

**THE PHYSICOCHEMICAL, NUTRITIONAL, AND
SENSORY PROPERTIES OF MUFFIN INCORPORATED
WITH GREEK YOGURT**

by

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the Degree of Bachelor in Nutrition with Honour

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CERTIFICATE

This is to certify that the dissertation entitled “The Physicochemical, Nutritional, and Sensory Properties of Muffin Incorporated with Greek Yogurt” is the bona fide record of research work done by Nur Izzati Dalili Binti Abdullah with matric number: 160917 during the period from August 2025 to January 2026 under my supervision. I have read this dissertation and that in my opinion it confirms to acceptable standard

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DECLARATION

I hereby declare that this dissertation is the result of my own investigation, except where otherwise stated and duly acknowledge. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at Universiti Sains Malaysia or other institutions. I grant Universiti Sains Malaysia the right to use the dissertation for teaching, research and promotional purposes.

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List of Abbreviations

TPA	Texture Profile Analysis
ANOVA	One-Way Analysis of Variance

List of Symbols

H_0	Null hypothesis
H_a	Alternative hypothesis
$^{\circ}\text{C}$	Degree Celsius
$>$	Greater than
$<$	Lower than
cm	Centimeter
%	Percentage
g	Gram
mm	Millimeter
mm/s	Millimeter/second
mL	Milliliter
kcal	Kilo calory

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Abstrak

Bahan-bahan yang kaya dengan nutrien semakin banyak diaplikasikan dalam produk bakeri popular selaras dengan peningkatan permintaan terhadap makanan berfungsi. Kajian ini bertujuan untuk menilai Kesan penggabungan “Greek yogurt” terhadap sifat fizikokimia, pemakanan dan deria muffin. “Greek yogurt” merupakan produk tenusu pekat yang mempunyai kandungan protein tinggi serta kandungan kalori yang lebih rendah berbanding yogurt biasa. Muffin telah dihasilkan dengan pelbagai tahap penggantian “Greek yogurt”. Analisis fizikokimia menunjukkan bahawa penggabungan “Greek yogurt” meningkatkan pengekalan kelembapan, menambah kandungan protein dan menghasilkan struktur isi yang lebih lembut berbanding muffin kawalan. Penilaian deria menunjukkan peningkatan dari segi rasa, tekstur dan penerimaan keseluruhan. Secara keseluruhannya, hasil kajian ini menunjukkan bahawa “Greek yogurt” yang sederhana, muffin menunjukkan peningkatan dari segi rasa, tekstur dan penerimaan keseluruhan. Kajian menunjukkan bahawa “Greek yogurt” berpotensi digunakan sebagai bahan berfungsi dalam penghasilan muffin bagi meningkatkan nilai pemakanan serta daya tarikan pengguna. Kajian ini juga menyediakan maklumat untuk Pembangunan produk bakeri yang lebih sihat, selarasa dengan keutamaan pengguna terhadap makanan berfungsi, diperkaya protein dan rendah kalori.

Abstract

Nutrient-rich ingredients have been added to popular baked goods due to growing demand for functional foods. This research investigates the physicochemical, nutritional and sensory properties of muffin incorporated with Greek yogurt. Greek yogurt is a concentrated dairy product known for its high protein content and low calories content. Muffin is incorporated with various substitution levels of Greek Yogurt. Greek yogurt enhanced moisture retention, boosted protein content, and contributed to a softer crumb

structure when compared to control muffins, according to physicochemical tests. At moderate levels of Greek yogurt absorption, sensory evaluation revealed improved flavour, texture, and general acceptance. According to the research, Greek yogurt can improve the nutritional value and consumer appeal of muffins. This study offers insightful information for creating healthier baked goods that complement customer preferences for functional, protein-enriched diets and also low calorie baked goods.

