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Effects of Processing on the Nutrient Composition of False Yam *(Icacina trichantha)* Flour

* Umoh, E.O.[1] and Iwe, M.O.[2]

ABSTRACT

False yam *(Icacina trichantha)* tubers were processed into different flour samples: the raw; steeped-sun-dried; steeped-oven-dried; blanched-sun-dried and blanched-oven-dried samples. The nutrient composition: proximate and mineral elements contents of the flour samples were studied. The lipid, protein and carbohydrate contents of the samples ranged between 1.77 to 5.76%, 3.01 to 60.3% and 85.56 to 93.31% respectively, while the energy values ranged between 394.27 to 412.46 Kcal. Concentration of potassium, sodium, calcium and iron (among others) ranged between 20.835 and 31.51 mg/l, 2.409 and 18.890 mg/l, 90.250 and 112.550 mg/l to 0.777 and 2.840 mg/l respectively. False yam tuber, apart from being a good source of energy for man, is rich in mineral elements (potassium, sodium and calcium).

Processing affected the levels of nutrients, in the flour samples.

Keywords: Processing, nutrient, false yam tuber.

Introduction

False yam *(Icacina trichantha)* is a small perennial shrub that is drought-resistant. The plant produces erect leafy shoots from a large underground fleshy tuber. It belongs to the family of *Icacinaceae*. It is indigenous to West and Central Africa.

It is known as *Bankanas* or *Kouraban* in Senegal, *Manankaso* in Gambia, *Pane* in Sudan, and *Takwara* in Ghana (Kay, 1987). It is also known as *Urumbia* or *Eriagbo* among the Ibos, *Gbegbe* by the Yorubas (Asuzu and Abubakar, 1995) and *Efik ison* by the Ibibios (Etukudo, 2003) in Nigeria.

False yam is seldom cultivated. However, it is reported from Senegal to be propagated by pieces of tuber, before the wet season. No pests and diseases have been reported (Kay, 1987). People truly enjoy the fruits as well as the seeds, which represent a permanent, reliable and very tasty food. The tubers which resemble large turnips or beet roots is such a great source of emergency moisture and food energy to the plant that it can survive at least four years without rain. Thus, as long as false yam is around, food is always available for people (NRCNAP, 2008).

False yam tuber are cleaned, sliced and soaked in clean water for several days to soften the flesh and leach out bitter compounds. They are then dried in the sun, pulverised, and sieved. The product is white, grayish, or creamy-yellowish flour. Drying the damp flour in a pot over a fire produces clear, hard 'rocks' of what is probably almost pure starch (NRCNAP, 2008).

1 Department of Agricultural Engineering, Akwa Ibom State University, Ikot Akpaden. P. M. B. 1167, Uyo, Nigeria.
2 Department of Food Science and Technology, Michael Okpara University of Agriculture, Umudike, P. M. B. 7267, Umuahia, Abia State, Nigeria.
* corresponding author: enoumoh40@gmail.com

Flour extracted from the seeds has 12 – 13% moisture, 8% protein, 0.1% fat, 0.5% ash and 72 – 73% carbohydrate (Kay, 1987).

The tubers contain about 10 – 15% starch, while flour produced from tubers has 11.7% moisture; 10.3% protein; 0.7% fat; 74.5% carbohydrate; 2.8% ash; 150 mg/100 g calcium; 7 mg/100 g iron; 0.04 g/100 g thiamine, 0.18 mg/100 g riboflavin and 1.4 mg/100 g niacin (Kay, 1987).

False yam is yet to gain recognition and popularity as a food crop. Processing it into stable flour and analysing its nutritional compositions will enhance the crop's recognition known to among greater majority of the people as a food crop, thus bringing to limelight its potential food uses (values).

This study was aimed at examining the nutrient composition of false yam flour processed from the tubers.

Materials and Methods

Sample collection and preparation

The tubers of *Icacina trichantha* were obtained from Akwa Ibom State College of Agriculture. Identification was carried out in the Department of Botany, University of Uyo, Uyo, all in Akwa Ibom State.

