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Evaluation of Nutrition and Acceptability of Cookies Substituted with Millet Flour and Butterfly Pea Flower Extract (*Clitoria ternatea*)

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ABSTRACT

Cookies that are circulated in the community are generally made from wheat flour that is high in gluten. In addition, the high sugar content increases the risk of consumers to various metabolic diseases. Therefore, it is necessary to develop substituted cookie products and use natural ingredient extracts as natural additives that can improve the biological function of food so that cookies can be designed as functional foods in the future. This study aimed to determine the effect of substituting wheat flour with millet flour on cookies' acceptability, water, protein, and carbohydrate content. In this study, wheat flour raw materials were substituted using millet flour (50:50, 70:30, and 100:0). Butterfly pea flower extract was added to the cookie dough, and then proximate analysis and acceptance tests were carried out. The water content of substituted cookies was higher than the standard. The protein content of cookies substituted with millet flour is still by SNI standards. Meanwhile, the carbohydrate content per serving of substituted cookies is lower (51.78%) than standard cookies (70%). Meanwhile, the hedonic test showed that the substitution of millet flour (50:50) was still within the normal acceptance range according to SNI standards. Based on chemical content tests and acceptance tests, it is known that the substitution of millet flour with a composition of 50:50 still meets the biscuit criteria based on SNI.

Keywords: butterfly pea flower; cookies; millet flour; proximate analysis; sensory analysis

1. INTRODUCTION

Cookies are food products made from processed cereals. Cookies are considered an energy source because they are generally made from wheat flour, fat, and sugar [1]. Cookies are very popular because they are cheap, rich in flavor variations, easy to consume, and have a long shelf life [2]. The quality and quantity of the raw materials used extensively influence the quality of cookies. The main composition of cookies is flour, fat, and sugar. Generally, cookies are made from wheat flour, which is high in gluten. Traditional cookies lack nutrients, phytochemicals, and fiber, thus considered unhealthy. To overcome these limitations, recent research is directed at enriching cookies with various food or plant ingredients considered good sources of nutrients and phytochemicals [3]. Increasing awareness of the impact of gluten consumption on health has encouraged the development of cookie products that are low in gluten and safe for consumption by consumers with special diets, such as diabetes, ADHD, and celiac syndrome. Unlike wheat flour, millet flour is lower in gluten. Cereals are also a source of essential nutrients because they contain carbohydrates, proteins, lipids, vitamins, minerals, and phytochemicals that benefit human health [4,5,6]. Products made from millet flour have dough properties that are less elastic, cohesive, and elongated during hydration [7]. However, by increasing the composition, millet-based products show nutraceutical properties and do not cause allergies. Millet flour is known to contain vitamin B, 1.5-5% fat, 6-19% protein, 2-4% minerals, 60-70% carbohydrates, and dietary fiber around 12-20% [8], amylopectin ranging from 16-28% and amylose 72-84% [9]. Poor quality attributes of millet and its traditional early consumption forms, such as dark and dull color, coarse and gritty texture, astringent taste, high fiber content,

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longer cooking time, antinutrient constituents, and low shelf life, have limited its utilization. Most of these limitations can be overcome using more appropriate processing and technology. Appropriate millet processing techniques yield promising results and successful utilization of millet in various traditional and practical health foods. Various processed products from millet have been developed in multiple categories, such as pop, flake, puffed, extruded, roller-dried, fermented, malted, flour composites, complementary foods, etc. Despite these limitations, millets are generally considered nutritious and offer a variety of health benefits, including being rich in fiber, antioxidants, and essential nutrients. They can be valuable to a balanced diet, especially for those seeking alternative grains or gluten-free options [10]. Food coloring was necessary in the food industry. Natural food dyes can be extracted from butterfly pea flowers. This deep blue color is due to the anthocyanin compounds in the flower [11]. Food fortification drives economic growth by encouraging the use of sustainable resources that are accessible to society, encouraging self-reliance, and creating market opportunities for locally produced food [12]. Butterfly pea flowers have antidiabetic characteristics and natural substances. Otherwise, the butterfly pea flower exhibits anti-inflammatory activities [13].

This study focuses on developing cookie products with millet flour as a raw material substitute and evaluating their acceptability.

