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Chemical Composition and Functional Properties of the African Locust Bean (*Parkia biglobosa*) Seeds

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The proximate and nutritionally valuable mineral compositions were determined in raw, cooked and fermented African locust bean seeds (ALBS). The functional properties were also evaluated in the fermented sample. Results showed that fermentation improved protein, ash and calcium quantitatively in over cooked sample while fat, carbohydrate, magnesium, sodium, phosphorus, zinc and iron values were more concentrated in the cooked sample. The functional property results showed that fermented ALBS was poor in most functional properties except in water absorption capacity. Protein solubility was high in the acid and alkaline media while the isoelectric point was 7.0 showing that fermented ALBS would be useful in food formulations involving both low and high pH.

Kew words: *Parkia biglobosa*, African locust bean, Chemical composition, Functional properties.

Introduction

The African locust bean (ALB) (*Parkia biglobosa*) tree is fairly widely distributed all over the natural grassland of Northern Nigeria (Oyenuga 1968) where it is planted mainly for the food value of its fruits. These fruits contain branches of pods that form the most valuable part of the plant. Each pod contains a yellow, dry powdery pulp inside which are embedded a number of brown or black seeds. All parts of the fruits such as the husk, pulp and seed have found useful applications.

The seed is often cooked and later fermented. The fermented ALBS is called *dawadawa* in Hausa, *iru* in Yoruba and *ogiri-igala* in Ibo land of Nigeria; it is called *kpalugu* among the Kumasis and Dagombas of Northern Ghana, *kinda* in Sierra Leone and *netelou* or *soumbara* in Gambia. It is the most important natural food condiment in the entire Savannah region of West and Central Africa. Oyenuga (1968), Campbell - Platt (1980), Odunfa (1981, 1983) carried out some nutritional studies on the ALBS while Ladipo and Adegboye (1976), Ogunbunmi and Bassir (1980), Eka (1980), Aderibigbe and Odunfa (1990) also examined some aspects of the fermented seeds. The present study focuses on the proximate mineral analyses of raw and cooked (fermented and unfermented), and the functional properties of the fermented seeds.

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Materials and Methods

Samples of raw, cooked (unfermented) and cooked (fermented ALBS were purchased from the local market in Akure, State of Nigeria. All impurities were removed by sorting. The fermented seeds were washed thoroughly with distilled water and all the seeds were later preserved in a deep freezer pending analyses after homogenisation in a Kenwood Major blender.

Moisture, ash and ether extract were determined by AOAC methods (1990). Nitrogen was determined by the micro-Kjeldahl method (Pearson 1976) and the crude protein was taken as N% x 6.25. Carbohydrates were determined by difference. Minerals were analysed using solution obtained by dry-ashing the sample flours at 55°C and dissolving it in 10% HCl (25ml) and 5% lanthanum chloride (2ml), boiling, filtering and making up to standard volume with distilled de-ionised water. Ca, Mg, Zn and Fe were determined with Pye Unicam Sp (9) absorption spectrophotometer. Na and K were measured with a Corning 405 flame photometer (AOAC 1990). The detection limits had previously been determined using the methods of Varian Techtron (1975) as K 0.005, Na 0.012, Fe 0.03, Ca 0.01 and Mg 0.001 ppm (all for aqueous solutions). The optimum analytical range was 0.1 to 0.5 absorbance units with a coefficient of variation of 0.87% to 2.20%. Phosphorus was determined using Spectronic 20 colorimeter by the phosphovanado-molybdate method (AOAC 1990). All chemicals were BDH analytical grade.

The protein solubility was examined from pH 2-12 by the method of Adeyeye *et al* (1994). The foaming capacity and stability and lowest gelation concentration were studied according to the method of Coffman and Garcia (1977). The oil absorption and water absorption capacities were studied according to the modified methods of Sosulski (1962). The modified procedure of Inklaar and Fortuin (1969) was followed to determine the oil emulsion capacity. Beuchat (1977) method was followed to determine the oil emulsion stability. All the data generated were analysed statistically.

