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Original Article

Chemical Characteristic and Sensory Evaluation of Glucomannan Porang Tubers and Hunkue Flour Combination based Cookies

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Abstract: This study aims to determine the optimal combination of hunkue flour and porang tuber glucomannan flour to manufacture cookie by chemical and organoleptic characterization. The materials used are porang tuber glucomannan flour, hunkue flour, and ingredients for making cookie. The experimental design was completely randomized design with 5 treatments and 4 replications. The treatment was combination of porang tuber glucomannan flour and hunkue flour. The treatment given was T_1 = 0% Glucomannan Flour: 100% Hunkue Flour, T_2 = 20% Glucomannan Flour: 80% Hunkue Flour, T_3 = 40% Glucomannan Flour: 60% Hunkue Flour, T_4 = 60% Glucomannan Flour: 40% Flour Hunkue, and T_5 = 80% Glucomannan Flour: 20% Hunkue Flour. The data analysis used was Analysis of Variance (ANOVA) at a significance level of 5%. The results showed that the combination of porang tuber glucomannan flour and hunkue flour had a significant effect ($p<0.05$) on moisture content, protein, fat, ash, carbohydrates, texture, taste, and preferences of cookie, but did not have a significant effect on crude fiber content, color, and aroma. Treatment with 20% glucomannan flour was the best treatment for organoleptic parameters as a whole with the chemical content characteristic is 4.77% moisture content, 8.11% protein, 22.43% fat, 4.09% ash, 60.60% carbohydrate, 6.14% crude fiber, and 28.60 kal energy.

Keywords: *chemistry, cookie, glucomannan, gluten free, hunkue, organoleptic*

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INTRODUCTION

One of the foods that are very popular and easy to find in the market is cookie. Most of the cookie that we find on the market are made from flour as a raw material. Flour contains a main protein called gluten. Gluten is a protein that is hydrophilic, elastic, and plays a role in developing the texture of food products [1]. Cookie products containing gluten are unsuitable for people with ASD (Autism Spectrum Disorder), people with gluten allergies, and celiac disease. The limited gluten free cookie on the market make it difficult for people with special needs to get cookie that do not contain gluten on the market. Consumption of gluten in people with autism will cause digestive problems, where gastrointestinal permeability will increase. By-products from protein are incompletely digested and negatively affect health [2]. So, we need alternative gluten-free ingredients, but with characteristics that are almost similar to flour.

Thus, research is needed to make gluten free cookie. One of the gluten free flours with high nutritional content is hunkue flour that made from mung bean starch. The starch content is quite similar to wheat flour. Hunkue flour has a low protein content (4.5%), which makes it suitable for making cookie. Cookie usually use low-protein wheat flour because it does not need over-developing of the gluten protein. Hunkue flour has a fairly high carbohydrate content from mung bean starch. The high starch content can help replace the starch found in wheat flour.

The absence of gluten in hunkue flour can be a problem for the final product of the cookie. Based on research conducted by [3], reducing the gluten content in the dumbo catfish substitution biscuit can produce a rather hard biscuit texture that the panelists dislike. This is because gluten plays a role in melting starch when it coagulates due to heating. Then, the film layer formed that softens the texture of the biscuit. Therefore, other ingredients are needed to replace the role of gluten in cookies. One of the ingredients that can be used is glucomannan flour. Glucomannan is a hydrocolloid polysaccharide composed of D-glucose and D-mannose units with a β-1,4 bond [4]. Glucomannan can substitute for gluten because glucomannan is a polysaccharide that dissolves in water and forms strong hydrogen bonds up to 50 times its actual weight. These bonds form a layer that keeps the cookie moist, so it is not too hard [5]. So that, both glucomannan and gluten can create an elastic film that protects the texture of the cookie. Research conducted by [6] regarding the use of glucomannan flour as a substitute in making baruasa cookie (a typical South Sulawesi dry cookie) affects absorbing water content, binding fat, increasing fiber content, preventing mold growth, and increasing texture hardness. Glucomannan flour also has many benefits for body health, such as lowering blood sugar levels, cholesterol levels, and body weight [7]. So, research still needs to be done regarding the optimization and combination of the two ingredients to produce cookies with gluten-free claims that have chemical and sensory characteristics that suit people's needs.

