PHYSICOCHEMICAL AND SENSORY PROPERTIES OF VEGAN CREAM CHEESE MADE FROM JACKFRUIT SEED FLOUR AND COCONUT MILK

BACHELOR'S THESIS

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BACHELOR'S PROGRAM OF FOOD TECHNOLOGY

FACULTY OF ANIMAL AND AGRICULTURAL SCIENCES

UNIVERSITAS DIPONEGORO

SEMARANG, INDONESIA

2026

PHYSICOCHEMICAL AND SENSORY PROPERTIES OF VEGAN CREAM CHEESE MADE FROM JACKFRUIT SEED FLOUR AND COCONUT MILK

By

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A thesis submitted in partial fulfillment of the requirements for obtaining a Bachelor's Degree in Food Technology, Faculty of Animal and Agricultural Sciences, Universitas Diponegoro.

BACHELOR'S PROGRAM IN FOOD TECHNOLOGY
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SEMARANG, INDONESIA
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1. Thesis entitled: **Physicochemical and Sensory Properties of Vegan Cream Cheese Made from Jackfruit Seed Flour and Coconut Milk,** and the research related to this scientific work are the result of my own work.

2. All sources and citations derived from the publications or other works of others incorporated into this bachelor's thesis have been properly acknowledged and referenced in accordance with accepted academic and scientific standards.

3. I also acknowledge that this bachelor's thesis was completed under the full guidance and supervision of **Prof. Ir. Anang M. Legowo, M.Sc., Ph.D.,** and **Setya Budi Muhammad Abduh, S.Pt., M.Sc., Ph.D.**

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APPROVAL PAGE

Title of Thesis	:	PHYSICOCHEMICAL AND SENSORY PROPERTIES OF VEGAN CREAM CHEESE MADE FROM JACKFRUIT SEED FLOUR AND COCONUT MILK
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Program Study/Department	:	FOOD TECHNOLOGY/AGRICULTURE
Faculty	:	ANIMAL AND AGRICULTURAL SCIENCES

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SUMMARY

AFIFAH. 23020122140202. 2026. Physicochemical and Sensory Properties of Vegan Cream Cheese Made from Jackfruit Seed Flour and Coconut Milk **(Supervisor: ANANG MOHAMAD LEGOWO** and **SETYA BUDI MUHAMMAD ABDUH**).

Coconut milk has potential as a base ingredient for vegan cream cheese due to its high fat content and creamy characteristics. However, the absence of casein limits its ability to form a stable structural network. Jackfruit seed flour, as a starch-rich ingredient, may provide an alternative structuring mechanism through starch gelatinization.

This study was conducted from May to August 2026 at several laboratories at Universitas Diponegoro, Semarang, and aimed to evaluate the effects of different concentrations of jackfruit seed flour on the physicochemical and sensory properties of vegan cream cheese made with coconut milk.

A single-factor experimental design consisting of five jackfruit seed flour concentrations of 2%, 3%, 4%, 5%, and 6% (w/v) with four independent replications was used. The evaluated parameters included proximate composition, color properties, and sensory characteristics. Proximate and color data were analyzed using ANOVA followed by DMRT, while sensory data were analyzed using the Kruskal-Wallis test followed by the Mann-Whitney test at a 5% significance level.

Increasing jackfruit seed flour concentration significantly affected all proximate parameters ($p < 0.05$). Moisture increased from 56.40% to 61.57%, protein from 2.95% to 3.95%, fat from 24.68% to 25.11%, ash from 0.93% to 1.57%, and calculated carbohydrate decreased from 15.05% to 7.84%. The decrease in calculated carbohydrate reflected the by-difference calculation method. Jackfruit seed flour concentration also significantly affected all color parameters ($p < 0.05$), with L* decreasing from 72.35 to 67.31, a* shifting from −6.30 to −2.69, and b* increasing from 2.52 to 8.65. C* showed a non-linear response, ranging from 6.21 to 8.81, with the highest value observed at 6% jackfruit seed flour. Sensory analysis showed a significant effect on organoleptic color scores and hedonic scores for color, savoriness, creaminess, and overall acceptability ($p < 0.05$), whereas the other evaluated sensory attributes were not significantly affected. Overall, increasing jackfruit seed flour concentration altered the physicochemical characteristics and selected sensory properties of vegan cream cheese made with coconut milk.

ACKNOWLEDGEMENT

All praise and gratitude are due to Allah SWT for His abundant grace and guidance, by which the author was able to complete a bachelor's thesis titled **"Physicochemical and Sensory Properties of Vegan Cream Cheese from Jackfruit Seed Flour and Coconut Milk."** This report was completed with the prayers, support, and assistance of various parties. Therefore, the author would like to sincerely express gratitude to:

1. The author's parents, Mr. Muslich and Mrs. Irnaningsih, as well as siblings, Fauzan and Nabilah, for their continuous support, encouragement, and prayers, enabling the author to complete both the study and this bachelor thesis successfully;
2. Prof. Ir. Anang M. Legowo, M.Sc., Ph.D., as supervisor, and Setya Budi Muhammad Abduh, S.Pt., M.Sc., Ph.D., as co-supervisor, for the guidance and valuable suggestions from the proposal preparation stage through to the completion of this bachelor's thesis;
3. Prof. Sugiharto, S.Pt., M.Sc., Ph.D., as the Dean of the Faculty of Animal and Agricultural Sciences, Universitas Diponegoro;
4. Ahmad Ni'matullah Al-Baarri, S.Pt., M.P., Ph.D., as the Head of the Bachelor Food Technology Study Program;
5. drh. Siti Susanti, Ph.D., and Setya Budi Muhammad Abduh, S.Pt., M.Sc., Ph.D., as the Coordinator of the Food Technology Laboratory, for the assistance provided to the author;
6. Dr. Rafli Zulfa Kamil, S.T.P., as the author's Academic Advisor, for his guidance and support throughout the completion of this study;
7. Dr. Bhakti Etza Setiani, S.Pt., M.Sc and Ratih Paramastuti, S.Gz., M.Si. as the Thesis Examiners, for their valuable time, insightful evaluations, constructive feedback, and meaningful suggestions that greatly enriched the development and completion of this thesis;
8. Fariz Nurmita Aziz, S.T.P., M.Sc., as a member of the Thesis Examination Committee, for his valuable time, assistance, and contribution in facilitating the thesis examination process;
9. All lecturers and administrative staff of the Food Technology Study Program and the Faculty of Animal and Agricultural Sciences for their guidance, assistance, and administrative support throughout the author's study and research;

10. Mr. Indarto and Ms. Nadya, the staff of the Food Technology Laboratory, for sharing their knowledge, providing technical assistance, and offering valuable information during the research;
11. Amatullah Maryam, as a research partner, for her dedication, constructive discussions, companionship, and collaborative efforts during the completion of this bachelor's thesis;
12. Najwa Ailsa Araminta, Lusiana Rahmaningrum, Choiriyatul Abidatillah, Zaleha Rumadi, and Inji Muhammad Zeidan as the author's close friends for moral support, motivation, encouragement, and assistance throughout the process of this bachelor's thesis implementation;
13. The author's fellow students of the Food Technology Study Program and friends who cannot be mentioned individually, for their support, motivation, and assistance in completing this bachelor's thesis.