Results and Discussion

The proximate composition of the raw, cooked and fermented samples of ALBS are shown in Table 1. The fermented sample has the highest value of crude protein (41.2%), ash (7.0%) and moisture (13.7%) but the lowest value of carbohydrate (30.6%). These observations can be attributed to fermentation and its agents. These results follow the same trend in other literature reports for fermented food products like *ugha* (Pierson *et al* 1986), *nono* (Eka and Ohaba 1977), *iru* (Eka 1980) and cassava tuber. The raw seed has the highest value of carbohydrate (51.2%) but lowest in the ether extract (6.6%). The cooked sample contains the highest ether extract (27.6%) due to mobilisation of the crude fat during boiling but is lowest in crude protein (18.9%), ash (4.7%) and moisture (11.5%). Statistical analysis showed that the coefficient of variation percent (cv%) is low in most of the parameters but high in ether extract (69.9%). However, the analysis of variance showed that Fc (3.30) < Ft (3.68) means that no significant differences existed among the samples at $p = 0.05$.

The process of fermentation involved two major steps which are boiling the ALBS in water for 12 h or more and fermenting for 36 h or more (Odunfa 1986). Microbial action during fermentation appears to boost the protein value even beyond that in the raw seeds. This means that fermented ALBS would serve both as food condiment and protein enricher in soup. Lipolytic activity during fermentation could have reduced the crude fat content (Odunfa 1986). The quantity of *iru* consumed varies with the country and within the country. The average per capita per day consumption of *iru* in Togo and Ghana is 4g and 2g respectively (Perisse 1958; Lawson 1965). This means a Togolese would receive 1.64 g and a Ghanaian 0.84 g protein respectively from *iru* based on our results of 41% protein in fermented ALBS. The Yarubas of southwestern Nigeria consume 10 g per day per person (Dema 1965), that is 4.1 g protein from *iru*. Overall, consumption estimated for parts of Nigeria ranges from 1 to 17 g per person per day (Dema 1965) of *iru* or 0.41 g to 6.97 g of protein from *iru* per person per day. Campbell-Pratt (1980) reported a crude protein value of 38.5% for *iru* while Odunfa (1981) and Oyenuga (1968) both reported a crude protein value of 30.0% for *iru*.

There is a noticeable decrease in carbohydrates from 51.2% in the raw seeds to 30.6% in the fermented seeds. During fermentation, some of the micro-organisms would have depended on the carbohydrate as a source of energy and this could account for the observed decrease. Hydrolytic processes during fermentation resulted in increased moisture content of the seeds while proteolysis appears to be the most significant biochemical change during ALBS fermentation (Odunfa 1985). The presence of raffinose in ALBS causes flatulence

Table 1

Composition of *P. biglobosa*

Parameters		Fermented seed	Cooked seed	Raw seed	Grand mean	S. D	CV%
Total ash	g $100g^{-1}$ wwb	7.0 ± 0.01	4.7± 0.05	4.8 ± 0.04	5.5	1.1	19.7
Moisture	"	13.7 ± 0.01	11.5 ± 0.02	13.4 ± 0.13	12.9	1.0	7.6
Dry matter	"	86.3 ± 0.01	88.5 ± 0.02	86.6 ± 0.13	87.1	1.0	1.1
Crude protein	"	41.3 ± 0.15	18.9 ± 0.01	24.1 ± 0.25	28.1	9.6	34.1
Total carbohydrate	"	30.6 ± 0.62	37.3 ± 0.35	51.2 ± 0.46	39.7	8.6	21.7
Crude fat	"	7.5 ± 2.30	27.6 ± 1.30	6.6 ± 1.40	13.9	9.7	69.9
Calcium	mg kg^{-1} wwb	754.6 ± 0.52	665.7 ± 0.55	942.6 ± 1.10	742.3	119.0	15.2
Magnesium	"	88.0 ± 1.73	295.1 ± 0.14	126 5 ± 1.18	169.9	89.9	53.0
Sodium	"	0.24 ± 0.02	0.25 ± 0.01	0.26 ± 0.03	0.25	0.01	4.0
Potassium	"	0.02 ± 0.0	0.09 ± 0.01	0.09 ± 0.0	0.07	0.03	42.9
Phosphorus	"	70.6 ± 0.05	115.6 ± 0.0	93.6 ± 0.0	93.3	18.4	19.7
Zinc	"	318.6 ± 0.01	358.2 ± 0.21	411.8 ± 0.10	362.8	38.2	10.5
Iron	"	10.2 ± 0.22	13.7 ± 0.11	19.0 ± 0.01	14.3	3.6	25.2

