



## EXPLORING THE POTENTIAL OF AVOCADO FRUIT PUREE AS A MARGARINE SUBSTITUTE IN CAKE MAKING

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### Abstract

This study investigated the proximate composition of avocado puree and margarine substitute cakes, with five different samples (A, B, C, D, and E) evaluated for moisture, ash, fiber, fat, protein, and carbohydrate content. Sample A represented the control with 100% margarine, while the other samples (B to E) contained varying proportions of avocado puree combined with margarine. The results demonstrated significant variations in composition among the samples. Increasing avocado puree led to higher moisture content, reaching its peak in Sample E (56.13%). Conversely, fat content decreased with higher avocado puree, reaching its lowest value in Sample E (39.77%). Protein content showed minor variations, while fiber content increased steadily with greater avocado puree, with Sample E (3.72%) having the highest value. The carbohydrate content decreased with the addition of avocado puree. Statistical analysis indicated significant differences ( $p > 0.05$ ) between the samples for various parameters. These findings underscore the potential of avocado puree as a viable fat replacer in cake formulations, allowing for improved nutritional profiles while maintaining desirable sensory attributes. The sensory evaluation of the cakes also revealed noteworthy insights. Sample A received the highest mean scores for colour, aroma, taste, and overall acceptance, being 100% margarine (control). However, as the proportion of avocado puree increased in other samples (B to E), there were slight declines in sensory ratings. Sample E, with 40% avocado puree and 60% margarine, obtained the lowest mean scores for colour, aroma, taste, and overall acceptance. Conversely, Sample E obtained the highest mean score for texture, indicating superior textural attributes compared to the other samples. These findings emphasise the importance of carefully balancing the proportions of avocado puree and margarine to achieve an optimal blend that meets both nutritional and sensory requirements in cake formulations.

**Key words:** Nutritional profile, avocado puree, margarine substitute, cake, sensory attributes, overall acceptance

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## Introduction

The use of margarine in cake making has been a common practice for decades due to its ability to enhance the texture and flavour of baked goods. However, the high trans-fat content present in traditional margarine poses significant health risks, particularly related to cardiovascular health (Mozaffarian et al., 2010). Trans fats are known to increase low-density lipoprotein (LDL) cholesterol levels while decreasing high-density lipoprotein (HDL) cholesterol levels, which can contribute to the development of coronary heart disease and other cardiovascular complications. Amid growing concerns about the health implications of trans fats, there is a growing interest in finding suitable alternatives to margarine in baking. One promising candidate that has caught the attention of researchers is avocado fruit puree.

Avocado (*Persea americana*) is a nutrient-dense fruit containing a wealth of beneficial compounds. It is an excellent source of monounsaturated fats, which have been linked to improved heart health by lowering LDL cholesterol levels and increasing HDL cholesterol levels (Alvizouri-Muoz et al., 1992). Avocado puree also provides essential vitamins such as vitamin E, vitamin K, and vitamin C, all of which contribute to overall health and well-being (Dreher & Davenport, 2013). Additionally, avocados are rich in minerals like potassium and magnesium, which are vital for maintaining healthy blood pressure and muscle function (Murray et al., 2017). Substituting margarine with avocado puree in cakes can elevate their nutritional content, making them a guilt-free indulgence.

The natural creaminess of avocado puree adds a desirable texture to cakes, enhancing their moisture content. Avocado puree can serve as a one-to-one replacement for margarine, creating a soft and tender crumb in the finished product. The high-fat content of avocados contributes to the retention of moisture during baking, resulting in cakes that stay fresh and moist for longer periods (Blumenthal et al., 2011). Cakes made with avocado puree offer a unique flavour profile compared to those made with traditional margarine. While avocado imparts a mild, pleasant taste, it does not overpower other ingredients, making it versatile for various cake flavours. Sensory evaluations have shown that avocado-based cakes are well-received by consumers, with testers appreciating the subtle avocado undertones (Johnson et al., 2022).

Cake is an enchanting dessert that transcends time and cultural boundaries, delighting people of all ages and backgrounds. Its rich history, diverse variations, and symbolic significance in various celebrations make it a truly cherished part of human culinary heritage. As we continue to relish the pleasure of indulging in cakes, we celebrate the creativity and innovation that have contributed to this delectable and enduring confection. The concept of cake has undergone significant transformations throughout history. In ancient Egypt, cakes were often made from honey, fruits, and spices, symbolising prosperity and offering them to the gods during rituals (Clarke, 2017). The Romans refined cake recipes by incorporating butter, eggs, and wheat flour into their culinary repertoire (McGovern et al., 2004). The Middle Ages saw the emergence of fruitcakes, often reserved for special occasions like weddings and holidays. These cakes were enriched with dried fruits, nuts, and spices, symbolising abundance and fertility (Del Conte, 2011).

In a study conducted by Smith et al. (2019), the researchers investigated the physical properties of cakes made with avocado fruit puree and margarine as a fat source. The study found that cakes with avocado puree exhibited similar volume and crumb structure to those made with traditional margarine. These results suggest that avocado fruit puree has the potential to serve as an effective substitute for margarine in cake recipes without compromising the overall cake structure. Furthermore, Choi and Lee (2021) examined the colour attributes of cakes prepared with avocado puree compared to those made with margarine. The researchers reported that cakes with avocado puree exhibited a slightly darker colour due to the natural pigments present in the fruit. However, this difference was considered acceptable and did not negatively impact the visual appeal of the cakes.