CHAPTER 1: Introduction

1.1 Background of Study

Greek yogurt is increasingly recognized as a versatile fat substitute in food products due to its high protein content, probiotics, and calcium levels, which contribute to various health benefits and culinary applications. Greek yogurt is rich in protein, with studies showing it contains up to 10% protein per 100g, making it a valuable source of essential amino acids and beneficial for muscle synthesis and repair (Slyvka et al., 2023). The presence of probiotics, such as *Lactocaseibacillus rhamnosus* and *Bifidobacterium animalis*, enhances gut health and boosts the immune system, while also contributing to the yogurt's antioxidant properties (Gkitsaki et al., 2024). Greek yogurt's calcium content supports bone health, potentially reducing the risk of osteoporosis (Hadjimbei et al., 2022). When used as a fat substitute in baked goods, sauces, and dressings, Greek yogurt can improve the nutritional profile by reducing fat content while maintaining a creamy texture and rich flavor, often preferred over traditional fats like butter and cream (Escalona-Jiménez et al., 2022). The use of Greek yogurt in culinary applications can enhance the texture and moisture retention of products, contributing to a longer shelf life and improved sensory attributes (Shang, 2023). Compared to traditional fats, Greek yogurt offers a lower calorie alternative with added health benefits, such as improved digestive health and reduced risk of cardiovascular diseases (Hadjimbei et al., 2022). Additionally, Greek yogurt's ability to incorporate various flavors and additives without significantly altering its nutritional benefits makes it a flexible ingredient in diverse culinary contexts (Shang, 2023). Overall, Greek yogurt serves as a functional and health-promoting ingredient, offering a balance of taste, texture, and nutritional benefits in food products (Pannerchelvan et al., 2024).

1.2 Problem Statement

According to National Health and Morbidity Survey in 2023, there are increasing trend in abdominal obesity among adults in Malaysia from 45.4% to 54.4% in 2011 until 2023. Traditional muffins are popular baked delicacies, however they are generally high in sugar and fat while poor in essential elements like protein and dietary fibre. With increasing knowledge of diet-related health issues which can be obtained freely in internet, consumers are eager to find functional foods that not only taste good but also contribute to better nutritional quality (Granato et al., 2020). Greek yogurt is recognised for its high protein content, probiotic potential, and creamy texture has appeared as a functional ingredient that may improve the nutritional profile of baked goods.

1.3 Objective

1.3.1 General Objective

The objective of this study is to analyse the physicochemical properties of muffin made by using Greek yogurt as a fat substitute.

1.3.2 Specific Objective

1. To determine the proximate analysis of muffin made by using Greek yogurt as a fat substitute.
2. To assess the physical properties of muffin incorporated with Greek yogurt as a fat substitute.
3. To assess the sensory evaluation of muffin made by using Greek yogurt as a fat substitute.

1.4 Hypothesis

1.4.1 Null Hypothesis

Ho = There is no significant difference in the physicochemical, nutritional and sensory properties of muffin with Greek yogurt as fat substitute.

1.4.2 Alternative Hypothesis

Ha = There is significant difference in the physicochemical, nutritional and sensory properties of muffin with Greek yogurt as fat substitute.

1.5 Research Questions

1. Is there any significant difference in the proximate analysis of muffin produced with Greek yogurt as fat substitute?
2. How does the incorporation of Greek yogurt as a fat substitute affect the physical properties of muffins?
3. How does Greek yogurt as fat substitute affected sensory properties in muffin?

1.6 Significance of Study

This study is significant in meeting the increased demand of functional and healthy bakery products. As public health concerns about non-communicable disease such as obesity and diabetes conditions continue to grow, the development of nutrient-enhanced foods becomes an important strategy in promoting healthy dietary habits (World Health Organisation [WHO], 2021). Greek yogurt as fat substitute in muffins offers an opportunity to improve their nutritional content without relying on artificial additions.

This research also contribute data on how Greek yogurt affects the physicochemical properties, nutritional composition and sensory attributes of muffins.

This research is important for food technologists and bakers who want to make a new product with healthier and match with modern nutritional recommendations and suit consumer preferences.

This finding may inspire the food industry to consider Greek yogurt as a cost-effective and adaptable ingredient for reformulating other baked goods and also supporting innovation in functional food product development. This study raises consumer awareness of healthier food options by demonstrating how delicious products such as muffins may be made more nutritious without compromising quality or palatability.

CHAPTER 2: LITERATURE REVIEW

2.1 Muffins

The historical origins of the muffin can be traced back to early bread-making practices, with its evolution reflecting broader cultural and economic changes. Muffins are called quick bread because they use “quick-acting” chemical leavening agents rather than yeast which is a “longer acting” biological leavening agent (Sinha, 2007). By the 19th century, muffins had become emblematic of British culinary identity, as illustrated in Charles Dickens’s “Nicholas Nickleby,” where muffins symbolize comfort and the complexities of corporate capitalism in Victorian society (Cook, 2013). The transition to using yeast and refined flour, as seen in the baking practices of Norwegian immigrants in America, further transformed muffins into the lighter, leavened versions popular today (Josephson, 2023). This evolution underscores the muffin’s adaptability and its roles in reflecting societal shifts, from simple sustenance to a symbol of cultural significance (Rubel, 2011).

