International Journal of Biochemistry Research & Review
9(2): 1-7, 2016, Article no.IJBcRR.21483
ISSN: 2231-086X, NLM ID: 101654445

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Effect of Cooking Methods on Proximate and Mineral Composition of Fluted Pumpkin (*Telfairia occidentalis)* Leaves

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Authors' contributions

This work was carried out in collaboration between all authors. Authors FGO and EDP designed the study, wrote the protocol and supervised the work. Author BJ carried out all laboratories work and performed the statistical analysis. Author FGO managed the analyses of the study. Author BJ wrote the first draft of the manuscript. Authors GAS and YAD managed the literature searches and edited the manuscript. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJBCRR/2016/21483
Editor(s):
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Complete Peer review History: http://sciencedomain.org/review-history/12342

Original Research Article

Received 19th August 2015
Accepted 8th October 2015
Published 19th November 2015

ABSTRACT

The effect of boiling, steaming and microwaving on proximate and mineral compositions of fluted pumpkin (*Telfairia occidentalis*) leaves were investigated. Standard methods of analyses were applied for the determinations of selected parameters. Results obtained indicated that at P<0.05 confidence level no significant losses in the values of proximate composition occurred, except for protein and carbohydrate. Decrease in protein contents were 18.36, 13.54 and 20.36% for steaming, boiling and microwaving respectively. Carbohydrate content decrease as follows: steaming (15.44%), boiling (18.35%), and microwaving (2.53%). The percentage reduction in

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nitrogen content on applying the three cooking methods were 1.10, 0.72 and 0.38% for steaming, boiling and microwaving respectively. Results showed that percentage decrease in P, K, Na, Ca, Mg, and Fe was highest for boiling relative to other methods of processing. The study recommended microwaving as the most appropriate method for processing *T. occidental* leaves for optimum nutritional benefit.

Keywords: T. occidentalis; proximate composition; mineral composition.

1. INTRODUCTION

Most vegetables are commonly cooked before consumption. In general, the purpose of preparing vegetables before consumption is to improve taste rather than retention of mineral nutrients which serve as health promoting compounds [1]. It is known that cooking induces significant changes in chemical composition [1]. Cooking methods were shown to affect content of nutrients and health promoting compounds such as vitamin C, carotenoids, and polyphenols in broccoli vegetables [2,3]. However, processing makes food safe for consumption and destroys pathogenic microorganisms. The effect of processing on food depends on the sensitivity of the nutrient to the various processing conditions such as heat, oxygen, pH and light [3]. It is necessary that vegetables are prepared in such a manner that retains maximum amounts of their nutrients, that is minimizing losses through oxidation and leaching [4].

There are many methods of cooking, most of which have been known since antiquity. These include baking, roasting, frying, grilling, barbecuing, and smoking. Others include boiling, steaming and braising [4]. Various methods use differing levels of heat and moisture and vary in cooking time. The method chosen greatly affects the end result because some foods are more appropriate to some methods than others. When heat is used in the preparation of food, it can kill or inactivate harmful organisms, such as bacteria and viruses, as well as various parasites such as tapeworms and *Toxoplasma gondii* [4,5]. Food poisoning and other illness from uncooked or poorly-prepared food may be caused by bacteria such as pathogenic strains of *Escherichia coli*, *Salmonella typhimurium* and *Campylobacter*, viruses such as noroviruses, and protozoa such as *Entamoeba histolytica* [5]. Parasites may be introduced through salad, meat that is uncooked or rarely cooked and un-boiled water [5]. The sterilizing effect of cooking depends on temperature, cooking time, and technique used. Studies have shown that some bacteria such as *Clostridium botulinum* or *Bacillus cereus* can form spores that survive cooking, which then germinate and re-grow after the food is cooled [6]. It is therefore recommended that cooked food should not be reheated more than once to avoid repeated growths that allow the bacteria to proliferate to dangerous level [6].