The author hopes that this thesis may provide useful benefits and valuable insights for all related parties. The author realizes that this report still has limitations; therefore, constructive suggestions and criticisms are highly welcome for the improvement of future research. Hopefully, this report can contribute knowledge and be beneficial to readers.

Semarang, 30 September 2026

Sincerely,

The Author, Afifah

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CHAPTER I

INTRODUCTION

1.1 Background

Cream cheese is a soft, unripened cheese characterized by its smooth texture and spreadable consistency (Codex, 2022). Due to these desirable characteristics, cream cheese is widely used as a spread and as an ingredient in various food products. However, conventional cream cheese is produced primarily from dairy ingredients. This limit its suitability for consumers following plant-based diets or those who avoid certain dairy components.

In recent years, consumer dietary patterns have shifted toward more sustainable food choices. This has resulted in an increased demand for plant-based alternatives, particularly in developed countries (Wouters *et al.*, 2016) . This trend is influenced by a combination of factors, including health considerations such as lactose intolerance, ethical concerns associated with vegan lifestyles, environmental sustainability, and the need to reduce greenhouse gas emissions linked to dairy production (Silva *et al.*, 2020; McClements, 2023; Alcorta *et al.*, 2021). As a result, plant-based alternatives to dairy products, including vegan cream cheese have received increasing research and commercial interest. These products are designed to reproduce the structural and sensory characteristics of conventional cheese by using ingredients sourced from plants (Atik and Huppertz, 2025).

One commonly used ingredient in plant-based cheese formulations is coconut milk due to its high fat content. This contributes to creaminess and mouthfeel. However, coconut milk differs in composition from dairy milk and does not contain casein. Therefore, it does not undergo the same casein-based gel formation as conventional cream cheese. Alternative structuring mechanisms are needed to develop the desired semi-solid consistency of vegan cream cheese made with coconut milk. Yunita *et al.*, (2022) reported that the spreadability of soft cheese made with coconut could be improved through starter culture optimization, moisture reduction, and stabilizer addition. The resulting texture was still not fully comparable to conventional cheese. Similarly, Halim *et al.*, (2022) observed improvements in texture when coconut milk was combined with soy milk, but the structural quality remained not optimal.

One possible approach is the use of starch-rich plant ingredients that can provide structure through heat-induced gelatinization. One promising ingredient is jackfruit seed flour derived from Jackfruit (*Artocarpus heterophyllus Lam*). Jackfruit seed contains significant amounts of starch (12.86–17.90 g/100 g), protein (18%), fiber (1.56–3.92 g/100 g), minerals and various bioactive compounds (López *et al.*, 2025). The high starch content, particularly its amylose and amylopectin that contribute to its gelatinization properties. When heated in the presence of water, the starch granules absorb water and swell. This resulted in increased viscosity and the development of a semi-solid matrix. These properties indicate the potential of jackfruit seed flour as a starch-based structuring ingredient in cream cheese made with coconut milk.

Previous research by Tharayil *et al.*, (2025) demonstrated that jackfruit seed flour has been used in vegan cheese spread formulations, combined with cashew kernels and sunflower oil. The results indicate that the developed product has an improved nutritional profile compared to commercially available vegan cheese alternatives. The rheological and microstructural properties of the product indicated that the overall structure of the cheese spread remained physically stable.

However, the application of jackfruit seed flour specifically in vegan cream cheese made with coconut milk remains limited. In particular, information regarding the effects of different jackfruit seed flour concentrations on its physicochemical and sensory properties is still lacking. Therefore, this study aimed to evaluate the effects of different concentrations of jackfruit seed flour on vegan cream cheese made with coconut milk by analyzing its chemical composition, color, and sensory properties. The findings are expected to provide scientific information regarding the utilization of jackfruit seed flour as a plant-based structuring ingredient and support the development of acceptable plant-based cheese alternatives.

1.2 Research Purposes

The research purpose of this study is to evaluate the effect of different concentrations of jackfruit seed flour on the physicochemical and sensory properties of vegan cream cheese made from coconut milk.

1.3 Significance of Study

The significance of this study lies in providing scientific insight into the physicochemical, and sensory characteristics of vegan cream cheese made with coconut milk formulated with different concentrations of jackfruit seed flour. The findings are expected to improve the understanding of how jackfruit seed flour concentration influences the chemical composition, color properties, and sensory acceptance of the product. In addition, this study contributes to the development of vegan cream cheese with improved nutritional quality, product quality, and consumer acceptability. Furthermore, the findings are expected to promote the utilization of jackfruit seed flour as an underutilized plant-based ingredient. This study is also expected to provide a scientific basis for the development of sustainable dairy alternatives from plant-based ingredients.

CHAPTER II

LITERATURE REVIEW

2.1 Cream Cheese

Cream cheese is a soft, unripened dairy cheese characterized by its smooth consistency, creamy mouthfeel, and spreadable texture. Conventional cream cheese is commonly produced through acid-induced coagulation. The coagulation of casein contributes to the formation of its characteristic structure. The spaces within this network are filled with whey and give cream cheese its characteristic creamy mouthfeel and spreadability (Pombo, 2021). This structural arrangement contributes to the characteristic creamy mouthfeel and spreadability of cream cheese.

The composition of cream cheese plays an important role in determining its physical characteristics. (Kim *et al.*, 2022) reported differences in fat, moisture, and protein contents among commercial cream cheese products. These differences can influence the structural and textural properties of cream cheese. Puck Cream Cheese is one example of a commercially available dairy cream cheese in the market. Its nutritional composition, based on the information provided on the product label, is presented in Table 1.