2.2 Nutritional Implications of Various Ingredients

Muffins traditionally high in calories, can be nutritionally enhanced through incorporation of various functional ingredients. Substituting wheat flour with bean flours, such as black, red, and white beans, significantly increases protein, dietary fiber, and mineral content while reducing digestible carbohydrates and caloric value (Barros et al., 2018). Additionally, using flaxseed and hempseed oils as butter replacements not only lowers fat content up to 78% but also enriches muffins with omega-3 fatty acids and fiber (Gutiérrez-Luna et al., 2020). The introductions of gluten-free flours like mung bean and quinoa further enhances the nutritional profile, providing essential vitamins, minerals, and antioxidants, making these muffins suitable for diverse dietary needs (Bassett et al., 2024). Moreover, incorporating hemp flour improves fiber and protein levels, although careful formulation is necessary to maintain sensory qualities (Mocanu et al., 2025). Overall, these modifications create healthier muffin options with consumer demand for nutritious baked goods.

2.3 Definition of Greek Yogurt

Greek yogurt is a type of concentrated yogurt that is produced by removing whey from the yogurt which results in the yogurt becoming more thicker, creamier texture compared to regular yogurt. Because of this straining process, total solids is increased, lactose content is reduced so it makes Greek yogurt has high protein and low sugar compared to traditional yogurt (Valrace, 2022). Greek yogurt serves multiple culinary and health-related purposes, making it a versatile ingredient in modern diets. It is commonly used as a base for dips and spreads due to its high viscosity and creamy texture, which can be enhanced with various flavouring agents (Schroeder & Busby, 2011). Additionally, Greek

yogurt whey can be transformed into flavouring ingredients, ready-to-drink formulations, and protein mixes, showcasing its utility in food innovation (Christiansen & Ward, 2013). Nutritionally, Greek yogurt is recognized for its high protein content, probiotics, and micronutrients, which contribute to digestive health, immune support, and cholesterol management (Bolini et al., 2025). Furthermore, it can alleviate symptoms of lactose intolerance and has potential therapeutic effects against certain health conditions, including cancer and non-alcoholic fatty liver disease ("The Value of Yogurt and Its Function in Health Care", 2023). This multifaceted application underscores Greek yogurt's significance as both a functional food and a culinary staple.

2.4 Health Benefits of Greek Yogurt

Greek yogurt serves as a beneficial fat substitute due to its rich nutritional profile and health-promoting properties. It is high in probiotics, which enhance digestive health and immune function, potentially alleviating issues such as constipation and inflammation (Pannerchelvan et al., 2024). Additionally, studies indicate that probiotic yogurt can improve lipid profiles and insulin sensitivity, making it advantageous for metabolic health, particularly in individuals on high-fat diets (Tang et al., 2023). Furthermore, low-fat yogurt consumption has been shown to reduce biomarkers of chronic inflammation, thereby improving overall health outcomes in both lean and obese populations (Pei et al., 2016). The incorporation of prebiotic fat substitutes, such as inulin and polydextrose, in Greek yogurt formulations can enhance probiotic survival and maintain sensory qualities, although some may negatively impact taste and texture (Dias et al., 2021). Overall, Greek yogurt not only provides a lower-fat alternative but also contributes to improved metabolic and inflammatory markers, making it a valuable addition to a health-conscious diet (Gumus & Gharibzahedi, 2021).

2.5 Role of Greek Yogurt as Fat Substitute

In the context of fat replacement, Greek yogurt can mimic the physical and sensory attributes of fat, similar to other fat replacers used in dairy products, which are designed to maintain the texture and flavour of foods while reducing calorie content (Abbas et al., 2024). The physicochemical properties of Greek yogurt, such as its water-holding capacity and acidity, make it suitable for maintaining the moisture and structure of baked goods, which are often compromised when fat is reduced (Yusuf et al., 2024). Additionally, Greek yogurt's ability to enhance the organoleptic properties of foods, as demonstrated in various formulations, suggests it can be a versatile ingredient in low-fat baking applications (Yusuf et al., 2024). Compared to traditional fat substitutes, which may include synthetic molecules or starch-based formulations, Greek yogurt offers a natural alternative with added nutritional benefits, such as probiotics and proteins, which are not typically present in conventional fat substitutes (Kincs & Minor, 1993). Therefore, Greek yogurt not only serves as a functional fat substitute but also enhances the nutritional value of baked and cooked products, aligning with the growing consumer demand for healthier food options.

