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Production of high dietary fiber and antioxidant activity bread from coffee parchment skin flour

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ABSTRACT

Parchment has a higher dietary fiber and antioxidant activity than coffee by-products. The increased food fiber and antioxidant parchment can be used to produce food products with nutritional value. One of the popular foods that be the most frequent choice is bread because it can provide a feeling of fullness compared to other snacks. However, bread can increase blood sugar levels and cause obesity because bread has a low dietary fiber content. Therefore, the high content of dietary fiber and antioxidants from parchment could potentially add to the nutritional value of bread, such as dietary fiber and antioxidants. In this study, we made formulation of bread with high dietary fiber and antioxidant activity content from coffee parchment flour. Several analyses were conducted, including sensory properties, dietary fiber, antioxidant activity, and physical and chemical properties. The addition of parchment can increase dietary fiber and antioxidants in bread formulation. Parchment makes the bread dough darker and enhances the reddish-brown color of the bread. Based on sensory evaluation, the panellists most liked the bread formulation with the addition of 2.5% parchment flour (P2). The addition of parchment flour can increase the carbohydrate content of the bread. Besides giving a feeling of fullness, this bread can also be a functional food that can reduce obesity and prevent disease. Parchment flour can add to the nutritional value of bread compared to other bread that does not use parchment flour.

Key words: Parchment; bread; dietary fiber; antioxidant activity; functional food.

1 INTRODUCTION

Coffee consumption in Indonesia for the 2016-2021 period has increased by 8.22% per year, causing coffee production also increases. 94.5% of coffee production in Indonesia is supplied from a coffee plantation in South Sumatra, Lampung, Bengkulu, East Java, and Central Java. Coffee fruit processing consists of dry, semi-dry, and wet. Besides coffee beans, coffee fruit processing produces by-products: skin, husk, pulp, parchment, and silverskin (Santos et al., 2021). The coffee by-product has a composition of 45-50% of the total coffee beans. Increasing coffee production will increase the number of coffee by-products too. In Indonesia, coffee farmers only use coffee by-products as compost and biogas. It has high nutrients such as carbohydrates, protein, dietary fiber, and minerals and has bioactive components such as antioxidants, anticancer, antidiabetic, anti-inflammatory, antifungal, and antimicrobial (Gemechu, 2020). Several studies have utilized it in food products such as bread, cakes, cookies, biscuits, and beverages (Klingel et al., 2020). It can be a functional food providing health value in food products.

Parchment is part of the coffee bean skin that is in the endocarp. Parchment is obtained after pulping the skin, fermentation, washing, and drying in wet and semi-dry processing (Santos et al., 2021). In Iriondo-DeHond's research (2019), no signs of toxicity, abnormal behaviour or death were found in rats given parchment at a dose of 2000 mg/kg (w/w), so parchment is safe for food. Parchment has a high food fiber content compared to other coffee by-products, namely 89-92% (Gemechu, 2020). Parchment in the form of flour shows more excellent dietary fiber than in the form of skin flakes (Benitez et al., 2019). Dietary fiber plays a role in the diet. It can help to control energy intake and reduce the risk of obesity by providing early signals of satiety and prolonged satiety signals. In addition, people who consume large amounts of dietary fiber have a lower risk of developing hypertension, stroke, diabetes, obesity, and digestive diseases. Parchment also has potential biological activity as a functional food, including hypoglycaemic and hypolipidemic, antifungal, and antioxidant (Benitez et al., 2019; Mirón-Mérida et al., 2019). Parchment of arabica coffee has a high antioxidant activity of 202.2 mg/g compared to arabica coffee husk 80.6 mg/g, silver skin arabica coffee 138.7 mg/g, and silver skin Robusta coffee 169.5 mg/g (Iriondo- DeHond et al., 2019). Therefore, the high dietary fiber and antioxidants parchment can be used to produce food products with nutritional value.

Culinary in Indonesia has developed rapidly with various types of food products served, causing the level of public consumption also to increase. One of the popular foods that are most frequently chosen is bread because provide a feeling of fullness compared to other snacks. However, bread can increase blood sugar levels and cause obesity because bread has a low dietary fiber content. Obesity is a significant risk factor for diabetes, cardiovascular disease, and cancer (Waddell; Orfila, 2022). Based on data from the Indonesian Ministry of Health in 2018, obesity in Indonesia in people aged > 18 years according to gender has increased yearly. In 2018 there was an increase of

2.6% for men and 2.8% for women. Therefore, the high content of dietary fiber and antioxidants activity from parchment could potentially add to the nutritional value of bread. Adding parchment to bread can reduce the risk of obesity because it can provide a feeling of fullness and nutritional value needed by the body. In this study, we made formulation of bread with high dietary fiber and antioxidant activity content from coffee parchment flour. Several analyses were conducted, including sensory properties, dietary fiber, antioxidant activity, physical properties and chemical properties.

