GLOBAL JOURNAL OF PURE AND APPLIED SCIENCES VOL. 9, NO. 2, MARCH 2003: 177-182
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EFFECTS OF ROASTING AND SOAKING ON THE PROXIMATE COMPOSITION AND FUNCTIONAL PROPERTIES OF SELECTED TROPICAL LEGUMES.

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(Received 3 October 2002; Revision accepted 19 November 2002

ABSTRACT

Proximate composition and functional properties of roasted and soaked *Afzelia africana* "akpalata", *Brachystegia eurycoma* "achi" and *Detarium microcarpum* "ofo" were studied. Result indicated no significant differences (P>0.05) in ether extract of the processed legumes but roasted *B. eurycoma, A africana* and *D. microcarpum* had the highest values. Also, no significant differences (P>0.05) were observed in the crude fibre and moisture contents of the three legumes. Control (raw) and soaked *B. eurycoma and A. africana* compared very well in ash contents but no significant differences (P>0.05) were observed in the raw, roasted and soaked *D. microcarpum* legumes. Roasting and soaking improved the crude protein contents of *B. eurycoma* and *D. microcarpum* while there was a decrease in the protein contents of *A. africana*. Although, the swelling index of the processed *B. eurycoma and D. microcarpum* respectively compared favourably with their raw legumes, the soaked (2.16 ml/g) *A. africana* was significantly better than the raw (1.7 ml/g) and the roasted (1.50 ml/g) legumes in swelling index. Roasted and raw *A. africana* showed no significant difference in oil absorption capacity while the roasted (8.00 ml/H_2O/g flour) *D. microcarpum* was better than the soaked (7.00 ml/H_2O/g flour) and raw (6.10 ml/H_2O/g flour) in water absorption capacity. Least gelation concentrations for raw, roasted and soaked legumes were indicated as 12%, 8% and 12% *(B. eurycoma)*. 18%, 16% and 14% *(A. africana)* and 6%, 4% and 6% *(D. microcarpum)* respectively. Roasting and soaking decreased the emulsion capacities of *B. eurycoma, A. afriana and D. microcarpum*. The three processed legumes were significantly higher than their raw legumes in thermal gelation temperature.

Keywords: Roasting, soaking, proximate composition , functional properties, tropical legumes.

INTRODUCTION

Afzelia africana 'akpalata', *Brachystegia eurycoma* 'achi' and *Detarium microcarpum* 'ofo' found in tropical and subtropical countries belong to the legume family (Onweluzo *et al.*, 1995). The flours from the seeds of these legumes which are regarded as unexploited and indigenous to Tropical West African countries have been used widely in Nigeria as traditional emulsifying, flavouring and thickening agents (Keay *et al.*, 1964). When the legumes are used in the preparation of certain Nigerian soups, they impart a gummy texture, a desirable attribute for the eating of garri, pounded yam or cocoyam and fufu. Also in Western and Eastern parts of Nigeria where *B. eurycoma* is regarded as an important economic tree, the seeds are widely used as condiment in soup making (Okigbo, 1975).

Flour from *Afzelia africana* 'akpalata' seeds have been shown to exhibit the same functional characteristic as soyabean flour (Onweluzo *et al.*, 1995). In developed countries, locally processed food gums from these legumes are used in the manufacture of most food products (Dziezak, 1991). In this respect, it has become necessary to adequately utilize the locally available sources of the gums in Nigeria's food industries. The enhanced utilization of the food gums such as 'achi', ogbono', 'ofo' and 'akpalata' known as *Brachystegia eurycoma, Irvingia gabonensis, Detarium microcarpum and Afzelia Africana* in conjuction with other materials in processing will definitely improve the economy of the developing countries by the reduction in cost of alternative food products (such as fabricated or roasted foods) (Anazonwu-Bello, 1979).

This study, is therefore undertaken to investigate the effects of roasting and soaking on the proximate composition and functional properties of some selected tropical legumes.

MATERIALS AND METHODS

Source of Materials

Afzelia africana 'akpalata', *Brachystegia*

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eurycoma 'achi' and *Detarium microcarpum* 'ofo' seeds were purchased from the New Market in Aba Abia State, Nigeria.

