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Sensory properties of gluten-free cookies high in dietary fiber

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Abstract

People with degenerative diseases require dietary and nutrient restrictions, necessitating the development of functional food products. This study aimed to develop gluten-free, high-fiber cookies using FiberCreme™, a commercial creamer containing oligosaccharides, as a substitute for coconut milk. Seventy-four non-trained panelists at the Sensory Laboratory of Universitas Gadjah Mada assessed the cookies using a 9-point Likert scale for attributes such as color, flavor, texture, and overall acceptance. The evaluation followed a randomized design. Sensory evaluation gave results that the level of chalky mouth coating and color uniformity of FiberCreme cookies and commercial cookies were not significantly different. Color, cheesy flavor, savory flavor, sweetness, hardness, and speed of melting in the mouth were not significantly different between FiberCreme and coconut milk cookies. Coconut milk products dominate in the attributes of density and color consistency, commercial items dominate in the attributes of melting speed and cheesy flavor, and FiberCreme cookies do not appear to dominate in any way but give close characteristics both with commercial and coconut milk cookies. Overall acceptance from the most liked were Commercial, FiberCreme and Coconut cookies respectively. These findings provide insights for the food industry in developing high-fiber functional cookies using FiberCreme™, potentially benefiting those with dietary restrictions.

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1. Introduction

Dietary fiber is known to have many benefits in health, especially in digestion and preventing non-communicable diseases. Degenerative diseases such as obesity, cardiovascular disease, heart disease, osteoporosis, diabetes mellitus, stroke and about 50 other types of degenerative diseases tend to increase every year (1). This is due to many factors such as lifestyle, diet, and decreased in physical activity (2). Other supporting factors, namely heredity and age, will further develop the emergence of other degenerative diseases (3). Meanwhile, degenerative diseases can be prevented by adjusting diet and regulating nutrient intake. Many studies have investigated the effects of dietary fibers on coronary heart and cardiovascular disease. Correlation between the increase in total dietary fiber intake and a reduction in the risk of cardiovascular disease has been found in several studies (4). One of the major risk factors for cardiovascular diseases (CVDs) is hyperlipidemia, a medical condition characterized by elevated levels of plasma lipids, such as triglycerides, and plasma lipoproteins, like very low-density lipoproteins. Foods that contribute to increased levels of sterols, fatty acids, and trans fats include dairy products, ice cream, pastries, fried foods, junk

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food, and meat (5). Individuals with hyperlipidemia are advised to limit their intake of high-saturated fats from these sources. Instead, they should consume foods rich in dietary fiber and unsaturated fats, as these can help prevent and manage elevated LDL cholesterol and triglyceride levels (6). Therefore, the provision of processed products that can help prevent degenerative diseases is very necessary. Market demand for functional foods has encouraged the food industry to diversify processing, among others, by making vegetable creamers that are high in fiber. In a double-blind, placebo and diet-controlled study on human subjects with chronic constipation showed that oral administration of isomalto-oligosaccharides (IMO) supplement resulted in a reduction in total cholesterol, LDL-cholesterol, along with colonic microbiota normalization during the 4-week intervention and 8-week follow-up period (7).

Although dietary fiber plays an important role in health, inadequate intake of dietary fiber is found to be more prevalent. Indonesian Dietary Guideline recommends fiber intake of 30 g/day from fruit and vegetables. According to data from the Indonesian Ministry of Health in 2018, 93.5% of Indonesian people did not fulfill the consumption needs of dietary fiber from vegetables and fruit. Whereas a lack of dietary fiber can trigger various diseases.

FiberCreme™ is a healthy commercial nondairy creamer that uses a combination of fiber from isomalto-oligosaccharides and fully hydrogenated oil. This multipurpose creamer can be applied to a wide range of food and is used to increase fiber content in various foods and drinks. Research on the use of FiberCreme™ to increase dietary fiber content in various foods has been carried out. Putri et al. reported that FiberCreme™ as a sucrose replacement in red kidney bean instant porridge formulation did not affect the texture, instead increased the amount of dietary fiber and decreased calories (8). In banana porridge, FiberCreme™ as sucrose replacement could decrease serum glucose levels by 47.61% in diabetic STZ-NA-induced rats(9). This creamer can fill the gap in dietary fiber intake by applying it to various daily menus. In a study with experimental animals, it was reported that substituting cellulose with FiberCreme™ in the diet decreased total cholesterol (46%), LDL-C (43%), triglycerides (15%) and increased HDL-C (108%) (9). Furthermore, Sunarti et al. have investigated FiberCreme™ as functional food ingredient in cookies as complimentary snacks for subjects with hyperlipidemia (10).

Cookies are one of the baked products that are consumed by an enormous number of people worldwide because of their universal appeal and other attractive features including a wider consumer base, ready-to-eat nature, moderate cost, great nutritional quality, availability in various pleasant tastes, and prolonged shelf life. Cookies are designed to not only provide nutrients, but also to prevent diet-related diseases. Cookies generally refer to a group of baked goods prepared from soft wheat flour with a low final water content that is heavy in sugar and shortening (i.e., solid fat at room temperature) (11). Typically, cookies are offered as treats, because they are little, sweet, and crispy. A popular cookie is the sugar-snap, which is distinguished by having a high sugar, high fat, and low moisture content.

