Evaluation of Physicochemical and Organoleptic Properties of Kimpul Cookies with Fat Sources from Corn Oil, Coconut Oil, and VCO

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Abstract. In general, cookies are wheat flour-based products that are still imported from abroad. Kimpul tubers (*Xanthosoma sagittifolium*) is one of the tubers, which contains a lot of carbohydrates, vitamin C, thiamin, riboflavin, iron, phosphorus, zinc, niacin, potassium, copper, manganese and fiber which are very beneficial for health. The carbohydrate content contained in kimpul to be used as a substitute for wheat flour. In this study, innovation was carried out in the form of replacing margarine with types of oil that contain rich essential oil. The process of making margarine mostly uses the hydrogenation process, which converts unsaturated fatty acids into saturated fatty acids. Therefore margarine needs to be replaced with other sources of fat. This food oil is beneficial for the health of the body. The purpose of this study was to obtain kimpul cookies with right functional, physicochemical and sensory characteristics. This study used factor I was egg concentration including 20%, 30%, and 40% (b/b) and factor II was the type of oil (40% v/b), namely corn oil, coconut oil, and VCO. The optimal results of physicochemical, functional and sensory characteristics in the treatment of kimpul cookies with 40% egg concentration and the use of 40% (v/b) VCO oil with a yield of 67.41%, 5.72% moisture content, 3.06% ash content, protein content 5.85%, fat content 19.32%, carbohydrate 66.03% (by difference), crude fiber 2.74%, dietary fiber 3.78%, 461.4 calories (empirically) and breakability 22.10 N, color 3.55 (like), taste 3.90 (like), texture 4.00 (like), aroma 3.70 (like).

Keywords: Cookies, Kimpul Flour, Corn Oil, Coconut Oil, VCO.

1 Introduction

In Indonesia, cookies popular as snack with good taste and crunchy texture that have low moisture content, allowing for long storage. The raw materials involve wheat flour, sugar, fat, and other optional ingredients such as milk and salt, with a baking process. In general, wheat flour is derived from wheat which is difficult to grow [1]. Reducing wheat flour dependency can be started by utilizing local sources, such as kimpul tubers, as a substitute for wheat flour up to 100%.

Kimpul is one source of local food that can be used as an alternative to meet food needs [20]. The use of kimpul flour in processing various cakes can reach 100%,

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depending on the product to be produced [21,22]. Kimpul (*Xanthosoma sagittifolium)* has high carbohydrates (28.66 grams) compared to purple sweet potato (20.1 grams), making it an alternative non-gluten carbohydrate source [2]. Fat in cookies affects texture and aroma, with excessive addition making cookies soft, while a little makes them hard. Margarine, often used as a fat source, involves a hydrogenation process that produces harmful trans fats. Vegetable oils such as corn oil, coconut, and VCO (Virgin Coconut Oil) can be a benefit-rich alternative, with phytosterols in corn oil helping cholesterol absorption, while coconut and VCO have many health benefits.

The eggs in cookies are high in fat and protein. Egg whites form a foam to develop the dough, while egg yolks provide nutrients, flavor, and color to the cookies. Previous studies [3] showed the potential of kimpul flour in bread, with the best results at a concentration of 30% wheat flour and 70% kimpul flour. This study aims to evaluate the effect of egg concentration and the use of corn oil, coconut oil, and VCO on the physicochemical and organoleptic properties of kimpul cookies.

2. Materials and Methods

Materials used in this study include kimpul tubers (*X. sagittifolium*) obtained from the Waru market, Sidoarjo, fat (corn oil, coconut oil, virgin coconut oil from supermarkets; powdered sugar, skim milk, eggs, developer materials. Materials for chemical analysis were distilled water, 10% Potassium Permanganate solution, 10% Potassium Sulfate solution, Sodium Hydroxide solution, Sulfuric Acid solution, 95% alcohol, Hydrochloric Acid, methylene blue, Sodium Hydroxide-Sodium thiosulfate solution.

