DEVELOPMENT OF LOW FAT MAYONNAISE USING WHEY PROTEIN AS A NATURAL EMULSIFIER

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Submitted 11 March 2022; Accepted 19 March 2022

ABSTRACT

Mayonnaise is an oil-in-water emulsion product that uses egg yolk as a stabilizer agent. Low-fat mayonnaise is made as a product modification to make it healthier by reducing fat. Whey protein concentrate is given as a natural emulsifier. The objective of this study was to determine the effect of whey protein concentrate addition on low-fat mayonnaise based on carbohydrates, ash, fat content and emulsion droplets. The material used in this study was vegetable oil, and the addition of whey protein concentrate. This research used was a laboratory experimental method with a completely randomized design with 4 treatments and 5 replications. The treatments using control treatment without the addition of whey protein concentrate and treatment using whey protein concentrate as much as 5%, 10%, and 15% of the total use of oil. The variables measured were carbohydrate, ash, fat, antioxidants and emulsion droplets. The results showed that the use of whey protein concentrate in mayonnaise gave highly significant difference (p<0.01) in carbohydrate and fat content, gave a significantly different result (p<0.05) in the ash content, didn’t gave significant difference (p>0.05) in antioxidants and gave a highly significant difference (p<0.01) in the length of the emulsion droplet diameter so that it looked uniform in shape and size. The conclusion of this study is the use of whey protein concentrate as much as 15% produces the best low-fat mayonnaise

Key words: Low fat mayonnaise; whey protein; emulsifier
INTRODUCTION

Mayonnaise is an emulsion product made from oil (oil phase) and vinegar (water phase) using emulsifier lecithin from egg yolks. The mayonnaise food product is classified as a water-in-oil emulsion using vegetable oil. Soft and savory taste due to the high-fat content. Traditional mayonnaise is known as a high-fat product because it uses 70 to 80% vegetable oil. Consumption of high fat is in line with an increase in several diseases such as obesity and cardiovascular. This incident resulted in consumers being more selective towards foods that contain excess oil. Restrictions on oil consumption are influenced by health, along with the increasing development of science and human awareness of a healthy lifestyle. Low-fat mayonnaise is a target for product diversification. The challenge in making low-fat mayonnaise is the low stability of the emulsion. Emulsifiers and stabilizers are needed to increase the emulsion stability of low-fat mayonnaise products.

The oil content in foods can be reduced such as oil and egg yolks. The reduction of fatty ingredients in mayonnaise can reduce product sensory because fat affects the taste and texture of mayonnaise. Reducing the content of fats such as eggs and oils can increase the water phase which makes the droplet size larger and the interfacial attraction greater. Egg yolk material plays an important role so it is preserved. If the oil is reduced, it can increase the water phase, so it needs to be combined with other ingredients so that the water phase decreases. Oil substitutes based on carbohydrates, proteins, and synthetic fats can improve the texture of mayonnaise (Galan, Callinescu, Trifan, Smith, Carrascal, Dodds, Binner. 2017). Protein-based fat substitutes also have a role as an emulsifier. Emulsifiers can reduce the interfacial tension of oil and water. Egg yolk as an emulsifier is needed because of the presence of protein and fat in lecithin. Lecithin can bind to oil and water so that the egg yolk becomes an emulsifier. According to Bakhsh, Esfahmi, Kenari, and Najafabadi (2021) stated that the whey protein concentrate product can be used as an encapsulation of fat globules (encapsulation) such as egg yolks to hold the surface of the fat globule interface. According to Cui, McClements, Liu, Liu, and Ngai (2021) stated that the mechanism of action of whey protein is to coat droplets and bind water components. The use of whey protein in the mayonnaise needs to be done and tested for quality to determine the development of a natural emulsion made from whey protein.

MATERIALS AND METHODS

The research materials include sunflower seed oil and whey protein concentrate. Other ingredients used were egg yolks, vinegar, mustard, sugar, salt, and pepper. The manufacturing procedure starts with the separation of the egg yolks. Other ingredients include mustard, sugar, salt, and pepper mixed in a mixer. In a mixer with spices, egg yolks are added and then homogenized until an emulsion is formed. The addition of oil and vinegar in the container is carried out alternately until the two ingredients are homogeneous with the spices. All the ingredients that have been mixed are allowed to stand for 1 x 24 hours to ensure the product reaches the stability of emulsion.

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How to cite:
The method in this study used was laboratory experiment. Samples were made with 4 treatments and 5 replications. Control treatment (P0) was made using sunflower seed oil as much as 70%. All treatment samples used 30% sunflower seed oil.