Several studies on gluten-free cookies have previously been conducted. Research from Brites et al. applying composite flour made from millet flour, chia seed, and buckwheat flour. The results demonstrate that the more the millet flour addition, the shorter the height and the greater the diameter and hardness level. The panelists did not respond to the inclusion of chia seeds up to 10%. Other than that, hydrocolloids are used as a gluten alternative in gluten-free cookies (12). In another study, Arabic and xanthan gum were utilized, as well as hydrocolloids newly derived from cress seed, fenugreek, flaxseed, and okra. The inclusion of Arabic gum enhanced the water activity, moisture content, ash content, and cookie fiber. The

presence of gum increases the hardness of cookies while decreasing their lightness and diameter. The cookies from the replacement of okra and Arabic gum tasted identical to controls, and the introduction of cress seed increased antioxidant activity (13). Another study about cookies is the reduced-fat butter cookie that was replaced by different hydrocolloid types, the results are xanthan gum and arabic gum are not suitable to replace butter in cookies because it has high peroxide value which leads to less shelf life and xanthan gum and Arabic gum did not help the rancidity of cookies because the pores on the cookie's surface caused oxidative rancidity during storage (14). The addition of hydrocolloids can bring a lower score for the sensory evaluation, this can happen because the addition of Arabic gum and xanthan gum makes the surface harder and difficult to bite, therefore the overall acceptance score gets lower by the increasing of hydrocolloid addition to the cookies.

Another study also evaluated replacing flour with alternative flour from Indonesia, such as taro, sorghum, mung bean, peanut, and sweet potato flour. In this study, a consumer test was conducted utilizing the CATA method to determine the customer preference for gluten-free cookies. Taro and the control or 'regular' cookies made with wheat flour received the highest overall liking score, however, gluten-free cookies made from mung bean were viewed as the most despised, with a liking score comparable to the other alternative flour. Most flours gave the cookies a darker color, especially sweet potato, which has phenolic and anthocyanin components that give the cookies a dark-purple tint (13). According to Grand View Research's Cookies Market Size, Share & Trends Analysis Report, 2019-2025, the global market for cookies was valued at USD 30.6 billion in 2018 and is projected to increase by 5.3% annually.

It showed that cookies containing FiberCreme™ can significantly reduce cholesterol, triglycerides, and cardiac risk ratio scores after 4 weeks of intervention. The study evaluated the benefit of the FiberCreme cookies as a functional food to reduce hyperlipidemia and the risk of cardiovascular diseases, but its sensory evaluation has not been reported. Several studies have been conducted to create cookies with various ingredients for health reasons, mostly containing high fiber. There is a study about the replacement of wheat flour with quinoa and sweet potato flour to create gluten-free, high-fiber and high protein cookies. The result shows that relatively cookies without replacement in wheat flour have the lowest fat content, meanwhile cookies with 60% sweet potato and quinoa blend have the highest protein, fiber, fat, and ash content (15). Because of the high-fat content, it is unknown whether these gluten-free cookies can be consumed by people who have hyperlipidemia condition.

The sensory evaluation of cookies formulated with quinoa, sweet potato and wheat flour blends was conducted by Chopra et al., where most of the sensory properties got a 6.7 score which represents “Like Slightly”. However, with the addition of quinoa blend and sweet potato increased, the sensory evaluation score decreased in some attributes. Therefore, the provision of processed products that can help prevent degenerative diseases is very necessary. Market demand for functional foods has encouraged the food industry to diversify processing, among others, by making vegetable creamers that are high in fiber. Food products that are enriched with fiber may be an option to meet this demand in the food industry. According to Baumgartner et al., cookies can be a choice of product to be developed with fiber enrichment since cookies are also a product that is ready to eat and store, available at any time, and has a low cost (16).

In the world of marketing, consumers are important things that need attention. Understanding consumers according to Kotler et. al, are all individuals and households that make transactions (purchases) and obtain goods or services for personal consumption (17). In the development of new products, a strategy is essential for market acceptance, including the use of sensory analysis. Therefore, it is necessary to conduct a scientific study on the sensory properties of cookies based on FiberCreme-IMO. This research aims to determine the relative sensory profile of each cookie, compare their level of acceptance for each cookie, determine the correlation between intensity levels and preference, and evaluate the purchase intention and the price that consumers would afford.

2. Materials and Methods

2.1. Materials

2.1.1. Gluten Free Cookies

The materials used in this study were FiberCreme cookies and Coconut cookies formulated in a previous study (10), as well as commercial cookies as a comparison. Cookies were formulated with a low-fat but sufficient fiber content in mind. Both FiberCreme and coconut cream cookie formulas were equivalent, but different creams: 1) which contained FiberCreme™, 2) contained coconut cream in a comparable proportion. The cookies were prepared by the continuous mixture of the raw materials, previously weighed in an analytical scale, rolling and pressing the dough with a metallic cylinder in a way that all the cookies presented the same thickness until they reached 3.0cm diameter. The cookies were then baked for 25 min at a monitored temperature of 180℃. After that, they were cooled at room temperature (23℃) and conditioned in packed in polyethylene until analyses. The nutrient values of the ingredients per 100g of final cookies are presented in Table 1. The cookies were baked, cooled, and packaged and after 15 hours the products were tested.

Table 1. Nutritional composition in 100 g of FiberCreme and coconut cookies

Composition	FiberCreme cookies[2)]	Coconut cookies[2)]	Commercial cookies[3)]
Energy (kcal)	409.00	393.80	500
Lipid (%)	11.45	11.98	20
Carbohydrate (%) [1)]	71.89	69.82	70
Protein (%)	5.04	4.83	3.33
Water (%)	4.73	7.31	NA
Ash (%)	1.11	1.37	NA
Fiber (%)	5.78	4.69	NA
Ingredients	Corn starch, sugar, FiberCreme, eggs	Corn starch, sugar, coconut cream, eggs	Sago flour, sugar, vegetable fat, eggs, tapioca flour, cheddar cheese, full cream milk powder, salt, synthetic vanilla flavoring.

