

**CHEMICAL COMPOSITION OF 'AKARA' (FRIED GROUND BEAN PASTE) DEVELOPED FROM FERMENTED AND GERMINATED GROUND BEAN (*Kerstingiella georcarpa*) AND MAIZE (*Zea mays*) BLENDS**

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**ABSTRACT**

*The chemical composition of 'akara' based on untreated, fermented and germinated groundbean (GB) and maize (M) flour blends were investigated. The GB and M were germinated for 48h and 72h, respectively. The chemical content of the untreated and treated (fermented and germinated) flours were analysed using standard assay techniques. These flours were blended in a ratio of 70:30 (GB:M) on protein basis and used to prepare 'akara' balls. Cowpea and unblended groundbean 'akara' balls served as controls. The protein content of the controls (BEK and GBK) were higher than those of the other blends. However, the GBK protein value (22.02%) was significantly higher than that of BEK (control) as well as the other blends (13.89 to 17.55%). The ash values for the products were similar except that of germinated GB and M 'akara' (1.11%). The other blends and their controls had lower fat against the high value for the germinated (GB) and (M) blend (20.20%). Fermented GB/M 'akara' had higher carbohydrate (70.26%) than others. The iron for the control (BEK) (24.64mg) was different from those of the GB alone and its blend 'akara' ( $p < 0.05$ ). The germinated GB/M 'akara' had higher zinc, calcium, magnesium and iodine (7.7, 24, 68.19 and 2.2mg, respectively) than the other products ( $p < 0.05$ ). On other hand, the copper of untreated GB 'akara' (0.77mg) was higher than those of controls and other blend. The untreated GB/M had least tannin, phytate and cyanide against high levels for the controls (BEK and GBK) and had similar oxalate ( $p > 0.05$ ). As judged by the result unsupplemented GB 'akara' (GBK) or its blends could be promising snacks that would contribute nutrients in school and some home meals.*

**Key words:** fermentation, germination, blends, 'akara', nutrient.

**INTRODUCTION**

Plant foods are processed into flours or paste and used in the preparation of various nutritious snacks such as "moin-moin", 'akara', biscuits etc. In Nigeria, cowpeas (*Vigna unguiculata*) are used in the preparation of 'akara' (fried bean paste). 'akara' made from cowpea and consumed singly is usually imbalanced because plant foods are deficient in one or more essential amino acid(s). Cereal and legume are known to complement each other when consumed together so as to provide adequate nutrients for the improvement of the nutritional well-being of the people. However, the use of

legume in human nutrition is militated by the presence of anti-nutrients which chelate the nutrients in them thereby making them unavailable to the body. Proper processing techniques are required to enhance their utilization. Germination and fermentation are common household processing methods that have been employed over the years to improve the nutritive value of plant foods (Obizoba, 1998).

In Nigeria, there exist cheap nutritious and lesser-known legumes such as groundbean which if properly processed and mixed could

help to reduce malnutrition. Groundbean is a popular legume in Nrobo, North of Enugu State, Nigeria where it is mainly produced. It constitutes a major source of energy and protein in this area where it is a staple. The protein levels varied from 19.19 to 22.36% (Chikwendu, 2004).

Yellow maize (*Zea mays*) is a popular cereal in southern part of Nigeria. Its protein content ranges from 8 to 11% protein (FAO, 1992). Dry maize seeds are used to prepare different dishes such as spiced steamed maize paste. It can also be roasted, kneaded, spiced and fried to produce snacks (“*Aadun*” and “*Kokoro*”) (Adegoke and Adebayo, 1994). Mixture of groundbean and maize will provide complementary effect on the amino acids.

There has not been detailed work in literature on nutrient content of ‘akara’ made from Groundbean – maize mixture. The objective of this study was to process, develop, prepare and evaluate the chemical composition of ‘akara’ produced from groundbean – maize flour blends. It is believed that this will be adopted and utilized in the preparation of nutritious home and school snacks.

## MATERIALS AND METHODS

The groundbean seeds used for the study were bought from the retailers in Nrobo while yellow maize and white bean were bought at Nsukka Local market in Enugu State, Nigeria, respectively.

**Groundbean samples:** Four kilogram groundbean seeds were cleaned and divided into two portions of 1kg and 3kg each. The 1kg portion was dried in an air oven (Gallenkamp Oven, 250°C, Model 320) at 50°C to dry matter. The 3kg was soaked for 4h in distilled water in the ratio of 1:3 ( $^{w/v}$ ) grains to water at room temperature of 28±2°C. After soaking, the seeds were divided into 3 equal portions. One portion was spread on wet jute bag and covered with moist muslin cloth and another wet jute bag to germinate for 48h at average room temperature of 28±2°C. Distilled water was sprinkled on the seeds every 12h until the end of germination period. The germinated seeds were

washed with distilled water, manually dehulled without removing the sprouts and dried at 50°C as in unsoaked sample.