Treatment samples were distinguished by the use of whey protein concentrate. P1 uses a whey protein concentration of 5%. P2 uses a whey protein concentration of 10%. P3 uses a whey protein concentration of 15%. Sample testing includes carbohydrate, ash, fat content, antioxidant, and droplet emulsion tests. The mayonnaise sample was tested for the presence of carbohydrates in the product using a different method according to AOAC (2005). Nasal ash content using the total ash method is the residual heating between 550 to 600°C according to AOAC (2005). Fat content was tested using the Babcock method according to AOAC (2002). Antioxidant activity in mayonnaise products was observed using the DPPH method according to Rasmy, et al. (2012). The data obtained were analyzed using Microsoft Excel software and then searched for the average and standard deviation. The data were analyzed using Analysis of Variance (ANOVA) and if the results were significantly different or highly significant, then further tested using Duncan’s Multiple Distance Test (DMRT).

RESULTS AND DISCUSSION

Carbohydrate

The results of testing low-fat mayonnaise products with the addition of whey protein concentrate are presented in Table 1.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>P0</th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrate (%)</td>
<td>5.14±0.71^a</td>
<td>7.88±0.64^b</td>
<td>8.96±0.49^bc</td>
<td>10.17±0.44^c</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>1.83±0.05^a</td>
<td>1.91±0.08^a</td>
<td>1.95±0.03^a</td>
<td>2.14±0.14^b</td>
</tr>
<tr>
<td>Fat Content (%)</td>
<td>63.88±0.65^c</td>
<td>31.44±0.56^b</td>
<td>29.92±0.57^a</td>
<td>29.35±0.54^a</td>
</tr>
<tr>
<td>Antioksidan</td>
<td>1.69±0.30</td>
<td>1.91±0.08</td>
<td>1.94±0.04</td>
<td>1.99±0.04</td>
</tr>
</tbody>
</table>

Remarks: *Mean values within a column followed by the different letters are significantly different at (p<0.05) according to Duncan’s Multiple Range Test.

The results of the analysis of variance showed that the addition of whey protein to low-fat mayonnaise gave a highly significant effect (p < 0.01) on carbohydrates. The average ranged from 5.14% to 10.17%. Control treatment is a low-fat mayonnaise product without an average value of 5.14%. The increase in the average value of carbohydrates was seen when the addition of whey protein was increased to P3 by 10.17%.

The carbohydrate content increased because it was influenced by the treatment material, namely whey protein from milk processing products. It is known that the carbohydrates in milk in the form of lactose are 4.8% (Smithers. 2008). Carbohydrates have a sweet taste and have benefits such as fiber, sugar, starch, and a source of energy (Siregar. 2014). The effect of carbohydrates in taste gives a mouthfeel sensation, and on products can increase viscosity because carbohydrates are an ingredient in fat replacement products (Heggset, Aen, Veslum, Henriksson, Simon, and Syverud. 2020). Carbohydrates are useful as a binder for water components in emulsion products such as mayonnaise (Guzman, Kollman, Zhang, Boom, and Nikiforidis. 2020).

Ash

The results of low-fat mayonnaise products with the addition of whey protein concentrate are presented in Table 1. The results of the analysis of variance showed that the addition of whey protein to low-fat mayonnaise had a significant effect (p <0.05) on ash content. The average ranged
from 1.83% to 2.14%. Mayonnaise control product without the addition of whey protein concentrate with an average value of 1.83%. The increase in the average value of ash along with the addition of whey protein increased with the highest value up to P3 of 2.14%.

The mayonnaise ash increased along with the increase in the percentage of a whey protein treatment. In previous studies, it has been known that whey protein is a source of ash or minerals. In unit weight, whey has a mineral content of 0.5% (Smithers. 2008). Several kinds of minerals are contained in dairy products such as Na, K, Ca, and Mg (Sanchez, Rocha, Charles, Boussaha, Hozé, Brochard, Buchet, Gosperrin, and Boichard 2021).

High ash content will affect the increase in ash to the product. This is in accordance with the research of Li, Wang, Jin, Zhou, and Li (2014) which states that the ash content of mayonnaise increases with the addition of treatment in the form of konjac gel. According to Evanuarini and Susilo (2021) stated that apple peel flour has a high ash content so it can increase the ash content of the product as a treatment.