[1)]Carbohydrate content calculated by difference, [2)]Sunarti et al. 2022 (10), [3)]Nutritional fact on its packaging

2.2. Methods

2.2.1. Gluten Free Cookies

A market survey was done to select non-gluten cookies as comparison online through e-commerce and offline to some shops in Yogyakarta. There were four types of cookies found in the market that have similar sensory properties to the sample. Commercial cookies

were selected based on the closeness of the sensory profile of FiberCreme cookies and Coconut cookies. Commercial cookies found in the market were evaluated by 4 trained panelists to identify and select one commercial cookies that could be used for comparison in the study. The nutritional fact, price, and sensory characteristics were compared and evaluated and it is selected the Sagoo Keju was the comparison as its texture, flavor, and taste similar to the tested gluten-free cookies even though the shapes were different, but the panelists were asked to focus on the other sensory properties of the cookies.

2.2.2. Product Sensory Testing

Sensory evaluation was performed by 74 non-trained panels recruited among students of Universitas Gadjah Mada, Yogyakarta. The test was performed at the Sensory Laboratory, Laboratory of Food and Nutrition, Faculty of Agricultural Technology, Universitas Gadjah Mada, Yogyakarta, Indonesia. The facility is specifically designed according to ISO 8589:2007 standards for sensory analytical tests, featuring individual cabins illuminated with fluorescent lamps. Testing the sensory properties of the product was carried out using the acceptance test as samples were served monadically and the intensity scale method using a 9-point Likert scale on three cookie products, namely cookies with FiberCreme-IMO cookies with coconut milk, and commercial cookies.

The sample was served on a paper plate coded with a three-digit number (Figure 1) and was evaluated by each consumer following a randomized design of 6 order variations. A cream cracker and a glass of water were used as a palate cleanser. The acceptance and attribute intensity were evaluated according to a 9-point scale (1=dislike extremely/lowest intensity and 9=like extremely/highest intensity, a score of 5 was considered the limit of acceptance (18). This evaluation needs to be done simultaneously in order to assess the appropriateness of the attributes (19) and to understand the preference of the panelists toward the sensory attributes (20).

Theoretically, when assessing multiple attributes, the ideal approach involves presenting the sample separately for each attribute. However, in practical descriptive analysis, this may become unfeasible due to the number of attributes involved, typically ranging from 6 to 25 in a given sample. By waiving the necessity to rate each attribute independently, sensory analysts acknowledge the likelihood of interdependence between the attributes (20).

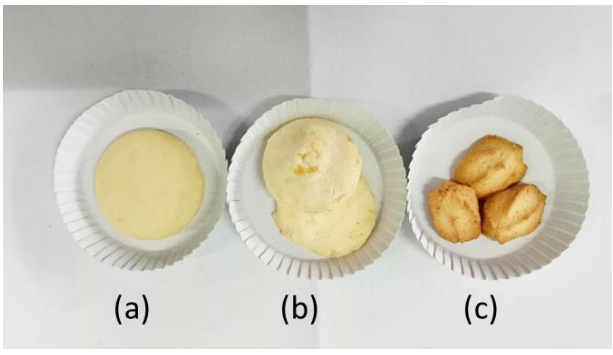


Figure 1. (a) Cookies with coconut milk, (b) Cookies with FiberCreme™, (c) Commercial cookies.

2.2.3 Purchase Interest and Pricing

In the end of the tasting session, the panelists were asked about the purchase intention and willingness to pay with and without information (21). For the development of the current study's questionnaire, validated instruments from prior studies were adopted and adapted with minimal modifications. The questionnaire was developed in a clear and unbiased manner for the respondents to clearly understand the questions. Items that measured purchase intention (9-point scale from 1-not willing at all to 9-very much willing) and willingness to pay with 9 ranges from 12000 IDR-92000 IDR per 150gr cookies. The price interval was based on the available cookies price in the market.

2.2.4. Sample Calculation Formula

The calculation of the number of panelists in this study was calculated using Raosoft software. The calculation is based on the Indonesian population who consume snacks every day (42.6% of the total Indonesian population of 270,200,000 = 115,969,712). The market share of biscuits as snacks is 6%, so the population of people who consume biscuits is 6,958,182 people. If the target market for new biscuits is 10% of the population, with an acceptable margin of error of 10% and a confidence level of 90%, the recommended sample size of respondents is 68 people. In an effort to anticipate the presence of people who did not come during the study, then 10% of the number of respondents were added, so that the minimum number of respondents needed was 74 people.

Recruitment of panelists was conducted by distributing information via social media containing explanations regarding the aims and objectives of the research, side effects that might occur, the rights and obligations of the panelists and stages of the study. Inclusion criteria for the respondents are age between 18-40 years old and cookie consumers. Subjects who agreed and qualified to be panelists were asked to fill out an Informed Consent form online, and sign an agreement to come to the laboratory to have a sensory evaluation. The sensory evaluation and consumer acceptance were established to follow the guidelines presented in the Declaration of Helsinki, which was approved by the Medical and Health Research Ethics Committee of the Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada, Yogyakarta, Indonesia (REF no. KE/FK/0404/EC/2021).

2.2.5. Statistical Analysis

The results were reported as mean and standard deviations. Analysis was done using the descriptive method and one-way analysis of variance (ANOVA) using SPSS 25 and XLSTAT 2019 software to evaluate statistical significance. Pearson correlation analysis was also carried out to show the correlation between intensity levels and panelists' preferences for sensory test parameters.

