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Effect of The Ratio of Purple Sweet Potato Flour and Rice Crust Flour on The Physical, Chemical, and Sensory Properties of High-Fiber Snack Bar

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ABSTRACT: Dietary fiber, an indigestible component of plants, offers significant health benefits for humans. Creating a high-fiber snack bar can be a substitute for meeting daily requirements for dietary fiber. This research aimed to create snack bar products utilizing locally sourced ingredients, specifically rice crust flour and purple sweet potato flour, with the goal of optimizing the utilization of local food resources and enhancing the diversity of Indonesian cuisine. This study aimed to investigate how the proportion of purple sweet potato flour and rice crust flour influenced the chemical, physical, and sensory characteristics of the high-fiber snack bars that were created. The proportions of purple sweet potato flour to rice crust flour differed across the four snack bar formulas: FI (100%:0%), F2 (90%:10%), F3 (80%:20%), and F4 (70%:30%). The effectiveness index method was employed to determine the optimal formulation for the snack bar. The results indicated that lowering the proportion of purple sweet potato flour would enhance the firmness and color of the snack bar. The dietary fiber content (%db) of each formula was as follows: F1 (18.92 ± 1.43%), F2 (18.33 ± 0.79%), F3 (18.56 ± 2.73%), and F4 (19.48 ± 0.40%). The sensory test results showed a direct correlation between the panelists' preference level and the decrease in the proportion of purple sweet potato flour. Formula F4, consisting of a 70% proportion of purple sweet potato flour and a 30% proportion of rice crust flour, is the optimal formula for creating a snack bar.

Keywords: dietary fiber, purple sweet potato flour, rice crust flour, snack bar

INTRODUCTION

The development of the times will influence the lifestyle of society. Nowadays, some people prefer ready-to-eat, modern, and convenient foods. However, on the other hand, people have become more aware of the importance of a healthy lifestyle, and they pay more attention to the fact that the food they consume should not only provide satiety but also have positive effects on their bodies (Septiani *et al*., 2016). A snack bar is one type of healthy and convenient food that can be consumed by society. According to Aini *et al*. (2020), a snack bar is a type of snack with high energy content. A snack bar is typically made from various combinations of ingredients, such as grains, fruits, and nuts, bound together with a binder or binding agent (Amalia, 2011).

Dietary fiber is defined as the fraction of plants that contain carbohydrates that humans' small intestines cannot digest or absorb. Instead, it is either partially or completely fermented in the large intestine (Santoso, 2011). According to the Regulation of the Indonesian Ministry of Health, it is recommended that the public consume 22 – 37 grams of fiber per day according to their age groups (Kementerian Kesehatan RI, 2019). The World Health Organization (WHO) recommends consuming 25-30 grams of dietary fiber. Though the mean of the fitter consumption of the Indonesian population is still very far from these recommendations, it is 9.9 - 10.7 grams per day (Jauhari & Sumarno, 2002). On the other hand, Santoso (2011) stated that dietary fiber is able to promote health conditions, such as weight control or obesity, diabetes management, gastrointestinal disorders, blood cholesterol levels, and cardiovascular diseases.

Purple sweet potato flour is one of the local flours in Indonesia that comes from purple sweet potatoes, which are widely cultivated in the country. The stages in producing purple sweet potato flour include washing, peeling, slicing, drying for 5 hours at 60 °C, milling, and sieving (Ambarsari *et al*., 2009). Purple sweet potato flour has a distinctive and robust aroma arising from the breakdown of starch into shorter glucose chains during the heating process, resulting in the characteristic scent of sweet potatoes (Nurminah, 2019). The purple sweet

potato flour also contains 12.9% dietary fiber (Kementerian Kesehatan RI, 2018).

Rice crust flour is formed from rice that has been dried until it forms a crust, slightly hardened and slightly scorched at the bottom of the rice cooker or pot (Hidayat & Sutrisno, 2018). Rice crust flour contains a relatively high amount of resistant starch, which falls into the category of dietary fiber (AACC, 2001). Rice crust flour belongs to the type 3 resistant starch, which is retrograded starch due to processing (Ha, 2012). According to Ha (2012), the content of resistant starch in rice crust flour is 13.9%, equivalent to 139 mg/g. To date, there have been few studies exploring rice crust flour despite its significant potential, especially due to its high dietary fiber content. This research is conducted as an effort to optimize the potential of rice crust flour, particularly in its application in food products.

