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COMPARATIVE NUTRITIONAL AND MINERAL ANALYSIS OF FERMENTED PENTACLETHRA MACROPHYLLA (UKPAKA), FERMENTED RICINUS COMMUNIS (OGIRI), AND FERMENTED PROSOPIS AFRICANA SEED (OKPEYE)

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ABSTRACT

Fermented African mesquite bean, Castor oil bean, and African oil bean seeds were Purchased at Ogige Main Market in Nsukka Local Government of Enugu State and examined for the relative assessments of their mineral and nutritional proximate qualities. The Association of Official Agricultural Chemists' techniques were used to ascertain the approximate composition and mineral characteristics of the fermented samples. The fermented African oil bean seed had the highest lipid content (43.31%) and fibre (16.85%), whereas the fermented African mesquite bean had the highest levels of carbs (41.98%), ash (6.54%), and protein (33.64%). The beans with fermented castor oil showed the highest moisture content (29.4320%). Fermented African mesquite bean seed had the highest levels of calcium (1813.30 mg/L), magnesium (292.03 mg/L), and iron (48.26 mg/L), according to the mineral contents, whereas fermented castor bean seed had the highest potassium levels (3,544.72 mg/L). There were no heavy metals such as lead(Pb), chromium (Cr), cadium (Cd), or cobalt (Co) in any of the samples. In comparison to fermented African oil bean and Castor oil bean seeds, it can be stated that fermented African mesquite bean seeds (Okpeye) contain higher amounts of protein, carbohydrates, and ash.

Keywords: Minerals, *Pentaclethra macrophylla*, Proximate, Prosopis Africana, Ricinus Communis

INTRODUCTION

Native to tropical Africa, the Leguminosea family includes the African oil bean (Pentaclethra macrophylla Benth), African mesquite (Prosopis Africana seed), and Castor oil bean (Ricinus communis). In Nigeria, where they go by numerous names, they are well-liked. In Yoruba, the fermented product and seed of the African oil bean are referred to as Apara. Igbo people refer to fermented African oil bean seeds (Pentaclethra macrophylla, Benth.) as ukpaka or ugaba. These seeds are a common condiment and meat substitute among consumers (Achi, 2005). In Southern Nigeria, the Efik people refer to it as Ukana.

According to (Ogunshe et al., 2007), African mesquite, also known as iron tree, is generally known by its native Nigerian names, Kiriya (Hausa), Kohi (Fulani), Sam chi lati (Nupe), Ayan (Yoruba), Kpaye (Tiv), Okpeye (Igbo), and Okpehe (Idoma). The traditional Igbo term for the fermented castor oil seeds (Ricimus communis) is ogiri (Achi, 2005). An estimated 15 million individuals in Eastern Nigeria, the majority of whom are Igbos, consume all of these (Ogueke et al., 2010). These are traditional foods that are typically made in tiny family businesses in homes. Different producers use different production techniques, which leads to non-uniform products (Ogueke et al., 2010).

According to (Omafuvbe et al., 1999), condiments made from these fermented seeds have a distinct ammoniacal smell in Nigeria and improve the flavour of local soups and sauces. They are a useful element in soups, a nutritional alternative to meat, and a vitamin.

Certain plant seeds' proximate compositions provide insight into their nutritional worth and significance in the human diet. Edible oil can be obtained from the oil bean seeds, known as Ukpaka in Eastern Nigeria. The oil tastes good and has a nice scent (Akinlabu et al., 2019). Sample beans that have undergone more than three days of fermentation are considered delicacies. The flavour of well-fermented beans is imparted to the soup. The proportion of protein and lipid content increases with the length of fermentation, according to the proximate analysis of fermented P. macrophylla seed. It has been demonstrated that products made from fermented P. macrophylla seeds have more nutritional value than those made from raw seeds (Afia, 2020). The raw seeds' flavours, digestibility, nutritional content, and shelf life are all significantly enhanced by fermentation. The fermenting seeds become flavorful and high in protein when seasoned. They are either added straight to food or utilized in soups and stews as thickening agents (Ogbadu, 1988).

