*Pak J Sci Ind Res 2000, **43** (5) 267-270*

Proximate Composition, Some Nutritionally Valuable Minerals and Functional Properties of Walnut (*Tetracarpidium conophorum* (Muell. Arg.) Flour

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(Received 3 August 1998; accepted 2 January 2000)

Full fat walnut *(Tetracarpidium conophorum)* seed flour was produced and evaluated for proximate and nutritionally valuable mineral composition and functional properties. The proximate composition of walnut was characterized by relatively high protein (14.75%), total carbohydrates (18.87%), fat (51.68%), crude fibre (1.16%) and ash (3.73%). The mineral analysis showed that seed flour was rich in the content of sodium, potassium and phosphorus. The foaming capacity and the least gelation concentration of the seed flour were found to be 7.8% and 5.10%, respectively. The effects of dilute solutions of NaCl and KCl on some functional properties of the seed flour were also examined. The results indicated that addition of NaCl or KCl solution improved the functional properties of the seed flour.

Key words: Composition, Mineral content, Functional properties, Walnut flour, *Tetracarpidium conophorum.*

Introduction

Walnut (*Tetracarpidium conophorum*) a non-timber forest fruit tree belongs to the Euphorbiacae family and is found in the rain forest zone of Nigeria. The plant is a climber i.e. a woody liane up to 30 m high in low bushes. It has glabrous leaves, which are chordate in shape. The inflorescence is a raceme upto 10 cm long. The fruits are 4 - winged, ridged between wings and up to 6 cm in diameter. The seeds are dicotyledonous sub-glubose and about 3 cm long. *Tetracarpidium conophorum* is planted for its edible seeds, which are cooked or roasted and commonly eaten with maize (Irvine 1952). It serves as the mainstay of some rural communities in Nigeria and its leaves are widely used in traditional medicine for the treatment of bile. There is little information on nutritional quality of walnut.

This report examines the proximate and mineral composition together with the functional properties of walnut flour. It is part of ongoing study of the evaluation of some indigenous under-exploited plant materials as source of food protein and/ or as inputs in food applications.

Experimental

Walnut seeds were purchased from market in Benin City, Nigeria, shelled, cut into small pieces with a plastic knife, air-dried, ground into fine powder, packed in polyethylene bags and afterwards stored below 4°C.

Proximate Analysis. The proximate analysis of the seed flour was carried out in triplicate using the methods described by the Association of Official Analytical Chemists (AOAC 1990). Nitrogen was determined by the micro-Kjeldahl method as described by Pearson (1976) and the percentage nitrogen was converted to crude protein by multiplying the values of nitrogen content by 6.25. The total carbohydrate was determined by difference in triplicate samples.

Mineral Analysis. The minerals were analysed in the extract obtained by first dry-ashing the seed flour at 55°C and then dissolving the ash in a flask using distilled, deionised water. Calcium, copper, iron, manganese, magnesium and zinc were determined by atomic absorption spectrophotometer (PYE UNICAM). Phosphorus was determined colorimetrically as described by Pearson (1976) and sodium and potassium were determined by using a flame photometer (Christian 1994).

Determination of functional properties. The water absorption capacity (WAC) of the seed flour was determined using the method described by Beuchatt (1977). One gram of the seed flour was mixed with 10 ml distilled water in a mixer maintained at room temperature (30 ± 1°C) for 30 minutes, centrifuged at 3500 rpm for 30 minutes and the volume of the supernatant was noted in a 10 ml measuring cylinder. The density of water was assumed to be 1gm l^{-3}. The average of triplicate determinations is reported as the WAC on dry weight basis of the flour.

The procedure described by Sosulki (1962) as modified by Adeyeye (1995) was used to determine the oil absorption capacity (OAC) of the seed flour. 0.5 g of the seed flour was added to 3 ml of 'Avop' vegetable oil in a 10 ml graduated

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centrifuge tube. The mixture was stirred with a glass rod to disperse the flour in the oil. After holding for 30 minutes, the mixture was centrifuged for 30 minutes and the volume of the supernatant was noted, and reported as OAC. The density of the oil was determined to the 0.88 gml^{-3}.