Table 1. Nutritional Composition of Puck Cream Cheese per 15 g

Parameters	Quantity
Energy	45 kcal
Total fat	4.5 g
Cholesterol	10 mg
Saturated fat	2.5 g
Protein	1 g
Total carbohydrate	0 g
Sugar	0 g
Sodium	135 mg

Source: PT Arla Foods Indonesia

2.2 Vegan Cream Cheese

Vegan cheese is made from plant-based ingredients as an alternative to conventional dairy cheese. According to Atik and Huppertz, (2025), vegan cheese is formulated to replicate the appearance, structure, and sensory characteristics of dairy cheese using ingredients of plant origin. Vegan cream cheese is formulated to resemble conventional cream cheese. It is characterized by spreadability, creaminess, and relatively high fat content. Unlike conventional cream cheese, vegan cream cheese does not rely on a casein-based network to develop its structure. Instead, plant-based fats, proteins, starches, and hydrocolloids can be used to provide the desired structural and sensory characteristics through alternative mechanisms such as emulsification and gelation.

From a formulation perspective, vegan cream cheese is classified as a non-dairy cheese analogue (Kamath *et al.*, 2022). Cheese analogues are products developed to resemble conventional cheese in terms of appearance, texture, functionality, and sensory properties. They partially or completely replace dairy

ingredients with alternative components. Regardless of the category, cheese analogues generally consist of water, fats/oils, starch, and protein sources (Grossmann and McClements, 2021). Therefore, selecting appropriate plant-based ingredients is essential to produce vegan cream cheese with desirable quality characteristics.

Various plant-based ingredients have been investigated in the development of vegan cream cheese. Examples of formulations and their main findings from previous studies are presented in Table 2.

Table 2. Examples of vegan cream cheese formulations reported in previous studies.

Main ingredients	Main findings	Reference
Pea protein, pea fiber, potato fiber, and sunflower oil/coconut oil	The type of plant oil influenced the physical and lubrication properties of the cream cheese analogue.	Michel *et al.*, (2022)
Chickpea/red lentil flour and avocado	Chickpea and red lentil formulations showed suitable adhesiveness and spreadability.	Palatzidi *et al.*, (2025)
Pea protein isolate and soybean oil	The combination of protein and oil produced an emulsion gel with cream cheese-like characteristics.	Choe *et al.*, (2026)
Watermelon seed milk, maltodextrin, and hydrocolloids	The optimized formulation showed cream cheese-like textural properties and acceptable sensory characteristics.	Janpeng *et al.*, (2026)

2.3 Jackfruit Seed Flour

Jackfruit seed flour is processed from the seeds of jackfruit (*Artocarpus heterophyllus Lam.*). It is a tropical fruit widely cultivated in Southeast Asia,

including Indonesia. The flour is obtained by processing jackfruit seeds through cleaning, drying, grinding, and sieving steps to produce a fine powder for the flour. Traditionally, jackfruit seeds are often discarded as agricultural byproducts despite their considerable nutritional and functional potential. Recent research has demonstrated the significant nutritional and functional value of jackfruit seeds. Particularly, their high levels of protein, starch, and various bioactive compounds (Dhani *et al.*, 2025). These nutrients are predominantly located in the cotyledons that are especially rich in protein and starch (Goh *et al.*, 2024). In addition, jackfruit seeds contain vitamins, minerals, polyphenols, flavonoids, saponins, and antioxidant compounds that contribute to their potential health benefits (Hajj *et al.*, 2022; Fabil *et al.*, 2024; Kamal *et al.*, 2024).

Jackfruit seeds can be further processed into flour as an effective approach to reducing agricultural waste while enhancing the value of underutilized plant materials. Proximate composition analyses reported by Islam *et al.*, (2025) indicate that raw jackfruit seed flour contains approximately 66.2% carbohydrates, 13.8% protein, 3.9% fat, 2.7% ash, and 5.1% dietary fiber. The carbohydrate percentage is predominantly composed of starch. It plays a crucial role in the functional behavior of the flour. The high crude fiber is due to the high content of jackfruit seeds that are rich in cellulose, hemicellulose, and lignin (Thatsanasuwan *et al.*, 2023).

Due to its starch nature, jackfruit seed flour exhibits the ability to form gels. This makes it particularly suitable for applications such as vegan cream cheese formulations. According to Akter and Haque (2018), jackfruit seed flour exhibits functional properties including high swelling power, bulk density, and oil

absorption capacity. When heat is applied to starch, it undergoes gelatinization, resulting in thickening and gel formation. Upon cooling, the gelatinized starch may undergo retrogradation as the amylose and amylopectin chains gradually reassociate and form a more ordered structure (Gong *et al.*, 2024). This process can contribute to the development and stabilization of the starch-based gel structure during cooling and storage.

According to Wong *et al.*, (2021) jackfruit seed starch exhibited a higher pasting temperature than rice and potato starches. This indicates greater resistance to heat during processing. The starch also demonstrated low breakdown viscosity. This suggests strong internal cohesive forces and improved resistance to heat and shear. These thermal and rheological properties support the application of jackfruit seed flour as a natural thickening and stabilizing agent in various food systems. For example, Maduwage *et al.*, (2025) demonstrated the utilization of jackfruit seed flour as a thickening agent in tomato sauce, supporting its potential application in products requiring controlled consistency and textural development. These functional properties also indicate its potential application in plant-based dairy alternatives such as vegan cream cheese.

2.4 Coconut Milk

Coconut milk is a traditional food ingredient widely used in cuisines in the tropical regions of Southeast Asia, South Asia, and parts of Africa. It is obtained by extracting the grated endosperm of mature coconut (*Cocos nucifera L.*) with water. It produces an opaque white liquid that is high in fat and flavor. Coconut milk is

categorized as a plant-based milk and is characterized as an oil-in-water emulsion (Marchini *et al.*, 2021). The stability of coconut milk emulsions is primarily attributed to coconut proteins that absorb at the oil-in-water interface and function as natural emulsifying agents (Saffarionpour and Ottens, 2018). According to (Darsana *et al.*, 2026), the proximate analysis indicates that coconut milk contains approximately 74.80% moisture, 20.14% fat, 2.83% protein, 0.63% ash, and 1.60% total solids. The fat percentage is specifically composed of saturated fatty acids, including lauric acid (45–48%), myristic acid (16–18%), and palmitic acid (8–10%). This fatty acid profile contributes to the physicochemical stability of coconut milk as well as its distinctive sensory characteristics. It also provides several essential minerals such as calcium, iron, magnesium, phosphorus, and potassium (Darsana *et al.*, 2026).

2.5 Proximate Composition

The proximate composition of foods includes moisture, fat, protein, ash, and carbohydrate contents. Determination of these components provides important information about the nutritional composition and overall quality of food products (Mario *et al.*, 2024). Proximate composition is widely used in food research to characterize raw materials and finished products to assess changes resulting from differences in formulation and processing. The importance and characteristics of each component are discussed in the following sections.

