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The Effect of Porang Flour (Amorphophallus Muelleri) as A Fat Replacer on the Acceptability and Characteristics of Cookies

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Abstract: Porang (Amorphophallus muelleri) is a tuber plant that contains a lot of glucomannan fiber. Glucomannan is a soluble fiber that can form a gel that mimics the characteristics of fat so that it has the potential to be used as a fat replacer in high-fat products such as cookies. The purpose of this study was to determine the effect of using fat replacer on the sensory acceptability and characteristics of cookies. The steps carried out in this study were to determine the concentration of porang flour in fat replacer (5 and 7.5%). Fat replacer with firmness that is closest to margarine at a concentration of 5%. Furthermore, cookies were made with fat replacer substitution (25, 50, and 75%). The cookies were then tested for their organoleptic properties using the hedonic method on the parameters of color, aroma, taste and texture. The best cookie formulation was obtained at 25% substitution, which was then compared with the control formulation by testing the parameters of proximate, crude fiber, texture, and oxalate content. The results showed that cookies with fat replacer had lower levels of ash, fat, protein, calories, and hardness than the control, although the difference in fiber and protein content was not significant.

Keywords: Cookies; Fat; Porang; Replacers; Substitutions

Introduction

Porang (Amorphophallus muelleri) is a root crop known for its high glucomannan fiber content. Porang belongs to the Araceae family, which is a plant that is able to live in various conditions and types of soil and is an intercropping plant in forest plants that do not have to get direct sunlight so that it is suitable to be managed with an agroforestry system (Miccolis et al., 2019).The thing that makes this plant has a fairly high economic value is because the tuber has a relatively large glucomannan content with a range between 5% -65% varies depending on the species (Acemi et al., 2019).

In addition to glucomannan, porang plants are also high in calcium oxalate crystals and alkaloids. Porang tuber flour can be used as a thickening agent and as well as the basic raw materials for making healthy foods such as noodles and shirataki rice as well as a thickener for syrup, jelly, sausage binder and edible film (Nehra et al., 2023).

Porang flour is a porang tube that is processed starting from drying to crushing. If processed into porang flour, porang tubers have a relatively longer shelf life (Rahmia et al., 2023). So that the innovation of porang flour began to be developed in the food industry, in order to captivate consumers by using it for a variety of foods. This plant has been widely cultivated in Indonesia, with a total production reaching 142,000 tons from a land of 19,950 Ha in 2020 and many are processed into porang flour or glucomannan flour (Dermoredjo et al., 2021). Glucomannan in porang has many benefits for digestive health and is commonly processed into noodles and rice substitutes in Japan (Fu et al., 2020).

Glucomannan is a water soluble fiber that can be used as a functional food. In addition, the nature of glucomannan as a soluble fiber (soluble fiber) that can form a gel makes people potentially used as a fat substitute (fat replacer) (Sołowiej et al., 2022).

Fat replacer is an ingredient or compound that can be used to replace all or some of the functions of fat with

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fewer calories than real fat (Witkamp, 2018). Fat mimetics or what can be called fat imitation is a fat replacer made of protein or carbohydrate type compounds that are used to mimic the properties of fat produced in food, but cannot be used to completely replace fat (Mirzanajafi-Zanjani et al., 2019). Complex carbohydrates such as glucomannan can bind water to form a paste or gel that mimics the texture and viscosity of fat in food products so that it can be a good fat replacer (Martins et al., 2018).

There have been several studies that utilize porang as a fat replacer, such as in mayonnaise and ice cream products (Herlina, 2019). Meanwhile, no research has been found to test the use of porang flour as a fat replacer in pastry products such as cookies (Anggraeni et al., 2023). However, the results of Colla et al. (2015) showed that inulin fiber can replace fat in Crackers products by as much as 75% without giving significant changes in consumer acceptance, although it still affects the texture and physical properties of the product (Bender et al., 2020).Therefore, this study aims to determine the effect of the use of porang flour as a fat replacer on the acceptability and characteristics of cookie products (Delicato et al., 2020).

Method

This study uses quantitative methods that are methods used if you want to try to make precise and accurate measurements of a thing. Simply put, this research method will translate data into numbers so that analysis can be done based on research that has already been done. The focus of research in quantitative methods includes elaboration, explanation and estimation. And for research purposes of this method, namely, to explain or predict, as well as develop and test existing theories.

