Effect of Processing on Chemical Composition of Fluted Pumpkin (*Telfairia Occidentalis*) Seed Flour and Sensory Evaluation of Soup Produced from The Flour.

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ABSTRACT

Background: *Soup thickeners usage/cost is on the increase. Fluted pumpkin seed can provide nutrients, food diversity/nutrition security and serve as soup thickener.*

Objective*: To determine effect of processing on chemical composition of fluted pumpkin seed flour and sensory evaluation of soup from the flour.*

Materials and methods*: Seeds were removed from pod, washed, dehulled, sliced into pieces, divided into three parts for boiling, roasting and fermentation. Samples were dried, milled, sieved, packaged and analyzed for chemical composition using standard methods and sensory evaluation of soup samples using 9-point hedonic scale. Data was analyzed with ANOVA and means separated with Duncan Multiple Range Test at p <0.05 level of significance.*

Results*: Carbohydrate (40.65%) of boiled sample was higher than other samples. Fermented sample's protein (26.06%) was significantly higher (p <0.05) than boiled (23.43%) and roasted (21.89%). Fat (26.59%) was highest in roasted. Ash (3.23%) in the boiled differed significantly (p < 0.05) from fermented (3.11%) and roasted (2.93%). Vitamin C (0.55mg/100g), B-Carotene (3.59 µg/100g), Vitamin* B_3 *(0.26mg/100g) and vitamin E (0.43mg/100g) were higher in fermented sample. Iron (3.96mg/100g) and zinc (2.68mg/100g) were significantly higher (p <0.05) in the fermented sample. The swelling index (5.24%), oil absorption (15.33%), water absorption (18.67%) of fermented sample was higher than other samples. Phytate, tannin, oxalate in all the samples were within safe level. Boiled sample was most accepted (sensory) following the control (Detarium microcarpium).*

Conclusion*: Fermented and boiled samples were better in nutrients, functional properties, anti-nutrients and soup thickener.*

Keywords: Fluted pumpkin seed flour, nutrient composition, sensory evaluation, fermentation, boiling

INTRODUCTION

Plant seeds form an important part of human diets and are usually regarded as good foods which have nutritive and caloric values that make them necessary in diets as good sources of proteins, edible oils and fats (1). Fluted pumpkin (*Telfairia occidentalis*), a perennial vine that belongs to the family *Cucurbitaceae*, occurs in the forest zone of West and Central Africa, most frequently in Benin, Nigeria and Cameroon and bears different names among the ethnic groups in Nigeria: "ugu" in Ibo, "iroko" or "aporoko" in Yoruba, "ubong" in Efik, "umee" in Urhobo and "umeke" in Edo (2, 3). The pods which contain the seeds are usually harvested in late September or early October and stored in a moderate warm, dry place (4). The oil of *Telfairia occidentalis* seeds has high iodine value and high content of unsaturated fatty acids when compared to palm oil and rich in proteins and other nutrients (5, 6). To achieve safe levels of anti- nutrition factors in foods and improve the nutritional properties, some form of processing is necessary such as roasting, boiling and fermentation (6). Roasting is similar to cooking/boiling but involves higher temperature and reduced time (**7**). During boiling, the action of the heated water makes the food to get cooked and the liquid is usually thrown away after the food is cooked (8). Food fermentation involves the use of microorganisms and enzymes for the production of foods with distinct quality attributes that are quite different from the original agricultural raw material (8). Like other plant seeds, fluted pumpkin seeds are perishable crops which need to be converted to stable products such as flour in order to minimize postharvest losses, extend their shelf life and enhance their utilization (9).The demand for and cost of thickening agents is on the increase (9). Instead of allowing the fluted pumpkin seed to rot during the harvesting season, it could be processed into flour by households for soup thickening or added to food products for additional nutrient to daily meals to add to both food and dietary diversity in household daily meals. Also, instead of just boiling the seed and eating it as snacks, it could be processed to add value and more utilized. The increased use of the seed by households could make it a source of income to the vegetable farmers who will not only gain from the leaves but also from the seeds as well. It is on this premise that this study to determine the effect of boiling, roasting and fermentation on chemical composition of fluted pumpkin seed flour and sensory evaluation of soup produced from the flour as soup thickener was carried out.

