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The Effect of Various Vegetable Oils on The Physical - Chemical Properties and Total Plate Count in Making Mayonnaise

Sudjatinah Sudjatinah

Department of Processing Agricultural Product, Universitas Semarang, Indonesia

*Corresponding author (m.sudjatinah@gmail.com)

Abstract

Mayonnaise is an oil emulsion product in water (o/w). The main component of mayonnaise is fat, or oil derived from vegetable oil. Fat or oil is very influential on the physical, chemical, and characteristics of mayonnaise because of the fatty acid content. The purpose of this study was to determine the effect of differences in the use of vegetable oil in making mayonnaise on physical, chemical, TPC, and antioxidant properties. This research was conducted experimentally, using a randomized block design consisting of 4 treatments, which were palm oil (P1), coconut oil (P2), corn oil (P3), and sunflower oil (P4) with 6 replications, while the observed variables were viscosity, water content, fat content, protein content, antioxidant content, and TPC. The results showed that various types of vegetable oil had a significant effect ($p < 0.05$) on physical properties: viscosity: P1 571.68 cP; P2 676.17 cP; P3 486.14; P4 552.81 cP. Water content P1 16.90%; P2 16.86%, P3 2067%, P4 17.47%, P1 Fat Content 88.96%, P2 75.22%, P3 72.74%, P4 63.97%, P1 Protein Content 1.89%, P2 1.98%, P3 1.83%, P4 1.61%. Antioxidant Content: P1 35.67 ppm P2 28.00 ppm P3 25.00 ppm P4 20.33 ppm, TPC: P1 24.76 CFU/g P2 22.84 CFU/g P3 21.63 CFU/g P4 21.04 CFU/g. The conclusion of this study shows that various types of vegetables have a significant effect ($p < 0.05$) on physical properties (viscosity), chemistry, and TPC of mayonnaise. Coconut oil / VCO (P2) produces mayonnaise with the best moisture content, viscosity, and protein content. Sunflower seed oil (P4) produces mayonnaise with the lowest fat content and TPC, while corn oil (P3) and sunflower seed oil, (P4) produce mayonnaise with almost the same TPC levels. Palm Oil (P1) Produces mayonnaise with the highest Antioxidants.

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Introduction

Mayonnaise is one of the dressing sauce types that is most widely used in various food products in the world today. In Indonesia, mayonnaise has long been known by the public and is often used as a dressing sauce in food products, such as salads, burgers, pizzas, sandwiches, sausages, and so on (Rahmawati et al., 2015). Mayonnaise is a food processing product with an oil emulsion system in water (o/w) with a high oil concentration, it is made from water, salt, sugar, oil, lemon, and egg yolk (Laca et al., 2010). Egg yolk is a good emulsifier because it contains lecithin. Lecithin is a lipoprotein that has a role as an emulsifier in egg yolk.

The three main components of mayonnaise consist of acid solution as a dispersing medium, egg yolk as an emulsifier, and vegetable oil as a dispersed medium. The three main components in making mayonnaise must be in balance. It is necessary to pay attention to producing mayonnaise with good quality in terms of organoleptic, texture, viscosity, and emulsion stability. One of the indicators of the physical properties of mayonnaise is viscosity. The viscosity of an emulsion does not only affect the organoleptic properties, especially the overall appearance but also affects the processing and shelf life of the product. Mayonnaise from vegetable oils has developed in France, they are from canola oil, sunflower oil, and olive oil, but it does not rule out the possibility of mayonnaise made from other vegetable oils, such as palm oil, coconut oil, and corn oil (Usman et al., 2015).

The use of vegetable oil in making mayonnaise can reach 50-75% of the total raw material for mayonnaise (Amertaningtyas and Jaya, 2012). The high concentration of the oil determines the physicochemical and sensory characteristics of the mayonnaise. Related to the background described above, the author is interested in conducting research on making mayonnaise with various types of vegetable oil in order to determine the effect on the physical, chemical, and sensory properties of mayonnaise. In Indonesia, there are many types of vegetable oils such as palm oil, coconut oil, corn oil, and sunflower seed oil. Because of its potential, it is necessary to conduct research on the differences in the use of vegetable oils for making mayonnaise on their physical, chemical, TPC, and antioxidant properties. Therefore, the aims of this study are to evaluate the effect of different uses of vegetable oil in making mayonnaise on physical, chemical, and antioxidant content and TPC, and also to determine the best vegetable oil used for making mayonnaise. It is hoped that it can provide benefits for researchers, the food industry, and the wider community regarding the different types of vegetable oils on the physical, chemical, TPC, and antioxidant properties.