Result and Discussion

Cookies Making Materials

The main ingredient is the material for making cookies, consisting of wheat flour, porang flour, margarine, refined sugar, brown sugar, eggs, milk powder, baking soda, water and vanilla powder (Lucky et al., 2020).

Organoleptic Test

Consumer acceptability was determined through organoleptic test of hedonic method using 25 semi-trained panelists. Panelists rated the level of preference for cookie products on the parameters of color, aroma, taste and texture using a scale from 1 (do not like) to 5 (very like). One treatment with the highest preference value was selected to compare its physical and chemical characteristics with control cookies (without fat replacer) (Azmoon et al., 2021).

Characteristic Analysis of Cookies

Characteristic analysis of cookies includes proximate test, oxalate levels, and texture test. Proximate assays include moisture content using moisture analyzer, ash content using kiln dry method, fat content using soxhlet method with chloroform solvent, crude protein content using kjedahl method, carbohydrate content using "by difference" calculation method, crude fiber content through gravimetric method, calorie content using calorie calculation of carbohydrate, protein, and fat content. Test rate oxalate titration is performed by permanganate titration. The texture test was performed on hardness parameters using a penetrometer (Wang et al., 2020).

Research Design

The study design used was a complete randomized design (RAL) with fat replacer substitution treatment. Statistical analysis was carried out with SPSS, to determine the difference between treatments, the results of organoleptic testing were analyzed using the Analysis of Variance (ANOVA) method and followed by the DMRT test. Meanwhile, for the characteristic test results in the analysis using the method of Independent Sample T-Test (Zhang et al., 2023).

Determination of Porang flour concentration in Fat Replacer

The selection of porang flour concentration on fat replacer is determined from the concentration of gel that has a texture consistency that most resembles fat. Tests were conducted on porang gel at a concentration of 5 and 7.5% and compared with margarine (room temperature) on the parameters of firmness (elasticity) using a texture analyzer (TA.XT Plus) (Lis et al., 2021).

Making Cookies

Making cookies is done by mixing flour, milk powder, baking soda and vanilla powder. In a separate container, creaming is done using a low speed mixer for 5 minutes on margarine, porang fat replacer, and sugar. Table 1 shows the formulations used in the manufacture of cookies. Ingredients that have gone through creaming are then added dry ingredients and then slowly mixed (Baghel et al., 2020). The dough is then put in a piping bag and formed on a baking sheet with a dose of 20-25g/cookies, then baked in the oven (Kirin) at a temperature of 190^0C for 10 minutes. Cookies are then allowed to stand until Not Hot before being packaged (Hongho et al., 2023).

Table 1. Cookies Making Formulation

Material	Ingredient Amount (g)							
	Control	S1	S2	S3				
	(g)	(%)	(g)	(%)	(g)	(%)	(g)	(%)
Wheat	210	33.8	210	33.8	210	33.8	210	33.8
Fat replacer porang*	0	0	35	5.63	70	11.3	105	16.9
Margarine	140	22.6	105	16.9	70	11.3	35	5.63
Fine granulated sugar	200	32.3	200	32.3	200	32.3	200	32.3
Egg	70	11.6	70	11.6	70	11.6	70	11.6
Baking soda	0.5	0.08	0.5	0.08	0.5	0.08	0.5	0.08
Vanilla flavor	1	0.16	1	0.16	1	0.16	1	0.16
Total		100		100		100		100

Porang Flour Concentration Test on Fat Replacer

Testing the elasticity of porang flour gel concentrations of 5 and 7.5% showed significantly different results, but not significant when compared with margarine (DMRT ③ =5%) after analysis. The results showed that the gel with a concentration of 5% had assignificantly lower consistency than the concentration of 7.5%. However, because the difference is not significant to the concentration of margarine then 5% is selected in the manufacture of fat replacer.

Table 2. Porang Gel Hardness Test Results

Treatment	Firmness
Margarine Control	22.67ab
Porang Gel 5%	21.12a
Porang Gel 7.5%	24.93b

Organoleptic Test Results

The use of fat replacer porang gives a significant effect (③<0.05) on all organoleptic parameters in the test including color, aroma, taste, and texture as well as the average value. Further test results showed that on color parameters only 75% Substitution difffers markedly (Yashini et al., 2021). On the parameters of aroma, taste, and mean, the results of control and substitution of 25% did not differ significantly, but were significantly different from other treatments. Meanwhile, on the texture parameter, the substitution of 25 and 50% is not significantly different, but significantly different from other treatments. The results showed that the 25% substitution treatment was the best treatment of all cookies with substitution fat replacer (Spohn et al., 2018).

