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Comparative Nutritional Analysis of *Daddawa* Made from Fermented *Parkia biglobosa* and *Glycine max* Seeds

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Abstract The nutritional constituents of Fadan Karshi *Daddawa* made from fermented *Parkia biglobosa* and *Glycine max* were determined using AOAC, (2006) official and recommended methods. The results obtained for the proximate analysis fermented *Parkia biglobosa max* were moisture (7.50 %), ash (11.50%), crude fat (6.36%), crude fibre (6.83%), crude protein (28.38%) and crude carbohydrate (28.42%). However, the correspond-ding values for the *Daddawa* made from the fermentation of *Glycine max* seeds were 15.93, 33.48 and 35.71% respectively. Calculated energy values were 471.75 and 462.23 kcal/100g for the *Parkia biglobosa* and *Glycine max* products respectively. Mean concentrations of Na, K, Mg, Ca, P, Zn, Cu, Fe and Mn in the fermented the *Parkia biglobosa* products were 18.89, 19.43, 278.23, 329.02, 12.19, 12.19, 6.11, 1.99, 21.55 and 18.177 mg/g respectively. However, mean concentrat-ions of these elements in the fermented *Glycine max* products were 18.28, 22.39, 244.76, 447.91, 13.45, 5.49, 1.62, 21.06 and 7.79 mg/100g. The amino acid profile of the two fermented seeds indicated highest concentration for aspartic acid (with concentrations of 10.12 and 10.23 g/100g for the fermented *Parkia biglobosa* and *Glycine max* products respectively) while methionine had the least concentrations (1.58 and 1.60g/100g for fermented *Parkia biglobosa* and *Glycine max* products respectively respectively). Measured values for the functional properties of the (6.65), wettability (401.00), bulk density (0.24), gelatinization temperature (82.50 °C), foaming stability (7.00%), viscosity (3.50 second), oil absorption property (2.38 g) and gelation capacity (14.00%). In the *Glycine max* fermented product, the corresponding values were 7.35, 55.50 s, 0.93 g/cm^{3}m 85.00 °C, 50.30%, 11.00%, 8.00%, 3.50 s, 1.03 g and 15.00% respectively.The results indicated significant nutrient enrichment due to fermentation of *Parkia biglobosa* and *Glycine max*. Hence fermentation of these plants seeds should be encouraged and practice.

Key Words: *Processing, fermentation, Daddawa, fermented, Glycine max, Parkia biglobosa, seeds, nutrient enrichment.*

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1.0 Introduction

Food processing involves all the steps taken to increase nutrient availability, appearance, palatability, ease of consumption, preservation and removal of unwanted components (ref). Processing techniques include, fermentation, baking, cooking, frying, etc. However, fermentation techniques has