Materials and Methods

This research was conducted at the Food Engineering Laboratory, Food Chemistry Laboratory, Sensory Test Laboratory, Agricultural Product Technology Department, Semarang University from February to March 2021.

Materials

The ingredients used in the production of mayonnaise include egg yolk, palm oil, coconut oil, corn oil, sunflower seed oil, sugar, salt, lemon, and water. Other materials used for analysis included distilled water, 95% alcohol, 1.25% H_2SO_4. HCl 0.1%. The tools used in this research were a medium bowl, mixer, analytical scale, spatula, plastic cup, freezer, porcelain cup, measuring cup, oven, desiccator, Kjeldahl flask, Soxhlet, Brookfield viscometer DV2T spindle RV-05 100 rpm.

The process of making mayonnaise

The flowchart of mayonnaise production can be seen in Figure 1. First of all, prepare a medium-sized bowl. Prepare egg and separate egg white with egg yolk. After the egg yolk is separated, the yolk is added to a medium-sized bowl with a concentration of 32% (40g). After adding the yolks, the egg yolks are mixed using a mixer at medium speed for 1 minute until they change color and form a dough. After changing color and forming a dough add additional seasonings such as 2g salt and 15g sugar. The addition of salt and sugar aims to give the mayonnaise a taste. Then the egg yolk mixture is mixed using a mixer at medium speed for 1 minute until the salt and sugar dissolve.

While in the mixing condition using a mixer prepare vegetable oils: palm oil (P1), coconut oil (P2), corn oil (P3), and sunflower seed oil (P4) then add vegetable oil gradually with a concentration of 48% (60g). The addition of vegetable oil to the egg yolk mixture is carried out drop by drop, let each drop mix evenly, and then add the next drop. This is done because the egg yolk and oil mixture can form an emulsion well. Do this until all the oil is evenly mixed and the egg yolk mixture is fluffy and stiff. After the oil is evenly mixed mix it on medium speed for 1 minute.

If the egg yolk mixture is fluffy and stiff, then add 7g of lemon. Apart from adding a sour taste to mayonnaise, the addition of lemon serves to remove the fishy taste and kill bacteria in the egg yolk dough. After adding the lemon, the dough is in the mixer on medium speed for 1 minute until it is evenly mixed. If the mayonnaise mixture is too thick, add 1g of warm water and mix until evenly distributed. The addition of warm water serves to change the color of the mayonnaise. After the mayonnaise is finished, the packaging is carried out using a 300 ml plastic cup, then closed tightly. Packaging is carried out to extend the shelf life so that the product is durable because the mayonnaise will spoil easily if it is stored in an open condition so the quality of the product will decrease. After being packed using a plastic cup, the mayonnaise is stored in the refrigerator. Storage is carried out in the refrigerator in the chiller section with a temperature of ± 11° C for 24 hours. Storage in the chiller is intended to extend the shelf life and maintain the quality of the mayonnaise.

