AMINO ACID PROFILE AND PROXIMATE ANALYSIS OF FERMENTED AFRICAN LOCUST BEAN (*Parkia biglobosa*) SEEDS

ABSTRACT

Fermented *Parkia biglobosa* seeds nutritional content make it suitable for use as a popular flavour intensifier in soups, stews and also as protein rich condiment in deficient diet. The seeds of the fermented *Parkia biglobosa*was analyzed for amino acid content and proximate composition using standard procedures to evaluate the seeds nutritional potential. The results of amino acid profile revealed the following: lysine (3.58 ± 0.01 mg/100 g), tryptophan (0.22 ± 0.01 mg/100 g), leucine (2.69 ± 0.00 mg/100 g), iso-leucine (3.01 ± 0.01 mg/100 g), cysteine (0.92 ± 0.02 mg/100 g), methionine (1.36 ± 0.02 mg/100 g), valine (1.11 ± 0.00 mg/100 g), tyrosine (1.34 ± 0.02 mg/100 g), glycine (1.23 ± 0.01 mg/100 g), arginine (3.00 ± 0.00 mg/100 g), phenylalanine (2.61 ± 0.02 mg/100 g), aspartic acid (6.14 ± 0.01 mg/100 g), glutamic acid (5.11 ± 0.00 mg/100 g), serine (0.99 ± 0.00 mg/100 g), proline (3.68 ± 0.02 mg/100 g), alanine (4.12 ± 0.01 mg/100 g), histidine (1.15 ± 0.01 mg/100 g) and threonine (1.22 ± 0.00 mg/100 g). The results of proximate analysis showed the following: moisture content (4.78 ± 1.70 %), ash content (5.40 ± 0.07 %), crude fats (11.00 ± 0.29 %), crude fibre (6.00 ± 0.02 %), crude protein (20.56 ± 0.04 %) and carbohydrate content (52.25 ± 0.01 %). The study on amino acid profile and proximate composition showed that fermented *Parkia biglobosa* seeds contained high protein content and can serve as a valuable dietary supplement, particularly in protein-deficient regions.

KEYWORDS: Fermented, African locust bean, Proximate, Amino acid profile and Nutritional content

1. INTRODUCTION

Most species of trees serve as sources of food and for medicinal purposes to the indigenous people in Africa. They also serve as source of income for many people dwelling in the rural areas [1]. Some of these trees and tree products are crucial as foods in West Africa due to their nutritional and sensory characteristics [2]. The seeds from these trees have protein content twice as much as that of cereals and usually contain more balanced profile of essential amino acids [3]. The protein content of legume grains ranges from 17 to 40 g/100 g, much higher than that in cereals (7-11.0 g/100 g) and approximately equal to the protein content of meat 18-25 g/100 g [4]. Seeds of legumes may account for up to 80 % of dietary protein for rural dwellers and may be the only source of protein for some groups [5]. One of the leguminous plants that produce seeds that can be consumed in meals is *Parkia biglobosa*(African Locust Bean) [1].

The plant is commonly called the African locust bean tree and it is known to grow in different agro-ecological areas around the world [6]. African locust bean (*Parkia biglobosa*) falls within the category of plant proteins [7]. The people living in the rural areas in developing countries like Nigeria consume African locust bean in search for plant protein, this has made *Pakiabiglobosa* to find popular use [8]. The most popular form of consumption of the African locust bean seeds is in its traditional fermentation into dawadawa (Locust beans cake), a food condiment for seasoning in traditional soups [9]. Locust beans cake, a popular food additive in Nigeria is a type of fermented and processed locust beans (*Parkia biglobosa*) used as a condiment in cooking [10]. Locust beans cake is known as Nune by Tiv people, Iru by Yoruba people and Dawadawa in Hausa land. It is used in cooking traditional soups like Egusi soup, okro soup and Ogbono soup. It has a black appearance and a strong pungent smell [10].

The traditional fermented condiment is rich in vegetable proteins and is consumed by different ethnic groups in Nigeria. It is evident that the condiment has played a major role in the food habit of communities in the rural regions. It serves not only as a nutritive non-meat protein supplement but as a functional ingredient in prepared foods [11]. The cooked form of the condiment is eaten as meal and is commonly used to enhance the flavour of foods [5]. With high contents of protein, the legume condiment can serve as a tasty complement to sauces and soups and can be used as a substitute for fish or meat in meals [5].