The current study's objective was to compare the nutritional and mineral values of fermented African oil bean seed (Ukpaka), castor bean seed (Ogiri), and African mesquite bean seed (Okpeyi) to offer preliminary data for the efficient use of these legumes in a variety of food applications in Nigeria and other countries.

MATERIALS AND METHODS

All the reagents used in this experiment are analytical grade reagents obtained from sigma chemicals in Shestco, Abuja Nigeria. These reagents include petroleum ether, sodium hydroxide, sulphuric acid, copper sulphate, boric acid, hydrochloric acid and anhydrous sodium sulphate. Distilled water was used throughout the experiment. Routine laboratory apparatus was used.

Sample Collection and Preparation

African mesquite, castor, locust, and fermented oil beans were acquired from the Ogige Main Market in the Nsukka Local Government of Enugu state. For two days, they were dehydrated at 50°C using a food dehydrator. After that, they were manually pulverized into powder and stored apart in an airtight container so they could be used as samples.

Proximate Analysis

Total Ash Content Determination

The (Pacquette et al., 2018) technique was utilized to ascertain the total ash content. 2g of the sample was weighed(W1) into preweighed empty crucible (W2) .After that, the crucible was heated to 600 degrees Celsius in a muffle furnace chamber until the sample was converted to ash. After being taken out of the furnace, the crucible was allowed to cool in desiccators until room temperature. It was then weighed again as W3.

Calculation:

$$\% \, Ash = \frac{W3-W1}{W2-W1} \times 100 \quad (1)$$

% Organic matter = 100 - %Ash

Where:

W1 is the weight of crucible

W2 is the weight of the crucible and sample before drying

W3 is the weight of the crucible and sample after drying

Moisture Content Determination

The moisture content was ascertained through the application of the air-over method, as detailed by (Thiex et al., 2012, p. 2) 2 g of each sample were weighed (W1) into a preweighed crucible (W2) and placed in a hot drying oven at 105^{O}c for 3h. The crucible was removed, cooled in a desiccator and weighed. The processes of drying, cooling and weighing were repeated until a constant weight (W3) was obtained. The weight loss due to moisture was obtained by the following equation

$$Moisture(\%) = \frac{W1-W2}{W1-W0} \times 100 \quad (2)$$

Where:

W0 is the weight of the empty crucible(g), W1 is the weight of the empty crucible and sample (g) and W3 is the weight of the empty crucible and dried sample(g)

Crude Protein determination

The (Thiex et al., 2012) micro Kjeldahl technique was utilized to ascertain the total crude protein content. A Kjeldahl tablet was filled with 0.2 g of the sample. A transparent solution was obtained by digesting the mixture. After cooling the digest, 50 millilitres of sodium hydroxide solution was added, and then 75 millilitres of distilled water. After the mixture's ammonia was generated, it was distilled into a 25 ml solution of 2% boric acid with 0.5 ml of methyl red indicator. After that, the collected distillate was titrated against 0.1M HCL. Additionally, the reagent underwent blank titration, and the nitrogen content of the sample was computed. The crude protein content was calculated by multiplying the nitrogen content by the conversion factor, which is 6.25.

Calculation:

$$\% \, Nitrogen = \frac{titrate\ value\ \times N \times 0.014}{weight\ of\ sample} \times 100 \quad (3)$$

$$Crude\ protein = \% \, Nitrogen \times 6.60 \quad (4)$$

Where: N is the total Nitrogen and 6.25 is the conversion factor

Crude lipids Determination

The technique outlined by (Pacquette et al., 2018) was used to calculate crude fat. The soxhlet apparatus was used to determine crude fat. A thimble containing around 3 g of the sample was used to extract it using n-hexane for roughly 6 hours. Evaporation was used to separate the solvent from the extracted oil. To eliminate any last traces of organic solvent and moisture, the oil was further dried in a hot-air oven set at 100°C for 30 minutes. This was weighed after being chilled in desiccators. The amount of oil was stated as a percentage of the initial sample that was utilised.