The second portion of the soaked seeds was manually wet dehulled and milled with the laboratory hammermill (Thomas Wiley Mill, Model, ED-5, England) to fine paste. The paste was put into plastic container of about 5cm deep with a lid to ferment for 48h at mean temperature of 28±2°C. After fermentation, the sample was dried in the oven at 50°C and remilled with the hammermill. The remaining soaked sample was wet dehulled and dried at 50°C as above. The samples were separately milled into fine flour with the laboratory hammermill and packaged. One kg of white bean was soaked for 5 minute and dehulled manually, dried and milled as in the other samples.

**Maize samples:** Three kilograms of cleaned yellow maize seeds were divided into two portions of 1kg and 2kg each. The 1kg portion was dried and milled as groundbean. The 2kg maize was steeped in distilled water for 24h. The steeped maize sample was divided into two equal portions. One portion was wet milled and sieved with sterilized muslin cloth into a 6 litre plastic container with lid to ferment for 48h in the same water at room temperature of 28±2°C. The fermented slurry was poured into a calico bag to drain. The sample was dried and remilled with the laboratory hammermill (Thomas Wiley Mill, Model, ED-5, England). The other steeped sample was germinated for 72h, dried and milled as groundbean. All the dried and milled samples of groundbean and maize were packed separately in polythene bags.

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**Chemical analysis:** The ‘akara’ products were analysed for proximate, mineral and antinutrient levels. The proximate and minerals were determined in triplicate using standard method of AOAC (1995). The residual moisture was determined and its value was calculated. A factor ( $F = 100/100 - \text{moisture value}$ ), Polacchi (1985) was calculated and used to bring all calculations to dry weight basis. Protein was

determined by microkjeldahl procedure (Method 981.10). Ash was estimated by incinerating 1g of each sample into a porcelain crucible in a muffle furnace at 600°C for 6h (Method 900.02). Crude fat was estimated by extracting a known weight of sample with petroleum ether (B.pt. 40° – 60°C) using Tecator Soxlec apparatus following the instructions of the manufacturer (Method 960.39). Carbohydrate was determined by difference. Mineral analysis was done by dry ashing of the sample followed by the determination of iron, zinc, copper, iodine, calcium, magnesium, potassium and phosphorus by atomic absorption spectrophotometer (Model 3030 Perkin-Elmer, Norwalk, USA; Methods 984.27 and 986.24). Phosphorus was determined by the molybdovanadate method.

Trypsin inhibitor (TI) was determined using the modified standard analytical procedure of Hammerstrand *et al.* (1981). The tannin levels of samples were determined spectrophotometrically using the method of Price *et al.* (1980). Phytate was estimated by modified method of Latta and Eskin (1980). Oxalate was determined by the method of Fassett (1973). Saponin value of the sample was estimated using the method of Bergmeyer (1974). The cyanide level was estimated by the method of Cooke (1978).

**Formulation of Blends:** Based on the protein contents of the flours, five products were developed in the ratio of 70:30 of groundbean and maize. These include BEK (unsupplemented fried white bean paste), GBK (unsupplemented fried groundbean paste), UGK (fried untreated groundbean and untreated maize paste), DFK (fried fermented groundbean and fermented maize paste) and DGK (fried germinated groundbean and germinated maize paste).

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'akara' products were separately prepared from 100g of each

flour blends, 100% groundbean and 100% white bean (*Vigna unguiculata*) flours. Each flour sample was mixed with 80ml of distilled water. The mixture was allowed to absorb water for 10 minutes, after which it was stirred with pestle in a mortar, till fluffy. Additional 20mls distilled water was added and stirred. Sliced onions (10g), and pepper (5g) were added and mixed. Salt (to taste) was added at the time the paste was about to be dispersed in hot vegetable oil (1 litre, heated at about 85-93°C). The mixture was dispersed with tablespoon in the hot oil and fried till golden brown in colour (3-5 minutes).

**Statistical analysis:** The data obtained was analysed using means  $\pm$  SD. Analysis of variance (ANOVA) and Duncan New Multiple Range Test were used to test the significant differences among the means using the SPSS 10 Computer Software Package.