This study aims at carrying out proximate and amino acid analysis on fermented *Parkia biglobosa* seeds. The study of the nutritional content of fermented *Parkia biglobosa* seeds will help to assess its potential as a source of food, providing an important insight on dietary considerations and addressing the issue of nutritional deficiencies. The amino acid analysis will help to evaluate the protein quality allowing for informed decisions regarding the use of fermented *Parkia biglobosa* seeds in diets especially in places where protein sources may be limited.

2. METHODOLOGY

2.1 Sample Collection and Pretreatment

Parkia biglobosa seeds were bought in Aliade market, Gwer East, Benue State. The seeds were packed in a nylon bag and transported to Chemistry Laboratory, Benue State University, Makurdi for analyses. A quantity of 2 kg of the seeds were boiled for 12 hours and dehulled to separate the cotyledons from the hulls. The loosened hulls were removed by flotation. The dehulled cotyledons were boiled in excess water for 2 hours and drained through a raffia basket while still hot. It was then covered with leaves and allowed to ferment for 24 hours. The resulting product was dried in an oven for 1 hours and crushed manually into powder using mortar and pestle and kept in an air tight container for use as sample [12].

2.2 Amino Acid Analysis

Exactly 10 g of defatted seed samples of *Parkia biglobosa* were analyzed for the amino acid profile using Amino Acid Analyzer (Technicon Instruments Corporation, and New York). The analysis period was 76 minutes with a column flow rate of 0.50 cm^3 per min at a temperature of 60 ^oC with reproducibility consistent within 5.0±3.0 %. The net height of each peak produced by the chart record of Amino Acid Analyzer was measured and calculated for the amino acid it represented [13].

2.3 Proximate Analysis

Proximate analysis (moisture, ash, fat, crude fibre, protein and carbohydrate contents) of the fermented *Parkia biglobosa*seeds was determined using the method of Association of Official Analytical Chemists (AOAC) [12].

2.3.1 Determination of moisture content

A crucible was thoroughly washed and dried in the oven at 100 °C for 30 minutes and allowed to cool inside desiccator. After cooling, it was weighed and recorded as (W_1). A quantity of 1 g of the sample was transferred into a crucible and reweighed as (W_2). Then, the sample plus the crucible were placed in an oven at 100 °C for 2 hours and cooled in a desiccator. The process was repeated until a constant weight was obtained as (W_3) [1, 12]. The values obtained were used to calculate the percentage of moisture content through the equation:

$$\% \text{ Moisture content} = \frac{W_2 - W_3}{W_2 - W_1} \times 100 \qquad \text{Equ. 1.}$$

Where; W_1 = Weight of crucible, W_2 = Weight of crucible + sample, W_3 = Weight of sample after heating.

2.3.2Determination of ash content

A crucible was washed with clean water and oven-dried for 30 minutes at 100 ^{o}C. The crucible was removed from the oven and cooled in a desiccator after which it was weighed. A quantity of 5 g of the powdered sample was weighed and transferred into the preweighed crucible and put into muffle furnace at 600 °C for 3 hours until light gray ash was obtained. The crucible was removed from the furnace, put in a desiccator to cool and was reweighed to obtain the weight of ash [14]. The percentage ash was calculated using the equation;

$$\% \text{ Ash content} = \frac{(\text{Weight of crucible} + \text{ash}) - (\text{Weight of crucible})}{\text{Weight of sample}} \times 100 \qquad \text{Equ. 2}$$

2.3.3 Determination of fats content

Fat content of the *Parkia biglobosa* seeds was determined using the Soxhlet extraction method. The extraction flask was washed, dried, cooled and weighed prior to extraction. Exactly 5 g of the sample was weighed into a beaker and introduced into a thimble. Exactly 250 mL of N-Hexane was added to the flask for extraction in the Soxhlet apparatus. After this, the extract was dried in an oven for 15 minutes at 100 ^{o}C to remove any remaining solvent, cooled in the desiccator and reweighed [14]. The percentage fat content was calculated using the equation:

$$\% \text{ Fat} = \frac{(\text{Weight of flask+oil}) - \text{Weight of flask}}{\text{Total weight of sample}} \times 100 \qquad \text{Equ. 3}$$