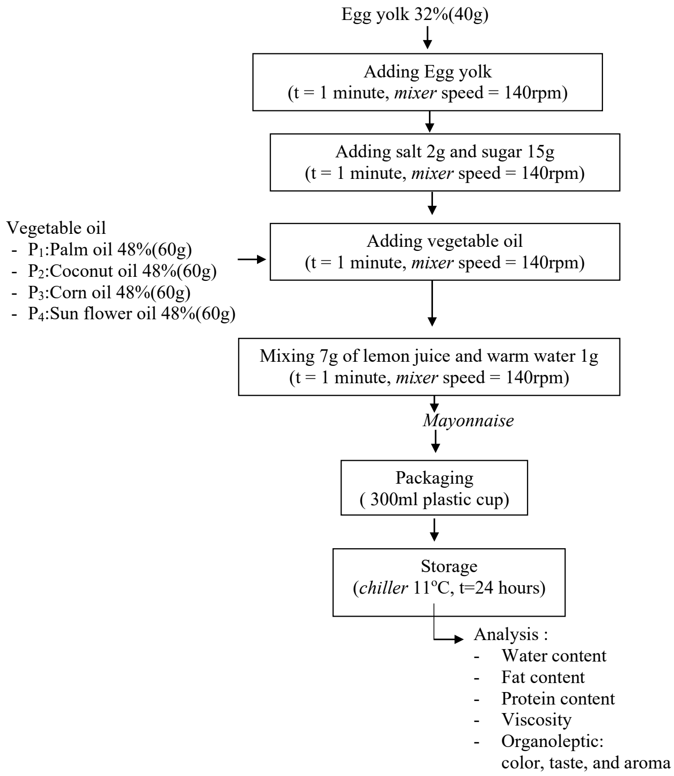

Figure 1. Flowchart of Making Mayonnaise

Experimental design

The experimental design used in this study was a randomized block design (RBD) with 4 treatments and 6 replications, they are palm oil (P1), coconut oil (P2), corn oil (P3), sunflower seed oil (P4) in order to obtain 24 experimental units. The formula for each treatment can be seen in Table 1:

Table 1. Mayonnaise Formula with Various Types of Vegetable Oil

Ingredients	formula with various types of vegetable oil			
	P1	P2	P3	P4
Egg yolk	32%(40g)	32%(40g)	32%(40g)	32%(40g)
Vegetable oil	48%(60g)	48%(60g)	48%(60g)	48%(60g)
Salt	1,6%(2g)	1,6%(2g)	1,6%(2g)	1,6%(2g)
Sugar	12%(15g)	12%(15g)	12%(15g)	12%(15g)
Lemon	5,6%(7g)	5,6%(7g)	5,6%(7g)	5,6%(7g)
Water	0,8%(1g)	0,8%(1g)	0,8%(1g)	0,8%(1g)

Source: Amertaningtyas and Jaya, 2011 which have been modified.

Water content analysis

Water content was analyzed gravimetrically according to (AOAC, 2005) with a modification, namely the aluminum plate was cleaned and preheated in the oven for 30 minutes at 105^{o} C. The plates were cooled in a desiccator for 15 minutes and weighed.

The ingredients weigh as much as 10g on a plate. The plate and its contents are put in the oven at 105^{o} C for 6 hours. The plate was removed and cooled in a desiccator for 15 minutes then weighed. This stage is repeated until a constant weight is achieved. The water content was carried out twice to determine the average weight of the sample and facilitate further processing. To determine the moisture content in the food being tested, the following formula can be used (Sudarmadji et al, 1984).

Water content (%) = $\frac{w-d}{w}$ x 100%

Where:
w: weight of wet sample (g)
d: weight of dry sample (g)

Fat content analysis

Fat content was analyzed using the Soxhlet method (Nielsen, 2010). The mayonnaise sample that had been dried at 500°C weighed as much as 5g and was wrapped in filter paper, and then placed in a Soxhlet extractor. A condenser was installed above it and a fat flask underneath. The hexane fat solvent was put into the fat flask as much as 2/3 of the capacity of the fat flask, then refluxed for ± 6 hours until the solvent dropped back to the fat flask and was clear in color. The solvent in the fat flask is distilled and collected again. Then the fat flask containing the extracted fat is heated in an oven at 105°C for 15 minutes, then cooled in a desiccator for 15 minutes. Fat content is calculated using the following formula:

Fat content (%) = $\frac{w2-wb}{w1}$ x 100%

Where:
wb: weight of the flask (g)
w1: initial weight of sample (g)
w2: weight of sample after drying

Protein content analysis

The protein content was analyzed using the Kjeldahl method (AOAC, 2001). The mayonnaise sample that had been dried at 50°C was weighed as much as 0.2 g, then put in a Kjeldahl flask, added with 10 ml concentrated H_2SO_4 and 5g Kjeldahl tablets as a catalyst. Samples are decoupled at 300°C for 4-6 hours or until the liquid is clear and all smoke clears. The Kjeldahl flask and its contents were cooled and then transferred to a distillation device. Then rinse with 40 ml of distilled water. Then added 60 ml of 4% boric acid solution. Then titrated with 0.1N HCl. The endpoint of the titration is indicated by the appearance of the titration result on the titration tool screen and the distillation device screen. Determination of blanks is carried out in the same way but without samples. Protein content is calculated using the following formula:

Protein content (%) = $\frac{(A-B) x N x 0.014 x FK}{w}$ x 100%

Where:
A: ml HCl for blank titration (ml)
B: ml of HCl for sample titration (ml)
N: normality of HCl used
FK: Conversion factor (6.25)
w: weight of sample

