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The Effect of Beneng Taro Flour (*Xanthosoma undipes* K. Koch) and Rice Bran (*Oryza sativa* L.) Substitution on the Physical and Sensory Characteristics of Bread

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ABSTRACT

Beneng taro is an indigenous tuber from Banten which is rich of functional components such as dietary fiber and carotenoid pigments. So far, processing of beneng taro has not been developed. One of method to process it is to make into flour. Another material that is not utilized is rice bran. Rice bran is a by-product of rice milling which has only been used as animal feed, but the majority of functional components in rice accumulate in rice bran such as dietary fiber, oryzanol, and phytosterol compounds. The application of beneng taro flour and rice bran for food products can increase food diversification, beside of that it can reduce the use of wheat flour. The purpose of this study was to evaluate the effect of adding beneng taro flour and rice bran to bread on the physical and sensory characteristics. This study used a completely randomized design (CRD) with one factor, namely the ratio of wheat flour: beneng taro flour: rice bran (control, 65:30:5; 65:25:10; 65:20:15). This research was carried out in two repetitions. The result of this research were the increase of rice bran and the decrease of beneng taro flour substitution in bread decrease the expansion ratio, lightness (L*) of the crust and crumb, a* chromaticity of the crust, b* chromaticity of the crust and crumb, hue (°h) of the crust and crumb, and sensory acceptance. However, the increase of rice bran and decrease of beneng taro flour substitution increased density of dough, density of bread, and a* chromaticity of the crumb. Based on the results of sensory analysis, the bread with 65:30:5 formula was the best formula because it was close to the control.

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Introduction

Beneng taro is an indigenous tuber of Banten which can be found in Pandeglang Regency. "Beneng" is an abbreviation of big and "koneng" which comes from Sundanese which means big and yellow because it has a length of 120 cm, a weight of 42 kg, and a diameter of 50 cm (Haliza *et al*., 2012; Yursak *et al*., 2021). Beneng taro contains 6.25% protein, 3.43% ash, 84.88% carbohydrates, 70.24% amylopectin, 2.29% crude fiber, and 7.19% dietary fiber (Apriani *et al*. 2011). Taro is also source of minerals, likes potassium, phosphorus, manganese, and copper (Temesgen and Retta 2015, Soudy *et al*. 2010). In addition, beneng taro contains beta carotene pigment of 6.92 ppm (Budiarto and Rahayuningsih, 2017). Beta carotene has great potential as a source of antioxidants (Marjan *et al*., 2016).

Beneng taro has the highest oxalate content compared to others taro. Lestari and Susilawati (2015) stated that the oxalate content in beneng taro is 6 times and 8 times higher than Malang taro and Bogor taro. This oxalate will cause itching if consumed. The process of reducing oxalate in beneng taro carried out by the people of Pandeglang is soaking in 1% salt solution for 1 hour (Nurtiana and Pamela, 2019).

The utilization of beneng taro that has been carried out is processing it into flour. The advantages of processing into flour is easier packaging and distribution, longer shelf life, and more practical processing. The addition of beneng taro flour in various food products has several objectives: 1) reducing the use of wheat flour and increasing the utilization of beneng taro, 2) increasing the nutritional value and functional of the product such as carotene and dietary fiber (Nurtiana *et al*. 2022).

Rice is the staple food consumed by 95% of Indonesian. Processing of unhusked rice into rice includes milling to remove the husk and polishing to remove the bran to make it whiter. So far, rice bran is only used as animal feed. By-products of grain processing are 20% husk, 8% bran and 2% germ. The content of dietary fiber in rice bran reaches 21.2–30.2%. Bioactive compounds found in rice accumulate in the bran. Rice bran contains flavonoid compounds (anthocyanins, tricin), ferulic acid, phytic acid, oryzanol, vitamin E complex, vitamin B complex, gallic acid, hydroxybenzoic, procatequatic, and phytosterols (Nurtiana *et al*., 2017). These components make rice bran good for health and has the potential to be utilized optimally for human health. Therefore, rice bran has the potential to be used as a functional food.

Rice bran is rich in antioxidants, so it has the potential to act as an antidote to free radicals. The main antioxidant in rice bran is γ-oryzanol. Apart from being an antioxidant, rice bran is reported to have chemopreventive activity against colon, breast, liver and skin cancer. Apart from dietary fiber, the γ-oryzanol component in rice bran is also reported to have hypocholesterolemic activity. Gamma oryzanol, apart from acting as an antioxidant, also increases the metabolism of food components, for example cholesterol (Tuarita et al., 2017).