MATERIALS AND METHODS

Materials

The main ingredient for making cookie used is commercial porang tuber glucomannan flour branded Ikarie Organic produced by CV. Ikarie Group and commercial hunkue flour with the Kura-Kura Mahkota brand from PT. Halus Ciptanadi. Other ingredients used in making cookie are cocoa powder (Benedico, PT Gandum Mas Kencana), coconut milk paste (Red Bell, CV. Verra Co), cornstarch (Royal Holland, PT. Cita Aroma Nusantara), sugar (Superindo, CV. Agro Lestari), skimmed milk (Indoprima, CV. Sari Indo Prima) cocoa butter, and eggs. The chemicals used in the Kjeldahl test for protein content were concentrated H_2SO_4, selenium, distilled water, 45% NaOH, 4% boric acid, 0.1 N HCl, and MR-MB indicator. The chemical used in the Soxhlet method of fat testing is N-hexane. The chemical used in the crude fiber test was Whatman filter paper no. 41, H_2SO_4 0.3 N, NaOH 1.5 N, alcohol, and hot water.

The tools used in making cookie are mixer, oven, star-shaped cookie cutters, spoons, scales, basins, and containers for weighing. The tools used in parameter testing are a set of Soxhlet tools, a set of Kjeldahl tools, furnace, fume cupboard, and oven.

Methods

Cookie Making Procedure

Cookie making is divided into three stages: dough making, molding, and baking. The dough preparation begins with cocoa butter as much as 7.45% of the total ingredients and 7.45% powdered sugar. Kneaded with a mixer at low speed for 1 minute. Then, add 17.88% egg yolk and 0.15% coconut milk paste and mix thoroughly until homogeneous. Then, add 2.98% skim milk and stir again, followed by 1.49% cornstarch and 2.98% cocoa powder and stirred until homogeneous. Hunkue flour and glucomannan flour were added last according to the treatment given, namely T_1 (0% Glucomannan Flour: 100% Hunkue Flour, T_2 (20% Glucomannan Flour: 80% Hunkue Flour), T_3 (40% Glucomannan Flour: 60% Hunkue Flour), T_4 (60% Glucomannan Flour: 40% Hunkue Flour), and T_5 (80% Glucomannan Flour: 20% Hunkue Flour. Then the dough is shaped and baked for 20-30 minutes at 150°C in an oven.

Table 1 Percentage of the composition of cookie ingredients

Material	Composition				
	T_1 (%)	T_2 (%)	T_3 (%)	T_4 (%)	T_5 (%)
Hunkue Flour	59.61	47.69	35.77	23.85	11.92
Glucomannan Flour	0	11.92	23.85	35.77	47.69
Egg yolk	17.88	17.88	17.88	17.88	17.88
Cocoa Butter	7.45	7.45	7.45	7.45	7.45
Sugar	7.45	7.45	7.45	7.45	7.45
Skimmed Milk	2.98	2.98	2.98	2.98	2.98
Cocoa Powder	2.98	2.98	2.98	2.98	2.98
Constrach	1.49	1.49	1.49	1.49	1.49
Coconut Milk Paste	0.15	0.15	0.15	0.15	0.15
Total	100	100	100	100	100

Chemical Analysis Procedure

The chemical analysis includes proximate analysis and crude fiber test. The proximate analysis included the oven test for moisture content, the Kjeldahl method for protein content, the Soxhlet method for the fat content test, the furnace method for the ash content test, and by difference method for the carbohydrate test. Measurement of fiber content using the SNI 01-2891-1992 method.

Organoleptic Test Procedure

The organoleptic test was carried out with the help of 25 trained panelists. The sensory attributes tested with the scoring test were color, taste, aroma, and texture. The preferences attribute was tested with the hedonic test. The skor range used is 1-4, depending on the quality attribute being tested. The skor range used can be seen in Table 2.

Table 2 Scores of organoleptic test scores

Organoleptic Skor	Color	Texture	Taste	Aroma	Preferences
1	Not brown	Not hard	Not savory	Not unpleasant	Dislike
2	Slightly brown	Rather hard	Rather savory	Rather unpleasant	Rather like
3	Pretty brown	Quite hard	Quite savory	Quite unpleasant	Quite like
4	Brown	Hard	Savory	Unpleasant	Like

Data Analysis

The data for moisture content, protein, fat, ash, carbohydrates, fiber, and energy were analyzed using the Analysis of Variance (ANOVA) test. If there is a significant effect, the test continue with Duncan's further test to identify the difference in the treatment given. The organoleptic test data obtained were analyzed using the Kruskal-Wallis method and then followed by the Mann-Whitney method with a significance level of 5% if there is a significant effect.