Fluted pumpkin *(T. occidentalis)* is a vegetable locally known as, ugwu in Igbo and eweroko in Yoruba languages of Nigeria. This leaf is a tropical vine grown in West Africa as a leafy vegetable. It is a vegetative shrub that creeps low across the ground with large lobed leaves and long twisting tendrils. *T. occidentalis* is a vegetable which is an important food component in diets in Nigeria mostly in southern part of Nigeria. The leaf is used primarily in soups and herbal medicines, they are believe to help reduce blood pressure, improve digestion and enhance healthy metabolism [7]. Young leaves of *T. occidentalis* sliced and mixed with coconut water and salt are used to treat convulsion in ethno medicine and the roots are used as rodenticides [7]. *T. occidentalis* is traditionally used by an estimated 30 to 35 million Indigenous people in Nigeria, including the Efik, Ibibio, and Urhobo; however, it is predominantly used by the Igbo tribe, who continue to cultivate the gourd for food sources and traditional medicines [7]. The fluted gourd is noted to have healing properties and is used as a blood tonic, administered to the weak or ill [8]. *T. occidentalis* leaf contains nutrients which can be absorbed by the human system for body building, energy, regulatory and protective functions. They are also source of vitamins, minerals and phytochemicals. A study conducted by the Federal Institute of Technology, Akure, examined the chemical properties of the fluted gourd and concluded that the leaves contained high amount of antioxidants and showed antimicrobial properties [8]. Considered an “oil seed”, the fluted gourd is high in oil (30%) [8]. Shoots of *T. occidentalis* contain high levels of potassium and iron, while the seeds are composed of 27% crude proteins and 53% fats [8].

A significant percentage of Nigerian population consumes this vegetable after subjecting it to one form of processing or the other. Hence, the need to evaluate the effect of the most commonly used methods of processing on the vital proximate and mineral composition of the vegetable with a view to providing useful data.

2. MATERIALS AND METHODS

2.1 Sample Collection and Treatment

Samples of *T. occidentalis* were purchased from Badeggi market, Lapai, Niger state, Nigeria. Prior to analysis, the leaves were washed with tap water then rinsed with distilled water. The residual moisture was evaporated at room temperature.

2.2 Boiling

About 200 g of homogeneous pieces of Fluted Pumpkin leaves were immersed in 400 ml of boiling water. The fluted pumpkin was drained off after boiling for 5 min.

2.3 Microwaving

A microwave oven (LOGIK Microwave appliance, model No: L20MS10, Tianjin Electronics, China) at full power (1000 W) was used for microwaving. About 200 g of Fluted Pumpkin leaves were placed in a plate and 10 ml water was added to prevent it from burning during cooking. The Fluted Pumpkin in the plate was placed in the microwave oven for 5-min, and then drained off.

2.4 Steaming

Steaming was conducted by suspending about 200 g of cut Fluted Pumpkin leaves above 200 ml of boiling water for 5 min in a steamer with a lid.

Thereafter, the leaves from the three cooking methods were separately oven dried at 60℃ until adjudged to be properly dried. The dried leaves were then ground in porcelain mortar, sieved through 2 mm mesh sieve and stored in polythene bags. The powdered samples were used for both proximate and mineral analyses.

Fresh samples of the vegetable which were not subjected to any of the cooking methods were also dried at 60℃ and grounded into powder for proximate and mineral analyses.

2.5 Proximate Analysis

Proximate compositions were estimated using standard methods of analysis. The moisture content of the leaves were determined by drying 5 g of the powdered leaves (in triplicate) in a Gallenkamp oven at 105℃ until constant weight was attained [9]. Ash content was determined according to the method described by [10] which involved dry ashing in lenton muffle furnace at 600℃ until grayish white ash was obtained. Crude protein content was determined by multiplying the value obtained from kjeldahl's nitrogen by a protein factor of 5.3, a factor recommended for vegetable analysis. Crude lipid was quantified by the method described by [9] using the soxhlet apparatus and petroleum ether (B.P. 60℃- 80℃) as solvent. Crude fiber was determined by acid-base digestion with 1.25% H_2S0_4 (W/V) and 1.25% NaOH (W/V) solutions.

The method described in [9] was used to calculate available Carbohydrates, where the total amount of carbohydrate in the sample was obtained by calculation using percentage weight difference. This involved subtracting the percentage sum of the food nutrients, % crude protein, % crude lipid, % crude fibre, and % ash from 100% dry weight. Percentage carbohydrate was calculated using equation: Carbohydrate % = 100 – (crude protein + crude lipid + crude fibre + ash).

The Energy Value (calorific Value) of a Food is given by energy Value of Food (in KJ per100 g) = [(% available Carbohydrate X 4) + (% available Protein X 4) + (% available Fat X 9)] [9].