Bread is very popular food. Main raw material for making bread is wheat flour. Until now, Indonesia still imports wheat because of subtropical plant. Total wheat imports to Indonesia in 2020 were 10.8 million tonnes, lower than 11.0 million tonnes in 2019 due to the COVID-19 pandemic (Maldin *et al*. 2022). Therefore, to reduce wheat imports, alternative efforts are needed to reduce its use. One of solution to reduce the use of wheat flour in making bread is to substitute with other flours. In addition, bread has a weakness, a low dietary fiber content of 2.27% (Khoirunnisa *et al*. 2021). The use of beneng taro flour and rice bran in bread is not only to reduce the use of wheat flour but also to increase its functionality.

Based on the research of Khoirunnisa *et al*. (2021), which substituted 30% of soy flour to bread and the dietary fiber increase to 44.78%. Lestari and Maharani (2017) conducted research on adding Belitung taro flour to bread and the 20% substitution was the selected formula based on sensory quality. However, the physical quality parameters of bread with 15% substitution of coconut dregs flour decreased compared to the control, including expansion ratio decreased by 96%, color parameters decreased by 19%, and sensory reception decreased by 17% (Pusuma *et al*., 2018). Thus, the addition of beneng taro flour and rice bran to bread is thought to affect the quality of bread, so it is necessary to conduct the research to determine the effect on physical and sensory characteristics of the resulting bread.

Method

Tools and Materials

Beneng taro flour (80 mesh) obtained from KWT Tanjung Kulon, Talaga Warna Village, Pabuaran District, Serang Regency and rice bran obtained from rice mills (60 mesh) PD. Srimulya, Kilasa Village, Kasemen District, Serang City. The raw materials for bread are obtained from the Pasar Lama, Serang consisting of high protein wheat flour (Cakra Kembar), margarine (Blueband), chicken eggs, salt (Dolpin), white sugar (Gulaku), milk (Ultramilk), and yeast (Fermipan). The tools used are aw meter (Aqualab Pawkit), Chromameter (Hunterlab Colorflex EZ), analytical balance (Excellent, model HZK), sensory booth, mixer (Cosmos, model CM-1279), oven (Kirin, model KBO-190LW), microwave (Samsung, model MS23K3515AS), bread baking pan, plastic wrap (Clingwrap), measuring glass (Pyrex), stationery, paper, millet, plastic, and kitchenware.

Research Method

This research was conducted using four treatments, bread control (100% wheat flour), bread with formulation ratio of wheat flour, beneng taro flour, and rice bran 65:30:5; 65:25:10; and 65:20:15. The research had been carried out in two repetitions. The physical tests carried out were water activity, dough density, bread density, expansion ratio and color. The organoleptic tests carried out were aroma, taste, texture, and color of bread.

Bread Production

The formula for making bread refers to research by Nugroho *et al*. (2016) modified (Table 1). The powder ingredients are sifted and weighed then put into the mixer bowl. Margarine that has been melted in the microwave is put together in mixer bowl and mixed with flour. Chicken egg yolks and white sugar are added gradually to the dough and then stirred. The milk is slowly added to the dough and stirred until smooth dough. The smooth dough is fermented for 15 minutes at room temperature, after the first fermentation the dough is patted until the air is gone. The dough is then divided into three portions and fermented again for 20 minutes at room temperature. Furthermore, the dough is rolled out, flattened with a rolling pin, rolled, and placed in a bread pan that was previously smeared with margarine and the final fermentation is carried out for 60 minutes at room temperature until the dough achieves optimum volume. Then the dough is baked in an electric oven at 200°C for 35 minutes.

Expansion Ratio Analysis

Expansion ratio analysis refers to Pusuma *et al*. (2018) modified. Expansion ratio is the ratio of bread volume increase and dough volume. Dough volume is measured by placing the dough in a measuring glass (V2) according to the weight of dough to be baked. Volume of bread was measured using seed displacement method, using millet as the grain. Millet seeds are put into the pan until the surface is flat. Pan is tapped ten times so that all the space in the pan is filled. Furthermore, some of the seeds in pan are temporarily transferred to another container. Next, bread is put into pan which contains some millet seeds and pan is filled with millet seeds until it is completely flat. The remaining millet seeds were measured in volume with a measuring glass to determine the volume of bread (V1).

$$\text{Expansion Ratio (\%)} = \frac{V1}{V2} \times 100\%$$

V1 = Volume of bread after baking (mL)
V2 = volume of dough (mL)