In this research, the development of high-fiber snack bar products was undertaken using purple sweet potato flour and rice crust flour as the main ingredients. These flours were chosen due to their high dietary fiber content, making them potential sources for producing high-fiber snack bars as an alternative snack to fulfill daily dietary fiber needs. The ratios of purple sweet potato flour and rice crust flour were varied to obtain the best snack bar formula, considering sensory, chemical, and physical aspects. Rice crust flour was added to replace purple sweet potato flour in the formulated mixture, and a higher quantity of purple sweet potato flour was needed. This substitution was made due to the greater availability of purple sweet potato flour in the market, whereas rice crust flour needed to be produced independently. Therefore, raw material availability would not pose an issue if this product were to be further developed and produced on a larger scale in the future. The high dietary fiber claim in this study adheres to the Indonesian National Agency of Drug and Food Control (BPOM) Regulation No. 1 of 2022 on the Monitoring of Claims on Product Labels and Advertising for Processed Foods on the Profile of Scheme of Labeling describes that the food claim "high or rich in dietary fiber," to be on the label on the cover of the package, should contain a minimum of 6 grams of dietary fiber per 100g of the food. (BPOM, 2022).

MATERIALS AND METHOD

Materials

Production of snack bars uses ingredients such as rice, purple sweet potato flour (Mama Kamu, Yogyakarta, Indonesia), red bean flour (Lingkar Organik, PT. Lingkar Organik, Indonesia), pumpkin seeds (Point), raisins (Point), chia seeds (Point), honey (Madu Nusantara, PT. Madu Murni Nusantara, Indonesia), unsalted butter (Anchor, imported by PT. Fonterra Brands Indonesia), eggs, Fiber Crème (Ellenka, PT. Lautan Natural Krimerindo, Indonesia), CMC (Koepoe Koepoe, PT. Gunacipta Multirasa, Indonesia), salt (Refina, PT. UnichemCandi Indonesia), chocolate flavoring (Koepoe Koepoe, PT. Gunacipta Multirasa, Indonesia), and vanilla powder (Koepoe Koepoe, PT. Gunacipta Multirasa, Indonesia).

The materials used for the sensory test include labels, tissues, mineral water (Vit, PT. Tirta Investama, Indonesia), and crackers (Roma, PT. Mayora Indah Tbk, Indonesia). The materials used for chemical property analysis include distilled water, catalyst (Merck Chemical and Life Sciences, Germany), concentrated sulfuric acid (H_2SO_4) (Mallinckrodt Chemicals, USA), 4% borax solution (Merck Chemical and Life Sciences, Germany), BCG-MR indicator (Merck Chemical and Life Sciences, Germany), sodium hydroxide-sodium thiosulfate (NaOH-$Na_2S_2O_3$) (Merck Chemical and Life Sciences, Germany), 0.02 N hydrochloric acid (HCl) (Mallinckrodt Chemicals, USA), filter paper, petroleum ether (Merck Chemical and Life Sciences, Germany), phosphate buffer pH 6.0 (CV. Chemix Pratama, Yogyakarta, Indonesia), alpha-amylase enzyme (Sigma Co., USA), protease enzyme (Xi'an Lyphar Biotech Co.Ltd, China), glucoamylase enzyme (Sigma Co., USA), 0.275 N NaOH, 0.325 N HCl, 95% ethanol (CV. Chemix Pratama, Yogyakarta, Indonesia), 78% ethanol (CV. Chemix Pratama, Yogyakarta, Indonesia), acetone (CV. Chemix Pratama, Yogyakarta, Indonesia), diatomaceous earth (celite) (CV. Chemix Pratama, Yogyakarta, Indonesia), and aluminum foil.