2.5.1 Moisture Content

Moisture content is the amount of water contained in a food product and is expressed as a percentage (AOAC, 2006). This is an important parameter for evaluating food quality because it influences food freshness and preservation (Fauzi *et al.*, 2025). The presence and proportion of water can influence various physicochemical characteristics of food, including texture, appearance, and chemical reactions that occur during processing and storage. In addition, moisture content influences microbial stability and shelf life (Zambrano *et al.*, 2019). The availability of water can affect the growth of microorganisms and the stability of food products. In vegan cream cheese, moisture content is particularly important because it influences the product's physical characteristics and stability. The amount of water present can influence properties such as texture and spreadability that are important characteristics of cream cheese products (Oupathumpanont *et al.*, 2025).

2.5.2 Protein Content

Protein content refers to the amount of protein present in a food product. Protein plays a particularly important role in nutrition as one of the three macronutrients, alongside fat and carbohydrates (Fazzino *et al.*, 2023). According to Savarino *et al.*, (2021), it contributes to essential physiological functions, including growth and tissue repair. Beyond its nutritional role, protein also influences several functional characteristics of food, such as emulsification, gel formation, water-binding capacity, and texture.

In plant-based foods, proteins can serve as nutritionally valuable alternatives to animal-based proteins while also providing functional properties that support their application in dairy substitutes (Magdum *et al.*, 2026). For plant-based cheese products, interactions between proteins and starches can contribute to the formation of a gel-like structure and consequently influence the texture of the final product (Oupathumpanont *et al.*, 2025). Vegan cream cheese is similarly influenced by the composition of its raw materials, to determine its protein content.

2.5.3 Fat Content

Fat content analysis is used to determine the total lipid concentration in food products. Fat is one of the three major macronutrients and serves as a concentrated source of energy (Vostrikova *et al.*, 2018). It influences the texture, mouthfeel of foods and functions as a carrier for fat soluble vitamins. These components originate from naturally occurring lipids in plant/animal materials and added fats/oils during processing. Moreover, fat plays a significant functional role in food systems by enhancing flavor perception that contributes to desirable sensory qualities such as richness and creaminess (Sanders, 2016). In vegan cream cheese, fat is particularly important because it contributes to the creamy mouthfeel and texture of the product. Therefore, variations in fat content may influence the sensory characteristics and overall quality of vegan cream cheese.

2.5.4 Ash Content

Ash content represents the total inorganic mineral fraction remaining in a food product after the removal of its organic components. It is commonly used as an

indicator for evaluating the nutritional quality and overall composition of food materials (Liu, 2019). It also reflects the contribution of raw materials that contain minerals to the final food product and can be used to assess its nutritional quality (Mario *et al.*, 2024). That's why it is an important component of proximate composition. In plant-based food products, the ash content may vary depending on the mineral composition of the ingredients used. For vegan cream cheese, ash content can reflect the contribution of minerals from ingredients such as jackfruit seed flour and coconut milk to the final product. Therefore, changes in ash content may indicate differences in mineral contribution and overall nutritional composition

2.5.5 Carbohydrate Content

Carbohydrate content analysis is used to determine the total carbohydrate levels in food products. Carbohydrates are one of the three major macronutrients, alongside proteins and fats. They serve as an important source of energy and metabolic fuel (Shailja and Singh, 2024). They primarily consist of sugars, starches, cellulose, and dietary fibre. Among these components, starch is typically the dominant contributor to available carbohydrates that affect both the energy value and functional properties of the product (McCleary *et al.*, 2020).

Beyond their nutritional role, carbohydrates also contribute to the structural and functional characteristics of food products (Campos *et al.*, 2022). In plant-based products, carbohydrate content is influenced by the composition of the raw materials used. For vegan cream cheese, carbohydrate content is influenced by its raw materials and may affect the nutritional and physical characteristics of the

product. Therefore, variations in carbohydrate content may influence the overall nutritional and functional properties of vegan cream cheese.

2.6 Color Properties

Color is an important attribute of food products and plays a significant role in their visual acceptance by consumers (Kosaplawan *et al.*, 2025). As one of the first characteristics perceived by consumers, it provides an initial visual impression and can serve as an important indicator of food quality (Khalisa *et al.*, 2021). Therefore, color properties are an important consideration in evaluating the quality and consumer acceptance of food products.

The CIELAB color system is widely used to describe the color properties of food products using three coordinates: L*, a*, and b* (Brühl and Unbehend, 2021). The L* value represents lightness, with lower values indicating darker colors and higher values indicating lighter colors. The a* value describes the color position between green and red. Negative values indicate green, and positive values indicate red. Meanwhile, the b* value represents the color range between blue and yellow. Negative values indicate blue, and positive values indicate yellow. In addition to these coordinates, chroma (C*) can be calculated from the a* and b* values to describe color intensity or saturation. A higher C* value indicates a more vivid or saturated color, whereas a lower C* value indicates a less saturated color (Al-Mtury *et al.*, 2025). Together, these parameters provide an objective representation of the color characteristics of food products.

Color properties of food products can be affected by the type of ingredients, concentration of ingredients, and processing conditions. These factors may contribute to variations in the color of the vegan cream cheese. These changes can be reflected in the L*, a*, b*, and C* values, providing an objective description of its color characteristics.

2.7 Sensory Properties

Sensory properties are important characteristics of food products because they influence consumers' perception and food choices (Chambers, 2019). These properties refer to characteristics that can be perceived through human senses, including taste, aroma, texture, color, and appearance. Sensory properties contribute to the overall quality and acceptance of food products by shaping consumers' perceptions of product characteristics. Differences in sensory properties may arise from variations in ingredients, formulation, and processing conditions. It is particularly important in vegan cream cheese because these properties contribute to the overall eating experience and consumer acceptance. Therefore, understanding these properties is important for evaluating the sensory characteristics and acceptance of vegan cream cheese.

2.7.1 Hedonic Test

The hedonic test is an affective sensory method used to determine the degree of liking or acceptance of a food product. It is commonly applied in food product development to assess consumer responses to different product formulations. One of the most widely applied methods is the nine-point hedonic scale, which ranges

from “dislike extremely” to “like extremely.” (Lawless and Heymann, 2010). In addition, there are other formats, including five-point, seven-point, and continuous scales, which are used depending on the study objectives. The scale contains a neutral point in the middle and is considered effective for identifying differences in consumer preference levels among products (Heymann and Ebeler, 2016). In this test, panelists evaluate several sensory attributes, including taste, aroma, texture, and color. The results obtained from the hedonic test can be used to determine consumer acceptance and provide important information for product development. For vegan cream cheese, this approach can be used to determine the degree of liking toward the sensory characteristics of the product.