Table 1. Basic bread formula design

Ingredients (g)	R0	R1	R2	R3
Wheat Flour	450	292,5	292,5	292,5

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Ingredients (g)	R0	R1	R2	R3
Beneng Taro Flour	-	135	112,5	90
Rice Bran	-	22,5	45	67,5
Margarine	20	20	20	20
Milk	150	150	150	150
Salt	8	8	8	8
Chicken Egg Yolk	10	10	10	10
White Sugar	225	225	225	225
Yeast	8	8	8	8

Note: R0 = Control/100% Wheat Flour, R1 = Ratio of Wheat Flour: Beneng Taro Flour: Rice Bran 65:30:5, R2 = Ratio of Wheat Flour: Beneng Taro Flour: Rice Bran 65:25:10, R3 = Ratio Wheat Flour: Beneng Taro Flour: Rice Bran 65:20:15

Water Activity Analysis
The water activity (aw) of bread was measured using an aw meter according to Ulfah *et al*. (2018). Sample is put into a specific tube and then put in an aw meter. The screen will show the measurement progress. After the value is stable the tool will sound indicating the process of measuring water activity has been completed.

Dough and Bread Density Analysis
Dough and bread density analysis are referred to Hasmadi *et al*. (2010) modified. Density is measured by dividing the weight of a product by the volume of space it occupies. The weight of the dough and bread was measured by weighing in analytical balance. The volume of the dough is measured using a measuring glass by using the weight of the dough as a reference in determining the volume of the dough that is put into the pan. The density of the dough is calculated based on the division of the weight of the dough by the volume of the dough (g/mL).
The volume of bread was measured using seed displacement method, using millet as the grain. Millet seeds are put into the pan until the surface is flat. Pan is tapped ten times so all space in pan is filled. Furthermore, some of seeds in pan are temporarily transferred to another container. Next, bread is put into a pan which contains some millet seeds and pan is filled with millet seeds until it is completely flat. The remaining millet seeds were measured for volume with a measuring glass to determine the volume of bread (mL). Weight of bread was measured using an analytical balance. Density of bread is calculated based on dividing weight of bread by volume of bread (g/mL).

Color Analysis
Color analysis refers to the method of Nurtiana *et al*. (2022) modified. Color analysis was performed on the crumb and crust of bread. Measurement of the crust was carried out by directly placing the sample in the container, while measurement of crumb was carried out by cutting the whole bread vertically and placing it in the container. Color measurement with the CIELAB system produces L*, a*, and b* values. L* values indicate brightness with values from 0 (black) to 100 (white), a* values indicate green (-a*) to red (+a*) values and b* values indicate blue (-b*) to yellow (+b*). Hue degrees (°h) are calculated as $\tan^{-1}$ (b*/a*). Where:
Hue 342-18°: Red purple
Hue 18-54°: Red
Hue 54-90°: Yellow red
Hue 90-126°: Yellow
Hue 126-162°: Yellow green
Hue 162-198°: Green
Hue 306-342°: Purple
Hue 270-306°: Blue purple
Hue 198-234°: Blue green
Hue 234-270°: Blue

Sensory Analysis
Sensory analysis was carried out using the BSN method (2006) based on SNI 01-2346-2006 regarding sensory testing standards. This test aims to determine level of consumer preferences and opinions regarding the product. This test was carried out by 40 panelists of Food Technology students, University of Sultan Ageng Tirtayasa with an age range of 19-21 years with female and male gender. The panelists will be given technical guidance on scoring hedonic scale 1-7 questionnaire, namely 1: strongly dislike, 2: dislike, 3: rather dislike, 4: neutral, 5: rather like, 6: like, 7: strongly like. This test was carried out with 4 parameters, namely taste, color, aroma, and texture.

Statistical Analysis
The research design used was a one-factor Completely Randomized Design (CRD), namely the substitution of beneng taro flour and rice bran consisting of 4 levels and 2 repetitions (100% flour, ratio 65: 30: 5; 65: 25: 10; and 65:20:15). The data obtained was then analyzed by ANOVA (Analysis of Variance) at α=5% to determine whether there was a significant effect on each test parameter. If it shows a significant difference, then proceed with Duncan's Multiple Range Test (DMRT) at α = 5% to determine the level of treatment that gives a significant difference.

Results
The four bread formulas that were produced (R0, R1, R2, R3) were then analyzed for physical and organoleptic characteristics. The physical analysis carried out is the expansion ratio, dough density, bread density, water activity and color parameters which include L*, a*, b* and °Hue on part of crust and crumb part of bread. Sensory analysis carried out included color, taste, aroma, and texture parameters. The results of the physical analysis can be seen in Table 2 and 3 and the sensory analysis can be seen in Table 4.