The tools used for making cookies are mixer, scales, wooden roller, cookie mold, oven, spoon, gas stove, steamer. The analysis equipment are cabinet dryer, oven (memert UN 55 53L), kjeldahl flask, analytical balance, desiccator, electric stove, muffle furnace (F348020), pH meter, water bath, and glassware.

2.1 Preparation of Kimpul Flour

Kimpul tubers as much as 7000 g through the process of washing with running water until clean from the soil and roots and the peeling process is carried out. Cleaned kimpul tubers are blanching for 15 minutes, then thinly sliced and soaked in 7.5% salt water for 30 minutes. The kimpul tubers were washed and dried at 60°C for 12-16 h. The dried kimpul tubers were ground and sieved with an 80 mesh sieve. Kimpul flour was then analyzed including yield, moisture content, ash content, protein content, fat content and carbohydrate content.

2.2 Cookies Making

The preparation stage starts from weighing the ingredients, including Kimpul flour with the addition of 3 types of oil: B1: coconut oil; B2: corn oil; B3: virgin coconut oil that the eggs (20 g, 30 g, 40 g). The other ingredients that were also weighed included salt 1 g, sugar 45 g, baking powder 1 g, skim milk 5 g. The prepared dough (sugar, oil, eggs, baking powder, skim milk) was mixed until homogeneous. Then kimpul flour and tapioca flour are added and stirred until homogeneous using a spatula or by hand. The dough that has been homogenized was molded with a

according to the treatment. The baking was done for 25 minutes at 125°C. Cookies that have been cooked, removed from the oven and cooled to room temperature. The finished product was then analyzed for water content, crude fiber content, starch content, yield, breakability test and organoleptic test. As well as the best treatment in the form of food fiber, carbohydrates by difference and empirical calories.

2.3 Data Analysis

This study used a completely randomized design (CRD) using a factorial pattern with 2 factors and two replicates. The data obtained were analyzed using analysis of variance (ANOVA), if there were significant differences between treatments then continued with Duncan Multiple Range Test (DMRT) at the 5% level.

3. Results and Discussion

3.1 Raw Material Analysis

Based on the results of the research that has been done, the yield of Kimpul flour produced is 25.25%. This several factors such as harvest age, place of growth, type of Kimpul and production process causes differences with previous research. The yield of tuber flour is influenced by several factors such as variety, place of growth, temperature and drying process time [4]. The difference in yield value is thought to be the difference in the process and raw materials that affect the yield factor. The resulting kimpul flour was subjected to raw material analysis and the results can be seen in Table 1.

Table 1. Results of raw material analysis of Kimpul flour

Parameters	Kimpul flour	
	Analysis (%)	Literature [2](%)
Yield	25.25 ± 0,65	20.76
Ash	2.04 ± 0,31	1.76
Water	9.90 ± 1,46	7.69
Fat	0.56 ± 0,03	0.18
Protein	5.72 ± 0,34	6.69
Carbohydrate (by difference)	81.76 ± 2,11	83.68

The ash content of the analyzed kimpul showed a result of 2.04%, which is not very different from the literature. The mineral content influences the ash content in the kimpul. According to [5], the high ash content in food is influenced by mineral content. The high ash content is thought to be due to differences in the growing location or habitat of the kimpul.

Similarly, there is a difference in moisture content in kimpul flour with a value of 9.87% and different from the literature with a value of 7.69%. The amount of water content in flour products is thought to be in addition to the type of kimpul and growing habitat, cutting size also affects the evaporation process. The size reduction process is carried out to determine the desired shape and facilitate the heating process [6].

The resulting protein content is also different from the literature. The results showed that the protein content in kimpul flour was 5.72% while according to [2]

The highest ash content was achieved in the 40% egg concentration treatment with an average of 2.99%, while the lowest ash content was recorded in the 20% egg concentration with an average of 2.647%. Ash content in raw materials, such as kimpul flour (2.04%) and eggs (1.13%) [10], also has an impact on the total ash content in cookies. The 20% egg concentration produced the lowest ash content, which was 2.657%, while at 40% concentration there was an increase to an average of 2.99%. This difference may be due to variations in egg concentration, where the addition of eggs with higher concentrations produces greater ash content, because eggs contain minerals, especially calcium.

