

The Effect Of The Substitution Of Soybean Flour, Butternut Squash Flour, And Brown Rice Flour On The Acceptability And Nutritional Content Of Almond Crispy

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ABSTRACT

Almond crispy is a popular snack due to its sweet taste and crispy texture. It is commonly made from wheat flour, eggs, margarine, powdered sugar, and cornstarch. In Indonesia, wheat flour production still depends heavily on imported wheat, making it necessary to develop products using locally sourced flour substitutes. This study aimed to determine the effect of substituting soybean flour, butternut squash flour, and brown rice flour on the acceptability (color, aroma, texture, taste, and aftertaste) and nutritional content (protein and dietary fiber) of almond crispy. This study employed a true experimental design using a Completely Randomized Design (CRD). A sensory evaluation was conducted 40 untrained panelists who assessed four formulations of almond crispy F1 (40% soybean flour : 10% butternut squash flour), F2 (30% soybean flour : 20% butternut squash flour), F3 (20% soybean flour : 30% butternut squash flour), and F4 (10% soybean flour : 40% butternut squash flour), with each formulation containing 40% brown rice flour. The results of the Kruskal Wallis and Mann-Whitney tests indicated that the substitution of soybean flour, butternut squash flour, and brown rice flour significantly affected the acceptability attributes of almond crispy, including color, aroma, texture, taste, and aftertaste ($p < 0,05$). Based on the sensory evaluation, the best formulation was F2, containing 30% soybean flour and 20% butternut squash flour. The nutritional analysis of F2 revealed that every 100 g of almond crispy contained 11,24 g of protein and 1,47 g of dietary fiber.

Keyword : *Almond Crispy, Brown Rice, Butternut Squash, Soybean*

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INTRODUCTION

Almond crispy is a popular snack due to its delicious flavor, characterized by a combination of sweetness and a crispy texture (Aprilia & Oktafiani, 2023). In addition to its appealing taste, almond crispy has a relatively long shelf life, a practical form, and is convenient to consume, making it suitable for snacking both at home and during outdoor activities. The nutritional facts of the commercially available "Punpun" Red Velvet Almond Crispy indicates that every 100 g of the product contains 566.7 kcal of energy, 36.7 g of total fat, 6.7 g of protein, 20 g of carbohydrates, and 6.7 g of dietary fiber. According to the Indonesian Food and Drug Authority (BPOM) Regulation No. 1 of 2022 concerning the Supervision of Claims on Processed Food Labels and Advertisements, a product may be classified as a source of protein if it contains at least 20% of the Nutrient Reference Value (NRV) per 100 g, whereas a high or rich in protein claim may be made if the product contains at least 35% of the NRV per 100 g. Based on the nutrition information stated on the product label, the protein content of "Punpun" Almond Crispy provides approximately 13.3% of the NRV per 100 g. In contrast, the dietary fiber content exceeds 6 g per 100 g. Therefore, in accordance with BPOM Regulation No. 1 of 2022, the product meets the requirements to be classified as a high-fiber food, and the "high in fiber" claim displayed on the product packaging is consistent with the applicable regulations.

Almond crispy is generally made from a mixture of wheat flour, eggs, margarine, powdered sugar, and cornstarch (Wicaksono & Handayani, 2023). Meanwhile, wheat flour remains the primary ingredient in almond crispy production despite Indonesia's heavy dependence on imported wheat, as the country's climate is not suitable for optimal wheat cultivation (Ibrohim et al., 2025). This

dependence is reflected in the increasing volume of wheat and meslin imports, which reached 11.7 million tons in 2024, up from 10.6 million tons in 2023 (Badan Pusat Statistik, 2025). Wheat flour is extensively used in the production of various processed foods, including bread, biscuits, instant noodles, and breakfast cereals (Putri N. P. A. M. & Karmini, 2023). These conditions highlight the need to develop food products utilizing locally sourced flour substitutes to reduce dependence on imported raw materials while supporting food diversification.

One of the local food ingredients with the potential to be used as a substitute for wheat flour is soybean flour. Soybeans are recognized as one of the plant-based food sources with a high protein content, containing approximately 30.2 g of protein per 100 g and possessing the most complete essential amino acid profile among legumes (Syafriani et al., 2024). Their protein content is higher than that of mung beans (22.9 g), red beans (22.1 g), and peanuts (27.9 g) per 100 g (Aninditia et al., 2023). Owing to its superior nutritional quality, soybean flour has considerable potential to enhance the protein content of almond crispy. Protein plays an essential role in tissue formation, maintenance, and regeneration, antibody production, and hormone synthesis that regulates numerous physiological functions (Akmaliyah, 2025).

Another local food ingredient with the potential to be developed as a substitute for wheat flour is butternut squash. Butternut squash is rich in carbohydrates and dietary fiber (Pradana & Ratnaningsih, 2021). Every 100 g contains 45 kcal of energy, 1 g of protein, 0.10 g of fat, 11.69 g of carbohydrates, and 2 g of dietary fiber. Its fiber content is higher than that of common pumpkin, which contains approximately 0.5 g of fiber, and parang pumpkin, which contains about 1.5 g of fiber per 100 g. Dietary fiber contributes to digestive health, helps prevent constipation, and promotes prolonged satiety, thereby supporting weight management (Saras, 2023). Despite these nutritional advantages, butternut squash consumption in Indonesia remains relatively low, accounting for only about 2% of the national vegetable consumption, indicating that its utilization as a food ingredient has not been fully optimized (Pradana & Ratnaningsih, 2021).