Table 2. Average of Expansion Ratio, Water Activity, and Density of Bread

Formula	Expansion Ratio (%)	Water Activity	Bulk Density of Dough (g/mL)	Bulk Density of Bread (g/mL)
R0	247.58±3.42[a]	0.67±0.03[a]	1.20±0.0[a]	0.69±0.01[a]
R1	119.51±0.22[b]	0.70±0.01[a]	1.25±0.04[a]	0.81±0.06[ab]
R2	117.32±0.19[b]	0.71±0.00[a]	1.24±0.06[a]	0.94±0.09[b]
R3	87.20±0.14[c]	0.71±0.05[a]	1.26±0.03[a]	0.97±0.09[b]

Note: R0 = Control/100% Wheat Flour, R1 = Ratio of Wheat Flour: Beneng Taro Flour: Rice Bran 65:30:5, R2 = Ratio of Wheat Flour: Beneng Taro Flour: Rice Bran 65:25:10, R3 = Ratio of Wheat Flour: Taro Beneng Flour: Rice Bran 65:20:15

Table 3. Average Color Attribute of Bread

Part of Bread	Formula	Color Attributes			
		L*	a*	b*	ºHue
Crust	R0	62.44±1.40[a]	15.12±0.63[a]	34.79±1.00[a]	116.08±1.65[a]
	R1	52.34±2.59[b]	14.90±0.90[a]	29.67±2.66[b]	111.74±2.37[a]
	R2	51.15±0.08[c]	14.58±0.15[a]	28.77±0.35[b]	110.17±0.18[a]
	R3	50.77±0.43[c]	13.25±1.09[a]	27.75±0.62[b]	112.77±0.01[a]
Crumb	R0	74.34±3.48[a]	4.25±0.08[a]	23.32±1.90[a]	139.17±0.04[a]
	R1	62.11±1.83[b]	5.40±0.23[ab]	15.30±0.08[b]	124.23±1.31[b]
	R2	59.34±0.26[b]	5.88±0.67[ab]	15.50±0.32[b]	124.70±0.13[b]
	R3	57.17±0.92[b]	5.13±0.16[b]	15.32±0.03[b]	124.80±1.01[b]

Note: R0 = Control/100% Wheat Flour, R1 = Ratio of Wheat Flour: Beneng Taro Flour: Rice Bran 65:30:5, R2 = Ratio of Wheat Flour: Beneng Taro Flour: Rice Bran 65:25:10, R3 = Ratio of Wheat Flour: Beneng Taro Flour: Rice Bran 65:20:15

Table 4. Average Acceptance Level of Panelists on Bread Sensory Attributes

Formula	Panelist Acceptance Levels			
	Color	Aroma	Taste	Texture
R0	6.13±1.22[a]	5.65±1.21[a]	5.45±1.28[a]	5.38±1.25[a]
R1	4.40±1.37[b]	4.33±1.33[b]	3.48±1.45[b]	3.33±1.31[c]
R2	4.48±1.50[b]	4.23±1.31[b]	3.13±1.54[b]	4.18±1.30[b]
R3	3.98±1.75[b]	3.55±1.62[c]	2.15±1.35[c]	3.40±1.57[c]

Note: R0 = Control/100% Wheat Flour, R1 = Ratio of Wheat Flour: Beneng Taro Flour: Rice Bran 65:30:5, R2 = Ratio of Wheat Flour: Beneng Taro Flour: Rice Bran 65:25:10, R3 = Ratio of Wheat Flour: Beneng Taro Flour: Rice Bran 65:20:15

Discussions

Expansion Ratio

Expansion ratio is an important parameter in the acceptability and physical properties of bread. Expansion ratio of bread is the ability of bread to increase in size before and after the baking process. Large expansion ratio reflects a more hollow and porous structure, because of that bread has a good acceptance value (Pusuma *et al*. 2018). The results of further test showed an average value of expansion ratio of bread with a ratio of wheat flour: beneng taro flour: rice bran 65: 30: 5 showed a significant difference compared to control but did not show a significant difference with bread with ratio of wheat flour: beneng taro flour: rice bran 65: 25: 10, while other three formulations showed a significant difference with bread with a ratio of wheat flour: beneng taro flour: rice bran 65: 20: 15. In general, the higher the rice bran substitution, the lower the expansion ratio of bread. In addition, beneng taro flour also has an effect on reducing expansion ratio of bread. This is because rice bran and beneng taro flour do not have gluten.