RESULT AND DISCUSSION

The cookie combination of porang tuber glucomannan and hunkue flour produced in the study was then chemically and organoleptic tested to determine the effect of the ingredients used on chemical characteristics, especially macronutrients such as moisture content, protein, fat, ash, and carbohydrates as well as crude fiber and energy content of the resulting cookie. Organoleptic testing was also carried out to determine the organoleptic properties of the cookie combination of porang tuber glucomannan flour and hunkue flour to conclude the best treatment based on its organoleptic properties.

Chemical Properties

The chemical properties tested on the cookie consisted of tests for moisture, protein, fat, ash, carbohydrates, crude fiber, and energy content. The average value of cookie chemical testing can be seen in Table 3.

Table 3 Chemical Characteristics of Cookie of Porang Tuber Flour and Hunkue Flour

Parameter	Glucomannan Flour and Hunkue Flour Combination (%)				
	0:100	20:80	40:60	60:40	80:20
Moisture Content (%)	5.43 ± 0.28^{b}	4.77 ± 0.16 ^{a}	5.32 ± 0.11^{ab}	6.21 ± 0.48^{c}	6.05 ± 0.71^{c}
Protein (%)	13.02 ± 0.66^{b}	8.11 ± 0.33^{a}	12.64 ± 0.96^{b}	14.51 ± 0.83^{c}	15.29 ± 0.49^{c}
Fat (%)	23.24 ± 0.49^{b}	22.43 ± 0.08^{ab}	23.16 ± 0.49^{b}	22.17 ± 0.72^{a}	22.15 ± 0.71^{a}
Ash (%)	1.67 ± 0.01^{a}	4.09 ± 0.04^{b}	6.53 ± 0.09^{c}	8.73 ± 0.08^{d}	11.28 ± 0.15^{e}
Carbohydrate (%)	56.65 ± 0.62^{d}	60.60 ± 0.37^{e}	52.35 ± 1.12^{c}	48.37 ± 0.96^{b}	45.23 ± 1.18^{a}
Crude Fiber (%)	5,19 ± 0.38	6.14 ± 0.81	5.13 ± 1.11	5.67 ± 0.85	5.30 ± 0.7
Energy (kal)	29.27 ± 0.13^{e}	28.60 ± 0.06^{d}	28.10 ± 0.18^{c}	27.07 ± 0.15^{b}	26.48 ± 0.19^{a}

Note: Different letter superscripts in the same line show a significant difference after the ANOVA test with Duncan's further test.

Moisture content

Moisture content is an essential factor in determining the quality of cookie. Table 3 shows that the water content of the cookie combination of porang tuber glucomannan flour and hunkue flour has a significant difference. The resulting cookie moisture content ranges from 4.77% to 6.21%. The water content of the T1, T2, and T3 treatments complies with the SNI 01-2973-2011 standard about Biscuits, where the maximum moisture content of cookie is 5%.

However, the moisture content of the T_4 and T_5 treatment cookie did not meet the SNI standard because the value had exceeded 5%. If seen in more detail, the combination of glucomannan increase the moisture content of the cookie. This can be influenced by glucomannan, which can absorb large amounts of water. Glucomannan gel has a very high viscosity of about 30,000 cP. Glucomannan weighing 1 gram can absorb as much as 100% water [8]. The amount of cookie moisture content is also affected by the presence of starch in hunkue flour. Starch granules swell and absorb water during the starch gelatinization process. The moisture content is related to the protein content in food products. The higher the protein content, the higher moisture content. This is because the higher opportunity for the amino acids in the protein to absorb water [9]. The moisture content can also affect the quality of the cookie. If the moisture content exceeds the SNI threshold, the quality of the cookies can decrease because it is easy for microbes to grow. Furthermore, the moisture content also affects the texture because the evaporation process during the baking process leaves cavities that make the crunchy texture of the cookie [10].

