

Full Length Research Paper

Comparative assessment of the performance of *Parkia biglobosa*, *Glycine max* and *Treculia africana* in the production of a local condiment (dawadawa) in Ghana

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This study was conducted to assess the performance of three high protein beans (*Parkia biglobosa*, *Glycine max* and *Treculia africana*) in dawadawa (fermented condiment) production. The beans of the crops were boiled for an hour and then fermented for 72 h. Standard procedures were used to assess the proximate, mineral and functional properties of the resultant condiments. Sensory evaluation was also conducted. The results showed that the protein content of *P. biglobosa* (49.69%) was not significantly ($P>0.01$) different from that of *G. max* (47.39%) but both were significantly higher than that of *T. africana* (21.28%). On the other hand, *T. africana* had a significantly higher ($P<0.01$) carbohydrate content (45.91%) than the other 2 crops. *G. max* had the highest K (1460 mg/100 g), Na (124 mg/100 g) and Ca (2400 mg/100 g) contents, while *T. africana* was highest in Mg (816 mg/100 g) and P (424 mg/100 g). As regards water absorption capacities, no significant differences were observed between the crops. However, the oil absorption capacities of the condiments differed significantly from each other ($P<0.01$). The colour and aroma of *P. biglobosa* was adjudged more acceptable than *G. max* and *T. africana*. Generally, the stew prepared using *P. biglobosa* was more acceptable than those from *G. max* and *T. africana* which were considered similar ($P>0.01$). The results showed that aroma of the condiment was the most important predictor ($R^2=0.84$) of overall acceptability. The results of this study indicate that although *P. biglobosa* condiment was the most acceptable, similar condiments could be produced using *G. max* and *T. africana* beans without much apprehension of its acceptability.

Key words: Proximate composition, mineral composition, functional properties, sensory attributes, condiment.

INTRODUCTION

According to Achi (2005) many food flavoring condiments in Africa are prepared by traditional methods of uncontrolled solid substrate fermentation resulting in extensive hydrolysis of the protein and carbohydrate components (Fetuga et al., 1973; Eka, 1980). The production of the pungent condiments is a traditional family craft (Campbell-Pratt, 1980) which has assumed commercial significance. Fermentation is known to result in increased

shelf life, reduced anti-nutritional factors, improvement in digestibility, nutritive value, and flavors of foods (Odunfa, 1985; Reddy and Pierson, 1999; Barimalaa et al., 1989; Achi and Okereka, 1999). Important condiments commonly produced from vegetable sources include *Afitin*, *iru* and *sonru* in Benin; *dawadawa* or *iru* in Nigeria and Ghana (Odunfa, 1981), *soumbala* in Burkina Faso (Diawara et al., 1998), *netetu* in Senegal (N'Dir et al., 1994), *natto* in Japan and *kinema* in Nepal (Wang and Fung, 1996; Beaumont, 2002). The condiments are flavor enhancers in many dishes including soups and sauces (Azokpota et al., 2006).

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They are also used as nutritious non-meat proteins substitute and as functional ingredients in fabricated foods and require no refrigeration during distribution and storage (Shao, 2002). In West Africa *Parkia* spp. are commonly used for condiment production. According to Oladunmoye (2007) common species within the genus *Parkia* include *Parkia biglobosa*, *Parkia filicoidea*, *Parkia bicolor*, and *Parkia biglobosa* although Sina and Traoré (2002) had indicated that they are synonyms. *Parkia* spp. are widely distributed in across savanna belts across West Africa. Unfortunately, the trees which have long gestation period are threatened for different end uses including charcoal production. This is thus threatening the survival of Dawadawa production which has been an important source of livelihood and nutrition to many rural inhabitants. Again, the beans of *Parkia* spp. are deficient in two critical amino acids, methionine and tryptophan (Booth and Wickens, 1988). The challenge is to screen and identify high protein vegetables whose beans could be used to produce condiments of similar if not superior characteristics as *Parkia* spp. This study was therefore, needed for a comparative assessment of *Parkia* spp., *Glycine max* and *Treculia africana*, (which are high in protein), in condiment (*dawadawa*) production.

MATERIALS AND METHODS

Sample collection and preparation

Beans of *P. biglobosa* and *G. max* were bought from the Central Market of Kumasi while *T. africana* was collected from Bobri Butterfly Sanctuary at Kubease in the Ashanti Region of Ghana. 600 g each of *P. biglobosa*, *G. max*, and *T. africana* beans were divided into 300 g halves. Each 300 g was soaked in 1 litre tap water for 12 h to facilitate cooking. They were then boiled in water (1:3 w/v) for 1 h for *G. max* and 3 h for *P. biglobosa*. Water was periodically added till cooking was complete for *P. biglobosa*. *T. africana* seeds were not soaked but boiled in distilled water for 1 h since it cooked faster. They were then allowed to cool. *Parkia* spp. *G. max* and *T. africana* and thoroughly mixed. The other halves were not treated with wood ash. They were then placed in polythene (LDPE) bags, covered and allowed to ferment for 72 h as per traditional technology sun-dried for 4 h and then moulded into balls.