2.7.2 Organoleptic Scoring Test

The organoleptic scoring test is a sensory method used to assess the intensity of specific sensory characteristics of food products. The method can be applied to attributes such as color, aroma, taste, and texture by assigning numerical scores according to a predetermined scale (Soekarto, 1985). According Stone and Sidel (2004), scoring tests can also be used to identify quality differences among similar products by assigning scores to specific sensory characteristics.

In the organoleptic scoring test, panelists assign scores based on a predetermined scale, for example ranging from “very weak” to “very strong.” The intensity of sensory perception may be expressed using scalar or numerical scales (Soekarto, 1985). This method is commonly used to provide a more detailed description of product sensory characteristics and is useful for comparing the

sensory profile of innovative products with reference or commercial products. In vegan cream cheese, an organoleptic scoring test can provide information about the intensity of sensory attributes such as color, aroma, taste, and texture,

CHAPTER III

MATERIALS AND METHODS

3.1 Materials

The research was conducted from May to August 2026 at several laboratories at Universitas Diponegoro, Semarang. Research activities were carried out at the Food Processing Laboratory, Food Chemistry and Nutrition Laboratory, Food and Agricultural Products Engineering Laboratory, and Sensory Laboratory within the Faculty of Animal and Agricultural Sciences. Additional analysis was conducted at the Integrated Laboratory Technical Implementation Unit (UPT), Universitas Diponegoro.

The tools used in this research included an analytical balance (Shimadzu ATX 224, Jepang), moisture dishes, porcelain crucibles, a drying oven (Memmert, Jerman), a muffle furnace, a desiccator (Memmert, Jerman), color reader (Cs-10, Taiwan), a Kjeldahl digestion, distillation apparatus, Erlenmeyer flasks, a Soxhlet extraction apparatus, filter paper, beakers, measuring cylinders, a thermometer, and a refrigerator for sample storage. A household blender (Mito BL100) was used to mill jackfruit seeds, and 200 mesh sieves were used to obtain a uniform particle size.

The materials used in this study included fresh jackfruit seeds (*Artocarpus heterophyllus* Lam.) obtained from a traditional market in Mranggen, Demak Regency, Central Java, Indonesia. Then coconut milk (Kara), bread for sensory

evaluation, aquades, and mineral water for palate cleansing during sensory testing. Chemical reagents used for analysis included mixed selenium catalyst, sulfuric acid (H_2SO_4), sodium hydroxide (NaOH) 45%, hydrochloric acid (HCl) 0.1 N, boric acid (H_3BO_3) 4%, methyl red (MR), methylene blue (MB), and n-hexane solvent for Soxhlet fat extraction.

3.2 Methods

The research method included experimental design, hypothesis, research procedures, parameter testing, and data analysis based on the experimental results. The detailed description of each component of the research method is presented as follows.

3.2.1 Experimental Design

The experimental design used in this study was a completely randomized single-factor design to evaluate the effect of jackfruit seed flour concentration on the chemical, color, and sensory properties of vegan cream cheese made with coconut milk. The treatments consisted of the addition of jackfruit seed flour at concentrations of 2%, 3%, 4%, 5%, and 6% (w/v) based on the volume of coconut milk used. The treatment range was selected based on preliminary trials. Concentrations above 6% (w/v) produced a considerably thicker and more viscous consistency, which reduced the spreadable characteristics expected of the product. Therefore, 6% (w/v) was selected as the maximum concentration, while 2% (w/v) was used as the minimum concentration to establish a treatment range for evaluating the effect of increasing jackfruit seed flour concentration. Each treatment

was replicated four times, resulting in a total of 20 experimental units, as presented in Table 3.

Table 3. Experimental Design of Vegan Cream Cheese Made with Coconut Milk and Formulated with Different Concentrations of Jackfruit Seed Flour

Replication	Treatment				
	T_1	T_2	T_3	T_4	T_5
1	T_1R_1	T_2R_1	T_3R_1	T_4R_1	T_5R_1
2	T_1R_2	T_2R_2	T_3R_2	T_4R_2	T_5R_2
3	T_1R_3	T_2R_3	T_3R_3	T_4R_3	T_5R_3
4	T_1R_4	T_2R_4	T_3R_4	T_4R_4	T_5R_4

Description:

T_1 : Jackfruit seed flour at 2% (w/v)

T_2 : Jackfruit seed flour at 3% (w/v)

T_3 : Jackfruit seed flour at 4% (w/v)

T_4 : Jackfruit seed flour at 5% (w/v)

T_5 : Jackfruit seed flour at 6% (w/v)

The formulation of vegan cream cheese consisted of coconut milk, jackfruit seed flour, and salt. Coconut milk and salt were maintained at constant amounts across all treatments. While the concentration of jackfruit seed flour was varied according to the experimental treatment. The formulation of each treatment is presented in Table 4.

Table 4. Formulation of Vegan Cream Cheese with Different Concentrations of Jackfruit Seed Flour

Ingredient	Treatment

	T_1 (2%)	T_2 (3%)	T_3 (4%)	T_4 (5%)	T_5 (6%)
Coconut milk (mL)	100	100	100	100	100
Jackfruit seed flour (g)	2	3	4	5	6
Salt	1 pinch	1 pinch	1 pinch	1 pinch	1 pinch

Note: Jackfruit seed flour concentration was expressed as % (w/v) based on 100 mL of coconut milk. Salt was added in approximately equal amounts to all formulations.

Color characteristics, proximate composition, and sensory properties were determined for each treatment to evaluate the influence of jackfruit seed flour concentration on the characteristics of the vegan cream cheese made with coconut milk.

The empirical hypotheses tested in this study were as follows:

H_0 : Jackfruit seed flour concentration has no significant effect on the chemical, color, or sensory properties of vegan cream cheese made with coconut milk.

H_1 : Jackfruit seed flour concentration has a significant effect on at least one of the chemical, color, or sensory properties of vegan cream cheese made with coconut milk.

Statistically, the hypotheses can be expressed as follows:

H_0 : $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$

H_1 : $\mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4 \neq \mu_5$, or at least one treatment mean differs, indicating that jackfruit seed flour concentration has a significant effect on the chemical, color, and sensory properties of vegan cream cheese made with coconut milk.

The statistical decision criterion was based on the significance level ($\alpha = 0.05$). The null hypothesis (H_0) was accepted when ≥ 0.05 and rejected when < 0.05.