Protein Content

The protein content of the cookie based on Table 3 shows that the highest protein content was found in treatment T5 which was 15.29%, while the lowest protein content was found in treatment T_2 which was 8.11%. This shows that the higher the combination of glucomannan flour, the higher the protein content. Glucomannan is a strong hydrocolloid and can bind and absorb water well [11]. This is predicted to affect the increase in protein levels in the cookie. The water holding capacity of glucomannan flour can bind water and trap other molecules such as proteins and carbohydrates to form a compact structural network matrix [12]. Based on Table 3, inversely proportional to glucomannan flour, the combination of less hunkue flour indicates an increasing protein content of cookie. Hunkue flour is made from mung bean starch, so the protein content is lower than mung bean flour. The protein content in the resulting cookie is also contributed by the skimmed milk and egg yolks added to the dough. The product produced in each treatment has a protein content that meets the minimum standard of SNI 01-2973-2011 about Biscuits, which is 5%.

Fat Content

Table 3 shows that the cookie with the highest fat content were in the control treatment T_1 and the lowest was in treatment T_5 with the largest combination of glucomannan flour. The fat content in the T_1 and T_5 treatments was 23.24% and 22.15%, respectively. The fat content of the control treatment was higher because the starch content of hunkue. The starch in hunkue flour consists of 71.2% amylopectin and 28.8% amylose [13]. High levels of amylopectin affect fat absorption. The higher the amylopectin level, the higher the fat content. Dough with high amylopectin does not form an anti-oil layer, while dough with high amylose can form an anti-oil layer that can resist fat absorption [14]. This means that the higher the hunkue flour, the higher the fat content. The fat content of hunkue flour and glucomannan flour is 1.49% and 0.01%, respectively [15, 16]. The use of cocoa powder and refined cocoa butter in the manufacturing process also influences the high-fat content in cookie. Cocoa powder has a fat content of around 22.2%. The refined cocoa butter used has a higher fat content than margarine.

The fat content of cocoa butter is 88.82%, while the fat content of margarine is 77.89% [17]. So that the fat content of the cookie produced is quite high even though the fat content of hunkue flour and glucomannan flour is relatively low. Fat functions in cookie is to improve the physical structure of cookie in the development, aroma, and texture aspects produced [18]. The best fat content produced was not much different from the fat content produced in previous studies regarding cookies from suweg flour and mung bean flour, which was 24% [19]. This is because porang flour and suweg flour have the same genus, that is *Amorphophallus*, and both cookies use flour sourced from mung beans so that the resulting fat content is not much different.

The fat profile of the resulting cookie is quite good for health, especially in preventing cardiovascular disease. Despite having a high fat content, the fat in cocoa butter contains stearic acid up to 1/3 of the lipid in cocoa butter. Stearic acid differs from other saturated fatty acids and does not increase serum lipids, so it is non-atherogenic and shows a neutral cholesterol response in humans [20]. Atherogenic refers to the harmful properties of cholesterol, which can lead to atherosclerosis or the buildup of cholesterol plaque in blood vessels. So its use for health is much safer than other fat types or margarine. In addition to using refined cocoa butter, which is non-atherogenic, glucomannan flour in cookie also helps improve the lipid profile in the resulting cookie. Porang tuber glucomannan flour can reduce total cholesterol levels in humans. Cholesterol levels in the digestive tract can be bound by soluble fiber from glucomannan flour, so the bile salt excretion mechanism can excrete it through feces [21]. Bile salts are made from blood cholesterol in the liver.

Ash Content

Ash content in food can indicate the presence of minerals in these food. Organic materials will burn at high temperatures, while inorganic materials such as minerals do not burn, so the resulting ash can be used to show the presence of minerals in food [22]. Based on Table 3, it can be seen that the ash content showed a significant difference, where the higher combination of glucomannan flour given, the ash content increased. This is indicated by the different superscripts found in the five treatments. The ash content of cookie ranges from 1.67% to 11.28%. The control treatment (T_1) without combining glucomannan resulted in the lowest ash content compared to the other treatments is 1.67%. The highest ash content was found in the T_5 treatment or the treatment with the highest combination of glucomannan flour, which was 11.28%. This shows that the glucomannan combination affects the presence of minerals in the resulting cookie. Glucomannan flour from porang tubers contains 0.08% ash content [23]. So that the higher the combination of glucomannan flour and the lower the hunkue flour in the dough, the ash content of the cookie will increase.

