IAA Journal of Biological Sciences 12(1):99-110, 2024 www.iaajournals.org
©IAAJOURNALS ISSN:2636-7254
https://doi.org/10.59298/IAAJB/2024/121.9911011 IAAJB:121.991101111

Nutritional Analysis of Traditional Fermented Food Condiments: Implications for Dietary Diversity and Health Security in Anambra Metropolis

Ejimofor, Chiamaka Frances[1] and Adaugo Ozioma Nwakuche[2]

[1]**Department of Biological Science, Chukwuemeka Odumegwu Ojukwu University Uli, Anambra State, Nigeria.**
[2]**Department of Botany, Nnamdi University Awka, Nigeria.**

ABSTRACT

Fermented food condiments play a crucial role in enhancing flavor and nutritional quality of various dishes across cultures. This study investigates the nutritional compositions of three widely consumed traditional condiments Ogiri, Okpei, and Dawa-Dawa commonly sold within Anambra metropolis. Proximate analysis, including moisture content, crude protein, crude fiber, and fat content, was conducted using standard Weende analysis methods. Additionally, mineral compositions, including calcium, sodium, magnesium, phosphorus, and potassium, were evaluated. Results reveal significant variations in nutritional profiles among the condiments, with Ogiri-Okpei exhibiting notably high levels of crude protein (23.68% ± 0.01) and Dawa-Dawa demonstrating elevated levels of crude fiber (1.94% ± 0.01) and fat content (23.19% ± 0.01). Mineral analysis highlights varying concentrations of essential nutrients, such as calcium (46.11 mg/100g ± 0.01) and sodium (147.22 mg/100g ± 0.01) in Ogiri-Igbo, and phosphorus (84.97 mg/100g ± 0.01) and potassium (860.12 mg/100g ± 0.02) in Ogiri-Okpei. These findings underscore the nutritional significance of traditional fermented condiments in the diet and emphasize the need for accurate nutritional labeling to promote dietary diversity and health security among consumers. Further research is warranted to comprehensively assess the vitamin content of these condiments and their impact on overall nutritional adequacy.

Keywords: Fermented condiments, Nutritional composition, Traditional foods, Anambra State, Nigeria

INTRODUCTION

Various ethnic groups in Nigeria have long cherished traditional fermented condiments derived from plant proteins, marking a rich culinary heritage spanning centuries [1, 2, 3, 4]. These condiments have been integral to the dietary practices of rural communities, serving as both wholesome meat alternatives and flavor-enhancing agents in soups [5, 6, 7, 8, 9]. Across Africa, numerous oily seeds abundant in protein, including cottonseed (Gossypium hirsutum), African yam bean, and melon seed (Citrullus vulgaris), undergo fermentation to produce soup condiments, imparting delightful aromas to culinary creations [10, 11, 12, 13, 14]. Ogiri Igbo, akin to other forms of ogiri, arises from the solid-state fermentation of Castor seeds (Ricinus communis), renowned for its distinctive ammoniacal flavor that enriches the palate of local Nigerian dishes [15, 16, 17]. This condiment, characterized by its strong aromatic essence and dark-brown appearance, infuses soups with a unique depth of flavor [18, 19, 20]. Similarly, Ogiri-okpei, a savory seasoning crafted from fermented Prosopis africana (Mimosaceae) oil seeds, permeates households with its intense aroma upon introduction to the soup pot [21, 22, 23]. This dark-brown condiment, derived from the fermentation of boiled leguminous oil seeds of Prosopis africana, finds widespread popularity among West African communities, serving primarily as a seasoning agent and meat substitute in diverse dishes [24, 25, 26]. Dawa-dawa, another revered seasoning, results from the fermentation of African locust beans (Parkia sp.) or soybean seeds. Once a traditional preparation, Dawa-dawa is now industrially produced by companies like Nestle and distributed across Africa [27, 28]. This culinary staple, cherished in the savannah regions of Western and Central Africa, adds depth and richness to soups, sauces, and various culinary creations [29, 30, 31, 32, 33, 34]. The nutritional profiles of these local condiments boast high mineral content, optimal moisture levels, low ash, and crude fiber [40, 41, 42]. Additionally, they are low in fat, rich in protein, and devoid of cholesterol, making them nutritionally advantageous additions to diets, particularly in developing nations [43, 44, 45, 46]. Beyond their nutritional value, these condiments harbor an array of bioactive compounds and phytochemicals, including antioxidants (e.g., polyphenols), soluble fiber (e.g., pectin and beta-glucanase), probiotics (e.g., inulin, fructan), vitamins (e.g., A, B group, and C), flavone glycosides (e.g., hesperidin), and organic acids (e.g., tartaric acid). These components serve as functional food materials or nutraceuticals, conferring specific health benefits such as disease prevention, bolstering immune function, safeguarding against cardiovascular ailments, cancer, osteoporosis, hypertension, and regulating the aging process.

