). The results of this study indicate that changes in weight over 5 years based on UPF consumption show that higher UPF consumption is associated with greater weight gain. Analysis by quintile of UPF consumption confirms these findings, with participants in the highest quintile experiencing more weight gain than those in the lowest quintile. Participants with normal weight initially in the highest quintile of UPF consumption had a 15%

No	Titles	Researcher / Year	Methods	Results
			and smoking history were collected through validated questionnaires at the start of the study. The relationship between UPF consumption and weight changes was analyzed using multilevel mixed linear regression with centers as random effects and UPF consumption and confounding factors as fixed effects. Potential interactions between UPF consumption and factors such as age, gender, and BMI category were also tested.	higher risk of becoming overweight or obese during the follow-up period. Similarly, overweight participants initially had a 16% higher risk of becoming obese (P trend <0.001) compared to the lowest quintile of UPF consumption. The conclusion of this prospective study of adults from 9 European countries representing a population with a heterogeneous diet provides additional evidence that a higher proportion of UPF in the diet is associated with greater weight gain and a higher risk of developing overweight or obesity.
9	High Consumption of Ultra-Processed Food is Associated with Incident Dyslipidemia: A Prospective Study of Older Adults	(Donat-Vargas et al., 2021)	This study was a cohort study utilizing data from the Seniors-Study on Nutrition and Cardiovascular Risk in Spain (ENRICA) Cohort in Spain, the methods of which have been previously reported. This cohort was established between 2008 and 2010 with non-institutionalized individuals aged ≥ 60 years. Participants were followed up until 2015 when additional data collection was conducted. With a response rate of 72%, the cohort consisted of 1821 participants. Dietary assessment and UPF consumption: To measure participants' habitual food consumption, a validated computerized dietary history (DH-ENRICA) was used. This dietary history comprised a structured questionnaire administered by trained interviewers regarding the foods consumed at each mealtime, from breakfast to bedtime. All foods were recorded and classified according to the NOVA classification, which organizes foods into 4 groups based on the extent and purpose of industrial processing. The association between the percentage of energy from UPF in the diet and the incidence of hypertriglyceridemia, low HDL cholesterol, and high LDL cholesterol were obtained using logistic regression.	From 1082 participants, the average age was 68 years (± 6 years), with 52% being women. The mean percentage of energy from UPF was 18.7% (± 11.2%). The UPF groups contributing the most to the total UPF consumed were: cookies and pastries (31.2%), processed meat and meat products (15.7%), breakfast cereals and breads (11.1%), and sweets (10.9%). The baseline concentrations of triglycerides, HDL cholesterol, and LDL cholesterol were 91.4 mg/dL (± 26.5 mg/dL), 58.7 mg/dL (± 12.1 mg/dL), and 109 mg/dL (± 16.3 mg/dL) respectively. During the 5–7 year follow-up period, the average concentrations of triglycerides, HDL cholesterol, and LDL cholesterol were 95.2 mg/dL (± 36.9 mg/dL), 56.8 mg/dL (± 13.1 mg/dL), and 102 mg/dL (± 23.9 mg/dL) respectively. Regarding the incidence of dyslipidemia during follow-up, 60 participants (out of 895) experienced hypertriglyceridemia (≥150 mg/dL), 112 (out of 878) had low HDL cholesterol (<40 in men or <50 mg/dL in women), and 54 (out of 472) had high LDL cholesterol (>129 mg/dL). After adjusting for potential confounders, those in the highest tertile compared to the lowest tertile of UPF energy percentage had more than double the odds of developing hypertriglyceridemia or low HDL cholesterol. This study concludes that UPF consumption is associated with an increased risk of dyslipidemia risk factors such as hypertriglyceridemia and low HDL cholesterol. However, no association was found between UPF consumption and high LDL cholesterol.