The method of Coffmann and Garcia (1977) as modified by Oshodi and Ekperigen (1989) was used to determine the least gelation concentration (LGC) of the seed flour. Appropriate amounts of the flour were dispersed in 5 ml of distilled water to give 2,4,6,8,10,14 and 16% (w/v). The suspensions were heated for 1h in boiling water and cooled rapidly in running tap water. The tubes containing the mixtures were then cooled for 2h at 4°C. The LGC was determined as the concentration at which the flour from the inverted test-tube did not slip or fall. The foaming capacity (FC) and foaming stability (FS) of the seed flour were determined according to the method described by Coffmann and Garcia (1977). One gram of the seed flour was whipped with 50 ml of distilled water for 5 min in a Kenwood blender at a speed setting "fast" and the mixture was poured into 100 ml graduated cylinder. The total volume of the mixture at various intervals of time was noted. The foaming stability is reported as the difference in the volume of the mixture before whipping, V_i and the volume after whipping, V_f, divided by V_i multiplied by 100.

The emulsion capacity, (EC) of the seed flour was determined by the method described by Inklaar and Fortuin (1969). One gram of the flour was made into a slurry in 20 ml of distilled water in a flask by stirring at 100 rpm for 15 min with a small magnetic bar. About 5 ml of AVOP vegetable oil were added over a period of 5 min while stirring at 100 rpm and stirring was continued for additional 10 min. The mixture was transferred into a centrifuge tube, heated in a water bath maintained at 85°C for 15 min with occasional swirling and then cooled in a water bath maintained at 25°C. The mixture was centrifuged at 3500 rpm until the volume of oil that separated from the emulsion was constant, and expressed as a percentage of the emulsified oil.

The effect of dilute sodium chloride and potassium chloride solutions (0.5-20%) (w/v) on the least gelation concentration, foaming capacity and foaming stability of the seed flour was examined by using appropriate amounts of the salt solution instead of distilled water.

Results and Discussion

Proximate and mineral composition. The proximate and mineral composition of walnut seed floor is shown in Table 1. The crude protein is relatively high (14.7%), but markedly lower than the values of about 40% reported for soybean (*Glycine max*) and winged bean (*Psophocarpus tetragonolobus*) flour and about the same order of magnitude with the values reported for varieties of lima bean (*Phaseolus lunatus*) flour (about 20%) (Oshodi and Adeladun 1993) and for African yam bean (*Sphenostylis stenocarpa*) flour (about 19-21%) (Adeyeye *et al* 1994). The mineral composition of the seed flour indicates relatively high levels of sodium, potassium and phosphorous and were consistent with the ash content (3.73%) of the flour.

Functional properties. The functional properties of walnut seed flour are shown in Table 2. It can be seen that the water absorption capacity of the seed flour is 283.3%. Water absorption capacity is an index of the amount of water retained within a protein matrix and includes entrapped, bound and hydrodynamic water (Kinsella 1979). The value of water absorption capacity reported in this study for walnut seed flour is higher than the values 180% reported for dehulled pigeon pea *Cajanus cajan* (Oshodi and Ekperigin 1989), 130% for soybean flour (Athschul and Wilcke 1985) and between 135-142% reported for varieties of Lima bean flour (Oshodi and Adeladun 1993).

The oil absorption capacity of walnut seed flour (Table 2) was found to be 201.1%, and was higher than the values of 89.7% reported for pigeon pea flour (Oshodi and Ekperigin 1989), approx 84% for wheat (*Triticum aestivum*)

Table 1

Proximate and mineral composition of Walnut (*Tetracarpiduim conophorum*) seed flour