when ingested (Rakis *et al* 1970) but its hydrolysis during fermentation is nutritionally significant.

The mineral composition is shown in Table 1. The table shows that calcium in the fermented ALBS is higher than that in the cooked sample but lower than the raw seed value. The trend in iron, zinc and sodium concentration follows the trend: fermented seeds < cooked seeds < raw seeds. This may be due to these minerals being used up by the fermenting organisms; also during boiling some of the minerals might be leached. However, in magnesium and phosphorus, the trend of concentration is: fermented seed < raw seeds < cooked seeds. The least value of potassium is recorded in the fermented seeds but similar values are observed for cooked and raw seeds. Schroeder (1971) asserted that losses during preparation and cooking of food may decrease the mineral contribution to diet. He concluded that raw foods are good sources of trace minerals. This is evident for zinc and iron in the raw seeds. The cv% are low and high depending on the minerals under consideration with values ranging between 4.0% (Na) and 53.0% (Mg). However, no significant differences (P=0.05) were found in the mineral elements analysed for in the samples. The fermented ALBS is a good source of calcium, magnesium, phosphorus, zinc and iron. This means that *iru* contains most of the important minerals which will meet the recommended daily allowance requirements in conjunction with other foods (Oke 1972).

Our results for the mineral elements in *iru* show that we have good comparison with literature values (Oyenuga 1968 and Odunfa 1986). The much talked about high salt content usually implicated in *iru* may not be based on the results in Table 1. The salt (sodium chloride, 5% w/w) that is added to *iru* before sundrying serves only as a temporary preservative inhibiting both the growth of *Bacillus subtilis* and its proteolytic activity (Preston-Holder 1981). The values for both sodium and potassium in Table 1 are low in all the samples, hence, *iru* cannot be said to be a promoter of hypertension. Toxicants like hydrocyanic, oxalic and phytic acids tended to get

Table 2
Functional properties of fermented *P. biglobosa*

	Percentage
Water absorption capacity	87.5 ± 0.0
Oil absorption capacity	13.3 ± 0.03
Oil emulsion capacity	5.7 ± 0.04
Oil emulsion stability 12h	4.7 ± 0.50
Foaming capacity 0 min	2.0 ± 0.01
Foaming stability 5 min	-
Lowest gelation concentration 16% w v^{-1}	-

reduced by fermentation (Eka 1980) thereby making available to the body all the contents of calcium, magnesium, phosphorus, zinc and iron in *iru*.

Functional properties. The results of the pH effects on protein solubility of fermented ALBS are shown in Fig 1. It shows high solubility in both acid and alkaline media. The isoelectric point (LEP) value was 7.0. The IEP of *iru* is close to the values quoted by Oshodi *et al* (1977) (IEP 4.0 and 7.0) and Ige *et al* (1984) (IEP 6.0 and 8.0). Protein concentrate, soluble at pH 4-7 could be used in such beverages as milk (Del Rosairo and Flores 1991). The high pH solubility of ALBS protein in both the acid (71.0%) and alkaline (81.0%) media indicates that it may be useful in the formulation of acid beverages like carbonated beverages (Olaofe *et al* 1998) and very low acid foods like meat products or beverages with high pH (Olaofe *et al* 1993) The possession of only one point of IEP suggests that ALBS may have one major protein constituent.