AIM OF THE STUDY

The aim of this research is to conduct a comparative analysis of the nutritional composition of ogiri, okpei, and dawa dawa, as produced and marketed in Anambra state.

MATERIALS AND METHODS

Collection of sample

Three food condiments (ogiri-igbo from Castor seed Ricinus comminis, Dawa dawa from African locust bean (Parkia biglobosa), and Ogiri-Okpei from Prosopis Africana) that served as samples for analysis were collected from different sellers in Awka, Anambra state.

Proximate, Mineral and Antioxidant vitamin

Proximate and mineral analyses were carried out using Official Methods of Analysis by the Association of Analytical Chemists [11]. Determination of antioxidant vitamins were done using standard methods of [15].

RESULTS AND DISCUSSION

The moisture content (MC) varied among the three samples, ranging from 19.03% in dawa-dawa to 19.95% in Okpei and 20.03% in ogiri. A significant decrease in moisture content ($p<0.05$) was observed, possibly due to the hydrolytic decomposition of protein during fermentation. This trend suggests that melon seeds might have contributed protein, which could have bound and retained free water. The higher moisture content in dawa-dawa samples may imply better shelf stability compared to ogiri and Okpei samples, as they would take longer to dry out and lose flavor. These results are lower than those reported by Ishiwu and Tope (2015) (39.70 to 50.84% and 27.00 to 31.00%), which could be attributed to differences in moisture and protein content of the raw materials and fermentation methods employed. The ash content ranged from 3.26% in dawa-dawa to 3.59% in Okpei and 3.71% in ogiri, indicating a significant decrease ($p<0.05$) in ash content with Okpei and dawa-dawa. This suggests that castor oil bean seeds have higher mineral content than melon seeds. These results are higher than those reported (2.98 to 3.47%), reflecting the total mineral content in the foods and serving as a useful tool for nutritional assessment. The crude protein content increased from 28.12% in dawa-dawa to 23.68% in Okpei and 20.15% in ogiri. This increase could be attributed to the high protein content of melon seeds and the fermentation process. The rise in protein content could be linked to the activities of proteolytic microorganisms during fermentation, leading to the hydrolysis of proteins into different amino acids. The high protein content is significant as it can contribute to dietary protein intake and provide essential nutrients for various bodily functions. Crude fiber content significantly increased ($p<0.05$) from 1.94% in dawa-dawa to 1.26% in Okpei and 1.08% in ogiri, consistent with previous reports. Fiber offers several health benefits, including reducing the risk of chronic diseases such as diabetes and cardiovascular disease. It may also help lower LDL cholesterol levels in the blood. The results suggest that the crude fiber content of ogiri can be enhanced by adding melon seeds. Fat content ranged from 23.19% in dawa-dawa to 17.88% in Okpei and 15.92% in ogiri, slightly higher than the 13.6% reported by Ugwuarua [57] for castor oil bean seed. Fat provides energy, absorbs certain nutrients, and helps maintain body temperature. The increase in fat content during fermentation may be attributed to the heightened activity of lipolytic microorganisms. This increased lipid content is nutritionally significant due to the high caloric value of fats, potentially providing essential fatty acids and fat-soluble vitamins. Carbohydrate content in the ogiri samples decreased significantly ($p<0.05$) from 23.55% in dawa-dawa to 33.58% in Okpei and 40.12% in ogiri, consistent with previous findings.