Brown rice (*Oryza nivara*) is recognized as a type of rice that offers various advantages over white rice. It is a fiber-rich food ingredient, making it an excellent dietary choice to help meet daily fiber requirements and support digestive health (Diana & Anggreini, 2023). Every 100 g of brown rice contains 352 kcal of energy, 7.3 g of protein, 0.9 g of fat, 76.2 g of carbohydrates, and 0.8 g of dietary fiber. Morendra et al. (2021) reported that substituting wheat flour with 70% to 80% brown rice flour produced products with more desirable textural characteristics, resulting in a crispier and more brittle texture preferred by panelists. The incorporation of brown rice flour as a substitute can be an effective approach to improve the crispness of the product while increasing its nutritional value, particularly its dietary fiber content.

Therefore, this study aims to analyze the effects of substituting wheat flour with soybean flour, butternut squash flour, and brown rice flour on the sensory acceptability of almond crispy, including color, aroma, texture, taste, and aftertaste, as well as to determine the protein and dietary fiber contents of the best-performing formulation. This study is significant because it provides an alternative approach to developing nutritious snack products based on local food resources while supporting food diversification and reducing dependence on imported wheat flour.

METHODE

This study employed a true experimental design using a Completely Randomized Design (CRD). The study aimed to analyze the effect of soybean flour, butternut squash flour, and brown rice flour substitutions on the acceptability and nutritional content of almond crispy. The study was conducted from May to July 2026 at the Dietetics and Culinary Laboratory of Surabaya State University, while nutritional analysis was conducted at the Food Analysis Laboratory of Jember State Polytechnic.

The acceptability test was conducted with 40 untrained panelists who evaluated almond crispy products prepared in four formulations: F1 (40% soybean flour and 10% butternut squash flour), F2 (30% soybean flour and 20% butternut squash flour), F3 (20% soybean flour and 30% butternut squash flour), and F4 (10% soybean flour and 40% butternut squash flour), with a constant substitution of 40% brown rice flour in each formulation. Each panelist evaluated one almond crispy

weighing approximately 5 grams from each formulation, while protein and dietary fiber analyses were conducted on 100 grams of the best formulation from the acceptance test.

The research instruments included a research explanation sheet, a consent form, an organoleptic test sheet, and a de Garmo method form. Acceptability was assessed using a preference scale for color, aroma, texture, taste, and aftertaste, while protein and dietary fiber content were analyzed using the Kjeldahl method and enzymatic gravimetry. The best formulation was determined using the de Garmo method (Kartika et al., 2025). Data were analyzed descriptively and using the Kruskal-Wallis test, followed by the Mann-Whitney test if significant differences were found ($p < 0,005$).

RESULT AND DISCUSSION

Acceptance Test Results

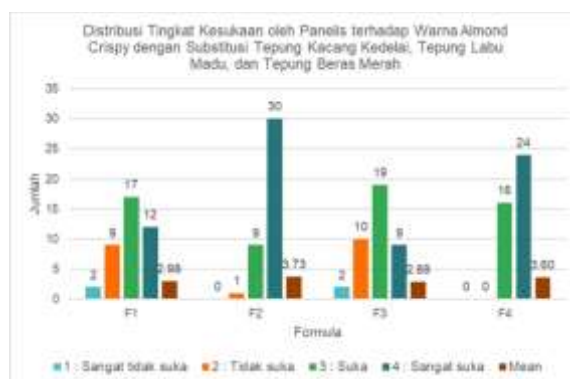


Figure 1 Distribution of Color Preference Levels

Statistical tests using Kruskal Wallis showed significant differences ($p < 0.001$) in the color characteristics of almond crispy with soybean flour, butternut squash flour, and brown rice flour substitutions. Therefore, further analysis using the Mann-Whitney test was necessary to determine the differences in the effects of each formula.

Table 1 Results of the Mann–Whitney Test for Almond Crispy Color

Treatment	Asymp. Sig. (2-tailed)
F1 with F2	<0.001
F1 with F3	0.562
F1 with F4	<0.001
F2 with F3	<0.001
F2 with F4	0.185
F3 with F4	<,001

Table 2 Notation of Color

Treatment	Mean	Notation
F1	2.98	a
F2	3.73	b
F3	2.88	a
F4	3.60	b

Based on the results of the Mann-Whitney statistical test, it shows that the level of preference for the color of almond crispy with substitutions of soybean flour, butternut squash flour, and brown rice flour did not have a significant difference ($p > 0.05$) in treatments F1 with F3 and F2 with F4. However, there were significant differences ($p < 0.05$) in treatments F1 with F2, F1 with F4, F2 with F3, and F3 with F4.