Four different samples of flour were prepared from the tubers of *Icacina trichantha* using four different methods of processing as shown below:

Steeped- sun-dried flour sample

The tubers were cleaned, peeled and washed before cutting them into pieces, using kitchen knife, of uniform sizes as described by Kay (1987). They were then soaked in clean water for about 24 h, after which they were sun-dried. That was followed by pulverisation, using a CORONA LANDERS & CIA.S.A.KI manual grinder, and was sieved using 500 mm mesh size. The flour obtained was packaged in a dry polyethylene sack and stored for subsequent use.

Steeped-oven-dried flour sample

The same method for the preparation of steep-sun-dried flour sample as described by Kay (1987) was adopted, except, that oven was used in the drying process at 50^{o}C.

Blanched-sun-dried flour sample

The freshly cleaned, peeled and sliced tubers were dipped in boiling water for a brief length of time, as described by Okaka and Okaka (2005). They were then drained, and sun-dried. Dry chips were pulverized and sieved. The flour obtained was packaged in a dry polyethylene sack and stored in a cool dry place for subsequent use.

Blanched-oven-dried flour sample

The blanched-over dried flour sample was prepared according to the method described by Okaka and Okaka (2005), except that oven was used in the drying process.

Determination of proximate composition

The moisture content, ash, crude fibre and crude fat, were determined using the method described by AOAC (1990). The crude protein was determined by Kjeldahl method, while the carbohydrate content was estimated by difference. The energy value was determined using the At water factor, in which the values obtained for the crude protein, fat, and carbohydrate were multiplied by 4, 9 and 4 Kcal respectively. The sum of the product was taken as the energy value of the flour sample (Smith and Ojofeitimi, 1995).

Determination of mineral elements

This was carried out according to the method of AOAC (1990). The residual ash from ash content determination was leached with 5 ml of 6M HCl. The volume was made up to 20 cm^3 with distilled water. The resulting solution was directly used for the analysis. Potassium, sodium, calcium, iron, zinc, and manganese were determined using Atomic Absorption Spectrophotometer. Determinations were carried out by direct aspiration of sample solution into air acetylene flame. The concentration of the mineral elements in the samples was then determined from a calibration curve.

Statistical analysis

The mean, standard deviation and standard error were calculated. Samples were compared using analysis of variance (ANOVA) and mean separation test was done using Least Significant Difference (LSD) method (Ihekoronye and Ngoddy, 1985). All statistical analyses were carried out using Statistical Package for Social Science (SPSS) version 15 (a computer software package). Significance was judged at $p < 0.05$.

Results and Discussion

There was a significant difference ($p < 0.05$) in moisture content of the false yam flour samples (Table 1). Moisture content of the samples ranged between 5.49 and 32.00% with steeped-oven-dried sample having the least, 5.49% and steeped-sun dried sample 9.49%. Blanched-sun-dried sample had 8.61%, while blanched-oven-dried had 9.22% respectively. The raw sample had a moisture content of 32.00%. The results indicate that processing especially, steeping/oven drying reduced the moisture contents of the processed flour samples (Table 1). The values obtained agreed with 7.6% reported for potato flour by Macrae *et al*. (1993). The values were below that reported earlier by Kay (1987), 11.7% for false yam tuber flour, except the raw sample (32.00%). The moisture content of processed flour samples ensures adequate storage in packages (Kay, 1987).

There was also a significant difference ($p < 0.05$) in the ash content of the false yam flour samples. The raw sample had 0.89% ash. Blanched-oven-dried sample had 1.89% ash, being the lowest, while steeped-sun-dried and blanched-sun-dried had 2.34% and 2.26% respectively. Steeped-oven-dried had the highest ash content of 2.57%. The values for the processed samples are within the range earlier reported for false yam tuber flour (2.8%) by Kay (1987), snake gourd seed flour (2.93%) by Yusuf *et al*. (2007) and fluted pumpkin seed flour (2.55%) by Fagbemi (2007). The results show that false yam tuber is a potential good source of minerals required by the body. It is also evident from the results that processing has a positive effect on the ash content of the processed flour samples by improving upon its contents.