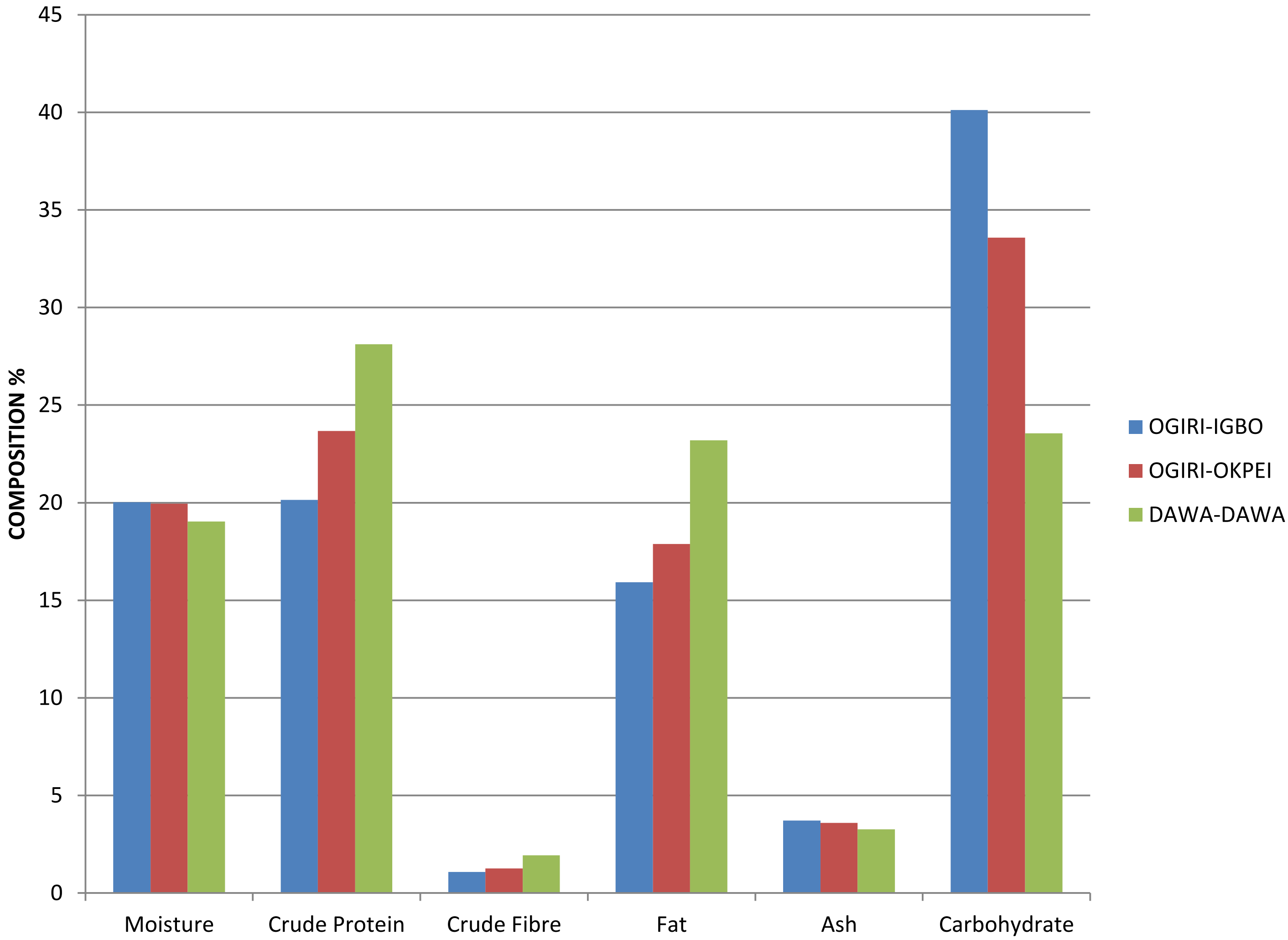
The results of the proximate composition are presented in Table 1.