The egg white has a calcium mineral content of about 147 ppm, while egg yolk is only 6 ppm [11]. The addition of other ingredients such as skim milk, salt, and baking powder can also contribute to the increase of minerals in the product. The determination of ash content aims to determine the amount of minerals in the product, which function as building and regulating substances in the body. Minerals, such as calcium and phosphorus, have important roles in the formation of bones, teeth, energy storage, and regulation of biological processes.

Fat Content. Based on the results of the analysis of variance, it can be seen that there is no interaction ($p \geq 0.05$) between the addition of egg concentration with different types of oil. Egg concentration has a significant effect on the fat content of cookies, and the type of oil treatment has a significant effect on the product. The average value of fat content of cookies with the effect of egg concentration and type of oil is shown in Table 2.

Based on Table 2, the increase in fat content occurred as the egg concentration in the cookies increased. The lowest fat content (18.33%) occurred at 20% egg concentration, while the highest fat content (19.20%) occurred at 40% egg concentration. Eggs, especially egg yolks, are known as a source of high protein with varying fat content.

Table 2 showed that there was no significant difference in the fat content of the cookies. The highest fat content (18.81%) is associated with the use of VCO oil, while the lowest fat content (18.66%) is associated with coconut oil. Although the difference is not significant, it is likely because the percentage of oil added to the cookies is the same, so it does not significantly affect the increase in fat content.

The fat content of cookies is also influenced by the oil added to the dough. Tests show that the fat content of cookies meets SNI requirements (minimum 9.5%). Fat in food plays a role in improving texture and flavor, as well as adding calories, with 1 gram of fat producing 9 calories compared to 4 calories from carbohydrates and protein. Based on [10], differences in the amount of triglyceride compounds in coconut oil, palm oil, and VCO can affect solubility in the extraction process,

corn oil (11%), which means that VCO and coconut oil have the potential to produce higher yields.

Water Content. Based on the results of the analysis of variance, it can be seen that there is no interaction ($p \geq 0.05$) between the addition of egg concentration with different types of oil. Egg concentration has a significant effect on the moisture content of cookies. The treatment of oil type has a significant effect on the moisture content of the product. The average value of moisture content of cookies with the effect of egg concentration and type of oil is shown in Table 2.

Table 2 showed that the moisture content of cookies varies based on egg concentration, with the highest value at 40% concentration (5.42%) and the lowest at 20% concentration (3.65%). These results indicate a significant effect of egg concentration on the moisture content of cookies, where the addition of more eggs causes an increase in product moisture content. This phenomenon is in accordance [8] research on coconut pulp-based cookies with the addition of egg yolk. The higher water content in eggs (66%) is considered the main cause of the increase in moisture content of cookies, because lecithin in egg yolks acts as a wetting agent that can absorb surrounding water vapor. The increase in moisture content is also caused by egg proteins that bind water, difficult to evaporate during drying, and affect the texture of cookies. In addition, the amylose and amylopectin content in cookie raw materials, such as kimpul with 70.78% starch (81.82% amylopectin and 18.18% amylose), also affects the moisture content through gelatinization reactions. The bonding between starch and protein can alter the exchange of moisture content, reducing the hydrogen bonding between starch molecules and water. This is consistent with the concept that the interaction between starch and protein can affect the moisture content of cookies, with potential influence on the texture and crispness of the final product.

Table 2 showed the variation in the average moisture content of cookies (4.37-4.85%) due to different types of oil. The increase in moisture content was not significant and was attributed to the moisture content of the oils, most of which had 0% moisture content according to [9]. The difference in moisture content values is likely due to the saturated fatty acids in the oils, where VCO and coconut oil with greater saturated fatty acids tend to have higher moisture content than corn oil. The process of inhibiting the evaporation of water by saturated fatty acid molecules may be the cause. Although the moisture content of the product slightly exceeded the SN1 (01-2973-2011) standard of 5% maximum, the different types of raw materials are thought to affect the result.

Ash content. Based on the results of the analysis of variance, it is known that there is no interaction ($p \geq 0.05$) between the addition of egg concentration and different types of oil. Egg concentration gave a significant effect on the ash content of cookies but different types of treatment did not give a significant effect on the product. There was a significant increase in ash content due to variations in egg concentration.