**Fat Content**

The results of the analysis of variance showed that the addition of whey protein to low-fat mayonnaise gave a highly significant effect (p<0.01) on fat content. The average ranged from 29.35% to 63.88%. Mayonnaise control without the addition of whey protein concentrate which has the highest average fat value of 63.88%. The lowest average value in treatment 3 is 29.35%. The addition of whey protein concentrate provides a decrease in fat content in low-fat mayonnaise products.

The decrease in the mean value of fat along with the addition of whey protein concentrate. Oil in the treatment of addition of stable whey protein concentrate is using oil at 30%. Whey protein concentrate as a treatment is a product from milk that has been separated between fat and serum. This makes whey protein concentrates a low-fat dairy product. According to Smithers (2008), the result of the separation of milk serum has a fat of 0.01%.

The presence of fat in the emulsion product is necessary because there is lecithin. The function of lecithin is to help reduce stress in the oil phase and water phase. Whey protein products do not have lecithin but can help as an emulsifier because they contain -lactoglobulin (Wang, Yue, Xu, Guan, Guo, Yang, Ma, and Shao, 2021).

**Antioxidant**

The results of the analysis of variance showed that the addition of whey protein to low-fat mayonnaise gave no significant effect (p>0.05) on antioxidant activity. The mean ranged of antioxidant from 1.69% to 1.99%. The mayonnaise control has an average antioxidant activity value of 1.69%. The increase in the average value of antioxidant activity along with the addition of whey protein increased with the highest value up to treatment 3 of 1.99%.

The effect of whey protein concentrate can be seen by increasing the value of the antioxidant activity. The graph has improved but is not statistically significant. The addition of a higher concentration of whey protein can change the analysis of variance to be significantly different. Whey protein concentrate was increased for each treatment by 5%. P3 has the highest mean antioxidant value of 1.99% which is the result of the addition of 15% whey protein concentrate.

In terms of the treatment material, whey protein concentrate has the potential for antioxidant activity in the form of -Lactoglobulin in the form of phenolic compounds (El-Maksound, El-Ghany, Beltagi, Anankanbil, Banerjee, Petersen, Perez, and Guo. (2018). Other ingredients that support the increase namely oil and eggs in the form of vitamin E and -carotene. These compounds can affect the oxidation of fat so that it changes off-flavor and off-odor (Evanuarini, Nurliyani, Indratiningsih and Hastuti 2019). Products with low
antioxidant activity can cause products to quickly experience rancidity.

**Emulsion Droplets**

The results of droplet emulsion image of mayonnaise products are presented in Figure 1. The results of the analysis of variance showed that the addition of whey protein to low-fat mayonnaise gave a highly significant difference \((p<0.01)\) on the droplet diameter of the emulsion. The average emulsion droplet diameter ranged from 5.45 m to 13.97 m. The control mayonnaise which has an average length diameter of 13.97 m. The decrease in the mean droplet diameter of the emulsion along with the addition of whey protein increased by 15% with the lowest value at a P3 length of 5.45 m.

![Emulsion Droplets Image](image)

**Remarks:**

(a) P0 emulsion droplets, (b) P1 emulsion droplets, (c) P2 emulsion droplets, (d) P3 emulsion droplets

Measurement of the length of the droplet diameter can be observed using a microscope with a magnification of 100x. It can be seen that the difference in the average diameter of the emulsion droplets is getting smaller. The droplet image proves that the effect of whey protein concentrate as an emulsifier can reduce droplet size. According to Matia (2015) stated that the success of the emulsion resulted in a decrease in the droplet size of the emulsion. Whey protein is proven to be able to be used as a double emulsifier in mayonnaise. This content is supported by the statement of Aaltonen, Kyto, Huusko, and Outinen (2020) stating that whey protein concentrate as an emulsifier makes the product soft and has small particles.

Whey protein treatment material can be used as an emulsifier and stabilizer. The effect of the material as an emulsifier is that it contains proteins that can reduce the interfacial tension between oil and water. The effect as a stabilizer is because the
treatment material is in the form of flour so that it can fill the gap between the droplets. According to Evanuarini, Nurliyani, Indratiningsih and Hastuti (2015), porang flour can act as a stabilizer because it can fill the gaps between droplets, thereby increasing the stability of the emulsion.

CONCLUSION

This study concluded that the addition of whey protein concentrate can act as an emulsifier and can maintain fat levels in low-fat mayonnaise products. The image of droplet emulsion showed the smaller diameter of the emulsion droplet and uniform oil globules. The addition of whey protein increased the ash content and antioxidant activity. The results of the study concluded that the addition of 15% whey protein gave the best treatment.

REFERENCES