been widely accepted and documented as a method that has several advantage (Murtala *et al.,* 2016; Thomas *et al.,* 2012; Olagunju *et al*. (2018). Enhancement of food quality has been reported by for some food and combination of food materials, According to Bayer *et* al. (1998), daddawa is made from locust beans from the wide-canopied *Parkia biglobosa* and *P. Clappertoniana* (Syn. *P. Filicoidea*) trees which shade West African farmlands from the northern edge of forest belt to the southern edge of the Sahel, Several analytical studies have been reported for *daddawa* produced from the fermentation of some plant seeds. Muetala *et al*. (2015) analysed samples of *daddawa* along street in Kano State, Nigeria and found significant concentration of crude protein and fat, followed by fibre, moisture, ash and lastly by carbohydrate. Locust beans had the highest concentrations of potassium, sodium, vitamin C and A compared to soya beans *daddawa*. However, highest concentration of calcium, zinc and iron was found in soya beans *daddawa*. Fermentation of *Glacine max* (soybeans) in the production of *daddawa* was studied by Omafuvbe *et al*. (2000) and it was found that bacterial involves in the fermentation are *B. subtilis*, *B. licheniformis* and *B. Pumilus*. They noted that bacterial population, protease activity (hence amino acid profile) pH and titratable acidity increase as the fermentation progresses. Concentration of sugar was observed to decrease as the period of fermentation increases. Dakare *et al*. (2011) carried out fermentation of pawpaw seeds by *B. subtillis,, B. pumillus and B. licheniformis* to produce *daddawa* and the results obtained indicated significant decrease in antinutritional factors but increase amino acid profiles (leucine, lysine, isoleusine and phenylalanine). Fatty acid content of the fermented product was also found to increase by an average value of 3 %. In their study, Ibrahim *and* Antai (1986), allowed African locust-bean (*Parkia filicoidea* Welw) seeds to ferment under natural conditions and the chemical changes occurring during the fermentation were studied. Their results indicated protein enrichment of the *daddawa* produced by the fermentation process. Olagunju *et al*. (2018) noted that *Bacillus subtilis*, *Bacillus licheniformis*, and *Bacillus pumilus* are the organisms fermenting the tamarind seed. they observed substantial decrease in phytic acid, tannin and trypsin inhibitor activity. *Diaddawa* is widely consumed in the Northern Nigeria and are produced through fermentation of some seeds; (Achi, 2005; Murtala *et al.,* 2016; Thomas *et al.,* 2012). The product is a traditionally accepted in the Northern Nigeria but little is known of its nutritional or antinutritional factors. Therefore, the aim of this study is to produce *diaddawa* from fermentation of *Parkia biglobosa* and *Glycine max* seeds, analyse and compare their proximate, elemental, amino acid profile and functional properties.

2. 0 Material and Methods

2.1 Sample Preparations

The samples were purchased in central market Minna between the months of January and February 2019. The seeds were separated dirt, washed and rinsed with clean water and sun dried for two days. After drying, they were ground into fine powder with porcelain mortar and pestle, sieved with mesh size of 0.5 mm. The traditional methods of African locust beans fermentation was adopted in this work with modification. 500 g of *Glycine max and Parkia biglobosa* seeds powder were weighed into 1000 cm^3 conical flask, 250 $cm^3$of distilled water was added while 2 g of yeast (*Saccharomyces cerevisiae*) was added to the mixture. It was mixed thoroughly, covered and was fermented for 48 h. The fermentation was quenched using freeze dryer and this was kept for further analysis (Mathew *et al.,* 2018a).

2.2 Proximate Analysis

The moisture, ash, fat and protein contents of the *Glycine max and Parkia biglobosa* seeds flour were determined using the methods of AOAC (2006). Total carbohydrate content was determined by subtracting percentage protein, ash, moisture, crude fiber, along with the fat from 100%. The energy value (kcal/100g) was estimated by multiplying the percentage of crude protein, crude lipid as well as carbohydrate by 4, 9 and 4 respectively as conversion factors (Mathew *et al.,* 2014).

2.3 Elemental analysis

The sample was digested by weighing in triplicate 1.00 g into beakers and 10 cm3 of the acid mixture ($HClO_4$:H_2SO_4:HNO_3) in the ratio of 1:4:3 was added in each case. The mixture was swirled and left in a fume cupboard overnight. The samples were then digested on a kjedhal digestion block until the solutions became quite clear. The digests were allowed to cool, diluted with 20 cm^3 of water, filtered using Whatman filter papers, made up to

mark with deionized water in 100 cm3 volumetric flasks and then transferred into sample bottles. The samples were analyzed for their mineral contents of interest using atomic absorption spectrophotometer (AAS) Buck model 210 VGP. A flame photometer (AA-500F, China) was used for the determination of potassium and sodium, while phosphorus was determined colorimetrically using the vanudo-molybodate colorimetric method (Etsuyankpa *et al.,* 2019; Mathew, *et al.,* 2020).

