

PJN

ISSN 1680-5194

PAKISTAN JOURNAL OF
NUTRITION

ANSI*net*

308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

Nutritional Evaluation and Physicochemical Properties of Processed Pumpkin (*Telfairia occidentalis* Hook) Seed Flour

Sara Y. Hamed¹, Nafisa M. El Hassan¹, Amro B. Hassan²,
Mohamed M. Eltayeb¹ and Elfadil E. Babiker¹

¹Department of Food Science and Technology, Faculty of Agriculture,
University of Khartoum, Khartoum North, 13314 Shambat, Sudan

²National Center for Research, Environment and Natural Resource Research Institute,
P.O. Box 6096, Khartoum, Sudan

Abstract: The effect of roasting on proximate composition and the levels of antinutritional factors, protein digestibility, minerals extractability and physicochemical properties of pumpkin seeds consumed in Sudan were determined. Results showed that processing significantly ($p \leq 0.05$) reduced protein content. Roasting of pumpkin seeds significantly ($p \leq 0.05$) reduced tannin and phytic acid content to 125.01 and 56.1 mg 100⁻¹ g with a concomitant improvement in protein digestibility. Roasting of pumpkin seeds significantly ($p \leq 0.05$) improve total and extractable minerals as well as physicochemical properties of the seeds flour with few exceptions.

Key words: Pumpkin seeds, roasting, antinutritional factors, protein digestibility, mineral extractability, physicochemical properties

Introduction

In many developing countries, the supply of animal protein is inadequate to meet the protein needs of the rapidly growing population. This has necessitated contemporary research efforts geared towards the study of the food properties and potential utilization of protein from locally available food crops, especially from underutilized or relatively neglected high protein oilseeds and legumes (Balogun and Fetuga, 1986; Ene-Obong and Carnovale, 1992; Giami and Wachuku, 1997; Enujiugha, 2000; Enujiugha and Ayodele-Oni, 2003). One of the locally available, under-exploited but potentially high protein food sources in Nigeria is fluted pumpkin (*Telfairia occidentalis* Hook) seed. In addition to its importance as an oilseed (54% fat), it is a valuable source of protein (27%) with a fairly well-balanced amino acid composition. However, the usefulness of fluted pumpkin seed as a protein source for human food is limited by the presence of antinutrients, particularly phytic acid (Giami and Isichei, 1999; Akwaowo *et al.*, 2000), which have been shown to lower the bioavailability of minerals in humans and to inhibit the digestibility of plant proteins (Lopez *et al.*, 2002). Fluted pumpkin seeds are cooked and used as an ingredient, or protein supplement, in a variety of local foods (Achinewhu, 1987). The development of value-added products from fluted pumpkin seed had been recommended as a way to increase the opportunity to expand the utilization of the seed in the tropics (Giami and Bekebain, 1992; Giami and Isichei, 1999). One potential food application for fluted Pumpkin Seed Flour (FPF) is its use in composite flours for the production of

bakery products, such as bread and cookies (soft type biscuits). Efforts have been made to promote the use of composite flours in which flour from locally grown high protein oilseeds and legumes replace a portion of wheat flour for production of high protein composite bakery products (United Nations Economic Commission for Africa, UNECA, 1985). The objective of the present investigation is to study the effect of processing on nutritive values, mineral and protein availability as well as physicochemical properties of pumpkin seeds.

Materials and Methods

Materials and sample preparation: Seeds of pumpkin were obtained as a local cultivar from Khartoum North, Sudan. Pumpkin seeds were cleaned and freed from foreign materials. The seeds were divided into two groups, one group was roasted and the other used as raw. The seeds hulls were removed manually milled in laboratory miller and then defatted. Refined Groundnut oil was brought from Bittar Co. Ltd., Khartoum, Sudan. Unless otherwise stated all chemicals used in this study were of reagent grade.

Proximate analysis: The proximate (moisture, ash, ether extract, fiber and crude protein) composition of the samples was done using the method reported by AOAC (1984). Carbohydrate (NFE) content was estimated by difference.

