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Production of Margarine from Rice Bran Oil and Palm Kernel Oil and Analysis of Physicochemical Properties

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Abstract *- Rice bran oil is a healthy food that contains vitamins, antioxidants, and nutrients needed in the human body and is widely used in food and cosmetics. Rice bran oil in Indonesia has also not been widely utilized as a raw material for food products. Therefore, to change the economic value of rice bran oil can be used as a food product, one of which is margarine. This study aims to determine the optimum conditions for making margarine from rice bran oil and palm kernel oil. The tests carried out in this study were water content, fat content, and emulsion stability tests. In this study, margarine was made with three variables, namely the ratio of rice bran oil and palm kernel oil (80:20; 70:30), stirring time (30 minutes, 40 minutes), and margarine storage time (5 days, 10 days) which will be designed using Factorial Design method. Based on the results, the optimal margarine formula from rice bran oil and palm kernel oil is in the variable stirring time of 37 minutes and 30 seconds, oil ratio of 80:20, and storage time of 5 days. In the optimum sample, the value of fat content was 82.94 ± 0.08%, moisture content was 14.08 ± 0.14%, and emulsion stability was 91.15 ± 0.21%.*

Keywords: *margarine; rice brand oil; palm kernel oil*
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INTRODUCTION

Margarine is a fat-based product that is widely used in food processing. Margarine is commonly used as a spread to give food good texture and flavor. (Srinovia, 2015). According to SNI (2014), margarine is a food product in the form of a solid, semi-solid, or liquid emulsion (w/o), which is made from edible fat and or vegetable edible oil and water or without the addition of other food ingredients and permitted food ingredients.

Margarine consists of several types of vegetable oils and fats through various *oil blends*. The composition of the *oil blend* will determine the solids content and crystal formation in the product, which will affect the product's physical characteristics. (Nugraha, 2014). Determine the oil or fat quality used can observe Physical characteristics. Margarine characteristics are largely controlled by *solid fat content*, *slip melting point (*SMP), consistency, cohesiveness, spreadability, and mouth feel (Scrimgeour & Harwood, 2007).

According to the Ministry of Trade (2017), rice production in Indonesia ranks third in the world after China and India. In rice seeds, a layer of bran is usually used for animal food and is still very limited for industries such as rice bran oil. The abundant availability of this raw material allows it to be developed again in the food industry. Rice bran oil can be converted into a food product such as margarine. Rice bran oil can be consumed and contains vitamins, antioxidants, and nutrients needed by the human body. Rice bran oil consists of 33% polyunsaturated fat (containing essential fatty acids), 20% saturated fat, and 47% monounsaturated fat (Suryati et al., 2015).

Therefore, rice bran oil, as one of the utilization of rice bran waste, can be processed into food products that are proven to be healthier. Margarine, in terms of health, has advantages over butter. The butter itself is made from animal milk fat, and animal milk has high

cholesterol (Winarni, 2018). Meanwhile, margarine is made from vegetable or plant fat (rice bran oil) which does not contain high cholesterol. Therefore, margarine is safe for consumption by the community and can meet the nutritional needs of the Indonesian people.

Based on the description above, this study analyzed the physicochemical properties of margarine made by mixing rice bran oil with palm kernel oil by treating the length of stirring, the ratio of oil used, and the length of product storage. The choice of using rice bran oil and palm kernel oil is because rice bran oil is rarely used as a raw material for processed food. This research was conducted to see the effect of the oil mixing ratio treated with variations in stirring duration and storage duration on the quality of margarine.

METHODOLOGY

Materials and Tools

The tools used in this research are a food processor (Philips), electric heater (Oxone), thermometer, basin, porcelain cup, test tube (Herma), centrifuge (80-2), plastic, rubber, ruler, beaker (Pyrex), oven (UN 110), magnetic stirrer (Heidolph), digital balance (Pioneer), dropper pipette and desiccator. The materials used were rice bran oil (Oryza Grace), palm kernel oil (bumi rahayu in metro lampung), lecithin, water, salt, skim milk, margarine flavor, βcarotene, and H2SO4.

Research Design

This study uses a research design with factorial design 23 with eight runs with independent variables of stirring time, storage time, and the ratio of rice bran oil and palm kernel oil, as seen in Table 1. The fixed variables in this study are lecithin, water, salt, skim milk powder, margarine flavor, and β-carotene. The dependent variables were fat content, moisture content, and emulsion stability test of margarine products.

Table 1. Margarine research design

NO	Variable			Interaction			
	T	P	R	TP	TR	PR	TPR
1	-	-	-	+	+	+	-
2	+	-	-	-	-	+	+
3	+	+	-	+	-	-	-
4	+	+	+	+	+	+	+
5	-	-	+	+	-	-	+
6	-	+	+	-	-	+	-
7	-	+	-	-	+	-	+
8	+	-	+	-	+	+	-

* Stirring time (T) = (-) 30 minutes and (+) 40 minutes; storage time (S) = (-) 5 days and (+) 10 days; rice bran oil : palm kernel oil ratio (R) = (-) 70:30 and (+) 80:20.