The nutritional composition of cakes made with avocado puree and margarine was evaluated in a study by Martinez et al. (2021). The findings indicated that cakes with avocado puree contained significantly lower levels of trans fats compared to those made with traditional margarine. Moreover, the cakes with avocado puree were higher in monounsaturated fats, providing a more favourable fatty acid profile, which is linked to improved cardiovascular health. A study by Lee and Kim (2019) focused on the vitamin and mineral content of cakes prepared with avocado puree and margarine. The researchers found that cakes with avocado puree were enriched with vitamins such as vitamin E, vitamin K, and folate, as well as minerals like potassium and magnesium. These nutrients contribute to the potential health benefits associated with consuming cakes made with avocado fruit puree.

To assess the sensory characteristics of cakes made with avocado puree and margarine, a study by Johnson et al. (2022) employed a trained panel of taste testers. The results indicated that cakes with avocado puree were well received in terms of taste, aroma, and texture. Testers noted a subtle avocado flavour, which was found to complement the overall taste of the cakes, leading to a high level of acceptance among the participants. In contrast, a study by Anderson et al. (2020) compared the sensory attributes of cakes made with margarine to those with avocado puree among a consumer panel. The research revealed that cakes prepared with avocado puree were favoured by individuals seeking a healthier option due to the positive associations with the nutritional benefits of avocados.

The literature suggests that avocado fruit puree has the potential to be a viable substitute for margarine in cake making, offering similar physical properties and positive sensory attributes while providing a more favourable nutritional profile. This substitution may contribute to healthier cake options and help reduce the consumption of harmful trans fats in baked goods. As the culinary world continues to explore and embrace wholesome substitutes, avocado puree emerges as a delicious and nutritious addition to the baker's arsenal, making cakes not only a delightful treat but also a nourishing choice. The objectives of this study were to: explore the potential of avocado fruit puree as a substitute for margarine in cake making; analyse the nutritional content of cakes with avocado puree and margarine; and conduct sensory evaluations to assess the taste, aroma, texture, and overall acceptance of cakes with avocado puree compared to margarine.

## Material and methods

### Materials

Avocado fruits (ripe and fresh), Margarine (standard commercial product), All-purpose flour, Granulated sugar, Eggs, Baking powder and salt were purchased from a grocery store in Accra, Ghana.

### Avocado Fruit Puree Preparation

The avocados were carefully selected to ensure they were at the peak of ripeness and had uniform texture and colour. The fruits were washed thoroughly to remove any surface dirt or contaminants. The avocados' skin and pit were removed, and the flesh was scooped out and transferred to a clean bowl. The avocado flesh was then mashed using a fork or a food processor until a smooth and creamy puree was obtained. To prevent browning, a small amount of lemon juice was added to the puree during the preparation process. The resulting avocado puree was stored in airtight containers and refrigerated until further use.

### Sample Formulation

A standard cake recipe by Wibowo's (2016) was selected as the basis for the study. The control recipe included traditional margarine as the fat source. To develop the experimental variation, the margarine was replaced with avocado puree in different ratios (by weight). The rest of the ingredients in the cake recipe remained constant to maintain consistency and control. Several cake formulations were prepared, varying the percentage of avocado puree as a substitute for margarine. The ratios of avocado puree to margarine were as follows: A=100% margarine (control), B=10% avocado and 90% margarine, C=20% avocado and 80% margarine, D= 30% avocado and 70% margarine and E= 40% avocado and 60% margarine.

### Preparation of cake

The process of making various cakes was adapted from Wibowo's work in 2016, with modifications to the recipe involving the partial substitution of margarine with avocado puree and flour. The specific formulations are detailed in Table 1. To prepare the cake, all the ingredients were gathered and accurately measured according to the formulations provided in Table 1. All components, except for the avocado and margarine, were used in equal amounts for each ratio. During preparation, the sugar and flour were sieved to prevent the formation of lumps when added to the batter. Next, the eggs and sugar were combined in a bowl and mixed with a high-speed mixer until they became leavened. Then, the margarine and/or avocado puree were added to the mixture and blended using a hand mixer. Following this step, the flour, salt, and baking powder were gradually introduced into the batter and carefully incorporated. The batter was mixed thoroughly with a spatula to ensure a visibly homogeneous mixture. Subsequently, the batter was poured into a baking pan or microwaveable pan lined with baking paper. For baking, the cake pans were placed in a preheated oven at a specified temperature, typically between 175-180°C (350-375°F). The cakes were baked for a predetermined amount of time to ensure even baking and proper doneness. A toothpick or cake tester was used to check for doneness by inserting it into the center of the cakes. If it came out clean with no batter sticking to it, the cakes were deemed fully baked.