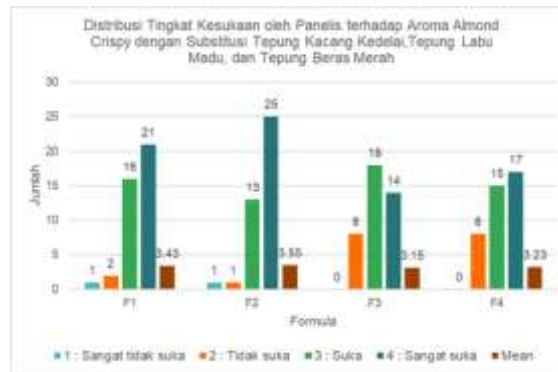


Figure 2 Distribution of Aroma Preference Levels

Statistical tests using the Kruskal Wallis test revealed a significant difference ($p=0.035$) in the aroma characteristics of almond crispy when substituting soybean flour, butternut squash flour, and brown rice flour. Therefore, further analysis using the Mann-Whitney test was necessary to determine the differences in the effects of each formula.

Table 3 Results of the Mann-Whitney Test for Almond Crispy Aroma

Treatment	Asymp. Sig. (2-tailed)
F1 with F2	0.360
F1 with F3	0.069
F1 with F4	0.215
F2 with F3	0.008
F2 with F4	0.039
F3 with F4	0.619

Table 4 Notation of Aroma

Treatment	Mean	Notation
F1	3.43	ab
F2	3.55	a
F3	3.15	b
F4	3.23	b

Based on the results of the Mann-Whitney statistical test, it shows that the level of preference for the aroma of almond crispy with the substitution of soybean flour, butternut squash flour, and brown rice flour did not have a significant difference ($p>0.05$) in treatments F1 with F2, F1 with F3, F1 with F4, and F3 with F4. However, there was a significant difference ($p<0.05$) in treatments F2 with F3 and F2 with F4.

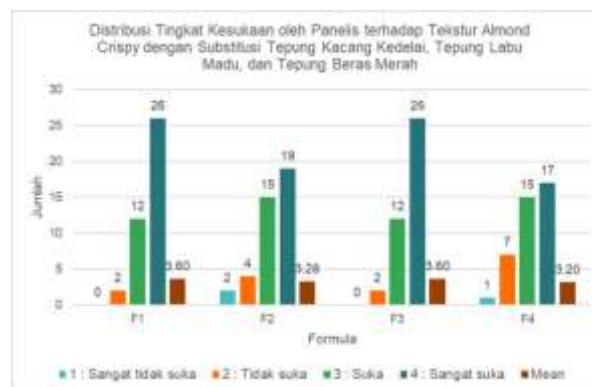


Figure 3 Distribution of Texture Preference Levels

Statistical tests using the Kruskal Wallis test revealed a significant difference ($p=0.035$) in the texture characteristics of almond crispy when substituting soybean flour, butternut squash flour, and brown rice flour. Therefore, further analysis using the Mann-Whitney test was necessary to determine the effect of each formula.

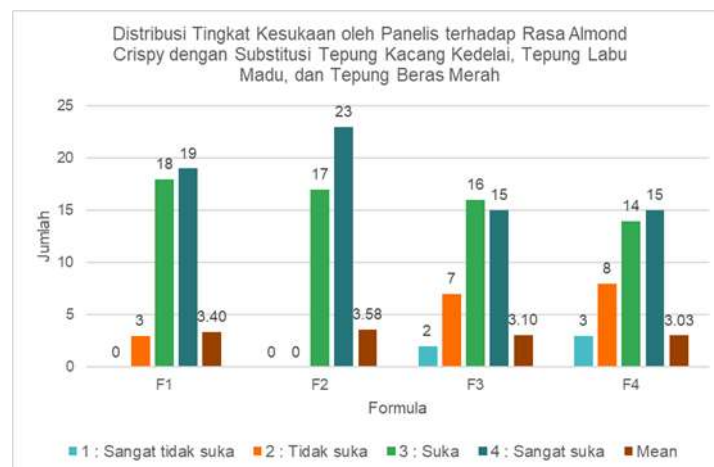
Table 5 Results of the Mann–Whitney Test for Almond Crispy Texture

Treatment	Asymp. Sig. (2-tailed)
F1 with F2	0.076
F1 with F3	1,000
F1 with F4	0.022
F2 with F3	0.076
F2 with F4	0.603
F3 with F4	0.022

Table 6 Notation of Textures

Treatment	Mean	Notation
F1	3.60	a
F2	3.28	ab
F3	3.60	a
F4	3.20	b

Based on the results of the Mann-Whitney statistical test, it shows that the level of preference for the texture of almond crispy with substitutions of soybean flour, butternut squash flour, and brown rice flour did not have a significant difference ($p > 0.05$) in treatments F1 with F2, F1 with F3, F2 with F3, and F2 with F4. However, there was a significant difference ($p < 0.05$) in treatments F1 with F4 and F3 with F4.

**Figure 4 Distribution of Taste Preference Levels**

Statistical tests using the Kruskal Wallis test revealed a significant difference ($p = 0.020$) in the flavor characteristics of almond crispy when substituting soybean flour, butternut squash flour, and brown rice flour. Therefore, further analysis using the Mann-Whitney test was necessary to determine the differences in the effects of each formula.