2 MATERIAL AND METHODS

2.1 Materials

The main ingredient in this study was Arabica coffee parchment obtained from coffee farmers in Ungaran, Central Java, Indonesia. The ingredients used in making the bread are wheat flour, bread flour, palm sugar, egg yolks, margarine, whole cream milk, baking soda, baking powder, cinnamon powder, vanilla, and salt, obtained from the market in Semarang. The chemicals used for analysis were DPPH (Sigma-Aldrich Ireland Ltd), buffer pH 8.2, 50 Alpha-Amylase (Sigma-Aldrich Ireland Ltd), distilled water, protease (Sigma-Aldrich Ireland Ltd), HCl (Merck, Jerman), amyl glucosidase (Sigma-Aldrich Ireland Ltd), ethanol (Merck, Jerman), acetone (Merck, Jerman), and methanol (Merck, Jerman). The tools used are pots, stoves, filters, pans, basins, silk, analytical scales, pH meters, desiccators, ovens (Mito Fantasy Mo-888, Indonesia), water baths, grinding machine, spectrophotometers (Genesys 150 UV-Vis, USA), Texture analyser (TVT-300XP, Sweden), and Chroma Meter (Konica Minolta CR-400, Japan).

2.2 Methods

2.2.1 Extraction of coffee parchment

Coffee parchment was extracted according to the patent WO 2013/004873 (del Castillo, 2013) with several modifications. A total of 50 grams of parchment was extracted with 1 Liter of distilled water for 10 minutes. The extract was filtered and dried using an oven at 50 ˚C to a constant weight. The dried extracts were ground using a grinding machine to form flour (Figure 1).

The resulting parchment extract flour was filtered and stored in a closed container.

2.2.2 Bread Making

The bread making is based on the recipe from a native person from Semarang with some modifications. The production of this bread consists of 4 formulations, namely P0 (without the addition of parchment flour), P1 (1% parchment flour), P2 (2.5% parchment flour), and P3 (5% parchment flour). The first step is to weigh the wheat flour with the addition of 1%, 2.5%, and 5% parchment flour with a total weight of 50 grams. The composition of the other ingredients is the same (Table 1), including bread flour, egg yolks, margarine, whole cream milk, baking soda, baking powder, cinnamon powder, and vanilla.

Figure 1: Parchment and Parchment Flour.

Table 1: Bread Formulation Composition

Materials	P0	P1	P2	P3
Parchment Flour (g)	-	1	2.5	5
Wheat flour (g)	50	49	47.5	45
Bread flour (g)	33	33	33	33
Full cream milk (g)	4	4	4	4
Baking soda (g)	0.3	0.3	0.3	0.3
Baking Powder (g)	1.2	1.2	1.2	1.2
Vanilla (g)	0.3	0.3	0.3	0.3
Egg Yolk (g)	5	5	5	5
Cinnamon powder (g)	1.2	1.2	1.2	1.2
Margarine (g)	20	20	20	20
Palm sugar (g)	30	30	30	30

All ingredients are mixed and shaken until everything is evenly mixed. Palm sugar that has been dissolved is added to the mixture of ingredients. Leave the bread dough for 30 minutes. The dough is moulded in rectangular melds measuring 18x6 cm with a thickness of ±5 cm and put into the oven at a temperature of 120 ˚C for 30 minutes. Then, the bread is cooled to room temperature.

2.2.3. Analysis of Bread

2.2.3.1. Total Dietary Fiber

Insoluble dietary fiber (IDF), soluble dietary fiber (SDF), and total dietary fiber (TDF) were determined using a gravimetric test based on the AOAC-991.43 and AACC-32.07.01 methods **(**Lee; Prosky; De Vries, 1992). The analysis was repeated twice for each sample. Yields are expressed as a percentage by weight (%).