Calculation:

$$\% \ Crude\ Lipid = \frac{W1-W2}{W0} \times 100 \quad (5)$$

Where:

W0 is the weight of sample(g), W1 is the weight of flask and oil (g) and W2 is the weight of flask(g)

Crude Fibre Content

The method of (ADEBAYO et al., 2019) technique was used. 2 g of each sample was weighed (W0) into a 1 dm^3 conical flask. Water (100 cm^3) and 20 cm^3 of 20% H_2SO_4 were added and boiled gently for 30min. The content was filtered through whatemann No.1 filter paper. The residue was scrapped back into the flask with a spatula. Water (100 cm^3) and 20 cm^3 of 10% NaOH were added and allowed to boil gently for 30min. the content was filtered and the residue was washed thoroughly with hot distilled water, then rinsed once with 10% HCl and twice with ethanol and finally three times with petroleum ether. It was allowed to dry and scrapped into the crucible and dried overnight at 105^{O}C in an air oven. It was then removed and cooled in a desicator. The sample was weighted (W1) and ashed at 550^{o}C for 90min in a lenton muffle furnace. It was finally cooled in a desicator and weighed again (W2). The percentage *of crude* fiber was calculated using the equation below.

$$Crude\ fibre\ (\%) = \frac{W1-W2}{W0} \times 100 \quad (6)$$

Where:

W0 is the sample weight (g), W1 is the weightof the dreid sample (g), W2 is the weighed of the ash sample (g)

Carbohydrate Content

The values of the components that were analyzed—moisture content, protein, crude fat, ash content, and crude fiber—were subtracted to find the percentage of carbohydrates. (Crude protein plus total ash plus crude fibre plus crude fat plus moisture content) = 100%

Mineral content

The method outlined by the Association of Official Analytical Chemists (A.O.A.C.) was used to ascertain the mineral contents of the fermented samples. A sample weighing 2-3g was finely ground and tested for K, Ca, Mg, Mn, Na, Fe, Cu, Ni, Pb, Cr, Co, Cd, and Zn.

RESULTS AND DISCUSISON

Proximate results of the samples

The results of the fermented samples' proximate composition are shown in Table 1. The beans that have undergone fermentation have the lowest moisture content. The beans that have undergone fermentation are mesquite (0.88%), Castor (29.43%), and African oil bean (5.54%). The percentage of ash varied between fermented mesquite beans (6.5352%), fermented castor beans (5.43%), and fermented African oil beans (1.95%). The crude protein content of castor and mesquite beans was 22.03 % and 33.64 %, respectively. Fermented African oil bee seed had less crude protein (16.57%).

Table 1: Proximate analysis results of the fermented African mesquite bean, castor bean and African oil bean seeds

Parameters (%)	African mesquite bean seed (Okpeye)	castor bean seed (Ogiri)	African oil bean seed (Ukpaka)
Ashing	6.54	5.43	2.95
Moisture	0.88	29.43	5.54
Fiber	6.61	6.70	16.85
Lipid	10.36	23.36	43.31
Crude Protein	33.64	22.03	16.57
Carbohydrate	41.98	13.05	14.78

Mineral results of the samples

Table 2 presents the mineral composition results of African oil bean seed (Ukpaka), Castor oil bean, and fermented mesquite bean seed. The castor oil bean sample has the lowest value of 8.40 mg/100g, 7.06 mg/100g, and 5.12 mg/100g for sodium composition, according to the results. Certain major trace elements were found in varying concentrations, as Table 2 demonstrates All of the samples contained low levels of cobalt, lead, and chromium, but high levels of potassium, magnesium, and calcium. Potassium is found to be the most prevalent mineral among all the fermented seeds. This is consistent with findings from studies by (Olaofe & Sanni, 1988), who found that potassium was the most prevalent mineral in Nigerian agricultural products.