The ash content of glucomannan flour comes from the manufacturing material, namely porang tubers. Porang tubers are known as tubers with a high mineral content concentration [24]. Phosphorus, magnesium, potassium, zinc, selenium, calcium, and copper are minerals in porang tubers. Porang tubers are famous for their high calcium oxalate content, which is 0.19%, that can cause itching [25]. Calcium oxalate is a compound formed by bonding oxalic acid and calcium. Glucomannan flour results from purification from porang tuber flour, which aims to remove the calcium oxalate. In refining porang flour into glucomannan flour, mineral components such as iron and calcium do not disappear, which can increase the ash content in glucomannan flour [26]. So, the higher the combination of glucomannan flour in the dough, the higher the ash content produced. This is inversely proportional to the combination of hunkue flour, where the ash content will increase by adding the combination of hunkue flour. The combination of 20% glucomannan flour and 80% hunkue flour produces a different ash content compared to previous studies conducted by [27] on cookie made from suweg and mung bean flour, which produced an ash content of 2.29%. The combination of different raw materials in making cookies causes differences in the resulting ash content.

Carbohydrate Content

Carbohydrate content in this study used the by-difference method, so the resulting carbohydrate content is very dependent on the levels of other macronutrients. Based on Table 3, after the ANOVA and Duncan tests were carried out with a significance level of 5%, there was a significant difference between the treatments given. The highest carbohydrate content was in the T_2 treatment, which was 60.60% and the lowest was in the T_5 treatment which was 45.23%. When observed in more detail, it can be seen that the carbohydrate content decreases if the combination of glucomannan flour is higher. This relates to the combination of flour used. The greater the combination of glucomannan flour, the lower the combination of mung bean starch in the dough. Mung bean starch contains a high carbohydrate content of 83.5 grams in every 100 grams of hunkue flour. This impacts the high carbohydrate content of cookies with an increasing combination of hunkue flour. The carbohydrate content of glucomannan flour after being analyzed by the Anthrone method using a UV spectrophotometer was 31.33% [28]. It is much lower than mung bean starch's carbohydrate content, so the higher the combination of glucomannan flour, the lower the carbohydrate content. The results of the highest carbohydrate content of pastries produced in this study were 60.60%, which was not much different from research conducted by [16] regarding cookies from suweg flour and mung bean flour which produced a carbohydrate content of 63%. The levels of carbohydrates produced in research can differ depending on the composition of the raw materials used.

Crude Fiber Content

Based on Table 3 it can be seen that the crude fiber content of the cookie combination of porang tuber glucomannan flour and hunkue flour was not significant for the treatment given. The average crude fiber content ranges from 5.13-6.14%. The crude fiber content of the control treatment was not much different from the treatment with the addition of porang tuber glucomannan flour. This is because the content of crude fiber in glucomannan flour is quite tiny, only 0.55% [29]. Measurable crude fiber content in food measures the content of cellulose, hemicellulose, and lignin [30]. Human digestion cannot digested crude fiber so it cannot be used as an energy source. Although it cannot be digested, crude fiber is beneficial to human health, including fighting diabetes, lowering high blood pressure, lowering cholesterol levels, and the risk of breast cancer [31]. Crude fiber can also reduce the contact time of toxic substances because of its ability to speed up the transit time of food in the intestines, has a satiating effect in the stomach, so it is suitable for dieting, reduces the risk of degenerative diseases and increases the absorption of antioxidant micronutrients.

The mechanism of crude fiber in facilitating digestion is related to the transit time of leftovers in the intestine. Crude fiber can bind water so that leftover food (feces) becomes bulkier, heavier, and softer so that it can move more regularly and quickly in the digestive tract. Because leftover food in the body can be removed, it can prevent the appearance of various diseases [32]. Therefore, the consumption of crude fiber is important for the body and prevents constipation. Crude fiber is a term that is different from dietary fiber. Dietary fiber is a material that cannot be hydrolyzed by human digestive enzymes, while crude fiber is a material that cannot be hydrolyzed by a solution of sulfuric acid and sodium hydroxide [33]. Dietary fiber is part of food plants that can be consumed and is a carbohydrate resistant to digestion and absorption in the human digestive tract. Dietary fiber is completely or partially fermented in the human large intestine [34]. The crude fiber content in this study was different when compared to previous research by [19] regarding cookies from suweg flour and mung bean flour which produced a carbohydrate content of 21.78%. This is because the crude fiber content of suweg flour (13.58%) and mung bean flour (31.52%) is higher than the crude fiber content of glucomannan flour (0.55%) and hunkue flour (1.66%) [19, 28, 34].