TABLE 1: PROXIMATE COMPOSITION OF OGIRI, OKPEI AND DAWADAWA PRODUCED AND SOLD IN AWKA (%)

Sample	Moisture	Crude Protein	Crude Fibre	Fat	Ash	Carbohydrate
OGIRI-IGBO	$20.03^{a}\pm0.02$	$20.15^{c}\pm0.01$	$1.08^{c}\pm0.01$	$15.92^{c}\pm0.01$	$3.71^{a}\pm0.01$	$40.12a^{b}\pm0.03$
OGIRI-OKPEI	$19.95^{b}\pm0.02$	$23.68^{b}\pm0.01$	$1.26^{b}\pm0.01$	$17.88^{b}\pm0.01$	$3.59^{b}\pm0.01$	$33.58^{b}\pm0.01$
DAWA-DAWA	$19.03^{c}\pm0.02$	$28.12^{a}\pm0.01$	$1.94^{a}\pm0.01$	$23.19^{a}\pm0.01$	$3.26^{c}\pm0.01$	$23.55^{c}\pm0.01$

*Values are mean scores± Standard deviation of triplicate
*Data in the same column bearing different superscript differ significantly ($p < 0.05$)

FIGURE 1: PROXIMATE COMPOSITION OF OGIRI, OKPEI AND DAWADAWA PRODUCED AND SOLD IN AWKA



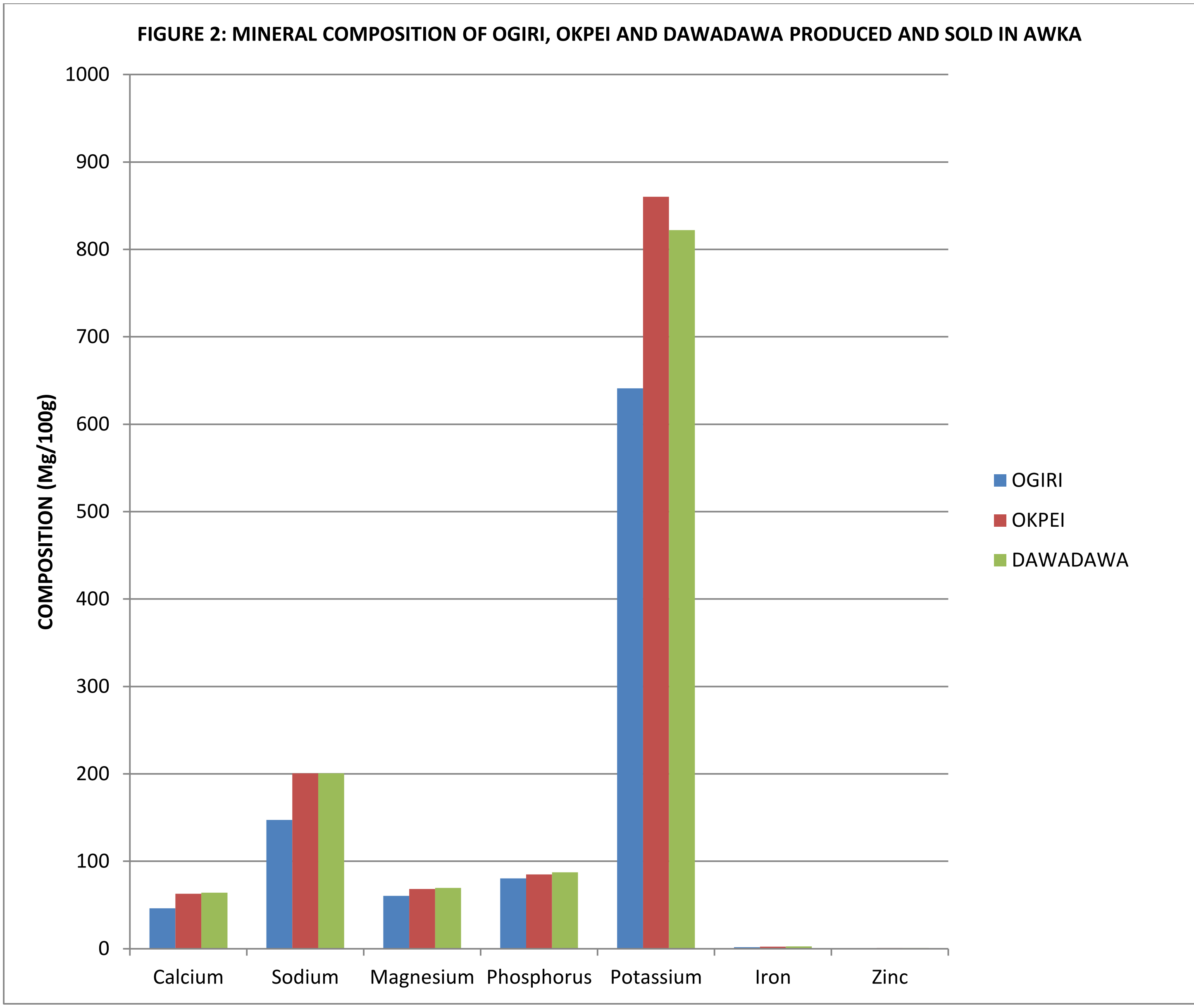
MINERAL COMPOSITION

The mineral composition results are shown in Table 2. The calcium content of the samples exhibited a significant decrease ($p<0.05$), dropping from 64.17% in dawa-dawa to 62.91% in Okpei and 46.11% in ogiri, compared to the values ranging from 125.44 to 345.65 mg/100g, likely due to differences in type and processing methods. Additionally, the addition of melon seed was observed to elevate the calcium content, which is vital for bone and tooth health, nerve transmission, muscle function, blood clotting, and energy metabolism. No significant difference ($p<0.05$) was noted in the sodium content of the samples containing castor oil bean seed with melon seed, ranging from 200.61% in dawa-dawa to 200.53% in Okpei and 147.22% in ogiri. This suggests that variations in sodium contribution between the two levels were not significant ($p>0.05$). Increasing the proportion of melon seed could potentially enhance the beneficial effects of sodium, crucial for nervous system function, muscular contraction, and nerve signaling. Similar to calcium content, the