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Physical and Organoleptic Characteristics of Tiwul Cookies

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A B S T R A C T

Cookies are a type of biscuit made from soft dough, high in fat, relatively crispy when broken, and have a solid cross-section. This study focuses on developing cookie products using tiwul flour as an alternative carbohydrate source to replace wheat flour. The addition of jewawut of high-starch food ingredients is needed to improve the texture of the cookies. Animal protein food ingredients used in this study include freshwater snails and anchovy flour. This research aims to determine the effect of the proportion of tiwul flour and jewawut flour with the addition of freshwater snail flour and anchovy flour on the physical and organoleptic characteristics of cookies and determine the best treatment based on physicochemical parameters. The research design used in this research was a Complete Randomized Design (CRD) with a 2-factor factorial pattern with 2 replications. The treatment used was proportions of tiwul and jewawut flour (80%:10%, 70%:20%, 60%:30%) and the addition of anchovy and freshwater snail flour (10%, 5%:5%, 10%). The observation variable data was tested statistically using analysis of variance at a=5% using the DMRT follow-up test. The best treatment with the proportion tiwul 60% : jewawut 30% : anchovy 5% : freshwater snail flour 5%. Which was the best treatment with a water content of 3,79%, ash content of 3,25%, fat content of 26,11%, color of 2,47 (brown), aroma of 4,03 (typical of cookies), taste of 3,70 (sweet savory), and texture 3,73 (crunchy)

1. INTRODUCTION

1.1. Research Background

Cookies are a type of biscuit made from soft dough, high in fat, relatively crispy when broken, and have a solid cross-section. Cookies are prevalent among children because they are relatively crispy and have a less dense texture. The average consumption of cookies in Indonesia shows an average consumption growth of around 21.21% in 2023 [13]. This study focuses on developing cookie products using tiwul flour as an alternative carbohydrate source to replace wheat flour. Tiwul, made from cassava flour, contains 342 calories and can be used as a good source of carbohydrates [11] The use of tiwul flour can produce cookies with a very crispy texture and a sandy mouthfeel; therefore, the addition of high-starch food ingredients is needed to improve the texture of the cookies.

Foxtail millet (*Setaria italica*) has a starch content of 69% [12] and a crude fiber content of 4.36% .[33] Animal protein is known to be of high quality because it contains complete essential amino acids with a composition that suits the body's needs and has high protein digestibility [16]. Animal protein food ingredients used in this study include snail flour and anchovy flour. Snails have a protein content of 10.67% [24]. Snail flour contains 56.05% protein, 6.24% fat, 12.14% ash, and 15.36% carbohydrates [2]. The mineral content, especially calcium, is higher in snails than in beef, at 129.18 mg/100 grams. Anchovies contain 16g of protein, 1.0mg of iron, 77 kcal of energy, 1g of fat, and 500mg of calcium [3].

1.2. Literature Review

Cookies are made from wheat flour, eggs, margarine, powdered sugar, baking powder, vanilla, and milk powder [17]. The principle of making cookies and forming the cookie framework into three stages, namely making dough, printing and baking. The formation of the cookie framework begins from the making of the dough. During mixing, water is absorbed by wheat proteins so that gluten is formed which will form a cookie structure until a homogeneous dough is formed, the second stage is printing, and the last is baking [21].

Tiwul made from cassava without adding other food ingredients contains 1.65% protein, 0.45% fat, 1.50% total

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minerals (ash), 1.63% crude fiber, and 10.00% water [28]. The next innovation in tiwul processing is bakery products that can be made from instant tiwul-based ingredients such as cookies [7]. Instant tiwul which will be used as raw material for making bakery is ground and sifted first using a 60-80 mesh sieve. Cookies made from tiwul flour show a moisture content of 5.8%, ash content of 1.6%, protein 4.5%, fat 30.7%, carbohydrates of 57.4%, energy of 524 kcal, and dietary fiber of 10.8% [14]

Jewawut is a source of carbohydrates and protein, has good antioxidant activity, is rich in vitamins and minerals, and has a high dietary fiber content. Jawawut contains carbohydrates of 84.2%, protein 10.7%, and fat of 3.3% As a source of cereals, millet can be used as flour to make various processed ingredients including cookies [26]. Jewawut flour is a good alternative as a source of iron that can be used as a mixed ingredient in food products. The calcium and iron levels of jewawut flour were 3.01 mg/100g [30] and 41.31 ppm [27].

freshwater snails (*Pila ampullacea*) are widely found in rice fields and lakes. The color and shell of freshwater snails are green to black [18]. Freshwater snails contain 15% protein, 2.4% fat, 6.09% crude fiber, and 2.4% ash content. The main mineral content in rice snails is calcium, iron, magnesium, potassium, and phosphorus. 100 g of freshwater snail meat contains several high nutrients such as energy 209.49 kcal, protein 18.8 g, calcium 812 mg, zinc 12 mg, and iron 102 mg. Anchovy meal contains 48.8 g of protein per 100 g, also a source of calcium and iron, where the calcium content in freshly dried anchovies is higher than in milk, which is 2381 mg per 100 g [21].