There was no significant difference ($p > 0.05$) in fibre content with regards to steeped-sun-dried flour sample, and blanched-sun-dried sample. However, there exists a significant difference ($p < 0.05$) in fibre content among other samples. The raw sample had 0.29% fibre. The fibre contents of the processed samples ranged from 1.06 – 1.51% with the blanched-oven-dried sample having the lowest (1.06%), while steeped-oven-dried sample had the highest (1.51%). Blanched-sun-dried sample and steeped-sun-dried sample had 1.32% and 1.31% respectively, which are comparable with that of potato flour (1.6%) (Macrae *et al*., 1993). However, the values are lower than that for cubed, cooked yam (5.30 g) as reported by Wood (1988). Though crude fibre does not contribute nutrients or energy, false yam tuber is a source of dietary fibre which is essential for food bowel movement and helps in preventing obesity, diabetes, and cancer of the colon and other ailments of the gastro-intestinal tract of man (Okaka and Okaka, 2005).

Lipids in the flour samples showed significant difference ($p < 0.05$). The raw sample had 2.10% lipid. Steeped-oven-dried sample had the least (1.77%). Blanched-oven-dried sample and blanched-sun-dried sample had 2.66% and 2.63% respectively. Steeping and sun drying reduced the lipid content as observed in steeped-sun-dried sample (from 2.10% in the raw sample to 1.77%).
The values are higher than those of potato flour, 0.8 g (Macrae *et al*., 1993b), wheat flour, 1.0 g/100 g (Macrae *et al*., 1993), and false yam tuber flour, 0.7%
(Kay, 1987). Heat processing increased the level of lipids in the processed flour samples, except in the steeped-sun-dried sample which is less than that of

the raw samples (Table 1). However, the observed values are lower than that of full fat and defatted fluted pumpkin seed flours (42.74% and 6.53%) respectively (Fagbemi, 2007). The low fat content is an indication that false yam tuber can be stored for long period at the right temperature and moisture without spoilage by rancidity.

There was a significant difference ($p < 0.05$) in protein content between the raw and blanched-sun-dried, steeped-sun-dried and steeped-oven dried flour samples respectively, while there was no significant difference ($p > 0.05$) between the raw and blanched-oven-dried samples (Table 1). The raw sample had 3.14% protein. Blanched-oven-dried had the least (3.01%) whereas steeped-oven-dried had the peak value (60.3%) steeped-oven-dried and blanched-oven-dried samples had 4.59% and 5.38% respectively. The 6.03% in steeped-sun-dried when compared with 4.59% in steeped-oven-dried and 3.10% in blanched-oven-dried may be due to the varying amount of heat applied during oven-drying which eventually resulted in protein denaturation. The same may be applicable to 5.38% in blanched-sun-dried sample and 3.10% in blanched-oven-dried sample. The observed values are quite below that earlier reported for false yam tuber flour 10.3% (Kay, 1987) for potato flour, 8 g/100 g and wheat flour, 1.05 g/100 g (Macrae *et al*., 1993). It is evident from the data obtained that false yam tuber flour may not be a very good source of protein. However, the result showed a remarkable increase in protein contents of the processed flour samples, except in blanched-oven-dried where there is a slight decrease. The decrease in blanched-oven-dried sample may be attributed to the heating processes in blanching and oven drying, which resulted in protein denaturation.

The carbohydrate content showed a significant difference ($p < 0.05$) between the raw and other samples while steeped-oven-dried and blanched-sun-dried were not significantly different ($p > 0.05$) from each other (Table 1). The carbohydrate content ranged between 88.38 – 93.31% for the processed samples, with blanched-sun-dried having the least (88.39%), while blanched-oven-dried had the highest (91.36%). Steeped-oven-dried and steeped-sun-dried samples had 85.56% and 88.53% respectively. The raw samples had the peak (93.31%) carbohydrate content. The values are higher than those of African locust bean fruit pulp, 63.30% (Gernah *et al*., 2007); potato flour, 79.9 g/100 g and wheat flour, 76.1 g/100 g (Macrae *et al*., 1993); false yam tuber 74.5% (Kay, 1987) and snake gourd seed flour, 7.59% (Yusuf *et al*., 2007). Processing significantly affected the level of caloric or energy values of the samples (Table 1).