Preparation of *Afzelia africana, Brachystegia eurycoma and Detarium microcarpum* flours

The legume seeds were cleaned to remove dirt and the red arid at the base of *A. africana* was removed. The seeds of each legume were divided into three batches. The first batch was roasted. The second batch was soaked and dried at 60°C. The control (raw) was milled directly. Roasting was done in a hot sandbath (150°C – 180°C) for 20 min and the roasted seeds dehulled and air dried at room temperature (27°C) for 5h. Soaking was carried out in tap water (3 times volume of the seeds) at room temperature (27°C) for 42h and the soak-water changed 6 hourly. The dehulled seeds of the soaked batch were dried in an air oven (Gallenkamp, England) at 60°C for 6h. The dried samples were ground with a hammer mill (Retsch, 5657, GmbH, Germany). The flours were sieved with a metal sieve of mesh size 1.0mm, packed in polyethylene bags and stored in airtight container at room temperature until used.

Proximate Analysis

The moisture, ash, crude protein and ether extract of the flours were determined using standard AOAC methods. The percentage carbohydrate was calculated by difference [100-(sum of % fat, protein, ash, fibre and moisture contents)] (A.O.A.C., 1990). Water and oil absorption capacities were determined by the method described by Abbey and Ibeh (1988). Emulsion capacity was detemined using the method of Yasumatsu *et al.,* (1972). The swelling index was determined by the method described by Narayana and Rao (1982).

Statistical Design and Analysis

The experiment was carried out using completely randomized design (CRD). Each treatment (achi, ofo and akpalata) was at three levels of flour (from raw, roasted and soaked) and each replicated three times. Data for the analysis were the recorded percentages, temperature (°C), ml/g, ml/H_2O/g flour and ml/oil/g flour and were analysed for significance using the one-way analysis of variance (ANOVA) and the least significant difference (LSD) (Steel and Torrie, 1981).

RESULTS AND DISCUSSION

The three processed legumes and their raw legumes were not significantly ($P>0.05$) different in percentage crude fat but roasted samples of the three legumes showed the highest values (Table 1). This agreed with the report on *D. microcarpum* that roasting increased appreciably the crude fat value (Okigbo, 1975). Soaking also decreased the crude fat contents from 30% to 29% in *A. africana* and 14% to 13.5% in *D. microcarpum*. Although, there were no significant differences ($P>0.05$) in percentage carbohydrate of the three processed legumes and their control (raw) respectively, only roasted and soaked *B. eurycoma* decreased in carbohydrate content. The decrease in carbohydrate of the roasted legume was as a result of heat processing and this decrease was observed in roasted *B. eurycoma* (Noor *et al.,* 1980). While roasting and soaking increased the carbohydrate contents in *A. africana* from 39.74% to 40.15% and 42.83% respectively, roasting did not affect the same nutrient in *D. microcarpum*. Significant differences were not observed for the processed *B. eurycoma* and the control (raw) in crude protein. Upon roasting and soaking, the crude protein contents of *D. microcarpum* significantly ($P<0.05$) increase from 15.13% to 17.15% and 16.42% respectively. This can be explained by the fact that proteins of the processed legumes possess greater affinity to imbibe more water when especially the roasted legume is re-soaked. Also *B. eurycoma* improved from 10.54% to 12.50% and 11.25% respectively. Raw and soaked *B. eurycoma* and *A. africana* compared very well ($P>0.05$) in ash contents while there was no significant difference in raw, roasted and soaked *D. microcarpum*. Treatments on the three legumes respectively actually indicated decrease in mineral contents. A decrease in the mineral contents of baked soyabean has been reported by Vijaya (1983).

Functional properties of processed legumes

Result showed no significant differences in the swelling index of processed *B. eurycoma and D. microcarpum* (Table 2). Roasting decreased the swelling index of *B. eurycoma* from 1.58 ml/g to 1.15 ml/g while soaking increased it to 2.00 ml/g *(B. eurycoma)* and 1.67 ml/g *(D. microcarpum)*. Denaturation of proteins during roasting decreased its contents due to the binding of nitrogen, making it unavailable for reaction. In the case of *A. africana,* the soaked legume (2.16

Table 1. Proximate composition of raw, roasted and soaked flours of *B. eurycoma, A. africana and D. microcarpum* (on dry weight basis)