Analytical Equipment

The equipment used for sensory testing includes trays and evaluation forms. The equipment for physical testing includes a Universal Testing Machine (Z0.5, Zwick) and a Chromameter (CR-400, Konica Minolta). The equipment used for chemical testing includes an analytical balance (FSAR-210, Fujitsu), oven (UN-110, Memmert), crucible, muffle furnace (FUW220Pa, Advantec), electric stove (S-301, Maspion), Soxhlet apparatus, fat flask, Kjeldahl apparatus, Kjeldahl flask, pipette, measuring pipette, Erlenmeyer flask, stand, burette, measuring glass, beaker, measuring flask, spatula, water bath shaker (WNB45, Memmert), hotplate magnetic stirrer (SP-88850105, Thermo), and a vacuum pump.

Table 1. The composition of ingredients for the four high-fiber snack bar formulas

Ingredients	Formula (g)			
	F1	F2	F3	F4
Purple sweet potato flour	**40**	**36**	**32**	**28**
Rice Crust Flour	**0**	**4**	**8**	**12**
Red bean flour	3	3	3	3
Pumpkin seeds	3	3	3	3
Raisins	5	5	5	5
Chia seeds	6	6	6	6
Honey	20	20	20	20
Unsalted Butter	9	9	9	9
Egg whites	5.5	5.5	5.5	5.5
Egg yolks	5	5	5	5
Fiber Crème	1.7	1.7	1.7	1.7
CMC	0.8	0.8	0.8	0.8
Salt	0.3	0.3	0.3	0.3
Chocolate flavoring	0.2	0.2	0.2	0.2
Vanilla powder	0.5	0.5	0.5	0.5
Total ingredients	100	100	100	100

Note: (F1) formula with 100% purple sweet potato flour and 0% rice crust flour, (F2) formula with 90% purple sweet potato flour and 10% rice crust flour, (F3) formula with 80% purple sweet potato flour and 20% rice crust flour, (F4) formula with 70% purple sweet potato flour and 30% rice crust flour.

Production of rice crust flour

The production of rice crust flour is based on the research by Nuraini and Widanti (2020) with some modifications. The process of making rice crust flour starts with making rice crust from white rice. White rice is washed with clean water. Then, the rice is partially cooked with water. The partially cooked rice is then cooked in a non-stick pan, spreading it evenly on the pan's surface until it becomes a uniform thickness. Cook until the rice layer dries and can be easily removed from the pan. Next, the finished rice crust is dried under the cabinet dryer with a temperature of 60 °C for about 10 hours, at which point the rice crust is absolutely dry and crispy. After the rice crust is dried, it is crumbing in a grinder and sifted with a 60-mesh sieve.

Production of snack bar

The main ingredients of the snack bar production are rice crust flour and purple sweet potato flour, with their quantities varied. The interval value of the ratio between purple sweet potato flour and rice crust flour in this research is 10%, which was determined through preliminary research (data are not shown). Based on sensory aspects, ratios below 10% could not be distinguished between treatments. Another consideration for determining this ratio is based on physical aspects, i.e., texture (level of hardness), and chemical aspects, i.e., dietary fiber content. Table 1 shows the component composition for four high-snack bar recipes.

The production of snack bars begins with reducing the size of pumpkin seeds, raisins, and chia seeds. Pumpkin seeds and raisins are reduced in size by slicing, while chia seeds are reduced to powder form using a blender. The purpose of reducing the size is to ensure even distribution of the ingredients throughout the snack bar. Next, all the ingredients are mixed in a single container, starting with the dry ingredients followed by the wet ones. Once homogenous, pour the mixture into a baking pan lined with baking paper. Subsequently, the mix is put in an oven, heated to 135 °C, and left to bake for 40 minutes. After the snack bar is fully cooked, it is cut into pieces with the size of 2.5 x 10 x 1 cm using a knife. The snack bars that have been cut are then packaged in aluminum foil and stored at room temperature.

Analysis Method

Physical properties are analyzed in terms of texture and color. Texture analysis (hardness) is conducted using a Universal Testing Machine (Z0.5, Zwick), while color analysis (lightness) is done with a Chromameter (CR-400, Konica Minolta). This research uses proximate analysis, including analysis of fat, protein, carbohydrates, moisture, and ash, conducted using the AOAC method (1995), while the analysis of dietary fiber is performed using the Enzymatic-Gravimetric method (AOAC, 1995). Sensory analysis is conducted with 60 untrained panelists using the Hedonic Preference Test and descriptive test. The

panelists scored the testing from 1-7, with the highest value representing the greatest preference level of panelists.

