The effect of catfish oil (Pangasius sp.) addition on physical and chemical characteristics of rice bran oil mayonnaise

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Abstract

Rice bran oil (RBO) and catfish oil (CFO) have high unsaturated fatty acids that are good for health. Mayonnaise products are made mostly from oil. Adding catfish oil and rice bran oil to the mayonnaise will add nutritional value to the product. This study aimed to determine the effect ratio of CFO:RBO on the physical, chemical, and sensory characteristics of mayonnaise. This research used a completely randomized design with one factor, that is ratio of RBO:CFO (74:0, 66.6:7.4, 59.2:14.8, 51.8:22.2 and 44.4:29.6) (% w/w). Data were analyzed by one-way analysis of variance method and continued by Duncan's multiple range tests (α=0.05). The research showed that the ratio of RBO:CFO significantly affected chemical and sensory characteristics but not physical characteristics. Mayonnaise in the % ratio of RBO:CFO = 59.2%:14.8% was the best formula. The selected mayonnaise has foaming capacity, foaming stability, total phenol, moisture, ash, protein, fat, and calorie content of 6.127%, 98.844%, 0.863%, 16.089%, 0.441%, 0.718%, 90% and 718.92 kcal/100 g, respectively. Panelists indicate their level of preference for the color, aroma, texture, and overall mayonnaise at a preference value between 3.067-3.867.

1. Introduction

Mayonnaise is an emulsion system oil-based food product generally made from vegetable oils, emulsifiers, and other condiments. Mayonnaise is a semi-solid emulsion that, in its manufacture, consists of a mixture of vinegar, vegetable oil, and egg yolk, which acts as an emulsifier. In addition, the manufacture of mayonnaise also requires the addition of salt and sugar. The principle of making mayonnaise is to add and mix until homogeneous between vegetable oil, sugar, salt, mustard, vinegar, and egg yolk as an emulsifier (Lioe et al., 2018; Aznury et al., 2022; El-Waseif et al., 2022). Products derived from egg-based emulsions other than mayonnaise, one of which is the salad dressing. Mayonnaise and salad dressing are types of an oil-in-water emulsions. However, the amount of vegetable oil in salad dressing is only about 30%, while the concentration of vegetable oil in mayonnaise is more (Abd Rashed et al., 2017; Hill et al., 2020).

Rice bran oil is one of the vegetable oils that can be used to make mayonnaise. The nutrients in rice bran are carbohydrates (42-45%), fat (23-27%), protein (12-14%), crude fiber (2-10%), and B vitamins, especially vitamin B1 (thiamin). Rice bran has excellent nutritional value, which includes fat content, amino acid lysine, fiber, and protein which are very beneficial for the body (Satter et al., 2014; Chakraborty et al., 2018). Indonesia is the third largest rice-producing country after China and India. In 2018, it was known that Indonesia produced about 56 million tons of rice. Rice processing produces by-products in the form of rice bran. Currently, rice bran in Indonesia is only used by the community for animal feed. It is due to a lack of knowledge about rice bran's nutritional value, which is beneficial for humans (Yunardi et al., 2020; Arsani, 2020; Sujarwanta et al., 2021).

The high-fat content in rice bran has the potential to be extracted and produce rice bran oil. Rice bran oil contains unsaturated fatty acids, with the main content of oleic acid at 54.1% and linoleic acid at 22.1%. In
addition, it also contains saturated fatty acids, especially palmitic acid (16.2%) and myristic acid (1.9%). Rice bran oil contains a phytonutrient that works as an antioxidant, vitamin E, γ-orthzanol, phytosterols, and squalene. Based on the content, rice bran oil is helpful for health, primarily related to preventing cholesterol-related diseases (Ali and Devarajan, 2017; Mingyai et al., 2017).

Rice bran oil mayonnaise can be added with catfish oil which is high in unsaturated fat. Catfish (Pangasius sp.) is very easy to breed in Indonesia. Catfish is one of the targets of the Indonesian government as the main freshwater fish commodity in aquaculture besides tilapia and carp (Henriksson et al., 2019). Catfish have a high nutritional content, especially fat, which is 8.1%. Catfish fat contains monounsaturated fatty acids, especially oleic acid (33.1%), palmitoleic acid (3.5%), and elaidate (2.5%). In addition, it also contains polyunsaturated fatty acids, such as linoleic (12%), arachidonic (1.9%), EPA, and DHA. The content of unsaturated fatty acids in catfish is also beneficial for health, especially those related to cardiovascular diseases (Hashim et al., 2015; Abdel-Mobdy et al., 2021).