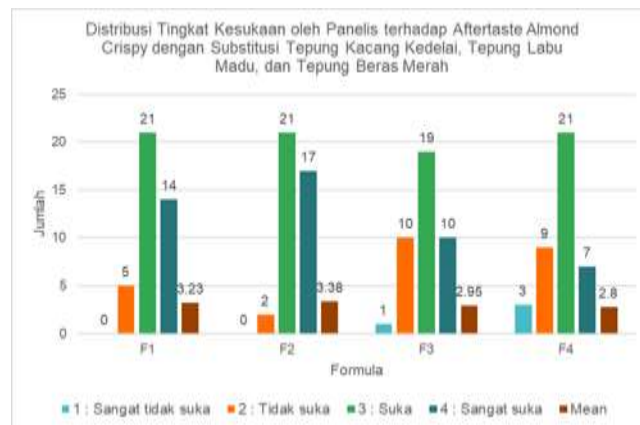
Table 7 Results of the Mann–Whitney Test for Almond Crispy Taste

	Asymp. Sig. (2-tailed)
F1 with F2	0.248
F1 with F3	0.143
F1 with F4	0.091
F2 with F3	0.012
F2 with F4	0.008
F3 with F4	0.779

Table 8 Notation of Taste

Treatment	Mean	Notation
F1	3.40	ab
F2	3.58	a
F3	3.10	b
F4	3.03	b

Based on the results of the Mann-Whitney statistical test, it shows that the level of preference for the taste of almond crispy with the substitution of soybean flour, butternut squash flour, and brown rice flour did not have a significant difference ($p>0.05$) in treatments F1 with F2, F1 with F3, F1 with F4, and F3 with F4. However, there was a significant difference ($p<0.05$) in treatments F2 with F3 and F2 with F4.

**Figure 5 Distribution of Aftertaste Preference Levels**

Statistical tests using the Kruskal Wallis test revealed a significant difference ($p=0.004$) in the aftertaste characteristics of almond crispy with the substitutions of soybean flour, butternut squash flour, and brown rice flour. Therefore, further analysis using the Mann-Whitney test was necessary to determine the differences in the effects of each formula.

Table 9 Results of the Mann–Whitney Test for Almond Crispy Aftertaste

Treatment	Asymp. Sig. (2-tailed)
F1 with F2	0.324
F1 with F3	0.114
F1 with F4	0.020
F2 with F3	0.012
F2 with F4	0.001
F3 with F4	0.472

Table 10 Notation of Aftertaste

Treatment	Mean	Notation
F1	3.23	ab
F2	3.38	a
F3	2.95	bc
F4	2.80	c

Based on the results of the Mann-Whitney statistical test, it shows that the level of preference for the aroma of almond crispy with the substitution of soybean flour, butternut squash flour, and brown rice flour did not have a significant difference ($p>0.05$) in treatments F1 with F2, F1 with F3, and F3 with F4. However, there were significant differences ($p<0.05$) in treatments F1 with F4, F2 with F3, and F2 with F4.

Table 11 Average Value of Almond Crispy Likeness Test Substituted with Soy Bean Flour, Butternut Squash Flour, and Brown Rice Flour

Parameter	Mean Value of Sample Preference Level							
	Test							
	F1		F2		F3		F4	
Color	2.98	± 0.862a	3.73	± 0.506b	2.88	± 0.822a	3.60	± 0.496b
Aroma	3.43	± 0.712ab	3.55	± 0.677a	3.15	± 0.736b	3.23	± 0.768b
Texture	3.60	± 0.591a	3.28	± 0.847ab	3.60	± 0.591a	3.20	± 0.823b
Flavor	3.40	± 0.632ab	3.58	± 0.501a	3.10	± 0.871b	3.03	± 0.947b
Aftertaste	3.23	± 0.660ab	3.38	± 0.586a	2.95	± 0.783bc	2.80	± 0.823c

Table 11 shows that there are significant differences in the parameters of color, aroma, texture, taste, and aftertaste in almond crispy products with substitutions of soybean flour, butternut squash flour, and brown rice flour.

Determining the Best Formula

Table 12 Results of Determining the Best Product with Average Analysis on Almond Crispy Substituted with Soybean Flour, Butternut Squash Flour, and Brown Rice Flour

Parameter	Treatment			
	F1 (051)	F2 (734)	F3 (178)	F4 (194)
Color	2.98	3.73	2.88	3.60
Aroma	3.43	3.55	3.15	3.23
Texture	3.60	3.28	3.60	3.20
Flavor	3.40	3.58	3.10	3.03
Aftertaste	3.23	3.38	2.95	2.80
Average	3.33	3.50	3.14	3.17

Table 13 Determination of the Difference Value between the Average Highest Value and the Average Lowest Value

Parameter	Order	Score	Treatment				The highest score	Lowest Value	Difference
			F1 (051)	F2 (734)	F3 (178)	F4 (194)			
Color	5	1	2.98	3.73	2.88	3.60	3.73	2.88	0.85
Aroma	3	3	3.43	3.55	3.15	3.23	3.55	3.15	0.40
Texture	2	4	3.60	3.28	3.60	3.20	3.60	3.20	0.40
Flavor	1	5	3.40	3.58	3.10	3.03	3.58	3.03	0.55
Aftertaste	4	2	3.23	3.38	2.95	2.80	3.38	2.80	0.58
Average		15	3.33	3.50	3.14	3.17	3.57	3.01	0.56