In vitro Protein Digestibility (IVPD) determination: *In vitro* protein digestibility of samples was measured according to the method of Sauders *et al.* (1973). About

250 mg sample was suspended in 15 mL of 0.1 N HCl containing 1.5 mg pepsin (1:10,000) in a 100 mL conical flask. The mixture was incubated at 37°C for 3 h. The mixture was then neutralized with 0.5 N NaOH and treated with 4 mg pancreatin (Grade VI porcine) in 7.5 mL of 0.2 M phosphate buffer (pH 8.0) containing 0.005 M sodium azide. The mixture was incubated at 37°C for 24 h. About 10 mL of 10% Trichloroacetic Acid (TCA) were added to the mixture to stop the reaction. The mixture was then centrifuged at 5000 rpm for 5 min. About 5 mL of the aliquots from the supernatant were pipetted and analyzed for nitrogen content (AOAC, 1984). Protein digestibility was determined according to the equation:

$$\text{Protein digestibility(\%)} = \frac{\text{N in supernatant} - \text{enzyme N}}{\text{N in sample}} \times 100$$

Determination of tannins content: Quantitative estimation of tannin for each sample was carried out using the modified vanillin-HCl in methanol method as described by Price *et al.* (1978). A standard curve was prepared expressing the results as catechin equivalents, i.e. amount of catechin (mg mL⁻¹) which gives a colour intensity equivalent to that given by tannin after correcting for blank.

Phytic acid determination: Phytic acid content was determined by the method described by Wheeler and Ferrel (1971) using 2.0 g of a dried sample. A standard curve was prepared expressing the results as Fe (NO₃)₃ equivalent.

Total minerals determination: Minerals were extracted from the samples by the dry ashing method that described by Chapman and Pratt (1961). The amount of iron, zinc, manganese and Cobalt were determined using Atomic Absorption Spectroscopy (Perkin-Elmer 2380). Ammonium Vanadate was used to determine phosphorus along with Ammonium Molybdate method of Chapman and Pratt (1982). Calcium and was determined by titration method that described by Chapman and Pratt (1961). Sodium and potassium were determined by flame photometer (CORNING EEL) according to AOAC (1984).

HCl extractability of mineral: The HCl extractability of minerals was performed according to Chauhan and Mahjan (1988) method. About 1.0 g was extracted using 10 mL of 0.03N HCl with shaking at 37°C for 3 h. The clear extract obtained was dried at 100°C and then placed in a muffle furnace at 550°C for 4 h. Thereafter, the samples were cooled and about 5 mL of 5N HCl were added and boiled gently for 10 min and then cooled, diluted to 100 mL with distilled water. Minerals were determined as described above.

Water and fat absorption capacity: Water Absorption Capacity (WAC) of the samples was measured by the centrifugation method of Sosulski (1962). Fat Absorption Capacity (FAC) of the defatted samples was measured by the method described by Lin *et al.* (1974).

Bulk density: The bulk density of the samples was determined by the method described by Wang and Kinsella (1976).

Dispersibility: The dispersibility of the samples at selected pH levels (3, 7 and 10) was measured according to the method of Kulkarni and Ingle (1991).

Statistical analysis: Each sample was analyzed in triplicate and the values were then averaged. Data were assessed by the Analysis of Variance (ANOVA) as described by Duncan's multiple range test with a probability $p \leq 0.05$.