2.3.4 Determination of crude fibre

A quantity of the sample (5 g) was weighed into a 500 mL beaker and the content was boiled in 200 mL hydrochloric acid (1 %) for 30 min. The suspension was filtered and the residue was washed to neutral pH. The sample residue was then boiled again in a 200 mL sodium hydroxide solution for 30 min, filtered through Whatman no.1 and the residue obtained was transferred into a crucible and heated in hot air oven at 80 ^{o}C for 30 minutes. The dried residue was then cooled in a desiccator and weighed. The weighed sample residue was ashed in a muffle furnace at 550 ^{o}C for 30 minutes. The sample was removed from the furnace when its temperature was 200 ^{o}C. It was then cooled in a desiccator and weighed [15]. The loss in weight of the incinerated residue before and after incineration was taken as the crude fibre content and calculated using the equation:

$$\% \text{ Crude ibre} = \frac{\text{Total weight of fibre}}{\text{Weight of sample}} \times 100 \qquad \text{Equ. 4}$$

2.3.5 Crude protein

A quantity of 2 g of the sample was weighed and transferred into a 100 mL Kjeldahl digestion flask. Exactly 2 g of anhydrous sodium sulphate (Na_2SO_4), 0.5 copper sulphate ($CuSO_4$) (catalyst) and 5 mL of concentrated sulphuric acid (H_2SO_4) were added. The flask was heated gently in a fume cupboard until the solution turned black. After this, heat was increased to obtain a clear solution, cooled, washed and transferred into 25 mL volumetric flask and rinsed with distilled water to mark [14, 16]. Exactly 5 mL of 2 % boric acid was measured into a 250 mL beaker and 2 drops of methyl red indicator was added. A quantity of 5 mL of the digest was poured into the distillation flask and the apparatus was set up. The heating system was switched on for 25 minutes and the receiver beaker was then removed [14, 16]. The collected distillate was cooled and titrated against 0.1 M HCl acid to an end point (indicated by change in colour from gray to purple). The titre value

(Final burette reading - Initial burette reading) was recorded [16]. Crude protein was determined using the equation:

$$\% \text{ Crude protein} = \frac{14.01 \times 0.1 \times 6.25 \times T}{W} \times 100 \quad \text{Equ. 5}$$

Where; 14.01 = Atomic weight of nitrogen, 0.1 = Molarity of acid, 6.25 = Protein conversion factor, T = Titre value and W = Weight of sample.

2.4.6 Carbohydrate content

Total carbohydrate content of the sample was determined by difference (subtracting crude protein, moisture, fat, fibre and ash content from 100%) [14]. The total carbohydrate content of the sample was obtained using the equation:

Carbohydrate = 100 - (% protein + % fat + % ash + % crude fibre + % moisture) Equ. 6

3. RESULTS

The proximate composition and amino acid profile of fermented *Parkia biglobosa* seeds were analyzed and presented in Table 1 and 2 respectively.

Table 1. Results of proximate composition of fermented *Parkia biglobosa* seeds

S/N	Parameter	Composition (%)
1	Moisture content	4.78 ± 1.70
2	Ash content	5.40 ± 0.07
3	Fat content	11.00 ± 0.29
4	Crude fibre	6.00 ± 0.02
5	Crude protein	20.56 ± 0.04
6	Carbohydrate content	52.25 ± 0.01

NB: Data are presented as mean ± SD value (n = 3).