Viscosity (cp) analysis

Viscosity describes the amount of fluid resistance to flow and stirring (Muchtadi, 1990). Viscosity is expressed in units of force (centrifuge). A 200mL sample was prepared in a beaker glass and the temperature was measured. Dip spindle no.6 into the sample until the boundary mark on the spindle is immersed. Enter the spindle code and set the rotating speed to 5 RPM. Press "start" to start the test and "stop" to end (spindle rotates 30 seconds). Read the scale indicated by the tool with units of centipoise (cP)

Total Plate Count test

The TPC analysis working procedure is as follows:

1. Weigh the sample aseptically as much as 25 grams and add 225 ml of Butterfield's phosphate-buffered solution, then homogenize it for 2 minutes.
2. This homogenate is a 10-1 dilution solution. Using a sterile pipette, take 1 ml of homogenate and put

it in a bottle containing 9 ml of Butterfield's phosphate-buffered solution so that an example is obtained with a 10^{-2} dilution. At each dilution, the shaking was performed at least 25 times. Do the same for the 10^{-3}, 10^{-4}, 10^{-5}, and so on dilutions according to the sample conditions.

3. Furthermore, for the pour plate method, pipette 1 ml from each dilution and put into a sterile petri dish twice using a sterile pipette.
4. Into each plate containing the sample, add 12 - 15 ml of Plate Count Agar (PCA) media which has been cooled to a temperature of 45° C. After the agar became solid, the Petri dishes that had been filled with agar and the sample solution were put into the incubator upside down for 48 hours, 35°C
5. Count the number of bacterial colonies in the petri dish. The number of bacterial colonies counted was a petri dish that had bacterial colonies between 25 - 250 colonies.

Antioxidant Content Analysis

The method of measuring antioxidant activity will detect different characteristics of the antioxidants in the sample, this explains why different methods of measuring activity will refer to different observations of antioxidant action mechanisms (Hasan Bag Lou, et al., 2012). A 40 ppm DPPH solution with a volume of 100 ml was prepared by weighing 0.004 g DPPH dissolved in 70% ethanol. As much as 3 ml was taken to observe the absorption at a wavelength of 450-600 nm. The main solution of 1000 ppm ethanol extract by maceration and soxchlet was prepared by weighing 0.01 g of the ethanol extract of mayonnaise and dissolving it in 70% ethanol. The mother liquor was diluted to obtain a concentration of 20; 40; 60; 80 and 100 ppm.

2 ml of each solution was taken, and 4 ml of DPPH 40 ppm was added, and incubated for 30 minutes and observed the absorption occurred at the maximum wavelength. As a comparison, the same method was conducted for vitamin C. The percentage of antioxidant reduction against free radicals was calculated using the following formula:

$$\% I = \frac{\text{Abs control} - \text{Abs sample}}{\text{Abs control}} \times 100\%$$

The percentage value of attenuation is obtained, the linear regression line equation is calculated and then the effective reduction price of fifty percent (IC50) is determined.

Data Analysis

The data obtained from chemical and organoleptic analysis were then analyzed statistically using analysis of variance (ANOVA). If there is a significant effect, then proceed with the Honest Real Difference test (BNJ) at the 5% level.

Result and Discussion

Water Content of Mayonnaise

Water is an important component in a food ingredient that can affect the appearance, texture, and taste of food (Winarno, 2008). The results of the analysis of variety showed that various types of vegetable oil in mayonnaise had a significant effect on water content. After further testing with BNJ at the 5% level, all treatments were significantly different and the mean water content of mayonnaise ranged from 14.86% - 20.67%. Treatment of various types of vegetable oil in the manufacture of mayonnaise was treated with palm oil (P1), coconut oil (P2), corn oil (P3), and sunflower oil (P4) producing an average mayonnaise water content of 16.90%, 14.86%, 20.67% and 17.48%, respectively. The following bar diagram of the mayonnaise water content can be in Figure 2.