Materials and methods:

Sample preparation

Fluted pumpkin pods and ingredients used in the soup preparation were purchased from Ahia-eke market in Ikwuano Local Government Area in Abia State. The seeds were removed from the pod, washed with tap water, dehulled, sliced into small pieces, divided into three equal parts and each processed by boiling (in a conventional water bath at 100°C for 1hr), roasting (oven dried at 121°C for 12hrs and allowed to cool naturally before milling and fermentation (tied in a black polythene bag for 24hours). All processed samples were dried and milled into flour using a milling machine (model SK-30-SS), sieved with a 60mm sieve and packaged in airtight container for proximate, mineral, vitamin, functional properties analysis and soup preparation for sensory evaluation.

Methodology

The proximate, mineral and vitamin content of the flour samples were carried out in triplicates using standard methods. Moisture was determined by gravimetric method; ash by furnace incineration method; crude fat by Soxhlet extraction; crude protein by micro-Kjedahl method and crude fibre all by the method of AOAC (10). Carbonhydrate was calculated by difference i.e. %carbohydrate = 100% - (%protein + %fat + %fibre + %moisture). Energy (Kcal) was calculated using the Atwater factor. Vitamin C, vitamin B_3, Beta-carotene, and vitamin E were determined using spectrophotometric method by AOAC (11). Minerals (iron, zinc, calcium, magnesium, phosphorus, copper, selenium, manganese and iodine) were determined using colorimetric and atomic absorption spectrophotometric method as described (11, 12). Tannin and oxalate content was determined using Folin-Dennis colorimetric method as described by Pearson (13). Phytate was determined using the method described by Harborne (14). Functional Properties (water absorption capacity, oil absorption capacity, swelling capacity and bulk density) were determined using the procedures as described (15, 16).

Materials for soup

The ingredients for soup preparation included: meat- 400g; stockfish-200g; smokedfish-250g; pepper-200g; onion- medium bulb; palm oil-375ml; crayfish-120g; maggi cubes-36g; 100g each of fermented, boiled and roasted fluted pumpkin seed flour; ofo-100g; oha leaf (*Pterocarpus mildraedii*)- 220g, water-3000ml and salt to taste. The oha leaves were removed from the stem, sorted, shredded and washed;

meat was washed and seasoned with onion, maggi cube and cooked till tender. The stock was divided into 4 equal portions. Palm oil was added to the first portion of the stock and allowed to boil for 5 minutes. Fermented fluted pumpkin seed flour was poured into the stock and boiled for 10minutes; crayfish, maggi cube, pepper and little quantity of water was added and allowed to boil for 10 minutes. The shredded oha leaf was then added and the soup was allowed to steam for about 1 minute and was ready for sensory evaluation. Soup preparation was repeated for the boiled, roasted and 'ofo' samples using the stock that was earlier separated. Sensory evaluation of aroma, taste, texture, colour and general acceptability were carried out using twenty randomly selected panelists from lovers of 'ofo' soup. A 9 point Hedonic scale with 9 as 'liked extremely' and 1 as 'disliked extremely' was used.

Statistical analysis

Analysis of variance (ANOVA) was performed on the generated data using IBM SPSS Statistics for windows version 23.0. Duncan Mean Separation was used to separate the means at 95% confidence level.

Results

Table 1 shows the proximate, energy and vitamin composition of the fluted pumpkin seed flour processed using the different methods. Moisture content significantly ($p < 0.05$) differed from each other ranging from 6.96% to 7.77% with boiled sample having the highest (7.77%). Ash content was between 2.93% for roasted to 3.23% for boiled sample. The fat composition showed significant differences ($p < 0.05$) among all the samples; roasted (26.59%), fermented (23.45%) and boiled (22.63%). The fermented sample had the highest protein (26.01%), boiled (23.43%) and roasted (21.90%). Fibre was 2.12% for roasted and 2.29% for boiled sample. The carbohydrate composition differed significantly ($p < 0.05$) for the boiled, roasted and fermented samples as 40.70%, 39.5% and 38.10% respectively. The roasted sample had the highest energy value (484.91 kcal) with no significant difference ($p > 0.05$) in all the samples. Vitamin C content of the fermented sample (0.55mg/100g) was significantly higher ($p < 0.05$) than the other samples. Beta-carotene content was highest in the fermented sample (3.59μg/100g). Vitamin E content (0.43mg/100g) was the same for the boiled and fermented samples.

