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# Micronutrients Composition of Cake Produced from Fermented Sorghum and Pigeon Pea Composite Flour

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**Abstract**
In order to assess the micronutrient value of cakes made from fermented sorghum and pigeon pea flour blends, this study examined the mineral and vitamin makeup of the cakes. Important native crops like sorghum and pigeon pea are high in micro-nutrients, which makes them good substitutes for traditional wheat flour when preparing cakes. Using standard techniques, the fermented sorghum and pigeon pea flours were combined in different ratios to make cakes. Standard analytical techniques were used to determine the cake samples' mineral and vitamin contents. The findings showed that all of the cake samples examined had significant levels of minerals and vitamins. Magnesium varied from 173.55 to 197.81 mg/100 g, potassium varied from 352.06 to 387.07 mg/100 g, calcium ranged from 301.77 to 322.77 mg/100, phosphorus concentration varied from 34.98 to 46.25 mg/100 g and iron content varied from 0.34 to 6.73 mg/100g. The addition of fermented sorghum and pigeon pea flours, increased the mineral content. Vitamin B1 concentration ranged from 0.021 to 0.035 mg/100 g, vitamin B2 from 0.328 to 0.377 mg/100 g, and vitamin B3 from 0.002 to 0.023 mg/100 g. The results showed that adding blends of fermented sorghum and pigeon pea flour enhanced the cakes' vitamin content. According to the study's findings, cakes made with fermented sorghum and pigeon pea flour blends had better mineral and vitamin compositions and can substitutes for traditional wheat-based cakes. By using these readily available and underutilized crops in cakes, food security and the value addition of local raw materials could all be enhanced, thereby reducing wastage and also wheat importation which affect affect the nation’s economy negatively. Therefore, it is advised to use fermented sorghum and pigeon pea composite flour while making cakes in order to create baked goods that are both functional and nutritionally enriched.

**Keywords:** Minerals, Vitamins, Cake, Sorghum, Pigeon Pea

## 1. Introduction

### 1.1 Background of the Study

Cake's sensory appeal, affordability, and ease of use make it one of the most popular bakery goods in the world. Wheat flour has historically been used as the main component in cakes due to its capacity to generate gluten, which gives cakes their desired structure and texture. However, wheat flour is highly dependent on imports in many developing nations, including Nigeria, and has inadequate nutritional value in several micronutrients, which raises production costs and increases food insecurity (FAO, 2022) [13]. Traditionally made using wheat flour, cake is a popular baked good. However, people with gluten-related conditions like celiac disease have intolerance to wheat flour because it contains gluten (Biesiekierski, 2017) [9]. Thus, a possible substitute for making gluten-free and nutrient-dense cakes is sorghum and pigeon pea composite flour. Research on alternative flours made from native crops like sorghum and pigeon pea has been spurred by the growing demand for wholesome and functional diets.A significant cereal crop that is extensively grown in Asia and Africa is sorghum (Sorghum bicolor L.). Carbohydrates, minerals including iron, magnesium, and phosphorus, and bioactive substances with antioxidant qualities are all abundant in it (Emojorho *et al*. 2025) [11]. Sorghum's protein quality is constrained by its comparatively low lysine content, an important amino acid. A significant amount of human diets are made up of cereal and legume grains, particularly in underdeveloped nations where they provide inexpensive sources of vitamins, minerals, proteins, and carbs. One of the most significant cereal crops in the world, sorghum comes in fifth place in terms of production behind wheat, rice, barley, and maize (Emojorho *et al*. 2025) [11]. Because of its ability to withstand drought and adapt to challenging environmental circumstances, it is widely grown in Asia and Africa. Sorghum grains are low in several critical amino acids, including lysine, but high in carbohydrates, dietary fiber, iron, phosphorus, and B-complex vitamins (Ratnavathi & Komala, 2016). Conversely, legumes are a great source of vitamins and protein. Rich in protein, iron, zinc, calcium, and vitamins, pigeon peas are an underappreciated tropical legume (Saxena *et al*., 2018). It has been found to be a useful crop for enhancing nutritional security, especially in areas with shortages in micronutrients and protein.