Before the formulation of the vegan cream cheese, proximate analyses were conducted on the raw materials, including jackfruit seed flour and coconut milk, to characterize their chemical composition. Moisture, protein, fat, ash, and carbohydrate contents were determined using the analytical methods described in this study. These analyses were performed to provide baseline compositional data for the raw materials and to facilitate the interpretation of changes in the proximate composition of the vegan cream cheese following the addition of different concentrations of jackfruit seed flour.

3.2.2 Research Procedures

This research was conducted in several stages, including material preparation, production of jackfruit seed flour, and production of vegan cream cheese made with coconut milk and jackfruit seed flour. The final stage involved parameter testing to evaluate the physicochemical and sensory properties of the vegan cream cheese. Physicochemical analysis included color properties and proximate composition that consist of moisture, protein, fat, ash, and carbohydrate contents. Sensory evaluation consisted of organoleptic scoring and hedonic tests.

a. Material Preparation

The main ingredients used in this study consisted of jackfruit seed, “Kara” brand coconut milk, and salt for taste. All materials were obtained from a local traditional market in fresh condition and were suitable for consumption.

b. Production of Jackfruit Seed Flour

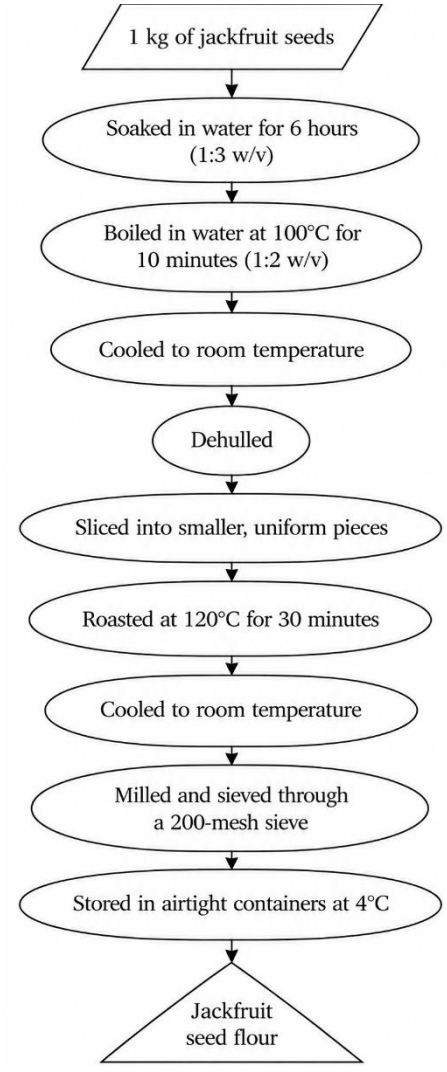


Figure 1. Process Flow of Jackfruit Seed Flour Production

As shown in Figure 1, the cleaned jackfruit seeds were soaked in distilled water for 6 hours at a room temperature of approximately 25°C using a seed-to-water ratio of 1:3 (w/v), equivalent to 1 kg of seeds in 3 L of water. After soaking, the water was drained and discarded. The soaking step was carried out to hydrate and soften the seed structure to enable better dehulling. Previous studies have shown that soaking or steeping jackfruit seeds facilitates the removal of the outer layers by loosening their attachment to the seed (Reddy and Narayanan, 2023).

The soaked seeds were then boiled in water at 100°C for 10 minutes using a seed-to-water ratio of 1:2 (w/v). The boiling process was carried out with the seed coats still intact to further soften the seeds and loosen the attachment of the outer seed coats. This makes the dehulling process easier. Heat treatment through boiling has been reported to be effective in softening seed coats and improving dehulling efficiency. This also reduces antinutritional factors such as trypsin inhibitors, tannins, and phytic acid (Olaniran *et al.*, 2020).

After boiling, the water was drained, and the seeds were allowed to cool to room temperature. The seeds were then manually dehulled to remove the outer seed coats, resulting in minimal damage to the cotyledons and improved processing efficiency.

The dehulled seeds were cut into smaller and uniform pieces to ensure even heat distribution during roasting. The sliced seeds were spread evenly on stainless steel trays and roasted in the oven at 120°C for 30 minutes. This roasting condition was modified from the method reported by Anaya-Esparza *et al.* (2018), applied

roasting at 120°C for 2 hours. The roasting time was shortened because the seeds were cut into smaller pieces, increasing the surface area exposed to heat and allowing a shorter processing time.

Brahma and Ray (2023) reported that roasting prior to flour production increased the protein content and water absorption capacity of jackfruit seed flour while reducing its oil absorption capacity. These characteristics were considered beneficial for the intended application of the flour as a structuring ingredient in vegan cream cheese, because its water absorption capacity may contribute to water retention and consistency development in the product. Therefore, roasting was selected as the drying treatment in this study.

The roasted samples were then milled into flour using a household blender (Mito BL100). The resulting flour was sieved through a 200-mesh sieve to obtain a uniform particle size. Finally, the flour was stored in airtight plastic containers to keep under refrigeration at approximately 4°C to extend shelf life and maintain quality before further analysis.

c. **Production of Vegan Cream Cheese using Coconut Milk Combined with Jackfruit Seed Flour**

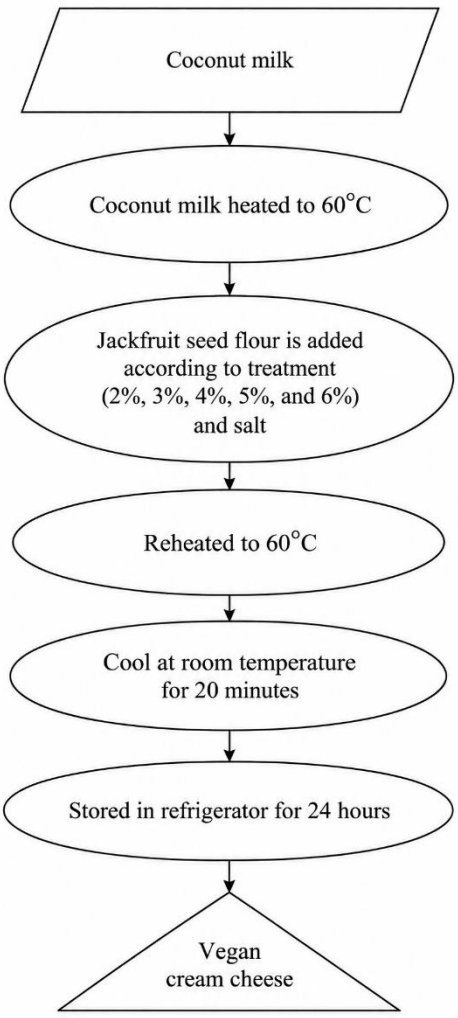


Figure 2. Process Flow of Vegan Cream Cheese using Coconut Milk Combined with Jackfruit Seed Flour Production