Table 2. Amino acid profile of fermented *Parkia biglobosa* seeds

S/N	Amino acid	Composition (mg/100 g)
1	Lysine	3.58 ± 0.01
2	Tryptophan	0.22 ± 0.01
3	Leucine	2.69 ± 0.00
4	Iso-leucine	3.01 ± 0.01
5	Cysteine	0.92 ± 0.02
6	Methionine	1.36 ± 0.02

7	Valine	1.11 ± 0.00
8	Tyrosine	1.34 ± 0.02
9	Glycine	1.23 ± 0.01
10	Arginine	3.00 ± 0.00
11	Phenylalanine	2.61 ± 0.02
12	Aspartic acid	6.14 ± 0.01
13	Glutamic acid	5.11 ± 0.00
14	Serine	0.99 ± 0.00
15	Proline	3.68 ± 0.02
16	Alanine	4.12 ± 0.01
17	Histidine	1.15 ± 0.01
18	Threonine	1.22 ± 0.00

NB: All values are presented as mean ± standard deviation in duplicates

4. DISCUSSION

Moisture content of a material is defined as the amount of water present in the material. This value is often represented as a percentage of the material mass [17]. High moisture content encourages microbial growth whereas low moisture content indicates a lesser propensity for microbial contamination [18]. From the results shown in Table 1, the fermented *Parkia biglobosa* seeds contained 4.78 ± 1.70 % moisture. This value is slightly greater than the value of 4.47 % reported by Tor *et al*. [12] but lesser compared to the value of 9.70 % reported by Adeyeye, [1]. The moisture content value obtained in this study is an indication of low amount of water in fermented *Parkia biglobosa* seeds hence giving it a longer shelf life.Ash refers to the inorganic residue remaining after either ignition or complete oxidation of organic matter in a foodstuff. The ash content is a measure of the total amount of minerals present in a food [19]. Ash is a crude indicator for minerals, and its content will not be affected by drying [20]. The result of ash content in this study was 5.40 ± 0.07 % (Table 1). Olakunle and Adebola, [21] and Ezegwu*et al*. [22] reported results (3.55 %) and (4.19 %) respectively which are less than the value presented in this work. Also, Ajegena*et al*. [23] reported an ash content value of 2.5 % which is far less than the value presented in this study. The value of ash content obtained in this work indicates that the fermented *Parkia biglobosa* seeds contains few mineral components and is safe for consumption.

This refers to the amount of fat present in a particular food or substance, usually measured as a percentage of the total weight [24]. Fat in food determine the amount of energy available. A diet providing 1-2 % of its caloric energy as fat is said to be sufficient to human beings [25]. The crude fat value of fermented *Parkia biglobosa* seeds was found to be 11.00 ± 0.29 % (Table 1). The value is lower than 24.21 % reported by Olakunle and Adebola [21]. Also, the value falls outside the range (10.50-8.50 %) and (18.78-19.62 %) reported by Ajegena*et al*. [23] and Ibrahim *et al*. [26] respectively. The value of fat content obtained in this work indicates appropriate concentration of dietary fats.Fiber is necessary for the lowering cholesterol level as well as the smooth intestinal functioning [24]. Fiber is characterized by low or no nutritional value however, its effect on digestive system may help to fight diabetes and lower high blood cholesterol level [27]. Low level crude fiber is considered appropriate [28] because high level can cause intestinal irritation, lower digestibility and decreased nutrient usage [29]. The result of crude fibre obtained in this study was 6.00 ± 0.02 % (Table 1). The value is slightly greater than 5.53 % reported by Ibrahim *et al*. [26], but appreciably higher than 3.55 % reported by Adeyeye, [1] and 3.84 % reported by Ezegwu*et al*. [22]. The value of crude fibre reported in this study is relatively high and shows that the fermented *Parkia biglobosa* seeds are rich in crude fibre which is beneficial to health.

This refers to the total protein content present in a food or substance. It contains essential amino acids responsible for growth and repair of worn-out tissues in humans [27]. The value of crude protein was found to be 20.56 ± 0.04 % (Table 1). The value is considerably less than 35.69 % reported by Tor *et al*. [12] and

36.5 % reported by Ajegena*et al*. [23], but slightly less than 21.24 % reported by Ezegwu*et al*. [23]. The value presented in this study indicates that fermented *Parkia biglobosa* seeds has a high crude protein which is a good source of amino acid requirement necessary for growth, maintenance and repair.This refers to the amount of carbohydrates present in a particular food or substance, usually measured as a percentage of the total weight [30]. Carbohydrate is the primary source of energy in the body [24]. Carbohydrates and lipid are the principal sources of energy [25]. The percent carbohydrate content was found to be 52.25 ± 0.01 % as shown in Table 1. The value is significantly greater than 37.14 % reported by Tor *et al*. [12] and 45.80 % reported by Ezegwu*et al*. [22]. The carbohydrate value in this study shows that the fermented condiment has high amount of carbohydrates.