magnesium content of the samples was notably higher in dawa-dawa when melon seed was added. This trend suggests that ogiri and other food materials could be enriched with magnesium through the incorporation of melon seeds. Magnesium collaborates with phosphorus to promote strong bones and teeth, and serves as a cofactor in numerous enzyme systems regulating biochemical reactions related to protein synthesis, muscle and nerve function, blood glucose control, and blood pressure regulation. Phosphorus levels ranged from 87.41% in dawa-dawa to 84.97% in Okpei and 80.3% in ogiri, indicating the increasing impact of melon seed incorporation on the phosphorus content of ogiri. There was a significant ($p<0.05$) difference in phosphorus between all the samples. Phosphorus works synergistically with calcium to form calcium phosphate, the primary mineral component of bones. Potassium was the most abundant mineral in the three ogiri samples, ranging from 822.12% in dawa-dawa to 860.12% in Okpei and 641.02% in ogiri. This suggests that okpei and dawa-dawa could serve as good sources of potassium, essential for the proper functioning of cells, tissues, and organs, as well as for skeletal and smooth muscle contraction. Iron ranked second to last in mineral content among the ogiri samples, ranging from 2.46% in dawa-dawa to 2.37% in Okpei and 2.46% in ogiri. Incorporating melon seed resulted in significant iron improvement. Iron is crucial for transporting oxygen in red blood cells and for energy production within cells. Zinc content was the lowest among the minerals, ranging from 0.82% in dawa-dawa to 0.72% in Okpei and 0.49% in ogiri. There were significant ($p<0.05$) variations in zinc between the samples, with levels increasing with higher melon seed substitution. Zinc is essential for proper immune function, cell division, growth, wound healing, and carbohydrate breakdown.