Gluten in flour affects the cohesive and viscoelastic forces during kneading and retains gas formed during fermentation. During fermentation, amylase enzyme plays a role in forming CO_2, increasing the ability to retain gas during kneading, and increasing expansion ratio and pore structure (Ahmadi *et al*., 2020). According to Zao *et al*. (2020) in Ahmadi *et al*. (2020), gluten determines texture of bread because gluten affects structure of bread that is formed. Gluten structure of gliadin and glutenin plays a role in the formation of an elastic film layer that can retain carbon dioxide, so that uniform pores are formed (Wulandari and Lembong, 2016). Decrease in formation of gluten structure in the dough causes dough's ability to retain gas during baking to decrease, so the resulting is lower expansion ratio (Nurtiana *et al*., 2022).

The presence of water in dough is also affect rheological characteristics of dough and quality of bakery products. Apart from helping formation of gluten network structure, water in dough is also needed for the starch gelatinization process, this process is important in formation of bakery structures (Rismaya *et al*. 2018). According to Muhandri and Subarna (2009), increase of water content in dough causes more water to diffuse into starch granules which can cause starch granules to swell and become irreversible, thereby increasing starch gelatinization. Increase of degree of gelatinization causes more amylose to escape from starch granules, which functions as a binder which

together with gluten structure can produce an elastic and cohesive dough mass.
The fiber contained in rice bran has high absorption and water holding capacity which can affect elasticity of resulting dough (Struck *et al*. 2016). The higher fiber, the more water will be absorbed, thereby reducing expansion ratio, therefore the more addition of rice bran, the higher fiber content, and the more it absorbs water, so the smaller expansion ratio for bakery products (Rismaya *et al*. 2018). Water in dough which is bound by rice bran fiber will cause the hydration process of starch in dough to be disrupted so starch gelatinization process is hampered and results in decreased dough elasticity, a less elastic dough causes the formation of bakery structures to be disrupted, as a result of which the dough's ability to hold gas during baking decreases (Nurtiana *et al*. al. 2022; Rismaya *et al*. 2018).

Water Activity
Water activity (Aw) is the amount of water available which can be used for enzymatic reactions and for microbial growth. Water that can be used for reactions and microbial growth is free water, while the type of water that is evaporated is free water and weakly bound water (Kusnandar, 2010). In Table 3, based on the results of further test on aw of bread, showed no significant difference in all formulas, however, in general, the higher the rice bran substitution, the higher the water activity value. According to Kusnandar (2010), it is difficult to remove water chemically bound to hydrophilic groups during the drying process, so less free water molecules are evaporated. Therefore, the more rice bran substituted, the higher the water activity.

Density
Bulk density is used as a physical analysis parameter because it can describe the compact and porosity of bread products (Muhandri *et al*. 2018). Formation of a porous structure due to air and water vapor trapped and expanding during baking, which will reduce density of t bread product. This exposed pore structure causes bread to have good texture and tenderness (Pratama *et al*. 2014). Density is calculated based on ratio between mass of product and the volume it occupies (Purwitasari *et al*. 2014). The higher bulk density, the more compact or dense the product (Rismaya *et al*. 2018).
Based on the results of further test, Table 3 shows that density of bread dough substituted with beneng taro and rice bran did not show a significant difference in all formulas. However, in general, the higher the rice bran substitution, the higher the density of the bread dough. Manley (2000) in Muhandri *et al*. (2018), stated that amount of solid fat during mixing will affect cream up phase and density of dough. Higher fat will result higher volume of dough, so the density will be lower. At the time of creaming, fat traps air so small air bubbles form which causes the volume of dough increase. Apart from having a high fat content, egg yolk also functions as an emulsifier because it contains about 10% lecithin (Muhandri *et al*. 2018). Because the use of the same weight of margarine and egg yolks in each formula, creaming up process will take place the same so that the formulas do not produce significant differences.
Table 3 shows that density of control bread was not significantly different from other formulas. Bread with ratio of wheat flour: beneng taro flour: rice bran 65: 30: 5, however, it was significantly different from other formulas. Meanwhile, between formulas that were substituted with beneng taro flour and rice bran were not significantly different. However, in general, the higher the rice bran substitution, the higher the density of bread.
Increase in the density of substitution bread was influenced by high fiber contained in beneng taro flour and rice bran. Similar research conducted by Rismaya *et al*. (2016) and Nurtiana *et al*. (2022) showed that bulk density of muffins could be increased by substitution treatment of several sources of dietary fiber, namely pumpkin flour and beneng taro flour. Muchtadi (2001) stated that components of total dietary fiber can increase bulk density in a material or product. Besides that, resistant starch can cause crumb bakery matrix to become compact (Bauxauli *et al*. 2008). The crumb structure which is compact and dense causes volume of bread to be low, so that resulting large bulk density.