Determination of proximate composition

Determination of moisture content, ash, crude protein, and crude fiber were carried out using methods prescribed by Association of Official Analytical Chemists AOAC (1990). Crude fat was extracted using the Soxhlet procedure with petroleum ether (60 to 80°C) for 16 h. Carbohydrate content was determined differently (Kirk and Sawyer, 1991).

Determination of mineral composition

Calcium was determined by O-cresolphthalein complexone method using Optima SP-300 spectrophotometer (Tietz, 1995). Iron content was determined by the 1, 10-phenanthroline method using Optima SP-300 spectrophotometer (Harris, 2003). Phosphorus was determined by ascorbic acid molybdate method using Optima SP-

300 spectrophotometer. Potassium and sodium were determined by the method of Taffouo et al. (2008) using Jenway Flame photometer. The Calmagite method was used in the determination of Magnesium content and Optima SP-300 spectrophotometer used at 520 nm (Tietz, 1995).

Determination of water and oil absorption capacities

Water and oil absorption capacities of the flour samples were determined using the methods of Abbey and Ibeh (1988) with slight modification. One gram of flour sample was mixed with 10 ml of distilled water or oil in a centrifuge tube. The suspension was agitated for 1 h on a griffin flask shaker after which it was centrifuged for 15 min at 2200 rpm. The volume of water or oil on the sediment water was measured. Water and oil absorption capacities were calculated as ml of water or oil absorbed per gram of flour.

Sensory evaluation

Sixty student of the University of Science and Technology, Kumasi, Ghana constituted the sensory panel. The sensory panel was composed of students 30 males and 30 females who were familiar with the consumption of the products (Nwabuenze and Atuonwu, 2007). Fresh samples of prepared products bearing different codes were placed on white disposable plates in a cool, dry, well lit and ventilated room. Each product (raw condiment and stew prepared from condiment) was put in a different plate. A 5-point hedonic scale described by Chinma and Gernah (2007) was used in scoring the products (1–Like very much; 2– Like slightly; 3– Neither like nor dislike; 4– Dislike slightly and 5– Dislike very much). Parameters assessed were colour, texture, taste, aroma and overall acceptability.

Data analysis

Data on nutritional composition and sensory parameters were analyzed with Statistix8 statistical software. Linear regression analysis was carried to identify important predictors of overall acceptability of the condiments. Data obtained for all parameters were reported as mean scores of triplicates. Differences among sample means were separated using the least significant difference (LSD) test at $p \leq 0.01$ (Snedecor and Cochran, 1976).

RESULTS AND DISCUSSION

Nutritional composition

Proximate composition

The condiment produced using *P. biglobosa* beans had the highest protein content (49.69%; Table 1) and was significantly different ($P < 0.01$) from *G. max* (47.39%) and *T. africana*. The protein content of *P. biglobosa* and *G. max* was higher than those reported by Soune (1985), Obizoba (1998) and Alabi et al. (2005) who reported 37.5, 27.44 and 34.3%, respectively. Although *T. africana* had the least protein content of 21.28% the value is acceptable for its use as a protein supplement. The high protein content of the condiments make them good sources of protein and therefore useful in combating protein malnutrition. The crude fat content of the condiments varied significantly between 17.36 and

Table 1. Proximate composition of condiments (%).

Species	Moisture	Crude protein	Crude fat	Crude fiber	Ash	Carbohydrate
<i>P. biglobosa</i>	10.23±0.07 ^b	49.69±0.04 ^a	26.85±0.07 ^a	1.49±0.10 ^b	4.32±0.04 ^a	7.43±0.01 ^c
<i>G.max</i>	11.40±0.20 ^a	47.39±0.03 ^b	19.90±0.08 ^b	4.30±0.21 ^a	3.70±0.03 ^b	16.19±0.20 ^b
<i>T. africana</i>	11.41±0.04 ^a	21.28±0.02 ^c	17.36±0.09 ^c	0.45±0.05 ^c	3.14±0.04 ^c	45.91±0.30 ^a
LSD (p=0.01)	0.54	2.23	1.40	0.26	0.52	0.97

Figures bearing different alphabets are significantly different at p<0.01.

Table 2. Mineral composition of condiments (mg/100 g).