The method used to determine the best formula is the effectiveness index method (DeGarmo *et al*., 1984). This method involves weighting/scoring each parameter used in the analysis. The weights are assigned according to the importance level of each parameter in determining the properties of the snack bar product. The formula with the highest score is considered the best formula.

The methodology used in this study is a Single-Factor Completely Randomized Design with four treatment levels: F1, F2, F3, and F4, based on the differences in the ratio of purple sweet potato flour to rice crust flour. These four samples will be analyzed for their physical and chemical properties with two replications of each treatment, and each analysis will be repeated three times. The data from the chemical, physical, and sensory analysis will then be analyzed using IBM SPSS Statistics 26 software with One-Way ANOVA (if the data have a normal distribution) or the Kruskal-Wallis Test (if the data do not have a normal distribution). Subsequently, post-hoc tests will be done at 5% significant level using the Duncan Multiple Range Test (if the data has a normal distribution) or the Mann-Whitney Test (if the data does not).

RESULT AND DISCUSSION

Physical Properties Analysis

The physical properties analyzed in this research encompass texture (hardness) and color analysis. In the color analysis, the values extracted from the results include the lightness value (L*), allowing for comparison with the lightness level in sensory analysis. Table 2 shows the results of the physical properties analysis, specifically hardness and lightness (L*), for the high-fiber snack bar products.

Based on statistical analysis using ANOVA and Post Hoc Duncan's test at a 5% significance level, it is evident that the hardness and lightness of the snack bar product are significantly impacted by the variation in the ratio of purple sweet potato flour and rice crust flour.

According to the lightness analysis, the snack bar's L* value increases in direct proportion to the quantity of rice crust flour used. The lighter the product's appearance, the higher the value of L*. The purple sweet potato flour has reducing sugars which can appear brownish after Maillard reaction during baking (Nindyarani *et al*., 2001). The Maillard reaction is a process that occurs between reducing sugars and amino acid or protein groups, producing a brown color in food products (Winarno, 2002). Moreover, physically, purple sweet potato flour has a dark purple color because of the presence of anthocyanin pigments, thus making the snack bar product darker. Therefore, the more purple sweet potato flour is used, the darker the color of the obtained product will be. The color analysis results, in the form of lightness levels obtained through a chromameter, align with the descriptive test in sensory analysis.

In the hardness analysis, an increase in the ratio of rice crust flour added resulted in higher hardness values in the produced snack bar. According to Cauvain and Linda (2008), a product's hardness may decrease as its water content rises. As stated by Nindyarani (2011), the moisture content (%wb) of purple sweet potato flour is 10.92±0.09%, while the moisture content (%wb) of rice crust flour is 1.12±0.09% (Nuraini & Widanti, 2020). The water content in rice crust flour is lower compared to purple sweet potato flour, so an increase in the ratio of rice crust flour used will also increase the hardness values of the product. The amylose content in the flour used can also influence the hardness level of the snack bar product. According to Koswara (2009), starch with a high amylose content tends to produce hard and dense products. The amylose percentage of rice crust flour ranges from 25.04% to 25.52%, whereas the amylopectin level ranges from 48.07% to 48.73% (Broto *et al*., 2013). On the other hand, purple sweet potato flour has an amylose content of 24.79% and an amylopectin content of 49.78% (Nindyarani *et al*., 2011).

Table 2. Results of the physical analysis of high-fiber snack bars

	F1	F2	F3	F4
Hardness (N)	70.23 ± 8.05^{a}	78.79 ± 10.05^{ab}	83.01 ± 10.23^{b}	90.59 ± 10.03^{b}
Lightness (L*)	32.22 ± 0.49^{a}	32.60 ± 0.95^{ab}	32.88 ± 0.37^{ab}	33.09 ± 0.43^{b}

Note: The values presented are the mean ± standard deviation. Significant differences at 5% significance level (p<0.05) were indicated by different notations within the same row (based on the One-Way ANOVA and post hoc Duncan test)

Table 3. Results of the chemical analysis of high-fiber snack bars.