Table 2: Mineral composition (mg/100g) of fermented mesquite bean, castor oil and african oil bean seeds

Mineral (mg/100g)	Fermented African mesquite bean seed	Fermented Castor oil bean seed	Fermented African oil bean
Na	8.40	5.12	7.06
Mn	35.34	0.43	-
K	227.56	354.47	102.13
Fe	4.83	4.22	0.64
Mg	29.20	28.60	24.82
Ca	181.33	46.54	138.65
Zn	13.36	7.22	2.52
Ni	0.21	0.29	0.41
Cu	8.63	2.98	3.80
Co	-	-	-
Pb	-	-	-
Cr	-	-	-
Cd	0.003	0.0032	0.004

Discussion

The proximate analysis showed that the moisture content of the fermented castor oil seed was higher than that of the African oil and mesquite bean seeds. The high moisture content of fermented castor seeds may be a result of the product's hydrolytic breakdown during fermentation, or it may have been absorbed by the seeds during boiling before fermentation. The bean may be more vulnerable to microbial infection due to its high moisture content (ADEBAYO et al., 2019). This supports the findings of (Ishiwu & Tope, 2015), who found that following fermentation, the moisture content of the fermented castor seeds rose.

The low moisture level in the fermented African mesquite bean sample, however, may be the cause of its high nutritious quality. Among the three samples, the fermented African mesquite bean had the highest protein content (33.64%), and the fermented African oil bean had the lowest (16.57%) while the fermented castor oil bean seed trails in between (22.03%). The presence of enzymes, which are proteins in nature, created by fermenting African mesquite bean seeds was responsible for the high protein content (ADEBAYO et al., 2019); (Sherief et al., 2010). The high protein content of fermented African mesquite bean seed could also be attributed to these enzymes' capacity to break down organic complexes and improve protein availability and release. Additionally, it is somewhat below the recommended daily allowance (RDA) of 46 grams for adults weighing 50 kg and 56 g for people weighing 70 kg; children are only allowed to consume 18 to 20 g of protein daily (Otori & Mann, 2014). Given its high protein content, African mesquite bean seeds may be used as food or to manufacture animal feed. They are also thought to be a rich source of protein.

Leaching during boiling may be the cause of African oil beans' lowest protein content. The proteolytic microorganisms' metabolic activities may also be the reason for the lowest protein content; they utilized the nitrogen content that increased the protein content in the seed, which resulted in a decrease in the protein content of the locally fermented African oil bean seeds (Ishiwu & Tope, 2015).

The high oil content (43.31%) suggested that oil extraction from the seeds would be cost-effective. This value was also in close comparison to that of African oil beans (47.25%) (Ikhuoria., 2008). Because humans are thought to need a diet that provides 1-2 percent of their caloric energy as lipids—excess lipid consumption leading to obesity and cardiovascular problems—the high crude fat content of plants is undesirable. However, because it is a great source of energy, aids in the transportation of fat-soluble vitamins, maintains essential cellular activities, and protects and insulates internal organs, lipid is necessary for the diet (Egwime et al., 2018). Crude fats are the primary sources of energy.

These samples have a high concentration of potassium, which is beneficial because potassium is a mineral required for all body functions. A diet rich in potassium is linked to several powerful health advantages. It lowers the risk of kidney stones and osteoporosis, lowers blood pressure, reduces water retention, and protects against stroke. The Dietary Reference Intakes for people include 400 mg to 3,400 mg of potassium daily, depending on age (Egwim et.al,. 2018).

The body has calcium at all times, which helps to create blood and maintain the body's structural integrity. The fermented ugba seeds' high mineral content, particularly the calcium they contain, suggests that eating the seeds may be able to treat metabolic bone disease. The fermented samples' lack of these heavy metals demonstrated that there was no health risk connected to their ingestion by humans.

