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Comparative phytochemical and mineral analysis of methanol extract of *Teifairia occidentalis* (Fluted pumpkin) leaves, stem, and roots

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Abstract: Fluted pumpkin (*Teifairia occidentalis*) is one of the most important vegetable crops in some countries and is widely cultivated in worldwide. Although pumpkins have long been consumed in farmland and certain urban regions, horticultural, commercial, industrial, and scientific studies nowadays examine them in detail. This study aimed to compare the phytochemical constituents and mineral composition in *Telfairia occidentalis* leaves, roots and stems. The plant samples were investigated for their phytoconstituents using standard methods while mineral component analysis was performed by X-ray fluorescence spectrometry. Glycosides, saponins, phenolics, flavonoids, and alkaloids were present in all three parts of the plant while tannins were absent in all three parts. Calcium, K, Fe, Mg, P, Mn, and Zn were present in all three samples with varying concentrations. The stem sample had the highest concentration of K (36.175%) compared to leaf sample (K, 25.157%) and root sample (K, 20.166%). However, trace amounts of toxic elements like Sn and Ti were detected in the root than in other parts. The findings from the mineral analysis suggest that the root part of *Telfairia occidentalis* might have some level of toxicity than other parts of the plant.

Introduction

The importance of vegetable plants for our health cannot be emphasized, and they are widely recognized as safe and free from toxins [1]. Consistently including vegetables in our diet, such as the pumpkin plant *(Telfairia occidentalis)*, water leaf *(Talinum triangulare)* and other vegetable plants have been reported to enhance the overall well-being of the human body [2]. Consuming vegetables plays a vital role in maintaining the optimal functioning of various systems in the human body, including the digestive, excretory, skeletal, and circulatory systems. Additionally, the consumption of vegetables should be done with care as the root of Fluted pumpkin has been reported to be toxic [3]. Consuming vegetables strengthens the immune system by providing antioxidants and nutrients that combat inflammation and promote overall health and well-being [4, 5]. Fresh green vegetables are rich in protein, dietary fiber, and essential minerals, which include potassium, magnesium, and calcium. These minerals are vital for maintaining electrolyte balance, supporting muscle function, and promoting bone health [6]. They also play a crucial role in preventing nutrient deficiency disorders, including obesity, and reducing the risk of heart attacks. Furthermore, green vegetables are low in calories and fat [7]. *Telfairia occidentalis,* family- *Cucurbitaceae,* is a tropical vine widely cultivated in West

Africa for its nutritional and medicinal benefits. It is a popular leafy vegetable known for its rich flavor and high content of essential nutrients. Oboh [8] investigated the antioxidant properties of green leafy vegetables, including fluted pumpkin, emphasizing its importance in combating oxidative stress. Furthermore, Onyeka and Ekweozor conducted an ethnobotanical survey [9, 10], highlighting the traditional usage of fluted pumpkins in treating malaria. Ethnobotanical surveys by Oyeyemi and Adisa, revealed the utilization of various plant species, including *Telfairia occidentalis*, for the treatment of malaria [11]. Fluted pumpkin exhibits significant medicinal properties, making it a valuable plant in traditional and modern medicine. The leaves of fluted pumpkin have been reported to possess antimicrobial [12], hematological properties, analgesic and anti-inflammatory effects [6], and glucose level reduction [13]. The utilization of fluted pumpkin seed oil has been identified as a potential remedy for male infertility by enhancing testicular function and increasing sperm count [7]. More, the consumption of fluted pumpkin provides protection against oxidative stress in humans due to the presence of antioxidants such as tocopherol and glutathione in the plant [6]. However, studies have shown that the roots of fluted pumpkins have toxic and poisonous properties with adverse effects on the stomach lining [3]. Traditionalist and rural farmers have reported that extracts of pumpkin roots, which are not consumed by humans, are lethal to rats and mice [14]. While fluted pumpkin leaves are commonly consumed, other parts of the plant, such as the roots and stems, have received less attention in terms of their chemical composition. Understanding the mineral composition of different plant parts is crucial for assessing their nutritional value and potential health benefits. Minerals are essential for various biological processes in plants and play a vital role in human health. Fluted pumpkin roots, leaves, and stems may exhibit variations in mineral content due to their different physiological functions and nutrient uptake pathways. Minerals such as calcium, potassium, iron, and magnesium are essential for maintaining healthy bodily functions, including bone health, muscle contraction, and enzyme activities. Therefore, investigating the mineral composition of fluted pumpkin roots, leaves, and stems can provide insights into their nutritional profiles and potential dietary contributions. Although fluted pumpkin has been the subject of scientific investigation, limited research has focused on the comparative mineral analysis of its different plant parts. Thus, this study is aimed at a comparative analysis of the phytochemical constituents and mineral elements in leaves stem and root of the fluted pumpkin plant (**Plat 1**).