Species	K	Na	Ca	Mg	P
<i>P. biglobosa</i>	1322.00±0.04 ^b	28.00±0.10 ^c	637.00±0.00 ^c	136.00±1.0 ^c	375.00±0.10 ^b
<i>G.max</i>	1460.00±0.00 ^a	124.00±0.40 ^a	2400.00±0.00 ^a	192.00±1.0 ^b	388.00±0.20 ^b
<i>T. africana</i>	520.00±0.02 ^c	54.00±0.00 ^b	800.00±0.00 ^b	816.00±0.00 ^a	424.00±0.30 ^a
LSD (p=0.01)	87.54	13.42	65.88	19.22	26.33

Figures bearing different alphabets are significantly different at p<0.01

26.85% with *P. biglobosa* having the highest. The fat content of the condiments suggests they could be good sources of fat-soluble vitamins and could also be useful flavor enhancers.

The crude fibre content was highest in *G. max* (4.30%) while *T. africana* had the least (0.45%). These values were lower than 1.92 to 3.3% found in cowpea (Chinma et al., 2008). High fiber intake has been linked with decreased chances of colon cancer and associated with reducing constipation (Shankar and Lanza, 1991). Since *G. max* condiment had the highest fibre content it is expected to be most useful in minimizing colon cancer and constipation. The ash content of *P. biglobosa* condiment (4.32%) was significantly higher (P<0.01) than the values for both *G. max* (3.70%) and *T. africana* (3.14%). These values were all higher than the 2.95% reported by Edema et al. (2005). The ash content is indicative of the mineral content of food. The high ash content suggests that the condiments would have high mineral content as was actually observed in this study (Table 2). The carbohydrate content of the condiments varied widely between the varieties. *T. africana* had the highest (45.91%) which was 6 times higher than the value in *P. biglobosa* (7.43%), which was the least. These values were lower than the 46.36% reported by Alabi et al. (2005). The results suggest that *T. africana* would be better than *P. biglobosa* and *G. max* in supplementing the carbohydrate content of meals in which they are used, in addition to providing protein.

Mineral content of condiments

There were significant differences (P<0.01) in potassium content of the condiments varying from 520 mg/100 g in

T. africana to 1460 mg/100 g in *G. max* (Table 2). The high potassium content of the condiments coupled with the low sodium levels seem to give credence to the claim by consumers that it is good for alleviating hypertension. Since *G. max* condiment had the highest potassium content it could be considered a better source of potassium. The condiments had calcium content ranging from 637 mg/100 g to 2400 mg/100 g with *G. max* having the highest. The calcium content of *T. africana* (800 mg/100 g) was higher (P<0.01) than for *P. biglobosa* (637 mg/100 g). The calcium content of the condiments suggests that the condiments might be good sources of calcium. The study showed that consuming 100 g of the condiment (*G. max* and *T. africana*) would provide the recommended daily intake of between 500 and 800 mg/day for children (1 to 8 years old) and at least 63.7% of the 1000 to 1300 mg/day for adults (National Academy of Sciences, 2004). *T. africana* had higher (P<0.01) magnesium content (816 mg/100 g) compared with *G. max* (192 mg/100 g) and *P. biglobosa* condiments (136 mg/100 g).

Nutritionally, *T. africana* condiment can be considered as a superior source of magnesium to *P. biglobosa* and *G. max*. Magnesium is essential in enzyme systems and helps maintain electrical potential in nerves (Ferraro et al., 1987). The study suggests that consuming 100 g of *T. africana* condiment would provide more than 200% of the daily requirement of magnesium for adults (265 to 350 mg; Food and Nutrition Board, 1997). The phosphorus content of *T. africana* (424 mg/100 g) condiment was significantly higher (P<0.01) than that of *P. biglobosa* (375 mg/100 g) and *G. max* (388 mg/100 g). According to Vitabase (2009) phosphorus is essential for the process of bone mineralization and maintenance of bone structure. Phosphorus is also known to make up the structure of cellular membranes, nucleic acids and

Table 3. Water and oil absorption capacities of produced condiments (ml/g).

Species	WAC (ml/g)	OAC (ml/g)
<i>P.biglobosa</i>	0.75±0.10 ^a	0.45±0.05 ^c
<i>G.max</i>	1.25±0.10 ^a	2.17±0.05 ^a
<i>T.africana</i>	1.00±0.10 ^a	1.75±0.04 ^b
LSD (p=0.01)	0.76	0.25

WAC-Water absorption capacity, OAC-Oil absorption capacity. Figures bearing different alphabets in a given column are significantly different at p<0.01.

Table 4. Sensory scoring for condiments and stew produced with condiments.