2.4 Determination of amino acid profile

The sample was defatted using chloroform/methanol mixture in 2:1 proportion. About 4.00 g of the sample was kept in extraction thimbles and extracted for 15 h in Soxhlet extractor (Nieman *et al.,* 1992).

2.5 Determination of nitrogen

In each case, 200 mg of the powdered sample was weighed, wrapped in Whatman filter paper (No.1) and kept in the Kjeldhal flask. 0.50 g of sodium sulphate (Na_2SO_4), copper sulphate ($CuSO_4$) and selenium oxide (SeO_2) at 10:5:1 ratio was added into the digestion flask. 10 cm^3 of concentrated sulphuric acid and anti-bumping agents were also added to the mixture. The distillate was then titrated with standardizing 0.01 $moldm^{-3}$ hydrochloric acid.

$$\%\text{Nitrogen} = \frac{(a-b)\times 0.01\times 14\times V\times 100}{W\times C} \quad (1)$$

Where a is the titre value of the digested sample; b = titre value of the blank sample; V = volume after dilution (100 cm^3); W = weight of dried sample (mg); C = aliquot of the sample used (10 cm^3)

About 2.00 g of the dried sample was weighed into extraction thimble and defatted with 2:1 chloroform and methanol mixture using Soxhlet extractor. From the defatted sample, 1.0 g was weighed into glass ampoule and 7 $cm^3$of 6.0 $moldm^{-3}$HCl was added and oxygen was expelled by passing nitrogen into the ampoule. The glass ampoule was sealed and placed in an oven preset at 105±5^{o}C for 22 h. The ampoule was allowed to cool before breaking open at the tip and the content filtered. The filtrate was then evaporated to dryness at 40^{o}C and the residue was dissolved in 5 cm^3 acetate buffer (pH 2.0) and stored in plastic specimen bottles. About 5-10 µl was dispensed into the cartridge of the sequential multi-sample amino acid analyzer (TSM). The net height of each peak produced by the chart recorder of TSM was measured. The half-height of the peak on the chart was found and the width of the peak on the half height was accurately measured and recorded. Approximately area of each peak was then obtained by multiplying the height by the width at half-height.

The norcleucine equivalent (NE) for each amino acid in the standard mixture was calculated using the formula:

$$\text{NE} = \frac{\text{Area of Norceucine Peak}}{\text{Area of each amino acid}} \quad (2)$$

A constant S was calculated for each amino acid in the standard mixture:

Where S_{std}= NE_{std} x Molecular weight x μMAA_{std} (3)

The amount of each amino acid present in the sample was calculated in g/16gN or g/100g protein using the formula:

Concentration (g/100g protein) = NH x W@NH/2 x S_{std} x C (4)

$$C = \frac{\text{Dilution factor}\times 16}{\text{Sample weight (g)}\times\%\text{N}\times 10\times\text{vol loaded}} \div \text{Nh} \times W(\text{norleucine}) \quad (5)$$

where Nh = Net height, W = Width at half height and W(norleucine) = Width of norleucine.

2.6 Determination of functional properties

The gelatinization temperature, water and oil absorption capacity were analyzed base on the method of Sathe *et al*. (1982). The method described by AOAC, (2006) was utilized in the analysis of pH, emulsification and swelling and foam capacity while the foam solubility was calculated after the determination of swelling capacity as per 100 g of starch on dry basis. Addition of 5 cm^3 of aliquot of the supernatant was dried to a constant weight at 120 ^{o}C. The procedure of AOAC (2006) was used to determine bulk density, wettability and gelation properties.

3.0 Results and Discussion

Proximate composition of fermented *Parkia Biglobosa* and *Glycine max* seeds are presented in Table 1. The mean moisture concentrations were 7.50±0.71 and 11.50±0.71 % for *Parkia Biglobosa Biglobosa* and *Glycine max* seeds respectively. This indicated that *Glycine max* seeds has higher moisture content than *Parkia biglobosa* seeds. The higher the moisture content, the lower the expected shelf life indicating that *Parkia biglobosa* seed should be higher than that of *Glycine max* seeds.