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resulting in different fat content. Corn oil contains more unsaturated fatty acids than coconut oil and VCO. These fatty acids have health benefits, including preventing heart problems and controlling cholesterol levels in the blood. VCO, as a healthy oil, has almost 50% medium chain fatty acids, which are easier to digest and absorb [12].

Protein Content. Based on the results of the analysis of variance, it can be seen that there is no interaction ($p \geq 0.05$) between the addition of egg concentration with different types of oil. Egg concentration has a significant effect on the protein content of cookies but the type of oil treatment does not have a significant effect on the product. The highest protein content of kimpul cookies was obtained in the 40% egg treatment (5.93%), while the lowest level occurred in the 20% egg concentration (4.60%). Egg concentration significantly affects the increase in protein content, considering that eggs themselves contain about 12.76% protein. The baking process causes protein coagulation, especially from the added egg white component, which increases the protein content of the cookies.

Protein from additional ingredients such as skim milk (35.9%) and kimpul flour (5.72%) also contributed to the protein content of the cookies. Although the results [13] standard with a minimum level of 9%, differences in raw materials can affect the final product.

Comparison between VCO and corn oil showed that the average protein content of VCO was higher (5.3%) than corn oil (5.29%). The separation process of VCO using proteolytic enzymes increased protein solubility, while the addition of corn oil, coconut oil, and VCO in the same volume did not show significant differences. However, VCO provided a higher value than corn and coconut oil.

Crude Fiber Content. Egg concentration and oil type did not significantly affect the crude fiber content of cookies. The value of fiber content of cookies in this product ranges from 2.81 - 2.99% and does not show any interaction and significant effect on the product. This is because eggs do not have crude fiber content so that when added it does not have a significant effect on the fiber content of cookies. This is in accordance with the statement [8] where the addition of egg concentration does not have a significant effect on the fiber content of coconut pulp cookies.

The highest crude fiber of cookies in the oil type treatment was obtained from corn oil at 3.01% and the lowest crude fiber value of cookies was obtained in the VCO treatment at 2.86%. The average results of crude fiber oil treatment did not show any significant differences. [14] states that the addition of different oils does not make a difference to crude fiber content. The addition of oil to cookie products has no difference due to the crude fiber content in oil of 0 grams [9].

Breaking Power. Based on the results of the analysis of variance, it is known that there is no interaction ($p \geq 0.05$) between the addition of egg concentration with different types of oil. Egg concentration has a significant effect on the breakability of cookies but the type of oil treatment does not have a significant effect on the product.

The average breakability of cookies ranged from 22.38 - 26.41 N. Analysis of egg concentration showed that increasing egg concentration decreased the breakability value of cookies because it increased the water content, which resulted in decreased

product hardness. Eggs affect the texture of cookies because they act as an emulsifier and trap air during shaking. The process of protein denaturation also affects the ability of cookies to expand and their hardness [15].

There was no significant difference in the breakability of cookies with the use of different types of oil, with mean values ranging from 24.25 - 24.55 N. Oil, unlike margarine, does not have a significant effect on texture because it does not provide plastic properties. Doughs with oil tend to be thicker and denser, which can result in cookies that do not rise when baked [15][16].

Organoleptic Test (Taste, Aroma, Texture). Based on the Friedman test, the average value of the organoleptic test can be seen in Table 11. Table 8 shows that the average value of cookie color ranges from 3.6 to 3.8; the average value of taste is 3.4 to 3.9; the average value of aroma is 3.30 to 3.70; and the average value of texture was 2.80 to 4.00. Color is an attribute that can be seen visually by the eye on the product. The color of cookies can be influenced by the length of the baking process and the raw materials used. The use of eggs in making cookies creates a browning reaction when going through the baking process so that it gives a brown color. The raw material of kimpul flour, which has a brownish color, also contributes to the color of the cookies. Roasting time also affects the color of the cookies. When roasting affects the color of cookies, the longer the roasting the resulting product is getting brown because of non-enzymatic browning, namely caramelization and Maillard.

