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Nutrients and Antioxidant Composition of Local Condiment "Ogiri" Produced from Different Leguminous Seeds

Aniebiet Timothy. A [a*], Burba, Rimamtsiwe Adi [b,c], Roland-Ayodele M.A [d] and Olanrewaju, O.I [c,d]

[a] *Department of Chemistry, Akwa Ibom State University, Ikot Akpaden, Akwa Ibom State, Nigeria.*
[b] *Department of Home Economics, Faculty of Agriculture, Taraba state university, Jalingo, Nigeria.*
[c] *Human Nutrition and Dietetics Department, Afe Babalola University, Ado-Ekiti, Nigeria.*
[d] *Nutrition and Dietetics Department, Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

'Ogiri' refers to a fermented oily paste that is used as soup condiments for its strong smell. Apart from the fact that it's mostly used in soup preparation because of the strong pungent odour and organoleptic properties, it also impact nutrients to soup. This study investigated the nutrients and antioxidant composition of Ogiri produced from different leguminous seeds. Raw material such as melon (EGU) and sesame (SES) seeds were procured from Oja Oba (Oba Market) in Owo, Ondo State while pumpkin (PUM) and Castor (CAS) seed were purchased at Upper Iweka market, Onitsha Anambra State, Nigeria. The raw materials were processed into 'Ogiri' using traditional methods and were subjected to chemical analysis using standard analytical methods." Data

**Corresponding author: Email: aakpakpan@gmail.com;*

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generated were subjected to One-way Analysis of Variance (ANOVA) and means were separated using Duncan Multiple Range Test at 5% level of significance. Findings shows that the moisture content was significantly (P<0.05) higher in PUM than any other sample. Sample SES was significantly (P<0.05) higher in Ash (10.22g /100g) content, and fibre (11.21g/100g) while EGU was significantly (P<0.05) higher in fat (30.17g/100g) and protein (29.30g/100g). CAS had the highest carbohydrate content (27.58g/100g).Minerals result shows that Na (14.835mg/g), Ca (22.570mg/100g) and Mg (3.351mg/100g) were significantly (P<0.05) higher in sample EGU. Sample SES was significantly higher in K (55.855mg/100g) and Zn (0.308mg/100g), while CAS was significantly lower (P<0.05) in Na (3.45mg/100g), Ca (13.15mg/100g) K, (21.655mg/100g), Zn (0.128mg/100g) and Mg (1.925mg/mg) but has the highest value in P (12,252mg/100g). PUM was significantly higher in Vitamin E (8.270mg/100g), while CAS was significantly higher in vitamin A (7.576UI/g). Sample PUM had the highest Polyphenol and Terpenoid content (106.82mg/g and 1.37mg/g respectively) while sample SES had the highest steroid content (0.92mg/g). In conclusion, this study revealed that the nutrients and antioxidant properties of the "Ogiri" samples vary proportionately. The results can guide farmers, processors, and consumers in making informed decisions regarding seed selection and Ogiri preparation.

Keywords: Ogiri; condiment; proximate; minerals; vitamin; antioxidant; leguminous seeds.

1. INTRODUCTION

Condiments are food ingredients particularly used for adding taste or flavour to food (Kevin et al., 2021). One of the ways to make a meal balanced is to improve the nutrient content of the soup. Fermented food condiments are cheap sources of plant protein with improved nutrients, enhanced flavour and possess bioactive compounds (Ifesan et al., 2019). Condiments constitute an essential part of the human diet in various cultures from different parts of the world. They are mostly of two types: fermented and non-fermented food condiments. They are particularly produced from leguminous plants and oilseeds. Common fermented Nigerian condiments include Ogiri from castor oil bean (*Ricinus communis*) or melon seed (*Citrullus vulgaris*), 'iru' or 'daddawa' from African locust bean (Parkia biglobosa), 'okpei' from mesquite seed (*Prosopis africana)* and 'ugba' from African oil bean (*Pentaclethra macrophylla*).

"Ogiri is a traditional oily paste fermented condiment which possesses a characteristic strong smell, ammoniacal flavour that enhances the taste and flavour of traditional delicacies in Nigeria" (Nnennaya et al., 2020). "It possesses very strong pungent odour and organoleptic properties which depend on microbial activities on the seed during fermentation. It is mostly used in soup preparation to impact unique aroma and taste. Ogiri is best known in West Africa. It is popular among the Yoruba and Igbo people of Nigeria. It is a product prepared by traditional method of uncontrolled solid state fermentation of seeds involving the use of natural inoculation or chance fermentation. This fermentation process is known to enhance the palatability, increases protein value, vitamin content and mineral levels of such condiments. It increases variety in the diet, improves nutritional value, reduces anti-nutritional compounds and in some cases, it improves functional properties" (Adebayo 2018, Ezekiel et al., 2015).

