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Comparative Phytochemical Studies and Proximate Analysis of Five Commonly Consumed Vegetables of Southern Nigeria

K. Okonwu[1*] and A. P. Enyinnaya[1]

[1]Department of Plant Science and Biotechnology, Faculty of Science, University of Port Harcourt, P.M.B. 5323, Choba, Rivers State, Nigeria.

Authors' contributions

This work was carried out in collaboration between both authors. Authors KO and APE designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author KO managed the analyses and literature searches of the study. Both authors read and approved the final manuscript.

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ABSTRACT

Background: A comparative qualitative phytochemical screening and proximate analysis were carried out on the leaves of five commonly consumed vegetables of southern Nigeria. These vegetables and families were *Telfairia occidentalis* (Cucurbitaceae), *Gnetum africanum* (Gnetaceae), *Hagenia abyssinica* (Rosaceae), *Vernonia amygdalina* (Asteraceae) and *Piper guineense* (Piperaceae).
Methods: Standard methods were used to qualitatively determine phytochemicals (Trease and Evans, Harbone) and proximate composition (AOAC) present in the leaves of *G. africanum, T. occidentalis, V. amygdalina, P. guineense* and *H. abyssinica.*
Results: The study revealed the presence of bioactive constituents; tannin, flavonoid, alkaloid, and saponin in the five plant samples except for tannin which was absent in *P. guineense.* Anthraquinone was absent in all the five samples. Proximate compositions of all the five selected vegetables were not the same. *Gnetum africanum* had the highest protein, carbohydrate, and ash

**Corresponding author: E-mail: kalu.okonwu@uniport.edu.ng;*

content (11.16%, 11.46% and 2.35%) respectively when compared with the other plants. *H. abyssinica* had the highest fibre content at 7.81%, while *V. amygdalina* had the highest lipid content at 0.50%.
Conclusion: Vegetables should be consumed based on the nutrient requirement of a given person.

Keywords: Proximate; Phytochemical; Telfairia, Gnetum; Hagenia; Vernonia; Piper.

1. INTRODUCTION

Plant materials such as *Telfairia occidentalis* Hook. f., *Gnetum africanum* Welw, *Hagenia abyssinica* Willd, *Vernonia amygdalina* Delile and *Piper guineense* Schumach. & Thonn. generally feature as one of the dietary constituents served as food in most homes. It is believed to contain secondary metabolites in the form of phytochemicals, vitamins and minerals. Vegetables are the edible parts of herbaceous plants that are consumed wholly or in parts, raw or cooked, as part of main dish or salad. They may be bitter, sweet, or tasteless [1]. Foods containing an abundance of fruits and vegetables give protection against a variety of diseases, particularly cardiovascular diseases [2]. Leafy vegetables are sources of essential and trace elements which play a major role in the normal functioning of the body system, maintaining regular metabolic processes and repair of worn out cells and tissues in man [3]. Many rare and useful herbs occur in Nigeria, from which important drugs could be prepared or agents which may serve as starting materials for the partial synthesis of some useful drugs [4]. Vegetables are included in meals mainly for their nutritional value and some are used to treat most illness because of their medicinal properties. The usefulness of these plant materials medicinally is due to the presence bioactive constituents such as phenols, flavonoids, tannins and alkaloids [5].

The primary benefits of using medicine derived from plant are that they are relatively safer than synthetic alternative, offering profound therapeutic benefits and more affordable treatment [6]. The use of medicinal plants in developing countries as a basis for the maintenance of good health has been widely observed [7]. More so, the increasing reliance on the use of medicinal plants in the industrialized societies has been traced to the extraction and development of several herbs and drugs and chemotherapeutics from these plants as well as from traditionally used rural remedies [8].

In southern Nigeria, *Telfairia occidentalis* (Cucurbitaceae), *Gnetum africanum* (Gnetaceae), *Hagenia abyssinica* (Rosaceae), *Vernonia amygdalina* (Asteraceae) and *Piper guineense* (Piperaceae) are mostly cultivated and used as a vegetable for soups and stews by millions of people, including the Effik, Igbos, Ikweres, Ibibio, Urhobo, Ijaw etc. These plants are used as herbal medicine [9]. The cooked leaves are staple vegetable in soups and stews of various cultures throughout equatorial Africa [10,11]. The aim of this study is to qualitatively compare some of the secondary metabolites inherent in these five commonly consumed vegetables in southern Nigeria and ascertain their nutritional contents.