In the manufacture of mayonnaise, oil is the main component compared to other ingredients. Adding catfish oil to manufacture mayonnaise increases nutritional value, such as omega-3. However, Amri et al. (2021) reported that catfish oil has a fishy smell. It will affect the smell of the mayonnaise products produced. Therefore, it is necessary to have the proper formulation between catfish oil and rice bran oil used. The purpose of this study was to determine the effect of variations in the concentration of catfish oil (Pangasius sp.) and rice bran oil on physical characteristics (foaming capacity and foaming stability), chemical characteristics (phenol content, moisture content, ash content, protein content, fat content, calorie content) and sensory characteristics in making mayonnaise and knowing the best mayonnaise formulation.

2. Materials and methods

2.1 Materials

This study used raw materials such as fresh catfish that are more than 45 cm in length. Catfish were obtained from the fish distributor in Pajang, Central Java, Indonesia. The rice bran oil was obtained from Oryza Grace Brand, produced by Kasisuri Co. Ltd, Thailand, and purchased from PT. Indoglobal Distribusi Nusantara, Karanganyar, Central Java, Indonesia. Eggs, sugar, vinegar, salt, and citron can be found at Jongke Pajang Traditional Market. All chemicals were of analytical grade from Merck.

2.2 Catfish oil extraction

Catfish oil extraction by dry rendering refers to method described by Lestari et al. (2020), with some modification. This procedure begins with fresh catfish being cleaned and separated from the viscera. A cleaned catfish is then cut into small pieces and heated using an oven at 90°C for 2 mins. The oil and liquid from oven heating were separated by a filter cloth and put in an Erlenmeyer flask. Then, manually press the heated catfish, and the yield containing crude catfish oil and other residue was collected in the earlier Erlenmeyer flask.

2.3 Refining of crude catfish oil

The refining procedure conducted refers to method described by Shabanakkakroodi et al. (2015). This procedure begins with crude catfish oil being centrifugated for 10 mins at 1000 rpm. The upper layer was heated at 65°C and 250 rpm for 1 min. Then add 3% citric acid, which is equivalent to 3% from the sample weight. The pH is then checked to ensure the pH value is below 7. The mixture was then held at room temperature for 5 mins. After that, 9.5% NaOH was added and stirred at 65°C and 250 rpm for 20 mins. The pH is then checked to ensure the pH value is at the neutral point. The mixture was then held at room temperature for 5 mins. 7% active carbon was added (w/w) and stirred at 250 rpm and 65°C for 20 mins. The mixture was then held at room temperature for 5 mins and then centrifugated at 1000 rpm for 10 mins. The top layer, refined fish oil, is used for further procedures.

2.4 Mayonnaise production

The production of mayonnaise refers to the method described by Yesiltas et al. (2021) with modifications. The process begins by beating the egg yolks at high speed for 5 minutes. Followed by the addition of sugar and salt, then mixed again at high speed for 2 minutes. Mustard was added and mix again with a mixer at high speed for 1 minute. After being homogeneous, the oil was added little by little while mixed at high speed for 7 minutes. Catfish oil and rice bran oil were gradually added up to 74% with various formulations (% w/w RBO (Rice Bran Oil): FO (Fish Oil)) {74% : 0%), (66.6% : 7.4%), (59.2% : 14.8%), (51.8% : 22.2%), and (44.4% : 29.6%)}. At the end of each formulation, vinegar was added while stirring at high speed for 1 minute until homogeneous.

2.5 Sample analysis

Analysis of chemical properties included total phenolic content by the Folin-Ciocalteu method (Muntana and Prasong, 2010), proximate analysis.
(moisture content using the Thermogravimetric method, ash content using the dry ashing method, fat content using the Soxhlet extraction method, protein content using the micro-Kjeldahl method), total calories using the Bomb Calorimeter method (Mulyaningsih and Rosida, 2002). The physical properties were analyzed for foaming capacity and stability (Mune and Sogi, 2016). Sensory properties were analyzed using preference test scoring (Hari et al., 2021).