Margarine Production

At this stage, the first is mixing the fat phase, including the rice bran oil and *palm kernel oil* ratio, then adding lecithin, β-carotene, and margarine flavor. Then stir until dissolved at a temperature of 80° C. Mix the water phase, namely water, skim milk powder, and NaCl, stirring until dissolved. Then mix the fat and water phases and stir using a food processor with a predetermined time variable of 30 minutes and 40 minutes. Then margarine is covered with a plastic clip. Then store the margarine samples at a temperature of 4° C according to the variables, namely five and ten days. It was then can test for fat content, moisture content, and emulsion stability test.

RESULTS AND DISCUSSION

This study used *factorial design* experiment design 2^3 with different operating conditions, namely mixing time (T), storage time (S), and oil ratio (R). This study focused on conducting a physicochemical analysis of margarine products from rice bran and palm kernel oil. To determine the influential variables in this study can be identified by factorial design analysis using the quicker method to calculate the main effect and interaction effect on the emulsion stability test.

Table 3. Main effect Calculation Result

Effect	Emulsion Stability
Stirring Time	35,42
Storage Duration	-5,63
Oil Ratio	-2,08
Length of Stirring * Length of Storage	-7,71
Storage Duration * Oil Ratio	7,92
Stirrting time * Oil Ratio	17,5
Stirring time * Storage Time * Oil Ratio	3,13

The stirring time can determine the main effect of emulsion stability, and the most influential interaction effect is the stirring time and oil ratio.

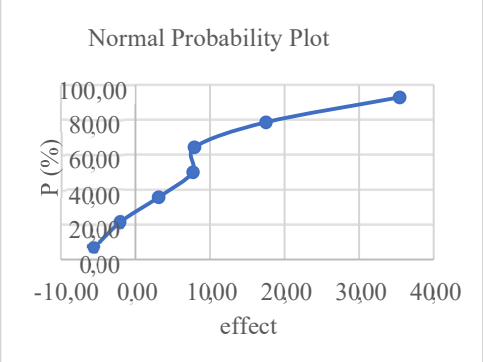

Figure 1. Normal Probability Plot 2^3

The normal probability plot graph between the P value and the effect obtained by the regression value (R2) is 0.8715, which means that the regression equation can represent 87.15% of the total variation in the model.

$$y = 2{,}0862x + 30{,}938 \quad (1)$$

So the emulsion stability test is the primary influential variable.

Optimization of Margarine

Optimization of the main effect study, where the variable of stirring time (T) is changed while the storage time (S) and oil ratio (R) are fixed.

The results of the emulsion stabilization test on rice bran oil margarine and palm kernel oil have an optimization value, namely with a stirring time of 37 minutes 30 seconds, an oil ratio variable of 80:20, and a storage time of 5 days. The optimization result of the emulsion stabilization test is 91.15 ± 0.21%. Where the length of stirring will affect the value of emulsion stability produced, the longer the stirring time, the value of emulsion stability will also be directly proportional.

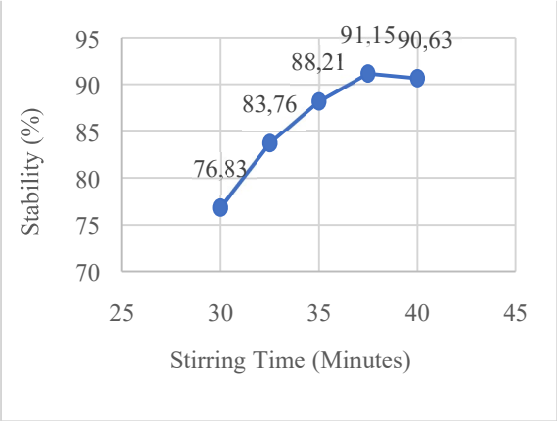

Figure 2. Margarine Optimization Chart

Analysis Result of Margarine

In this study, after optimization, the margarine samples were tested. The tests carried out were a fat content test, water content test, and emulsion stability test. The analysis optimization results of this margarine can be seen in Table 4.

Table 4. Margarine Analysis Results

Test Name	Value
Fat Content (%)	82,94 ± 0,08
Water Content (%)	14,08 ± 0,14
Stability test (%)	91,15 ± 0,21

Fat Content Test

According to Rusalim et al. (2017), The fat content test was carried out by putting a 2-gram margarine sample in a cuvette, then adding 2 ml H_2SO4. Then centrifuge for 15 minutes; after that, add 3 ml of heated distilled water. Then centrifuge again for 5 minutes. Then measure the volume of separated oil.

The fat content results obtained in this study were 82.94 ± 0.08% which can be seen in Table 4. The fat content of this product meets the standards of SNI 3541:2014, which is the required fat content of at least 80% (w/b). Margarine is a semi-solid fat product that is an emulsion of the *water in oil* (w/o) type, namely the water phase is in the oil phase, with the requirement that it contains no less than 80% fat. The rest is water and additives in the form of emulsifiers, preservatives, fragrances, colors, antioxidants, and vitamins. (Winarno, 1997). This high-fat content is obtained from the raw materials used, primarily fats and oils, where more than 80% of the raw materials are fats and oils; the rest are water and water-soluble materials.