Results and Discussion

Proximate composition of pumpkin seeds: Pumpkin seeds were consumed as roasted. The results of the proximate composition of the samples (unroasted and roasted pumpkin seeds flour) are shown in Table 1. The moisture content was quite low and was found to be 5.47 and 6.10% for unroasted and roasted pumpkin seeds, respectively which may be advantageous in view of the samples' shelf life. The result showed that roasted pumpkin seeds flour is quite rich in protein (67.75 and 60.17%). Thus, pumpkin seeds could contribute significantly to the recommended human daily protein requirement which was reported to be ranged from 23% to 56% (NRC, 1980). Both unroasted and roasted pumpkin seeds contained significantly ($p \leq 0.05$) high ash and were found to be 9.04 and 8.78%, respectively. Since the ash content of a sample is a reflection of the minerals it contains therefore, pumpkin seeds are expected to be rich in minerals. Pumpkin seeds contained higher amount of oil and expected to interfere with other parameters determination, therefore, the samples were defatted and the remaining oil was found to be 1.37 and 1.43% for the samples, respectively. Results reported for pumpkin seeds were higher than that reported by Giami *et al.* (2005) after defatting. Fats are essential in diets as they increase the palatability of foods by absorbing and retaining their flavours and help in the transport of nutritionally essential fat-soluble vitamins (Omotoso, 2006). As shown in Table 1, roasting of the seeds significantly ($p \leq 0.01$) increased crude fiber and carbohydrate content to 3.80 and 18.68% respectively and had no significant effect on moisture, ash and oil content but caused a significant ($p \leq 0.01$) reduction in protein content to 60.17%. The reduction in protein content may be attributed to denaturation of it during heating as reported by Bradbury *et al.* (1984).

Table 1: Proximate composition (%) of processed pumpkin seeds

Samples	Moisture	Crude protein	Crude fiber	Crude ash	Ether extract	Carbohydrate (NFE)
Unroasted	5.47±0.23 ^b	65.05±0.19 ^b	2.98±0.06 ^b	9.04±0.03 ^a	1.37±0.03 ^b	15.63±0.03 ^b
Roasted	6.10±0.03 ^a	60.17±1.07 ^c	3.75±0.01 ^b	8.78±0.02 ^a	1.43±0.18 ^b	18.68±0.11 ^a

Values are means (±SD) of triplicate samples. Values having different superscript letter(s) in a column differ significantly at $p \leq 0.05$

Table 2: Antinutritional factors content (mg/100g) and protein content and digestibility (%) of processed pumpkin seeds

Samples	Protein		Antinutritional factors	
	Content	Digestibility	Tannin	Phytic acid
Unroasted	65.05±0.19 ^a	59.39±0.23 ^b	228.31±0.09 ^a	63.62±0.11 ^c
Roasted	60.17±1.07 ^b	92.76±0.13 ^a	125.01±0.25 ^b	56.13±0.03 ^d

Values are means (±SD) of triplicate samples. Values having different superscript letter(s) in a column differ significantly at $p \leq 0.05$

Antinutritional factors and protein digestibility of pumpkin seeds:

Table 2 shows the antinutritional factors content and protein digestibility of pumpkin seeds flour. The level of tannin and phytic acid content of untreated samples was found to be 228.3 and 63.6 mg 100⁻¹ g, respectively. The results obtained for pumpkin seeds was higher than that of pumpkin seed flour reported by El-Adawy and Taha (2001). Roasting of seeds significantly ($p \leq 0.05$) reduced tannin and phytic acid content to be 125 and 56.1 mg 100⁻¹ g, respectively (Table 2). The reduction of tannin and phytic acid content of roasted samples may be due to the effect of the heat treatment. Hassan *et al.* (2005) reported that the application of processing such as cooking have been effective in reducing antinutritional factors of lupin seeds. The *in vitro* Protein Digestibility (IVPD) of unroasted and roasted pumpkin seeds was 59.39 and 92.76%, respectively. It was clear that roasting of pumpkin seeds was significantly ($p \leq 0.05$) increased the IVPD. Although pumpkin samples were very rich in tannin and low in phytate content, they had significantly ($p \leq 0.05$) high IVPD. The increment of IVPD of roasted sample may be attributed to the reduction in antinutritional factors tannin and phytic acid. The relation between IVPD and antinutrients had been observed by Bradbury *et al.* (1984).