2.6 Statistical analysis

This research used a completely randomized design (CRD) with one factor: catfish oil and rice bran oil percentage ratio. Data were analyzed using IBM SPSS Statistic version 23 by the one-way analysis of variance (ANOVA) method and continued by Duncan's multiple range test (DMRT) \( (\alpha = 0.05) \) if there is a significant difference result.

3. Results and discussion

3.1 Foaming capacity and foaming stability

The principle of foaming capacity testing is to provide a mixing treatment (hand mixer) to trigger the capture of air in the sample so that it can form foam. In contrast, the foaming stability test measures the decrease in foam volume according to the resulting time function. The speed of air absorption determines the foam formation in the liquid phase during the whipping process. Proteins are mainly from egg yolk, which acts as an emulsifier that is hydrophilic and hydrophobic. The hydrophilic group will bind water, while the hydrophobic group will bind air so that it will form bubbles (foam) during the whipping process. The foam will be more stable if the amount of air trapped inside the foam is between 30-70%. However, whipping too high a speed will produce smaller and more unstable foam (Lomakina and Míková, 2011; Hou and Wang, 2017).

The results showed that variations in the concentration of rice bran oil and catfish oil had no significant effect on the foaming capacity and stability of the resulting mayonnaise foam (Table 1). The foaming capacity of mayonnaise ranged from 5.637-6.373%. The mayonnaise content foam stability ranged from 98.141-99.314%. The results in this study are higher than the findings of Fauziah et al. (2016), who reported that adding egg yolk to mayonnaise produces a foaming capacity of 4% and foaming stability of 94.55%. The difference in foam capacity and stability is influenced by the effectiveness of the emulsifier added (Hari et al., 2021).

3.2 Phenolic content

Table 2 shows that the amount of rice bran oil and catfish oil significantly affects the phenol content of mayonnaise. The results of the analysis of phenol levels ranged from 0.748-1.020%. The water content of mayonnaise was only significantly different in F1 and F5. The highest phenol content is F1, where there is no addition of catfish oil, while the lowest is F5 which is mayonnaise with the highest concentration of catfish oil addition. The higher the rice bran oil concentration, the higher the phenol value produced. Rice bran oil is known to contain a lot of phenols and flavonoids. The most abundant phenolic compounds in rice are oryzanol and its derivatives and tocotrienols. The rice bran contains several phenolic compounds and is rich in dietary fiber, minerals, and vitamins (Issara and Rawdkuen, 2016; Mingyai et al., 2017).

3.3 Proximate

The results of proximate analysis (water, ash, protein and fat) are shown in Table 2. The water content of mayonnaise ranged from 15.606%-16.603%. According to SN101-4473-1998, the water content in mayonnaise is 30% (Badan Standar Nasional, 1998). The results obtained in this study indicate that the water content in F5 mayonnaise is significantly different from F1. This result is suspected of being influenced by the water content in catfish oil. Lestari et al. (2020) reported that catfish oil extracted by dry rendering contains water between 0.08-4.02%. Furthermore, Anandganesh et al. (2016) reported that the process of refining fish oil was only able to reduce the water content by 54.29%, so after the refining process, fish oil still contained water. The results in this study are lower than commercial mayonnaise in Malaysia, which contains a moisture content of 28.71% (Abd Rashed et al., 2017).

The mayonnaise ash content was 0.423%-0.465%. The highest ash content is found in mayonnaise F1, which is mayonnaise without adding catfish oil. Rice bran oil contains the minerals Fe, Si, and P at 17 mg/L, 13 mg/L, and 955 mg/L, respectively (Mas'ud et al., 2017). In contrast, fish oil contains lower minerals ranging from 4.2-43.9 mg/L (Arena et al., 2021). Based

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Table 1. Foaming capacity and foaming stability of rice bran oil mayonnaise with the addition of catfish oil.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Foaming capacity (%)</th>
<th>Foaming stability (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>5.637±0.490(^a)</td>
<td>98.141±0.767(^a)</td>
</tr>
<tr>
<td>F2</td>
<td>5.637±0.490(^a)</td>
<td>98.619±1.187(^a)</td>
</tr>
<tr>
<td>F3</td>
<td>6.127±0.490(^a)</td>
<td>98.844±0.887(^a)</td>
</tr>
<tr>
<td>F4</td>
<td>6.373±0.566(^a)</td>
<td>99.071±0.756(^a)</td>
</tr>
<tr>
<td>F5</td>
<td>6.373±0.566(^a)</td>
<td>99.314±1.570(^a)</td>
</tr>
</tbody>
</table>