"The processing of foods by fermentation has excellent advantages such as the elimination of undesirable flavours and odours, production of a good flavour, increased digestibility, and synthesis of desirable constituents and changes in physical state, longer shelf-life and destruction of inhibitors. Health benefits of fermented condiments include reduction of high cholesterol levels in the blood as well as the ability to fight and prevent tuberculosis, cancer and cardiovascular complications by boosting body immune" (Chukwu et al., 2018). The anti-nutritional factors in the oilseeds are reduced through fermentation, while flavour compounds, digestibility and nutritive value are improved and developed (Ahaotu et al., 2020). Apart from regular melon seed (*Citrulus lanatus)* used for "Ogiri" preparation, it can also be produced from castor oil seeds (*Ricinus cummunis*), fluted pumpkin (*Telfairia occidentalis*) and Soybeans (*Glycine max*). These other seeds which are underutilized can serve as alternative substrates for the production of Ogiri" thereby increasing their utilisation (Ajala and Akinterinwa, 2016, Dimejesi and Odibo 2017). "In recent years, plant proteins have been playing significant roles in combating food insecurity in developing countries where average protein intake is less than required. The prevailing population pressure in Nigeria has resulted in an increasing demand for wild underexploited nutritious plant products with organoleptic appeal in the daily diet. This led to the focus on uncommon seeds for possible development and use, in the search for novel sources to complement the traditional ones and due to inadequate supplies of food proteins, there has been a constant search for unconventional legumes or oilseeds as new protein sources for use as functional supplements. Modern researches have thus focused more on oilseed crops as largely unexploited sources of food crops" (Ahaotu et al., 2020). This study unravel the Nutrients and antioxidant composition of local condiment made from different leguminous seeds.

2. METHODOLOGY

The raw materials which include: Sesame seed, Melon seed, and other ingredient that used in his study were purchased from Oja Oba (Oba Market) in Owo, Ondo State while Pumpkin and Castor seeds were purchased at Upper Iweka market, Onitsha Anambra State, Nigeria. It was then taken to Diet Kitchen, Nutrition and Dietetics Department, Rufus Giwa Polytechnic Owo for processing.

2.1 Preparation of Samples

2.1.1 Preparation of Ogiri from castor seed

Castor seeds were thoroughly sorted and washed. The seed was dehulled and washed and the dehulled seed was wrapped in plantain leaves. The wrapped dehulled seed was boiled for about 9–18 hours. It was allowed to cool and ferment. The fermented seed was unwrapped and milled into a paste using a mortar and pestle. It was then be packaged in a fresh blanched leaves and allow to age under the sun for 3 days before it was subjected to chemical analysis".

Undehulled melon seeds was properly washed and boiled for 3h and dehulled. The cotyledon was wrapped tightly in layer of blanched short banana leaves (*Musa sapietum*) and then perforated with fork. The wrapped cotyledon was then boiled for 2hours, and was placed on a wire mesh to drain for 1hour. The wrapped cotyledon was then left to ferment at the prevailing ambient temperature (28ºc) four days. At the end of the fermentation period, the seeds were pounded in a laboratory mortar and pestle into a paste. The paste was then wrapped in little portions with banana leaves.

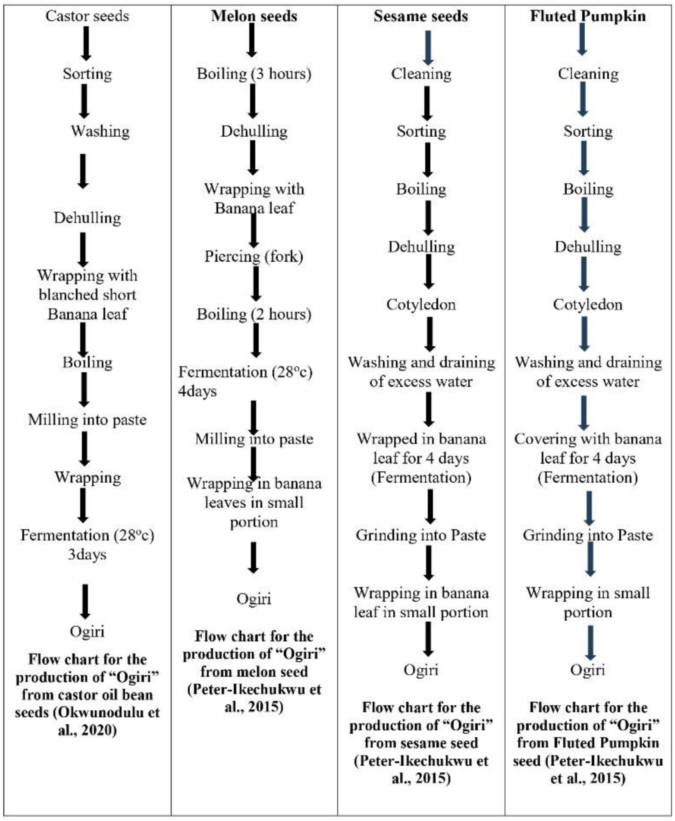

Fig. 1. Flow chart for the production of "Ogiri" from four different leguminous seeds
Preparation of *Ogiri* from Melon seed

2.1.2 Preparation of Ogiri from sesame seed

Sesame seeds were sorted, washed and cleaned thoroughly in clean water. The seeds were cooked until they get softened so that the seeds coverings can easily be peeled off. Afterwards, the cotyledons was washed and poured in a sieve to drain excess water. Then the cotyledons was placed into a vessel then covered with local leaves (banana leaves) and was allowed to stay for 4 days to undergo fermentation. To hasten up the fermentation process the vessel was placed under sunlight. Once the fermentation process was complete, the fermented seeds were grounded into a smooth thick paste, and were mould into small balls and packaged.