Proximate composition	
Moisture content (%)	10.91 ± 0.05
Crude protein (%)	14.75 ± 0.03
Fat (%)	51.68 ± 0.04
Crude Fibre (%)	1.16 ± 0.02
Ash content (%)	3.73 ± 0.02
Carbohydrate (%)	18.87 ± 0.04
Mineral composition ($mg\,kg^{-1}$)	
Sodium	60.21 ± 0.52
Potassium	41.34 ± 0.81
Calcium	5.82 ± 0.22
Copper	0.57 ± 0.03
Iron	0.89 ± 0.04
Manganese	0.61 ± 0.05
Magnesium	1.16 ± 0.04
Phosphorus	9.60 ± 0.21
Zinc	0.97 ± 0.06

Values are means of triplicate determinations. Errors are computed as standard errors.

and soyabean flour (Althschul and Wilcke 1985), between 82.3% and 91.5% for varieties of lima (*Phaseolus lunatus*) seed flour (Oshodi and Adeladun 1993) and 125% for *Adenopus breviflorus* seed flour (Oshodi 1992). The oil absorption capacity may be regarded as an aspect of emulsifying capacity and it is a useful index of flavour retention in good preparation.

The least gelatin concentration of walnut seed flour is relatively low (5.10%) and lower than the values reported for African yam bean (*Sphenostylis stenocarpa*) flour (Adeyeye *et al* 1984) and for varieties of lima bean flour (Oshodi and Adeladun 1993). Protein gels provide a structural matrix for retaining water contents, flavour and other food ingredients that are useful in food applications. The relatively low least gelatin capacity obtained for walnut flour indicates a potential for application of the seed or its protein concentrate in the production of curd or as an additive to other gel forming materials in food production (Althschul and Wilcke 1985; Adeyeye *et al* 1994).

The foaming capacity and foaming stability of walnut seed flour were 7.8% and 2%, respectively. The FS and FC values of walnut seed flour are markedly lower than that reported for lima bean flour (Oshodi and Adeladun 1993), pigeon pea flour (Oshodi 1992) and lupin (*Lupinus albus*) seed flour (Sathe *et al* 1982). The capacity of proteins to form stable foam is an important property in cakes and confectioneries and is related to its solubility in the aqueous phase and on the flexibility and strength of the protein films formed around the gel droplets.

The emulsion capacity of walnut seed flour (30%) was much lower than the values of 66% reported for cherry (*Chrysophyllum albidium*) seed flour (Atuegbunam and Okieimen 1992) and 95% for sunflower (*Helianthus annus*) flour (Oshodi and Adeladun 1993). Emulsifying properties of protein play an important role in a number of food applications, in baking, in milk mayonnaise, salad dressings etc.

Table 2

Functional properties of walnut (*Tetracarpidium conophorum*) seed flour

Functional property	
Water absorption capacity (%)	283.2 ± 0.2
Oil absorption capacity (%)	201.1 ± 0.3
Lowest gelatin concentration (%)	5.10 ± 0.1
Foaming capacity (%) (volume increase)	7.8 ± 0.1
Foaming stability (%) after 2h	2.0 ± 0.1
Emulsion capacity (%)	30.5 ± 0.2

Values are means of triplicate determinations. Errors are computed as standard errors.

Effect of sodium chloride and potassium chloride solutions on some functional properties of walnut seed flour. The effects of NaCl and KCl solutions on some functional properties of walnut seed flour are shown in Table 3. It can be seen that the added chloride salts of sodium and potassium improved the measured functional properties of the seed flour, within the range of concentrations used. The observed improvement in the foaming properties (Fc and Fs) of the seed flour may be attributed to increase in protein solubility due to partial denaturation (Sathe *et al* 1982).