Table 1: Proximate, energy and vitamin composition of fluted pumpkin seeds using different processing methods

Samples	Moisture(%)	Ash (%)	Fat (%)	Protein (%)	Fibre (%)	CHO (%)
A	$7.77^{a}\pm.01$	$3.23^{a}\pm.00$	$22.63^{c}\pm.02$	$23.43^{b}\pm.00$	$2.29^{a}\pm.00$	$40.65^{a}\pm.01$
B	$6.96^{c}\pm.00$	$2.93^{c}\pm.00$	$26.59^{a}\pm.04$	$21.89^{c}\pm.00$	$2.12^{c}\pm.00$	$39.50^{b}\pm.03$
C	$7.04^{b}\pm.00$	$3.11^{b}\pm$ 00	$23.45^{b}\pm.00$	$26.06^{a}\pm.00$	$2.25^{b}\pm.00$	$38.09^{c}\pm.01$

Samples	Energy (Kcal)	Vit C mg/100g	Vit B_3mg/100g	Vit E mg/100g	Bcarotene µg/100g
A	$460.02^{a}\pm17.68$	$0.48^{b}\pm.00$	$0.26^{a}\pm.00$	$0.43^{a}\pm.00$	$3.33^{b}\pm.00$
B	$484.91^{a}\pm23.83$	$0.41^{c}\pm.00$	$0.22^{c}\pm.00$	$0.39^{c}\pm.00$	$2.76^{c}\pm.00$
C	$467.58^{a}\pm16.44$	$0.55^{a}\pm.01$	$0.27^{b}\pm.00$	$0.43^{b}\pm.07$	$3.59^{a}\pm.00$

Values are mean ± standard deviation of triplicate samples. Means with the different superscript letters in the same column are statistically different ($P < 0.05$) from each other Keys:
Sample A = Boiled Fluted pumpkin seeds; Sample B = Roasted Fluted pumpkin seeds;
Sample C = Fermented Fluted pumpkin seed

Table 2 shows the mineral composition of the samples. Iron ranged from 3.28mg/100g in roasted to 3.96mg/100g in fermented. Calcium composition of the boiled, roasted and fermented samples were 0.67%, 0.57% and 0.44% respectively. Magnesium content was least (1.12mg/100g) in the roasted sample and highest (1.34mg/100g) in the boiled. The boiled sample had the highest copper content (0.41mg/100g) and fermented sample (0.23mg/100g) had the least. Trace amount of selenium was found in all the samples. The boiled sample had manganese content of 0.28mg/100g which was lower in roasted and fermented.

Table 3 shows the functional properties and anti-nutrient composition of the study samples. The bulk density ranged from 0.87% in fermented to 0.97% in the roasted. The water absorption capacities (13.67%) for both boiled and roasted samples were significantly lower ($p< 0.05$) than that of fermented sample (18.67%). The oil absorption capacity was highest in the fermented sample (15.33%). The swelling capacity was least in roasted (4.11%) and highest in fermented (5.24%). The roasted sample had the highest tannin (2.77mg/100g) with least in the boiled (1.83mg/100g). The roasted sample (2.85mg/100g) had significantly ($p <0.05$) higher phytate content than the other two samples. Oxalate content was 12.64mg/100g in roasted sample.

Table 2: Mineral composition of fluted pumpkin seeds using different processing methods

Parameter Samples	Iron (mg/100g)	Zinc (mg/100g)	Calcium (mg/100g)	Magnesium (mg/100g)	Copper (mg/100g)	Selenium (mg/100g)	Manganese (mg/100g)	Iodine (mg/100g)	Phosphorous (mg/100g)
A	3.89^b± .00	2.37^c± .00	0.44^c± .00	1.34^a± .00	0.41^a± .00	0.18^a± .00	0.28^a± .00	0.08^c± .00	0.58^c± .00
B	3.28^c± .00	2.45^b± 00	0.56^b± .00	1.12^c± .00	0.39^b± .00	0.13^c± .00	0.25^b± .00	0.11^b± .00	0.63^b± .01
C	3.96^a± .002	2.68^a± .00	0.67^a± .00	1.29^b± .00	0.23^c± .00	0.16^b± .00	0.24^c± .00	0.12^a± .00	0.79^a± .04