	F1	F2	F3	F4
Moisture (%wb)	15.24 ± 0.32^{c}	14.58 ± 0.07^{b}	14.13 ± 0.14^{a}	13.91 ± 0.12^{a}
Ash (%db)	3.06 ± 0.13^{b}	2.81 ± 0.29^{ab}	2.62 ± 0.28^{a}	2.66 ± 0.14^{a}
Protein (%db)	6.05 ± 0.22^{a}	6.26 ± 0.20^{ab}	6.34 ± 0.18^{b}	6.50 ± 0.16^{b}
Fat (%db)	16.06 ± 0.30^{a}	16.10 ± 0.08^{a}	16.08 ± 0.46^{a}	16.49 ± 0.13^{b}
Carbohydrates (%db)	74.82 ± 0.36^{a}	74.83 ± 0.43^{a}	74.97 ± 0.75^{a}	74.35 ± 0.14^{a}
Dietary fiber (%db)	18.92 ± 1.43^{a}	18.33 ± 0.79^{a}	18.56 ± 2.73^{a}	19.48 ± 0.40^{a}
Energy (kcal)	119.03 ± 0.70^{a}	120.26 ± 0.28^{b}	121.05 ± 0.50^{c}	121.84 ± 0.20^{d}

Note: The values provided represent the average ± variation from the average. Distinct letters within the identical column signify notable distinctions at a 5% significance level (p<0.05) as determined by the One-Way ANOVA and post hoc Duncan test.
(F1) formula with 100% purple sweet potato flour and 0% rice crust flour, (F2) formula with 90% purple sweet potato flour and 10% rice crust flour, (F3) formula with 80% purple sweet potato flour and 20% rice crust flour, (F4) formula with 70% purple sweet potato flour and 30% rice crust flour.

The snack bar product analyzed in this research has a greater degree of hardness in comparison to comparable products. In the study by Rahayu *et al*. (2022) involving arrowroot flour and red bean flour snack bars, the hardness level was reported as 37.52 N. The amylose content in arrowroot flour is 11.72%, and its amylopectin content is 71.98% (Suhaili *et al*., 2013), while the amylose and amylopectin content in red bean flour is 15.44% and 27.61%, respectively (Astuti *et al*., 2019). Furthermore, in the research by Hartaty *et al*. (2017) with snack bars made from pumpkin flour, corn flour, and jackfruit puree, the hardness level ranged from 5.73N to 7.05 N. The amylose content in pumpkin flour is 9.86%, and its amylopectin content is 1.22% (Purnamasari, 2015). In contrast, the amylose and amylopectin content in corn flour is 21.53-29.80% and 45.77-59.57% (Ekafitri, 2009). Based on the data from both studies, it can be observed that the flours used in the snack bar products for each study have lower amylose content than the snack bar product in this research, resulting in a lower hardness level.

Chemical Properties Analysis

The chemical characteristics of the four high-fiber snack bar formulas are shown in Table 3. The statistical analysis conducted using ANOVA and Post Hoc Duncan's test at a 5% significance level clearly demonstrates that the variation in the ratio of purple sweet potato flour and rice crust flour has a significant impact on the moisture, ash, protein, fat content, and energy of the snack bar products. However, it does not have a substantial impact on the carbohydrate and dietary fiber levels.

The snack bars' moisture content decreased in proportion to the quantity of purple sweet potato flour used, as shown by the moisture content analysis. The reason for this is that purple sweet potato flour contains a greater amount of water compared to rice crust flour. According to Nindyarani (2011), the moisture content of purple sweet potato flour is 10.92±0.09% (wb), while the moisture content of rice crust flour is 1.12 ± 0.09% (wb) (Nuraini & Widanti, 2020). Consequently, reducing the quantity of purple sweet potato flour utilized results in a decrease in the moisture level of the snack bar product. The USDA (2018) sets the standard moisture content for snack bar products at 11.26% (wb), so all four formulas have a moisture content above the set standard.

Ash content is the inorganic component that remains after the burning of organic material and is directly connected to a substance's mineral content (Sandjaja, 2009). This study discovered that lowering the quantity of purple sweet potato flour used in the snack bars resulted in a corresponding decrease in the ash content. This is because purple sweet potatoes contain various minerals, including calcium, phosphorus, iron, sodium, potassium, copper, and zinc. (Kementerian Kesehatan RI, 2018). The USDA (2018) sets the standard ash content for snack bar products at 1.72%, so all four formulas have ash content above the standard.