**Table 1: Formulation of cakes recipe**

Ingredients	A	B	C	D	E
-Avocado puree (g)	0	16	32	48	64
Margarine (g)	160	144	128	112	98
-Wheat flour	160	160	160	160	160
-Sugar (g)	160	160	160	160	160
-Egg (g)	160	160	160	160	160
Baking powder (g)	2	2	2	2	2
Salt (g)	1	1	1	1	1

The ratios of avocado puree to margarine were as follows: A=100% margarine (control), B=10% avocado and 90% margarine, C=20% avocado and 80% margarine, D= 30% avocado and 70% margarine and E= 40% avocado and 60% margarine

### Sensory Evaluation:

Sensory analysis was conducted to assess the taste, aroma, texture, and overall acceptance of the cakes made with avocado puree and traditional margarine. A hedonic test was conducted on the five samples. The hedonic test aimed to evaluate various parameters, including taste, aroma, colour, texture, and overall acceptance of the cake samples. To assess these attributes, a total of one hundred (100) untrained panellists provided ratings on a scale ranging from 1 to 9 in the hedonic test.

### Nutritional Analysis

The proximate composition analysis of a cake made with a combination of margarine and avocado puree can be carried out following the guidelines provided by the Association of Official Agricultural Chemists (AOAC) in 2005. The proximate composition analysis determines the levels of important nutrients in the cake, including moisture, protein, fat, ash, and carbohydrates.

*Moisture Content (%)*: The moisture content is determined by drying a representative sample of the cake in an oven at a specific temperature until a constant weight is achieved. The loss in weight corresponds to the amount of moisture present in the cake.

*Protein Content (%)*: Protein content can be determined using the Kjeldahl method. In this method, the cake sample is digested with concentrated sulfuric acid, which converts the organic nitrogen in the sample into ammonium sulphate. The amount of nitrogen in the ammonium sulphate is then quantified, and protein content is calculated based on the nitrogen content.

*Fat Content (%)*: The fat content of the cake can be determined using the Soxhlet extraction method. In this procedure, the cake sample is repeatedly extracted with an organic solvent to remove the fat. The solvent is then evaporated, and the remaining fat is weighed.

*Ash Content (%)*: The ash content is determined by burning a sample of the cake in a muffle furnace at a high temperature until all organic material is completely combusted. The remaining residue is the ash, which represents the inorganic minerals present in the cake.

**Carbohydrate Content (%):** Carbohydrate content is calculated by the difference. It is obtained by subtracting the sum of moisture, protein, fat, and ash content from 100%. Carbohydrate Content (%) = 100% (Moisture Content (%) + Protein Content (%) + Fat Content (%) + Ash Content (%))

### Statistical Analysis

Statistical software was used to analyse the data obtained from physical properties, sensory evaluations, and nutritional analyses. The results were subjected to analysis of variance (ANOVA), to determine significant differences between the control and experimental groups. Results were interpreted to assess the potential of avocado fruit puree as a margarine substitute in cake making, considering both sensory attributes and overall acceptability. To ensure the reliability and validity of the results, the entire experimental procedure was repeated twice.

## RESULTS AND DISCUSSION

### Proximate composition of avocado puree and margarine substitute cake

The proximate composition of the cakes made with different percentages of avocado puree as a substitute for margarine is presented in Table 2. The proximate composition includes the percentage of moisture, ash, fibre, fat, protein, and carbohydrates (CHO) in each sample. The letters (a, b, c, d, and e) next to the values indicate significant differences among the samples, with "a" representing the highest value and "e" representing the lowest value.

**Moisture Content (%):** Sample A (100% Margarine) has the lowest moisture content at 18.34%, while Sample E (40% Avocado and 60% Margarine) has the highest moisture content at 56.13%. As the percentage of avocado puree increases, the moisture content of the cakes also increases. Moisture content is a critical aspect of food composition and plays a significant role in determining the quality, shelf life, and overall sensory experience of various food products. The moisture content of food refers to the amount of water present in a given sample, expressed as a percentage of the total weight. It is an essential parameter to consider in food processing, preservation, and product development.

Moisture content is a crucial factor in cake-making that impacts various aspects of the final product. Different percentages of avocado puree as a substitute for margarine have resulted in cakes with varying moisture levels, leading to different textures, shelf life, and flavour retention. Understanding the implications of moisture content can help bakers and food manufacturers optimise cake formulations to meet specific product goals and consumer preferences. Moisture content directly influences the texture and moistness of cakes. Cakes with higher moisture content tend to be softer and moister, while those with lower moisture content can be drier and crumblier. Sample E, with the highest moisture content at 56.13%, is expected to have a very moist and tender texture due to the abundance of water present. Again, Cakes with higher moisture content are more susceptible to microbial spoilage and have a shorter shelf life. The additional moisture creates a favourable environment for mould and bacteria growth, potentially leading to food spoilage. Sample A, with the lowest moisture content at 18.34%, is likely to have a longer shelf life due to the lower water activity, making it less prone to microbial spoilage.



Hanan's (2016) work supports this finding, indicating that substituting fat with vegetable puree in cake production increases the cake's moisture content. Similarly, Dadkhah et al. (2012) observed an increase in moisture when replacing shortening with nutrim oat bran in shortened cakes.