2.2.3.2. Antioxidant Activity

Antioxidant activity was determined during the DPPH method (Molyneux, 2004). Bread samples are crushed until it crumbles. The crumble bread samples were added to the methanol solution and filtered. Samples were prepared at a concentration of 1.000 ppm in methanol solution. The sample solution was diluted to obtain 200, 400, 600, 800, and 1.000 ppm concentrations. Each concentration of sample solution was taken as much as 4 mL and reacted with 1 mL of 0.2 mM DPPH solution. Sample absorbance was measured using a spectrophotometer (Genesys 150 UV-Vis, USA), at a wavelength of 517 nm. The analysis was repeated twice for each sample. Inhibition (%) can be calculated using the Equation 1 below:

$$\%Inhibition = \frac{Blanck\ Absorbance - Sample\ Absorbance}{Blanck\ Absorbance} x100\% \quad (1)$$

2.2.3.3. Physical and Chemical Properties

Physical properties analysisincludes hardness level and color intensity. The hardness level of the bread was measured using a Texture Analyzer (TVT-300XP, Sweden) with a 75 mm diameter cylindrical probe. Color intensity analysis was calculated using Chroma Meter (Konica Minolta CR-400, Japan), which is expressed as brightness values, L (black-and-white), a (redness level), and b (yellowness level). Chemical properties analysis included moisture, ash, carbohydrates, fats, and proteins according to standard AOAC procedures (Association of Official Analytical Chemists - AOAC, 2005).

2.2.3.4. Sensory Evaluation

Sensory analysis was carried out to determine the acceptability of the bread. The bread sample consists of 4 bread formulas. A total of 20 untrained panellists were randomly recruited to assess the acceptability of the 4 bread formulas using a structured quantitative acceptance assessment test. Each panellist was requested to drink after tasting the samples to eliminate taste disturbances. The parameters assessed were texture, taste, aroma, and preference level. The 4-point rating scale used is (1) Like very much, (2) Like, (3) Dislike, and (4) Really Dislike.

2.2.3.5. Statistical analysis

All treatments were repeated 3 times, each carrying out 3 analysis repetitions. Data were expressed interms of mean ± standard deviation. The data obtained were subjected to statistical tests using ANOVA (analysis of variance) and Duncan's Multiple Range Test (DMRT). Differences between comparable sets of results were considered significant at $p < 0.05$. Statistical tests were performed using the Statistical Package for Social Science (SPSS) version 23. The graphed using MS Excel 2019.

3 RESULT

3.1 Total Dietary Fiber and Antioxidants Activity

The total dietary fiber and antioxidant activity are shown in Table 2.

Bread has total dietary fiber and antioxidant activity that increases with the increasing concentration of parchment flour.

3.2 Bread Physical Properties

The texture of the bread formulation is shown in Table 3.

Table 2: Total Dietary Fiber and Antioxidants Activity Breads (%).

Formulation	Insoluble Dietary Fiber	Soluble Dietary Fiber	Total Dietary Fiber	Antioxidants Activity
P0	4.15±0.08[a]	0.32±0.00[a]	4.77±0.05[a]	17.88±0.12[a]
P1	5.36±0.04[b]	0.39±0.00[b]	5.54±0.02[b]	18.65±0.15[a]
P2	6.15±0.06[c]	0.42±0.00[c]	6.89±0.05[c]	25.43±0.12[b]
P3	7.14±0.05[d]	0.51±0.00[d]	7.93±0.04[d]	30.65±0.10[c]

All data is the average of 3 repetitions. The mean followed by different letters in the same column shows a significant difference ($p<0.05$).

The bread formulas P1, P2, and P3 were not significantly different. The addition of parchment flour did not affect the texture of the bread. The color intensity of the formulas P1, P2, and P3 show that the more parchment flour concentration added will reduce the brightness of the bread. The addition of parchment flour also caused an increase in the level of redness on the bread, but the level of yellowness was not significantly different. It is seen in Figure 2 that shows the differences in color and appearance of each formulas P1, P2, and P3.

3.3 Sensory Evaluation

The results of the sensory evaluation are shown in Table 4.

The bread formulas P1, P2, and P3 were not significantly different based on flavour, texture, and level preference. The P2 formula has a higher score based on taste, while the other three formulas are not significantly different. It shows bread formulation with the addition of 2.5% parchment flour, which is more like other formulations.

3.4 Bread Chemical Properties

The sensory analysis results showed that the panellists preferred the P2 formula. Bread's chemical properties are shown in Table 5.

The bread formulation with 2.5% parchment flour is not significantly different from the control except for carbohydrates. It shows that parchment does not increase nutrient content such as protein, fat, water, and ash but increases carbohydrate content.