TABLE 2: MINERAL COMPOSITION OF OGIRI, OKPEI AND DAWADAWA PRODUCED AND SOLD IN AWKA (Mg/100g)

Sample	Calcium	Sodium	Magnesium	Phosphorus	Potassium	Iron	Zinc
OGIRI	$46.11^{c}\pm0.01$	$147.22^{c}\pm0.01$	$60.25^{d}\pm0.01$	$80.33^{d}\pm0.01$	$641.02^{c}\pm0.01$	$1.63^{d}\pm0.01$	$0.49^{d}\pm0.01$
OKPEI	$62.91^{b}\pm0.01$	$200.53^{b}\pm0.72$	$68.13^{c}\pm0.01$	$84.97^{c}\pm0.01$	$860.12^{a}\pm0.02$	$2.37^{c}\pm0.01$	$0.72^{c}\pm0.01$
DAWADAWA	$64.17^{a}\pm0.01$	$200.61^{b}\pm0.01$	$69.33^{b}\pm0.01$	$87.41^{b}\pm0.01$	$822.12^{b}\pm0.00$	$2.46^{b}\pm0.02$	$0.82^{b}\pm0.01$

*Values are mean scores± Standard deviation of triplicate
*Data in the same column bearing different superscript differ significantly ($p < 0.05$)