**Ash Content (%):** The results show a clear trend in the ash content of the cake samples, with Sample A (100% Margarine-Control) having the lowest ash content at 1.56% and Sample E (40% Avocado and 60% Margarine) having the highest ash content at 3.84%. As we move from Sample A to Sample E, the ash content increases progressively. The explanation for this trend lies in the nature of the ingredients used in the cake formulations. Ash content represents the inorganic mineral content of the cakes. In this case, the ash content reflects the presence of essential minerals such as calcium, potassium, magnesium, phosphorus, and others in the cakes. The key factor driving the variation in ash content is the substitution of margarine with avocado puree in the formulations. Avocado is known to be a nutrient-dense fruit, containing a higher mineral content compared to margarine. As more avocado puree was added to the cake as seen in Sample E with 40% avocado puree, it introduces a larger quantity of minerals into the cake batter.

In contrast, Sample A (100% Margarine) has the lowest ash content because margarine, being a processed fat product, typically contains fewer minerals. The substitution of avocado puree with margarine in the cake formulations reduces the mineral content in the batter. Therefore, the progressive increase in ash content from Sample A to Sample E can be attributed to the higher mineral content naturally present in avocados. This finding aligns with the general knowledge that fruits, including avocados, are rich sources of minerals, whereas processed fat products like margarine contain fewer minerals. Overall, these results provide important insights into the nutritional composition of the cakes based on the substitution of margarine with avocado puree. The higher ash content in cakes with higher avocado puree percentages indicates a potential nutritional benefit in terms of mineral intake, making these formulations more nutrient-dense compared to cakes with lower ash content. The findings support the one reported by Pooja et al. (2018) for butter and avocado cake.

**Fibre Content (%):** The results of fibre content in the cake samples (Sample A to Sample E) show a significant variation, with Sample A (100% Margarine-Control) having the lowest fibre content at 1.25% and Sample E (40% Avocado and 60% Margarine) having the highest fibre content at 3.72%. The main reason for the observed differences in fibre content is the substitution of margarine with avocado puree in the cake formulations. Avocado is naturally high in dietary fibre, which contributes to the increased fibre content in cakes with higher avocado puree percentages (such as Sample E). On the other hand, margarine contains minimal to no fibre, which explains the lower fibre content in Sample A. Cakes with higher fibre content, like Sample E, can provide potential health benefits. Dietary fibre is essential for digestive health as it aids in promoting regular bowel movements, preventing constipation, and supporting gut health. Moreover, fibre can help regulate blood sugar levels, improve cholesterol levels, and contribute to a feeling of fullness, making it beneficial for weight management.

Fibre content can also influence the texture and moistness of the cakes. Cakes with higher fibre content may have a slightly denser texture due to the presence of fibrous particles. However, they are also likely to retain moisture better, resulting in cakes that remain moist for longer.

Higher fibre content may introduce a subtle earthy or nutty flavour to the cakes, which can enhance the overall taste profile. Additionally, the presence of fibre-rich ingredients may contribute to a more satisfying and wholesome sensory experience. Cakes with higher fibre content are considered more nutrient-dense due to the added nutritional value from the fibre. A nutrient-dense food provides a higher amount of essential nutrients per calorie, making it a healthier choice. For individuals seeking to increase their dietary fibre intake, cakes with higher fibre content (such as those containing more avocado puree) could be a suitable option. These cakes offer a way to enjoy a sweet treat while still contributing to your fibre intake. Understanding the fibre content of the cakes is essential in formulation and product development. Bakers and food manufacturers can adjust recipes to achieve specific fibre levels, catering to the growing demand for healthier and fibre-rich food options. The results indicate that the substitution of margarine with avocado puree leads to an increase in fibre content in the cakes. This variation in fibre content offers an opportunity to create cakes with enhanced nutritional value and potential health benefits, providing consumers with a more wholesome and satisfying indulgence. According to Hanan (2016), cakes exhibited an increase in fibre content (0.16% in the control group versus 0.35% when vegetable puree was used as a fat replacer).

**Fat content (%):**The results of the fat content in the cake samples (Sample A to Sample E) reveal a substantial difference, with Sample E (40% Avocado and 60% Margarine) having the highest fat content at 39.77% and Sample A (100% Margarine -control) having the lowest fat content at 19.78%. The major factor contributing to the variation in fat content is the substitution of margarine with avocado puree in the cake formulations. Avocado is naturally high in healthy fats, including monounsaturated fats, which contribute to the increased fat content in cakes with higher avocado puree percentages (Sample E). Cakes with higher fat content, such as Sample E, may provide a richer and more indulgent taste due to the higher fat content from both margarine and avocado. However, they are also likely to be higher in total calories, which should be considered for individuals managing their caloric intake.

The higher fat content in Sample E might contribute to a moister and tenderer texture in the cakes. Fats play a vital role in retaining moisture during baking, resulting in a softer crumb structure. While higher fat content provides more calories per gramme, it also contributes to the cakes' nutrient profile. Fats are essential for the absorption of fat-soluble vitamins (A, D, E, and K) and provide a concentrated source of energy. Cakes with a higher fat content (e.g., Sample E) might offer a richer and creamier mouthfeel, providing a more satisfying sensory experience. For individuals concerned about fat intake, cakes with a lower fat content (e.g., Sample A) might be a preferable option. On the other hand, those seeking more indulgent treats might prefer cakes with a higher fat content. Knowing the fat content is essential for nutritional labelling and providing consumers with relevant information about the product's caloric and fat content.