Total and extractable minerals of pumpkin seeds:

Table 3 shows total and extractable minerals of pumpkin seeds flour. Potassium (K) content of untreated pumpkin seed was found to be 1078.55 mg/100 g and out of this amount about 70.11% was found to be extractable. The result obtained was lower than that (1379 mg/100 g) reported by Giami *et al.* (2005) and higher than that (982 mg/100 g) stated by El-Adawy and Taha (2001). Total and extractable K were significantly ($p < 0.05$) increased when the seeds were roasted and it was found to be 1331.7 mg 100⁻¹ g and 85.23%, respectively. Both roasted and unroasted pumpkin seeds contained significantly ($p \leq 0.05$) high amount of Ca (134.0 and 152.5 mg/100 g) and out of this amount about 77 and 84% were found to be extractable for unroasted and roasted seeds, respectively. Results obtained in this

study were higher than those reported by Giami *et al.* (2005) and El-Adawy and Taha (2001) for pumpkin seed flour. Results obtained for Na and P for pumpkin seeds are similar to that obtained for Ca. Processing of the two samples was significantly ($p \leq 0.05$) increased the extractable Na and P. Fe content significantly ($p \leq 0.05$) decreased when seeds were roasted and it was found to be 17.36 mg/100 g, however, after processing Fe extractability increased to 13.48%. The values obtained were higher than that of pumpkin seed flour (4.5 mg/100 g) stated by Giami *et al.* (2005) and (10.9 mg/100 g) that reported by El-Adawy and Taha (2001). Other trace minerals (Mn, Zn and Co) followed a trend similar to that obtained for Fe with few exceptions. Results obtained indicated that a successive increase in minerals extractability of pumpkin seeds occurred after roasting the seeds. Divalent cations, such as Ca, are generally present in association with phytic acid; this may be responsible for its lower extractability. However, reduction in phytic acid as a result of roasting may explain higher Hcl-extractability of calcium and other minerals (Duhan *et al.*, 2002). The differences between the results obtained in this study and the other ones may be attributed to the variation of the varieties. Increment in mineral extractability may be due to qualitative as well as quantitative differences between mineral obtained after treatment.

Physicochemical properties of pumpkin seeds:

Table 4 shows the physicochemical properties of pumpkin seeds. Fat Absorption Capacity (FAC) was 180.7 mL g⁻¹ and it increased to 200.7 mL g⁻¹ after roasting of the seeds. It was clear that roasted pumpkin seeds had FAC significantly ($p \leq 0.05$) greater than that of unroasted one. Oil absorption capacity may determine whether the protein will perform well as meat extenders (Circle and Smith, 1972) and also it is important since oil acts as flavour retainer and increases the palatability of foods (Kinsella, 1976). Water Absorption Capacity (WAC) values of pumpkin seeds were 179.7 mL g⁻¹ and 240.0 mL g⁻¹ for unroasted and roasted seeds, respectively. The increase in WAC could be caused by the dissociation of proteins that might occur as a result of heating and denaturation and could be minimized by

Table 3: Total (mg/100 g) and extractable (%) minerals of processed pumpkin seeds

	Unroasted		Roasted	
	Total	Extractable	Total	Extractable
Ca	152.50±0.06 ^a	77	134.00±0.03 ^b	84
K	1078.55±1.2 ^b	70	1331.70±0.05 ^a	85
Na	35.54±0.01 ^a	51	25.59±0.08 ^b	52
P	66.90±0.07 ^a	35	63.05±0.07 ^b	43
Fe	23.97±0.08 ^a	11	17.36±0.25 ^b	13
Mg	5.34±0.05 ^a	23	3.46±0.60 ^b	87
Zn	17.17±0.90 ^a	39	16.71±0.08 ^b	39
Co	6.36±0.31 ^a	97	4.88±0.23 ^b	75

Values are means (±SD) of triplicate samples. Values having different superscript letters in a row are differ significantly at p ≤ 0.05

Table 4: Physiochemical property of pumpkin seeds flour before and after processing

Pumpkin seeds		
Roasted	Unroasted	Property
200.7±1.35 ^a	180.70±0.15 ^b	Fat absorption capacity (mL/100 g)
240.00±0.00 ^a	179.70±0.34 ^b	Water absorption capacity (mL/100 g)
3.13±0.025 ^a	2.97±0.005 ^a	Bulk density (g mL ⁻¹)
Dispersibility		
66.68±0.73 ^a	55.98±1.03 ^c	pH 3
66.72±0.75 ^a	60.03±1.23 ^c	pH 7
66.71±0.83 ^a	53.13±1.03 ^d	pH 10