3. Results and Discussion

This study involved 83 respondents as panelists in sensory evaluation. The results showed that the number of female panelists dominated in this study, specifically 54 female panelists (65%) and 29 male panelists (35%). The ages of the respondents were in the range of 19 to 27 years, with an average age of 21 years and 6 months. The frequency of consumers consuming commercial biscuit products in general can be seen in Table 2. The results showed that the largest proportion, namely 41% of consumers, consumed commercial products 2-3 times per month, while the lowest proportion, 3.6% of consumers, consumed commercial

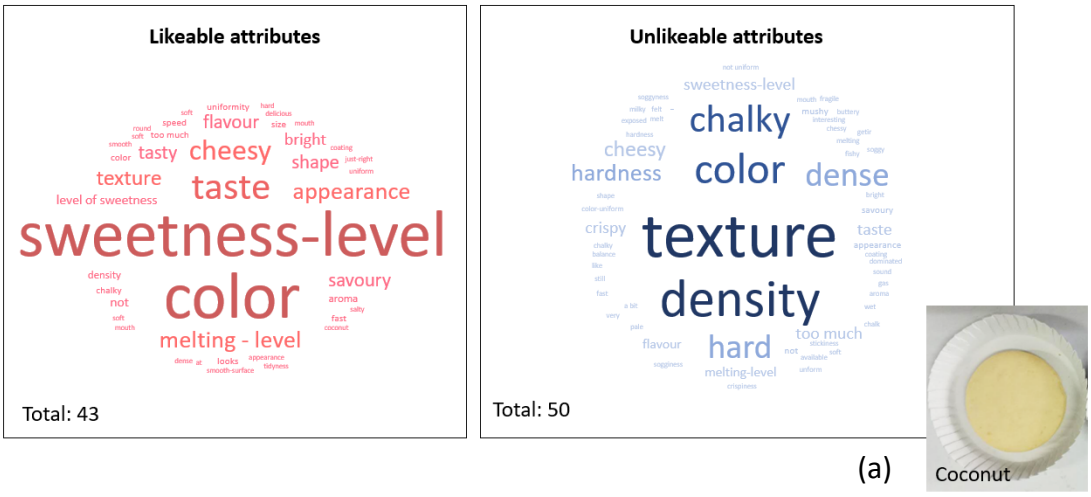
products every day. This shows that consumption of biscuits is done as a non-routine distraction.

Table 2. Frequency of consumers consuming commercial biscuit products.

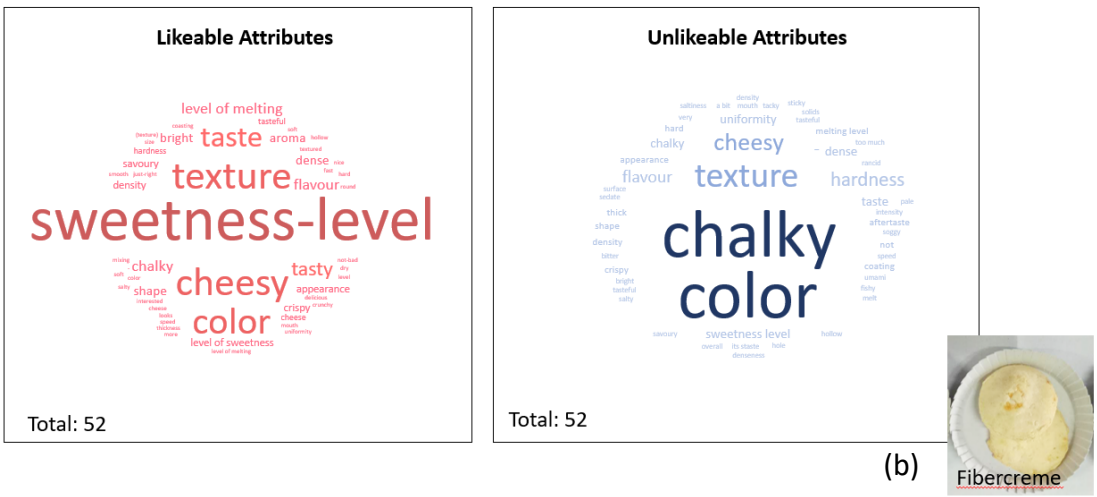
Categories	Frequency (N)	(%)
Once in 6 months	4	4.8
Once in 2-3 months	11	13.3
2-3 times in a month	34	41.0
Once in a week	17	20.5
2-3 times in a week	14	16.9
Every day	3	3.6

3.1. The Verbal Sensory Descriptives

In the first stage of the sensory test, the panelists were asked to describe the sensory attributes they liked and disliked about the three samples. The word clouds were used to visually explain the main attributes of each sample (Figure 2).



(a)



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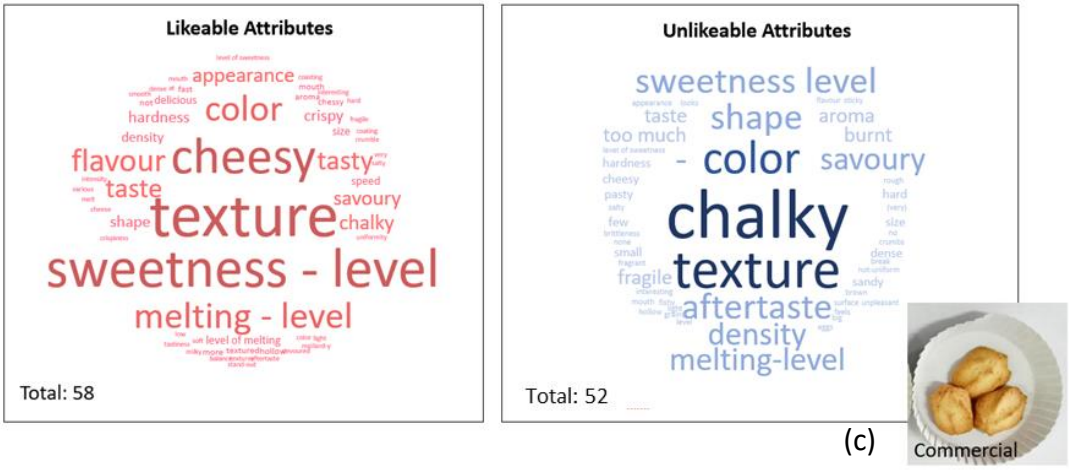