After barley, rice, corn, and wheat, sorghum is the fifth most popular crop in the world (Emojorho *et al*., 2025) [11]. Proteins, minerals, vitamins, phenolic compounds, micronutrients, macronutrients, and bioactive substances are all abundant in sorghum grains and sorghum flour (SF) (Emojorho *et al*., 2025) [11]. Sorghum has binding qualities that aid in the formation and preservation of food structures due to its distinct protein makeup. SF can absorb and retain emulsifiers, lipids, and oils. Because it can improve the volume, tenderness, and duration of storage of bread, cakes, and pastries, this property is advantageous for baked goods (Emojorho *et al*., 2025) [11]. On the other hand, the pigeon pea (Cajanus cajan) is a high-protein legume that also includes essential vitamins, minerals, and amino acids like calcium, potassium, and iron (Olagunju *et al*., 2018) [17]. It is also an excellent source of nutrients, especially B vitamins. The complementing protein and micronutrient compositions of grains and legumes enhance nutritional quality. As a result, making cake with fermented sorghum and pigeon pea flour may increase the amount of micronutrients, including vitamins and minerals, while encouraging the use of regional crops and lowering reliance on imported wheat flour (Olagunju *et al*., 2021) [19].

The nutritional value and functional qualities of baked goods including bread, biscuits, and cakes have been successfully enhanced by the use of sorghum-legume composite flours. Phytates, tannins, and oxalates are anti-nutritional elements found in sorghum and pigeon pea that lower mineral absorption despite their nutritional advantages (Kayodé *et al*., 2018). A traditional method of food preparation, fermentation increases vitamin content, improves mineral absorption, boosts nutrient bioavailability, and lowers antinutritional elements like tannins and phytates (Adebo & Medina-Meza, 2020) [1]. Additionally, fermentation can enhance flour's functional and sensory qualities. Microorganisms like Saccharomyces cerevisiae and Lactobacillus, which produce enzymes that break down anti-nutritional substances and create certain vitamins, are involved in fermentation (Marco *et al*., 2021) [16]. Because of their complimentary amino acid profiles and increased micronutrient density, combining cereals with legumes enhances the nutritional value of food. In order to assess the impact of fermentation on the mineral and vitamin composition of cake made from sorghum and pigeon pea flour, this study is required. The goal of this study is to assess the mineral, vitamin, and phytochemical content of cake made from fermented sorghum and pigeon pea composite flours. In developing nations like Nigeria, micronutrient deficiencies—especially those in iron, zinc, calcium, and vitamins—remain a serious public health concern (WHO, 2021) [23]. Due to manufacturing losses and absence of fortification, traditional cakes prepared with refined wheat flour often have low levels of vitamins and phytochemicals. Additionally, there is a significant reliance on imports because wheat is not commonly grown in tropical areas.Due to this circumstance, bakery goods must be developed using nutrient-dense, regionally accessible crops like pigeon pea and sorghum. Despite the nutritional value of sorghum and pigeon pea, anti-nutritional substances such phytates and tannins restrict their mineral absorption. According to Nkhata *et al*. (2018) [18], these substances bind minerals and decrease their absorption in the human body. Although fermentation has been demonstrated to increase mineral and vitamin bioavailability, nothing is known about the mineral and vitamin makeup of cake made from mixes of fermented sorghum and pigeon pea flour. Furthermore, cakes made with regular wheat flour could not contain enough micronutrients and are inappropriate for people who are gluten intolerant. In developing nations like Nigeria, micronutrient deficiencies—especially those in iron, zinc, calcium, and vitamins—remain a serious public health concern (World Health Organization, 2021) [23]. Due to manufacturing losses and absence of fortification, traditional cakes prepared with refined wheat flour often have low levels of vitamins and phytochemicals. Additionally, there is a significant reliance on imports because wheat is not commonly grown in tropical areas. Due to this circumstance, bakery goods must be developed using nutrient-dense, regionally accessible crops like pigeon pea and sorghum. Despite the nutritional value of sorghum and pigeon pea, anti-nutritional substances such phytates and tannins restrict their mineral absorption. According to Nkhata *et al*. (2018) [18], these substances bind minerals and decrease their absorption in the human body. Fermentation has been shown to improve mineral and vitamin bioavailability; however, limited research exists on the mineral and vitamin composition of cake produced from fermented sorghum and pigeon pea flour blends. In addition, cakes produced from conventional wheat flour may not provide sufficient micronutrients and are unsuitable for gluten-intolerant individuals. This study is significant since it encourages the use of crops that are readily available in the area. It lessens reliance on imported wheat flour and increases micronutrient intake through better food items. In addition to providing scientific data on the mineral and vitamin makeup of composite cakes, this research will improve nutrition and help to food security. The purpose of this study is to ascertain the micronutrient content of cake made from blends of fermented sorghum and pigeon pea flour.