Values are presented as mean±SD. Values with different superscripts within the same column are statistically significantly different (\(p<0.05\)).
on this, the higher the addition of catfish oil, the lower the ash content of mayonnaise. Sarungallo et al. (2021), reported that the highest ash content of mayonnaise with the addition of palm oil is 4.50%. It shows that the mineral content in vegetable oil is higher than in fish oil.

The analysis of mayonnaise protein levels ranged from 0.680% to -0.792%. The highest protein content is found in mayonnaise F5, which is mayonnaise with the addition of the highest catfish oil. In addition to being sourced from added egg yolk, protein in mayonnaise is also influenced by the protein content of catfish oil. Sarungallo et al. (2021) reported that the protein content in the oil is in the form of lipoproteins that are followed during the extraction process. The degumming process in oil refining does not remove protein content. Salman et al. (2021) reported that the protein content in catfish meat ranges from 14.75-16.6%. The high protein content in catfish is thought to be from the lipoprotein in fish oil during the extraction process, so the higher the addition of catfish oil the higher the protein content in mayonnaise.

The fat content analysis of mayonnaise ranged from 85.0% to 90.0% and was not significantly different for all mayonnaise tested. According to SNI 01-4473-1998, the fat content in mayonnaise was at least 60%. The analysis of the caloric content of mayonnaise ranged from 689.18 kcal/100 g to 756.01 kcal/100 g. The results in this study indicate that all the calories of mayonnaise produced have met the SNI.

3.4 Sensory characteristics

The sensory characteristics of mayonnaise are shown in Table 3. The panelists’ assessment of the color of mayonnaise ranged from 3.400-3.867, with the analysis results are not significantly different for all mayonnaises tested. This value means that the panelist accepts mayonnaise on the color parameter at a neutral level. The color produced from rice bran oil mayonnaise with the addition of catfish oil is bright yellow (Figure 1). The formation of the mayonnaise color is caused by the materials used, such as the rice bran oil, fish oil, egg yolk, and mustard which are all yellow. The results in this study concurred with El-Waseif et al. (2022), where mayonnaise with the addition of flaxseed oil enriched with omega-three fatty acids fish oil produces a mayonnaise color that is not significantly different.

Values are presented as mean±SD. Values with different superscripts within the same column are statistically significantly different (p<0.05).

![Figure 1. Image of rice bran oil mayonnaise with the addition of catfish oil.](https://doi.org/10.26656/fr.2017.7(S3).3)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Phenol (%)</th>
<th>Moisture (%)</th>
<th>Ash (%)</th>
<th>Protein (%)</th>
<th>Fat (%)</th>
<th>Calorie (kcal/100 g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>1.02±0.010c</td>
<td>15.60±0.103a</td>
<td>0.46±0.025b</td>
<td>0.68±0.0007a</td>
<td>85.00±4.082a</td>
<td>756.01±88.153c</td>
</tr>
<tr>
<td>F2</td>
<td>0.89±0.046b</td>
<td>15.97±0.318ab</td>
<td>0.44±0.029ab</td>
<td>0.69±0.010a</td>
<td>88.75±6.292a</td>
<td>727.36±257.721bc</td>
</tr>
<tr>
<td>F3</td>
<td>0.86±0.026b</td>
<td>16.08±0.656ab</td>
<td>0.44±0.016a</td>
<td>0.71±0.024a</td>
<td>90.00±7.071a</td>
<td>718.92±306.977ab</td>
</tr>
<tr>
<td>F4</td>
<td>0.76±0.009a</td>
<td>16.47±0.678ab</td>
<td>0.42±0.036ab</td>
<td>0.74±0.020a</td>
<td>90.00±4.000a</td>
<td>699.92±156.764ab</td>
</tr>
<tr>
<td>F5</td>
<td>0.74±0.007a</td>
<td>16.60±0.787b</td>
<td>0.42±0.011a</td>
<td>0.72±0.007d</td>
<td>90.00±4.082a</td>
<td>689.18±55.833a</td>
</tr>
</tbody>
</table>

Table 2. Chemical characteristics of rice bran oil mayonnaise with the addition of catfish oil.

