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# Nutrient and Phytochemical Composition of *Telfairia Occidentalis* Seed Processed by Boiling, Roasting and Fermentation Methods

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**Abstract**

This study assessed the nutrient and phytochemical composition of *Telfairia occidentalis* seed processed by fermentation, roasting, and boiling. The seeds were obtained from three local markets in Enugu State. A total of three samples were prepared using the three selected processing methods. The nutrient and phytochemical composition of the processed samples were analysed using standard procedures. Data were analysed as mean and standard deviation using Statistical Product for Service Solution (SPSS) Version 23.0. Analysis of variance (ANOVA) was used to compare means while Duncan's Multiple range test was used to separate significant means at $P < 0.05$ level of significance. Samples were brought to the same moisture level before analysis. The proximate composition of the samples showed that seeds subjected to roasting had higher carbohydrate (54.88%) levels, while boiled seeds had the highest protein contents (23.12%). Mineral compositions of the seeds showed that magnesium was 58.8% in fermented seeds, 43.20% in boiled seeds, and 52.20% in roasted seeds. Calcium content was 20.0% in fermented seeds, 68.00% in boiled seeds, and 32.00% in roasted seeds. The fermented seeds were higher in vitamin A (21.42ug) and vitamin B9 (58.53mg) but lower in vitamin $B_2$ (0.09mg) and $B_3$ (0.72mg). Phytochemical levels of the seeds showed that the fermented seeds were lower (2.20%) in saponin and flavonoid (1.00%) but higher in alkaloids (9.00%) than the other samples. The fermentation method had the least effect on the nutrient and phytochemical composition of the *Telfairia occidentalis* seed.

**Keywords:** phytochemicals, processing methods, nutrient contents, fluted pumpkin seed

## Introduction

Fluted pumpkin (*Telfaria occidentalis* Hook F.) is a creeping vegetable herb that spread on the ground with large lobbed leaves and long twisting tendrils. Its habitat is the wet part of Nigeria and Africa in general (Horsfall & spiff, 2005), it also belongs to the family cucurbitaceae (Ehiagbonase, 2008). Common names of the plant include fluted gourd, and fluted pumpkin, it is also known as ugu, among the Igbos in

Nigeria. The seeds contain 13% oil and are used for cooking and other culinary purposes. This oil of Telfaria occidentalis seeds has high iodine and a high content of unsaturated fatty acids when compared to palm oil (Aaron, Ukam, & Markson, 2017).

Food processing helps to sterilize it by killing harmful bacteria and other microorganisms and increasing the availability of nutrients, however, processing may reduce the nutritional value of some foods as a result of losses and changes in major nutrients, including proteins, carbohydrates, minerals and vitamins (Ibironke & Owotomo, 2020). It includes cooking, dehydration, drying, freezing and hot dry heating. Processing of food can improve the digestibility of the food, it can also improve taste, aroma, palatability and also its keeping quality (Ibironke & Owotomo, 2020). Removal of undesirable components in pumpkin seeds is essential to improving the nutritional quality of foods and effectively utilizing their full potential as food ingredients (Aaron, Ukam, & Markson, 2017).

Even though fluted pumpkin seeds are very nutritious and a lot of people consume it, however, when fluted pumpkin seeds are not properly processed they can be harmful to the body, these can be removed by washing, soaking and parboiling (Kuku, Etti & Ibronke, 2014). In addition, when fluted pumpkin seeds are overly-processed or under-processed, it loses its nutrient. Therefore, there is a need to determine the best processing method that will retain more nutrients and improve the nutritional quality of fluted pumpkin seed to successfully utilize its full potential as a food ingredient.

**Objectives of the study:** The broad objective of this study is to evaluate the chemical composition of processed fluted pumpkin seeds.

The specific objectives are:

i. to determine the proximate composition of processed fluted pumpkin seed;
ii. to determine the phytochemical properties of processed pumpkin seed;
iii. to evaluate the contents of the vitamin in fluted pumpkin seed;
iv. to evaluate the mineral contents of fluted pumpkin seed;

**Materials and methods**

***Study design*:** This study employed an experimental design

**Procurement of raw materials:** Matured fluted pumpkin (*Telfairia occidentalis*) fruits were obtained from farmers from different local markets in Enugu State.