## 2. Materials and Methods

### 2.1 Materials

Sorghum grains, pigeon pea seeds, wheat flour (control), sugar, butter, eggs, baking powder, milk, vanilla flavor, nitric acid, hydrochloric acid, standard mineral solutions, and vitamin standards were purchased from Ozoro and Asaba main market.

### 2.2 Preparation of Fermented Sorghum Flour
Wet milling was used to create the fermented sorghum flour. The sorghum grains was cleaned to get rid of extraneous items and broken grains. The grains were cooked in water (1:2 w/v) at 100 ± 2ºC for 2 min. In a professional sorghum mill, the cooked grains were wet milled before being filtered through cheesecloth soaked in extra water. The resulting slurry were allowed to settle and ferment at room temperature (27 ± 2ºC) for three days. The resulting paste were baked in an oven at 40ºC for two days after the water has been decanted. A sorghum mill (type Corona-2N, England) were used to grind the dried mixture into flour. The flour were packaged in 55 µm-thick polyethylene bags after being sieved (45 µm). After that, they were kept in a refrigerator at 4ºC until it is needed (Ityotagher, 2022).

### 2.3 Preparation of Fermented Pigeon Pea Flour
As stated by Akubor (2017) [6], a part of the raw pigeon pea flour (RPPF) was combined with water in a covered plastic bowl at a ratio of 3.2 (water: flour). The paste undergo three days of fermentation, oven drying at 60°C for three hours, attrition milling, and screening through a 60 mesh sieve (0.1 mm). Before being used, all of the flour samples were kept in high density polyethylene (HDPE) bags that are 0.77 mm thick.

### 2.4 Flour Formulation
Composite flour blends will be prepared in the following ratios:

| Sample | Wheat (%) | Sorghum (%) | Pigeon Pea (%) |
|---|---|---|---|
| CC | 100 | 0 | 0 |
| CP25 | 75 | 25 | 0 |
| CP50 | 50 | 50 | 0 |
| SC25 | 75 | 0 | 25 |
| SC50 | 50 | 0 | 50 |

### 2.5 Cake Production Procedure
The creaming process was used to produce the cakes. Baking powder, baking soda, and Amul powder were sieved into the flour. After using a hand blender to cream the oil and sugar in a container, and other ingredients were added. The cream was mixed with the sieved flour mixture. Batter was prepared by correct pounding, and milk or water was be used to keep the right consistency. It was pour it into a greased cake to for after the batter is ready, then bake at 1800 degrees Celsius, then let it cool, and then keep at room temperature.

### 2.6 Determination of mineral and vitamin composition
In pursuant to standardized procedures stipulated by the Association of Official Analytical Chemists (AOAC, 2019) and Adepoju *et al*., (2021) [3] the mineral contents of the samples, namely phosphorus, iron, calcium, magnesium, and potassium, were determined. The AOAC (2019) was used to measure vitamin B1 (thiamine), vitamin B2 and Vitamin B3.

### 2.7 Experimental Design
The experiment was conducted using a complete randomized design. The gathered data was examined using analysis of variance (ANOVA). The least significant difference (LSD) test was used to find significantly different means. At $p < 0.05$, significance was aaccepted.

## 3. Result and Discussion
### 3.1 Mineral concentration of cakes produced from blends of wheat, pigeon pea and sorghum flour
The mineral composition of the cake samples are shown in Table 1.

**Table 1:** Mineral concentration of cakes produced from blends of wheat, pigeon pea and sorghum flour

| Sample | P | Fe | Ca | Mg | K |
|---|---|---|---|---|---|
| CP25 | $40.26^c$+0.04 | $2.08^b$+0.01 | $309.44^d$+0.02 | $185.74^d$+0.04 | $362.67^c$+0.64 |
| CP50 | $47.86^a$+0.08 | $0.34^d$+0.01 | $316.28^b$+1.17 | $192.25^b$+0.25 | $372.00^b$+2.02 |
| SC25 | $39.00^d$+0.05 | $2.17^c$+0.04 | $311.63^c$+0.04 | $189.45^c$+0.15 | $373.20^b$+0.65 |
| SC50 | $46.25^b$+0.47 | $0.35^d$+0.01 | $322.14^a$+0.20 | $197.81^a$+0.62 | $387.07^a$+0.48 |
| CC | $34.98^e$+0.97 | $6.73^a$+0.40 | $301.77^e$+0.47 | $173.55^e$+0.97 | $352.06^c$+0.23 |