2. METHODS

2.1. Materials

Millet flour was obtained from the marketplace; butterfly pea flowers from personal planting; sugar, salt, butter, dried fruit (raisins), and granola. Meanwhile, for the chemical content analysis (carbohydrate and proteins analysis), distilled water, hexane (Merck), boiling stone, cotton, filter paper, sulfuric acid (Merck), selenium mixture, Munsell indicator, 0.5 N Hydrochloric acid (Merck), starch indicator, 30% Hydrochloric acid (Merck), 30% Sodium Hydroxide, litmus paper, Luff-Schroll solution, 25% Hydrochloric acid (Merck), and 0.1 N thiosulfate.

2.2. Method

2.2.1. Material Preparation

Millet flour and wheat flour were roasted separately to reduce water content.

2.2.2. Butterfly Pea Flower Extract

50 grams of dried butterfly pea flowers were extracted using 100 mL of distilled water and then heated until the solution volume was reduced to 25 mL.

2.2.3. Cookie Making

100 grams of egg white were high-speed mixed until stiff peak with 100 grams of powdered sugar gradually until soft peak, then dry ingredients such as a mixture of millet flour and wheat flour with their respective compositions (50:50; 70:30; 100:0] and salt are added using a plastic spatula after all ingredients are mixed then add 100 grams of melted butter, 5 grams of cocoa powder, and stirred until mixed. Then, butterfly pea flower extract water was added and stirred until it was mixed. The dough was molded and baked at a temperature of 150^{o}C. Cookie making was done in duplicate. The formulation of cookies was egg white (24.5%), powdered sugar (24.5%), butter (24.5%), cocoa powder (1.22%), salt (0.76%), and flour (24.5%).

2.2.4. Chemical Content Analysis of Cookies

The chemical content analysis of cookies carried out in duplicate includes water, carbohydrate, and protein content analysis using the SNI 01-2891-1992 Food and Beverage Testing Method.

2.2.5. Sensory Analysis

The sensory test was conducted using a hedonic test method to see the acceptance in the form of consumer preference for this product innovation based on color, taste, flavor, and texture parameters. The panelists used were untrained panelists, totaling at least 15 people. Preference scores in sensory tests using a scale of 1-7 (strong dislike, dislike, somewhat dislike, neutral, somewhat like, like, very like).

3. RESULTS AND DISCUSSION

Food and beverage testing methods, including water, carbohydrate, and protein content tests, were used to carry out the chemical content analysis [14]. The results of the proximate test are shown in **Table 1.**

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Table 1. Chemical Content Analysis Results of 50:50 variant

Analysis	Result (%)
Water content (wet basis)	9.6
Water content (dry basis)	10.7
Carbohydrate content	51.78
Protein Content	11.53

The development of cookie products was carried out by finding a suitable recipe and conducting experiments on the formulation of substitute wheat flour with millet flour (data not shown). The following recipe composition was obtained after conducting experiments with variations in the composition of millet flour substituents of 50:50, 70:30, and 100:0. The development of cookie products substituted with millet flour is a mixture of egg white (24.5%), powdered sugar (24.5%), butter (24.5%), cocoa powder (1.22%), salt (0.76%), flour (24.5%) producing a round product with a medium size and brownish color. After the product was finished, tests were carried out on acceptance testing. In addition, water content, carbohydrate content, and protein content were carried out for acceptable variants.

3.1. Water Content

Water content is one of the physical quality parameters of cookies, as in Table 1. Compared with the quality requirements of SNI 2973:2011, the results of the water content of cookies are above the maximum figure of 5%. Water content testing uses the oven method, where the weight loss during heating is calculated as the water content in the food. The heat distributed through the baking tool will evaporate the water contained in the food ingredients [15]. So, the longer the product interacts with heat, the more the water content evaporates and decreases. The water content of cookies substituted with millet flour is 10.7%. This water content is higher than the quality requirements for cookies made from wheat flour due to the characteristics of millet flour, which has a higher swelling capacity. Water content affects the shelf life of a product. The high water content in food products will stimulate the growth of microorganisms that accelerate product damage [16]. Further improvements to the product of cookies substituted with millet flour need to be made, one of which is by varying the temperature and baking time. In addition, it is possible to reduce the water content in flour before processing by roasting wheat flour and millet flour. Wheat flour has a water content of around 14.5%, while millet flour contains a water content of 10.19%.