Figure 2. Sensory descriptive of the three cookies samples: (a) the coconut, (b) the FiberCreme, and (c) the commercial cookies.

Likeable and Unlikeable sensory attributes of commercial cookies and gluten-free cookies (coconut cream and FiberCreme cookies) are shown in Figure 2. The attributes of coconut cookies that were liked and most mentioned by the panelists were levels of sweetness (53.49%) and color (34.88%). The least liked attributes of coconut cookies are texture (36%) and density (14%). For FiberCreme cookies, the preferred attributes are level of sweetness (53.85%), cheesy (19.23%), and texture (13.46%). The least liked attributes are chalky (25%) and color (19.23%). The preferred attributes of commercial cookies are cheesy (39.66%), texture (37.93%), and level of sweetness (27.59%), while the least liked attributes of commercial cookies are chalky (18.97%), texture (13.79%), and color (12.07%).

Based on the verbal sensory descriptive, of those three cookies, the attributes that are equally preferred are the level of sweetness. The sweetness of these cookies becomes an equally preferred sensory attribute in these cookies (53.49% on coconut cream cookies, 53,85% FiberCreme cookies, and 27.59% commercial cookies). As in coconut cookies, based on research by Tulashie et al (22) the sugar content in 100g of the produced coconut milk was determined to be 3.34g/100g. The sucrose content of coconut milk was measured to be 0.55 g/100g. For FiberCreme cookies, because this creamer contains oligosaccharides, so it has a sweet taste that can replace sugar and has the potential to produce a well-balanced sweetness profile (23).

The attributes that are equally least disliked in all three cookies are chalky, color and texture. Based on a journal review by Xu et al. (24) to get desirable sensory acceptability, experiments are needed using different ingredients. Appearance, color, and texture are depend on the material used. Due to the mixing of ingredients in forming gluten-free cookie formulations, some sample cookies have a color that is usually darker (24). However, the color of cookies also depends mostly on the color of the flour or ingredients that is being used for these cookies (25). White color with a slight touch of cream is the color of coconut milk and FiberCreme used in cookies. So, when compared to some types of gluten free cookies and commercial cookies, the color of FiberCreme cookies and coconut cream cookies has a lighter color.

Gluten-free batter is less cohesive, non-elastic, scarcely rises upon leavening, and is difficult to handle due to the lack of gluten in the dough (24). The increase in the number of

gliadin-glutenin fractions of gluten in the cookie quality influences the texture(25). Gluten-free cookies have a different texture and spread (25). In these sensory attributes word cloud, texture and color attributes are included in both liked and least liked sensory attributes. This can occur due to some errors mainly because it is assessed by untrained panelists, so one assessment can affect the assessment of other samples' characteristics (26).

3.2. Relative sensory attribute profile of each product

The relative sensory attribute focuses on the relative intensity of each attribute of FiberCreme, Coconut and Commercial cookies samples. A value of 1 is the lowest value for the intensity of each component of the assessment of each attribute, while a value of 9 is the highest intensity value for each component of the assessment of each attribute. The result can be seen in Table 3. There were 9 sensory attribute parameters evaluated in this study. Among these 9 parameters, there were 4 parameters (color uniformity, savory flavor, compactness and chalky mouth coating) which gave significantly different results between the FiberCreme and Coconut cookies, the other 5 parameters were not significantly different. In addition, the Commercial cookies sample still dominates the intensity values from all parameters which is better when compared to the other samples in this study.

Table 3. Product Sensory Attribute Profile

Parameter	Samples		
	FiberCreme	Coconut Cream	Commercial
Color Intensity	2.76 ± 1.55^{a}	2.53 ± 1.38^{a}	5.50 ± 1.74^{b}
Color Uniformity Intensity	5.80 ± 1.92^{a}	7.47 ± 1.53^{b}	6.19 ± 2.04^{a}
Cheesy flavor intensity	5.28 ± 1.86^{a}	5.17 ± 2.04^{a}	6.57 ± 1.74^{b}
Savory flavor intensity	5.44 ± 2.06^{ab}	5.27 ± 1.99^{a}	6.04 ± 1.89^{b}
Sweetness Intensity	5.60 ± 1.67^{a}	5.36 ± 1.65^{a}	6.23 ± 1.72^{b}
Hardness Intensity	5.37 ± 1.94^{b}	4.83 ± 2.10^{b}	3.63 ± 2.17^{a}
Intensity of Density	5.73 ± 2.09^{b}	7.04 ± 1.46^{c}	3.95 ± 1.95^{a}
Melting speed in the mouth	5.37 ± 1.89^{a}	5.03 ± 2.12^{a}	7.59 ± 1.32^{b}
Intensity of chalky mouth coating	6.61 ± 1.63^{b}	5.49 ± 2.00^{a}	6.38 ± 1.83^{b}

Ns: The same notation shows that there is no significant difference at the level of confidence α=0.05

In testing the product's sensory attribute profile, 9 sensory attribute parameters were analyzed. Among these parameters, 4 parameters (uniformity of color, savory flavor, density, and chalky mouth coating) give significantly different results between FiberCreme samples and coconut milk, while the other 5 parameters do not produce significant differences. Meanwhile, the two research samples produced significant differences in all the parameters tested. In addition, samples of commercial cookies still dominate the intensity values of all parameters which are better when compared to the two samples in this study. In summary, these 9 parameters can be seen in the presentation of the spider web diagram in Figure 3.