**Sample preparation**: Fluted pumpkin seeds were extracted from the fruits. The fresh mature seeds were washed to remove dirt and foreign particles. The seeds were then divided into three equal parts each weighing 500g. The first part of the seeds was roasted in the oven at 160°C for 30 min. The second part was boiled at $100^0$C for 30 min, drained, and allowed to cool. The third part was subjected to fermentation. This was done by first boiling the seeds for 30 minutes and then wrapping the boiled seeds in blanched banana leaves and allowing them to ferment naturally for 72 hrs. All samples were thereafter grounded separately using an electric grinder (Binatone, 300w; 1.8l blender), packaged separately in a well-labelled airtight container and stored under refrigerating temperature ($-4^0C$) until analysis, adopted from Kuku et al., (2014)

***Chemical analysis*:** Chemical analysis was carried out in duplicates for all parameters

**Proximate composition:** The moisture content of the sample was determined using the hot air oven method (AOAC, 2010). Ash determination was carried out using the standard procedure of the Association of Official Analytical Chemists (AOAC, 2010). The micro Kjeldahl method described by AOAC (2010) was used for crude protein determination. The crude fibre was determined using the aid and alkaline digestion method (A0AC, 2005). The standard AOAC (2010) method was used for crude fat determination. The total carbohydrate was obtained by difference: 100%- (% Moisture + % crude protein + % crude fat + % crude fibre + %Ash)

***Vitamin analysis*:** Vitamin C (ascorbic acid) was determined using the standard AOAC (2010) method. The quantity of beta-carotene in the samples was determined using the Harbone method as described by Jakutowicz et al. (1997). Riboflavin (Vitamin $B_2$) was determined using the standard method described by AOAC (2006). Niacin (Vitamin $B_3$) was determined using the spectrophotometric method described by AOAC (2010). Folate (Vitamin $B_9$) was determined using the standard method described by AOAC (2005).

***Mineral analysis*:** Calcium was determined using the dry ashing method described by AOAC (2010). The standard AOAC (2010) method was used to determine the iron content of the sample. The formula for sodium and potassium determination:

Ppm = Gf X Total volume of extract X Ab X DF/ Weight of sample

Where;

DF = Dilution factor, GF = Gram factor, Ab = Absorbance

**Magnesium determination**: After acid digestion of the sample, the magnesium content was then determined by atomic absorption spectrophotometer as described in the official method of the Association of Official Analytical Chemists (AOAC, 2010).

***Phytochemical analysis*:** Total Saponin content was determined by using the spectrophotometric methods described by (Pearson, 1976). Alkaloid content was determined by the alkaline precipitation-gravimetric method described by Harborne (1973). Flavonoid was determined using the Boham and Kocipai-Abyazan (1994) method.

*Statistical analysis*

Data collected were statistically analysed using Statistical Product and Service Solution (SPSS version 23.0). Descriptive statistics (means and standard deviations) were used to present the data. Analysis of Variance (ANOVA) was used to compare the means of variables. Duncan Multiple Range test (DMRT) was used to separate means at a 5% probability level ($p < 0.05$).

**Results**

Table 1 shows the proximate composition of processed fluted pumpkin seed. The moisture contents of the samples ranged from 16.00% in boiled fluted pumpkin (FF2) to 64.50% in roasted fluted pumpkin (FF3). The fat content ranged from 2.00% in FF2 to 3.50% in fermented fluted pumpkin (FF1) and FF3 respectively. The fibre content of the samples was highest

(13.50%) in FF3 and lowest (2.00%) in FF1. The protein contents of the samples ranged from 11.12% in FF2 to 23.12% in FF1. The ash content ranged from 2.00% in FF3 to 3.50% in FF1 and FF2 while the carbohydrate content varied from 2.58% in FF3 to 54.88% in FF2. Statistically, there were significant differences ($P<0.05$) in all the proximate parameters, except in fat and ash.