Samples	Ether extract (%)	Crude protein (%)	Ash content (%)	Moisture content (%)	Crude fibre (%)	Carbohydrate (%)
B. eurycoma						
Raw	8.50^a	10.54^a	5.68^a	8.60^a	2.50^a	64.18^a
Roasted	10.25^a	12.70^a	4.50_b	8.40^a	3.40^a	60.75^a
Soaked	8.50^a	11.27^a	5.61^a	8.63^a	2.30^a	63.68^a
LSD values	-	-	0.82	-	-	-
A. africana						
Raw	30.00^a	13.86^a	3.50^a	10.50^a	2.40^a	39.74^a
Roasted	33.00^a	12.25^{ab}	2.50^a	10.10^a	2.00^a	40.15^a
Soaked	29.00^a	11.27^b	3.40^a	11.00^a	2.50^a	42.83^a
LSD value	-	2.46	0.76	-	-	-
D. microcarpum						
Raw	14.00^a	15.13^b	6.50^a	2.00^a	3.40^a	57.97^a
Roasted	15.00^a	17.15^a	5.30^a	2.00^a	2.60^a	57.95^a
Soaked	13.50^a	16.42^a	5.90^a	2.40^a	2.50^a	59.28^a
LSD value	-	1.83	-	-	-	-

a,b: Means in a column with different superscripts for each legume are significantly different ($P<0.05$).

ml/g) differed significantly ($P<0.05$) from the raw (1.70 ml/g) and roasted (1.50 ml/g). The higher swelling index of the soaked legumes was consistent with the result on *A. africana* that increased solubilization of proteins increased the imbibition of the legumes (Onweluzo and Morakinyo, 1996). Water absorption capacity (WAC) of processed *B. eurycoma, A. africana and D. microcarpum* indicated increases. But no significant difference ($P>0.05$) was observed in WAC between processed *A. africana* (3.64 ml/H_2O/g flour) and the raw (3.30 ml/H_2O/g flour). Water absorption capacity of roasted D. microcarpum (8.00 ml/H_2O/g flour) differed significantly ($P<0.05$) from the soaked (7.00 ml/H_2O/g flour) and the raw (6.10 ml/H_2O/g flour) due to reduced moisture content. In the case of *B. eurycoma*, the soaked legume was better than the roasted and raw legumes in WAC. Hsu *et al.*, (1983) reported similar absorption increases of soaked beans. The higher water absorption during soaking has been attributed to the displacement of pressurized gases entrapped in the interior of the legumes. Water absorption capacity property may be due to the water binding activity of proteins and therefore unavailability of water for the thermal changes involved in roasting. These effects could be crucial factors controlling the processes. Furthermore, the increase in WAC of the three soaked legumes is similar to the results of Onweluzo and Morakinyo (1996) on soaked and roasted *A. africana* legumes in which they observed that protein molecules influenced greatly the increases in WAC property. Water absorption capacity depends on the amount and nature of hydrophilic constituents, to some extent on protein denaturation and processing methods (Lin *et al.*, 1974; Wu and Inglette, 1974; Kinsella, 1979).

The roasted and soaked legumes were indicated to have higher oil absorption capacities (OAC) (Table 2). Although, there were no significant differences ($P>0.05$) in the processed *A. africana* and *D. microcarpum*, roasted (1.41 ml/oil/g flour) and soaked (1.63 ml/oil/g flour) *B. eurycoma* differed significantly ($P<0.05$) from the raw legume in OAC. The rise in oil absorption capacity (OAC) of the soaked flours can be explained by the variations in the amounts and physical properties of the other food components such as fat and carbohydrate (Kinsella, 1976). The disruption of native protein structure to yield smaller protein aggregates, which may unmask the non-polar residues from the interior of the protein molecules, can also contribute to the rise in oil absorption capacity. The swelling index of the fibres is also another reason. No significant difference ($P>0.05$) was observed in emulsion capacity between the processed *B. eurycoma* and the raw legume (Table 2). But processing on the other hand decreased the emulsion capacity to 46.89% (roasting) and 46.94% (soaking). There were significant differences in emulsion capacity ($P<0.05$) between the raw and processed *D. microcarpum and A. africana* legumes respectively. The decreased emulsification