In the analysis of protein content, using more rice crust flour results in a corresponding increase in protein content. The reason for this is that rice crust flour contains a greater amount of protein than purple sweet potato flour.

Table 4. Sensory analysis results of high-fiber snack bars

Sensory outcome	F1	F2	F3	F4
Color[1]	5.15 ± 0.80[b]	4.88 ± 1.25[ab]	4.55 ± 1.38[a]	4.48 ± 1.35[a]
Hardness[2]	4.67 ± 1.35[a]	4.67 ± 1.32[a]	4.63 ± 1.58[a]	4.40 ± 1.48[a]
Aroma preference[3]	4.62 ± 1.33[a]	4.35 ± 1.25[a]	4.23 ± 1.40[a]	4.47 ± 1.55[a]
Taste preference[3]	4.12 ± 1.26[a]	4.45 ± 1.29[a]	4.47 ± 1.26[a]	4.65 ± 1.47[a]
Aftertaste preference[3]	4.72 ± 1.42[a]	4.45 ± 1.49[a]	4.48 ± 1.50[a]	4.88 ± 1.47[a]
Overall preference[3]	4.18 ± 1.21[a]	4.48 ± 1.11[ab]	4.48 ± 1.14[ab]	4.82 ± 1.41[b]

Note: The values presented are the mean ± standard deviation. Significant differences at 5% significance level ($p<0.05$) were indicated by different notations within the same row (based on the One-Way ANOVA and post hoc Duncan test)
[1]Value 1= highly light, 2= light, 3= relatively light, 4= neutral, 5= a little dark, 6= dark, 7= extremely dark.
[2]Value 1= highly soft, 2= soft, 3= relatively soft, 4= neutral, 5= a bit hard, 6= hard, 7= extremely hard.
[3]Value 1= extremely, 2= dislike, 3= somewhat dislike, 4= neutral, 5= somewhat like, 6= like, 7= strongly like.

The protein content of rice crust flour is 5.99% according to Nuraini and Widanti (2020), whereas the protein content of purple sweet potato flour is 2.8% as reported by Kementerian Kesehatan RI (2018). Therefore, incorporating rice crust flour into the snack bar product can enhance its protein content. According to the USDA (2018), the standard protein content for snack bar products is 9.38%. Therefore, all four formulas still have protein content that is lower than the set standard.

Regarding the fat content, an increase in the ratio of rice crust flour used resulted in an increase in the fat content. Based on the data from Kementerian Kesehatan RI (2018), the fat content of purple sweet potato flour is 0.6%, while the fat content of rice is 0.5%. The fat content in purple sweet potato flour and rice is not significantly different. Therefore, the fat content in all four formulas should also not be significantly different. This deviation may occur due to uneven distribution of materials, such as pumpkin seeds, in the tested sample, thereby affecting the final test results. Yellow pumpkin seeds contain a relatively high-fat content, amounting to 6.68% (Suwanto & Rahmawati, 2019). The USDA (2018) sets the standard fat content for snack bar products at 10.93%, while SNI 01-4216-1996 sets the standard at 1.4% – 14%, so all four formulas have fat content above the standards.

According to Regulation Number 1 of 2022 from the Indonesian National Agency of Drug and Food Control, in order for a solid food product to be considered "high or rich in dietary fiber", it must contain a minimum of 6 grams of dietary fiber per 100 grams of the product, or 6% dietary fiber (BPOM, 2022). Based on this regulation, all four snack bar formulas in this research can meet the "high in fiber" claim as they have dietary fiber content above 6%. The high dietary fiber content also affects the texture of the final snack bar product, namely its crumbly texture and non-compact structure.

The calculation of the total energy using the empirical formula is highly influenced by carbohydrates, proteins, and fats. The lower the content of these components, the lower the total calories. Sample F1 (100% purple sweet potato flour, 0% rice crust flour) has the lowest calorie content at 119.03±0.70 kcal, while sample F4 (70% purple sweet potato flour, 30% rice crust flour) has the highest calorie content at 121.84±0.20 kcal. Compared to a similar commercial product in the Indonesian market, Soyjoy, which has an energy content of 130 – 160 kcal, all four formulas in this research have lower calorie content. As a result, the snack bar products in this research have a strong chance of being developed as an alternate snack for those on a low-calorie diet, particularly to help avoid obesity-related disorders.