CONCLUSION

The results of the study showed that African mesquite (Prosopis Africana seed), African oil bean (*Pentaclethra macrophylla Benth*), and Castor oil bean (Ricinus communis) are all excellent sources of essential minerals, such as calcium, magnesium, potassium, iron, and manganese, along with other nutrients. These are high-nutrient, mineral-rich condiments. Prosopis Africana seed, which is fermented African mesquite, has high levels of protein, carbohydrates, and ash. Thus, an attempt has been made to enlighten the consumer about the potential health benefits of ingesting this Okpeye. Although the potassium content of the fermented castor oil bean seed was excessively high in comparison to other sources, it is still a rich source of calcium and potassium.

REFERENCES

Achi, O. (2005). The potential for upgrading traditional fermented foods through biotechnology. *African Journal of Biotechnology*, *4*(5), 375–380.

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. *Asian Journal of Natural Product Biochemistry*, *17*(2).

Afia, K. (2020). A Review of Pentaclethra macrophylla (African oil bean) seed. *Int Digit Org Sci Res*, *5*, 1–7.

Akinlabu, D., Owoeye, T., Owolabi, F., Audu, O. Y., Ajanaku, C., Falope, F., & Ajani, O. (2019). *Phytochemical and proximate analysis of African oil bean (Pentaclethra macrophylla Benth) seed*. *1378*(3), 032057.

Egwime, E., Ossamulu, I., Akanya, H., Onuekwusi, E., & Ibeji, L. (2018). PROTEIN AND MINERAL PROFILE IN FERMENTED AFRICAN OIL BEAN (PANTACLETHRA MACROPHYLLA BENTH) SEED. *AU eJournal of Interdisciplinary Research (ISSN: 2408-1906)*, *3*(2).

Ishiwu, C., & Tope, V. (2015). Effect of period of fermentation on nutrients of Castor oil seed (Ricinus communis). *Direct Research Journal of Agriculture and Food Science*, *3*(10), 178–183.

Ogbadu, L. (1988). *Studies on glutamic acid production by Bacillus isolates involved in "daddawa" fermentation*.

Ogueke, C., Nwosu, J., Owuamanam, C., & Iwouno, J. (2010). Ugba, the fermented African oilbean seeds; its production, chemical composition, preservation, safety and health benefits. *Pakistan Journal of Biological Sciences*, *13*(10), 489.

Ogunshe, A. A., Omotosho, M. O., & Ayanshina, A. (2007). Microbial studies and biochemical characteristics of controlled fermented afiyo-a Nigerian fermented food condiment from Prosopis africana (Guill and Perr.) Taub. *Pakistan Journal of Nutrition*, *6*(6), 620–627.

Olaofe, O., & Sanni, C. (1988). Mineral contents of agricultural products. *Food Chemistry*, *30*(1), 73–77.

Omafuvbe, B., Abiose, S., & Adaraloye, O. (1999). The production of 'Kpaye'–a fermented condiment from Prosopis africana (Guill and Perr) Taub. Seeds. *International Journal of Food Microbiology*, *51*(2–3), 183–186.

Otori, A., & Mann, A. (2014). Determination of chemical composition, minerals and antinutritional factors of two wild seeds from Nupeland, North central Nigeria. *Am J Chem Appl*, *1*(1), 20–26.

Pacquette, L. H., Thompson, J. J., & Collaborators: Malaviole I Zywicki R Woltjes F Ding Y Mittal A Ikeuchi Y Sadipiralla B Kimura S Veltman H Miura A. (2018). Minerals and trace elements in milk, milk products, infant formula, and adult/pediatric nutritional formula, ICP-MS method: Collaborative study, AOAC final action 2015.06, ISO/DIS 21424, IDF 243. *Journal of AOAC International*, *101*(2), 536–561.

Sherief, A., El-Tanash, A., & Temraz, A. (2010). Lignocellulolytic enzymes and substrate utilization during growth and fruiting of Pleurotus ostreatus on some solid wastes. *Journal of Environmental Science and Technology*, *3*(1), 18–34.

Thiex, N., Novotny, L., & Crawford, A. (2012). Determination of ash in animal feed: AOAC official method 942.05 revisited. *Journal of AOAC International*, *95*(5), 1392–1397.