## RESULTS

The proximate composition of 'akara' made from supplemented and unsupplemented groundbean compared with cowpea (white beans) is shown in Table 1. The protein values for the 'akara' varied. The unsupplemented fried GB paste had higher protein (22.02%) than the unsupplemented fried bean paste (20.87%) and the groundbean supplemented 'akara'. The protein value for the fried fermented groundbean and maize paste was the least (13.89%). The fried untreated groundbean and maize paste and the fried germinated groundbean and maize paste (DGK) had comparable protein (17.55%).

The fat values ranged from 11.79 to 20.22%. The 'akara' from germinated groundbean had the highest fat (20.02%) when compared with all the other 'akara' samples. The DFK had the least fat value (11.79%). The fibre ranged from 0.88 to 3.60%. The 'akara' made from the untreated groundbean and maize blend (UGK) had higher fibre than those of the

**Table 1: Proximate composition of 'akara' made from groundbean and maize Blends compared that of cowpea (% dry weight)**

Composition	BEK	GBK	UGK	DFK	DGK
Protein	20.87 $\pm$ 0.12 <sup>b</sup>	22.02 $\pm$ 0.01 <sup>a</sup>	17.34 $\pm$ 0.07 <sup>c</sup>	13.89 $\pm$ 0.06 <sup>d</sup>	17.55 $\pm$ 0.13 <sup>c</sup>

Fat	18.76±0.13 <sup>b</sup>	18.79±0.12 <sup>b</sup>	16.07±0.06 <sup>c</sup>	11.79±0.44 <sup>d</sup>	20.02±0.06 <sup>a</sup>
Crude fibre	1.44±0.13 <sup>d</sup>	1.74±0.05 <sup>c</sup>	3.60±0.06 <sup>a</sup>	2.03±0.02 <sup>b</sup>	0.88±0.06 <sup>e</sup>
Ash	2.05±0.03 <sup>ab</sup>	2.29±0.12 <sup>a</sup>	2.24±0.12 <sup>ab</sup>	2.03±0.02 <sup>b</sup>	1.11±0.01 <sup>c</sup>
Carbohydrate	56.88±0.06 <sup>c</sup>	55.16±0.02 <sup>c</sup>	60.75±0.01 <sup>b</sup>	70.26±0.06 <sup>a</sup>	60.44±0.06 <sup>b</sup>

Mean±SD of triplicate determinations

a,b,c,d,e, values in the same row if they do not share the same superscripts are significantly different

( $p < 0.05$ )

BEK	=	Unsupplemented fried white bean paste
GBK	=	Unsupplemented fried groundbean paste
UGK	=	Fried untreated groundbean and untreated maize paste
DFK	=	Fried fermented groundbean and fermented maize paste
DGK	=	Fried germinated groundbean and germinated maize paste

other samples. The increases were 150.0% when compared with the control (BEK) and 106.0% when compared with the GBK. The ash values for all the 'akara' were comparable except for that of the DGK blend (1.11%). The carbohydrate values of 'akara' varied from 55.16 to 70.44%. The carbohydrate values of the 'akara: made from GB and M blends were significantly higher than the unsupplemented 'akara' (BEK and GBK) ( $p < 0.05$ ). The 'akara' made from fermented groundbean and maize blend (DFK) had the highest carbohydrate (70.26%). The DFK had 23.5% increase as compared to the control (56.88 vs 70.26%). The carbohydrate values of UGK and DGK 'akara' were similar ( $p > 0.05$ ). The UGK and the DGK had 6.8 and 6.3% increase in carbohydrate, respectively.

The mineral content of 'akara' made from groundbean and maize blends are shown in Table 2. The Iron (Fe) content of the 'akara' differed widely. It ranged from 6.39 in UGK to 24.64mg in the BEK. The BEK had the highest Fe and the UGK had the least. The DFK had more Fe (12.17mg) than the other groundbean supplement and unsupplemented 'akara'. The Copper (Cu) levels of 'akara' varied. The values ranged from 0.09 – 0.77mg). The UGK had higher Cu than those of the BEK, the GBK, and others ( $p < 0.05$ ). Fermentation decreased Cu levels. The decrease was 88.3% when compared

with the UGK (0.77 vs 0.09mg) or 79.5% when compared to the GBK (0.44 vs 0.09mg). The Zinc (Zn) levels for the 'akara' were comparable

except for the DGK, which had higher Zn than all the other 'akara'. The Iodine (I) value for the 'akara' varied widely. The BEK and GBK had the least and comparable values (0.37mg) ( $p > 0.05$ ). The supplemented 'akara' had the higher iodine level than the unsupplemented groundbean and beans ( $p < 0.05$ ).