1.3. Research Objective

This research aims to determine the effect of the proportion of tiwul flour and jewawut flour with the addition of freshwater snail flour and anchovy flour on the physical and organoleptic characteristics of cookies and determine the best treatment based on physicochemical parameters.

2. MATERIALS AND METHODS

2.1. Materials and Tools

The Materials utilized in this research are tiwul flour, jewawut flour, anchovy flour, rice field snail flour, Amanda brand margarine, baking powder, eggs, and vanilla. The materials used for the analysis are sulfuric acid, methyl red, methyl blue, hydrochloric acid, sodium dioxide, petroleum benzene, Nelson A, Nelson B, arsenomolybdat, aquadest, pH paper, and glucose.

The Tools used are a cabinet dryer, blender, mixer, stove oven, knife, 80 mesh sieve, spoon, spatula, baking sheet, pan, digital scale, and basin. Instruments used for analysis include ovens, cups, desiccants, erlemenyer, soxhlets, fat flasks, water baths, autoclaves, distillers, furnaces, vortex, measuring cups, pipettes, measuring flasks, test tubes, and spectrophotometers.

2.2. Research Design and Analysis

The research design used in this research was a Complete Randomized Design (CRD) with a 2-factor factorial pattern with 2 replications. The treatment used was proportions of tiwul and jewawut flour (80%:10%, 70%:20%, 60%:30%) and the addition of anchovy and freshwater snail flour (10%, 5%:5%, 10%). The observation variable data was tested statistically using analysis of variance at a=5% using the DMRT follow-up test. The Treatment combinations of cookies can be seen in **Table 1**.

Table 1. Treatment combinations of cookies

Tiwul and jewawut flour (%)	Anchovy and freshwater snail flour (%)		
	M1	M2	M3
T1	T1M1	T1M2	T1M3
T2	T2M1	T2M2	T2M3
T3	T3M1	T3M2	T3M3

Note :

T1M1 = Tiwul flour 80% : jewawut flour 10% : anchovy flour 10%

T1M2 = Tiwul flour 80% : jewawut flour 10% : anchovy flour 5% : freshwater snail flour 5%

T1M3 = Tiwul flour 80% : jewawut flour 10% : freshwater snail flour 10%

T2M1 = Tiwul flour 70% : jewawut flour 20% : anchovy flour 10%

T2M2 = Tiwul flour 70% : jewawut flour 20% : anchovy flour 5% : freshwater snail flour 5%

T2M3 = Tiwul flour 70% : jewawut flour 20% : freshwater snail flour 10%

T3M1 = Tiwul flour 60% : jewawut flour 30% : anchovy flour 20%

T3M2 = Tiwul flour 60% : jewawut flour 30% : anchovy flour 5% : freshwater snail flour 5%

T3M3 = Tiwul flour 60% : jewawut flour 30% : freshwater snail flour 10%

2.3. Research Implementation

2.3.1 Making Tiwul Flour

Cassava flour is mixed with water 25% until it forms a dough and sifted using an 80-mesh sieve until it becomes a granule. Steam blanching 15 minutes, drying using a cabinet dryer at a temperature of 55 °C for 5 hours, the dried tiwul is grinding using a blender and sifting with 80 mesh.

2.3.2 Making Anchovy Flour

Prepare fresh anchovy, washing the anchovy with running water, grinding, and drying using a cabinet dryer for 9 hours at a temperature of 50ºC. grinding with a blender and sifting 80 mesh.

2.3.3. Making Freshwater Snails Flour

Freshwater snails are washed using running water and soaked using table salt (25%) for 15 minutes, freshwater snails are washed again and boiled using water that has been mixed with 3% betel shell for 20 minutes at a temperature of 60 ºC. The freshwater snail's meat is separated from the shell. Drying use a cabinet dryer with a temperature of 50 ºC for 24 hours. Grinding using a blender and sifted using an 80-mesh sieve.