Values are means (±SD) of triplicate samples. Values having different superscript letter(s) in a row are differ significantly at p ≤ 0.05

short-period treatment (Abbey and Ibeh, 1987). The degree of WAC is considered to be useful as an indication of performance in several food formulations, especially those involving dough handling (Circle and Smith, 1972). The Bulk Density (BD) of pumpkin seeds was 2.97 and 3.13 g mL⁻¹ before and after roasting. Results obtained for BD showed that processing of both samples slightly increased it. Higher bulk density is desirable since it helps to reduce the paste thickness which is an important factor in convalescent and child feeding (Padmashree *et al.*, 1987). As shown in Table 4 both processed and unprocessed pumpkin seeds had high dispersibility at pH 7 compared to other pH values. It was reported that higher dispersibility enhances emulsifying and foaming properties of proteins, which was observed during bread making, macaroni and cookies (Kinsella, 1979).

In conclusion, the results obtained in this study indicated that pumpkin seeds are rich sources of nutrients. Therefore, it can be consumed as food or as supplementary ingredients especially in Africa and Asia to alleviate the problem of nutrient/protein malnutrition. Further work is needed to evaluate the nutritional value by using *in vivo* tests.

References

- AOAC., 1984. Association of Official Analytical Chemists. Official Methods of Analysis, 14th Edn. Washington DC.
- Abbey, B.S. and G.O. Ibeh, 1987. Functional properties of raw and heat processed brown bean (*Ganavalia rosea* DC) Flour. J. Food Sci., 52: 406-408.
- Achinewhu, S.C., 1987. Protein quality evaluation of weaning food mixtures from indigenous fermented foods. Nig. J. Nutr. Sci., 8: 23-31.
- Akwaowo, E., B.A. Ndon and E.U. Etuk, 2000. Minerals and antinutrients in fluted pumpkin (*Telfairia occidentalis* Hook). Food Chem., 70: 235-240.
- Balogun, A.M. and B.L. Fetuga, 1986. Chemical composition of some under-exploited leguminous crop seeds in Nigeria. J. Agric. Food Chem., 34: 189-192.
- Bradbury, J.H., J.G. Collins and N.A. Pyliotis, 1984. Digestibility of protein of the histological components of cooked and raw rice. Br. Nutr., 52: 507-513.
- Chapman, H.D. and F.P. Pratt, 1961. Ammonium Vanadate-Molybdate Method for Determination of Phosphorus. In: Methods of Analysis for Soils, Plants and Water. 1st Edn. California: California University, Agriculture Division, pp: 184-203.
- Chapman, H.D. and P.F. Pratt, 1982. Method and of Analysis of Soil, Plant and Water. 2nd Edn. California: California University Agricultural Division, pp: 170.
- Chauhan, B.M. and L. Mahjan, 1988. Effect of natural fermentation on the extractability of minerals from pearl millet flour. J. Food Sci., 53: 1576-1577.
- Circle, S.J. and A.K.Smith, 1972. Functional Properties of Commercial Edible Soybean Protein Products. In: Seed Proteins. Hnglet, E.G. (Ed.). Avi-Westport, Ct. pp: 242-254.
- Duhan, A., N. Khetarpaul and S. Bishnoi, 2002. Changes in phytates and HCl-extractability of calcium, phosphorus and iron of soaked, dehulled, cooked and sprouted pigeon pea cultivar. Plant Food Human Nutr., 57: 275-284.
- El-Adawy, T.A. and K.M. Taha, 2001. Characteristics and composition of different seed oils and flours. Food Chem., 74: 47-54.
- Ene-Obong, H.N. and E. Carnovale, 1992. A comparison of the proximate, mineral and amino acid composition of some known and lesser known legumes in Nigeria. Food Chem., 43: 169-175.
- Enujiugha, V.N., 2000. Development of a new food paste from seeds of *Pentaclethra* species. Applied Trop. Agric., 5: 89-94.
- Enujiugha, V.N. and O. Ayodele-Oni, 2003. Evaluation of nutrients and some anti-nutrients in lesser known, underutilized oilseeds. Int. J. Food Sci. Tech., 38: 525-528.