2.1.3 Preparation of Ogiri from fluted pumpkin seed

Pumpkin seed was sorted, washed and cleaned thoroughly in clean water. The seed was cooked until they get softened so that the seeds coverings can easily be peeled off. Afterwards, the cotyledons was washed and poured in a sieve to drain excess water. Then the cotyledons was placed into a canister or vessel then cover with local leaves (banana leaves) and was allowed to stay for at least 4 days to undergo fermentation. To hasten up the fermentation process the vessel was placed under sunlight during the process of fermentation. Once the fermentation process is complete, the fermented seeds were grounded into a smooth thick paste, and were mold into small balls and packaged.

2.2 Methodsof Chemical Analyses

2.2.1 Proximate analysis

The moisture, ash, protein, crude Fibre and crude fat were determined according to AOAC (AOAC, 2010). Protein conversation factor of 6.25 was used to convert Nitrogen content to crude protein, while the carbohydrate content was determined by difference. The percentage total carbohydrate was estimated to be equal to the sum of percentage moisture, protein, ash and fibre subtracted from 100g.i.e % carbohydrate = 100%- protein (%), + fat (%) + crude fibre (%) +ash (%).

2.2.2 Mineral analysis

Analysis of phosphorus was determined by the phosphovanado-molybdate method of AOAC (AOAC, 2010), while Calcium, sodium, Magnesium, potassium and Zinc content of each sample was estimated using the method of AOAC, (2010). Two grams of each sample was ash in muffle furnace at 550ºC for 6 to 8 hours. The ash was dissolved with HCl. The analysis of sodium, calcium, potassium, magnesium, and zinc was carried out with a Buck Model 210 VGP atomic absorption spectrometer, USA. Air-acetylene the flame was used and hollow cathode individual metals was the resonance line source. The calibration plot method was adopted for the analysis. For each element, the instrument was auto zeroed using the blank (de-ionized water) after which the standard was aspirated into the flame starting from the lowest concentration. The corresponding absorbance values were obtained and the graph of absorbance against concentration was plotted by the instrument. The digested samples were analyzed in duplicates with the average concentration of the metal present being displayed in part mg/g the instrument after extrapolation from the standard curve.

2.3 Vitamin Analysis

2.3.1 β- Carotene and α- tocopherol determination

The procedure adopted in this study make used of hexane for the extraction process instead of the normal petroleum ether (AOAC, 2010). This protocol agrees (Nyambaka and Ryle, 2001) method. In each extraction 2g of the mashed samples were used. The extracts were purified and diluted to a standard volume of 25 ml in the mobile phase constituted as methanol; dichloromethane; water (79:18:3). Three extractions were done in duplicate for each Ogiri. The extracts were filtered using a 0.45 micro millipore filter before 30 µl were injected in a HPLC (Hitachi, model L4000H), pump (L6000), RP C18 column (25 cm x 4.5 mm)) rate set at 1 ml / min with a UV/Visible detector at 450 nm for β-carotene and 470 nm α-Tocopherol

2.4 Determination of Polyphenol

Polyphenol content of the Ogiri samples was determined using the Folin- ciocalteu method (Ghorai et al., 2012) while Terpenoid was determined by the method described by Ghorai et al., (2012) Steroid was quantitatively determined by a modified method of Francesca et al., (2022).

2.5 Statistical Analysis

All data obtained from the analysis of the samples was subjected to statistical analysis using Statistical Package for social sciences version 16 software package and expressed as

Mean ± Standard deviation for duplicate experiment. One-way analysis of variance (ANOVA) was used for the analysis and means separation was done using Duncan Multiple Range Test method to determine the significant differences at 5% (0.05) level of significance.

3. RESULTS

Table 1 shows the proximate composition of the condiment samples. Moisture content ranged from 14.52±0.00-19.17±0.00 %. Sample CAS had the lowest value of moisture content (14.52+0.00%) while sample PUM had the highest value of moisture content (19.17±0.00%) with significant dish content ranged from 5.41±0.00-10.22±0.00%. Sample SES had the highest value of ash content (10.22±0.00%) while sample EGU had the lowest value of ash content (5.41±0.00%) when compared with other samples. The fibre content ranged from 7.53±0.00%-11.21±0.00% respectively. Sample SES had the highest value of fibre content (11.21±0.00%) while sample EGU had the lowest value of fibre content (7.53±0.00%) with significant difference. The protein content ranged from 20.7±0.00%- 29.30±0.00% respectively. Sample EGU had the highest value of protein content (29.30±0.00%) while sample CAS had the lowest value of fibre content (20.71±0.00%) with significant difference ($p>0.05$) respectively. The carbohydrate content ranged from 10.85±0.02- 27.58+0.00%. Sample EGU had the lowest value of carbohydrates content (10.85±0.02%) while sample CAS had the highest value of carbohydrates content (27.58±0.00%) with significant difference ($p>0.05$) respectively.