Plate 1: Fluted pumpkin plant

Materials and methods

Sample collection, treatment and extraction: The leaves, stem, and roots of *Telfairia occidentalis* were collected from its natural habitat in Iguoshodin community, Ovia North East Local Government Area of Edo State. The plant was identified and authenticated in the Department of Plant and Biotechnology, University of Benin, Benin City, Edo State, Nigeria. The leaves stems and roots were sorted, cleaned immediately and air dried for 24 hours in the laboratory. The respective parts were pulverized with an electric blender and a portion was met for mineral analysis by X-ray fluorescence Spectrometry while the other was extracted by maceration in a 500 mL beaker for 72 days, using methanol solvent. After extraction, each sample was dried over sodium sulphate and concentrated using a rotary evaporator (model, RE, 200) at 50°C. The crude extract was used for phytoconstituents screening by standard methods.

Phytoconstituents screening of hexane extract of Tetracarpidium conoforum root bark: The phytochemical screening of the leaves, stem, and root of fluted pumpkin plant was performed using standard procedures [15, 16].

Test for glycosides: one milliliter of the plant extracts was dissolved in 1ml glacial acetic acid containing one drop of ferric chloride solution. This was underlain with 1ml concentrated sulphuric acid. The formation of a brown ring, indicates the presence of glycoside.

Test for saponins: one milliliter of each plant extract was shaken with water in a test tube and observed for the frothing. Saponins rein Swiss (supplied by Merck) were used as a standard.

Test for phenolics: one milliliter of the plant extracts was added to 5.0 ml of 90.0% ethanol, in addition, one drop of 10.0% ferric chloride was added respectively. A pale yellow colouration indicates the presence of phenolic compounds.

Test for tannins: To 2.0 ml of the plant extract, 10.0 ml of distilled water was added and boiled for five minutes and filtered into halves. To two drops of the filtrate, a ferric chloride solution was added. The formation of bluish precipitates indicates the presence of hydrolyzable tannin. To about two drops of the filtrate, 2.0 ml of dilute HCl was added and boiled for five minutes. Red precipitates indicate the presence of condensed tannin.

Test for terpenoids: 5.0 ml of each extract was mixed in 2.0 ml chloroform, and 3.0 ml concentrated sulphuric acid was carefully added down the side of the inner wall of the test tube to form a layer. A reddish-brown colouration indicates the presence of terpenoids.

Test for steroids: 2.0 ml of acetic anhydride were added to 0.5 g plant extract in 2.0 ml dilute sulphuric acid. A colour change from violet to blue-green indicate the presence of steroids.

Test for flavonoids: one milliliter of the plant extract was measured and a few drops of dilute lead acetate were added. An intense yellow colour appears in the test tube, and becomes colourless on addition of a few drops of dilute acid. This indicates the presence of flavonoids.

*Test for eugenols***:** 2.0 ml of the plant extract was mixed with 5.0 ml of 5.0% potassium hydroxide solution. The aqueous layer where separated and filtered. A few drops of dilute HCl were added to the filtrate, and pale-yellow precipitates indicate a positive test.

Test for alkaloids: Picric acid was used to test for alkaloid. About 1.0 ml of each of the plant extract was transferred to 2.0 ml of picric acid respectively. A yellow precipitate indicates a positive test.

Determination of mineral element by X-ray fluorescence spectrometry: The energy dispersed X-ray Fluorescence Spectrometer was used for the determination of the mineral element. Here, an X-ray beam was used to excite each sample, and spectra were recorded with high-resolution detectors. Mineral elements including potassium (K), calcium (Ca), magnesium (Mg), Iron (Fe), and copper (Cu) among others were estimated and elemental concentrations were determined in percentage.