Energy

The energy produced by cookie can be seen from the total calories of these cookie. Cookie calories can be calculated using the Atwater factor by converting protein, fat, and carbohydrate levels into caloric values [35]. One gram's protein and carbohydrate content is multiplied by 4 cal, while the fat content is multiplied by 9 cal. Based on Table 3. it can be seen that the energy of the cookie has a significant difference in treatment, evidenced by the difference in superscripts that follow in each treatment. The T_1 treatment cookie had the highest energy content, 29.27%, while the T_5 treatment cookie had the lowest energy content, 26.48%. Each treatment was significantly different from the other treatments. The higher the combination of hunkue flour added to the dough, the greater the energy produced. This is inversely proportional to glucomannan flour, where the decreasing combination of glucomannan flour in the dough increases the energy produced. Energy in cookie correlated with levels of protein, carbohydrates and fat. Fat content has the highest conversion value, namely 9 kal. Fat is the main macronutrient component that contributes the most energy in food [36]. The fat content of the T_1 treatment was the highest among the other treatments, so the conversion value to the calories produced was also the highest, affecting the energy produced.

Other energy-contributing macro-nutrients are carbohydrates and protein. Carbohydrate treatment T_1 was higher than treatment T_5 with a fairly large difference, 11.42%. This of course has an impact on the amount of energy produced by the T_1 treatment cookie to be higher than T_5. Increasing carbohydrate levels will increase the energy produced [37]. The protein content of the T_5 treatment was 15.29% greater than the T_1 treatment, which was 13.02%. However, the total calories produced were greater in treatment T_1 because the number of carbohydrates in treatment T_1 was much larger than in treatment T_5. Protein and carbohydrates produce the same calories, 4 kal, so if the total content of protein and carbohydrates is greater, the energy will also be greater. The energy produced in this study is different from that produced in previous studies by [38] taro and peanut flour produced 506 cal per 100 grams, while in this study it was 476 cal per 100 grams. The resulting difference is caused by the components of the raw materials and their different combinations.

Organoleptic Evaluation

Organoleptic testing of color, texture, taste, aroma, color and preferences of cookie combined with porang tuber glucomannan flour and hunkue flour. The range of organoleptic test scores can be seen in Table 2. The organoleptic test was carried out with 25 trained panelist. The average results of organoleptic testing are presented in Table 4.

The average results of the organoleptic test conducted on cookie with a combination of glucomannan flour and hunkue flour did not show a significant difference in the color of the cookie from the control treatment to the T_5 treatment. Based on Table 4, it can be seen that the response range of the color of the cookie ranged from 3.60-3.86. The response refers to the chocolate color skor of the cookie. The resulting brown color is insignificant because glucomannan flour is white and does not affect the product's color, regardless of the amount added. Porang tuber flour has a brownish-white color and after being refined into glucomannan flour by ethanol extraction, the color is white [39]. So, adding it in the brown dough does not have a real effect.

Table 4 Organoleptic of Cookie Combination of Porang Tuber Flour and Hunkue Flour

Parameter	Porang Tuber Flour and Hunkue Flour Combination (%)				
	0:100	20:80	40:60	60:40	80:20
Color	3.64 ± 0,56	3.76 ± 0,52	3.6 ± 0,64	3.84 ± 0,37	3.76 ± 0,52
Texture	1.64 ± 0,86[a]	2.8 ± 0,81[b]	2.64 ± 0,90[b]	3.52 ± 0,82[c]	3.76 ± 0,43[c]
Taste	1.36 ± 0,86[a]	1,52 ± 0,65[a]	1,88 ± 0,92[ab]	2,44 ± 1,00[c]	2,84 ± 1,06[c]
Aroma	1.68 ± 0,1	1.52 ± 0,77	1.92 ± 0,99	1.96 ± 1,01	2.24 ± 1,16
Preferences	2.96 ± 0,93[a]	3.04 ± 0,79[a]	2.80 ± 0,82[a]	1.88 ± 0,78[b]	1.46 ± 0,78[c]

Note: Different letter superscripts in the same line show a significant difference after the Kruskal-Wallis test followed by the Mann-Whitney test.