3.1 Mineral Composition of the Samples

Table 2 shows the mineral composition of 'Ogiri' produced from different seeds. Sample EGU was significantly ($P<0.05$) higher in sodium (14.83±0.21mg/g), calcium (22.57±0.28mg/g and magnesium (3.351±0.00mg/g) while sample SES was significantly ($P<0.05$) higher in potassium (55.855±0.50mg/g) and zinc (0.308±0.01mg/g). The phosphorus (12.525±0.00 mg/g) content of the sample was significantly ($P<0.05$) higher in CAS sample.

3.2 Vitamin and Anti-Oxidant Composition

Table 3 shows the Vitamin and anti-oxidant composition of Ogiri produced from different seeds. The table revealed that vitamin A (7.576±0.01 iu/100g) was significantly ($P<0.05$) higher in CAS sample compared with other sample. Sample PUM was significantly ($P<0.05$) higher among the samples in vitamin E (8.270±0.00 mg/100g), polyphenol (121.57±0.00 mg/100g), and steroid (1.51±0.01mg/100g) while sample EGU was significantly ($P<0.05$) higher in Terpenoid (2.19±0.01mg/100g). Sample SES was significantly ($P>0.05$) lower in vitamin A, polyphenol, steroid and Terpenoid.

Table 1. Proximate composition of condiment samples

Parameters (%/100g)	CAS	EGU	SES	PUM
Moisture	14.52±0.002^{d}	16.72±0.009^{b}	15.38±0.009^{c}	19.17±0.004^{a}
Ash	6.34±0.005^{c}	5.41±0.002^{d}	10.22±0.004^{a}	6.58±0.012^{b}
Fat	22.51±0.004^{d}	30.17±0.009^{a}	25.64±0.003^{c}	28.79±0.011^{b}
Fibre	8.31±0.004^{b}	7.53±0.002^{c}	11.21±0.004^{a}	6.73±0.010^{d}
Protein	20.71±0.002^{d}	29.30±0.007^{a}	21.65±0.002^{c}	24.28±0.004^{b}
Carbohydrate	27.58±0.002^{a}	10.85±0.026^{d}	15.88±0.019^{b}	14.42±0.002^{c}

Values are mean ± standard deviation of duplicate analysis. Values with the same superscript in the same row are statistically not significant at (p<0.05). Key: CAS: Ogiri from Castor seed, EGU: Ogiri from Melon seed, SES: Ogiri from Sesame seed and PUM: Ogiri from Pumpkin seed

Table 2. Mineral compositions of the samples (mg/100g)

Parameters (mg/100g)	CAS	EGU	SES	PUM
Sodium (Na)	3.450±0.42^{d}	14.835±0.21^{a}	10.275±0.07^{b}	7.775±0.21^{c}
Calcium (Ca)	13.150±0.28^{d}	22.570±0.28^{a}	20.235±0.50^{b}	19.540±0.14^{c}
Potassium (K)	21.655±0.50^{d}	37.220±0.28^{b}	55.855±0.50^{a}	29.070±0.14^{c}
Zinc (Zn)	0.128±0.00^{d}	0.258±0.00^{b}	0.308±0.01^{a}	0.218±0.00^{c}
Magnesium (Mg)	1.925±0.00^{d}	3.351±0.00^{a}	2.788±0.01^{b}	2.457±0.00^{c}
Phosphorus (P)	12.525±0.00^{a}	6.793±0.00^{d}	11.421±0.00^{b}	9.524±0.00^{c}

Values are mean ± standard deviation of duplicate analysis. Values in the same superscript in the same row are statistically not significant at (P<0.05). Key: CAS: Ogiri from Castor seed, EGU: Ogiri from Melon seed, SES: Ogiri from Sesame seed and PUM: Ogiri from Pumpkin seed

Table 3. Vitamin and Antioxidant composition of the samples

Parameters	CAS	EGU	SES	PUM
Vitamin A (IU/g)	7.576 ± 0.01^a	4.218 ± 0.00^c	2.957 ± 0.00^d	5.177 ± 0.00^b
Vitamin E (mg/g)	6.910 ± 0.01^b	3.518 ± 0.01^d	3.808 ± 0.00^c	8.270 ± 0.00^a
Polyphenol (mg/g)	75.31 ± 0.01^c	106.82 ± 0.01^b	69.17 ± 0.01^d	121.57 ± 0.00^a
Steroid(mg/g)	0.92 ± 0.00^c	1.21 ± 0.01^b	0.63 ± 0.01^d	1.51 ± 0.01^a
Terpenoid (mg/g)	1.37 ± 0.00^c	2.19 ± 0.01^a	0.94 ± 0.00^d	1.82 ± 0.00^b