Lightness (L*)
Color is an important parameter and is first seen by consumers in choosing food products. Attractive colors and in accordance with the wishes of consumers are the main attraction in choosing food. Color measurement in this research is important to determine the effect of substitution treatment of beneng taro flour and rice bran on the color quality of the resulting bread. Color testing was carried out on the crust and crumb of bread.
L* value represents brightness parameter with L*=0 meaning black and L*=100 meaning white (Andarwulan *et al*. 2011). Based on the results of further test, Table 4 shows that L* value of bread crumb substituted with beneng taro flour and rice bran is significantly different from control. However, between all formulas of substituted bread did not provide a significant difference. In general, the higher the rice bran substitution, the lower the brightness value of bread crumb
Table 4 shows that L* value of control crust shows a significant difference with the substituted bread. However, between bread with ratio of wheat flour: beneng taro flour: rice bran 65:25:10 and 65:20:15 did not show a significant difference. In general, the higher the rice bran substitution, the lower the brightness value of the bread crust.
L* value of crust ranged from 50.77-62.44 while L* of crumb ranged from 57.17-74.34, it shows that the brightness of crust is lower than crumb. As beneng taro flour along with wheat flour is a contributor of protein, so intense maillard browning reaction occurs in crust, crumb does not undergo maillard reaction, but is affected by ingredients of dough. Intense maillard browning makes color of crust darker than crumb (Conforti and Davis, 2006).

Decrease of L* value on substituted bread was influenced by differences in color of the flour used as a raw material in making bread. Beneng taro flour has a darker color (low L*) than wheat flour (Wongsagonsup *et al*. 2015; Rostianti *et al*. 2018). Beneng taro flour has a yellow color due to presence of carotenoid pigments of 6.92 ppm (Budiarto and Rahayuningsih 2017). In addition, the higher the use of rice bran, the browner the color of the bread produced. According to Damayanthi *et al*. (2001) in Pertiwi *et al*. (2021), rice bran has whiteness degree value of 43.5%, which is visually indicated by a light brown color. This value is smaller than whiteness degree of wheat flour, which is 70%. Decrease in the brightness value (L*) is also affected by formation of a brown color due to a non-enzymatic browning reaction (maillard reaction). Maillard reaction occurs due to the presence of reducing sugars and amino acids due to high temperature of baking. The formation of brown color is more dominant in substituted bread due to high reducing sugar content in beneng taro flour (Laguna *et al* 2011; Kusnandar 2010). Protein content in rice bran of 14-16% also influences the maillard reaction (Huang *et al*. 2005 in Nurtiana *et al*. 2017).

Water content in dough also tends to shift the reaction towards the formation of N-substituted glycosylamine as a precursor for formation of melanoidin compounds to be inhibited (Kusnandar, 2010). This melanoidin compound plays a role in formation of brown color in bread. In bread which is substituted with beneng taro and rice bran, presence of water is bound by dietary fiber so the presence of water in the dough is reduced. The presence of low water in bread substituted for fiber-rich flour causes the reaction to shift towards formation of more melanoidin compounds, so the brown color becomes more dominant. These results are in accordance with research by Rismaya *et al*. (2018) and Nurtiana *et al*. (2022) who stated that low water content of dough caused color of the pumpkin and beneng taro muffins to become darker.

a* Chromaticity

a* chromaticity indicates a green (a negative) to red (a positive) color (Santoso *et al*. 2013). The average value of a* chromaticity of crust of bread ranged from 13.25-15.12. The average value of a* chromaticity of bread shows a positive value indicating a tendency towards red color.

Table 4 shows that a* chromaticity of bread crust, based on the results of further test, did not show a significant difference between all formulas and control, but the trend decreased with increasing of rice bran substitutions. Table 4 shows that a* chromaticity of bread crumbs, based on further test results, did not show a significant difference between the control and bread with a ratio of wheat flour: beneng taro flour: rice bran of 65:30:5 and 65:25:10, whereas showed a significant difference between the control and bread with a ratio of wheat flour: beneng taro flour: rice bran of 65:20:15. However, the three substituted bread did not have a significant difference. In general, the more rice bran substitutions, the higher the a* chromaticity.