Table 14 Results of Determining the Best Product Using the De Garmo Method

Parameter	Weight	Treatment							
		F1		F2		F3		F4	
		NE	NP	NE	NP	NE	NP	NE	NP
Color	0.07	0.12	0.01	1	0.07	0	0	0.85	0.06
Aroma	0.2	0.69	0.14	1	0.2	0	0	0.19	0.04
Texture	0.27	1	0.27	0.19	0.05	1	0.27	0	0
Flavor	0.3	0.68	0.23	1	0.33	0.14	0.05	0	0
Aftertaste	0.13	0.74	0.10	1	0.13	0.26	0.03	0	0
Total	1		0.74		0.78		0.35		0.09

Parameter	Weight	Treatment							
		F1		F2		F3		F4	
		NE	NP	NE	NP	NE	NP	NE	NP
Ranking		2		1		3		4	

The ranking order in the De Garmo method is derived from an organoleptic assessment form, in which panelists rank five parameters—color, aroma, texture, taste, and aftertaste—in order of importance. These rankings are used to determine the weighting of each parameter in the De Garmo method to select the best almond crispy formulation.

The weighting was determined based on the influence of each parameter on product acceptance by panelists (Kartika et al., 2025). The weighting order, from highest to lowest, was taste, texture, aroma, aftertaste and color. Based on the average results and the De Garmo test, formulation F2 obtained the highest average value of 3.50 with a productivity value of 0.78, thus being determined as the best formulation.

Nutritional Content Test Results

Table 15 Nutritional Content Test Results

Parameter	Test Results	Unit	Method
Protein	11.24 ± 0.04	%	SNI 01-2891-1992
Dietary Fiber	1.47 ± 0.02	%	AOAC 2011.25

The nutritional content of Formula 2 almond crispy per 100 grams contains 11.24 g of protein and 1.47 g of dietary fiber. Protein content was analyzed using the Kjeldahl method and dietary fiber using the enzymatic-gravimetric method

DISCUSSION

Acceptance Test Results

1. Color Preference Level

In organoleptic testing, color is the first characteristic observed by panelists before evaluating other attributes. This initial assessment is made through the sense of sight, so color plays a role in forming first impressions of a product. Attractive colors can enhance visual appeal and encourage panelists to taste the product. (Makmur et al., 2022). Based on the results of the panelists' acceptance test for the color of almond crispy, it shows that the treatment with the highest preference value is F2, namely the formulation with a substitution of 30% soybean flour and 20% butternut squash flour, with an average value of 3.73. While the lowest preference value was obtained in treatment F3, namely the formulation with a substitution of 20% soybean flour and 30% butternut squash flour with an average value of 2.88.

The results of statistical analysis using the Kruskal–Wallis test showed an Asymp. Sig. value of <0.05 ($p < 0.001$). This indicates that there is a significant difference in the panelists' preference level for the color parameter in the almond crispy product substituted with soybean flour, butternut squash flour, and brown rice flour among the four formulations tested. This research is in line with research conducted by Aprilia & Oktafiani (2023), this indicates a significant difference in color preference for almond crispy with moringa leaf flour substitution ($p = 0.000$). The color change in almond crispy occurs as a result of increasing the proportion of moringa leaf flour used in the formulation. The higher the moringa leaf flour substitution level, the lower the product brightness level, resulting in a darker almond crispy color.

However, this research is not in line with research Jaya (2019) which showed that there was no significant difference in the level of color preference for purple sweet potato cookies with the addition of soybean flour ($p = 0.199$). This indicates that panelists were unable to distinguish the color characteristics of each treatment because all had a relatively similar appearance.

Almond crispy substituted with soybean flour, butternut squash flour, and brown rice flour, the almond crispy product has a yellow-brown color. The resulting color of the almond crispy product is influenced by the characteristics of the raw materials used. Based on the research results, Aninditia et al., (2023), increasing the proportion of soybean flour tends to result in a darker product color. This color change is influenced by the natural characteristics of soybean flour, which has a yellow-brown color. Furthermore, the flavonoid pigments in soybean flour react during the high-temperature roasting process, resulting in a darker color. Furthermore, the yellow color of the product is also influenced by the carotenoid pigments found in pumpkin flour. These compounds act as natural dyes, giving the product its characteristic yellow color. (Putri C.Y.K.C et al., 2019).

The browning that occurs in food products after heating, such as oven-baking, is a result of non-enzymatic browning known as the Maillard reaction. The Maillard reaction is a chemical process that occurs when compounds resulting from the breakdown of complex carbohydrates and proteins are heated at a specific temperature. This process involves the interaction between the amino groups of reducing carbohydrates. (Rahmawati & Saputrayadi, 2020). The protein ingredients are soybean flour, egg whites, and wheat flour. The reducing sugars come from butternut squash flour and the hydrolysis of starch from wheat flour, brown rice flour, and cornstarch during the heating process. This reaction produces melanoidin compounds, which contribute to the brown color of the product. (Rahmawati & Saputrayadi, 2020).