Values are mean ± standard deviation of duplicate analysis. Values in the same superscript in the same row are statistically not significant at (P<0.05). Key: CAS: Ogiri from Castor seed, EGU: Ogiri from Melon seed, SES: Ogiri from Sesame seed and PUM: Ogiri from Pumpkin seed

4. DISCUSSION

The moisture contents obtained in all the samples in this study were lower than the reports value by Achi, (2010) in their study, on traditional fermented protein condiments in Nigeria. This may be attributed to sample source or method of processing. The decrease in the moisture content of samples in this study could be attributed to increase in protein content as a result of the fact that all the raw for the samples were leguminous plan which contained high content of protein which has more affinity to moisture than carbohydrate (Mutiat et al., 2017). The implication of the lower moisture content found in sample CAS will have a longer storage time than the other samples. However, high moisture content affects the shelf- life which leads to spoilage over a short period of time unless the product undergoes drying to further reduce the moisture content (Okpo et al. 2022). Reduced moisture content indicates better storage potential because microorganisms require water for their activities (Okpo et al. 2022). The ash content ranged from 5.41%-10.22%. Sample SES had the highest value of ash content (10.22%) while sample EGU had the lowest value of ash content (5.41%) with significant difference (p>0.05) respectively. This high ash content translates into high mineral contents or this might be due to the high amount of mineral present in sesame seed. However, the result obtained from this study was higher than the result obtained by Akinyele and Oloruntoba, (2013). The high ash content of all the condiment samples is indication of the high mineral contents of the castor seed, melon seed, sesame seed and pumpkin seeds, although the mineral composition vary in different proportions. These minerals are required for body regulation and bone formation. The fibre content ranged from 7.53%-11.21% respectively. Sample SES had the highest value of fibre content (11.21%) while sample EGU had the lowest value of fibre content (7.53%). High fibre aids stool transition, digestion and water retention in the human system (Oboh et al., 2005). The difference in fibre content of the condiment may be attributed to the differences in the composition of the seeds used (Oboh et al., 2005). However the result obtained from this study was higher than the result obtained in the study reported by (Okwunodulu et al., 2020). This might be due to the different seed used in this study. The protein content ranged from 20.7%- 29.30% respectively. All the samples had an appreciable amount of protein this might be due to the fact that all the samples were leguminous plant. Although, Sample EGU had the highest value of protein content while sample CAS had the lowest value of protein content. The protein contents of EGU condiment were higher than the result obtained in a similar study Akinyele and Oloruntoba, (2013). Although, the values were generally higher than the commonly consumed plant foods in Nigeria like cassava products, yam tubers and leafy vegetables (Okwunodulu et al., 2020). This high protein content in these condiments suggests that they could be a good and cheap source of dietary protein, where animal proteins are presently highly unaffordable to many of the populace. The carbohydrate content ranged from 10.85%-27.58%. Sample EGU had the lowest while sample CAS had the highest value of carbohydrates. However, the result obtained from this study was lower than the result obtained by Akinyele and Oloruntoba (Akinyele and Oloruntoba, 2013). This might be due to the specie of pumpkin seed and other seed used for their samples.