Sample	Condiment		Stew produced with condiment		
	Colour	Aroma	Taste	Aroma	Overall acceptability
<i>P.biglobosa</i>	1.50 ^b	1.25 ^b	1.80 ^c	1.80 ^b	1.55 ^c
<i>G.max</i>	2.25 ^a	2.10 ^a	1.95 ^b	1.83 ^b	2.05 ^b
<i>T.africana</i>	1.80 ^b	2.35 ^a	2.40 ^b	2.50 ^a	2.10 ^b
No condiment	-	-	3.10 ^a	2.90 ^a	3.15 ^a
LSD (P=0.01)	0.43	0.44	0.57	0.53	0.41

Figures bearing different alphabets are significantly different at p<0.01.

nucleotides, including adenosine triphosphate. The study shows that consuming 100 g of *T. africana*, *G.max* and *P. biglobosa* condiment could provide 60.6, 53.60 and 55.40%, respectively of the recommended daily intake of 700 to 1250 mg/day (Food and Nutrition Board, 1997).

Functional properties

Water absorption capacity (WAC (P))

The WAC of the condiments stood at 0.75 and 1.25 ml/g (Table 3) for *P. biglobosa* and *G. max* respectively, while *T. africana* had 1.0 ml/g. However, the differences between the varieties were not significant. The water absorption capacity of a flour is an indication of the amount of water available for gelatinisation (Edema et al., 2005). Depending on a protein side chain (number of charged and polar group), a protein may bind varying amount of water (Vaclavik and Christian., 2003). The water absorption capacity of the condiments suggests they would be suitable functional ingredients in food systems (Chinma et al., 2008).

Oil absorption capacity (OAC)

The oil absorption capacity of the condiments, *P. biglobosa* (0.45 ml/g), *T. africana* (1.75 ml/g) and *G. max* (2.17 ml/g) were significantly different (P<0.01) from each other. The ability of proteins to bind oil is significant since it acts as flavour retainer and increase the mouth feel

when used in food preparations. Since the oil absorption capacity of *G. max* and *T. africana* condiments were higher than *P. biglobosa*, it is indicative that they could be better flavor retainers and mouth-feel improvers when used as food ingredients.

Sensory performance of condiments

T. africana condiment performed better than *G. max* (2.25; Table 4) in terms of colour but poorly against *P. biglobosa* (1.5) with a score of 1.8, which was within the 'like slightly' category. This could be attributable to the lighter colour of *T. africana* condiment (Figure 1). With respect to the aroma of the condiment, *T.a fricana* (2.35) performed similarly as *G. max* (2.1) but poorly against *P. biglobosa* (1.25). Generally, the aroma of all the condiments was liked. Evaluation of stew prepared using the condiments showed that there was no significant difference in likeness for the taste of *T. africana* (2.4) and *G. max* (1.95) but both were better than that containing no condiment (3.10). However, *P. biglobosa*, was the most liked. Similar results were obtained for aroma. *T. africana* scored poorly against *P. biglobosa* (1.8) and *G. max* (1.8) but better than that prepared without any condiment (2.9). The performance of *T. africana* (2.5) notwithstanding, the aroma of stew containing *T. africana* was acceptable (within the like slightly and neither-like-nor-dislike range). As regards the overall acceptability of the condiment, *T. africana* stew performed similarly to *G. max* and higher than stew with no condiment but lower than *P. biglobosa*.



A: *P. biglobosa* condiment B: *G. max* condiment C: *T. africana* condiment

Figure 1. Condiments; A, B, and C produced for evaluation.

Table 5. Relationship between overall acceptability and sensory variables for condiments.

Product	Regression equation	R ²	P value
Condiment	Overall acceptability =0.28+0.87(colour)	0.79	0.0001
	Overall acceptability =0.39+0.87(aroma)	0.84	0.0001
Stew	Overall acceptability =0.76+0.67(aroma)	0.63	0.0001
	Overall acceptability =0.78+0.65(taste)	0.69	0.0001

The performance of *T. africana* notwithstanding, the values were still within the 'like slightly' and 'neither like nor dislike' suggesting that *T. africana* produced condiment acceptable to the sensory panelists. Overall, the stew produced with *T. africana* performed poorly against *P. biglobosa* and similarly against *G. max* with a score of 2.1. Even though *T. africana* scored better than the stew without condiment, *P. biglobosa* was adjudged the best condiment with a mean score of 1.55. There was a significant ($P=0.0001$) positive association ($r=0.64$) between colour and aroma of the condiments. This implies that as the colour of the condiment improves the aroma is expected to be better. Regression analysis indicated that aroma is the single most important predictor of overall acceptability ($R^2=0.84$; Table 5) of the condiments. On the other hand the taste of the stew ($R^2 = 0.69$) was a better predictor of acceptability than aroma ($R^2 = 0.63$).

Conclusion

The study has shown that the condiments produced using beans of *P. biglobosa*, *G. max* and *T. africana* possessed good nutritional properties and can be used as sources of nutrients. The high water and oil absorption capacities indicated that they would play important

functional roles in food systems. The results of this study indicate that although *P. biglobosa* condiment was the most acceptable, similar condiments could be produced using *G. max* and *T. africana* beans without much apprehension of its acceptability.

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