Sarungallo et al. (2002) obtained a fat content value of 67.5% in the study. In the study of Philip Ityotagher & Terhile (2020), 57.66%, compared to the optimization results, occurs because the stirring process when making margarine is too fast, so the ingredients have not mixed perfectly. The raw materials from the manufacture of margarine influence it. Where in the research by Sarungallo et al. (2002) and Philip Ityotagher & Terhile (2020), the stirring process was carried out for 10 minutes. The research from Putra & Salihat (2021) did not experience a significant difference from the optimization results that had been done. Namely, 84.74% and the research of Todingbua et al. (2017) obtained fat content of 81.34%, where the stirring process of this study took 20 minutes.

Moisture Content Test

Moisture content analysis is one of the most essential chemical laboratory test methods in the food industry to determine the quality and resistance of food to damage.

In this study, the results of the optimization of the water content test obtained were 14.08 ± 0.14%. Where these results meet the standards of SNI 3541: 2014, which is the maximum qualified water content of 18%. Water is an important component in food ingredients because the water content in food ingredients determines the freshness and durability of the food ingredients. The presence of water in food can cause fat oxidation. Therefore, it is necessary to analyze the water content. According to SNI 3541:2014, the analysis of moisture content in margarine samples is carried out by the drying method. The principle of this method is to dry the sample at 103-105º C for 20-30 minutes. According to Fardiaz (1996), the value of water content in foodstuffs also determines the material's durability. The limit of moisture content microbes can not grow 14-15%.

In the study of Sarungallo et al. (2002), which showed different fat content values, namely in samples that showed a moisture content value of 30.07% compared to the optimization results, it occurred due to the long stirring time and formulation in the manufacture of margarine where the research used 50% water in the margarine making process. In the research, Philip Ityotagher & Terhile (2020) used a variable length of stirring time of 10 minutes in the margarine-making process. However, his research

used a formulation of adding 16% water, resulting in a water content value of 9.83%. Meanwhile, in the research Putra & Salihat (2021) and Todingbua et al. (2017) did not experience a significant difference, namely 14.86% and 15.54%. It is because the formulation of the margarine-making process uses about 14-16% water from the total ingredients used.

Emulsion Stability Test

The margarine produced in this study has reasonably good emulsion stability, whereas this applied research uses lecithin-type emulsifiers that can maintain emulsions. In this applied research, the emulsion stability value is 91.15 ± 0.21%, while commercial margarine has a stability value of 83.6%. According to Putra & Salihat (2021), margarine that can be categorized as good enough is margarine, which has a stability value of more than 85%. Therefore, the margarine from this study has a reasonably good emulsion stability value, where a suitable emulsion will not change color during standing.

The study by Sarungallo et al. (2002) showed a value of emulsion stability of 78.67%. It happened because of the long stirring time and formulation in making margarine. In his research, he used 50% water and 50% oil raw materials, and the stirring process was carried out for 10 minutes to make margarine. In the research, Philip Ityotagher & Terhile (2020)used the same variable, namely the length of time for stirring 10 minutes in the margarine-making process. However, his research used a formulation of adding 16% water and 81.7% oil raw material, resulting in an emulsion stability value of 85.23%. In the research Putra & Salihat (2021) and Todingbua et al. (2017) did not experience significant differences, namely 96.27% and 98.8%. It is due to the formulation of the margarine-making process using about 14-16% water. In comparison, the oil raw material is about 80% of the total ingredients used, as well as the length of stirring carried out, which is 20 minutes.

The stability of the emulsion between oil and water does not depend on the type of oil or fat used but is influenced by the quality of the emulsifier used and the process of making the margarine. Emulsion stability can be caused by many things, including the inappropriate ratio between oil and water phases, wrong amount and selection of emulsifiers, freezing, and inappropriate or suitable mixing time and speed. Based on Stokes' law, emulsion stability will increase if the particle size is reduced by using a homogenizer or mixer. One of the factors of emulsion stability is the length of stirring time, and the emulsifier used. According to Oyutri et al. (2022), due to the contact between the oil and water phases caused by the stirring process, a high homogeneity value is obtained. Lecithin is an excellent emulsifying agent, whereas lecithin has two ends with hydrophobic properties that are soluble in oil and hydrophilic, soluble in water. Lecithin can also help stabilize the oil and water phases.

CONCLUSION

This study used the factorial design method. The results showed that the process variable that greatly influenced the optimization of margarine production was the variable stirring time (T), with an influence value of 35.42. The process of optimizing the emulsion stability test is with the operating conditions of 37 minutes 30 seconds stirring time, with a storage time of 5 days, and the oil ratio used is 80:20. Thus, the optimization results obtained emulsion stability test value of 91.15 ± 0.21%, fat content value of 82.94 ± 0.08%, and moisture content value of 14.08 ± 0.14%.

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