The results of a* chromaticity of crumb showed a tendency that the higher concentration of rice bran substitutes added, the higher a* chromaticity. High a* chromaticity are found in bakery products with a dark surface (low L*) (Rismaya 2016). The increase of a* chromaticity is affected by the formation of a more dominant brown color resulting from the maillard reaction that occurs in the dough. Meanwhile, the a* chromaticity value of bread crust showed the opposite, this is presumably because the surface of the bread which is exposed to more heat during baking so it accelerates the formation of color tends towards redness.

b* Chromaticity

b* chromaticity shows a blue color (b* negative) to yellow (b* positive) (Santoso *et al*. 2013). The average b* chromaticity of bread crust ranged from 27.75-34.79, and average b* chromaticity of bread crumb ranged from 15.32-23.32. Average b* chromaticity of bread shows a positive value indicating a tendency towards yellow color.

Based on the further test results, Table 5 shows that b* chromaticity crust and crumb of control bread had a significant difference with substitution treatment, but between substitution formulas did not provide a significant difference. In general, the higher the substitution of rice bran, the lower the b* chromaticity.

Beneng taro flour on bread causes a decrease of b* chromaticity which is thought to be yellow-orange color due to the presence of natural pigments from beneng taro (carotenoids) (Rismaya 2016). In addition, the higher the rice bran substitution added, the lower b* chromaticity because rice bran has a brownish color so the formation of a dark brown color resulting from the Maillard reaction is more dominant in substitution bread (Nurtiana *et al*. 2022).

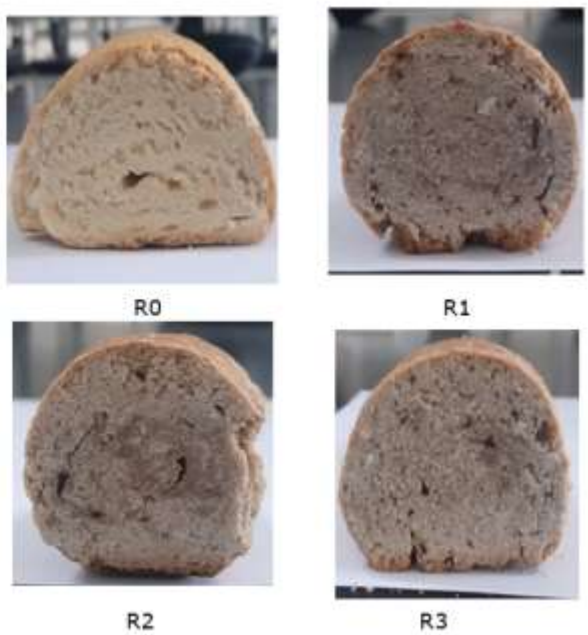

Figure 1. Bread with Taro Beneng Flour and Rice Bran Substitution

Note: R0 = Control/100% Wheat Flour, R1 = Ratio of Wheat Flour: Beneng Taro Flour: Rice Bran

65:30:5, R2 = Ratio of Wheat Flour: Beneng Taro Flour: Rice Bran 65:25:10, R3 = Ratio of Wheat Flour: Beneng Taro Flour: Rice Bran 65:20:15

Hue (°h)

Hue is a real color that can be observed by the eye, such as red, yellow, blue, green and etc. (Andarwulan *et al*. 2011). Measured of L*, a* chromaticity and b* chromaticity can be converted into Hue (°h) values (Santoso *et al*. 2013). In general, Hue value of bread crust obtained ranges from 112.77-116.08 which indicates a yellow color range (Hue 90-126). Meanwhile, Hue value of bread crumbs obtained ranged from 124.80-139.17 which indicates a range of yellow (Hue 90-126) and yellow green (Hue 126-162) colors. Table 5 shows the results of further tests showed that all breads with various concentrations of beneng taro flour and rice bran substitution showed Hue crust values that were not significantly different from control bread. However, based on the results of further tests, it showed that hue crumb values of all substituted breads were significantly different from the control, while the substitution formulas were not significantly different. In general, the higher the concentration of rice bran substitution, the lower hue value in the crust and crumb of bread.

This decrease in Hue indicates that the color of bread substituted for beneng taro flour and rice bran tends towards yellow for crust and greenish yellow for crumb which is more dominant. While wheat flour does not have a yellow and greenish yellow color, so color of the bread control does not have a greenish crumb color and a yellowish crust. According to Muchtadi (2010), the difference in the color of the crumb in the bakery product is strongly influenced by color of flour which used as raw material. Beneng taro flour has a yellow color that comes from carotenoid pigments and rice bran has a brownish color. In addition, the difference in color is also affected by formation of a brown color due to the Maillard reaction that occurs between reducing sugars and free amine groups (Man *et al*. 2014; Struck *et al*. 2016). Starch content in beneng taro is 81.81% (Kusumasari *et al*., 2019) and protein content in rice bran is 14-16% (Nurtiana *et al*., 2017) causing formation of a brown color due to Maillard reaction which occurs more in substitution bread.