VITAMIN COMPOSITION

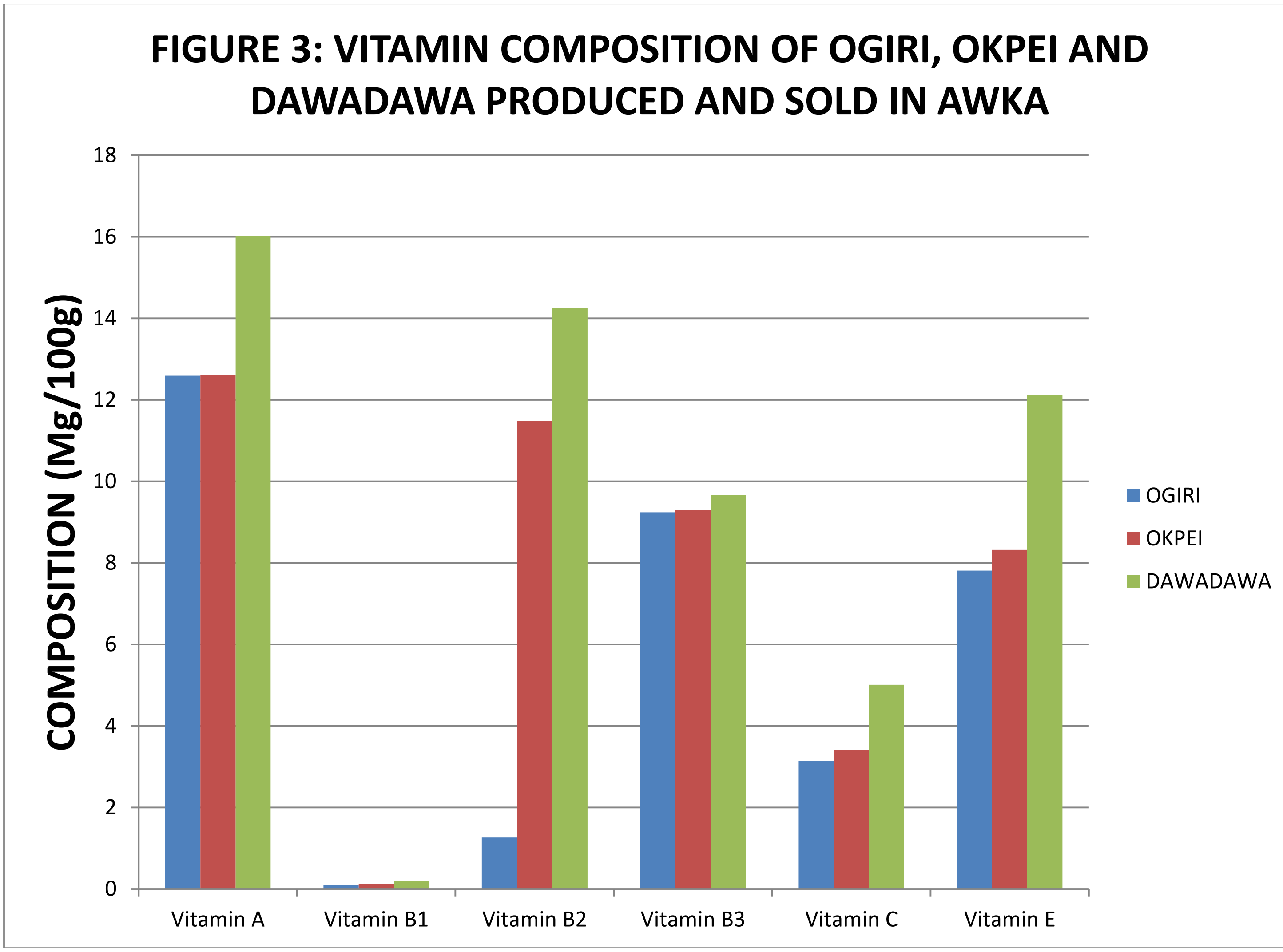
The results of the vitamin composition are presented in Table 3.

The vitamin A content of the ogiri samples increased proportionally with the substitution of melon seeds, rising from 12.59mg/100g in the original ogiri to 12.62mg/100g in okpei and 16.03mg/100g in dawa dawa. This suggests that melon seeds could potentially contain a significant ($p<0.05$) amount of vitamin A. Significant differences ($p<0.05$) were observed between all samples except for samples CBS95:MS5 and CBS90:MS10, which showed similarities. Retinol, a precursor of vitamin A and a fat-soluble antioxidant, is crucial for maintaining healthy vision, neurological function, skin health, and immune support. It also aids in reducing inflammation by combating free radical damage. The vitamin B1 content varied from 0.19% in dawa-dawa to 0.12% in okpei and 0.10% in ogiri, indicating that melon seeds might contain more vitamin B1 than castor oil bean seeds, potentially improving the vitamin B1 content of ogiri when added above 10%. Vitamin B2 significantly increased ($p<0.05$) with higher melon seed substitution, rising from 4.26% in dawa-dawa to 1.48% in okpei and 1.26% in ogiri. This increase could be attributed to the higher inclusion of melon seeds, known as a good source of B-complex vitamins necessary for growth, heart function, nervous system health, and cellular respiration. Similarly, vitamin B3 increased with melon seed substitution, ranging from 9.96% in dawa-dawa to 9.31% in okpei and 9.24% in ogiri, all higher than the control value (9.21 mg/100g). This suggests that melon seeds are a better source of vitamin B3 than castor oil bean seeds. The vitamin C content varied from 5.01% in dawa-dawa to 3.41% in okpei and 3.14% in ogiri, with an observed increase in ogiri samples with melon seed inclusion. This increase is beneficial for bone and joint development, blood purification, and acting as an antioxidant. Furthermore, the vitamin E content was highest in dawa dawa samples with melon seed, ranging from 12.11% in dawa-dawa to 8.32% in okpei and 7.81% in ogiri. Vitamin E acts as a potent antioxidant, preventing damage by free radicals to cellular components such as proteins, DNA, and lipids. It may also prevent oxidation of low-density lipoprotein cholesterol, potentially playing a role in preventing cardiovascular diseases and cancer, maintaining cellular functionality, inhibiting cell proliferation, and enhancing immune function. Overall, the results suggest that the studied samples could serve as viable sources of essential vitamins capable of combating free radicals in the human body.