Ultra-processed foods (UPF) are designed to have high palatability, easy accessibility, and immediate consumption, which may explain their increased consumption in recent decades in high- and middle-income countries. Based on several studies, the percentage of total energy derived from UPF is 17.0% in Spain, 24.6% in Brazil, 48.6% in the UK, 45.0% in Canada, and 56.1% in the United States. In addition to high and widespread consumption, UPF also has other characteristics that may be related to metabolic disease risk factors (González-Palacios et al., 2023). Fardet et al (2017) found that the higher the level of food processing, the lower its satiating potential, which may lead to increased daily intake. UPF consumption is also associated with poor nutritional intake. Along with the increased consumption of UPF, the total energy content, carbohydrates, free sugars, total fat, and saturated fat in foods have also increased, while the content of protein, fiber, some vitamins, and minerals has decreased. A recent review indicates that the biological mechanisms supporting the relationship between UPF and cardiovascular disease include increased energy intake, changes in satiety signals between the gut and brain, hormonal effects, and changes in the gut microbiome (Martini et al., 2021).

Several mechanisms and factors can explain the positive relationship between ultra-processed food (UPF) consumption and increased mortality rates. Firstly, increased UPF consumption is associated with overall poor diet quality and excessive calorie intake due to the high energy density and low satiety of UPFs, all of which may be linked to increased mortality. Secondly, diets high in UPF content provide large amounts of trans fatty acids, salt, and/or sugar. Thirdly, higher UPF intake is associated with unhealthy behaviors such as smoking or a sedentary lifestyle. Fourthly, some studies have shown a significant relationship between mortality from cardiovascular disease (CVD) and UPF consumption, although UPF-rich diet characteristics such as low-fat quality, low consumption of fresh fruits and vegetables, and high sodium content indicate adverse effects on CVD mortality (Torres-Collado et al., 2024).

The following research results indicate the association between ultra-processed food consumption and metabolic syndrome. Ultra-processed food (UPF) intake increases the risk of hypertension and, consequently, cardiovascular disease (CVD) (Rey-García et al., 2021). Based on a recent meta-analysis by (Pagliai et al., 2021) the risk of developing cardiovascular disease (CVD)

increases with high UPF consumption (RR: 1.29, 95% CI: 1.12-1.48; n = 5). Furthermore, a recent meta-analysis examining the relationship between UPF intake and hypertension risk shows a strong association between high UPF intake and hypertension risk (OR: 1.23; 95% CI: 1.11-1.37; P = 0.034, n = 9) (Cai et al., 2022). Recent dose-response meta-analyses also indicate that a 10% increase in UPF intake raises the risk of type 2 diabetes by 15%. Consistent with these findings, our dose-response meta-analysis results indicate that each additional daily portion of UPF increases the risk of CVD by approximately 6%. Therefore, it is important to address risky eating habits and raise awareness about reducing UPF consumption to mitigate the risk of lifestyle-related diseases (Guo et al., 2023).

The majority of observational studies indicate a positive association between ultra-processed food (UPF) consumption and various anthropometric measures such as BMI, overweight, obesity, and abdominal obesity. Nearly all of these studies use the NOVA classification system to assess UPF consumption. In a large prospective study involving the NutriNet-Santé French cohort (n = 110,260), it was found that UPF intake was associated with increased BMI and the risk of overweight and obesity. All studies examining the relationship between UPF consumption and the risk of type 2 diabetes (T2D) also found a strong and positive association using the NOVA food classification (Grinshpan et al., 2024).

4 CONCLUSIONS

The conclusion drawn from this research indicates a significant association between the consumption of ultra-processed foods (UPF) and an increased risk of obesity, metabolic syndrome, and cardiovascular disease (CVD). Studies demonstrate that high UPF consumption is linked to elevated BMI, overweight, abdominal obesity, and increased risk of hypertension and type 2 diabetes. UPF is also known to diminish overall nutritional quality and escalate calorie, carbohydrate, free sugar, total fat, and saturated fat intake while reducing protein, fiber, vitamin, and mineral intake. Furthermore, UPF consumption often accompanies unhealthy behaviors such as smoking and sedentary lifestyles. Therefore, it is paramount to limit UPF consumption through education and public health policies that promote healthy eating patterns and increased intake of minimally processed fresh foods.

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