4 DISCUSSION

Adding parchment can increase dietary fiber and antioxidants in bread formulation (Table 2). This nutrition is essential for health. Dietary fiber can prevent and reduce obesity because it has physicochemical properties such as water-holding capacity (2.01 - 25.03 g/g), water swelling capacity (0.95 - 23.9 mL/g), oil-holding capacity (0.95 - 23.9 mL/g), 65 – 29 g/g), glucose adsorption capacity (0.17 - 4.65 mmol/g) and cholesterol adsorption capacity (0.03 - 37.10 mg/g) (He et al., 2022). Parchment has an oil-holding capacity (3.8 mg/L), water-holding capacity (3.4 mg/L), glucose adsorption capacity (3 mg/L), and water-selling capacity (14 mg/L) (Benitez et al., 2019). High dietary fiber can reduce calorie intake, so can help the body regulate energy balance for weight maintenance (Church; Martin, 2018). Consumption of dietary fiber can also trigger a satiety effect by stimulating the release of hormones such as cholecystokinin (CCK) and glucagon-like peptide-1 (GLP-1). The CCK hormone regulates satiety and the absorption and metabolism of nutrients (Burton-Freeman et al, 2002) while GLP-1 controls insulin and glucagon secretion, which is related to response and blood glucose levels (Ye et al., 2015). Bread has antioxidant activity that increases with the increasing concentration of parchment flour added (Table 2). Parchment has high antioxidant components, including caffeine (58.2 mg/g), chlorogenic acid (68.2 mg/g), and flavonoids (6%) which lead to the high antioxidant activity of parchment (202.2%) (Iriondo-DeHond et al., 2019). This shows that the antioxidants from the parchment can increase the antioxidant content of the

Table 3: Texture and Color Intensity Bread.

Formulation	Texture	Color Intensity		
		Brightness Values (L)	Redness Level (a)	Yellowness Level (b)
P0	56.80±2.00^{a}	46.70±0.10^{c}	6.34±0.75^{a}	28.25±1.05^{a}
P1	52.00±2.04^{a}	45.60±0.24^{b}	7.61±0.02^{b}	28.40±0.18^{a}
P2	55.32±3.15^{a}	44.85±1.20^{b}	7.45±0.54^{b}	29.55±1.20^{a}
P3	52.05±1.70^{a}	40.65±0.06^{a}	8.23±0.23^{c}	30.78±2.12^{b}

All data is the average of 3 repetitions. The mean followed by different letters in the same column shows a significant difference ($p<0.05$)

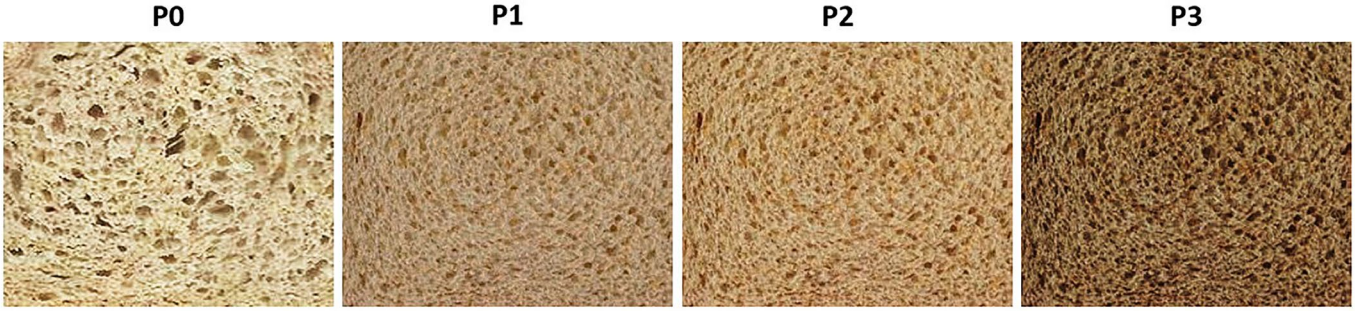

Figure 2: The Appearance of Bread.

Table 4: Sensory Evaluation.