Table 3. Sensory of rice bran oil mayonnaise with the addition of catfish oil.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Color</th>
<th>Aroma</th>
<th>Taste</th>
<th>Texture</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>3.56±0.817a</td>
<td>3.03±0.928a</td>
<td>3.13±0.973b</td>
<td>3.73±0.785b</td>
<td>3.40±0.855b</td>
</tr>
<tr>
<td>F2</td>
<td>3.56±0.858a</td>
<td>3.16±0.834a</td>
<td>3.30±0.877b</td>
<td>3.06±1.015b</td>
<td>3.36±0.765b</td>
</tr>
<tr>
<td>F3</td>
<td>3.86±0.681a</td>
<td>3.06±0.907a</td>
<td>3.16±1.117b</td>
<td>3.13±1.074b</td>
<td>3.20±0.997ab</td>
</tr>
<tr>
<td>F4</td>
<td>3.40±0.814a</td>
<td>3.10±0.712a</td>
<td>2.96±0.890ab</td>
<td>2.93±0.980b</td>
<td>3.16±0.648ab</td>
</tr>
<tr>
<td>F5</td>
<td>3.40±0.932a</td>
<td>2.90±0.960a</td>
<td>2.53±1.008b</td>
<td>2.70±1.055b</td>
<td>2.76±0.935a</td>
</tr>
</tbody>
</table>

Values are presented as mean±SD. Values with different superscripts within the same column are statistically significantly different (p<0.05).
is known that the fishy aroma of catfish oil can be covered by rice bran fish oil, so mayonnaise with the addition of catfish oil is not significantly different from mayonnaise without the addition of catfish oil.

Panelists' preferences for the taste of mayonnaise ranged from 2.533-3.300. This value means that the panelist accepts mayonnaise on the color parameter at a neutral level. Mayonnaise has a distinctive taste, such as sweet, salty, and slightly sour (Lioe et al., 2018). Mayonnaise's with the highest catfish oil addition resulted in the lowest panelist acceptance value. It was influenced by the fishy taste and smell of catfish oil. These two parameters cannot be separated where aroma and taste shape food flavor (Miedviedeivo, 2016; Hastarini et al., 2021). The results of this study were in agreement with Kartikasari et al. (2019), who added an egg yolk to mayonnaise, resulting in the acceptance of panelists at a neutral level.

The panelists received mayonnaise on texture parameters with values ranging from 2.700-3.733. This value means that the panelist accepts mayonnaise on the color parameter at a neutral level. However, the results of this analysis are not significantly different for all mayonnaise tested. In general, mayonnaise has a thick, paste-like texture and is creamy, where consumers assess the texture of mayonnaise-based on its ease of breakdown in the mouth (Olsson et al., 2018). However, the mayonnaise with rice bran oil with catfish oil has a slightly denser texture. The results in this study concurred with El-Waseif et al. (2022), who reported that mayonnaise with the addition of flaxseed oil enriched with omega-three fatty acids fish oil produces a mayonnaise color that is not significantly different. The highest overall value was given to panelists on Mayonaise F1 and F2, where panelists received a neutral level.

4. Conclusion

Variations ratio of rice bran oil and catfish oil significantly affect the chemical (phenolic content, water, ash, protein, calorie) characteristics, but not the physical characteristics of mayonnaise (foaming capacity and stability of the resulting mayonnaise foam). Mayonnaise's with the highest catfish oil addition resulted in the lowest panelist acceptance value. It was influenced by the fishy taste and smell of catfish oil. Mayonnaise in the % ratio of RBO:CFO=59.2%:14.8% was the best formula.

Conflict of interest

The authors declare no conflict of interest.

References


Mendapatkan Supplementasi Tepung Purslane (Portulaca oleracea). Jurnal Ilmu Produksi dan Teknologi Hasil Peternakan, 7(2), 81–87. https://doi.org/10.29244/jitphp.7.2.81-87 [In Bahasa Indonesia]


Pangasius st.—).—.–. https://doi.org/10.26656/fr.2017.7(S3).3 © 2023 The Authors. Published by Rynnye Lyan Resources