Values are mean ± standard deviation of triplicate samples. Means with different superscript letters in the same column are statistically different ($P < 0.05$) from other. Keys: Sample A = Boiled fluted pumpkin seeds; Sample B = Roasted fluted pumpkin seeds;
Sample C = Fermented fluted pumpkin seeds

Table 3: Functional properties and anti-nutrient composition of fluted pumpkin seeds using different processing methods

Samples	Oil absorption Capacity (%)	Water Absorption Capacity (%)	Swelling Index (%)	Bulk Density (%)	Phytate (mg/100g)	Tannin (mg/100g)	Oxalate (mg/100g)
A	12.67^b±.67	13.67^b±.67	4.66^b±.01	0.89^b±.00	2.39^c±0.01	1.83^c±0.01	1.88^c±0.01
B	10.33^c±.33	13.67^b±.67	4.11^c±.00	0.97^a±.01	2.85^a±0.01	2.77^a±0.00	2.64^a±0.01
C	15.33^a±.67	18.67^a±.67	5.24^a±.00	0.87^c±.00	2.68^b±0.01	2.68^b±0.01	2.45^b±0.01

Values are mean ± standard deviation of triplicate samples. Means with the different superscript letters in the same column are statistically different ($P < 0.05$) from the other.
Keys: Sample A = Boiled fluted pumpkin seeds; Sample B = Roasted fluted pumpkin seeds;
Sample C = Fermented fluted pumpkin seeds

The sensory properties of the soups prepared from the study samples and 'ofo' soup (control) in Table 4 showed no significant difference ($p > 0.05$) in the aroma, taste, texture and colour for the study samples. However, sample D (ofo seed flour soup) was significantly higher ($p < 0.05$) in all the sensory attributesand general acceptability than soup from the study samples.

difference in the fermentation process. The reduction in crude fibre with fermentation in this study could also be as a result of breakdown of the fibre by the micro-organisms involved in the fermentation process or through conversion of carbohydrate and lignocelluloses into protein (6).The fermented sample had the lowest carbohydrate composition which was lower than

Table 4: Sensory properties of fluted pumpkin seeds using different processing methods

Sample	Aroma	Taste	Texture	Colour	General acceptability
A	$6.53^{b}\pm1.74$	$6.00^{b}\pm2.03$	$6.42^{b}\pm1.12$	$6.42^{b}\pm0.96$	$6.35^{b}\pm 1.46$
B	$6.16^{b}\pm1.26$	$5.74^{b}\pm1.95$	$6.00^{b}\pm1.53$	$6.11^{b}\pm1.35$	$6.03^{b}\pm1.52$
C	$6.32^{b}\pm1.52$	$5.32^{b}\pm1.95$	$6.32^{b}\pm1.42$	$6.37^{b}\pm1.90$	$6.09^{b}\pm1.52$
D	$7.53^{a}\pm1.12$	$7.84^{a}\pm0.96$	$6.32^{a}\pm1.42$	$8.26^{a}\pm1.00$	$7.83^{a}\pm0.99$

Values are mean ± standard deviation of triplicate samples. Means with the different superscript letters in the same column are statistically different ($P < 0.05$) from other.
Keys: Sample A = Boiled fluted pumpkin seeds; Sample B = Roasted fluted pumpkin seeds; Sample C = Fermented fluted pumpkin seeds; Sample D= 'ofo' seed flour

Discussions

The moisture content in the processed samples were within the recommended moisture content of less than 14% to prevent microbial changes during storage (16). However, the value for the fermented sample was slightly higher than that from earlier reports (17, 18). These differences could be due to varietal differences or probably as a result of the level of maturity of the pod at harvest. Lower fat content in the fermented sample could be because increased lipolytic enzyme activities hydrolyze fat component into glycerol and fatty acid during fermentation (19). Protein content highest in the fermented sample compared with some protein rich plant foods such as soybean and cowpea with values from 23.10 - 33.10% and also higher than that reported for watermelon seed (20, 21, 22). Use of fluted pumpkin seed could contribute to the reduction in protein malnutrition especially with the high cost of animal protein. The fibre content of all the study samples were relatively lower than that reported earlier (5). This could have been due to varietal differences, probably pod maturity or those reported for *Afzelia africana*, *Brachystegia nigerica*, *Mucuna sloanei* and *Detarium microcarpium* which were 53.66±0.80, 65.97±0.70, 70.71±0.90 and 70.38± 0.6 respectively by Ogunlade and Agbeniyi (23) and 29.25% in watermelon seed (22). Thus the fermented fluted pumpkin seed could be used to replace or alternate with either yam or cocoyam as soup thickeners for weight reduction programmes.The roasted sample had the highest energy value which could also be due its higher fat content. The values obtained in this study were lower than 531.90 kcal/100g in fluted pumpkin seed flour as reported by Alozie *et al*. (24).