The water absorption capacity (WAC) value (87.5%) of *iru* is shown in Table 2. This value is lower than the hulled sample of *Adenopus breviflorus* benth seed flour (175.0%), the dehulled full-fat of *A. breviflorus* benth seed (112.5%) (Oshodi 1992) and sunflower flour (130.0%) (Lin *et al* 1974). These literature values show that *iru* is less hydrophilic than *A. breviflorus* benth, sunflower and soy flours. However *iru* is better value than that for full-fat fluted pumpkin seed flour (85.0%) (Fagbemi and Oshodi 1991), hence *iru* may be used in viscous foods like soups, gravies, doughs, baked products, etc to increase viscosity. The value of oil absorption capacity (OAC) (13.3%) is lower than those for pigeon pea flour (89.7%) (Oshodi and Ekperigin 1989) and wheat and soy flours (84.2% and 84.4% respectively) (Lin *et al* 1974). OAC is important since oil acts as flavour retainer and increases

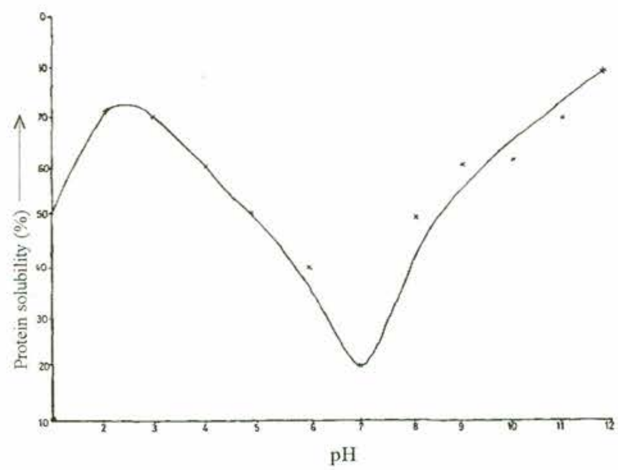

Fig 1. Protein solubility as a function of pH effects on fermented *Parkia biglobosa*.

the mouth feel of foods (Kinsella 1976). The oil emulsion capacity (OEC) value is 5.7%. This value is lower than reported by Oshodi (1992) in hulled *A. breviflorus* benth flour (20.46%); 7.0 - 11.0% reported for wheat and 18.0% for soy flours (Lin *et al* 1974); 20-70% for African yam bean flours (Adeyeye *et al* 1994). The present result for *iru* shows that it may not be useful as an additive for the stabilisation of the emulsions in sausage, soup and cake (Altschul and Wilcke 1985). The oil emulsion stability (OES) is 4.7% which collapsed within 12 h. The low OES could be due to the possibility of denaturation which might have destroyed the hydrophobic domains thereby reducing the oil binding (Hutton and Campbell 1981). *Iru* may not be very useful for the stabilisation of emulsions due to the fermentation process. The foaming capacity (FC) and foaming stability (FS) values are shown in Table 2. The FC value of 2.0% is lower than those quoted in various literature. The low FC of *iru* will not enhance its functionality for the production of cakes and whipping toppings (Kinsella 1979). The FS disappeared within few minutes; this could be due to serious protein denaturation of *iru*. The lowest gelation concentration (LGC) was nil even at 16% (sample weight/volume). The non gelation of *iru* could be due to the denatured protein and the reduced carbohydrate content which might have enhanced gelation. Pectin breakdown during fermentation may not favour gelation. This means that *iru* will not be useful in the production of curd or as an additive to other materials for forming gel in food products.

Conclusion

Although *iru,* a fermentation product of ALBS is used as a flavouring agent, it is also capable of contributing to the calorie and protein intake. As the sodium content is low, *iru* would be suitable for hypertensive patients. The pH solubility of *iru* is high, its WAC is also favourably comparable to literature values thereby making *iru* a potentially useful ingredients of some food formulations.

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