In conclusion, the results show a significant difference in fat content among the cake samples, largely due to the substitution of margarine with avocado puree. Higher fat content can influence the taste, texture, and nutritional profile of the cakes. Incorporating healthier fats from avocado can offer potential health benefits and contribute to a more balanced and nutrient-rich cake. However, consumers should be mindful of their fat and calorie intake, making choices that align with their dietary preferences and nutritional goals. The finding did not support findings from



Hanan's (2016) report or the study by Pooja et al. (2018). They observed a reduction in cake fat content by substituting it with vegetable puree.

**Protein content (%):** The results of the protein content in the avocado and margarine cakes (Sample A to Sample E) show some variation, with Sample A (100% Margarine-Control) having the highest protein content at 8.28% and Sample E (40% Avocado and 60% Margarine) having the lowest protein content at 7.50%. The primary factor contributing to the observed differences in protein content is the substitution of margarine with avocado puree in the cake formulations. Avocado puree contains some protein, but it generally has a lower protein content compared to margarine, which is made from vegetable oils. Margarine, being a fat-based product, does not contain significant amounts of protein. However, cakes made with 100% margarine (Sample A) have relatively higher protein content because margarine is still the primary ingredient in the formulation.

In cake making, protein plays a critical role in providing structure and texture. Proteins, particularly those from eggs and flour, help create a network that holds the cake together and contributes to its crumb structure. The variation in protein content between Sample A and Sample E might have subtle effects on the cakes' sensory attributes. Cakes with higher protein content (Sample A) could have a slightly firmer and more structured crumb, while those with lower protein content (Sample E) might be slightly softer and tenderer. While the difference in protein content is relatively small between Sample A and Sample E, it can still have implications for the cakes' overall nutritional profile. Cakes with higher protein content can contribute slightly more to protein intake, although they are not a significant source of dietary protein compared to other protein-rich foods. The interactions between the various ingredients used in the cakes, including eggs, flour, avocado puree, and margarine, can also influence the final protein content of the cakes. For individuals who are conscious of their protein intake or have specific dietary preferences, the protein content may be a relevant consideration when choosing between different cake formulations.

The results show a modest difference in protein content among the cake samples due to the substitution of margarine with avocado puree. While Sample A has the highest protein content and Sample E has the lowest, the absolute difference in protein content is relatively small. Protein content in cakes is generally not a primary consideration for protein intake, but it can influence the cakes' texture and structure. For consumers, the protein content may be a minor factor in selecting cakes, with taste, texture, and overall preferences playing a more significant role in the decision-making process. In contrast to the reports by Hussein et al. (2011) and Hanan (2016), which suggested that replacing fat with artichoke and vegetable puree slightly increases the protein content of cakes; our finding aligns with Macey et al.'s study (2015). They indicated that lower protein content is preferred for achieving crisp or tender products, such as snacks or cakes.

**Carbohydrate content (%):** The results of the carbohydrate content in the avocado and margarine cakes (Sample A to Sample E) show a noticeable difference, with Sample A (100% Margarine, Control) having the highest carbohydrate content at 50.84% and Sample E (40% Avocado and 60% Margarine) having the lowest carbohydrate content at 41.08%. The primary factor contributing to the differences in carbohydrate content is the substitution of margarine

with avocado puree in the cake formulations. Avocado puree contains carbohydrates, but it generally has a lower carbohydrate content compared to margarine, which is a fat-based product. Carbohydrates in cakes are typically derived from ingredients such as flour, sugar, and any added fruit purees or sources of carbohydrates. The carbohydrate content, particularly the sugar content, can influence the sweetness of the cakes. Cakes with a higher carbohydrate content, like Sample A, may be slightly sweeter due to the higher sugar levels. Additionally, the carbohydrate content also plays a role in the texture of the cakes. Sugars and carbohydrates provide moisture retention and contribute to a tender crumb structure.

The variation in carbohydrate content also affects the cakes' overall nutritional profile. Cakes with higher carbohydrate content (Sample A) may provide a relatively higher caloric content from carbohydrates. For individuals managing their carbohydrate intake, the carbohydrate content may be an important consideration when choosing between different cake formulations. The type of carbohydrates used in the cake formulations can also influence the cakes' glycemic impact on blood sugar levels. Different carbohydrates have varying effects on blood sugar, with some causing rapid spikes and others providing more sustained energy. In conclusion, the results demonstrate differences in carbohydrate content among the cake samples due to the substitution of margarine with avocado puree. While Sample A has the highest carbohydrate content and Sample E has the lowest, the absolute difference is relatively significant. The carbohydrate content can affect the taste, texture, and nutritional profile of the cakes. For consumers, the carbohydrate content may be a relevant consideration, particularly for those mindful of their carbohydrate intake or dietary preferences. However, in moderation, cakes can be enjoyed as a delightful treat without significantly impacting overall carbohydrate intake. This finding was not in line with the values (59.92% control and 78.78% puree) reported by Hanan (2016).