Table 1: Proximate composition of raw and processed false yam tuber flour

Sample	Moisture Content	Ash (%)	Fibre (%)	Lipid (%)	Protein (%)	Carbohydrate (%)	Energy Value (kcal)
Raw	32.00^a	0.89^e	0.29^d	2.10^d	3.41^d	93.31^a	408.79^b
Steeped-sun-dried	9.49^b	2.34^a	1.31^a	1.77^e	6.03^a	88.53^c	394.27^e
Steeped-oven-dried	5.49^c	2.57^b	1.51^b	5.76^a	4.59^c	85.56^d	412.46^a
Blanched-oven-dried	9.22^d	1.89^c	1.06^c	2.66^b	3.01^d	91.36^b	401.53^c
Blanched-sun-dried	8.61^e	2.26^d	1.32^a	2.63^c	5.38^b	88.39^c	398.79^d
Least significant difference	0.05	0.06	0.04	0.01	0.56	0.94	0.29

Means with similar superscripts in the same column are not significantly different ($p > 0.05$) from each other.

The energy values obtained were significantly different ($p < 0.05$) for respective samples. The raw sample had 408.79 Kcal, steeped-oven-dried sample had the least caloric value (394.27 Kcal) whereas steeped-sun-dried had the highest (412.46 Kcal). Blanched-oven-dried and blanched-sun-dried had 401.53 Kcal and 398.79 Kcal respectively.

The energy values for false yam tuber are higher than those of whole meal flour (310 Kcal); brown flour (323 Kcal); white flour for bread making (341 Kcal) (Holland *et al*., 1988); potato flour, 351.0 Kcal and wheat flour, 364.0 Kcal (Macrae *et al*., 1993).

The implication of the high energy value of false yam tuber is that it is a potential source of energy for man, hence, may be very useful in supplementing daily energy requirement of man.

Composition of mineral elements in false yam

Table 2 shows results of the composition of mineral elements in raw and processed false yam tuber flour. Potassium content of the flour samples ranged between 20.835 and 31.51 mg/l. Potassium content in all the samples did not significantly differ ($p > 0.05$). Steeped-sun-dried had 25.40 mg/l, steeped-oven-dried had 25.20 mg/l, blanched-sun-dried had 27.34 mg/l. While the raw sample had the highest (32.51 mg/l), blanched-oven-dried had the lowest value of 20.835 mg/l. These values are much lower compared with the values reported for fluted pumpkin seed flour samples, 4,207.47 ± 1.8 to 11,713.13 ± 1.6 mg/kg (Fagbemi, 2007); potato flour, 1,588.0 mg/100 g and wheat flour, 95.0 mg/100 g (Macrae *et al*., 1993). Equally, potassium contents in false yam are low when compared to 911.20 mg/l in cubed/cooked yam (Wood, 1988). However, the observed values of potassium for false yam flour samples are higher than those for water yam powder (0.66±0.20 mg/100 g); white yam powder (0.39 ± 0.10 mg/100 g); yellow yam powder (0.75 ± 0.10 mg/100 g); aerial yam powder (1.00 ± 0.11 mg/100 g) and bitter yam powder (0.85 ± 0.20 mg/100 g) (Okwu and Ndu, 2006).

There was significant difference ($p < 0.05$) in sodium content of the flour samples. The raw sample had 18.89% sodium, being the highest, while steeped-oven-dried had the least (2.409 mg/l). Blanched -sun-dried had 11.47 mg/l, steeped-sun-dried had 5.19 mg/l while blanched-oven-dried had 2.89 mg/l (Table 2). These values are much lower when compared with 63.50 ± 1.6 to 131.79 ± 2.1 mg/kg dry weight for fluted pumpkin seed flour samples (Fagbemi, 2007), 34.0 mg/100 g for potato flour and higher than 2.0 mg/100 g for wheat flour (Macrae et al., 1993). These observed values are also higher than 0.18 ± 0.10 mg/100 g for water yam, 0.14 ± 0.10 mg/l for bitter yam, 0.22 ± 0.11 mg/l for aerial yam and 0.19 ± 0.11 mg/l for yellow yam (Okwu and Ndu, 2006). The implication of the mineral element content in false yam is that, false yam could serve as a nutrient supplement and in the formulation of infant's food products.