The vitamin C content of the study samples were lower than 10.12mg/100g and 4.8mg/100g respectively reported for *Brachystegia eurycoma* /African mahogany / '*achi*'/ and *Mucuna flagellipes /ukposeed/* respectively (25). However, it can complement other soup thickeners and be consumed in addition to vitamin C rich foods like fruits in the daily meals. Beta-carotene content was highest in the fermented sample and least in the roasted sample which was slightly lower than that reported for fermented fluted pumpkin seed (7.15ug/100g) by Kim *et al.* (26).

The fermented sample had the highest iron content. Gianmi and Bakebain (27) reported higher value of (4.5mg/100g) for unfermented fluted pumpkin seed while EL- Adawy and Taha (28) reported 10.9mg/100g for fermented pumpkin seed. Calcium highest in the fermented sample could be attributed to the fact that divalent cation such as calcium are generally present in association with phytic acid which may lead to low extractability of calcium (29). However, reduction in phytic acid as a result of fermentation may explain higher calcium content as the duration of fermentation period increases (20). Although the calcium content of fluted pumpkin seed is low but since in soup preparation; fish (with bones) which are good sources of calcium are added thus making up for dietary calcium requirement for those who will use fluted pumpkin seed as soup thickener. FAO/WHO (30) and Betty *et al.* (31) opined that magnesium is very important in regulating fluxes and it is involved in calcium metabolism in bones and prevention of circulatory disease as well as help in regulating blood pressure and insulin release. The magnesium content of the study samples are low but dietary deficiency of magnesium of a severity sufficient to provoke pathologic changes is rare (30). Also trace amount of manganese was found in the study samples with more in the boiled sample. Elfadil *et al.* (32) reported a higher value of 5.34mg/100g and 3.46mg/100g for the boiled and fermented samples of fluted pumpkin seed respectively. The iodine content was highest in the fermented sample but lower than that reported for fluted pumpkin seed (4.74mg/100g) fermented for 7days (28). The difference could be due to difference in duration of the fermentation period. Phosphorus highest in the fermented sample could be because fermentation process increases the extractability of phosphorus from food products (33).

The tannin content of the study samples were all higher than the safe level (0.15 - 0.20mg) for tannin(34). Phytate levels of the study samples were all below the safe level (5.00mg/100g) (34). Oxalate content of the study samples were not high as to pose any health threat and lower than 0.023mg/100g reported by Elinge *et al.*(35).
Water absorption capacity was higher in the fermented sample which could be attributed to the low moisture and high carbohydrate content of the fermented sample as carbohydrate have been reported to greatly influence the water absorption capacity of foods (36). All the study samples had high oil absorption capacity which could be as a result of the hydrophobia character of the protein in the flour and as such require lesser quantity of oil when used as soup thickening agent (37). The swelling capacity was highest in the fermented sample which could be due to the difference in processing method applied.

The study samples did not differ from each other in all the sensory attributes. All the same, apart from taste where the roasted and fermented samples were neither liked nor disliked, all the attributes scored above 6 indicating slightly liked. This shows that fluted pumpkin seed processed by boiling, fermentation and roasting could possibly be used as soup thickener for its nutritional benefits as well as in dietary diversification. However, 'ofo' soup sample (control) was significantly higher than all the study samples in terms of aroma, taste, appearance, texture, colour and general acceptability. This is also expected because it has been noted that consumers are inclined to accept more of products they are familiar with (38).

Conclusion: The study revealed that processing by fermentation and boiling proved to be the best method of processing of the fluted pumpkin seed as a soup thickener and for consumption as they led to retention of higher amounts of some of the nutrients and reduction in anti-nutrients. The boiled fluted pumpkin seed flour soup had the best sensory acceptability next to "ofo" seed flour soup (control).

Conflict of interest: There is no conflict of interest.

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