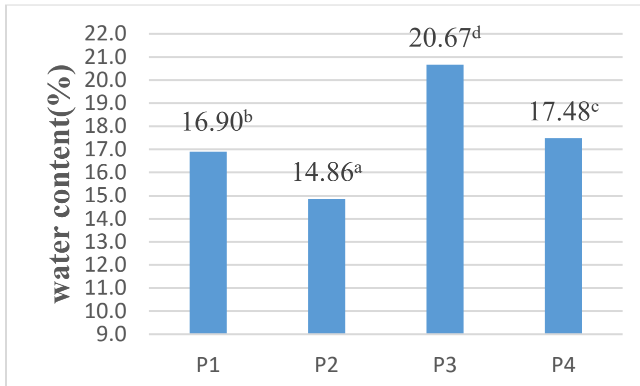

Figure 2. Mayonnaise Moisture Bar Chart

In the Figure shows that the treatment of various types of vegetable oil in the manufacture of mayonnaise produces different water content. Lioe et al (2018) this difference occurs because water content affects viscosity, corn oil has low viscosity because the saturated fatty acid content in corn oil is low so that the highest water content is obtained in corn oil (P3). Meanwhile, coconut oil has a high viscosity because coconut oil has a high content of saturated fatty acids so that the lowest water content is obtained in coconut oil (P2).

The water content of the resulting mayonnaise is obtained from the water content of the raw materials used, namely the water content of egg yolks, lemon, and the addition of water. Chicken egg yolk has a water content around 49.4% per 100g (MOH, 1989). However, the formula in this study for adding egg yolk, lemon juice and adding warm water is the same so that the difference in the fatty acid content of each vegetable oil contributes to the water content. Mutiah (2002) water plays an important role for an emulsion product, namely in the balance of the proportion of oil and protein, the water content is one of the quality requirements of mayonnaise. Based on SNI, the maximum water content is 30%. The mayonnaise product in this study had an average water content ranging from 14.86% - 20.67%. The water content produced by the four treatments had met the requirements (SNI 01-4473-1998) containing a maximum of 30% water. Meanwhile, the water content of commercial mayonnaise on the market is 21.89% (Gaonkar et al, 2010). The water content is low enough to affect the physical characteristics of the mayonnaise, especially its texture.

Viscosity of Mayonnaise (Cp)

The mayonnaise food quality is determined based on physical and chemical criteria. One of the important quality parameters for liquid or semi-solid products is viscosity (Winarno, 2008). The results of the variance analysis showed that various types of vegetable oil in mayonnaise had a significant effect on viscosity. After further testing with BNJ at the 5% level, all treatments were significantly different and the mean viscosity ranged from 486.14 cp - 676.11 cp. The following mayonnaise viscosity bar chart can be seen in Figure 3.

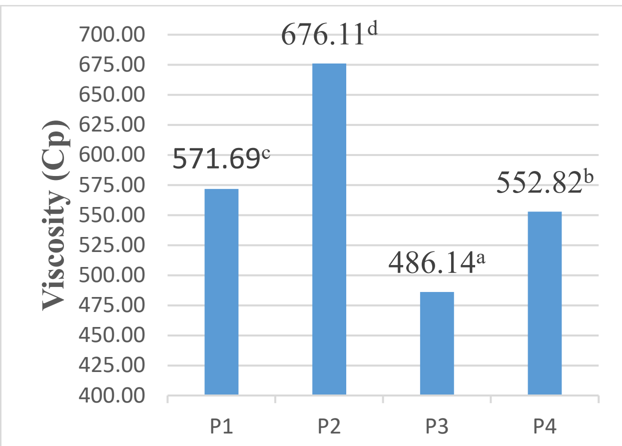

Figure 3. Mayonnaise Viscosity Bar Diagram

Figure 3 shows that the different types of vegetable oil in mayonnaise produce a viscosity that is inversely proportional to the water content. The difference in viscosity is due to the water content and the type of vegetable oil used. With the characteristics of vegetable oils, the difference in water content is caused by the fatty acid content in each oil. According to Usman et al (2015) that each type of vegetable oil has different characteristics depending on the fatty acid content contained in it. The highest viscosity of mayonnaise was found in the use of coconut oil (P2). This is presumably because coconut oil is a vegetable oil that contains high saturated fatty acids, namely lauric acid by 48.5% (Rahmawati, 2016). Meanwhile, the lowest viscosity of mayonnaise is found in the use of corn oil (P3), the resulting low viscosity is because corn oil has low saturated fatty acids so the resulting viscosity is low.

Amertaningtyas and Jaya (2012) stated that the viscosity standard of commercial mayonnaise on the market has a viscosity of 334.7 cp. Mayonnaise in this study has a higher viscosity characteristic than commercial mayonnaise, this is due to differences in the formulation and ingredients used in the manufacture of mayonnaise. Depree and Savage (2001) the viscosity of mayonnaise can be increased if a number of continuous phases (egg yolk) are added and other ingredients such as dextrins and gums as stabilizers.