The value of sodium content in this study varied across all samples. Sample EGU shows the highest sodium while sample CAS has the lowest sodium content. The value obtained in sample CAS was lower than (147.22mg/g) reported Ikechukwu (Ikechukwu et al., 2020) in their study on Nutritional property of indigenous fermented condiments. Sodium obtained from PUM is higher than the value (0.015mg/g) reported by Ogbuonye, (2018) in their study on Nutritional composition and anti-oxidative potentials of fermented fluted pumpkin seed (Ogiri). All results of sodium obtained from this study is lower than the value (113mg/g) reported by EFSA in his study on Chemical and microbial evaluation of *Ogiri*. This variation could be due to high sodium content present in groundnut seed. This low sodium content of Ogiri could serve as a good condiment for people with hypertension. Sodium is an essential nutrient involved in the maintenance of normal cellular homeostasis and in the regulation of fluid and electrolyte balance and blood pressure (BP) (Strazzullo and Leclercq, 2014). Appreciable amount of calcium (Ca) which is one of the major minerals our bodies need in relatively larger amounts to keep healthy was found in this study. These values are higher than value (0.74mg/g) obtained by Adebayo et al., (2019) in their study on *Ogiri* produced from watermelon seed. However, the values obtained in this study were lower than (108mg/g) obtained by EFSA (2019). This variation could be due to different seeds used in the preparation of *ogiri*. Yu and Sharma (2023) Reported a value of 0.10mg/g for calcium in their study on Nutritional value and safety of castor bean seed detoxified in solid-state fermentation, this value is lower compared to the value 13.150mg/g obtained in this study. The calcium content of sample PUM in this study is higher than the value (0.28mg/g) reported by Ogbuonye (2018) in their study. This difference could be as a result of fermentation duration. This study revealed that sample EGU could be a better source of calcium compared to other samples. Calcium, together with phosphorus, is needed to form and keep our bones and teeth strong. Calcium is also a key element to activate different enzymes and helps our bodies release hormones (EFSA, 2015, Dogan et al., 2019). Potassium (K), one of the body's electrolytes found in this study is higher than the value 1.08mg/g obtained in *Ogiri* produced from watermelon seed as reported by Adebayo (2019). The potassium content found in sample EGU is higher than the value (1.11mg/g) obtained by Adebayo, (2019) in their study on Effect of fermentation on the anti-nutritional factors and mineral composition of melon seed varieties for *Ogiri* production. The value 29.070mg/g reported in sample PUM was lower to the value 77mg/g reported by Ogbuonye (2018) in their study. The 27.93mg/g obtained by EFSA, (2019) was lower than the value obtained from sample EGU, SES and PUM but higher than the value obtained from sample CAS. This variation could be as a result of different nutritional makeup of the seeds. Potassium is required for proper fluid balance, nerve transmission and muscle contraction. It acts as a vasodilator, reduces blood constriction, and lowers blood pressure (Yusuf et al., 2014, Hou et al., 2021). The zinc content found in this study ranged between 0.128mg/g and 0.308mg/g. This shows that *Ogiri* from Melon, Sesame, Pumpkin and Castor seed have a trace amount of zinc. The values obtained in this study are comparably with the value 0.29mg/g obtained by Adebayo et al., (2019). Okwunodulu, et al. (2020) and Adebayo, et al., (2019) reported value 0.49mg/g and 0.69mg/g respectively for *Ogiri* produced from Castor bean, these values were higher than the value obtained from this study. The value of zinc reported in this study for sample EGU is similar to the value 0.31mg/g reported for *ogiri* from Melon seed by Strazzullo and Leclercq, (2014). Zinc (Zn) is an essential cofactor of more than 70 enzymes. Its deficiency is ranked in the top five risk factors of disease and death in developing countries (Yusuf et al., 2014, Hou et al., 2021). Magnesium content found in this study was lower than the value (0.84mg/g) reported by Adebayo et al., (2019) on their study on *ogiri* from watermelon seed. The value reported for sample CAS in this study is lower to the value 6.86mg/g and 7.16mg/g reported by Ezekiel (2018) in their study on Nutritional value and safety of castor bean seed. The magnesium content of sample EGU higher than the value 0.94mg/g reported by Adebayo et al., (2019) in their study on *ogiri* from Melon seed. Sample PUM magnesium content in this study is higher than the value (0.650mg/g) reported by Yu, (2023) in their on *ogiri* produced from pumpkin. Magnesium is found in bones, and is required for production of protein, muscle contraction, nerve transmission, and immune system health (Berdanier and Berdanier, 2015, NIH, 2021).

Phosphorus is found in every cell; important for healthy bones and teeth, and part of the system that maintains acid-base balance. The phosphorus content found in sample PUM in this study is higher than value 2.4mg/g reported by Okwunodulu et al., (2020) in their study on *ogiri* produced from pumpkin seed. However, phosphorus content found across all samples in this study is lower than the value (37.90mg/g) reported by Ikechukwu et al., (2020). This variation could be due to different seeds used in the preparation of *ogiri*. Phosphorus is found in every cell; important for healthy bones and teeth, and part of the system that maintains acid-base balance (Arukwe and Onyeneke, 2020).

The vitamin composition of ogiri produced from castor, melon sesame and pumpkin seeds. The Vitamin A as seen in the Table 3 range from 2.957 IU/100g to 7.576 IU/100g, CAS (castor ogiri sample) was observed to have the highest value of 7.576 IU/100g while the least was found in SES sample. PUM was also found to have the highest value for vitamin E. The result reported in this study was lower than the reported value by (Awuchi, 2019) for Ogiri produced from Melon and Groundnut Seeds. Polyphenol are a diverse group of plant secondary metabolites that possess various biological activities, including anti-oxidant, anti-inflammatory, and anti-cancer properties (Adeyemo et al., 2013). They are known for their ability to scavenge free radicals and protect cells from oxidative damage (Adeyemo et al. 2013). In the study, samples under investigation had an appreciable amount of Polyphenol content higher than the reported value by James and Engelmann, (2017) on the anti-oxidant properties of different seeds. This study also reveals that Ogiri produced from sample SES had the highest steroid content. Steroids are a group of organic compounds with a specific four-ring structure. They have various biological functions, including hormone regulation and anti-inflammatory effects (Croteau et al., 2012). In this study, the vales obtained from Terpenoid were significantly higher in Ogiri produced from sample PUM. Terpenoid are a large and diverse group of organic compounds derived from isoprene units. They exhibit a wide range of biological activities, including anti-oxidant, anti- inflammatory and anti-cancer properties (AOAC, 2012).