2.6 Samples Preparation for Mineral Analysis

Six (6) grams of the powdered sample was weighed into a crucible and gently heated over a Bunsen burner until it charred. The charred sample with the crucible was transferred into a lento muffle furnace at about 600℃ and constantly heated until grayish white ash was obtained. It was cooled first at room temperature and then in a desiccator. 5 cm^3 of concentrated HCl was added and heated for 5 minutes on a hot plate in a fume cupboard. The mixture was then transferred into a beaker and the crucible washed several times with distilled water. The mixture was made up to 40 cm^3 and boiled for 10 minutes over a Bunsen burner. This mixture was then cooled, filtered and rinsed into 100 cm^3

volumetric flask and made up the volume to 100 cm^3 [10]. The solution prepared in triplicates.

2.7 Determination of Mineral Concentration

Sodium (Na) and Potassium (K) were analyzed by Flame Atomic Emission spectrophotometer. Phosphorus (P) was determined with Jenway 6100 spectrophotometer at 420 nm using vanadium phosphomolybdate (vanadate) colorimetric method with KH_2P0_4 as the standard [10]. The concentrations of calcium (Ca), magnesium (Mg), copper (Cu), Iron (Fe), Manganese (Mn) and Zinc (Zn) in the solutions were determined using Atomic Absorption Spectrophotometer AAS 969 (Bulk Scientific, MODEL VGB 210/211) [9].

2.8 Statistical Analysis

Statistical analysis was performed using the SPSS package program version 20 (SPSS Inc., Chicago, IL, USA). Data were analyzed by one-way analysis of variance (ANOVA), followed by Duncan's multiple range post-hoc test. Results are expressed as mean ± *SD* of triplicate samples. Differences were considered significant at $P<0.05$.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition

The effect of different cooking methods on the proximate composition of *T. occidentalis* is presented in Tables 1 & 2. The results indicated increase in the values of crude fibre, fat, moisture and ash contents of *T. occidentalis* after processing. Protein and carbohydrate content were observed to decrease on cooking for all methods used.

Percentage decrease in crude protein values were 18.36, 13.54 and 20.36% for steaming, boiling and microwaving respectively. This means that boiling retains more of protein than the other cooking methods used in this study. This may be due to the high heating temperature involved in steaming and microwaving where there is no much water to serve as a shield as is the case with boiling. It has been reported by Rahama and Mustapha [11] that increase in temperature can cause severe protein damage in food ranging from destruction of amino acid to complete racemization. Also, Komolafe and Obayanju [12] reported that during heating, cellular protein are denatured and chlorophyll which was bound to the protein may be released. Such free chlorophyll is highly unstable and readily converted to pheophytin, which could enhance denaturation of protein when heated.

A decreasing trend in carbohydrate content was observed for the different cooking methods in the following manner, boiling > steaming > microwaving (Table 2). Microwaving in this case retains the highest amount of carbohydrate followed by steaming and then boiling, this may be as a result of some of the carbohydrate dissolving in the large volume of water in the boiling method. Increased temperature reduced the carbohydrate content of vegetable and hence limits its possible usefulness as an energy source. Carbohydrate is made up of starches and sugars. Heating starches changes crystallized starch molecules into gels during which the starch granules swell and absorb water becoming soft and easier to dissolve [13].

An increasing trend of Fat content was observed in the manner steaming<microwaving<boiling. This shows that heating frees the crude fat from the vegetable matrices. This may be due to the increase in the extraction efficiency of crude fat by water as the rate of heating increases. Some lipids in foods are in complex lipoprotein and liposaccharides, hence heat breaks the bond between them and the lipids are freed and solubilized in the extracting solvent [14].

3.2 Mineral Composition

The result of the effect of various cooking methods on the mineral compositions of *T. occidentalis* is presented in the Tables 3 & 4.

All the mineral compositions of *T. occidentalis* analyzed were observed to decrease for all the methods of cooking. The percentage changes in nitrogen content were 1.10, 0.72 and 0.38% for steaming, boiling and microwaving methods respectively. Generally, mineral contents were observed to decrease for all the cooking methods applied in this study. This general decrease in the mineral content after processing is attributed to losses arising from the solubility of these elements in water. Results showed that percentage decrease (Table 4) in P, K, Na, Ca, Mg, and Fe was highest for boiling relative to other method of processing. This observation may be related to the large volume of water used in this processing method. From the results of mineral analysis microwaving *T. occidentalis* leaves will retain more of the mineral content than steaming and boiling.