Formulation	Flavour	Texture	Taste	Level of Preference
P0	2.75±0.63[a]	2.40±0.68[a]	3.35±0.58[b]	2.40±0.82[a]
P1	2.50±0.88[a]	2.20±0.69[a]	2.85±0.87[a]	2.22+0.89[a]
P2	2.75±0.71[a]	2.00±0.72[a]	3.35±0.87[b]	2.50±0.68[a]
P3	2.55±0.82[a]	2.25±0.72[a]	2.75±0.96[a]	2.45±0.82[a]

All data is the average of 3 repetitions. The mean followed by different letters in the same column shows a significant difference ($p<0.05$).

Table 5: Bread Chemical Properties.

Formulation	Water (%)	Ash (%)	Protein (%)	Lipid (%)	Carbohydrate (%)
P0	7.26±0.20[a]	1.65±0.85[a]	7.75±1.58[b]	16.75±0.56[b]	45.88±0.35[a]
P1	7.30±0.21[a]	1.60±0.76[a]	7.56±0.24[b]	15.80±1.03[b]	47.30±0.15[a]
P2	6.87±0.38[a]	1.76±1.18[a]	7.30±2.31[b]	14.65±2.06[a]	66.78±0.13[b]
P3	6.93±0.18[a]	1.88±0.23[a]	6.12±0.15[a]	13.30±0.89[a]	72.21±0.95[c]

All data is the average of 3 repetitions. The mean followed by different letters in the same column shows a significant difference ($p<0.05$).

bread. Antioxidants play a role in neutralizing free radicals, which can cause cell damage and diseases such as cancer. The human body maintains a balance between free radicals and naturally occurring antioxidants. Oxidative stress can occur when this balance is disturbed (Bajaj; Ballal, 2021). Antioxidants are needed from food to neutralize free radicals and reduce oxidative stress. Therefore, bread with the addition of parchment flour has the potential as a functional food to reduce obesityand prevent free radicals and oxidative stress that triggers the disease.

The addition of parchment flour did not affect the texture of the bread (Table 3). Wheat flour has a maximum moisture content of 14.5% based on SNI 01-3751—2018 (National Standardization Agency of Indonesia, 2018). While, the moisture content of parchment is 7.6% (Elba; Bonilla-Leiva; Eva, 2017). So, it causes the addition of parchment flour does not have a big effect on the texture of the bread. This can be seen in the chemical content of the bread, where the moisture content of bread with the addition of parchment flour compared with the control is not much different.

Parchment has a light brown base color (Figure 1). The more parchment flour added will made the bread darker, so 5% parchment flour was darker (Table 3). The addition of parchment flour enhances the redness value of bread color but not the yellowness value. The baking of dough with the addition of parchment flour produced reddish-brown. This can be seen in Figure 2 which bread with the addition of more parchment flour has a darker and reddish-brown color. Compare with the bread without the addition of parchment flour has tend whiter color.

Adding parchment flour did not make a difference in the bread's flavour and texture, so adding parchment flour with a concentration of 1 - 5% was acceptable to consumers. However, the P2 formula has a higher rating for the taste parameter, while the other three formulas are not significantly different. Adding parchment flour with a concentration of >2.5% gives an unpleasant taste that comes from the parchment. Parchment has a high content of caffeine and chlorogenic acid (58.2 mg/g and 68.2 mg/g) (Iriondo-DeHond et al., 2019). Caffeine and chlorogenic acid taste bitter (Santosa et al., 2020). This causes more parchment concentration to be added to give a bitter taste that the panelists don't like.

The addition of parchment flour did not increase nutrient content such as protein, fat, water, and ash but increases carbohydrate content (Table 5). This is because parchment has a high carbohydrate of 55.75% (Martinez et al., 2019), so adding carbohydrate value to bread formulations. Meanwhile, the nutritional components of parchment consist of a moisture content of 7.6-11%, a lipid content of 0.3%, and a protein content of 3.1% (Martinez et al., 2019; Iriondo-DeHond, 2019). Therefore, other parchment nutritional components are not too big, so they don't have a significant effect.

5 CONCLUSIONS

Parchment flour can increase dietary fiber content and antioxidant activity in bread. Panellists preferred bread with the addition of 2.5% parchment flour. The addition of parchment flour can increase the carbohydrate content of the bread. Besides giving a feeling of fullness, this bread can also be a functional food that can reduce obesity and prevent disease. Adding parchment flour can add to the nutritional value of bread compared to others that do not use parchment flour.

6 AUTHOR CONTRIBUTIONS

WR and RP wrote the manuscript and did the experiment, MWH supervised the experiment and worked with the manuscript, and KMS reviewed and approved the final version of the work. WR, MWH, and KMS performed all statistical analyses.

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