Table 2: Mineral elements composition of raw and processed false yam tuber flour (mg/1)

Sample	Potassium (K)	Sodium (Na)	Calcium (Ca)	Iron (Fe)	Manganese (Mn)	Zinc (Zn)	Phosphorus (P)
Raw	31.51^{a}	18.89^{e}	98.32^{b}	2.84^{a}	0.93^{a}	1.90^{a}	0.12^{a}
Steeped-sun-dried	25.400^{a}	5.190^{c}	93.185^{c}	0.777^{e}	0.095^{cd}	0.520^{d}	0.002^{b}
Steeped-oven-dried	25.200^{a}	2.409^{e}	90.250^{d}	1.165^{d}	0.090^{d}	0.696^{c}	0.018^{b}
Blanched-oven-dried	20..835^{a}	2.890^{d}	83.885^{e}	1.343^{b}	0.121^{b}	1.018^{b}	0.016^{b}
Blanched-sun-dried	27.340^{a}	11.470^{b}	12.550^{a}	1.279^{c}	0.104^{c}	0.513^{d}	0.024^{b}
Least significant difference	2.193	0.251	0.883	0.009	0.011	0.009	0.008

Means with similar superscripts in the same column are not significantly different ($p > 0.05$) from each other.

Calcium content of the flour samples also showed significant difference ($p < 0.05$) among samples, values ranging between 83.89 to 112.55 mg/l.

The raw sample had 98.32 mg/l calcium while, steeped -sun-dried, steeped-oven-dried, blanched-oven-dried and blanched-sun-dried had 98.32 mg/l, 90.25 mg/l, 83.86 mg/l and 112.550 mg/l respectively. This range is comparable with 63.50 ± 1.6 to 121.79 ± 2.1 mg/kg dry weight for fluted pumpkin seed flour samples (Fagbemi, 2007). These values are also higher than 27.62 ± 1.2 mg/100 g for snake gourd seed flour (Yusuf *et al*., 2007); 33.0 mg/100 g for potato flour and 16.0 mg/100 g for wheat flour (Macrae *et al*., 1993). These values for calcium content in false yam are also higher than 1.80 ± 0.10 mg/100 g for water yam powder, 1.60 ± 0.11 mg/l for yellow yam powder, 2.41 ± 0.10 mg/l for bitter yam and 2.00 ± 0.11 mg/l for aerial yam powder (Okwu and Ndu, 2006).

There were significant differences ($p < 0.05$) in iron content of the samples. The raw samples had 2.84 mg/l iron, being the highest, steeped-oven-dried had 1.165 mg/l, blanched-oven-dried had 1.343 mg/l, while steeped-sun-dried and blanched-sun-dried had 1.16 5 mg/l and 1.279 mg/l respectively.

These values are low when compared with 4.31 ± 0.31 mg/100 g for snake gourd seed flour (Yusuf *et al*., 2007) and 7.2 mg/100 g for potato flour (Macrae *et al*., 1993).

Manganese concentration in the samples ranged between 0.090 to 0.93 mg/l with steeped-sun-dried having the least (0.093 mg/l). Steeped-sun-dried had 0.095 mg/l, blanched-oven-dried had 0.121 mg/l while blanched-sun-dried had 0.104 mg/l. There was significant difference ($p < 0.05$) in manganese concentration with regards to all the samples. From the observed values, it is evident that false yam is not rich in manganese.

Zinc concentration showed a significant difference ($p < 0.05$) between the raw and all other samples. However, there was no significant difference ($p > 0.05$) between steeped-sun dried and blanched-sun-dried samples in terms of zinc concentration. The raw sample had 1.90 mg/l zinc, being the highest. Blanched-oven-dried had (1.018 mg/l) concentration of zinc, while blanched-sun-dried had the least (0.513 mg/l). Steeped-sun-dried and steeped-oven-dried samples had 0.520 mg/l and 0.676 mg/l respectively. These values are however lower than the reported value of 87.25 ± 9.3 mg/100 g for snake gourd seed flour (Yusuf *et al*., 2007).

Phosphorus concentrations were quite low. The raw sample had 0.12 mg/l, steeped-sun-dried had 0.022 mg/l, steeped-oven-dried had 0.018 mg/l, while blanched-oven-dried and blanched-sun-dried had 0.016 mg/l and 0.024 mg/l respectively.