Amino acids are needed for the synthesis of most body tissues, enzymes, hormones and other metabolic molecules [31]. The results of amino acid analysis shown in Table 2 revealed that *Parkia biglobosa* contained varying concentrations of essential amino acids such as lysine (3.58 ± 0.01 mg/100 g), methionine (1.36 ± 0.02 mg/100 g), phenylalanine (2.61 ± 0.02 mg/100 g), leucine (2.69 ± 0.00 mg/100 g), threonine (1.22 ± 0.00 mg/100 g), tryptophan (0.22 ± 0.01 mg/100 g), histidine (1.15 ± 0.01 mg/100 g), iso-leucine (3.01 ± 0.01 mg/100 g), valine (1.11 ± 0.00 mg/100 g) and some non-essential amino acids such as arginine (3.00 ± 0.00 mg/100 g), aspartic acid (6.14 ± 0.01 mg/100 g), glutamic acid (5.11 ± 0.00 mg/100 g), serine (0.99 ± 0.00 mg/100 g), proline (3.68 ± 0.02 mg/100 g), alanine (4.12 ± 0.01 mg/100 g), cysteine (0.92 ± 0.02 mg/100 g), tyrosine (1.34 ± 0.02 mg/100 g) and glycine (1.23 ± 0.01 mg/100 g), which could carry out important roles in the body. For the essential amino acids, lysine was found to be highest, followed by iso-leucine and tryptophan the least. The essential amino acids suggested that the fermented seeds of *Parkia biglobosa* could serve as a good source of amino acids.

The non-essential amino acids were also observed to be in varying concentrations with highest amount been aspartic acid followed by glutamic acid while cysteine was found to be the lowest. These amino acids help in regulating the blood sugar levels, promoting the growth and recovery of muscles and bones, as well as the production of the growth hormones. Isoleucine takes part in the formation of haemoglobin, used for energy by muscular tissues. Methionine helps remove toxic waste from the liver and assist in regeneration. Glycine enhances sleep and supports whole-body health, maintains the strength and support of muscles and bones. Cysteine helps prevent damages from alcohol and tobacco use, stimulates white blood cell activity, while glutamic acids are a chemical that helps nerve cells in the brain, send and receive information from other cells [32]. In summary, the results of amino acids indicated that the seeds of *Parkia biglobosa* are good sources of both essential and non-essential amino acids which can supplement diets.

5. CONCLUSION

This study has shown that fermented *Parkia biglobosa* seeds contain appreciable nutrients required for the body. The result of the proximate composition showed high levels of protein and carbohydrates but moderate moisture, fat, fibre and ash contents. The results of amino acid analysis revealed that *Parkia biglobosa* contained varying concentrations of essential and non-essential amino acids. In summary, the study on amino acid profile and proximate composition showed that fermented *Parkia biglobosa* seeds contained high protein content and can serve as a valuable dietary supplement, particularly in protein-deficient regions.

REFERENCES

[1] Adeyeye A. The Nutritional Composition and Fatty Acid Profile of African Locust Bean (*Parkia biglobosa*) Seed and Seed Oil. *International Journal of Agriculture and Nutrition*, 2020, 2(2): 1-4.

[2] Burlando B, Palmero S, Cornara L. Nutritional and medicinal properties of underexploited legume trees from West Africa. *Critical reviews in food science and nutrition*, 2019, *59*(sup1), S178–S188. https://doi.org/10.1080/10408398.2018.1551776

[3] Farinde EO, Adeniran HA, Abiose SH. Comparative microbial assessment of fermented Lima bean (*Phaseolus lunatus*) and Locust bean (*Parkia biglobosa*) in production of Daddawa. *British Microbiology Research Journal*, 2014, 4(7). 772-784.