5. CONCLUSION

This study revealed Ogiri being one of the traditional and ancient condiment used in soup sweetening can be produced from other leguminous plants not limited to melon seed only. Although, the nutrients and antioxidant properties of the "Ogiri" samples vary proportionately, but, EGU sample still content the highest protein and fat content while sesame seed was richer in fibre. Mineral constituent such as sodium, calcium and magnesium were higher in EGU while Zinc and potassium was higher SES sample. CAS sample was more in phosphorus and vitamin A. PUM was significantly higher in Polyphenol, vitamin E and steroid. The results can guide farmers, processors, and consumers in making informed decisions regarding seed selection and Ogiri preparation.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

Achi, O. K. (2010). Traditional fermented protein condiments in Nigeria. *African Journal of Biotechnology*, *4*(13), 1612–1621. https://doi.org/10.5897/AJB2010.000-3132

Adebayo, F. (2018). Microbiological profile of 'Ogiri' condiment made from seeds of watermelon (*Citrullus lanatus*). *Asian Food Science Journal*, *1*(1), 1–9.

Adebayo, O. C., Ogidi, C. O., & Akinyele, B. J. (2019). Nutritional value and safety of castor bean (*Ricinus communis*) seeds detoxified in solid-state fermentation by *Pleurotus ostreatus*. *Biofarmasi: Journal of Natural Products and Biochemistry*, *17*(2), 51–60.

Adeyemo, A. A., Adeyemo, A. A., & Adeyemo, O. A. (2013). Antihypertensive effects of *Vernonia amygdalina* leaf aqueous extract in spontaneously hypertensive rats. *Journal of Ethnopharmacology*, *147*(2), 440–446. https://doi.org/10.1016/j.jep.2013.03.002

Ahaotu, N., Echeta, C., Evelyn, B., Awuchi, C., Anosike, C., Ibeabuchi, C., & Ojukwu, M. (2020). Study on the nutritional and chemical composition of "Ogiri" condiment made from sandbox seed (*Hura crepitan*) as affected by fermentation time. *GSC Biological and Pharmaceutical Sciences*, *11*(02), 105–113.

Ajala, A. S., & Akinterinwa, O. E. (2016). Quality evaluation of tunnel dried 'Ogiri'. *Journal of Biotechnological Research*, *1*(2), 81–88.

Akinyele, B. J., & Oloruntoba, O. S. (2013). Comparative studies on *Citrullus vulgaris*, *Citrullus colocynthis*, and *Cucumeropsis mannnii* for Ogiri production. *British Microbiology Research Journal Science*, *3*(1), 1–18. https://doi.org/10.9734/BMRJ/2013/1602

AOAC. (2010). *Official methods of analysis* (17th ed.). Washington Association of Official Analytical Chemists. D.C., USA.

AOAC. (2012). *Official method of analysis: Association of Analytical Chemists* (19th ed.). Washington, D.C.

Arukwe, D. C., & Onyeneke, E. N. (2020). Evaluation of mineral, vitamin, and phytochemical composition of Ogiri from melon and groundnut seeds. *Nigerian Food Journal*, *38*(2), 46–52.

Awuchi, C. G. (2019). Medicinal plants: The medical, food, and nutritional biochemistry and uses. *International Journal of Advanced Academic Research*, *5*(11), 220–241.

Berdanier, C. D., & Berdanier, L. A. (2015). *Advanced nutrition: Macronutrients, micronutrients, and metabolism*. CRC Press.

Chukwu, M. N., Nwakodo, C. S., Alozie, Q., & Ndulaka, J. C. (2018). Comparative studies on organoleptic properties of Ogiri-Ahuekere and Ogiri-Egusi condiments. *Research Journal of Food Science & Quality Control*, *4*(1), 11–19.

Croteau, R. E., Jones, R. A., & Lyons, R. M. (2012). Terpenoids: The largest and diversified family of natural products. In *The biosynthesis of plant secondary metabolites* (pp. 161–206).

Dimejesi, S. A., & Odibo, F. J. C. (2017). Determination of heavy metals, aflatoxin and amino acid profile of fermented seeds of *Telfairia occidentalis*. *Proceedings of the 41st Nigeria Institute of Food Science and Technology (NIFST) Conference and Annual General Meeting*, 251–252.

Dogan, M. F., Yildiz, O., Arslan, S. O., & Uluso, K. G. (2019). Potassium channels in vascular smooth muscle: A pathophysiological and pharmacological perspective. *Fundamental & Clinical Pharmacology*, *33*(5), 504–523. https://doi.org/10.1111/fcp.12471

European Food Safety Authority (EFSA). (2015). Scientific opinion on dietary reference values for calcium. *EFSA Journal*, *13*(5), 4101. https://doi.org/10.2903/j.efsa.2015.4101

European Food Safety Authority (EFSA). (2019). Scientific opinion on the dietary reference values for sodium. *EFSA Journal*, *17*(9), 5778. https://doi.org/10.2903/j.efsa.2019.5778

Ezekiel, O. O., Ogunshe, A. A. O., & Jegede, D. E. (2015). Controlled fermentation of cotton seeds (*Gossypium hirsutum*) for Owoh production using bacterial starter cultures. *Nigerian Food Journal*, *33*(1), 54–60.