These values are much lower than those for potato flour, 178.0 mg/100 g; wheat flour, 87.0 mg/100 g (Macrae *et al*., 1993), and snake gourd seed flour, 135.0 ± 1.2 mg/100 g (Yusuf *et al*., 2007). The result for the raw sample (0.12 mg/l) is comparable with 0.16 ± 0.11 mg/100 g for water yam powder and 0.17 ± 0.21 mg/100 g for white yam (Okwu and Ndu, 2006). However, there was significant difference ($p < 0.05$) in phosphorus concentration between the raw sample and all other samples, but there existed no significant difference ($p > 0.05$) among steeped-sun-dried, steeped-oven-dried, blanched-oven-dried and blanched-sun-dried samples (Table 2). Processing reduced the level of mineral elements in the processed false yam samples (Table 2). This implies that the mineral elements are inherent in the raw sample of false yam.

False yam tuber may be a fair source of the macro elements (potassium, calcium, magnesium and phosphorus), making it useful in the food system. High amount of calcium, potassium and magnesium have been reported to reduce blood pressure (Ranhotra *et al*., 1998). False yam tuber may serve this purpose.

Conclusion

This study has shown that false yam is a root/tuber crop with appreciable levels of macro and micro-nutrients such as protein, lipids, carbohydrate, potassium, sodium, calcium and zinc and could be a good source of nutrients/energy in the body, if properly and adequately processed. However, processing affects the levels of nutrients in false yam tuber flour. Steeping enhanced protein quality of the flour, while heat processing, on the whole reduced the level of mineral elements in the false yam flour.

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References

AOAC (1990). *Official Methods of Analysis,* 15th edition. Association of Official Analytical Chemists, Washington DC, USA.

Azuzu, I.U. and Abubakar, I.I. (1995). The effects of *Icacina trichantha* tuber extract on the nervous system. *Phytotherapy Res*. 28: 21 – 25.

Etukudo, I. (2003). *Ethnobotany: Conventional and Traditional Uses of Plants*. Vol.1. The Verdiet Press, Uyo, Nigeria, p. 65.

Fagbemi, T.N. (2007). Effects of processing on the nutritional composition of fluted pumpkin *(Telfaria occidentalis)* seed flour. *Nigerian Food J.* 25(1): 1 – 11.

Gernah, D.I., Atolagbe, M.O. and Echegwo, C.C. (2007). Nutritional composition of the African locust bean *(Parkia biglobas)* fruit pulp. *Nig. Food J.* 25:189 – 195.

Holland, B., Unwin, I.D. and Buss, D.H. (eds) (1988). *Cereals and Cereal Products. Third Supplement of McCance and Widdowson's, the Composition of Foods*, 4th edn. London: Royal Society of Chemistry, and Ministry of Agriculture, Fisheries and Food.

Ihekoronye, A.I. and Ngoddy, P.O. (1985). *Integrated Food Science and Technology for the Tropics*. Macmillan Education Ltd., pp. 275 – 293.

Kay, D.E. (1987). *Crop and Product Digest No. 2 – Root Crops*, 2nd edn (revised by Gooding, E.G.B.). London Tropical Development and Research Inst., pp. 91 – 93.

Macrae, R., Robinson, R.K. and Sadler, M.J. (eds) (1993). *Flour in Encyclopedia of Food Science, Food Technology and Nutrition*. Vol.2. Academic Press, pp. 1929 – 1932.

National Research Council of the National Academic Press (NRCNAP) (2008). Lost Crops of Africa: Fruits, Vol. 111 ICACINA. http://www. books. nap. edu/open book. php. 23/07/2008.

Okaka, J.C. and Okaka, A.N.C. (2005). *Foods: Composition, Spoilage, Shelf-life Extension*. OCJAN CO. Academic Publishers, Independent Layout, Enugu. Nigeria, pp. 57 – 58.

Okwu, D.E. and Ndu, C.E. (2006). Evaluation of the phytonutrients, minerals and vitamin contents of some varieties of yam (*Dioscorea* sp.). *International Journal of Molecular Medicine and Advance Sciences* 2(2): 199 – 203.

Ranhotra, G.S., Gelroth, J.A., Leinen, S.O., Vrnas, M.A. and Lorenz, K.J. (1998). Nutritional Profile of some edible plants from Mexico. *J. Food Comp. and Analysis* 11: 298 – 304.

Wood, R. (1988). *The Whole Food Encyclopedia*. Prentice – Hall Press, New York, NY. PMID: 15220.

Yusuf, A.A., Folarin, O.M. and Bamiro, F.O. (2007). Chemical composition and functional properties of snake gourd *(Trichosanthes cucumerina)* seed flour. *Nig. Food J.* 25: 36 – 45.