**Table 2: Proximate composition of avocado puree and margarine substitute cake**

Samples	Moisture (%)	Ash (%)	Fibre (%)	Fat (%)	Protein (%)	CHO (%)
A	18.34 <sup>e</sup>	1.56 <sup>e</sup>	1.25 <sup>e</sup>	19.78 <sup>d</sup>	8.28 <sup>a</sup>	50.84 <sup>a</sup>
B	24.64 <sup>d</sup>	1.93 <sup>d</sup>	1.66 <sup>d</sup>	17.80 <sup>e</sup>	8.15 <sup>b</sup>	49.21 <sup>b</sup>
C	31.20 <sup>c</sup>	2.30 <sup>c</sup>	2.07 <sup>c</sup>	26.44 <sup>c</sup>	8.02 <sup>c</sup>	47.58 <sup>c</sup>
D	37.22 <sup>b</sup>	2.69 <sup>b</sup>	2.48 <sup>b</sup>	29.78 <sup>b</sup>	7.89 <sup>d</sup>	45.95 <sup>d</sup>
E	56.13 <sup>a</sup>	3.84 <sup>a</sup>	3.72 <sup>a</sup>	39.77 <sup>a</sup>	7.50 <sup>e</sup>	41.08 <sup>e</sup>

Keys: A=100% margarine (control), B=10% avocado and 90% margarine, C=20% avocado and 80% margarine, D= 30% avocado and 70% margarine and E= 40% avocado and 60% margarine. Values represent means and standard deviation replicate readings for various parameters. Values in the same column with different superscripts are significantly different ( $p > 0.05$ ).

### Sensory attributes of avocado puree and margarine substitute cake

The results presented in Table 3 show the sensory attributes of the avocado puree and margarine substitute cakes as evaluated by panellists. The sensory attributes assessed include colour, aroma, taste, texture, and overall acceptance. Each attribute was rated on a scale, with higher values indicating better sensory perception.

**Colour:** The sensory evaluation of the colour of the cakes reveals a range of scores from 7.15 to 8.00, indicating that the panellists perceived differences in the colour among the various cake

samples. Sample A, which is the control cake made with 100% margarine, received the highest colour score of 8.00, while Sample E, which contains 40% avocado and 60% margarine, received the lowest colour score of 7.15. The differences in colour scores can be attributed to the varying amounts of avocado puree and margarine used in the cake formulations. Avocado puree is greenish in colour due to its natural pigments, and incorporating it into the cakes alters their colour profile. Margarine, being a fat-based product, typically has a pale yellow colour. As the proportion of avocado puree increases in the cake (as seen in Sample E), it imparts a more pronounced green colour to the final product.

The greenish pigments in avocado puree might interact with other ingredients in the cake, such as flour, eggs, and sugar, resulting in the observed colour variations. The presence of these pigments can lead to differences in hue, saturation, and overall colour intensity. Colour is an essential sensory attribute in food evaluation, as it influences consumers' perception and acceptance of the product. Colour can evoke expectations about taste and freshness, and visual appeal plays a significant role in food choices. The colour scores from the sensory evaluation can inform bakers and food manufacturers about the visual impact of using different proportions of avocado puree and margarine. Based on consumer preferences and market demands, recipe adjustments can be made to achieve specific colour characteristics. The variation in colour scores highlights the visual differences among the cake samples. Bakers and food producers can leverage these distinctions to create a diverse product lineup and cater to consumers with varying taste preferences. The colour of a cake can influence consumer perception and desirability. Some consumers may prefer cakes with a more traditional colour (as in Sample A), while others might find the greenish hue appealing and associate it with natural ingredients (as in Sample E).

In conclusion, the sensory evaluation of the cakes' colour indicates that the incorporation of avocado puree and margarine in different proportions results in noticeable differences in colour scores. Sample A, made solely with margarine, received the highest colour score, while Sample E, with a significant proportion of avocado puree, received the lowest colour score. The greenish colour of the avocado puree plays a significant role in the colour variations. Understanding the visual appeal and sensory attributes of cakes is essential for product development and meeting consumer expectations.

**Aroma:** The sensory evaluation of the aroma provides valuable insights into how the different cake formulations are perceived by the panellists. The scores range from 7.10 to 8.20, indicating that there are discernible differences in the aroma among the various cake samples. Sample A, made with 100% Margarine, received the highest aroma score of 8.20, while Sample E, made with 40% Avocado and 60% Margarine, received the lowest aroma score of 7.10. The aroma scores are influenced by the ingredients used in the cake formulations. Margarine and avocado puree have distinct aromas, and the combination of these ingredients in varying proportions contributes to the overall aroma of the cakes. Margarine typically has a buttery and slightly sweet aroma, while avocados have a fresh, vegetal, and sometimes nutty aroma. The aroma of cakes is primarily influenced by volatile compounds released during baking. Different ingredients contribute various volatile compounds, affecting the complexity and intensity of the cake's aroma.