The values represent three replications' means ± standard deviations. Values in the same column with similar superscripts do not differ substantially ($p>0.05$), however values in the same column with varying superscripts differ significantly ($p<0.05$). CP25: cake made with 25% pigeon pea flour; CP50: cake made with 50% pigeon pea flour; CS: CS25: cake made with 25% sorghum flour; CS50: cake made with 50% sorghum flour;

The cake samples' potassium level varied from 352.06 to 387.07 mg/100g, with the 100% wheat flour cake having the lowest value at 352.06 mg/100g. According to Onuoha *et al.* (2025) [20] and Emojorho *et al.* (2023) [12], the values were greater than 149.94 to 195.54 mg/100g and 156.49 to 270.271 mg/100g, respectively, for biscuits made using composite flour. Higher amounts of sorghum and pigeon pea flour considerably raised the cake's potassium content. Potassium concentrations were much greater when sorghum flour was substituted for pigeon pea supplementation; the formulation comprising 50% sorghum flour had the highest value at 387.07 mg/100g. The potassium concentrations of the cakes differed significantly ($p<0.05$).

The cake samples' magnesium level varied from 173.55 to 197.81 mg/100g, with the cake made entirely of wheat flour having the lowest value at 173.55 mg/100g. For biscuits made using composite flour, the readings were marginally higher than the 126.75 to 168.34 mg/100g reported by Onuoha *et al.* (2025) [20]. Higher percentages of sorghum and pigeon pea flours considerably raised the cake's magnesium content. Adinkwu *et al.* (2025) [4] also showed elevated levels of sorghum flour in bread samples, ranging from 123.43 to 182.34 mg/100g. Magnesium concentrations were higher when sorghum flour was substituted for pigeon pea supplements, reaching a maximum of 197.81 mg/100g in the formulation with 50% sorghum flour. The magnesium concentrations of the cakes differed significantly ($p<0.05$).

The cake samples' calcium level varied from 46.25 mg/100g to 34.98 mg/100g, with the cake made entirely of wheat flour having the lowest amount. For complementary food made from composite flour, the values were greater than the 0.45 to 1.02 mg/100g reported by Ihedinachi *et al.* (2025) [14]. Higher amounts of sorghum and pigeon pea flour considerably raised the cake's calcium content. Calcium concentrations were much greater when sorghum flour was substituted for pigeon pea supplementation, reaching a peak of 322.14 mg/100g in the formulation with 50% sorghum flour. The calcium concentrations of the cakes differed significantly ($p<0.05$).

The iron content of the cake samples ranged from 0.34 to 6.73 mg/100g, with the cake composed wholly of wheat flour having the highest value at 6.73 and the cake supplemented with 50% pigeon pea flour having the least value at 0.34 mg/100g. The findings were slightly more than the 0.44 to 1.17 mg/100g recorded by Ihedinachi *et al*. (2025) [14] for complementary food manufactured with composite wheat. The iron level of the cake was significantly decreased by using more sorghum and pigeon pea flour. Notably, pigeon pea substitution resulted in lower phosphorus concentrations than sorghum supplementation. The iron levels of the cakes varied significantly ($p<0.05$). Iron leaching is caused by the fermentation process.

The cake samples' phosphorus content varied from 34.98 to 46.25 mg/100g, with the 100% wheat flour cake having the lowest value at 34.98 mg/100g. The results were marginally less than the 40.64 to 51.97 mg/100g for biscuits made with composite flour that Onuoha *et al*. (2025) [20] reported. Higher amounts of sorghum and pigeon pea flour considerably raised the cake's phosphorus levels. According to Adinkwu *et al*. (2025) [4], bread samples with more sorghum flour had higher levels of phosphorus. Phosphorus concentrations were significantly greater when pigeon pea flour was substituted for sorghum, reaching a peak of 47.86 mg/100g in the formulation that contained 50% pigeon pea flour. The phosphorus concentrations of the cakes differed significantly ($p<0.05$).

### 3.2 Vitamins. Concentration of cakes produced from blends of wheat, pigeon pea and sorghum flour

The vitamin composition of the cake samples are shown in table 2.

**Table 2:** Vitamins. Concentration of cakes produced from blends of wheat, pigeon pea and sorghum flour (mg/100g)

| Sample | B1 | B2 | B3 |
|---|---|---|---|
| CP25 | $0.028^{b}$+0.001 | $0.367^{ab}$+0.001 | $0.004^{c}$+0.000 |
| CP50 | $0.027^{b}$+0.002 | $0.377^{a}$+0.006 | $0.002^{c}$+0.000 |
| SC25 | $0.030^{ab}$+0.001 | $0.333^{d}$+0.002 | $0.009^{b}$+0.001 |
| SC50 | $0.035^{a}$+0.004 | $0.340^{b}$+0.004 | $0.023^{a}$+0.001 |
| Control | $0.021^{c}$+0.001 | $0.328^{c}$+0.004 | $0.006^{b}$+0.003 |

Values are means ± SD of two determinations. Values in the same column bearing similar superscripts are not significantly ($p>0.05$) different, while values in the same column with different superscript are significantly ($p<0.05$) different.