Significant differences between treatments occur due to the reduction of fat content and the addition of water in the manufacture of cookies. Fat content in food affects the perception of taste, where foods with higher fat content will extend the duration of the aftertaste of the flavor of the food consumed (Rahmawati et al., 2021). This causes panelists to feel the flavor of cookies longer resulting in a better perception of cookies with less fat. Flavor is influenced by fat replacer because the interaction between flavor compounds with fats that are hydrophobic is different from the reaction to hydrophilic compounds made from protein and carbohydrates (Ateş et al., 2018). In addition, the additional water content of fat replacer causes changes in the texture characteristics of cookies (Schefer et al., 2021). During the process of making cookies, water from fat replacer can bind the flour to form gluten (Nazari et al., 2023). The presence of gluten causes the texture of the cookies to turn out to be harder and rubbery than it should be more crispy (Yang et al., 2022).

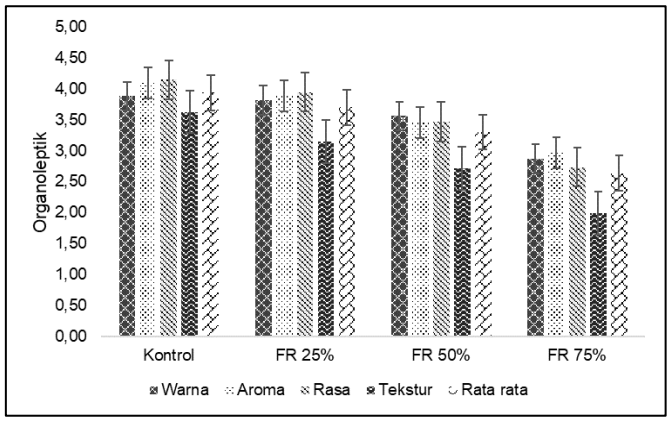

Figure 1. Graph of cookies organoleptic test results

Characteristic Analysis of Cookies

Substitution margarine with fat replacer porang significant influence on most of the physical and chemical characteristics of cookies. Analysis of the proximate test showed a significant difference to the parameters of water, ash, fat, carbohydrates, and calories cookies, and not significant to the parameters of protein and fiber. Cookies water content has significantly increased due to the water content contained in the fat replacer. In addition, the water-binding properties of glucomannan make evaporation difficult so that some of the water remains bound in the cookies. The reduced fat content is also due to fat substitution which reaches 25% so that the changes that occur are also significant.

Ash content in cookies higher control due to the addition of salt in margarine. Salt is an inorganic compound so it is not lost during the ashing process.

Protein levels do not change significantly because there is no protein content in margarine or fat replacer, so that the substitution does not affect much. Carbohydrate content in cookies substitution is higher because of the reduction of fat content and the addition of fiber from fat replacer so that the proximate component of cookies changed. Similarly, changes in the number of calories cookies caused due to the reduction of fat. Fat has a calorie count of 9 per gram, in contrast to carbohydrates and proteins which only contribute 4 calories. This led to a significant reduction in calories in cookies with fat replacer.

Fiber levels in the cookies experience the addition but no real effect. This is because the concentration of porang flour used is not enough to give a significant change.

Table 3. Proximate Test Results and Calorie Cookies

Treatment	Water (%)	Ash (%)	Fat (%)	Proteins (%)	Carbs (%)	Fiber (%)	Calories/30g (cal)
Control	5.97	1.62	23.04	6.66	62.71	1.97	143.10
FR 25%	8.4	1.48	19.06	6.20	64.86	2.27	134.02

The use of porang fat replacer also gives a real effect on the texture of cookies but no real effect on oxalate levels. The water content in the substitution cookies is higher, causing the cookies to have a softer texture than the control cookies. Meanwhile, oxalate levels have no real effect because the use of porang flour on fat replacer slightly plus oxalate levels in porang flour has been reduced during the flour making process so as not to give a significant change.

Table 4. Oxalate Test Results and Texture Cookies

Sample	Oxalate (mg/100g)	Texture
Control	0.01	3.67
FR 25%	0.015	2.70

Conclusion

The substitution of margarine fat from cookies using fat replacer porang gives a real influence on the acceptability and characteristics of cookies. Significant changes to the fat content of cookies but still able to maintain the preference of panelists for the product shows the potential for further development of porang flour fat replacer, especially in high-fat products and low moisture content such as cookies.

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