As shown in Figure 2, the coconut milk was first heated to approximately 60°C and then removed from the heat source. A moderate heating temperature was used because coconut milk is an oil-in-water emulsion naturally stabilized by proteins that are sensitive to high temperatures. Coconut proteins have been reported to undergo denaturation and coagulation at approximately 80°C or higher,

which may promote aggregation and destabilization of the emulsion (Patil and Benjakul, 2018). The jackfruit seed flour was subsequently added and mixed thoroughly to ensure uniform dispersion. The mixture was then reheated to approximately 60°C with continuous stirring. Gel formation in this formulation relied on heat-induced gelation mechanisms rather than acid induced coagulation. According to Braitmaier *et al.* (2024), one common gelation mechanism in plant-based systems involving the application of heat is called starch gelatinization. During heating, the starch granules present in jackfruit seed flour absorb water, swell, and undergo gelatinization that results in increased viscosity with the formation of a semi-solid gel structure.

The heating process enabled starch gelatinization that facilitated interactions between the gelatinized starch matrix and fat components from coconut milk. This led to the development of a texture that resembles cream cheese. After reaching the target temperature, the mixture was allowed to cool at room temperature for approximately 20 minutes to promote initial gel setting and structural stabilization.

The vegan cream cheese was then transferred to closed containers and refrigerated for 24 hours to allow complete gel development. During this cooling stage, the starch undergoes retrogradation. Retrogradation refers to the reassociation and realignment of gelatinized starch molecules into a more ordered structure. As the temperature decreases, the mobility of starch chains is reduced, and this promotes the reformation of hydrogen bonds between starch molecules (Zheng *et al.*, 2025).



Source: Personal Documentation (2026)

Figure 3. Finished Product of the Vegan Cream Cheese Made with Coconut Milk and Jackfruit Seed Flour

3.2.3 Color Analysis

Color measurement was performed to evaluate the color characteristics of the samples using a color reader based on the CIELAB Color system. The CIELAB system expresses color in three parameters: L*, a*, and b*, which provide an objective and standardized description of color (Brühl and Unbehend, 2021). In this system, L* represents lightness (black to white), a* represents the green to red axis, and b* represents the blue to yellow axis.

The first step is to calibrate the color reader using a standard white calibration plate according to the manufacturer's instructions to ensure measurement accuracy. Then 2 g of vegan cream samples were placed in a flat and clean sample holder to obtain a smooth and uniform surface. The sample surface must be even and free

from air bubbles or excess moisture. These conditions may affect light reflection and measurement accuracy. The color reader was then positioned perpendicular to the sample surface at a fixed distance to ensure consistent measurement conditions. The instrument emitted light onto the sample surface and detected the reflected light using photoelectric sensors. The reflected signals were processed and recorded as L*, a*, and b* values.

Chroma (C*) was subsequently calculated from the measured a* and b* values to determine the color saturation or intensity of the samples using the following equation (1) (Al-Mtury *et al.,* 2025):

$$\text{Chroma } (C*) = \sqrt{(a*)^2 + (b*)^2} \quad (1)$$

3.2.4 Moisture Content Analysis

Moisture content analysis was conducted to determine the amount of water present in the sample using the gravimetric method according to AOAC (2006). This method is based on drying the sample at a controlled temperature until a constant weight is achieved after water evaporation.

An empty moisture dish was first dried in an oven at 105°C for 30 minutes. The dish was then cooled in a desiccator for 15 minutes and weighed. Approximately 2 grams of the sample were placed into the pre-dried dish. The sample was dried in an oven at 105°C for 4 hours. After drying, the dish containing the sample was cooled in a desiccator for 15 minutes to prevent moisture absorption before weighing. The heating process was repeated for an additional 1 hour until a

constant weight was obtained. Constant weight was indicated by a weight difference of less than 0.5 grams between measurements.

Achieving a constant weight indicated that the moisture had been removed to the maximum possible extent. The percentage of moisture content was then calculated using the following equation (2) :

$$Moisture\ Content\ (\%) = \frac{[A - (C - B)]}{A} \times 100\ \% \qquad (2)$$

Description:

A = Weight of the sample before oven drying (g)

B = Weight of the dish after oven drying (g)

C = Weight of the dish and sample after oven drying (g)

3.2.5 Protein Content Analysis

Protein content analysis was performed to determine the total protein present in the sample. Protein represents the sum of nitrogen compounds in the material. Most of which come from naturally occurring proteins or protein-based ingredients. The method used was the Kjeldahl method as a standard procedure based on the AOAC (2007). The first step involved weighing approximately 0.5g of the sample, which was then transferred into a Kjeldahl flask. About 0.5 grams of mixed selenium catalyst were added to the flask, followed by 10 mL of concentrated sulfuric acid. The sample was then digested in a fume hood until a clear green solution was obtained. The digestion process was monitored regularly, and the solution was allowed to cool afterward.

Subsequently, 100 mL of distilled water and 40 mL of 45% NaOH solution were added to make the mixture alkaline. Under alkaline conditions, ammonium sulfate was converted into ammonia gas (NH_3). The released ammonia was distilled and captured in 5 mL of 4% H_3BO_3 solution containing two drops of methyl red (MR) and methylene blue (MB) indicators. Distillation was continued until the color of the receiving solution changed from purple to green and approximately 40 mL of distillate was collected.

The same procedure was repeated to prepare a blank sample without adding the test sample. The obtained distillate was then titrated using 0.1 N HCl until a purple color was formed. Protein content was calculated using the following equation (3) :

$$Protein\ Content\ (\%) = \frac{(V_a - V_b) \times N_{HCl} \times 14{,}008}{Weight\ of\ sample\ (g) \times 1000} \times 100 \qquad (3)$$

$$\text{Protein total (\%)} = \text{protein content (\%)} \times \text{conversion factor of } 6.25$$

Description:

V_a = volume of HCl for sample (mL)

V_b= volume of HCl for blank (mL)

N = normality of HCl

3.2.6 Fat Content Analysis

Fat content analysis was performed to determine the total lipid content present in jackfruit seed flour, coconut milk, and the vegan cream cheese. The analysis was conducted using the Soxhlet extraction method based on the standard procedure of

AOAC (2005) and Sumartini *et al.*, (2021) with modifications adapted for vegan cream cheese (Safari *et al.*, 2024). Due to their high moisture content, these samples were first dried in an oven at 105°C until a constant weight was obtained prior to extraction.