**Table 1: Proximate composition of processed fluted pumpkin seed**

| Sample | Moisture (%) | Fat (%) | Crude fibre (%) | Protein (%) | Ash (%) | CHO (%) |
|---|---|---|---|---|---|---|
| FF1 | 56.50±0.71$^{b}$ | 3.50±0.71$^{a}$ | 2.00±0.57$^{a}$ | 23.12±0.49$^{c}$ | 3.50±0.71$^{a}$ | 11.38±0.35$^{b}$ |
| FF2 | 64.50±0.71$^{c}$ | 3.50±0.71$^{a}$ | 13.50±0.14$^{b}$ | 13.92±0.13$^{b}$ | 2.00±0.00$^{a}$ | 2.58±0.40$^{a}$ |
| FF3 | 16.00±0.00$^{a}$ | 2.00±0.00$^{a}$ | 12.50±0.71$^{b}$ | 11.12±0.86$^{a}$ | 3.50±0.71$^{a}$ | 54.88±0.28$^{c}$ |

Values are Means ± SD (standard deviation) of duplicate determination. Means on the same column with different superscripts are significantly different at $p<0.05$. Key: FF1= fermented fluted pumpkin, FF2= boiled fluted pumpkin, FF3= roasted fluted pumpkin

Table 2 shows the mineral contents of processed fluted pumpkin seed per 100g. The magnesium content of the samples ranged from 43.20mg in FF2 to 58.80mg in FF1, the mean Magnesium differed significantly ($P < 0.05$) in all the samples. FF2 had the least magnesium content while FF1 had the highest magnesium content. The calcium contents of the samples ranged from 20.0 mg in FF1 to 68.00 mg in FF2. The potassium content ranged from 0.76 mg in FF1 to 1.20 mg in FF3. FF1 had the least potassium content while FF3 had the highest potassium content. The iron content of the samples was highest in FF2 (0.31 mg) and lowest in FF1 (0.20mg). Statistically, there was no significant difference ($P > 0.05$) between FF1 and FF2 in their potassium content and between FF1 and FF3 in their calcium and iron contents.

**Table 2: Mineral contents of processed fluted pumpkin seed per 100g**

| Sample | Magnesium (mg) | Calcium (mg) | Potassium (mg) | Iron (mg) |
|---|---|---|---|---|
| FF1 | 58.80±1.70$^{c}$ | 20.0±5.66$^{a}$ | 0.76±0.06$^{a}$ | 0.20±0.32$^{a}$ |
| FF2 | 43.20±1.80$^{a}$ | 68.00±5.66$^{b}$ | 0.90±0.00$^{a}$ | 0.31±0.02$^{b}$ |
| FF3 | 52.20±0.85$^{b}$ | 32.00±0.00$^{a}$ | 1.20±0.14$^{b}$ | 0.25±0.01$^{ab}$ |

Values are Means ± SD (standard deviation) of duplicate determination. Means on the same column with different superscripts are significantly different at $p<0.05$. Key: FF1= fermented fluted pumpkin, FF2= boiled fluted pumpkin, FF3= roasted fluted pumpkin

Table 3 presents the vitamin contents of processed fluted pumpkin seed per 100g. The beta carotene content of the samples was highest (21.42 μg) in FF1 and lowest (19.93μg) in FF2 and FF3. The vitamin $B_2$ content of the samples ranged from 0.09 mg in FF3 to 0.79 mg in FF2. The vitamin $B_9$ content ranged from 14.20 mg in FF2 to 58.53 mg in FF1. The vitamin $B_3$ content was highest in FF1 (3.39 mg) and lowest in FF3 (0.72 mg). Statistically, there was a significant difference ($P>0.05$) in the vitamin contents of the samples. However, the beta-carotene contents of FF2 and FF3 were comparable at $P >0.05$.