TABLE 3: VITAMIN COMPOSITION OF OGIRI, OKPEI AND DAWADAWA PRODUCED AND SOLD IN AWKA (Mg/100g)

Sample	Vitamin A	Vitamin B_1	Vitamin B_2	Vitamin B_3	Vitamin C	Vitamin E
OGIRI	$12.59^b \pm 0.01$	$0.10^d \pm 0.00$	$1.26^b \pm 0.01$	$9.24^c \pm 0.00$	$3.14^c \pm 0.01$	$7.81^c \pm 0.01$
OKPEI	$12.62^b \pm 0.01$	$0.12^c \pm 0.01$	$1.48^b \pm 0.01$	$9.31^b \pm 0.01$	$3.41^b \pm 0.01$	$8.32^b \pm 0.01$
DAWADAWA	$16.03^a \pm 0.01$	$0.19^a \pm 0.01$	$4.26^a \pm 0.01$	$9.66^a \pm 0.01$	$5.01^a \pm 0.01$	$12.11^a \pm 0.01$

*Values are mean scores± Standard deviation of triplicate
*Data in the same column bearing different superscript differ significantly ($p < 0.05$)



CONCLUSION

The nutritional analysis of ogiri derived from castor seed, okpei made from African oil bean seed, and dawa dawa from melon seed reveals that all three variants are abundant in crude protein, crude fiber, fat, ash, essential minerals, and vitamins. Notably, melon seed exhibits the highest concentration of all minerals and vitamins. This investigation confirms the viability of incorporating melon seed into ogiri production to enhance its nutritional value and health benefits. Furthermore, dawa dawa exhibits significant nutritional properties, serving as a rich source of protein, carbohydrates, and essential trace elements like Calcium, Magnesium, Phosphorus, Sodium, and Potassium. It also acts as a flavor enhancer, contributing to the sensory appeal of dishes, and possesses herbal and medicinal qualities, as demonstrated through experimental analysis detailed in chapter four of this research. The chemical composition, including both macro and micro-nutrients, encompasses moisture content, dry matter, ash, crude protein, fat, oil, fiber, and carbohydrates. Additionally, essential dietary trace elements such as Calcium, Magnesium, Phosphorus, Sodium, and Potassium are identified as constituents of dawa dawa.

RECOMMENDATIONS

Researchers suggest implementing the following crucial steps to optimize the utilization of ogiri, okpei, and dawadawa efficiently: Modernize the production process of dawadawa, turning it into a consumer product. It is vital to package the product in a more appealing form for commercial purposes. Emphasize the nutritional value of dawadawa, underscoring the need for widespread public adoption and use. Advocate government support for producers, encouraging institutions like SHS boarding schools to incorporate dawadawa into their food preparations.

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CITE AS: Ejimofor, Chiamaka Frances and Adaugo Ozioma Nwakuche (2024). Nutritional Analysis of Traditional Fermented Food Condiments: Implications for Dietary Diversity and Health Security in Anambra Metropolis. IAA Journal of Biological Sciences 12(1):99-110.
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