2. Aroma Preference Level

Aroma is a sensory attribute that influences panelists' acceptance of a food product. Aroma characteristics originate from volatile compounds released by the food. When the product is consumed, these volatile compounds evaporate in the oral cavity, allowing the aroma to be detected by the sense of smell. (Makmur et al., 2022). Based on the results of the panelists' acceptance test for the aroma of almond crispy, it showed that the treatment with the highest preference value was F2, namely the formulation with a substitution of 30% soybean flour and 20% butternut squash flour, with an average value of 3.55. While the lowest preference value was obtained in treatment F3, namely the formulation with a substitution of 20% soybean flour and 30% butternut squash flour with an average value of 3.15.

The results of statistical analysis using the Kruskal–Wallis test showed an Asymp. Sig. value of <0.05 ($p=0.035$). This indicates that there is a significant difference in the panelists' preference level for the aroma parameter among the four formulations tested for almond crispy products substituted with soybean flour, butternut squash flour, and brown rice flour. This research is in line with research conducted by Aprilia & Oktafiani (2023) showed that there was a significant difference in the level of preference for the aroma of almond crispy with the substitution of moringa leaf flour ($p=0.000$). This research is in line with the research Jaya (2019) which shows that there is a significant difference in the level of preference for the aroma of purple sweet potato cookies with the addition of soybean flour ($p=0.029$).

The best formulation F2, with a substitution of 30% soybean flour and 20% butternut squash flour, produced a distinctive aroma of soybean flour. The distinctive aroma that appears in soybean flour comes from the beany odor that is naturally present in soybeans. This beany odor is caused by the activity of the lipoxygenase enzyme found in soybean seeds. The lipoxygenase enzyme reacts with fat to produce ethylphenyl-ketone compounds that contribute to the distinctive beany odor of soybean-based products. (Simanjuntak & Pato, 2020). Meanwhile, the aromas from the butternut squash flour and brown rice flour were less pronounced because they were masked by the addition of vanilla and butter flavoring. The addition of vanilla and butter flavoring provided a more fragrant aroma, thus increasing panelists' acceptance of the almond crispy product.

3. Texture Preference Level

In organoleptic testing, texture is assessed through the ability of the sense of touch to perceive the physical characteristics of a product. (Indahsari et al., 2025). Texture plays a role in determining the level of consumer acceptance of food products, especially in snack products such as almond crispy. Based on the results of the panelist acceptance test on the texture of almond crispy, it shows that the treatment with the highest preference value is F1, namely the formulation with a substitution of 40% soybean flour and 10% butternut squash flour and F3, namely the formulation with a substitution of 20% soybean flour and 30% butternut squash flour with an average value of 3.60. While the lowest preference value was obtained in treatment F4, namely the formulation with a substitution of 10% soybean flour and 40% butternut squash flour with an average value of 3.20.

The results of statistical analysis using the Kruskal–Wallis test showed an Asymp. Sig. value <0.05 ($p=0.035$). This indicates that there is a significant difference in the level of panelists' preference for the texture parameter among the four formulations tested for almond crispy products substituted with soybean flour, butternut squash flour, and brown rice flour. This research is in line with research conducted by Aprilia & Oktafiani (2023) showed that there was a significant difference in the level of taste preference for almond crispy with the substitution of moringa leaf flour ($p=0.000$). This research is in line with research Hidayah et al., (2019) which shows that there is a significant difference in the level of preference for texture in sweet potato flour and soy flour cookies ($p=0.04$). However, this study is not in line with the research Jaya (2019) which showed that there was no significant difference in the level of texture preference of purple sweet potato cookies with the addition of soybean flour ($p=0.067$). This indicates that the panelists gave relatively similar assessments of the texture characteristics of the four samples given.

All almond crispy recipes have a characteristic crunchy texture. The crispy texture of the cookies can be influenced by the proportion of rice flour used. The higher the ratio of rice flour used, the crispier the

resulting cookies.(Rizky et al., 2018). In addition, adding a higher amount of soybean flour can produce a crispier cookie texture.(Hidayah et al., 2019). However, the F4 treatment with a 40% substitution of butternut squash flour achieved the lowest level of crispiness. Based on the research results Puspita et al., (2021), the texture characteristics of a food product can be influenced by the fiber content of its ingredients. Using ingredients high in fiber can result in a harder texture and reduced crispiness. This occurs because fiber components, particularly water-soluble fiber, have the ability to bind and retain water, thus suboptimally evaporating water during baking, resulting in a denser, harder texture.

4. Taste Preference Level

One of the aspects that determines an individual's level of preference for a food product is taste. Taste is an important component in evaluating food quality because it serves as a basis for consumers to assess whether a product has a desirable and acceptable flavor. The taste characteristics produced are influenced by the composition of raw materials used during the manufacturing process (Makmur et al., 2022). Based on the results of the panelists' acceptance test for the taste of almond crispy, the treatment with the highest preference score was F2, which consisted of a formulation with 30% soybean flour and 20% butternut squash flour substitution, with an average score of 3.58. Meanwhile, the lowest preference score was obtained in treatment F4, which consisted of a formulation with 10% soybean flour and 40% butternut squash flour substitution, with an average score of 3.03.

The statistical analysis using the Kruskal–Wallis test on the taste parameter showed an Asymp. Sig. value of <0.05 ($p=0.020$). These results indicate that almond crispy products substituted with soybean flour, butternut squash flour, and brown rice flour showed significant differences in panelists' preference levels for the taste parameter among the four tested formulations.