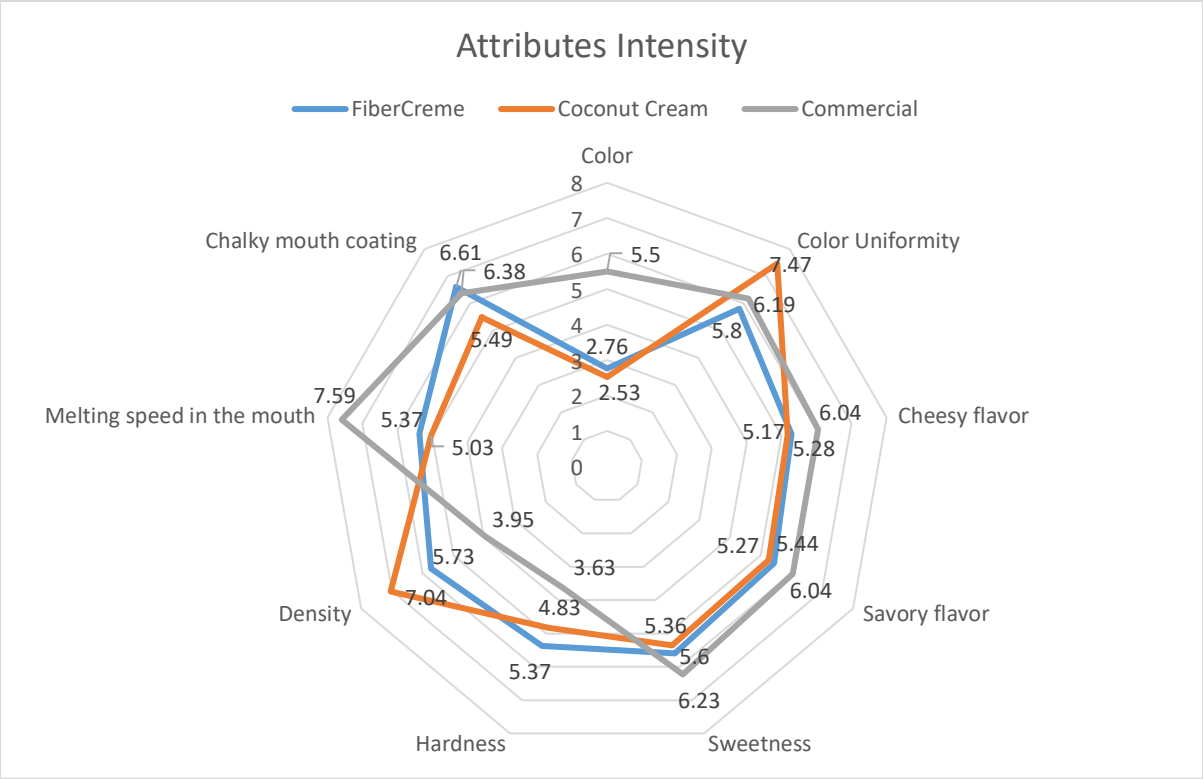

Figure 3. Spider web diagram of relative intensity profile for cookies sensory attributes

It can be seen in Figure 3 that the intensity of chalky mouth coating in FiberCreme and commercial color uniformity is not significantly different. FiberCreme and coconut milk were not significantly different in the attributes of color, cheesy flavor, savory flavor, sweetness, hardness, and speed of melting in the mouth. Coconut milk products dominate the attributes of density and uniformity of color, commercial products dominate the melting speed and cheesy flavor, while FiberCreme products do not appear to dominate in any attributes but in large part have close characteristics for the two products.

In the process of cookies development, cookies that remain delicate and soft are expected. However, cookies become dry and crumbly when packaged. Firm cookies can be made through the recrystallization of sucrose and redistribution of moisture to other components. So that the hardness of cookies can be anticipated by repressing or lessening sugar crystallization. High Fructose Corn Syrup (HFCS), raffinose and trehalose have been considered and utilized effectively to anticipate recrystallization of sucrose (27). In this study, the hardness level of Commercial cookies was lower than the two other samples. Therefore, both FiberCreme and Coconut cookies need improvement by restraining sugar recrystallization or using baking powder to form a hollow structure.

On the color attribute, commercial cookies also produce better colors than FiberCreme and coconut cookies. According to Chintyadewi et al (28), FiberCreme™ is a non-dairy creamer in the form of a white powder, if it is mixed with parboiled rice which is also white in color it will not give a difference in color. Therefore, the color of FiberCreme cookies should not be significantly different or much better than commercial or coconut cookies.

3.3. Relative Sensory Acceptance Profile of Each Product

The level of consumers' subjective acceptance can be assessed through sensory analysis of the Hedonic test which can be seen in Table 4. Hedonic analysis uses the acceptance test method, which is one method of sensory analysis through the assessment of the level of consumer acceptability of the products. The general comparison of the three samples acceptance profile is shown in Figure 4.

Table 4. Product sensory acceptance profile.