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2.3.4. Making Cookies

Mixing margarine, sugar, baking powder, skimmed milk, and egg yolks using a mixer for 3 minutes and then mix with flour that has been prepared according to the treatment. Next, the dough is stirred until homogeneous and molded using a circular cookie mold with a thickness of 0.5 cm. The cookie dough is baked in the oven at 150 ºC for 20 minutes. Cooked cookies are removed from the oven and cooled at room temperature

2.4. Observation

Analysis parameters include water content (gravimetry methode), ash content (gravimetry method), and organoleptic (scoring method)

3. RESULT AND DISCUSSION

3.1. Water Content

Based on the analysis of variance, there was a significant interaction (p≤0,05) between the treatment of the proportion of tiwul and jewawut flour and the addition of anchovy flour and freshwater snail flour. Based on **Table 2**. It shows that the average moisture content of cookies ranges from 3.60% - 5.21%. The proportion of tiwul flour, the higher the jewawut flour, the higher the anchovy flour, and the smaller freshwater snail flour, causing the water content of cookies to decrease. This is because of the starch and fiber levels of the material with high water absorption. The crude fiber in jewawut flour is 4.36% higher than tiwul flour by 1.45% [9]. Coarse fibers have high water absorption because coarse fibers contain a lot of hydroxyl groups that can bind large amounts of water [4]. Therefore, the more jewawut flour is added, the lower the moisture content of the cookies. Starch is a hydrophilic compound. According to Kusumawati and Putri (2013), starch can absorb water because it has a hydroxyl group that can bind to water through hydrogen bonding, [13] starch can absorb water but it is easy to release water at high temperatures so that the water content decreases.

Table 2. Average value of water content of tiwul cookies

Treatment	Water Content (%) ± SD	DMRT 5%
T1M1	4.04 ± 0.07	
T1M2	4.94 ± 0.03	0.14
T1M3	5.21 ± 0.09	0.15
T2M1	3.94 ± 0.02	0.15
T2M2	4.64 ± 0.01	0.15
T2M3	4.83 ± 0.01	0.15
T3M1	3.60 ± 0.01	0.15
T3M2	3.79 ± 0.02	0.16
T3M3	4.44 ± 0.04	0.16

Note: Average values accompanied by different letters indicate significant differences at p ≤ 0.05

3.2. Ash Content

Based on the analysis of variance, there was a significant interaction (p≤0,05) between the treatment of the proportion of tiwul and jewawut flour and the addition of anchovy flour and freshwater snail flour. Based on **Table 3.** It shows that the average ash content of cookies ranges from 2,53%-3,42%. The proportion smaller of tiwul flour, the higher of jewawut flour, the higher the anchovy flour, and the smaller the freshwater snail flour causing the ash content of cookies to decrease. This is because jewawut flour contains minerals such as: calcium, iron, magnesium, phosphorus, zinc and potassium [6]. stated that the iron content of jewawut is 5.3 mg per 100 grams [27]

Animal protein flour has mineral content including iron, calcium, and phosphorus [31]. The iron content of anchovy meal is 5.82 mg/g [10] Magnesium 78.66 mg [8], and calcium 504 mg [10] Meanwhile, freshwater snail flour contains magnesium 31.19 mg and calcium 129.18 mg.

Table 3. Average value of ash content of tiwul cookies

Treatment	Ash Content (%) ± SD	DMRT 5%
T1M1	3.21 ± 0.04	
T1M2	2.61 ± 0.02	0.15
T1M3	2.53 ± 0.03	0.16
T2M1	3.39 ± 0.03	0.17
T2M2	2.81 ± 0.05	0.17
T2M3	2.77 ± 0.06	0.17
T3M1	3.42 ± 0.06	0.17
T3M2	3.25 ± 0.01	0.17
T3M3	3.05 ± 0.08	0.17

Note: Average values accompanied by different letters indicate significant differences at p ≤ 0005

3.3. Color

Based on the results of the analysis of variance, there was a significant interaction (p≤0,05) between the treatment of the proportion of tiwul and jewawut flour and the addition of anchovy flour and freshwater snail flour on the organoleptic properties of the color of the cookies, as well as each treatment has a significantly effect on the color of the cookies. Based on **Table 4**. It shows that the average color of cookies ranges from 2.17-3.20. This value indicates that the color of the cookies is brown-yellowish brown.

The proportion of tiwul flour is getting less and the more jewawut flour, the less anchovy flour, and the more rice field snail flour causes the color of the cookies to be browner. This is due to the heating process during baking, resulting in the Maillard reaction. According to [29], the Maillard reaction occurs because the primary amino group reacts with reducing sugars to form a browner color.

Table 4. The average value of the color of tiwul cookies

Treatment	Color ± SD
T1M1	3.20 ± 0.48
T1M2	2.67 ± 0.75
T1M3	2.60 ± 0.66
T2M1	3.17 ± 0.73
T2M2	2.80 ± 0.75
T2M3	2.57 ± 0.56
T3M1	2.77 ± 1.02
T3M2	2.47 ± 0.67
T3M3	2.17 ± 0.90

Note: Average values accompanied by different letters indicate significant differences at p ≤ 0.05

3.4. Aroma

Based on the results of the analysis of variance, there was a significant interaction (p≤0,05) between the treatment of the proportion of tiwul and jewawut flour and the addition of anchovy flour and freshwater snail flour on the organoleptic

properties of the aroma of the cookies. Based on **Table 5**. It shows that the average aroma of cookies ranges from 2,87 – 4,13. The value indicates that the aroma of the cookies is pretty fishy –typical of cookies.