The cake samples' vitamin B1 level varied from 0.021 to 0.035 mg/100g, with the 100% wheat flour cake having the lowest value at 0.027 mg/100g. The values were comparable to o.0.035 to 0.315 recorded by Aniemena for cake made from composite flour, but lower than 1.00 to 2.33 mg/100g reported by Anene *et al*. (2025) for composite flour. With higher amounts of sorghum and pigeon pea flour, the cake's vitamin B1 levels rose dramatically. Vitamin B1 concentrations were significantly greater when sorghum flour was substituted for pigeon pea supplements; the formulation comprising 50% sorghum flour had the highest value at 0.035 mg/100g. The vitamin B1 concentrations of the cakes differed significantly ($p<0.05$).

The cake samples' vitamin B2 level varied from 0.328 to 0.377 mg/100g, with the 100% wheat flour cake having the lowest value at 0.328 mg/100g. According to Adinkwu *et al*. (2025) [4], the values for bread made with sorghum flour were less than 0.99 to 1.04. As the amounts of sorghum and pigeon pea flour increased, the cake's vitamin B2 content rose dramatically. Vitamin B2 concentrations were significantly greater when pigeon pea flour was substituted than when sorghum flour was supplemented; the formulation that had the highest score at 0.035 mg/100g and included 50% pigeon pea flour. There were significant ($p<0.05$) differences in the vitamin B2 contents among the cakes.

The cake samples' vitamin B3 level varied from 0.002 to 0.023 mg/100g, with the 50% pigeon pea cake having the lowest value at 0.002 mg/100g. For biscuits made with composite flours, the readings were less than the 0.56 to 1.63 mg/100g reported by Emojorho *et al*. (2023) [12]. When the amount of sorghum flour in the cake was increased, the levels of vitamin B3 rose noticeably, but when the amount of pigeon pea flour was increased, the levels of vitamin B3 declined. Vitamin B3 concentrations were significantly higher when sorghum flour was substituted for pigeon pea supplementation; the formulation comprising 50% sorghum flour had the highest value at 0.023 mg/100g. The vitamin B3 amounts of the cakes differed significantly ($p<0.05$).

## 4. Conclusion

The current study showed that adding sorghum and pigeon pea flours to cake recipes greatly enhanced the cakes' mineral and vitamin content. The findings showed that as the amount of sorghum and pigeon pea substitution in the flour blends increased, so did the concentrations of potassium, calcium, magnesium, vitamin B1 (thiamine), vitamin B2 (riboflavin), and vitamin B3 (niacin). This suggests that the composite flour cakes possessed higher micronutrient quality when compared with cakes manufactured only from traditional wheat flour.

The nutritional potential of sorghum and pigeon pea as useful ingredients in baked goods is highlighted by the noted improvement in mineral and vitamin levels. The addition of these locally grown crops to cakes may enhance dietary intake of micronutrients needed for healthy bodily processes and general well-being. Additionally, using pigeon pea and sorghum flour to make cakes could encourage the use of underutilized native crops, diversify bakery raw materials, and lessen reliance on imported wheat flour.

Cakes made from blends of sorghum and pigeon pea flour can therefore be regarded as nutritionally superior in terms of minerals and vitamins and also creation of functional bakery goods with added value for customers looking for healthier eating options. Additional research could concentrate on the produced products' nutrient bioavailability, storage stability, and sensory acceptance.

## 5. Recommendations

1. Because sorghum and pigeon pea flours can improve the nutritional quality of cakes, especially in terms of mineral and vitamin content, it is advised to use them more frequently in baked goods.
2. As healthier substitutes for traditional wheat-based cakes, the food industry and commercial bakers ought to investigate the large-scale manufacture of composite flour cakes.
3. To help address micronutrient deficiencies, particularly in developing nations, nutritionists and public health organizations should promote the intake of products made from sorghum and pigeon peas.

4. More research should be done on the sensory qualities, shelf stability, consumer acceptability, and storage features of cakes made using blends of sorghum and pigeon pea flour.

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