Based on Table 4, it can be seen that the texture of the cookie has a significant difference between the treatments given. T_1 has an average value of 1.64, so it tends to be rather hard, and the hardest is T_5, which has an average value of 3.75. If observed in more detail, the more combinations of glucomannan flour in the dough, the harder the texture of the cookie. Glucomannan can produce a hard and compact texture because it traps much water in the gel matrix [40]. The more water that is bound, the space between molecules will be narrower so that the texture of the gel becomes hard and compact. Glucomannan can bind to water because in the chemical structure of glucomannan, many O from OH bond with H from water and then form strong hydrogen bonds [41].

Based on Table 4, the T_1 and T_2 treatments were not significantly different but different from the T_3, T_4, and T_5 treatments. The average results for the T_1 and T_2 treatments were 1.36 and 1.52, respectively, which referred to the slightly savory score. Treatment of T_3 is significantly different from T_4 and T_5. At the same time, the T_4 treatment was not significantly different from T_5. The average result for the T_3 treatment was 1.88, which means it was rather savory. The fourth and fifth treatments were 2.44, which means rather savory, and 2.84, which means quite savory. When viewed in more detail, the combination of glucomannan flour increases the savory taste of the resulting cookie. This is because the glucomannan flour used is the result of purification from porang flour, where porang flour has a taste that tends to be salty [42]. This aligns with research by [43], where konjac glucomannan can increase the salty taste. Konjac glucomannan and porang tuber glucomannan are flours with almost the same characteristics.

Based on Table 4, the aroma of the cookie produced has no significant difference. The lowest aroma value was in the T_2 treatment, which was 1.52, which meant that the aroma was not unpleasant. The treatment with the highest score is the T_5 treatment, with an average value of 2.24, which means it is rather unpleasant. The aroma of cookie is influenced by the ingredients used. Glucomannan flour has a neutral aroma, so it does not affect the aroma of the cookie dough. This is in line with research from [44], which states that adding glucomannan flour, which tends to be odorless or neutral, does not significantly affect the aroma of ice cream. The unpleasant aroma is produced from hunkue flour or mung bean starch. Green beans contain lipoxygenase enzymes, which cause their aroma to be unpleasant [45]. Indirect heating in the oven can less inactivate the lipoxygenase enzyme than heating with direct fire [46]. The cookie preference needs to be tested to determine consumer acceptance of cookie made of the combination of glucomannan flour from porang tuber and hunkue.

Table 4 shows that the highest average result for liking cookie is found in treatment T_2 with a value of 3.04, which is included in the criteria of quite like. Treatments T_1, T_2, and T_3 were not significantly different, with values that referred to being quite like. But significantly different from treatment T_4 and T_5. The T_4 treatment was included in the rather like criteria with an average result of 1.88. At the same time, the T_5 treatment had an average result of 1.46 with the criteria of dislike. If observed in more detail, the higher the combination of glucomannan flour, the lower the panelist's preference for the cookie combination of porang tuber glucomannan flour and hunkue flour. This relates to the attribute values of the cookie's texture, taste, and aroma. The greater the combination of glucomannan flour in cookie, the harder the texture, the more unpleasant the taste, and the more unpleasant the aroma.

Based on Table 4, it can be seen that the most preferred cookie, according to the preference of the panelists, the T_2 treatment with 20% glucomannan flour combination. The T_2 cookie had an attractive brown color, a rather pleasant taste, and a fairly hard but crunchy texture and was easy to chew. People generally like crunchy cookie, sweet and soft in the mouth [47]. The combination of glucomannan flour, as much as 20% and 40% was still acceptable to the panelists, but the panelists disliked the combination of 60% and 80% glucomannan flour. This is due to the appearance of a slightly bitter taste from the conisin and a slightly salty taste in the cookie. Food taste is influenced by various things, such as the heating temperature, the concentration of chemical compounds, and their interactions with other ingredients [48].

CONCLUSION

Based on the results of the study, it can be concluded that there is a significant effect of the difference in the combination of porang tuber glucomannan flour and hunkue flour on moisture content, protein, fat, ash, carbohydrates, energy, texture, taste, and preference of cookies. However, it did not significantly affect the crude fiber content, color and aroma of the cookies. The combination of 20% porang tuber glucomannan flour and 80% hunkue flour produces the most optimal cookie based on their organoleptic properties, and is supported by parameters of moisture and protein content that are in accordance with SNI standards, as well as fat, ash, carbohydrates, crude fiber content, and energy. Which is not much different or even better than previous studies

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