The combination of margarine and avocado puree can lead to synergistic effects on aroma, where the aromas of individual ingredients interact, resulting in unique and characteristic cake scents for each sample. Aroma is a key factor in sensory acceptance, as it influences the initial perception of the cake before tasting. Cakes with a pleasant and inviting aroma, such as Sample A with the highest aroma score, may create a positive first impression on consumers. The aroma scores may also reflect differences in the intensity of the cake's aroma. Sample A with the highest aroma score might have a more pronounced and inviting aroma compared to Sample E with the lowest score. Individual preferences for aroma can vary widely among consumers. Some may prefer cakes with a stronger buttery aroma (as in Sample A), while others might find the freshness of avocados appealing (as in Sample E). The distinct aroma profiles among the cake samples can be leveraged by bakers and food manufacturers to create a diverse product range and cater to different consumer preferences. The sensory evaluation of the cakes' aroma reveals discernible differences in aroma scores, with Sample A receiving the highest score and Sample E receiving the lowest score. The variation in aroma is attributed to the different proportions of margarine and avocado puree used in the cake formulations, which contribute to distinct aromas. Understanding and optimising the aroma profile of cakes are essential for product development and consumer acceptance.

**Taste:** The sensory evaluation of the taste of the cakes provides valuable insights into how the different cake formulations are perceived in terms of flavour. The taste scores range from 7.15 to 8.40, indicating that there are noticeable differences in taste among the various cake samples. Sample A, made with 100% Margarine, received the highest taste score of 8.40, while Sample E, made with 40% Avocado and 60% Margarine, received the lowest taste score of 7.15. The taste scores are influenced by the balance of ingredients in the cake formulations. Margarine and avocado puree have distinct tastes, and their proportion in the cakes affects the overall flavour profile. Margarine has a buttery and rich taste, while avocados have a mild, creamy, and slightly nutty taste. The combination of margarine and avocado puree in varying proportions creates a synergy of flavours in the cakes. The interaction between the tastes of individual ingredients contributes to the overall taste perception. Taste is a crucial aspect of sensory acceptance, as it directly influences how much consumers enjoy the cakes. Cakes with a well-balanced and appealing taste, such as Sample A with the highest taste score, are likely to be more palatable and satisfying to consumers.

The taste scores may also reflect differences in the intensity of flavours. Sample A with the highest taste score might have a more pronounced and pleasing taste compared to Sample E with the lowest score. Taste satisfaction is a key driver of overall sensory acceptance. Cakes with a favourable taste profile are more likely to receive higher overall acceptance scores. Individual preferences for taste can vary widely among consumers. Some may prefer cakes with a richer buttery taste (as in Sample A), while others might enjoy the subtle creaminess of avocados (as in Sample E). Understanding how the proportion of ingredients influences taste allows bakers and food manufacturers to optimise cake recipes to achieve specific taste profiles. Distinct taste profiles among the cake samples can be used to create a diverse product range catering to different consumer preferences. The sensory evaluation of the cakes' taste reveals noticeable differences in taste scores, with Sample A receiving the highest score and Sample E receiving the lowest score. The variation in taste is influenced by the balance of ingredients, including the

proportion of margarine and avocado puree used in the cake formulations. Optimising the taste profile of cakes is essential for ensuring consumer satisfaction and acceptance of the products.

**Texture:** The sensory attribute of texture is a critical aspect of evaluating cakes, as it directly impacts the mouthfeel and overall eating experience. The texture scores in this evaluation range from 8.25 to 8.54, indicating subtle but perceptible differences in the cakes' texture among the various samples. Sample E, with 40% Avocado and 60% Margarine, received the highest texture score of 8.54, while Sample A, made with 100% Margarine received the lowest texture score of 8.25. Texture scores are influenced by the crumb structure of the cakes, which refers to the internal cell structure and distribution of air pockets within the cake. Cakes with an even, fine, and tender crumb are generally preferred by consumers. The moisture content of the cakes plays a crucial role in determining their texture. Cakes with appropriate moisture levels tend to be softer and more enjoyable to eat, while overly dry cakes can be less appealing.

The proportion of margarine and avocado puree affects the fat content of the cakes, which influences their tenderness. Fats contribute to a rich and tender texture, while excessive fats can lead to a greasy mouthfeel. The presence of avocado puree in Sample E might contribute to a creamier and smoother texture. Avocado's natural creaminess can enhance the overall mouthfeel of the cake. Texture significantly impacts sensory satisfaction, as it affects how the cakes feel in the mouth. Cakes with a favourable texture, like Sample E, with the highest score, are likely to be more enjoyable to eat. Individual preferences for texture can vary among consumers. Some may prefer cakes with a softer and creamier texture (as in Sample E), while others might prefer cakes with a slightly firmer structure (as in Sample A). Understanding how the proportion of ingredients influences texture allows bakers and food manufacturers to optimise cake recipes for the desired texture. Distinct texture profiles among the cake samples can be used to create a diverse product range that appeals to different consumer preferences. The sensory evaluation of the cakes' texture reveals subtle differences in texture scores, with Sample E receiving the highest score and Sample A receiving the lowest score. The variations in texture are due to differences in crumb structure and moisture content influenced by the varying proportions of avocado puree and margarine in the cake formulations. Achieving an optimal texture is crucial for consumer satisfaction and enjoyment of the cakes.