Fermented from *Parkia biglobosa* and *glycine max* had ash contents of 0.36±0.71 and 6.83±0.47 respectively while their crude fat contents were 28.38±0.78 and 28.42±0.21% respectively. The fibre contents were 1.71±0.04 and 1.48±0.05 %

respectively. *Daddawa* produced from *Parkia biglobosa* and *glycine max* seeds had mean protein contents of 20.13±1.24 and 15.93±1.48% respectively while the carbohydrate contents were 33.84±1.24 and 35.71±1.48% respectively.

Table 1: Proximate Composition of *Daddawa* made from Fermented *Parkia biglobosa* and *Glycine max* Seeds (%)

Parameter	Fermented p*arkia Biglobosa* seeds	Fermented *Glycine max* seeds
Moisture content	7.50±0.71	11.50±0.71
Ash content	6.36±0.71	6.83±0.47
Crude fat	28.38±0.78	28.42±0.21
Crude fibre	1.71±0.04	1.48±0.05
Crude protein	20.13±1.24	15.93±1.48
Carbohydrate	33.84±1.24	35.71±1.48
Energy value (kcal/100g)	471.75± 0.05	462.23±0.06

**** values are means of duplicate determinations ± standard deviations**

The energy content of the products which depends on their contents of carbohydrates, protein and fat were 471.75± 0.05 and 462.23±0.06 kcal/100g for *Daddawa* produced from *Parkia biglobosa* and *glycine max* seeds respectively. The results indicated that mean moisture content, ash content, crude fat content, and carbohydrate contents of *daddawa* produce from fermentation of *glycine max* seeds are higher than those from *Parkia biglobosa* seeds. However, the energy value of *dadawa* from *Parkia biglobosa* seeds is higher than the one from *glycine max* seed. This is due to higher fat content and higher activity of proteases during the fermentation of Parkia *biglobosa* seeds compared to *Glycine max* seeds. Muetala *et al.* (2015) observed that increase porteases activity can enrich *dadawa* with protein which explain why the protein content, hence the energy content of *daddawa* produced from *Parkia biglobosa* seeds is higher than those from *Gkycine max* seeds. The observed proximate parameters are higher in values than those *daddawa* produced from pigeon pea flour Babalola and Giwa (2012). According to Soetan *et al*. (2014) seeds of *Parkia biglobosa* had significantly concentrations of crude fat (49.20%), %dry matter (95.20%) and crude protein (33.50%). The measured concentrations of these proximate paramters in the *daddawa* samples are lower than their background concentrations, which indicates that some nutrients were lost during the fermentation process. On the other hand, proximate composition of soybean seeds is rated to include, 36% protein and 20% fat, 30% carbohydrates, 9% water and 5% ash (Ta'awu *et al*. 2020). This also implies that some proximate constituents were lost during the fermentation process.

Table 2 shows elemental compositions of *daddawa* produced from fermented *Parkia biglobosa* and *Glycine max* seeds. Highest concentrations were observed for calcium and magnesium while the least was measured for zinc in both products.

Table 2: Mineral Concentrations of *Daddawa* made from Fermented *Parkia biglobosa* and *Glycine max* Seeds

Parameter	Fermented p*arkia Biglobosa* seeds	Fermented *Glycine max* seeds
Sodium	18.89±0.13	18.28±0.09
Potassium	19.43±0.08	22.39±0.05
Magnesium	278.23±0.06	244.76±0.13
Calcium	329.02±0.02	447.91±0.02
Phosphorous	12.19±0.12	13.45±0.05
Zinc	6.11±0.37	5.49±0.13
Copper	1.99±0.02	1.62±0.08
Iron	21.55±0.01	21.06±0.02
Manganese	18.17±0.02	7.79±0.01