The filter papers were first dried in an oven at 105°C for 1 hour before use. Approximately 2g of sample was accurately weighed and wrapped in the dried filter paper with a small amount on both sides of the sample. The wrapped samples were then dried in an oven at 105°C for 4 hours, cooled in a desiccator for approximately 15 minutes, and weighed. The drying process was repeated at 105°C for 1-hour intervals, followed by cooling in a desiccator until a constant weight was obtained with a weight difference of less than 0.02 g.

The dried samples were subsequently placed into the Soxhlet extraction apparatus. N-hexane solvent was added at approximately 2.5–3 times the volume of the extraction flask, and the extraction process was carried out using a water bath at approximately 50°C for a minimum of six extraction cycles. After extraction, the samples were removed and dried at room temperature for approximately 30 minutes. The extracted samples were then dried again in an oven at 105°C for 1 hour, cooled in a desiccator, and weighed to determine the fat content using the following equation (4):

$$Fat\ Content\ (\%) = \frac{B - C}{A} \times 100 \quad (4)$$

Description:

A = Weight of the initial sample before oven drying (g)

B = Constant weight of the sample after oven drying before Soxhlet extraction (g)

C = Final weight of the sample after Soxhlet extraction and oven drying (g)

3.2.7 Ash Content Analysis

Ash content analysis was performed to determine the total mineral content in the sample. The method that is going to be used is the dry ashing method as a standard gravimetric procedure (AOAC, 2006). The first step is to weigh 2 g of the sample, then place it into the porcelain crucibles. The crucibles containing the samples were then placed in a muffle furnace and heated at 600°C for 4-6 hours to ensure complete combustion of organic matter. During this process, the organic components were oxidized at high temperature. This leaves inorganic ash as the mineral residue. After the heating period, the crucibles were carefully removed and allowed to cool in a desiccator to prevent moisture absorption from the surrounding environment. Once cooled, the crucibles were weighed to obtain the weight of the remaining ash. The ash content was calculated by comparing the weight of the ash residue with the initial sample weight using the following equation (5):

$$Ash\ Content\ (\%) = \frac{Weight\ of\ ash\ (g)}{Weight\ of\ sample\ (g)} \times 100\% \quad (5)$$

3.2.8 Carbohydrate Content Analysis

Carbohydrate content analysis was performed to determine the total carbohydrate content present in the sample. The method used was the calculation by difference method based on the standard procedure of the AOAC (2006). This

method estimates total carbohydrate content indirectly by subtracting the measured values of other proximate components from the total sample composition.

The first step involved determining the moisture, protein, fat, and ash contents of the sample using their respective analytical methods. The carbohydrate content was then obtained by subtracting the sum of these components from the total sample weight. This approach is based on the principle that carbohydrates represent the remaining fraction after all other major components have been accounted for. Carbohydrate content was calculated by comparing the combined values of moisture, protein, fat, and ash with the total sample weight using the following equation (6) :

$$Carbohydrate\ Content\ (\%) = 100 - (Moisture + Protein + Fat + Ash) \quad (6)$$

3.2.9 Organoleptic Scoring Test

The organoleptic scoring test was conducted following a modified procedure adapted from Lawless and Heymann (2010) using a scoring or scaling method. A total of 30 untrained panelists participated in the evaluation. Vegan cream cheese was served in small containers and identified using random three-digit codes. Each panelist received all samples, drinking water for palate cleansing, and a sensory evaluation form. Panelists were instructed to evaluate the samples sequentially from left to right and record their assessments on the evaluation form. The attributes assessed included color, creaminess, saltiness, savoriness, and spreadability. Spreadability was evaluated by spreading the samples onto white bread using a knife provided to each panelist. All attributes were rated using a five-point scoring

scale. The scoring criteria and numerical scales for each sensory attribute are presented in Table 5, while the organoleptic evaluation form is provided in Appendix 1.

Table 5. Scoring Criteria for Sensory Attributes of Vegan Cream Cheese

Sensory Properties	Attribute Scale	Numerical Scale
Color	White	1
	Off-white	2
	Slightly beige	3
	Light beige	4
	Beige	5
Creaminess	Very thin and not creamy mouthfeel	1
	Slightly creamy with a thin consistency	2
	Moderately creamy	3
	Creamy with a smooth mouthfeel	4
	Very creamy with a rich and smooth mouthfeel	5
Saltiness	Very not salty	1
	Not salty	2
	Moderate	3
	Salty	4
	Very salty	5
Spreadability	Very difficult to spread	1
	Difficult to spread	2
	Moderate	3
	Easy to spread	4
	Very easy to spread	5
Savoriness	Very not savory	1
	Not savory	2
	Moderate	3
	Savory	4
	Very savory	5

3.2.10 Hedonic Test

The hedonic test was conducted following the method of Setiaji *et al.*, (2019) using a five-point acceptance scale. A total of 30 untrained panelists evaluated vegan cream cheese samples coded with random three-digit numbers. Each panelist received two samples of drinking water for palate cleansing and an evaluation form. The samples were assessed sequentially from left to right for color, creaminess, saltiness, savoriness, spreadability, and overall acceptability. Spreadability was evaluated by spreading the samples onto white bread using a knife provided to each panelist. The results were recorded using a five-point hedonic scale: 1 = Dislike, 2 = Slightly dislike, 3 = Neutral, 4 = Slightly like, and 5 = Like. The hedonic test scale form is presented in Appendix 2.

3.2.11 Data Analysis

The data obtained in this study were analyzed using descriptive and inferential statistical methods. Color data and proximate composition data, including moisture, protein, fat, ash, and carbohydrate contents. These were analyzed using one-way Analysis of Variance (ANOVA) at a significance level of 5% ($\alpha = 0.05$) to determine the effect of jackfruit seed flour concentration on the characteristics of vegan cream cheese made with coconut milk. When significant differences among treatments were detected, Duncan's Multiple Range Test (DMRT) was performed as a post hoc test to identify significant differences between treatment means. The results were expressed as mean ± standard deviation based on four independent replications for each treatment. All statistical analyses

were performed using the Statistical Package for the Social Sciences (SPSS) version 25.0.

Data obtained from the hedonic and organoleptic scoring tests were analyzed using the nonparametric Kruskal-Wallis test at a 95% confidence level. When significant differences among treatments were observed then the analysis was followed by the Mann-Whitney test as a post hoc comparison method.