Parameter	Samples		
	FiberCreme	Coconut Cream	Commercial
Overall appearance	5.93 ± 1.68^{a}	6.65 ± 1.91^{b}	7.09 ± 1.54^{b}
Overall flavor	6.35 ± 1.77^{a}	6.07 ± 1.75^{a}	6.99 ± 1.84^{b}
Overall texture	6.11 ± 1.86^{b}	5.41 ± 1.96^{a}	7.09 ± 1.78^{c}
Color acceptance	5.92 ± 1.91^{a}	6.64 ± 2.09^{b}	7.51 ± 1.44^{c}
Color uniformity acceptance	5.99 ± 1.64^{a}	7.05 ± 1.75^{b}	7.11 ± 1.44^{b}
Cheesy flavor acceptance	6.44 ± 1.92^{a}	6.09 ± 1.81^{a}	7.04 ± 1.73^{b}
Savoury flavor acceptance	6.16 ± 1.77^{a}	6.41 ± 1.75^{ab}	6.80 ± 1.47^{b}
Sweetness acceptance	6.87 ± 1.57^{a}	6.92 ± 1.74^{a}	7.19 ± 1.63^{a}
Hardness acceptance	6.48 ± 1.88^{b}	5.51 ± 2.04^{a}	7.11 ± 1.85^{c}
Density acceptance	6.33 ± 1.90^{ab}	5.95 ± 2.23^{a}	6.85 ± 1.91^{b}
Acceptance ofmelting speed in mouth	6.41 ± 1.63^{b}	5.80 ± 1.99^{a}	7.42 ± 1.77^{c}
Acceptance of chalky mouth coating	5.65 ± 2.08^{a}	5.80 ± 1.96^{a}	6.53 ± 1.92^{b}
Overall liking	6.21 ± 1.49^{a}	6.05 1.58^{a}	7.12 ± 1.54^{b}

ns= The different letter within the same row indicated significance different (p<0.05)

Based on Table 4, it is known that the level of acceptance for texture (hardness, density, and speed of melting in the mouth) of the three samples was significantly different. The acceptance level of the overall appearance and color uniformity of commercial samples and coconut milk was not significantly different. The acceptance of the taste of coconut milk and FiberCreme was not significantly different, but significantly different from the commercial cookies.

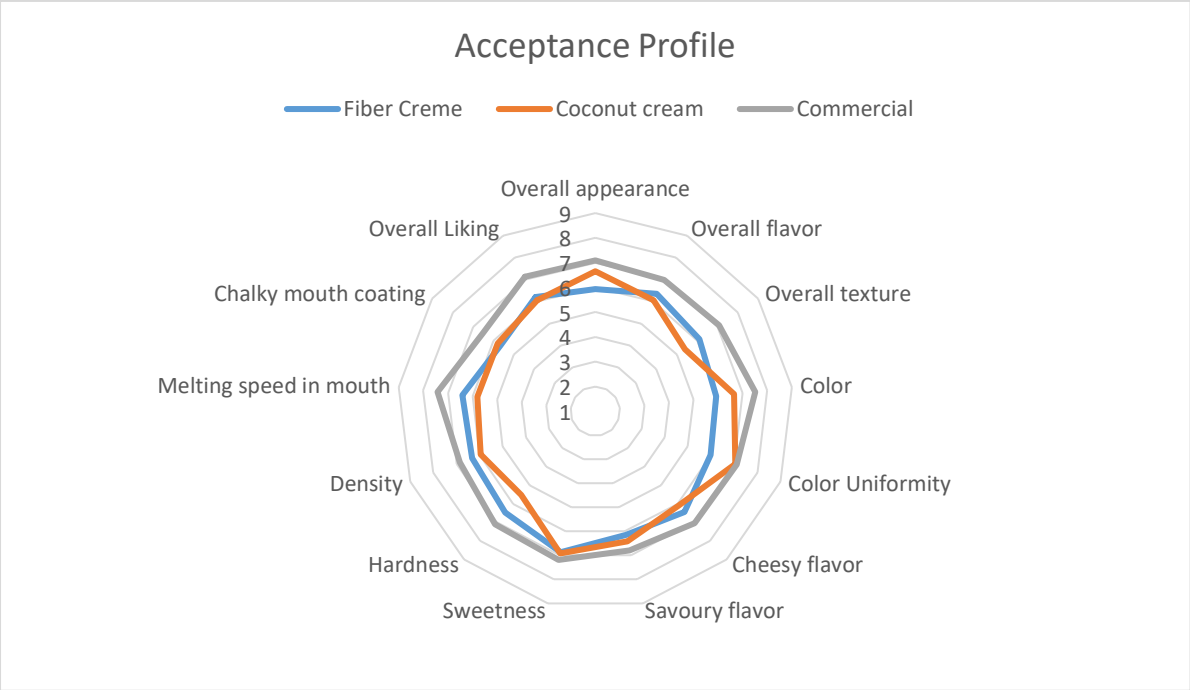

Figure 4. Spider web diagram of acceptance cookies profile.

FiberCreme™ is a creamer containing dietary fiber with oligosaccharides as the main sources, namely inulin and isomalto-oligosaccharides (IMO). FiberCreme™ is a product that claim to replace milk or coconut milk because it can produce creamy properties in food products(29). Commercial products dominate the level of acceptance for texture attributes (Table 5). Commercial products contain a powdered milk on the ingredient that may increase its texture acceptance. According to Putri et al (8), skim milk can increase the water-holding capacity (WHC) and fat-binding capacity (OHC) in the product so that a strong emulsion is produced. In addition, skim milk can produce a good product appearance and improve product flavor attributes.