****The values are means of triplicate determinations ± standard deviations**

Mean sodium concentrations in *daddawa* produced from *Parkia biglobos* (18.89±0.13 mg/g) was slightly higher than the same product from *Glycine max* seeds (18.28±0.09 mg/g). However, potassium ion concentration in *Glycine max daddawa* (22.39±0.05 mg/g) was higher than the one in *Parkia biglobasa* seeds (19.43±0.08 mg/g). Concentrations of magnesium (278.23±0.06 mg/g), zinc (6.11±0.37 mg/g), copper (1.99±0.02 mg/g), iron 21.55±0.01 mg/g) and manganese (18.17±0.02 mg/g) were higher in *Parkia biglobosa daddawa* than in *Glacine max daddawa* which had; Mg (244.76±0.13 mg/g), Zn (5.49±0.13 mg/g), Cu (1.62±0.08 mg/g), Fe (1.62±0.08 mg/g) and Mn (7.79±0.01 mg/g) respectively. On the other hand, concentrations of calcium in *Glacine max daddawa*

(447.91±0.02 mg/g) was higher than the concentration in *Parkia bigloboda daddawa* (329.02±0.02 mg/g). Similar observation was applicable to phosphorus in *daddawa* produced from *Glycine max* (13.45±0.05 mg/g) and from *Parkia biglobosa* (12.19±0.12 mg/g) seeds. According to Soetan *et al*. (2014) seeds of *Parkia biglobosa* had significantly concentrations of calcium (0.703%), Mg (0.356%), K (0.211%), Na (86.729%), Mn (54.811 ppm), Fe (69.828 ppm), Cu (9.766%), and Zn (12.156%).Therefore, they might have been enrichment of the *daddawa* with micronutrients during fermentation. The observed concentrations of elopements are lower those reported by Mathew (2018b) except for Cu and Fe.

The amino acid profile of the studied samples is presented in Table 3.

Table 3: The Concentration of Amino acids of *Daddawa* made from Fermented *Parkia biglobosa and Glycine max* Seeds *(*g/100g protein)

Parameters	Fermented *Parkia biglobosa* seeds	Fermented *Glycine max* seeds
Leucine	8.25	8.93
Lysine	6.49	6.90
Isoleucine	4.75	5.01
Phenylalanine	5.27	5.85
Tryptophan	1.38	1.52
Valine	5.17	5.64
Methionine	1.38	1.60
Proline	3.34	3.96
Arginine	8.20	8.17
Tyrosine	3.00	3.61
Histidine	2.77	3.00
Cystine	1.43	1.70
Alanine	4.12	4.44
Glutamic acid	14.03	14.38
Glycine	4.30	5.01
Threonine	3.70	4.30
Serine	4.25	4.86
Aspartic acid	10.02	10.23

The essential amino acids such as leucine, lysine, valine, phenylalanine and isoleucine of *Daddawa* made from fermented *P. biglobosa* showed higher concentrations compared to *daddawa* from *G. max* viscosity and foaming stability. Significant differences were observed for other parameters seed. However, concentration of tryptophan in *G. max* sample is higher than the concentration in *parkia biglobosa daddawa*. Other literature in which the raw seeds were used for analysis of amino acid profiles, showed relatively low concentrations compared to the fermented seeds used in this work. The observed increase in amino acid profile compared to those reported for the raw seed is due to higher proteases activity (Odunfa, (2008). The *Daddawa* made from fermented *P. biglobosa* and *G. max* seeds showed good functional properties as shown in Table 4. When compared with each other, the pH (6.65 and 7.35) for *P. biglobosa* and *G. max* respectively are mildly acidic (*Parkia biglobosa daddawa*) and mildly alkaline (*Glycine max daddawa*). Wattability and oil absorption capacity for *Parkia biglobosa daddawa* were higher than *daddawa* from *Glycine max* seeds. Consequently, *Glycine max* daddawa displayed higher indices for bulk density, gelatinization temperature, emulsification capacity foaming capacity and foaming stability than *Parkia biglobosa daddawa*. The viscosity of the two *daddawa* fermented the two seeds was the same. The functional properties of these fermented seeds correlate with the analysis of other fermented foods such as fermented oil bean, with gelation concentrations of 14% and 16% similar to the results in Table 4. (Akubor and Chukwu, 1999).