**Table 3: Vitamin contents of processed fluted pumpkin seed per 100g**

| Sample | Beta-carotene (μg) | Vitamin $B_2$ (mg) | Vitamin $B_9$ (mg) | Vitamin $B_3$ (mg) |
|---|---|---|---|---|
| FF1 | 21.42±0.20[b] | 0.56±0.06[b] | 58.53±1.47[c] | 3.39±0.06[c] |
| FF2 | 19.93±0.30[a] | 0.79±0.01[c] | 14.30±3.16[a] | 1.12±0.01[b] |
| FF3 | 19.93±0.30[a] | 0.09±0.05[a] | 36.57±0.36[b] | 0.72±0.06[a] |

Values are Means ± SD (standard deviation) of duplicate determination. Means on the same column with different superscripts are significantly different at $p<0.05$. **Key**: FF1= fermented fluted pumpkin, FF2= boiled fluted pumpkin, FF3= roasted fluted pumpkin

Table 4 presents the phytochemical contents of traditionally processed fluted pumpkin seed per 100g. The saponin content of the samples ranged from 2.20% to 19.70%. FF1 had the least saponin content while FF3 had the highest saponin content. The flavonoid content ranged from 1.00% in FF1 to 3.50% in FF2 and FF3 while the alkaloid content ranged from 6.00% in FF3 to 11.00% in FF2. Statistically, there was no significant difference ($P>0.05$) in the flavonoid content of the samples.

**Table 4: Phytochemical contents of processed fluted pumpkin seed per 100g**

| Sample | Saponin (%) | Flavonoid (%) | Alkaloid (%) |
|---|---|---|---|
| FF1 | 2.20±0.28[a] | 1.00±0.00[a] | 9.00±0.01[b] |
| FF2 | 12.40±0.00[b] | 3.50±0.71[a] | 11.00±0.20[c] |
| FF3 | 19.70±0.14[c] | 3.50±3.54[a] | 6.00±0.00[a] |

Values are Means ± SD (standard deviation) of duplicate determination. Means on the same column with different superscripts are significantly different at $p<0.05$. Key: FF1= fermented fluted pumpkin, FF2= boiled fluted pumpkin, FF3= roasted fluted pumpkin

## Discussion

The proximate composition of the processed fluted pumpkin seed revealed that the sample had low-fat content. The fat content of fluted pumpkin seed was observed to reduce during various processing. It may be suggested that the shelf life of pumpkin seed flour will be prolonged as the rate of rancidity will be slow and also contribute to the low energy of the samples (Fasasi, 2009). Kuku, (2014) also carried out a similar study; however, her findings showed that fat was not affected by boiling. But this disagrees with the study done by Alozie et al., (2017) whose fat contents were high, especially unsaturated fatty acids.

The crude fibre content was low. This is similar to the findings of Hamilton (2021). The quantity of crude fibre was not affected by dry heat (roasting) and boiling of pumpkin seeds, however, the reduction of crude fibre during fermentation in the study is likely a result of the breakdown of the fibre by the micro-organisms involved in the fermentation process or through conversion of carbohydrate and lignocelluloses into protein (Aaron et al., 2017). A low level of crude fibre also suggests that the pumpkin seeds are suitable for formulating baby's food, for they do not need an excessive intake of dietary fibre (Eneobong, 2001).

The protein analysis indicated that the fluted pumpkin seed contains an appreciable amount of protein. According to a study done by Fagbemi, (2007), fermentation had the highest crude protein content of fluted pumpkin seed, followed by the boiled sample, while the roasted sample had the least. Protein is high in pumpkin seeds assessed with increasing duration of fermentation. Similar results were also obtained by (Aaron et al., 2017). Onimawo and Akubor (2012) suggested that the increases in protein observed during fermentation might result from the degradation of stored proteins and other materials during fermentation.

The percentage of carbohydrates also showed that the products contained a high quantity of carbohydrates. The study carried out by Christian (2007) agrees with this study which shows that the seed contained high carbohydrates. Carbohydrates are energy-giving macronutrient which is required for various body metabolisms. Nwaigwe and Adejumo (2015) asserted that shorter processing time results in higher carbohydrate yields.

Fermented fluted pumpkin had the highest amount of magnesium, while boiled fluted pumpkin had the least amount of magnesium. This disagrees with the study done by Akintade et al., (2019) with lower magnesium content for fermented, boiled and roasted seeds. Ibironke and Owotomo (2019) confirmed that magnesium helps the brain and nervous system, improving cognitive reasoning, memory loss (Dementia) and other health conditions associated with memory health such as Alzheimer's disease. Magnesium is a cofactor required for the movement of glucose into the cell and for carbohydrate metabolism. It is involved in the cellular activity of insulin. Low magnesium intake is a risk factor for diabetes (Lopez-Ridaura, et al., 2004). Magnesium deficiency inhibits cellular defences against oxidation damage, which in turn results in a decreased resilience to the oxidative stress caused by diabetes, thereby expediting the progression to diabetes-related complications.