Sensory Characteristics

Color is a factor that must be considered in food product development, because panelist will first assess the product through its visual appearance. Based on Table 6, the results of further test showed that there was a significant difference in panelist acceptance of color of control bread with substituted bread for beneng taro flour and rice bran in various concentrations. However, between all substituted bread did not show a significant difference. On the color attribute, panelist's assessment was neutral to like. The more rice bran substitutions added to bread will cause a decrease in color acceptance because the resulting color impression is dark due to brown color of rice bran and presence of carotenoid pigments from beneng taro flour. This is caused Maillard reaction which produces brown melanoidin pigment due to higher sugar and starch content of beneng taro and the higher protein content of rice bran compared to wheat (Kusnandar, 2010; Kusumasari *et al*., 2019, Nurtiana *et al* 2017).

Aroma is one of the sensory characteristics received by the sense of smell which can affect the level of sensory acceptance. Based on Table 6, the results of further test showed a significant difference between the bread control and substituted bread. The substitution formulas for beneng taro and bran 30:5 and 25:10 did not show a significant difference, while the two formulas produced significant differences with the substitution for beneng taro and rice bran 20:15. On the aroma attribute, the panelist's assessment ranged from rather dislike to somewhat like. The more rice bran substitutes added to the bread, the lower the panelists acceptance. This result is presumably because rice bran has a higher acid number due to more intensive enzyme activity. Enzymes present in bran oil include α-amylase, β-amylase, ascorbic acid oxidase, catalase, cytochrome, oxidase, dehydrogenase, deoxyribonuclease, esterase, flavin oxidase, α and β glycosidase, invertase, lecithinase, lipase, lipoxygenase, pectinase, peroxidase, phosphatase, phytase, proteinase, and succinate dehydrogenase. Enzyme activity that is more intensive in rice bran results in an unfavorable smell, namely the lipase enzyme easily smells rancid because the free fatty acid content in rice bran increases (Purwanto *et al*., 2014).

Taste attributes depend on the composition of the ingredients used in making product. Based on Table 7, results of further test showed a significant difference between control and substituted bread. Substitution formulas for beneng taro and rice bran 30:5 and 25:10 did not show a significant difference, while the two formulas produced significant differences with the substitution for beneng taro and rice bran 20:15. On the taste attribute, the panelist's assessment was from dislike to rather like. The more rice bran substitutes to bread, the lower the panelist acceptance. This is because beneng taro still has a slightly itchy taste because the oxalate content has not completely disappeared (Lestari and Susilawati, 2015), besides that because rice bran is very fibrous, it causes a lot of aftertaste to be left behind.

Texture is one of the most important sensory characteristics in consumer perception. One of the parameters of a good bakery product is soft crumb (Rismaya *et al*. 2018). Table 7 shows the results of further test that there was a significant difference in panelists' acceptance of the texture of the bread and the formulas, while for the three substitutions of bread there was a significant difference in the formulas of the substitution of taro beneng and rice bran 25:10 and 20:15. On texture attribute, panelist's assessment is that don't like until slightly like. Increased hardness of the texture makes it less favored by the panelists because the high dietary fiber in rice bran and beneng taro flour provides greater mechanical resistance during compression (Struck *et al*. 2016). Fiber component causes the crumb matrix to become more compact and reduces the softness of bakery products, thereby reducing the expansion ratio of the dough during baking (Rismaya *et al*. 2018).

Conclusion

Increasing concentration of rice bran in bread decreases expansion ratio, brightness (L*) in crust and crumb, a* chromaticity in crust, b* chromaticity in crust and crumb, hue (°h), and sensory acceptance which includes color, aroma, taste, and texture. However, increasing the concentration of rice bran in bread increased bulk density of dough, bread density, and a* chromaticity of crumb. Changes in physical and sensory properties of bread were related to addition of rice bran and beneng taro flour which are rich in dietary fiber, presence of reducing sugars and carotenoid pigments in beneng taro flour, protein and free fatty acids in rice bran. Based on the results of sensory analysis, formula for bread with a ratio of wheat flour: beneng taro flour: rice bran 65: 30:5 was the best formula because it was closest to the control.

The weakness in this research is that the bread produced is less expand due to the low gluten content, so it is less accepted by the panelists. Suggestions that can be made for further research are the use of commercial gluten flour for food products that is substituted by non-gluten flour, so the resulting product is more expand.

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