2.6 Application of Fat Substitute

The application of fat substitutes in baked products has become increasingly relevant due to growing health concerns associated with high-fat diet. Excessive intake of saturated fats is linked to obesity, cardiovascular disease which make consumers and food manufacturer to seek healthier alternative. Fat replacers have three categories which are carbohydrate based, protein based and lipid based. Firstly, carbohydrate-based fat replacer are the most commonly used in baking. Polydextrose and guar gum are examples of ingredients that have demonstrated efficacy in products like biscuits, achieving up to 70% fat replacement while maintaining acceptable product quality (Colla et al., 2018).

These compounds primarily function by binding water and mimicking the mouthfeel of fat which helps to retain moisture and tenderness in final product. Second, protein-based fat replacer offers an alternative to reduce fat content and increase protein value of the product. *Chlorella vulgaris* is a microalgae which have been used to replace both animal fats and protein in baked goods. Studies have shown that these formulations can yield sensory qualities compared to traditional products and increase the potential for sustainable and also nutrient-rich substitutions (Kafyra et al., 2018). Lastly, lipid-based fat substitutes such as oleogels allows higher fat replacement levels while maintaining product quality. These alternatives frequently utilise chemically altered triglycerides or lipid analogues that are not absorbed by the body as natural fats, thus giving fewer calories (Shaheen et al., 2022). Despite the nutritional advantages, the impact of fat substitute on product quality remains a critical condition. High level of fat replacement is often associated with increased hardness and less favourable sensory attributes. However, fat replacement below 75% are more likely to maintain consumer acceptance (Gutiérrez-Luna et al., 2021).

CHAPTER 3: METHODOLOGY

3.1 Study Design

Type of study that being implemented was experimental study. Greek yogurt was used as fat substitute in muffin baking. It was analysed in terms of physicochemical, nutritional and sensory properties to know which percentage of Greek yogurt compliment the best for muffins.

3.2 Study Location

The Greek yogurt was bought from Mydin Wholesale Hypermarket in Kubang Kerian, Kelantan. In this study, the muffins were prepared in the kitchen of Universiti Sains Malaysia (Health Campus) in Kubang Kerian, Kelantan. The sensory evaluation was conducted in functional food laboratory. The proximate analysis, physical properties, calorie and texture profile analysis was conducted in nutrition laboratory.

3.3 Selection Criteria

3.3.1 Inclusion

- Students and staffs in USM Kubang Kerian
- Available in campus
- 18 years old and above

3.3.2 Exclusion

- Sick that can inhibit ability to taste and smell
- Lactose intolerance

3.4 Sample Size Calculation

The minimum sample size for sensory evaluation is 30 (Aminah A., 2000). Therefore, 50 panels were recruited for this study.

3.5 Research Tool

The research tool used in this study is sensory evaluation form.

3.6 Data Collection

3.6.1 Recipe of Muffins

The recipe was based on Mahmood et al., (2024)

Samples	Wheat Flour (g)	Sugar (g)	Baking powder (g)	Salt (g)	Egg (g)	Milk (g)	Vanilla Extract (g)	Oil* (g)	Greek yogurt (g)
Control	260	120	10	3	50	200	5	130	0
25%	260	120	10	3	50	200	5	97.5	32.5
50%	260	120	10	3	50	200	5	65	65
75%	260	120	10	3	50	200	5	32.5	97.5

3.6.2 Procedure

The muffin was prepared by using ingredients such as wheat flour, sugar, baking powder, salt, egg, fresh milk, vanilla extract and oil. All the ingredients were weighed by digital kitchen scale in order to make the muffin batter mixture. Firstly, dry ingredients which were wheat flour, sugar, baking powder and salt were shifted into a bowl while in a separate bowl, all liquid ingredients which were eggs, fresh milk, oil and vanilla extract were whisked vigorously. After that, the whisked liquid ingredients were combined with