The viscosity will increase as the storage temperature decreases. This could be caused by very fast flocculation of small droplets occurring with increasing storage temperature. Protein and interactions affect the stability and viscosity of mayonnaise by forming a steric barrier around the oil droplets. (Ghosh et al, 2008). The mayonnaise products in this study ranged from 486.14cP to 676.11cP.

Fat Content of Mayonnaise

The use of vegetable oil and egg yolk can affect fat levels because each of them contributes quite a lot to mayonnaise (Amertaningtyas and Jaya, 2012). The results of the variance analysis showed that various types of vegetable oil in mayonnaise had a significant effect on fat content. After further testing with BNJ at the 5% level, all treatments were significantly different, and the mean levels of mayonnaise fat ranged from 63.97% - 88.97%.

The results of the analysis show that the various types of vegetable oil in mayonnaise show a difference. The bar diagram of fat content can be seen in Figure 4.

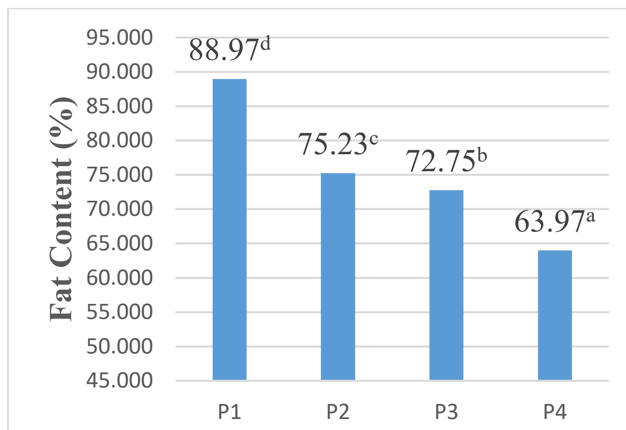

Figure 4. Bar Chart of Mayonnaise Fat Content.

Figure 4 shows that the treatment of various types of vegetable oil in the manufacture of mayonnaise produces different levels of fat. The highest fat content was found in the use of palm oil (P1) of 88.969% and the lowest fat content was found in sunflower oil (P4). Sources of fat in mayonnaise are egg yolk and vegetable oil, but the amount of oil and egg yolk used in this study was the same in each treatment, so that the fatty acid content in each type of oil had a different effect on fat content. The fat content in egg yolk is 31.9% (Ministry of Health, 1989). Palm oil, coconut oil, corn oil, and sunflower oil are vegetable oils as the main ingredients in making mayonnaise which is a liquid form of fat.

The increase of fat content is due to the ability to increase fat by the hydrofobic group possessed by egg yolk lecithin (Hutapea et al., 2016) and because of the high saturated fatty acids in using palm oil, which contains 41% saturated fat compared to saturated fatty acid content of sunflower oil. only about 12.60% (Rahmawati, 2016) while coconut oil based on the fatty acid content is classified as lauric acid oil because the content of lauric acid is the largest when compared to other fatty acids.

The mayonnaise product in this study had an average fat content ranging from 63.971% - 88.969%. The fat content produced by the treatment of palm oil (P1), coconut oil (P2) and corn oil (P3) has met the quality requirements of mayonnaise (SNI 01-4473-1998) containing at least 65%, while mayonnaise with sunflower oil (P4) has not met the quality standard (SNI 01-4473-1998) which only produces a fat content of 63.971%.

Protein Content of Mayonnaise

Egg is a food product from livestock which has a high enough nutritional value so that egg is widely consumed and processed into other products such as mayonnaise. The eggs used in this study were purebred chicken eggs. The protein source of mayonnaise is egg yolk of purebred chickens, where the protein content of the egg yolk is 15-16% (MOH, 1989). The results of the variance analysis showed that various types of vegetable oil in mayonnaise had a significant effect on protein content. After further testing with the BNJ level of 5%, all treatments were significantly different and the mean protein content ranged from 1.61% - 1.98%. The following bar chart of mayonnaise protein content can be seen in Figure 5.