This study is in accordance with the research conducted by Aprilia & Oktafiani (2023), which showed that there was a significant difference in taste preference levels of almond crispy substituted with moringa leaf flour ($p=0.000$). However, this study differs from the research conducted by Hidayah et al. (2019), which showed that there was no significant difference in taste preference levels of cookies made with sweet potato flour and soybean flour ($p=0.148$). This indicates that the panelists provided relatively similar evaluations of the taste characteristics among the four samples tested.

The F2 treatment, which used a substitution of 30% soybean flour and 20% butternut squash flour, produced a balanced flavor between sweetness and savory taste and was in accordance with the panelists' preferences. In contrast, the F4 treatment with a composition of 10% soybean flour and 40% butternut squash flour produced a taste that tended to be sweeter. This may be attributed to the higher proportion of butternut squash flour used in the formulation. Butternut squash has characteristics of naturally sweet flavor, soft flesh texture, and a palatable taste that is widely preferred. The higher the proportion of butternut squash flour added, the more dominant the sweet taste produced in almond crispy becomes (Pradana & Ratnaningsih, 2021).

5. Aftertaste Preference Level

Aftertaste is the residual taste sensation that remains in the mouth after a product has been consumed. The characteristics of aftertaste are an important aspect in sensory evaluation because they can influence the final impression of a product. However, consumer acceptance of aftertaste is highly influenced by individual preferences, making its assessment subjective and varying among panelists (Fisdiana et al., 2021). Based on the results of the panelists' acceptance test for the aftertaste of almond crispy, the treatment with the highest preference score was F2, which was the formulation substituted with 30% soybean flour and 20% butternut squash flour, with an average score of 3.38. Meanwhile, the lowest preference score was obtained in treatment F4, which was the formulation substituted with 10% soybean flour and 40% butternut squash flour, with an average score of 2.80.

The results of statistical analysis using the Kruskal–Wallis test on the aftertaste parameter showed an Asymp. Sig. value of < 0.05 ($p = 0.004$). This indicates that almond crispy products substituted with soybean flour, butternut squash flour, and brown rice flour showed significant differences in panelists' preference levels for the aftertaste parameter among the four tested formulations.

The aftertaste characteristics of each formulation showed differences influenced by the proportion of substitution ingredients. Treatment F2, which was substituted with 30% soybean flour and 20% butternut squash flour, produced a relatively mild aftertaste, resulting in a less noticeable bitter taste that was still

acceptable to the panelists. In contrast, treatment F4 with 10% soybean flour and 40% butternut squash flour produced a more dominant characteristic aftertaste of butternut squash, causing the butternut squash flavor to remain noticeable after product consumption. Based on the research conducted by Winiastri (2021) on snack bar formulation with substitution of sorghum flour and pumpkin flour, an increase in pumpkin flour concentration has the potential to produce a more dominant beany or grassy flavor. The emergence of this flavor is associated with the flavonoid content present in pumpkin flour, which can affect the taste characteristics of food products (Sari & Kurniawati, 2023).

Nutritional Content Test Results

Based on the results of determining the best formulation, F2 was then compared with a commercial almond crispy product, the “Punpun” brand. The product was selected based on the consideration that the “Punpun” brand almond crispy has more complete nutritional value information on the packaging label than other commercial almond crispy products. In addition, the “Punpun” product has included a high fiber claim. The comparison was conducted to evaluate the differences in protein and dietary fiber content contained in every 100 g of almond crispy product with soybean flour, butternut squash flour, and brown rice flour substitutes with products already on the market. The results of the nutritional content comparison can be presented as follows.

Table 16 Comparison of Nutritional Content of Almond Crispy per 100 g

Parameter	Almond Modification	Crispy Almond High Fiber “Punpun”
Protein (g)	11.24	6.7
Dietary fiber (g)	1.47	6.7

In table 16, it is known that the modified almond crispy F2 with the substitution of soybean flour, butternut squash flour, and brown rice flour has a protein content of 11.24 g per 100 g, while the commercial almond crispy brand "Punpun" contains 6.7 g of protein per 100 g. These results indicate that the protein content of the modified almond crispy is higher than that of the commercial product. When compared with the quality requirements of cookies based on SNI 2973:2011, the protein content of the modified almond crispy has met the minimum standard protein requirements, which is a minimum of 5%. The increase in protein content comes from the use of soybean flour as a substitute material of 30% in the best formulation.

Among various types of legumes, soybeans are known to have the highest vegetable protein content. Whole soybeans contain around 35-40% protein, making them one of the highest sources of vegetable protein among other legumes.(Syafriani et al., 2024). The results of this study are in line with research Lestiarini & Rindiani (2023) which shows that the substitution of soybean flour in crispy cookies products increases the protein content along with the increasing proportion of soybean flour added.

In contrast to the protein content, the analysis results show that the dietary fiber content of modified almond crispy is only 1.47 g per 100 g, while commercial almond crispy contain 6.7 g of dietary fiber per 100 g. These results indicate that the dietary fiber content of commercial products is much higher than that of modified almond crispy. The difference in dietary fiber content may be influenced by the composition of the raw materials used. Commercial almond crispy products use a combination of moca flour and arrowroot flour which has a higher dietary fiber content compared to the combination of butternut squash flour and brown rice flour. In every 100 g of moca flour contains 6 g of fiber and arrowroot flour contains 0.4 g of fiber. Meanwhile, 100 g of butternut squash contains 2 g of fiber and brown rice contains 0.8 g of fiber. The difference in fiber content in the raw materials is a factor that causes the dietary fiber content of commercial almond crispy to be higher than that of modified almond crispy.