2. MATERIALS AND METHODS

2.1 Collection of Plants

The leaves of *G. africanum, T. occidentalis, V. amygdalina, P. guineense,* and *H. abyssinica* used for this research were purchased from a local market in Choba community. They were properly identified by the Curator at the University of Port Harcourt Herbarium.

2.2 Proximate Analysis

Proximate analysis (moisture, ash, protein, carbohydrate and lipid content) was determined using standard method of AOAC [12]. Fibre was determined by difference.

2.2.1 Determination of crude protein (Kjeldahl method)

Plant samples weighing 0.1 g were put into different conical flasks, 3 g of digestion catalyst and 20 ml of concentrated sulphuric acid was added into the flask. The flasks were then heated gently to boil in a fume chamber, until charred particles disappeared and clear greenish grey solution was obtained. The resulting solution in the conical flask was heated for an additional 20 minutes and allowed to cool. The digest was diluted with water to 100 ml capacity and 20 ml

was then measured into a distillation flask and this was connected to a condenser adapted to a receiver beaker containing 10 ml of 2% boric acid with 2 drops of double indicator. NaOH (40%) was added to the digest, the distillation flask was then heated to distil the nitrogen present as ammonia. The boric acid in the receiver was titrated with standard 0.1N hydrochloric acid. The volume of HCl used was recorded as titre value. The formula for the calculation of total Nitrogen is:

$$\%\text{Nitrogen} = \frac{\text{Titre value x 1.4 x 100}}{\text{1000 x 20 x 0.1}}$$

Titre value = Volume of Hydrochloric acid used.

1.4 = Nitrogen equivalent in relation to the normality of HCl used in titration.

100 = Total volume of digest dilution

100 = Percentage factor

1000 = Conversion factor from gram to milligram.

20 = Integral volume of digits analyzed or distilled

0.1 = The weight of sample in gram digested

$$\%\ \text{Crude protein} = \%\text{Nitrogen X } 6.25$$

2.2.2 Determination of carbohydrate (CleggAnthrone method)

Plant samples weighing 1 g were put into a 250 ml volumetric flask. Distilled water (10 ml) and 13 ml of 62% perchloric acid was added and the mixture was shaken in order for it to homogenize completely. The flask was made up to 250 ml with distilled water; the solution formed was filtered through a glass filter paper. Filtrate (10 ml) was collected and transferred into a 100 ml test tube; this was also diluted to volume with distilled water. The hydrolyzed solution was pipetted into a clean test tube and 5 ml of Anthrone reagent was added, they were then mixed together. The whole mixture was read at 630 nm wavelength using the 1 ml distilled water and the 5 ml anthrone prepared as blank. Glucose solution of 0.1 ml was also prepared and this was treated with the anthrone reagent. Absorbance of the standard glucose was calculated using the formula below:

$$\%\text{CHO} = \frac{\text{25 x Absorbance of sample}}{\text{Absorbance of standard glucose x 1g of sample used}}$$

2.2.3 Determination of moisture using the air oven method

Samples weighing 1 g were placed in a clean dry porcelain evaporation dish. This was placed in an oven to maintain a temperature of 105°C for six hours. The evaporating dish was cooled to room temperature in a desiccator and re-weighed.

$$\%\ \text{Moisture} = \frac{\text{weight of fresh sample} - \text{weight of dried sample}}{\text{Weight of sample used}} \text{ X } \frac{100}{1}$$

2.2.4 Determination of lipid by soxhlet extraction method

Samples weighing 2 g was inserted into a filter paper and placed into the soxhlet extractor. The extractor was fitted into a pre-weighed round bottomed dry distillation flask and the solvent acetone was added into it through the condenser. The extractor and the flask were held in place with a retort stand clamp. Cold water was passed into the condenser via the rubber tubing and the flask was heated such that the solvent refluxed continuously within the enclosure. The lipid in the solvent chamber was extracted through this process of continuous refluxing. After the lipid had been extracted completely from the sample, the condenser and the extractor were disconnected, the acetone solvent was distilled off and the lipid concentrate was cooled in the oven and re-weighed.