The proportion of tiwul flour is getting less and more jewawut flour, less snail flour, and more rice field snail flour, causing the distinctive aroma of cookies to increase. This is because there is a Maillard reaction during roasting that produces a distinctive aroma, the aroma is stronger when the protein content of the ingredient is higher [20]. The aroma of cookies is influenced by several raw materials used in making cookies, including fat, milk, eggs, and flour [1].

Table 5. The average value of aroma of tiwul cookies

Treatment	Aroma ± SD
T1M1	2.87 ± 1.28
T1M2	3.90 ± 0.94
T1M3	3.70 ± 1.00
T2M1	3.13 ± 1.20
T2M2	4.00 ± 0.82
T2M3	4.17 ± 0.56
T3M1	3.20 ± 1.05
T3M2	4.03 ± 1.14
T3M3	4.13 ± 0.96

Note: Average values accompanied by different letters indicate significant differences at $p \leq 0.05$

3.5. Taste

Based on the results of the analysis of variance, there was a significant interaction ($p \leq 0,05$) between the treatment of the proportion of tiwul and jewawut flour and the addition of anchovy flour and freshwater snail flour on the organoleptic properties of the taste of the cookies. Based on **Table 6.** It shows that the average taste of cookies ranges from 3,13-3,97. This value indicates that the taste of the cookies is sweet and savory of cookies.

The proportion of tiwul flour is getting less and the more jewawut flour and the less anchovies and more rice field snail flour causing the taste of cookies to be sweeter and savory. This is due to the addition of sugar and other ingredients such as flour and milk flavors. Anchovies contain several essential and non-essential amino acids, of which the most prominent non-essential amino acid in anchovies is glutamic acid with a level of 1.439 mg/100g which causes a savory taste [25]. Meanwhile, according to [18] rice field snail meat contains the amino acid glutamate 5.1 %.

Table 6. The average value of taste of tiwul cookies

Treatment	Taste ± SD
T1M1	3.13 ± 0.96
T1M2	3.17 ± 1.04
T1M3	3.23 ± 0.92
T2M1	3.20 ± 0.79
T2M2	3.83 ± 0.87
T2M3	3.97 ± 0.56
T3M1	3.33 ± 1.22
T3M2	3.70 ± 0.82
T3M3	3.63 ± 0.98

Note: Average values accompanied by different letters indicate significant differences at $p \leq 0.05$

3.6. Texture

Based on the results of the analysis of variance, there was a significant interaction ($p \leq 0,05$) between the treatment of the proportion of tiwul and jewawut flour and the addition of anchovy flour and freshwater snail flour on the organoleptic properties of the texture of the cookies. Based on **Table 6**. It shows that the average texture of cookies ranges from 3,47-4,47. This value indicates that the texture of the cookies is crunchy

Tiwul flour is getting smaller, jewawut flour is increasing and the proportion of anchovy flour and rice field snail flour is causing the texture of the cookies to be harder. This is because the level of development and texture of a food ingredient is influenced by the ratio of amylose and amylopectin [32] In addition, the high protein content will cause food products to have a sturdier and harder structure. [22] who stated that the high baking temperature produces energy that will damage the hydrogen bonds on the protein so that the protein structure changes to be exposed. This condition makes hydrophilic molecules in proteins bind to water molecules, while hydrophobic molecules bond to hydrophobic molecules from other proteins. The bonds between proteins formed will produce a stronger structure and affect the hardness.

Table 5. The average value of texture of tiwul cookies

Treatment	Texture ± SD
T1M1	3.93 ± 0.68
T1M2	4.10 ± 0.7
T1M3	4.47 ± 0.56
T2M1	3.77 ± 0.80
T2M2	3.87 ± 0.85
T2M3	4.03 ± 0.85
T3M1	3.47 ± 0.92
T3M2	3.72 ± 0.89
T3M3	3.90 ± 0.91

Note: Average values accompanied by different letters indicate significant differences at $p \leq 0.05$

4. CONCLUSION

Based on the results of the research, cookies based on tiwul flour and jewawut flour with the addition of anchovy flour and rice field snail flour had a real effect ($p \leq 0.05$) on moisture content, ash content, fat content, color, aroma, taste, and texture. The research results of the best treatment based on physical and organoleptic parameters were cookies with the proportion tiwul 60% : jewawut 30% : anchovy 5% : freshwater snail flour 5%. Which was the best treatment with a water content of 3,79%, ash content of 3,25%, fat content of 26,11%, color of 2,47 (brown), aroma of 4,03 (typical of cookies), taste of 3,70 (sweet savory), and texture 3,73 (crunchy)

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