The addition of different eggs and the type of oil used affects the taste of cookies. Different oils give different flavors to the cookies. for example, cookies with the addition of coconut oil and VCO give a distinctive coconut flavor to the cookies. The kimpul flour has a distinctive flavor so that it provides its own flavor assessment on cookies.

[14] states that the cause of the increase in the good taste of a food product is determined by the amount of protein and fat in the product. This statement is supported by [17] that the protein content of food ingredients has a high correlation with consumer assessment, especially in terms of taste. In addition, skim milk also gives a distinctive milk flavor to the bran cookies so that the panelists like it and the addition of salt gives a salty taste to the cookies. [18] that the function of skim milk in making cookies is to add nutritional value, the taste and aroma of skim milk provides a taste that is favored by panelists. In addition, the same opinion is also supported by [19], that salt (sodium chloride) is an acid-base substance used in food as a salty flavor giver.

Table 3. Average value of organoleptic test Kimpul Cookies

Egg concentration (%)	Oil type	color	flavor	aroma	texture
20	Corn oil	3.80	3.95	3.55	3.25
	Coconut oil	3.75	3.85	3.50	3.75
	VCO	3.65	3.85	3.50	3.30
30	Corn oil	3,65	3.45	3.30	2.80
	Coconut oil	3.65	3.70	3.65	3.50
	VCO	3.75	3.60	3.30	3.05

	Corn oil	3.70	3.80	3.70	3.60
40	Coconut oil	3.60	3.70	3.60	3.95
	VCO	3.55	3.90	3.70	4.00

Notes: the higher the average value, the more favorable it is

Kimpul flour has a languorous aroma so that when VCO oil or coconut oil is added, it can cover the languorous aroma of kimpul flour so that the aroma of VCO is preferred by panelists compared to other types of oil. The aroma produced in kimpul cookies is influenced by the raw materials used. Skim milk and vanilla increase the aroma of cookies so that they are more flavorful. The use of oils such as VCO can provide a distinctive aroma like coconut in cookies.

The effect of using oil in cookies differs from fat in terms of development. The decrease in development volume can be caused by the lack of liquid in the cookie dough [12]. The results of [15] show that the use of 100% VCO produces cookies that are drier and harder than margarine, due to the low water content in VCO dough. The texture of non-gluten cookies is not as good as cookies with gluten, because the interaction of water and gluten forms a network that supports development during baking.

Cookies were analyzed by the De-Garmo method to get the best treatment, and the results were cookies with a proportion of eggs of 40% with VCO oil as the best treatment. Then the analysis of food fiber, carbohydrates by difference and caloric value was carried out. Kimpul flour cookies with 40% egg concentration and VCO oil have 67.62% carbohydrates, not achieving the minimum standard of 70% (SNI 01-2973-2011). Carbohydrates act as a source of energy and help characterize food ingredients. This product produced 3.78% total dietary fiber, lower than cookies with modified kimpul flour and tapioca flour 70:30 with margarine (6.45%). Analysis showed that the calories of kimpul flour cookies with 40% egg and VCO amounted to 461.4 kcal, almost the same as the literature value (460.2 kcal). The energy value comes from protein, fat, and carbohydrate, with fat as the largest source of energy. This product meets the minimum standard of 400 kcal in 100 grams of ingredients (SNI 01-2973-2011). Carbohydrates also play a role in preventing excessive breakdown of body proteins, mineral loss and help in fat and mineral metabolism [19].

4. Conclusion

The treatment of egg concentration had a significant effect on yield, moisture content, ash content, fat content, protein content, breakability of Kimpul cookies, while the treatment of oil type had a significant effect on yield, moisture content and fat content of Kimpul cookies. The two factors did not interact on all test factors. The optimal treatment results based on chemical, physical and organoleptic parameters are kimpul cookies with 40% egg concentration and VCO oil type obtained yields of 67.41%, moisture content 5.72%, ash 3.06%, protein 5.85%, fat 19.32%, crude fiber 2.74% and breakability 22.10 N, color 3.55 (like), taste 3.90 (like), texture 4.00 (like), and aroma 3.70 (like).

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