The calcium contents of the samples were high. This agrees with the study conducted by Boraso (2002) which showed high content of calcium in processed fluted pumpkin seed. Calcium is a vital mineral for bone growth and muscle and neurological function. The daily requirement of calcium is 1200 mg until the age of 24 years, so an adequate consumption of Telfairia occidentalis (approximately 1kg) per day would satisfy about one-fourth of this requirement (Agathemor, 2006) functions. The concentration of calcium (280.44 mg/L) obtained in this study can supply about one-third of the daily requirement of man.

The potassium content of the fluted pumpkin was low. This disagrees with the finding of Akintade et al (2019) work which showed higher potassium content. Potassium is one of the minerals that keep the bone intact and prevent the leaching of the mineral. It also prevents osteoporosis which is characterized by low bone mass and results in vulnerability to fracture (Adefisola et al, 2019; Ibironke et al., 2017).

The iron content of the fluted pumpkin seed was low and the iron content is lower than the value reported by Longe et al., (2008) and Akintade (2019) and thereby disagrees with the study. Iron is important for haemoglobin formation.

The vitamin A (Beta-carotene) content of the samples were low. The study by Kayode (2019) disagrees with this study which has a vitamin A content of 890ug. β-Carotene is one of the plant carotenoids converted to vitamin A in the body. In the conversion of Vitamin, A, β-carotene performs many functions in overall health; It works most efficiently in combination with other carotenoids and has been found to reduce the risk of lung and colon cancer. Pumpkin also has a huge concentration of β-carotene which protect against certain cancers and cataract and is a powerful ally against the degeneration aspect of ageing. Carotenoids are the primary source of vitamin A.

The vitamin B2 content of the fluted pumpkin seed was low. This agrees with a study conducted by Okpalamma et al., (2013). it also agrees with the study done by Orole, (2020) which showed that vitamin B2 contents were low. The vitamin B9 result revealed appreciable amounts of vitamin B9 and minimal concentrations of vitamin B3. This disagrees with the study conducted by Okpalamma et al, (2013), and research by Orole (2020) disagrees with this study.

The saponin content of the samples was appreciable. This disagrees with the study by Orole et al, (2020) which had a low saponin value. Most seeds contain Saponins as their main ingredient. One useful type of saponin for skin care is triterpenoid saponin, which can be found in herbs such as Licorice root (Glycyrrhizaglabra). This particular saponin can aid the absorption of nutrients. High level of saponin has been associated with gastroenteritis manifested by diarrhoea and dysentery, but it was reported that saponin reduces body cholesterol by preventing its re-absorption and suppressing rumen protozoan by reacting with cholesterol in the protozoan cell membrane thereby dissolving it (Ganiyu, 2005).

The flavonoid content of the samples was low. This is comparable with research conducted by Orele et al, (2020). Flavonoids are particularly useful for maintaining healthy circulation and some are antioxidant, while others are anti-inflammatory, anti-viral or capillary strengthening (Ejidike & Ajileye, 2007). The alkaloid content of the samples was high compared to the findings of Enujiugha et al. (2014) who reported a lower (0.350 mg/g) alkaloid content of Telfairia occidentalis aqueous extracts in a similar study.

**Conclusion**

The processing method is considered acceptable when it retains or leads to an increase of nutrients and lowers toxic components in the food materials processed. From the findings of this study, fermentation has proved the best method of processing seeds of fluted pumpkin for consumption as it has led to the retention of higher amounts of some nutrients like protein, moisture, carbohydrates, magnesium, calcium, vitamin A and vitamin B9 than boiling and roasting methods of processing.

**Recommendation**

1. Nutritionists should create awareness among the public on the importance of using the best processing method (fermentation) that will ensure optimum nutrient retention in processing fluted pumpkin seeds.
2. People should be encouraged to consume fluted pumpkin seeds because the result of the study has shown that it is nutrient dense.
3. More studies should be done to know if fluted pumpkin seed can be used to formulate baby food, due to its low fibre content.

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