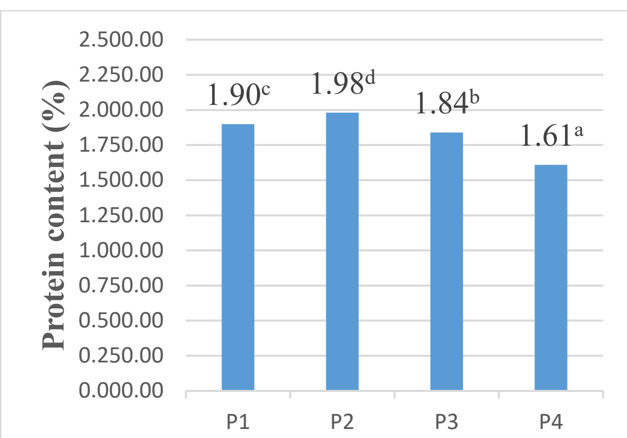

Figure 5. Bar Chart of Mayonnaise Protein Levels.

Figure 5 shows that the treatment of various types of vegetable oil produces different levels of protein. The highest protein level was obtained coconut oil (P2) of 1.98% and the lowest protein content was obtained by sunflower oil (P4) 1.61%.

The protein source of mayonnaise is egg yolk, wherein egg yolk protein content ranges from 15-16% and vitamin A (Department of Health, 1989). However, the formula in this study for adding egg yolk is the same so that the difference in protein content in each vegetable oil contributes to the protein content. According to Amertaningtyas and Jaya (2012) all fats and oils or fats in food contain a number of fats-phosphorus. Phosphorus is a mineral found in food ingredients with high protein content, while coconut (as the basic raw material for coconut oil) is a food ingredient that has high protein.

According to Winarno (1990) mayonnaise protein is a high protein because it comes from egg yolks which contain essential amino acids. The mayonnaise product in this study had an average protein content of 1.614% - 1.984%. The protein content produced by the four treatments had met the quality requirements of mayonnaise (SNI 01-4473-1998) which contained at least 0.9% protein content.

Mayonnaise Antioxidant Activity

Antioxidants are compounds that can prevent the dangers that come from oxidation reactions. These compounds can function to inhibit the possibility of degenerative diseases and aging. Under normal circumstances, free radicals produced in the body will be neutralized by antioxidants in the body.

If the levels of free radicals are too high, the ability of endogenous antioxidants is inadequate to neutralize free radicals resulting in an imbalance between free radicals and antioxidants which causes an increase in leakage of electrons from mitochondria which will become ROS (Reactive Oxygen Species) which is called oxidative stress.

The results of the variance analysis showed that various types of vegetable oil in mayonnaise had a significant effect on antioxidant activity. After further testing with the BNJ level of 5%, all treatments were significantly different, and the mean ranged from 21.04 ppm to 24.76 ppm.

Based on some literature specifically, a compound is said to be a very strong antioxidant if the IC50 value is less than 50 mcg/ml, strong for the IC50 is 50-100 mcg/ml, moderate if the IC50 is 100-150 mcg/ml, and weak if the IC50 is worth 151-200 mcg/ml (Sinaga et al, 2012). The results of the analysis showed that all treatments had very strong antioxidant activity because they ranged from 21.04 ppm - 24.76 ppm. P4 (Mayonnaise with the addition of sunflower oil) has the strongest antioxidant activity than P1, P2, and P3. This is in accordance with research from Putri (2020) which states that the antioxidant activity of sunflowers is 88.37% more than others. Mawardi et al, 2016 stated that the antioxidant activity of corn has 36.54% lower than sunflower. This is in accordance with the results of this study which stated that the highest antioxidant activity was found in sunflowers.

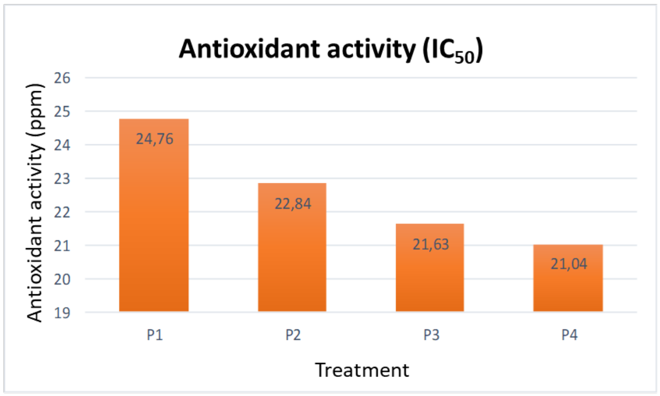

Figure 6. Mayonnaise's Antioxidant Activity Bar Chart.