Results

The results of this research indicated that tannins were absent in all three parts while other phytoconstituents were present in varying degrees as shown in **Table 1** and the percentage distribution of the investigated phytochemicals given in **Figure 1**. The mineral constituents of the three parts are reported in **Table 2 and Figure 2**.

Table 1: Phytochemical constituents in leaves, stem, and roots of Pumpkin plant

S/N	Phytochemicals	Pumpkin leaves	Pumpkin stem	Pumpkin roots
1	Glycosides	+	+	+
2	Saponins	+	+	+
3	Phenolics	+	+	+
4	Tannins	-	-	-
5	Terpenoids	+	+	-
6	Steroids	+	-	-
7	Flavonoids	+	+	+
8	Eugenols	+	_	-
9	Alkaloids	+	+	+

+ = present - = absent

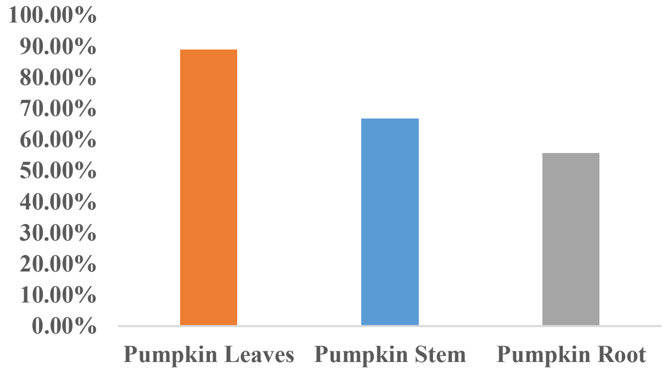

Figure 1: Percentage distribution of phytochemicals in the leaves, stem, and root *T. occidentalis*

Table 2: Percentage of mineral elements in leaves, stem and roots of Pumpkin plant

Mineral elements	Pumpkin leaves (%)	Pumpkin stem (%)	Pumpkin roots (%)
Ca	17.507	18.262	12.941
K	25.157	36.175	20.166
Mg	5.725	0.000	8.412
Fe	1.301	0.693	3.939
P	1.803	1.354	1.002
Mn	0.186	0.168	0.461
Zn	0.120	0.064	0.078
Si	4.523	5.078	5.232
Ti	0.351	0.201	1.015
Cu	0.200	0.139	0.243
Sn	0.577	1.341	0.761

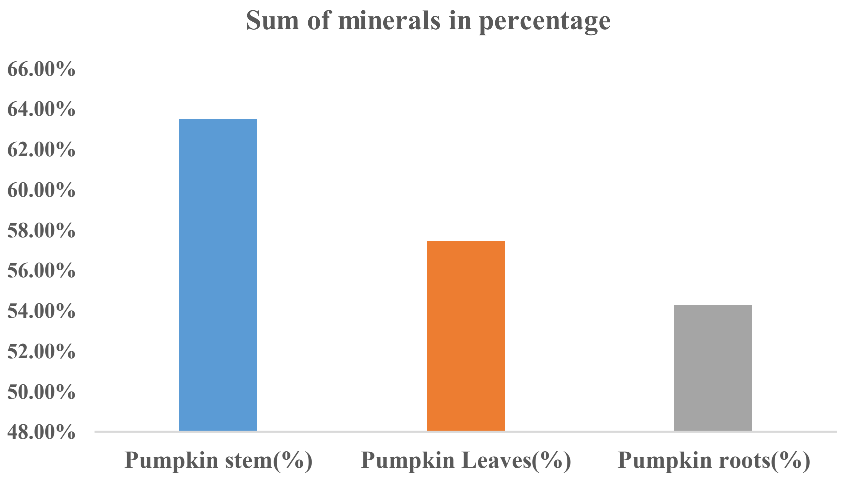

Figure 2: Percentage distribution of minerals in the leaves, stem, and root *T. occidentalis*