Elfadil E. Babiker *et al.*: Processed Pumpkin (*Telfairia occidentalis* Hook) Seed Flour

- Giami, S.Y. and D.A. Bekebain, 1992. Proximate composition and functional properties of raw and processed fullfat fluted pumpkin seed (*Telfairia occidentalis*) flour. *J. Sci. Food Agric.*, 59: 321-325.
- Giami, S.Y. and Wachuku, O. C. 1997. Composition and functional properties of unprocessed and locally processed seeds from three underutilized food sources in Nigeria. *J. Plant Food Hum. Nutr.*, 50: 27-36.
- Giami, S.Y. and I. Isichei, 1999. Preparation and properties of flours and protein concentrates from raw, fermented and germinated fluted pumpkin (*Telfairia occidentalis* Hook) seeds. *Plant Foods Human Nutr.*, 54: 67-77.
- Giami, S.Y., S.C. Achinewhu and C. Ibaakee, 2005. The quality and sensory attributes of cookies supplemented with fluted pumpkin (*Telfairia occidentalis* Hook) seed flour. *In. J. Food Sci. Technol.*, 40: 613-620.
- Hassan, A.B., G.A. Osman and E.E. Babiker, 2005. Effect of domestic processing on antinutrients and availability of protein and mineral of lupin (*Lupinus termis*) seeds. *J. Food Technol.*, 3: 263-268.
- Kinsella, J.E., 1976. Functional properties of protein in food. A survey. *Crit. Rev. Food Sci. Nutr.*, 7: 219-280.
- Kinsella, J.E., 1979. Functional properties of soybean proteins. *J. Am. Oil Chem. Soc.*, 56: 242-249.
- Kulkarni, K.D. and U.M. Ingle, 1991. Sorghum malt-based weaning food formulations: Preparation, functional properties and nutritive value. *Food Nutr. Bull.*, 13: 4324-4327.
- Lin, M.J.Y., E.S. Humbert and F.W. Sosulski, 1974. Certain functional properties of sunflower meal products. *J. Food Sci.*, 39: 368-370.
- Lopez, H.W., F. Leenhardt, C. Coudray and C. Remesy, 2002. Minerals and phytic acid interactions: Is it a real problem for human nutrition? *Int. J. Food Sci. Tech.*, 37: 727-739.
- NRC (National Research Council), 1980. Recommended Dietary Allowances, 9th Edn. Nat. Acad. Sci., Washington DC., pp: 23-34.
- Omotoso, O.T., 2006. Nutritional quality, functional properties and antinutrients compositions of the larva of *Cirina forda* (Westwood) (Lepidoptera satuniidae). *J. Zhejiang Univ. Sci.*, B 7: 51-55.
- Padmashree, T.S., L. Vijayalakshmi and S. Puttaraj, 1987. Effect of traditional processing on the functional properties of cowpea (*Vigna catjang*) Flour. *J Food Sci. Tech.*, 24: 221-224.
- Price, M.L., Van S. Socoyoc and L.G. Butter, 1978. A critical evaluation of the vanillin reaction as an assay for tannin in sorghum grain. *Agric. Fd. Chem.*, 26: 1214-1218.
- Sauders, R.M., M.A Conner, A.N. Booth, E.M. Bickott and G.O. Kohler, 1973. Measurements of digestibility of alfalfa proteins concentrate by *in vivo* and *in vitro* methods. *J. Nutr.*, 103: 530-535.
- Sosulski, F.W., 1962. The centrifuge method for determining flour absorption in hard red spring wheats, *Cereal Chem.*, 39: 344-350.
- UNECA (United Nations Economic Commission for Africa), 1985. Technical Compendium on Composite Flours. Ethiopia: United Nations Economic Commission for Africa.
- Wang, J.C., J.E. Kinsella, 1976. Functional properties of novel proteins: Alfalfa leaf protein. *J. Food Sci.*, 286-292.
- Wheeler, E.I. and R.E. Ferrel, 1971. Methods for phytic acid determination in wheat and wheat fractions. *Cereal Chem.*, 48: 312-320.