[4] De Oliveira AC. Chemical Composition, Dietary Fibre and Resistant Starch Contents of Raw and Cooked Pea, Common Bean, Chickpea and Lentil Legumes. *Food Chemistry*, 2006, 94: 327-330.

[5] Achi OK. Traditional Fermented Protein Condiments in Nigeria. *African Journal of Virology Research*,2015, 9(1): 1-10.

[6] Abioye EO, Akinpelu DA, AiyegoroOA, AdegboyeMF, Oni MO, Okoh AI. Prelminary Phytochemical Screening and Antibacterial Properties of Crude Stem Bark Extracts and Fractions of *Parkia biglobosa* (Jacq.). *Molecules*, 2013, 18: 8485-8499.

[7] Adepoju AL, Falua KJ, Badmus AO, Bolarinwa MO. Influence of Sun and Oven Drying Methods on the Proximate, Phytochemical and Vitamin C Composition of Fermented African Locust Beans (*Parkia biglobosa*) Powder. *Journal of Engineering and Environmental Sciences*, 2022, 4(1): 173-178.

[8] Abey S, Nosarieme OA. Effects of Gamma Irradiation and Cooking on the Physico-Chemical Properties of African Locust Bean (*Pakiabiglobosa*) Seeds. *Food and Public Health*, 2016, 6(1): 8-14.

[9] Elemo GN, Elemo BO, Olufunmilola OO,Erukainure OL. Comprehensive Investigation into the Nutritional Composition of Dehulled and Defatted African Locust Bean Seed (*Parkia biglobosa*). *African Journal of Pant Science*, 2011, 5(5): 291-295.

[10] Murtala Y, Babandi A, Mashi JA, Ubayi HM, Ibrahim S, Ibrahim A, Shehu D, Alhassan AJ. Proximate, Vitamins and Mineral Compositions of Locust and Soya Beans-Based Daddawa Sold in Kano Metropolis, Kano, Nigeria. *Bayero Journal of Biomedical Science*, 2016, 1(1): 1-7.

[11] Kolhe RC, Chaudhari RY. A Review on Phytopharmacological Profile of traditionally used medicinal plant Parkia biglandulosa (Mimosaceae). *Asian J. Pharm. Res*. 2020; 10(1): 34- 38. doi: 10.5958/2231-5691.2020.00008.8

[12] Tor PN, Ijuo AG, Ogoh B, SurmaN. Comparative Proximate Analysis for Processing of *Parkia biglobosa. World News of Natural Sciences,* 2018, 19:51-57.

[13] Alawode AR, Ndamitso MM, Iyaka AY, Anuonye CJ. Effects of Fermentation on the Proximate, Anti-Nutrients, Minerals, Fatty Acids and Amino Acids Profiles of Jujube (*Ziziphus mauritiana* Lam) Seeds. *AROC in Food and Nutrition*, 2021, 1(1): 31-40.

[14] Hassan A, Ambi AA, Shitu FA, Musa NU. Comparative Analysis on the Proximate and Mineral Contents of Local Condiment Produced from Soya Bean and Locust Bean Seeds (Daddawa). *Chemistry Research Journal*, 2020, 5(2):157-161.

[15] James S, Nwabueze TU, Onwuka GI, Ndife J, Usman MA. Chemical and Nutritional Composition of Some Selected Lesser-Known Legumes Indigenous to Nigeria. Heliyon, 2020, 6: 1-8.

[16] Yahaya M, Adamu SA, Salary IA, Sambo S. Processing Effect of Nutritional and Anti-Nutritional Content of African Locust Beans (*Parkia biglobosa* Benth). *Greener Journal of Agricultural Sciences*,2018, 8(12): 370-375.

[17] Olive A, Noble K, Fredrick W, Akuffo O, Deryl N,Okantey K. Chemical Composition and in Vitro Evaluation of the Mosquito (Anopheles) Repellent Property of Neem (Azadirachta indica) Seed Oil. *Journal of Tropical Medicine,* 2021, 5: 1-7.

[18] Rezaei F, VanderGheynst JS. Critical moisture content for microbial growth in dried food-processing residues. *Journal of the science of food and Agriculture,*2010, 90(12) 2000-2005.