The phosphorus (P) values for the 'akara' varied fairly widely. The values for the UGK and the DGK were similar (61.48 vs 61.70mg) and these values were higher than others ( $p < 0.05$ ). The GBK had the lowest value (54.08mg). The Calcium (Ca) values differed widely (6.99–24.24mg). Germination increased Ca in the 'akara' sample while fermentation decreased Ca when compared with the control and the other groundbean 'akara'. There was 47.6% decrease in the DFK when compared with the GBK (13.34 vs 6.99mg). The magnesium (Mg) composition of the 'akara' varied from 15.75 to 63.19mg. Combination of germinated groundbean and maize (DGK) increased Mg more than the other 'akara' ( $p < 0.05$ ). The DFK had the highest decrease (54.1%) when compared with the BEK or 51.5% as compared to the GBK. The potassium (K) levels ranged from 166.95mg in the UGK to 571.59mg in the BEK. The value for the BEK was higher than that of the GBK ( $p < 0.05$ ). The decrease was 8.9%. Supplementation had no effect on the K levels. The DGK had higher K than the other 'akara' produced from groundbean and maize blends when compared with the GBK (520.93 vs 275.6mg) ( $p < 0.05$ ). The 'akara' from untreated groundbean and maize had the least K (166.95mg).

**Table 2: Mineral content of processed and unprocessed blends of groundbean and maize 'akara' compared to cowpea (mg/100g dry weight)**

Composition	BEK	GBK	UGK	DFK	DGK
Iron	24.64±0.13 <sup>a</sup>	9.28±0.12 <sup>c</sup>	6.39±0.06 <sup>e</sup>	12.17±0.06 <sup>b</sup>	6.99±0.06 <sup>d</sup>
Copper	0.26±0.01 <sup>c</sup>	0.44±0.07 <sup>b</sup>	0.77±0.01 <sup>a</sup>	0.09±0.01 <sup>d</sup>	0.22±0.01 <sup>c</sup>
Zinc	4.66±0.19 <sup>b</sup>	4.66±0.01 <sup>d</sup>	4.41±0.12 <sup>b</sup>	4.66±0.17 <sup>b</sup>	7.76±0.12 <sup>a</sup>
Iodine	0.37±0.06 <sup>d</sup>	0.37±0.01 <sup>d</sup>	0.82±0.01 <sup>c</sup>	1.12±0.07 <sup>b</sup>	2.25±0.12 <sup>a</sup>
Phosphorus	58.04±0.02 <sup>c</sup>	54.08±0.02 <sup>d</sup>	61.48±0.10 <sup>a</sup>	58.46±0.12 <sup>b</sup>	61.70±0.06 <sup>a</sup>
Calcium	11.32±0.06 <sup>d</sup>	13.34±0.09 <sup>c</sup>	16.86±0.06 <sup>b</sup>	6.99±0.06 <sup>e</sup>	24.24±0.14 <sup>a</sup>
Magnesium	34.31±0.06 <sup>b</sup>	32.52±0.12 <sup>c</sup>	21.96±0.06 <sup>d</sup>	15.75±0.06 <sup>e</sup>	63.19±0.06 <sup>a</sup>
Potassium	571.59±0.12 <sup>a</sup>	520.93±0.06 <sup>b</sup>	166.95±0.06 <sup>e</sup>	243.23±0.12 <sup>d</sup>	275.67±0.17 <sup>c</sup>

Mean±SD of triplicate determinations

a,b,c,d,e, values in the same row if they do not share the same superscripts are significantly different (p < 0.05)

BEK	=	Unsupplemented fried white bean paste
GBK	=	Unsupplemented fried groundbean paste
UGK	=	Fried untreated groundbean and untreated maize paste
DFK	=	Fried fermented groundbean and fermented maize paste
DGK	=	Fried germinated groundbean and germinated maize paste

The antinutrient composition of 'akara' produced from processed and unprocessed groundbean and maize blends compared to that of cowpea (mg/100 dry weight) are presented in Table 3. There were no differences (p > 0.05) in the trypsin inhibitor levels of the 'akara' samples. The tannins content of the 'akara' ranged from 0.17 to 0.65mg. The BEK and the GBK had similar tannins (0.38 and 0.39mg). The 'akara' produced from germinated blend had the highest tannin (0.65mg) (p < 0.05). The phytate levels of all the 'akara' were comparable except for the UGK which had the least (0.11mg).