Texture is defined as the combination of physical, mechanical, and surface structures of a material (30). When we eat, food that is small enough for a single bite is processed by the tongue and teeth before being swallowed. The time required to process food in the mouth is short, about 1 second for liquids , 10 seconds for thick and semisolid liquids, and 100 seconds for solid (31). Consequently, the assessment of texture parameters in food is relies heavily on the individual perception of the panelists (32). To further analyze the correlation between attribute intensity and their acceptance, Pearson correlation analysis was conducted. The result is shown in Table 5.

Table 5. Correlation analysis between attributes intensity and acceptance.

Parameter	Correlation coefficient
Sweetness	.915
Color	.858
Color uniformity	.645
Savoury flavor	1.000
Cheesy flavor	.754
Density	.077

Hardness	-.579
Melting speed in mouth	.967
Chalky mouth coating	.158

Table 5 shows that certain parameters, such as density and chalky mouth coating, exhibit a low correlation. In contrast, attributes like sweetness, color and savory flavor, have a strong correlation. Additionally, attributes like color uniformity, cheesy flavor, and hardness have a moderate positive correlation. Conversely, hardness shows a negative correlation with intensity and liking attributes. A high correlation indicates a strong link between the intensity of a characteristic and the level of liking for that attribute among panelists. Meanwhile, a negative level of correlation a negative or inverse correlation between intensity and liking level (32).

3.4. Consumer Interest in Purchasing the Products

Table 6 provides an overview of consumer interest in purchasing products, highlighting key insights into buying intentions and willingness to pay. This data is critical for understanding market potential and the factors influencing consumer decision-making. The table categorizes responses to purchasing interest, allowing for an in-depth analysis of consumer behavior.
As shown in Table 6, the data emphasizes varying levels of interest across different situation (blind and informed), offering valuable information for tailoring marketing strategies and product development. The inclusion of this table enables a comprehensive understanding of consumer attitudes, serving as a foundation for further discussion on market trends and opportunities.

Table 6. Overview of consumer interest in purchasing products.

Cookies Samples	Purchase intention (blind)	Purchase intention (informed)	Willingness to pay (blind) in rupiah	Willingness to pay (Informed) in rupiah
Fiber Creme	5.72 $\pm$ 0.22^{b}	6.17 ± 0.20^{ab}	18,667 $\pm$ 1,186.18^{a}	16,629 ± 865.24^{a}
Coconut Cream	5.32 $\pm$ 0.22^{b}	6.00 ± 0.25^{a}	19,867 $\pm$ 1,186.18^{a}	18,666 ± 1,152.28^{a}
Commercial	6.69 $\pm$ 0.23^{a}	6.78 ± 0.25^{a}	19,973 $\pm$ 1,194.16^{a}	17,185 ± 1,232.59^{a}

We found that information does not increase purchase intention. The appropriate price according to consumers objectively per 150 g biscuit is around IDR. 20,000, not significantly different for the three types of cookies. With or without information, objectively, consumers judge that the price of around twenty thousand rupiahs is reasonable.

The study's findings suggest that FiberCreme cookies are a viable alternative to commercial and coconut milk cookies, offering similar sensory attributes. However, improvements are needed to enhance specific attributes such as texture and color uniformity. The positive correlation between certain sensory attributes and overall acceptance highlights the importance of these factors in product development. This study highlights the hedonic and relative sensory attributes profile of non-gluten cookies developed with and without FiberCreme™. The strengths and weaknesses of desirable attributes of each cookie have been profound. Information potentially increases the purchase intention. However, this study has limitations, particularly regarding the position of the FC cookies compared to other cookies in

the market. This presents an opportunity for further research to compare among the "healthy-claimed" cookies in the market. The results provide valuable insights for the food industry in developing high-fiber, gluten-free cookies. FiberCreme™ can be utilized to create healthier cookie options that appeal to consumers. Future research should explore further improvements in formulation and sensory properties to increase consumer acceptance.

4. Conclusions

This study demonstrated that FiberCreme cookies are comparable to commercial and coconut milk cookies in terms of sensory attributes, with the potential to be developed as a functional food product. The sensory profiles of FC cookies and coconut milk were not significantly different in the attributes of color, cheesy flavor, savory flavor, sweetness, hardness and melt speed in the mouth. Chalky mouth coating and color uniformity of FC and commercial cookies were not significantly different. Overall acceptance from the most liked were commercial cookies, FiberCreme and Coconut cookies respectively. The appropriate pricing for these cookies, as determined by consumer feedback, is around Rp. 20,000 per 150gr. The findings highlight the importance of sensory evaluation in product development and provide a basis for future research on high-fiber, gluten-free cookies.

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Author Contributions

Concept and design; D.L.N.F, A.W.P, S, Y.M, A.M. Analysis and interpretation; D.L.N.F, A.W.P. Data collection; D.L.N.F, A.W.P. Writing the article; D.L.N.F, R.G.P. Critical revision of the article; D.L.N.F, R.G.P. Final approval of the article; all authors. Statistical analysis; D.L.N.F. Obtained funding; Y.M, S, D.L.N.F, A.M. Overall responsibility; D.L.N.F.

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Institutional Review Board Statement

The sensory evaluation and consumer acceptance were established to follow the guidelines presented in the Declaration of Helsinki, which was approved by the Medical and Health Research Ethics Committee of the Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada, Yogyakarta, Indonesia (REF no. KE/FK/0404/EC/2021).

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request. Due to privacy and ethical considerations, some data may be subject to restrictions and cannot be shared publicly.

Conflicts of Interest

The authors declare no conflict of interest regarding the publication of this manuscript.

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