$$\%\ \text{Lipid} = \frac{\text{Weight of fl and extract} - \text{Weight of empty fl}}{\text{Weight of sample extracted}} \text{ X } \frac{100}{1}$$

2.2.5 Determination of ash by furnace method

The dried sample weighing 1 g was placed into a porcelain crucible which had been preheated and weighed. The crucible was inserted into a muffle furnace and regulated to a temperature 630^{o}C. After three hours it was removed from the furnace and allowed to cool to room temperature, and then it was re-weighed.

2.2.6 Determination of fibre

The fibre content was determined by difference. The other five proximate components were summed and the value gotten was subtracted from 100% giving the fibre content

(100 - per cent estimated proximate components represented the per cent fibre in the sample).

2.3 Phytochemeical Screening

The standard methods were used to qualitatively determine the phytochemical (tannin, flavonoid, alkaloid, saponin and anthraquinone) present in the leaves of five commonly consumed vegetables (*G. africanum, T. occidentalis, V. amygdalina, P. guineense,* and *H. abyssinica)* in southern Nigeria [4,13,14].

3. RESULTS AND DISCUSSION

3.1 Phytochemical Screening

The study showed that flavonoid, tannin, saponin, and alkaloid were present in *G. africanum, T. occidentalis, V. amygdalina, P. guineense,* and *H. abyssinica.* But tannin was absent in *P. guineense* while anthraquinone was absent in all the samples (Table 1).

3.2 Proximate Analysis

The proximate compositions of the five plants are shown in Table 2.

3.3 Discussion

The result obtained for tannin differs with the earlier work [15] that reported that tannin was absent in *V. amydalina* but present in *P. guinensis*. The work also showed that saponin was absent in *T. occidentalis* [15]. However, Idoko et al. reported that tannin and alkaloid were present in *V. amydalina*, *T. occidentalis, P. guinensis, G. africanum* while flavonoid absent [16]. Tannins are molecules useful for the human health because of their antioxidant properties [17] and antibacterial effect [18]. The antioxidant capacity of these compounds have been related to health benefits such as counteracting the risk of cardiovascular diseases, cancer and cataract as well as a number of other degenerative diseases [19]. The presence of tannins in *T. occidentalis, G. africanum, H. abyssinica,* and *V. amygdalina,* suggests that they could be useful for the prevention of cancer as well as treatment of inflamed or ulcerated tissues. Alkaloids have medicinal usefulness as agents possessing analgesic, antimalarial, antiseptic, ant-inflammatory, anti-carcinogenic, and bacterialcidal activities [20]; therefore the presence of alkaloid in the plant samples tested, could suggest that these vegetables could be useful in these areas. Saponin in medicinal plants are responsible for most biological effects related to cell growth and division in humans and have inhibitory effects on inflammation. Tannin was not found in *P. guineense*, while anthraquinone was not found in these plant samples. A variety of herbs and herbal extracts contain different phytochemicals with biological activity that can be of valuable therapeutic index. Phytochemicals have been found to possess a wide range of activities, which may help in protection against chronic diseases. For example flavonoids, tannins and alkaloids have hypoglycemic activities; steroids and saponin are responsible for central nervous system activities [21]. Anti-diarrheal and anti-dysenteric properties were found to be due to presence of tannins, alkaloids, saponins, falvonoids, steroids and terpene in some extracts [22,23].