The oxalate contents of the 'akara' were comparable. The saponin levels of the 'akara' varied from 0.05 to 0.14mg. The BEK and GBK had 0.05mg. The UGK had highest saponin (0.14mg). However, the value was comparable to that of the DGK (0.12mg). Processing increased saponin levels. However, the increases were not different from that of the DFK (0.06mg). Germination increased cyanide in 'akara'. It caused 19.0% increase when compared with the GBK (0.50 vs 0.42mg).

Chemical Composition Of 'Akara' (Fried Groundbean Paste) Developed From Groundbean and Maize Blends

**Table 3: Antinutrients composition of 'akara' made from processed and Unprocessed groundbean and maize blends (mg/100g dry weight)**

Antinutrients	BEK	GBK	UGK	DFK	DGK
Trypsin	0.21±0.01 <sup>a</sup>	0.21±0.01 <sup>a</sup>	0.20±0.01 <sup>a</sup>	0.20±0.06 <sup>a</sup>	0.28±0.01 <sup>a</sup>

Tannin	0.38±0.01 <sup>c</sup>	0.39±0.01 <sup>bc</sup>	0.17±0.01 <sup>d</sup>	0.41±0.01 <sup>b</sup>	0.65±0.01 <sup>a</sup>
Phytate	0.21±0.01 <sup>a</sup>	0.21±0.01 <sup>a</sup>	0.11±0.01 <sup>b</sup>	0.20±0.00 <sup>a</sup>	0.22±0.00 <sup>a</sup>
Oxalate	0.09±0.01 <sup>a</sup>	0.09±0.01 <sup>a</sup>	0.08±0.01 <sup>a</sup>	0.10±0.01 <sup>a</sup>	0.09±0.02 <sup>a</sup>
Saponin	0.05±0.01 <sup>b</sup>	0.05±0.01 <sup>b</sup>	0.14±0.01 <sup>a</sup>	0.06±0.01 <sup>b</sup>	0.12±0.01 <sup>a</sup>
Cynide	0.20±0.01 <sup>b</sup>	0.42±0.02 <sup>a</sup>	0.01±0.00 <sup>c</sup>	0.26±0.02 <sup>b</sup>	0.50±0.06 <sup>a</sup>

Mean±SD of triplicate determinations

a,b,c,d,e, values in the same row if they do not share the same superscripts are significantly different (p < 0.05)

BEK	=	Unsupplemented fried white bean paste
GBK	=	Unsupplemented fried groundbean paste
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DFK	=	Fried fermented groundbean and fermented maize paste
DGK	=	Fried germinated groundbean and germinated maize paste

## DISCUSSION

The proximate composition of 'akara' produced from groundbean was within the range of findings of McWatters (1983) and McWatters *et al.* (1993) for 'akara' produced from cowpea flour except fat values which were lower in this work. The lower fat could be attributed to treatment and supplementation effects and consistency of the products. The lower levels of proteins in the blended 'akara' indicated that fermentation and germination had no beneficial effect on them. On contrary Nnam (1995) observed increased protein content of foods due to fermentation and germination. The decrease in the fibre content of germinated groundbean maize 'akara' could be attributed to type of seed and metabolic activities of the hydrolytic enzymes within the seeds during germination. The lower fibre value of 'akara' produced from germinated blend showed that it would be useful in infant feeding because fibre is indigestible in gastrointestinal tract of humans. The groundbean-based 'akara' alone could contribute moderately to average protein (62%) and iron (51%) allowances based on FAO/WHO/UNU (1985) and FAO/WHO (1988) report. For the blends they could contribute 39-49% and 35-67% daily protein and iron allowances.

The variations in minerals and antinutrients were due to treatment, supplementation, sources of the grains

and preparation method adopted. The antinutrients content of the products were generally low and the bioavailability of the minerals in these products is likely not to be affected when consumed. The higher level of tannin in all the products except the 'akara' made from untreated blends observed in this study was surprising. The increase in tannin could likely be that the processing period was not optimum for the activity of the hydrolytic enzyme that break down tannin from its bound organic compounds. Obizoba and Atu (1993) reported increase in tannin level of 4d fermented traditional Nigerian condiment.

## CONCLUSION

The 'akara' produced from groundbean or groundbean-maize blends had promising nutritional attributes and could be a good substitute for cowpea 'akara'. The low level of antinutrient and low fat absorption of the 'akara' products is added advantage to their utilization. It might not pose a health problem to the consumer. Promotion is needed to popularize the use of groundbean 'akara' for its nutritional benefits.

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