Table 1. The effect of cooking methods on the proximate compositions of *T. occidentalis*

Cooking methods	Moisture %	Fat %	Crude protein %	Crude fibre %	Ash %	CHO %	Energy value
Uncooked	4.66±0.16[a]	12.76±1.26[a]	31.74±0.19[b]	4.35±0.13[a]	13.48±0.55[c]	51.01±1.34[d]	332.62±2.67[a]
Steam	5.60±0.05[a]	13.26±0.56[a]	13.38±0.44[d]	4.50±0.5[a]	13.74±0.17[b]	35.57±0.63[b]	378.70±23.51[b]
Boil	6.50±0.50[c]	13.40±0.36[a]	18.20±0.70[c]	5.42±0.15[b]	13.86±0.31[a]	32.66±0.69[a]	378.7±1.59[b]
Microwave	5.70±0.49[b]	13.30±0.35[a]	11.38±0.07[b]	6.00±0.12[c]	15.14±0.29[d]	48.48±0.51[c]	359.14±0.86[b]

a: significant in the comparison between uncooked and cooked vegetables *b: moderately significant in the comparison between uncooked and cooked vegetables*
c:highly significant in the comparison between uncooked and cooked vegetables *d: very highly significant in the comparison between uncooked and cooked vegetables*

Table 2. Percentage change in proximate composition of *T. occidentalis*

Proximate composition	Steaming %	Boiling %	Microwaving %	Change
Moisture	0.94	1.84	1.04	Increase
Fat	0.50	0.64	0.54	Increase
Protein	18.36	13.54	20.36	Decrease
Fibre	0.15	1.07	1.65	Increase
Ash	0.26	0.38	1.66	Increase
Carbohydrates	15.44	18.35	2.53	Decrease

Table 3. The Effects of cooking methods on the mineral compositions of *T. occidentalis*

Cooking methods	Nitrogen (N) %	Phosphorus (P) %	Potassium (K) %	Sodium (Na) %	Calcium (Ca) %	Magnesium (Mg) %	Iron (Fe) %
Uncooked	2.20±0.20[a]	0.91±0.09[a]	0.83±0.23[c]	0.180±0.03[a]	5.30±0.20[a]	0.038±0.001[a]	0.142±0.004[b]
Steam	1.10±0.51[c]	0.88±0.21[a]	0.65±0.13[a]	0.040±0.01[b]	4.20±0.26[b]	0.036±0.002[a]	0.101±0.001[a]
Boil	1.48±0.51[c]	0.77±0.10[a]	0.08±0.13[a]	0.020±0.01[a]	4.00±0.50[b]	0.030±0.007[b]	0.100±0.020[d]
Microwave	1.82±0.74[b]	0.74±0.05[b]	0.09±0.51[b]	0.055±0.01[b]	4.40±0.58[b]	0.037±0.002[c]	0.106±0.010[c]

a: significant in the comparison between uncooked and cooked vegetables *b: moderate significant in the comparison between uncooked and cooked vegetables*
c:highly significant in the comparison between uncooked and cooked vegetables *d: very highly significant in the comparison between uncooked and cooked vegetables*

Table 4. Percentage change in mineral composition of *T. occidentalis*

Minerals	Steaming %	Boiling %	Microwaving %	Change
Nitrogen	1.10	0.72	0.38	Decrease
Phosphorus	0.03	0.14	0.17	Decrease
Potassium	0.18	0.75	0.74	Decrease
Sodium	0.14	0.16	0.13	Decrease
Calcium	1.10	1.30	0.90	Decrease
Magnesium	0.002	0.008	0.001	Decrease
Iron	0.041	0.042	0.036	Decrease

4. CONCLUSION

This study has revealed that *T. occidental* leaves contain an appreciable amount of proximate and mineral nutrients. However, cooking methods of steaming, boiling and microwaving have effects on the retention of these compositions. For proximate composition, protein and carbohydrate content decreased while, crude fat, crude fibre, ash and moisture contents increased on application of the three cooking methods. A general decrease in mineral composition was observed for all the minerals evaluated. On the whole, this study recommended microwaving as the most appropriate method for processing *T. occidental* leaves for optimum nutritional benefit.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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