Ghorai, N., Sondipon, C., Shamik, G., et al. (2012). Estimation of total terpenoid concentration in plant tissue using a monoterpene, linalool, as standard reagent. *Research Square*, 1–5. https://doi.org/10.21203/rs.3.rs-18750/v1

Hou, R., He, Y., Yan, G., Hou, S., Xie, Z., & Liao, C. (2021). Zinc enzymes in medicinal chemistry. *European Journal of Medicinal Chemistry*, *226*, 113877. https://doi.org/10.1016/j.ejmech.2021.113877

Ifesan, B. O. T., Adetogo, T. T., & Ifesan, B. T. (2019). Production and quality assessment of local condiment ‘Ogiri’ from watermelon seed (*Citrullus lanatus*) and melon (*Citrullus vulgaris*). *Advances in Food Processing Technology*, *2*(1), 23–29.

Ikechukwu, A., Onyekachi, O., Agatha, K. U., David, C. N., Kingsley, T. J., Hannah, N. T., Jesse, P. S., & Abuchi, E. (2020). Nutritional composition and antioxidative potentials of fermented fluted pumpkin seed (Ogiri) extract on H2O2-induced oxidative stress in rats. *Food Science and Technology*, *8*(3), 43–49.

James, W. P. T., & Engelmann, J. (2017). Steroids. In *The biochemistry of plants* (pp. 409–454).

Kevin, B. C., Gregory, D. M., Wendy, R. K., & Katie, A. (2021). The complementary roles for plant-source and animal-source foods in sustainable healthy diets. *Nutrients*, *13*(3), 469–477. https://doi.org/10.3390/nu13030469

Merlo, F., Sara, S., Maraschi, F., P., Antonella, P., & Andrea, S. (2022). A simple and fast multiclass method for the determination of steroid hormones in berry fruits, root, and leafy vegetables. *Talanta Open*, *5*, 1–7. https://doi.org/10.1016/j.talo.2022.100094

Mutiat, A. B., Oyeyiola, G. P., & Fausat, L. K. (2017). Comparative study of physicochemical analysis of *Prosopis africana* seeds fermented with different starter cultures. *Croatian Journal of Food Science & Technology*, *9*(1), 25–30.

National Institutes of Health (NIH). (2021). Phosphorus. *Fact sheet for consumers*. Ods.od.nih.gov/factsheets/Phosphorus-Consumer/. Updated March 22, 2021. Accessed March, 2024.

Nnennaya, A. N., Julian, I. C., Ijeoma, A., Echeta, C. K., Awuchi, C. G., & Promise, O. (2020). Antinutritional and phytochemical composition of fermented condiment (Ogiri) made from sandbox (*Hura crepitan*) seed. *European Academic Research*, *8*(4), 1871–1879.

Nyambaka, H., & Ryle, J. (2001). Degradation of provitamin A, active components of all-trans–β-carotene in dehydrated dark green leafy vegetables. *Bulletin of the Chemical Society of Ethiopia*, *15*, 157–164. https://doi.org/10.4314/bcse.v15i2.19407

Oboh, G., Ekperigin, M. M., & Kazeem, M. I. (2005). Nutritional and haemolytic property of eggplant (*Solanum macrocarpon*) leaves. *Journal of Food Composition and Analysis*, *18*(2–3), 153–160. https://doi.org/10.1016/j.jfca.2004.08.003

Ogbuonye, E. O. (2018). Chemical and microbial evaluation of 'Ogiri' (a locally fermented food condiment) produced from Kersting groundnut seeds. *Specialty Journal of Biological Sciences*, *4*(2), 7–13.

Okpo, N. O., Alalade, O. M., Dawi, A. W., & Tahir, Z. H. (2022). Quality attributes of condiments made from some locally underutilized seeds. *Dutse Journal of Pure and Applied Sciences (DUJOPAS)*, *8*(2).

Okwunodulu, I. N., Onwuzuruike, A. U., & Agha, F. E. (2020). Response in quality traits of ogiri to partial substitution of castor oil bean seeds (*Ricinus communis*) with melon seeds (*Citrullus vulgaris*). *Nigerian Agricultural Journal*, *51*(3), 54–64.

Peter-Ikechukwu, A., Enwereuzoh, R., Uzoukwu, N., Nze, S., Agunwa, M., Anagwu, F., Onyemachi, C., Chinwendu, D., & Okafor, D. (2015). Effect of fermentation on the anti-nutritional factors and mineral composition of melon seed varieties for Ogiri production. *Food Science and Quality Management*, *43*, 98–111.

Strazzullo, P., & Leclercq, C. (2014). Sodium. *Advances in Nutrition*, *5*(2), 188–190. https://doi.org/10.3945/an.113.004734

World Health Organization (WHO). (2002). *The world health report 2002: Reducing risks, promoting healthy life*. World Health Organization.

Yu, E., & Sharma, S. (2023). Physiology, calcium. *StatPearls*. https://www.statpearls.com/physiology/

Yusuf, P. A., Egwujeh, S. I. D., Damak, A., & Netala, J. (2014). Enrichment of apula – A roasted maize meal with African yam bean and plantain flour. *Pakistan Journal of Nutrition*, *13*(7), 377–380.

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