Discussion

Glycosides, phenolics, flavonoids, and alkaloids were all present in the leaves, stem, and root of *T. occidentalis while* tannin was completely not detected in the methanol extract. On a scale of 100% from **Table 1** and as shown in **Figure 1**, the leaves portion of the phytochemicals under investigation was found to contain 88.89%, while the stem extract gave 66.67%, and root, 55.56%. This suggests that the leaf extract contains more of the phytoconstituents than other parts. Tannin was not also reported in the leaf extract of *T. occidentalis* [6]. More, Ominakinde *et al.* [13], recorded more terpenes, flavonoids, and phenolics in the leaf extract than in the pod of *T. occidentalis*. Considering the mineral composition, the concentration of K was detected as the highest (36.175%) in the stem extract while the leaves and root extracts gave 25.157% and 20.166% respectively. The presence of Ca, Mg, K, P, Mn, Fe, Zn, Si, Ti, Cu, and Sn, though in varying concentrations indicated that the leaves extract (with 63.4%) contains more minerals than another part (**Figure 2**). Potassium was also recorded as the highest mineral in the leaf extract of the pumpkin plant according to Usunobun and Egharevba [6] and the present results support our findings in this study. The detection of titanium (1.015%) in the root extract may raise some worry due to the toxic nature of titanium. It has been reported that Ti when absorbed by the human intestinal cells may lead to oxidative stress, lung diseases, breathing difficulty, cough, irritation of the skin or eyes, and cancer growth, and tin when ingested in food and vegetables may cause stomachache, anemia, liver and kidney problems [17]

Conclusion: This study indicated that fluted pumpkin leaves, roots, and stems are rich in minerals such as calcium, potassium, magnesium, iron, zinc, phosphorus, and manganese which are important in human nutrition and health. However, the presence of trace elements like titanium in the roots may suggest some level of toxicity of the root part.

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Ethical issues: Including plagiarism, informed consent, data fabrication or falsification, and double publication or submission were completely observed by the authors.
Data availability statement: The raw data that support the findings of this article are available from the corresponding author upon reasonable request.
Author declarations: The authors confirm that they have followed all relevant ethical guidelines and obtained any necessary IRB and/or ethics committee approvals.

تحليل كيميائي نباتي ومعدني مقارن لمستخلص الميثانول من أوراق وسيقان وجذور نبات القرع المضلع (تيفيريا أوكسيدنتاليس)

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*** المؤلف الذي تُوجه إليه المراسلات**

ملخص: يُعدّ القرع المُخدّد (Teifairia occidentalis) أحد أهم محاصيل الخضراوات في بعض البلدان، ويُزرع على نطاق واسع في جميع أنحاء العالم. على الرغم من استهلاك القرع منذ زمن طويل في الأراضي الزراعية وبعض المناطق الحضرية، إلا أن الدراسات البستانية والتجارية والصناعية والعلمية تُعنى حاليًا بدراسته بالتفصيل. هدفت هذه الدراسة إلى مقارنة المكونات الكيميائية النباتية والتركيب المعدني في أوراق وجذور وسيقان نبات القرع المُخدّد. حُقّقت مكونات عينات النبات النباتية باستخدام طرق قياسية، بينما أُجري تحليل المكونات المعدنية باستخدام مطيافية الأشعة السينية الفلورية. وُجدت الجليكوسيدات والسابونينات والفينولات والفلافونويدات والقلويدات في جميع أجزاء النبات الثلاثة، بينما غابت التانينات في جميع الأجزاء الثلاثة. وُجد الكالسيوم والبوتاسيوم والحديد والمغنيسيوم والفوسفور والمنجنيز والزنك في جميع العينات الثلاث بتركيزات متفاوتة. أظهرت عينة الساق أعلى تركيز للبوتاسيوم (36.175%) مقارنةً بعينة الأوراق (25.157%) وعينة الجذر (20.166%). ومع ذلك، اكتُشفت كميات ضئيلة من العناصر السامة، مثل القصدير والتيتانيوم، في الجذر مقارنةً بأجزاء أخرى. تشير نتائج تحليل المعادن إلى أن جذر نبات تيلفيريا أوكسيدنتاليس قد يكون أكثر سميةً من أجزاء أخرى من النبات.