Commercial almond crispy products brand "Punpun" in one package consists of 5 servings. Based on the information on the packaging label, each serving has a serving size of 30 g which is equivalent to 6 pieces of almond crispy, so the weight of each piece is approximately 5 g. The comparison of the protein and dietary fiber content of modified almond crispy with substitutions of soybean flour, butternut squash flour, and brown rice flour and commercial almond crispy brand "Punpun" per 30 g serving is presented in the following table.

Table 17 Comparison of Nutritional Content of Almond Crispy per 30 g serving

Parameter	Almond Modification	Crispy Almond Crispy high Fiber “Punpun”
Protein (g)	3.37	2
Dietary fiber (g)	0.44	2

1. Protein Contribution for Snacks

Based on the results of the nutritional content test, the protein contribution of almond crispy with the substitution of soybean flour, butternut squash flour, and brown rice flour can be seen in the following table.

Table 18 Fulfillment of Protein Content Requirements in Almond Crispy per 30 g serving

Category	Age (year)	Daily Needs (20% of AKG) (g)	Contribution of Protein Intake that Meets (%)
Child	4-6	5	67.4
	7-9	8	42.1
Man	10-12	10	33.7
	13-15	14	24.1
	16-18	15	22.5
	19-29	13	25.9
	30-49	13	25.9
	50-64	13	25.9
	65-80	12.8	26.3
	10-12	4.4	76.6
Woman	13-15	13	25.9
	16-18	13	25.9
	19-29	12	28.1
	30-49	12	28.1
	50-64	12	28.1
	65-80	11.6	29.1

Based on the Recommended Dietary Allowance (RDA), one serving of 30g of modified almond crispy contains 3.37g of protein. Table 18 shows that this content can meet 22.5-76.6% of the protein requirement from a snack portion (20% of the RDA), depending on age and gender. The highest protein contribution was found in girls aged 10-12 years, at 76.6%, while the lowest contribution was found in boys aged 16-18 years, at 22.5%.

These results indicate that almond crispy substituted with soybean flour, butternut squash flour, and brown rice flour can provide protein as a snack for various age groups. Although the contribution varies depending on the protein needs of each group, this almond crispy product still has the potential to be a snack alternative that can help supplement daily protein intake. Consumption of this product still needs to be balanced with staple foods, animal protein, plant protein, vegetables, and fruit to optimally meet daily nutritional needs.

2. Dietary Fiber Contribution for Snacks

Based on the results of the nutritional content test, the contribution of dietary fiber from almond crispy with the substitution of soybean flour, butternut squash flour, and brown rice flour can be seen in the following table.

Table 19 Fulfillment of Dietary Fiber Content Requirements in Almond Crispy per 30 g serving

Category	Age (year)	Daily Needs (20% of AKG) (g)	Contribution of Adequate Dietary Fiber Intake (%)
Child	4-6	4	11
	7-9	4.6	9.6
Man	10-12	5.6	7.85
	13-15	6.8	6.5
	16-18	7.4	5.9
	19-29	7.4	5.9

Category	Age (year)	Daily Needs of AKG (g)	Snack (20%)	Contribution of Adequate Dietary Fiber Intake (%)
Woman	30-49	7.2		6.1
	50-64	6		7.3
	65-80	5		8.8
	10-12	5.4		8.1
	13-15	5.8		7.6
	16-18	5.8		7.6
	19-29	6.4		6.9
	30-49	6		7.3
	50-64	5		8.8
	65-80	4.4		10

Table 19 shows that one serving of 30g of almond crispy substituted with soybean flour, butternut squash flour, and brown rice flour provides 0.44g of dietary fiber, with a percentage of meeting the recommended daily intake ranging from 5.9 to 11%, depending on age and gender. The highest contribution was found in children aged 4-6 years, at 11%, while the lowest contribution was found in men aged 16-18 and 19-29 years, at 5.9%. This difference is influenced by variations in daily fiber requirements in each age group.

CONCLUSION

Based on the results and discussion, the following conclusions can be drawn:

1. The substitution of soybean flour, butternut squash flour, and brown rice flour significantly affected the color, aroma, texture, taste, and aftertaste of almond crispy.
2. The best formulation (F2), containing 30% soybean flour and 20% butternut squash flour, had a protein content of 11.24 g/100 g and a dietary fiber content of 1.47 g/100 g.

Recommendations

Based on the conclusions above, the following recommendations are proposed:

1. Future studies are recommended to analyze the nutritional composition of all almond crispy formulations to determine the effect of each substitution level of soybean flour, butternut squash flour, and brown rice flour on the nutritional content.
2. Further research should evaluate additional macronutrients, including energy, carbohydrates, and fat, to provide a more comprehensive nutritional assessment of the product.
3. Future studies are also recommended to investigate the shelf life of almond crispy formulated with soybean flour, butternut squash flour, and brown rice flour to evaluate its storage stability and product quality over time.

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