Table 1. Qualitative phytochemical screening of five commonly consumed vegetables of southern Nigeria

Phytochemical	*T. occidentalis*	*G. africanum*	*V. amygdalina*	*P. giuneense*	*H. abyssinica*
Flavonoid	+	+	+	+	+
Tannin	+	+	+	-	+
Saponin	+	+	+	+	+
Alkaloid	+	+	+	+	+
Anthraquinone	-	-	-	-	-

Table 2. Proximate composition of five common vegetables in southern Nigeria

S/N	Sample identity	Protein (%)	CHO (%)	Fibre (%)	Lipid (%)	Moisture (%)	Ash (%)
1.	*G. africanum*	11.16 ± 1.55	11.46 ± 1.5	1.46 ± 0.60	0.3 ± 0.00	74.27 ± 2.07	2.35 ± 22.18
2.	*H. abyssinica*	8.75 ± 0.00	3.36 ± 0.05	7.81 ± 0.09	0.2 ± 0.00	78.37 ± 0.01	1.51 ± 0.09
3.	*P. guineense*	5.69 ± 0.00	2.50 ± 0.00	0.77 ± 0.51	0.30 ± 0.00	87.94 ± 0.25	2.79 ± 0.26
4.	*T. occidentalis*	5.47 ± 0.31	6.46 ± 0.33	1.36 ± 1.22	0.60 ± 0.00	84.84 ± 1.10	1.27 ± 0.12
5.	*V. amygdalina*	3.94 ± 0.62	5.42 ± 1.18	2.26 ± 1.09	0.50 ± 0.00	86.47 ± 0.54	1.41 ± 0.00

Results are presented as Mean ± standard deviation

The result of the proximate analysis is comparable with those obtained by other workers [24,25,26,27]. Composition (%) amount of Moisture 84.84 (87.00 [24], 7.45 [25], 6.6 [26], 10.94 [27]), Ash 1.27 (17.2, 7.73, 12.3, 8.31), Lipid 0.60 (14.27 [24], 2.0 [25], 10.7 [26], 6.46 [27]), Protein 5.47 (8.72 [24], 56.0 [25], 35.4 [26], 21.14 [27]), Carbohydrate 6.46 (39.64 [24], 26.82 [25], 33.4 [26], 53.10 [27]), Fiber 1.36 (20.17 [24]). The moisture content of *T. occidentalis* leaves was 84.84 ± 1.10%. This value agreed with the fact that leafy vegetables have high moisture content. The ash content of the leaves (1.27 ± 0.12%) was low when compared other works (17.2, 7.73, 12.3, 8.31 [24,25,26,27]) respectively. The Crude protein content of *T. occidentalis* leaves (8.72 ± 0.03%) indicated that it is a poor source of protein. The crude lipid content of *T. occidentalis* leaves (0.60%) is low which is in agreement with general observation that leafy vegetables are low lipid containing food, thus advantageous health wise to avoid over weighting [28]. The present study shows that *T. occidentalis* leaves contain low percentage of protein (5.47%), and carbohydrate (6.46%), while the % composition of lipid (0.60%) is relatively low compared to others. The fiber content in the leaves of *T. occidentalis* was found to be 1.36%. Carbohydrates provide the body with a source of fuel and energy that is required to carry out daily activities and exercise. The lipid content (0.60%) of the studied leaves is lower than those values reported in some vegetables consumed in West Africa [29,30]. Proximate composition showed that *P. guineense* had the least fibre content of 0.77%, suggesting that it is not a good source of fibre. Vegetables like *H. abyssinica* which showed the highest fibre content of 7.81% when compared with the other vegetables tested, will be a better source of fibre. Adequate intake of dietary fibre can lower the serum cholesterol level, risk of coronary heart disease, hypertension, constipation, diabetes, colon and breast cancer [31,32]. *Gnetum africanum* had the highest crude protein and carbohydrate content of 11.16% and 11.46 respectively, and could be said to be a better source of protein and carbohydrate when compared with the other vegetables tested. The crude lipid composition showed that vegetables are deficient in lipids and this makes them good for health. It is required that vegetables should be used frequently as they are good for health and provide most of the essential nutrients for normal body functions when consumed in appropriate combination.

4. CONCLUSION

The study revealed that some of the biologically active phytochemicals were present in *T. occidentalis, G. africanum, V. amygdalina, P. guineense,* and *H. abyssinica.* Also, the nutrient compositions of all the five selected vegetables were not the same. Vegetables should be consumed based on the nutrient requirement of a given person. The low lipid content obtained from the vegetables confirms the fact that vegetables are poor sources of lipid; this makes them good food for obese people. It has been shown that vegetables are nutritious foods that provide sufficient amount of nutrients needed for normal body function, maintenance and reproduction.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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