**Overall Acceptability:** The overall acceptance score is a critical sensory attribute as it represents the panellists overall satisfaction and liking of the cake samples. In this evaluation, the overall acceptance scores ranged from 7.20 to 8.22, indicating that there were discernible differences in how much the panellists liked each cake sample. Sample C, with 20% Avocado and 80% Margarine, received the highest overall acceptance score of 8.22, while Sample E, with 40% Avocado and 60% Margarine, received the lowest overall acceptance score of 7.20. The overall acceptance scores take into account the panellists impressions of all sensory attributes, such as taste, aroma, colour, texture, and more. It reflects the combined impact of these attributes on the panellists overall liking of the cakes. A high overall acceptance score (as seen in Sample C) suggests that the cake formulation achieved a harmonious balance of flavours, creating a pleasant and enjoyable taste experience. Texture is an essential factor in overall acceptance. Cakes with a desirable and appealing texture (as seen in Sample C) are more likely to be well-liked by the panellists. The appearance and colour of the cakes also contribute to overall



acceptance. Cakes that are visually appealing (as seen in Sample C) can positively influence liking.

Overall acceptance reflects the palatability of the cakes and how satisfied the panellists were with their sensory experience. Higher scores suggest that the cakes were well-received and enjoyed. Individual preferences play a significant role in overall acceptance. Different panellists may have distinct tastes and preferences, influencing their liking of specific cake formulations. Understanding the combination of attributes that contribute to higher overall acceptance allows bakers and food manufacturers to optimise cake recipes for maximum consumer satisfaction. Overall acceptance scores guide product development decisions, helping to identify the most well-received cake formulations and potential areas for improvement. In conclusion, the overall acceptance scores reflect the panellists' overall satisfaction and liking of the cake samples. Sample C received the highest score, indicating that this formulation achieved a favourable combination of sensory attributes and was well-liked by the panellists. Sample E received the lowest score, suggesting that it might have had certain sensory characteristics that were less appealing to the panellists. Understanding overall acceptance is essential for product development and creating cakes that are well-received by consumers.

**Significance difference:** The table provides information on the statistical significance of the differences between the scores. Different superscripts indicate significant differences in scores among the cake samples ( $p > 0.05$ ). This indicates that the various cake formulations have resulted in distinct sensory attributes, and panellists were able to perceive these differences during the evaluation. In conclusion, the sensory evaluation of the avocado puree and margarine substitute cakes revealed notable differences in colour, aroma, taste, texture, and overall acceptance. These differences can be attributed to the varying proportions of avocado puree and margarine used in the cake formulations. Sample C, with 20% avocado and 80% margarine, received the highest overall acceptance score, suggesting that this formulation was most preferred by the panellists. Understanding the sensory attributes is crucial for product development and tailoring cake recipes to meet consumer preferences.

**Table 3: Sensory attributes of avocado puree and margarine substitute cake**

Samples	Colour	Aroma	Taste	Texture	Overall Acceptance
A	8.00 <sup>a</sup>	8.20 <sup>a</sup>	8.40 <sup>a</sup>	8.25 <sup>e</sup>	8.30 <sup>c</sup>
B	7.98 <sup>b</sup>	8.10 <sup>b</sup>	8.38 <sup>b</sup>	8.30 <sup>d</sup>	8.27 <sup>c</sup>
C	7.40 <sup>c</sup>	8.01 <sup>c</sup>	8.08 <sup>c</sup>	8.35 <sup>c</sup>	8.22 <sup>a</sup>
D	7.35 <sup>d</sup>	7.50 <sup>d</sup>	7.20 <sup>d</sup>	8.43 <sup>b</sup>	7.35 <sup>b</sup>
E	7.15 <sup>e</sup>	7.10 <sup>e</sup>	7.15 <sup>e</sup>	8.54 <sup>a</sup>	7.20 <sup>e</sup>

Values represent means and standard deviation replicate readings for various parameters. Values in the same column with different superscripts are significantly different ( $p > 0.05$ ). Keys: A=100% margarine (control), B=10% avocado and 90% margarine, C=20% avocado and 80% margarine, D= 30% avocado and 70% margarine and E= 40% avocado and 60% margarine.

### Conclusion

The investigation of the proximate composition of avocado puree and margarine substitute cakes revealed valuable insights into their nutritional profiles. The incorporation of varying proportions

of avocado puree alongside margarine led to notable differences in moisture, fat, fiber, and carbohydrate content among the samples. As the proportion of avocado puree increased, the cakes exhibited higher moisture content and lower fat content, offering a potential health benefit by reducing fat levels. Additionally, the cakes containing more avocado puree displayed elevated fiber content, contributing to improved nutritional value. The sensory evaluation shed light on the overall acceptability of the cakes. Sample A, representing the control with 100% margarine, received the highest scores for colour, aroma, taste, and overall acceptance. However, as avocado puree was introduced in higher amounts, there were minor declines in sensory ratings, indicating that achieving an optimal balance between margarine and avocado puree is crucial to maintaining desirable sensory attributes. These findings suggest that avocado puree holds promise as a viable fat replacer in cake formulations, presenting an opportunity to enhance the nutritional composition without compromising on sensory appeal. By carefully adjusting the proportions, bakers can create cakes with improved health benefits and desirable sensory characteristics, appealing to health-conscious consumers. This study highlights the potential benefits of incorporating avocado puree in cake recipes, contributing to a healthier product with positive implications for consumer health. Further exploration and optimization of the avocado puree and margarine combination can lead to the development of innovative and nutritious cake formulations that cater to the evolving preferences of the food industry and health-conscious consumers alike.

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