Sensory Analysis

According to the sensory test results presented in Table 4, at a significance level of 5%, the color and overall preference qualities are significantly impacted by the variation in the ratio between purple sweet potato flour and rice crust flour. The characteristics of hardness and preference for aroma, taste, and aftertaste, on the other hand, are not greatly impacted by it.

The color attribute of the product exhibited a direct correlation with the percentage of purple sweet potato

Table 5. The evaluation results of the best snack bar formula

Parameter		WV	WVP	Result Value			
				F1	F2	F3	F4
Sensory Properties	Overall	8	0.17	0.00	0.10	0.10	0.22
	Taste	7	0.14	0.00	0.12	0.13	0.19
	Aftertaste	6	0.11	0.10	0.00	0.01	0.17
	Aroma	5	0.08	0.14	0.04	0.00	0.09
Chemical Properties	Dietary fiber	4	0.22	0.06	0.00	0.02	0.11
	Moisture content	3	0.19	0.00	0.04	0.07	0.08
Physical Properties	Texture	2	0.06	0.00	0.02	0.03	0.06
	Color	1	0.03	0.00	0.01	0.02	0.03
Total value		36	1	0.30	0.35	0.39	0.95

Note:
WV = Weighted Value
WVP = Weighted Value of Parameter

flour used, wherein a reduction in the flour amount led to a corresponding decrease in the darkness of the product. This occurs because purple sweet potato flour contains reducing sugars that undergo the Maillard reaction during baking, resulting in a brownish-purple color of the product (Nindyarani, 2011). Therefore, reducing purple sweet potato flour makes the snack bar product appear lighter. The descriptive test results for the color attribute in the sensory analysis are consistent with the color analysis conducted using a chromameter. It was observed that lowering the quantity of purple sweet potato flour used led to a lighter color of the snack bar product.

The panelists' overall preference for the snack bar product tends to correlate positively with the percentage of rice crust flour used. Formula F1 (100% purple sweet potato flour, 0% rice crust flour) has the lowest overall preference, with a score of 4.18 ± 1.21. Formula F4 (70% purple sweet potato flour, 30% rice crust flour) has the highest overall preference, with a score of 4.82 ± 1.41.

Best Formula Determination

The evaluation results of the best snack bar formula are displayed in Table 5.The method used to determine the best formula is the effectiveness index method (DeGarmo *et al*., 1984). Three parameters were used to determine the best formula, namely sensory properties, chemical properties, and physical properties. Sensory properties had the highest weight because they are related to consumers, which includes aroma, taste, aftertaste, and overall preference. The next parameter was chemical properties, namely the fiber content and moisture content. The fiber content is a crucial parameter in determining the best formula, as this research primarily aims to create a product with high fiber content. Moisture content is considered a parameter because it will influence the shelf life of the snack bar product. Other chemical properties are not considered as parameters in determining the best formula since they are not the main focus of this research and only serve as supporting parameters. Then, the parameter with the smallest value was the physical properties, including color and texture. Physical properties also influence consumer acceptance. According to the assessments, the best snack bar formula in this research was formula F4, with a ratio of 70% purple sweet potato flour and 30% rice crust flour, with a result value of 0.95.

CONCLUSIONS

The decrease in the percentage of purple sweet potato flour in the ratio of purple sweet potato flour and rice crust flour affected the physical characteristics of the snack bar, including an increase in the hardness and lightness levels of the product. It also affected the chemical properties of the snack bar, resulting in a decrease in moisture and ash content while increasing protein and fat content. Additionally, it affected the snack bar's sensory properties, leading to an increase in the intensity of color lightness and an overall increase in panelist's preference for the snack bar. Formula F4 (70% purple sweet potato flour, 30% rice crust flour) was the best high-fiber snack bar formula based on its physical, chemical, and sensory properties, with a dietary fiber content of 19.48 ±

0.40%db. Further improvements in the formula are needed to reduce the hardness of the snack bar.

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