Statistical T-test can be used to show the significant difference between two set of data with known mean and standard deviation. The appropriate T-test for the observed data can be expressed according to equation 6 (Bewick, *et al.,* 2003)

$$t_{tedt} = \frac{\overline{X_2} - \overline{X_1}}{\sqrt{\frac{s_2^2}{n_2} + \frac{s_1^2}{n_1}}} \qquad (6)$$

Table 5 shows calculated t-values for the different proximate, elemental and functional properties between *daddawa* from *Parkia biglubosa* and *Glycine ax seeds.* potassiumhe results indicate that there was no significant difference ($T_{critical}$ at P>0.05) between *daddawa* produced from *Gycine max* and *Parkia biglubosa* seeds with respect to ash, crude fat, carbohydrate and potassium contents. Also, there was no significant difference between the following functional properties: gelatinization temperature, emulsification capacity,

Table 4; Functional Properties of *Daddawa* made from Fermented *Parkia biglobosa* and *Glycine max* seeds

Parameter	Fermented *Parkia biglobosa* seeds	Fermented *Glycine max* seeds
pH	6.65±0.07	7.35±0.07
Wetability (s)	401.00±4.24	55.50±2.12
Bulk density (g/cm^3)	0.24±0.04	0.93±0.01
Gelatinization temperature (^{o}C)	82.50±0.71	85.00±1.41
Emulsification capacity (%)	50.14±0.19	50.30±0.42
Foaming capacity (%)	7.50±0.71	11.00±1.41
Foaming stability (%)	7.00±1.41	8.00 ±0.00
Viscosity (s)	3.50±0.71	3.50±0.71
Oil absorption capacity (g)	2.38±0.12	1.03±0.06
Gelation capacity (%)	14.00±2.83	15.00±1.41

****The values are means of duplicate determinations ± standard deviations (SD).**

Table 5: Calculated t-values for *Diaddawa* produced from the fermentation of *Parkia biglubosa* and *Glycine max.*

Proximate parameters	T_{Cal}	Elements	T_{Cal}	Functional properties	T_{Cal}
Moisture	4.8790	**Sodium**	4.8025	**pH**	8.6604
Ash content	*0.6899	**Potassium**	*0.5061	**Wettability**	94.0918
Crude fat	*0.0700	**Magnesium**	305.1140	**Bulk density**	23.9023
Crude fibre	4.42635	**Calcium**	5148.088	**Gelatinization temperature**	*2.04251
Crude protein	2.6745	**Phosphorous**	12.8375	**Emulsification capacity**	*0.4543
Carbohydrate	*1.1908	**Zinc**	2.1477	**Foaming capacity**	2.8595
Energy value	149.9010	**Copper**	6.4086	**Foaming stability**	*1.2284
		Iron	28.2902	**Oil absorption capacity**	12.9904
		Manganese	599.290	**Gelation capacity**	0.4085

** **Asterick = significant difference exist**

4.0 Conclusions

From the analytical results above, in conjunction with the objectives of this research, *Daddawa* made from *P. biglobosa* have good percentages of nutritional values, mineral concentrations, amino acids concentrations and good functional properties. However, *Daddawa* made from *Glycine max* seeds have higher nutritional value. Therefore, processing of these seeds of *P. max* and *G. max* into condiments (*Daddawa*) should be encouraged due to their good nutritional values, but more
interest should be given to the *Daddawa* made from *G. max* due to its higher nutrient.

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