Table 2. Functional properties at room temperature (27^{0}C) of processed *B. eurycoma, A. africana and D. microcarpum*

Samples	Swelling Index (ml/g)	Water absorption capacity (ml/$H_2$0/g flour)	Oil absorption capacity (ml/oil/g flour)	Thermal gelation temperature (^{0}C)	Emulsion capacity (%)
B. eurycoma					
Raw	1.58^a	2.00^b	1.00^b	84.00^b	48.89^a
Roasted	1.15^a	2.40^b	1.41^a	93.00^a	46.89^a
Soaked	2.00^a	2.90^a	1.63^a	94.00^a	46.94^a
LSD values	-	0.68	0.33	5.89	-
A. africana					
Raw	1.70^{ab}	3.30^a	1.00^a	95.00^b	48.75^a
Roasted	1.50^b	3.64^a	1.14^a	99.00^a	46.94^b
Soaked	2.16^a	3.85^a	1.23^a	100.00^a	43.75^c
LSD values	0.59	-	-	3.67	1.56
D. microcarpum					
Raw	1.55^a	6.10^b	0.96^a	57.00^b	78.57^a
Roasted	1.30^a	8.00^a	1.07^a	91.00^a	46.57^b
Soaked	1.67^a	7.00^{ab}	1.32^a	79.00^a	46.38^b
LSD values	-	1.22	-	19.05	15.35

a,b,c: Means in a column with different superscripts for each legume are significantly different ($P<0.05$).

Table 3. Effect of temperature and time on the least gelation concentration of *B. eurycoma, A. africana and D. microcarpum*

Samples	Least gelation Concentration (%) (W/V)	Temperature range (^{0}C) 60	70	80	90	100	Time (min)
B. eurycoma							
Raw	12.00^a			Gel			40
Roasted	8.00^b				Gel		50
Soaked	12.00^a				Gel		45
LSD values	2.23						
A. africana							
Raw	18.00^a				Gel		60
Roasted	16.00^{ab}					Gel	60
Soaked	14.00^b					Gel	60
LSD values	3.08						
D. microcarpum							
Raw	6.00^a	Gel					30
Roasted	4.00^b				Gel		30
Soaked	6.00^a			Gel			30
LSD values	1.90						

a, b: Means in a column with different superscripts are significantly different ($P<0.05$).

potential of all the processed legumes as in the case of cowpea and soyabean (Abbey and Ibeh, 1988) as well as winged bean flours (McWaters and Holmes, 1979; Narayana and Rao, 1982) were as a result of denaturation of proteins during processing. Processed *B. eurycoma, A. africana and D. microcarpum* showed increased gelatin temperature (Table 2). Roasted and soaked *B. eurycoma, A. africana and D. microcarpum* differed significantly (P<0.05) from their raw legumes. The increased gelation temperature of the processed legumes agreed with the work of Schmidt (1981) that high protein concentration is required for the gelation of globular proteins.

Effect of temperature and time on the least gelation concentration of processed legumes

The least gelation concentration of the raw, roasted and soaked legume flours were indicated as 12%, 8% and 12% *(B. eurycoma)*, 18%, 16% and 14% *(A. africana)* and 6%, 4% and 6% *(D. microcarpum)* (Table 3). The least gelation concentration reported for other legume flours such as the Great Northern bean *(Phaseolus vulgaris L)* is 10% (W/V) (Sathe and Salunkhe, 1981) and lupin seed protein is 14% (W/V) (Sathe *et al.*, 1982). Fleming *et al.*, (1975) also reported that globulin fraction was implicated in the gelation capacity of legume proteins. The gelling properties of different legume flours were associated with the relative ratios of different constituent proteins, carbohydrates and lipids that make up the legumes, suggesting that interactions between such components may have a significant role in the functional properties (Sathe *et al.*, 1982).

CONCLUSION

At present, the major utilization of *B. eurycoma, A. africana and D. microcarpum* is in the traditional soup making as thickners. It is apparent from this study that the processing methods used influenced ether extract and crude protein contents, including such functional properties as WAC, OAC and thermal gelation temperature. It could therefore be inferred that the affinity for water by roasted and soaked legumes depends mostly on the degree of the solubilization of the protein molecule and its ability to absorb oil and water when processed.

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