In the light of the observed results, it can be concluded that walnut seed when converted into flour can be used solely or in blends with other flour types for varieties of food preparations. Its high minerals content, its ability to retain

Table 3

Effect of dilute aqueous solutions of NaCl and KCl on some functional properties of Walnut (*Tetracarpidium conophorum*)

Concentration of salt % (wv^{-1})	Least gelaton concentration (%)		Foaming capacity (%)		Foaming stability(%)	
	NaCl	KCl	NaCl	KCl	NaCl	KCl
0.0	5.0 ± 0.2	5.0 ± 0.2	7.8 ± 0.3	7.8 ± 0.1	1.96 ± 0.1	1.96 ± 0.1
0.5	4.8 ± 0.2	4.9 ± 0.2	10.0 ± 0.2	9.2 ± 0.3	2.6 ± 0.1	2.4 ± 0.2
1.0	4.4 ± 0.2	4.6 ± 0.2	9.6 ± 0.3	8.9 ± 0.4	2.8 ± 0.2	2.6 ± 0.2
2.0	3.9 ± 0.3	3.9 ± 0.3	10.4 ± 0.4	9.8 ± 0.2	2.4 ± 0.2	2.4 ± 0.2
5.0	3.9 ± 0.3	4.1 ± 0.2	10.6 ± 0.3	9.6 ± 0.3	2.4 ± 0.2	2.4 ± 0.2
10.0	4.2 ± 0.2	4.0 ± 0.2	9.1 ± 0.2	8.8 ± 0.2	2.4 ± 0.2	2.2 ± 0.1
20.0	4.0 ± 0.2	4.2 ± 0.2	8.6 ± 0.2	8.7 ± 0.2	2.2 ± 0.2	2.3 ± 0.1

Values are means of triplicate determinations. Errors are computed as standard.

flavour and its emulsifying property permits its wide usage in baking, salad dressing etc.

References

Adeyeye E I 1995 Studies in the chemical composition and functional properties of African yam bean (*Sphenostylis stenocarpa*) flour, Ph.D thesis, Federal University of Technology, Akure, Nigeria.

Adeyeye E I, Oshodi A A IPinmoroti K O 1994 Functional properties of some varieties of African yam bean flour. *Int J Food Sci Nutr* **45** 115-126.

Althschul H M, Wilcke H L 1985 *New Protein Foods: Seed Storage Protein. London Academic Press,* Vol 5, pp 25-34.

AOAC 1990 *Official Methods of Analysis* . Association of Official Analytical Chemist. Washington, DC.15th ed.

Atuegbunam C E, Okieimen F E 1992 Proximate Composition, some nutritionally valuable minerals and functional properties of Cherry (*Chrysophyllum albidium*) and pumpkin (*Telfaira accidentails*) seed flours. *Niger J Appl Sci* **10** 33-39.

Beuchat L B 1977 Functional and electrophoretic characteristic of succinylated peanut flour protein. *J Agric Food Chem* **25** 258-261.

Christian G D 1994 *Analytical Chemistry* John Wiley & Sons Inc. 5th ed. pp 740-742.

Coffmann C W, Garcia V V 1977 Functional properties and amino acid content of protein isolate from mung bean flour. *J Food Technol* **12** 473-484.

Inklaar P A, Fortuin J 1969 Determining emulsifying and emulsion stabilishing capacity of meat additives. *J Food Technol* **23** 103.

Irvine R F 1952 Supplementary and emergency food plant for West Africa. *Economic Botany* **6**(1) 23.

Kinsella J E 1979 Functional properties of soya proteins. *J Am Oil Chem Soc* **56** 242-258.

Oshodi A A 1992 Proximate analysis, some nutritionally valuable minerals and functional properties of *Adenopus breviflorus* seed flour and protein. *Food Chem* **45** 79-83.

Oshodi A A, Adeladun M O 1993 Proximate composition, some nutritionally valuable minerals and functional properties of three varieties of lima bean flour protein. *Int J Food Sci Nutr* **43** 181-185.

Oshodi A A, Ekperigin M M 1989 Functional properties of piegeon pea (*Cajanus cajan*) flour. *Food Chem* **34** 187-191.

Pearson D C 1976 *Chemical Analysis of Foods.* J & A Churchill, London, 7th ed.

Sathe S K, Desphande S S, Salunke D K 1982 Functional properties of lupin seed protein and protein concentrate. *J Food Sci* **47** 491-498.

Sosulski F W 1962 The centrifuge method for determining flour absorption in hard red spring wheat. *Cereal Chem* **39** 344-350.