Figure 6 shows that the highest antioxidant activity is P1 followed by P2, P3, and P4. However, with the IC50 calculation, the strongest antioxidant activity was in the P4 treatment, namely the addition of sunflower oil compared to palm oil, coconut oil, and corn oil. Sukandar et al, 2009 stated that the antioxidant activity of VCO (coconut oil) was lower. The very small antioxidant activity is due to the fatty acids contained in VCO, namely 50% saturated fatty acids in the form of lauric acid which do not have double bonds. While the unsaturated fatty acids in VCO are only 5%, which are antioxidants, due to the presence of double bonds that can stabilize free radicals, so there is still a possibility that the compounds contained have stronger free radical inhibition activity than their extracts in addition to optimization of the method that must be done for compounds nonpolar.

TPC

The growth of microorganisms that form a colony can be considered that each colony that grows comes from one cell, so by counting the number of colonies, it can be seen the spread of bacteria present in the material. The number of microbes in a material can be calculated in various ways, depending on the material and the type of microbe (Anggraeni, 2012). Microbial growth is influenced by intrinsic factors including nutritional content. In this case, the types of lipids in vegetable oils, both quantitatively and qualitatively, pH, and water activity, water content, can be related to one another. The content of saturated and unsaturated fatty acids, both the type and ratio in vegetable oils, affects microbial growth.

One of the ways to detect or analyze the number of microbes is by means of the TPC (Total Plate Count) test, which is intended to show the number of microbes present in a product by counting bacterial colonies grown on agar media (Yunita et al., 2015). The results of the analysis of variance showed that the various types of vegetable oil in mayonnaise had a significant effect on the results of the TPC calculation. After further testing with the BNJ level of 5%, all treatments were significantly different.

In general, bacteria do not directly break down fatty acids. But once the fatty acids are induced to be broken down, the next active fatty acid oxidation occurs. The degradation of fat by microbes is influenced by the environmental conditions of its growth. For example, the presence of glucose in the growth medium will suppress the microbial enzymes involved in the fat oxidation process, which is called the catabolite repression phenomenon.

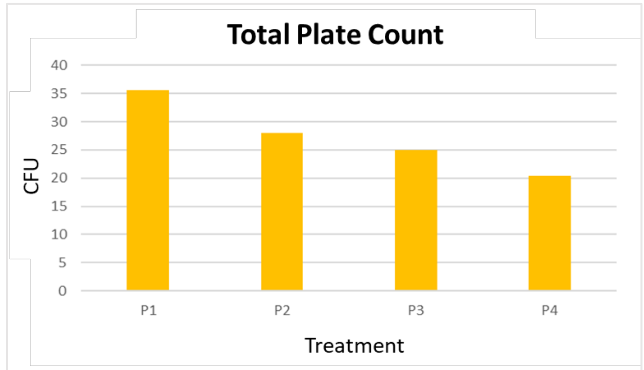

Figure 7. Bar Chart of the Mayonnaise TPC Value

Figure 7 shows that each treatment is significantly different. The highest total TPC in treatment 1 was 35.67 CFU/g (Mayonnaise with the addition of palm oil). This is due to the position of saturated and unsaturated fatty acids in palm oil. Meanwhile, the P2 and P3 treatments were not significantly different. This is in accordance with Utami (2019) statement that there is no significant difference in total microbes, with pH and fat data that are not significantly different from mayonnaise made using corn and coconut oil with various comparisons. Treatment P4 has the lowest TPC, which is 20.33 CFU/g. This is caused by the stability of the formed emulsion due to the saturated/unsaturated fatty acid composition of the type of vegetable oil, namely sunflower oil, so the microbes will take longer to degrade these fats. The longer the fatty acid chain and the more saturated the fatty acids, so it results in lower emulsion stability.

Conclusion

Various vegetable oils, including palm oil, coconut oil, corn oil, and sunflower oil, were studied for their impact on mayonnaise properties. The research found significant effects ($p < 0.05$) on physical attributes like viscosity, as well as chemical aspects such as moisture content, fat content, protein content, and antioxidant levels. Among these oils, coconut oil (specifically VCO) stood out, resulting in mayonnaise with optimal moisture content and viscosity. Sunflower seed oil (P4) yielded mayonnaise with the lowest fat content and total phenolic content (TPC), similar to corn oil. Palm oil (P1) stood out for producing mayonnaise with the highest antioxidant content.

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