3.2. Carbohydrate Content

The carbohydrate content test of cookies substituted with millet flour can be seen in Table 1. From the test, the average carbohydrate content of cookies substituted with millet flour was 51.78%. Referring to [14], the minimum carbohydrate content of cookies made from wheat flour is 70%. The serving size per cookie (15 grams) has a carbohydrate content of 8 grams. The substitution of raw materials using millet flour reduces carbohydrate content by 18%. The decrease in carbohydrate content can positively reduce sugar levels in cookies. The lower sugar content makes these cookies more friendly for consumption by those on a low-sugar diet. Further research is needed regarding the effect of consuming cookies substituted with millet flour on consumers' blood sugar levels.

3.3. Protein Content

Substitution of flour for biscuits using millet flour increases protein levels. According to the SNI 2973:2011 standard, the minimum protein content of biscuits is 9%. The protein content of biscuits substituted with millet flour is 11.53%. The serving size per cookie (15 grams) has a protein content of 2 grams. In another study, the protein content of cookies substituted with buckwheat (*Fagopyrum esculentum*) also increased along with the percentage of buckwheat substituent used. The protein content of biscuits substituted with 10%, 20%, 30%, and 40% buckwheat was 9.63%, 10.27; 10.92; and 11.66% compared to standard biscuits made from wheat flour, which was 9.10% [17]. The increase in protein in both millet-substituted cookies and buckwheat-substituted biscuits is because both are cereals that are protein sources [18].

3.4. Acceptability Test

Consumers who adhere to gluten-free diets more and more require gluten-free foods that resemble traditional ones. Consequently, in recent years, there has been extensive research on the development of

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gluten-free sweet bakery products with improved structure, mouth feel, acceptability, shelf-life, and nutritional quality of the final products [19]. The sensory test was carried out using the hedonic test method. The cookie acceptability evaluation was conducted on sixteen semi-trained panelists. The average results of cookie acceptability with variations of millet flour substitution are shown in **Table 2.**

Table 2. The average results of cookie acceptability with variations of millet flour substitution

Cookies	Color	Taste	Flavor	Texture
A	6	6	6	6
B	4	3	4	4
C	4	3	3	4

Cookies A, B, and C are cookies with substitution variations of 50:50, 70:30, and 100:0, respectively. The acceptability evaluation data shows that cookies with a 50:50 substitution variation have an average value of 6, meaning that cookies with this variant have standard acceptability (acceptable). Meanwhile, cookies with a 70:30 and 100:0 substitution variation have an average acceptability value below 5 for all parameters, including taste, texture, color, and flavor. In addition, cookies with a 100:0 substitution variation have a bitter aftertaste, so the panelists do not like them. Based on this acceptance test, the chemical content of food in cookies was evaluated at the 50:50 variant.

Table 3. Acceptability of Cookies Sensory Attributes

Criteria	Std*	Sample
Flavor	N	N
Taste	N	N
Color	N	N
Texture	N	N

*Std: SNI 2973:2011
N: Normal

Table 3 shows the results of the hedonic test 50:50. The resulting cookies are round with a diameter of 5 cm and a thickness of 1.5 cm. The cookies substituted with millet flour were evaluated for color, texture, flavor, and taste using seven hedonic test scales.

Based on the assessment results in **Table 2**, all panelists can accept all attributes for variant 50:50, including color, taste, flavor, and texture. These results are in line with research conducted by [20], where cookies were made with variations in the percentage of substituents from 0% to 25%, 50%, 75%, and 100%. Sensory evaluation revealed that cookies containing more than 50% substituents were less preferred by panelists.

4. CONCLUSION

Millet is a food commodity that has the potential to be used as a substitute in the development of food products because of its nutritional content. Substitution of millet flour (50:50) as a raw material for making cookies produces protein levels above the minimum required protein levels. Evaluation of sensory acceptance of the substituted cookie products is also still on a standard scale for color, taste, flavor, and texture attributes.

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