[19] Afify AS, Abdalla AA, Elsayed A, Gamuhay B, Abu-Khadra AS, Hassan M, Ataalla M, Mohamed A. Survey on the Moisture and Ash Contents in Agricultural Commodities in Al-Rass Governorate, Saudi Arabia in 2017. *Assiut Journal of Agricultural Sciences,*2017, 48(6):55-62.

[20] Rohmah M, Saragih B, Amaliah N, Kristopal K, Hendriansyah Y, Putra E,Rahmadi A. Determination of Moisture, Ash, Protein, Polyphenolic, Flavonoids, and Amino Acid Contents and Antioxidant Capacity of Dried Mekai (*Pycnarrhenatumefacta* Miers) Leaf as Potential Herbal Flavor Enhancers. *Advances in Biological Sciences Research*, 2021, 17: 149-158.

[21] Olakunle MM, Adebola A. Effect of Natural Fermentation on the NutritiveValue and Mineral Composition of African Locust Beans. *Pakistan Journal of Nutrition*, 2012, 11(1): 11-13.

[22] Ezegwu EN, Okoye JI, Ene GI. Effects of Processing on the Nutrient and Anti-Nutrient Contents of African locust bean (*Parkia biglobosa*) flour. *International Journal of Food Science and Nutrition*, 2018, 3(4): 107-111.

[23] Ajegena YS, Atara JG,Emgba KS. Proximate Analysis of Fermented and Unfermented African Locust Beans (*Parkia Biglobosa*), Found in Lafia, Nasarawa State, Nigeria. *International Journal of Research and Scientific Innovation*, 2020, 7(10): 235-236.

[24] Khan N, Ruqia B, Hussain J, Jamila N, Rahman NU, Hussain ST. Nutritional Assessment and Proximate Analysis of Selected Vegetables from Parachinar Kurram Agency. *American Journal of Research Communication*, 2013, 1(8): 184-198.

[25] Sodamade A, Bolaji OS, AdeboyeOO. Proximate Analysis, Mineral Contents and Functional Properties of *Moringa Oleifera* Leaf Protein Concentrate. *Journal of Applied Chemistry,*2013, 4(6): 47-51.

[26] Ibrahim DF, Hassan AS, Sani A, Zakariyya A, Shema FB, Zubair RU, Riruwai GY. Effect of Aqueous Stem Bark Extract of Parkia Biglobosa on the Histological Morphology of Liver of Adult Wistar Rats. *American Journal of Medical Science and Innovation*, 2023, 2(1): 13-20.

[27] Shamsun N, Ghosh A, Shahin A. Comparative Studies on Physicochemical Properties and GC-MS Analysis of Essential Oil of the Two varieties of Aniseed (*Piminellaanisum Linn*), *International Journal of Pharmaceutical and Phytopharmacological Research*, 2012, 2(2): 92-95.

[28] Akpabio UD, Ikpe EE. Proximate Composition and Nutrient Analysis of *Aneilemaaequinoctiale*Leaves. *Asian Journal of Plant Science and Research*, 2013, 3(2): 55-61.

[29] Lattimer JM, Haub MD. Effects of dietary fiber and its components on metabolic health. Nutrients, 2010, 2(12): 1266–1289. https://doi.org/10.3390/nu2121266

[30] Termote C, Nicanor OO, Dreyer BS, Guissou B, Parkouda C,Vinceti B. Nutrient Composition of *Parkia biglobosa* Pulp, Raw and Fermented Seeds: A Systematic Review. *Critical Reviews in Food Science and Nutrition*, 2020, 20: 1-26.

[31] Asunni AO, Fagbemi SA, Oyinloye AM, Gowon CB, Enujiugha VN. Amino Acid Profile and Physicochemical Properties of African Locust Bean (Parkia biglobosa) Seeds as affected by Combined Irradiation and Cooking. *International Journal of Environment, Agriculture and Biotechnology*, 2024,9(1): 153-164.

[32] Anhwange B, Kyenge B, Kukwa R, Ishwa B. Chemical Analysis of Prosopis Africana Seeds. *Nigerian Annals of Pure and Applied Sciences*, 2021,3(2): 129-140.