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Mineral, Phytochemical, and Toxicological Analyses of Root Extracts of Fluted Pumpkin (*Telfairia occidentalis* Hook f.)

***[1]Isola, O.B., [2]Ehigie, S., & [2]Iyekowa, O.**
[1]Department of Chemical Sciences, Glorious Vision University, Ogwa, Edo State, Nigeria
[2]Department of Chemistry, University of Benin, Benin City, Edo State, Nigeria

***Corresponding author email:** dotmanchope@gmail.com

Abstract
Fluted pumpkin (*Telfairia occidentalis*) is a widely consumed vegetable in Nigeria due to its nutritional and medicinal benefits. While its leaves, stems, and seeds have been extensively studied, the root is often discarded as waste. This research investigates the phytochemical composition, bioactive compounds, mineral analysis and toxicological properties of the ethanolic root extract of *T. occidentalis*. The study employed phytochemical screening and X-ray fluorescence spectroscopic techniques (XRF) to characterize the bioactive compounds and mineral components in *T. occidentalis*. The leaves, stem and root were analyzed for Calcium (Ca), Potassium (K), Iron (Fe), Magnesium (Mg), Phosphorus (P), Manganese (Mn) and Zinc (Zn). Acute toxicity were conducted on mice, to assess the biological effect of the root extract, administered at different concentrations (1 mg/kg, 2 mg/kg, and 3 mg/kg) for 14 days while, Wistar rats were used for the sub-acute test at different concentrations of (1000 mg/kg, 1600 mg/kg, 2900 mg/kg and 5000 mg/kg). The percentage yield of the ethanolic root extract of *T. occidentalis* was 7.69%. The presence of alkaloids, flavonoids, saponins, phenolics, and glycosides was confirmed, while tannins, steroids, and reducing sugars were absent. Mineral analysis showed substantial concentrations of K (20.17%), Ca (12.94%) and Mg (8.41%) in the root. The root also exhibit the highest Mg (8.41%), Fe (3.939 %) and Mn (0.461 %) content than the leaves and stem. The sub-acute test showed variations in body weight of Wistar rats, and acute toxicity tests determined an LD_{50} value of approximately 3200 mg/kg, suggesting moderate toxicity at high doses. The findings highlight the nutritional potential of *T. occidentalis* root as a source of essential minerals and bioactive compounds, while also emphasizing the need for cautious dosage due to possible toxicity at elevated concentrations. This supports the plant's prospective applications in nutrition and phytomedicine, provided safe consumption guidelines are established. Further research is recommended to explore its pharmacokinetics, optimize extraction methods, and determine safe therapeutic doses.

Keywords: *Telfairia Occidentalis*, Fluted Pumpkin, Phytochemicals, Bioactive Compounds, Toxicology

Introduction

Telfairia occidentalis, commonly known as fluted pumpkin, is a member of the Cucurbitaceae family and is predominantly found in the forest zones of West and Central Africa, particularly in Nigeria, Benin, and Cameroon (Kayode, 2011). The plant is dioecious, perennial, and drought-resistant (Philippa, 2022). In Nigeria, it is commonly referred to as *Ugwu* and is highly regarded as a dietary vegetable, especially in the southern regions where it is a staple component of various soups and dishes, often eaten with solid foods such as Amala, Eba, Fufu, Iyan, Akpu, Semovita, Pupuru, Wheat, Pap, or Eko. The plant is primarily cultivated for its edible leaves and seeds (Ahmad and Khan, 2019), and nearly all aerial parts—leaves, tendrils, stems, and young shoots—are consumed, while the remaining parts are either discarded or used as animal feed. *Telfairia occidentalis* is widely consumed due to its rich nutritional profile and health-promoting properties. Its leaves are an excellent source of essential amino acids, dietary fiber, phenolic compounds, proteins, vitamins (notably beta-carotene and vitamin C), and minerals such as iron (Fe), calcium (Ca), phosphorus (P), potassium (K), zinc (Zn), manganese (Mn), and copper (Cu) (Nkereuwem et al., 2011; Idris, 2011; Eseyin et al., 2014; Gbadamosi et al., 2018). According to Aisegbu (1987), *Telfairia occidentalis* contains a total amino acid concentration of 455.3 mg/g, with essential amino acids comprising about 56.3% of the total. These include lysine, methionine, histidine, tryptophan, leucine, valine, and isoleucine, making the plant comparable to legumes in protein content. The seeds are also nutritionally

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dense, containing 34.56% protein, 32.50% fat, 15.71% fiber, 11.43% carbohydrates, and 4.40% ash (Chuku & Chinaka, 2021). They possess a balance of simple sugars (glucose, fructose, sucrose) and essential fatty acids, offering significant dietary value (Daramola et al., 2016; Eseyin et al., 2017). Furthermore, the leaves and seeds contribute to food fortification, especially in flour-based products, enhancing their protein and micronutrient content.

Beyond its nutritional contributions, *Telfairia occidentalis* possesses notable medicinal properties, primarily due to its rich phytochemical composition. The leaves and seeds contain flavonoids, alkaloids, glycosides, saponins, terpenoids, tannins, steroids, and phenolic compounds that contribute to its antioxidant, anti-inflammatory, and antimicrobial effects (Oboh et al., 2010; Akubue et al., 1980; Ajibesin et al., 2002). The plant has been traditionally used in managing and preventing diseases such as diabetes, cardiovascular diseases, cancer, and metabolic disorders like obesity (Mungofa et al., 2022). The antioxidant activity of *Telfairia occidentalis* is attributed to the presence of polyphenols, carotenoids (including lycopene), and vitamins C and E, which help neutralize free radicals and mitigate oxidative stress (Eseyin et al., 2014). The root contains specific bioactive compounds such as resins, alkaloids, and saponins, which have been explored for pest and rodent control in agricultural settings (Ajibesin et al., 2002). Despite its benefits, *Telfairia occidentalis* contains anti-nutritional compounds such as phytic acid (22.11 mg/100 g), oxalates (0.35 mg/100 g), and tannins (4.98 mg/100 g) (Idris, 2022; Gemede, 2018). These compounds can interfere with the absorption of key minerals such as calcium, iron, and zinc by forming insoluble complexes, thus reducing their bioavailability (Elinge et al., 2012; Afsana et al., 2004). Excessive consumption of oxalates may contribute to kidney stone formation, while high tannin levels can inhibit iron absorption and protein digestion (Getachew et al., 2013). However, the levels present in *Telfairia occidentalis* are generally within safe limits. Traditional processing techniques such as boiling, fermentation, and blanching are effective in reducing these anti-nutritional factors and improving nutrient availability.

Although the leaves and seeds of *Telfairia occidentalis* are considered safe for consumption, the root has demonstrated toxicological effects in various studies. Akindele et al. (2018) reported no fatalities in albino mice following oral administration of up to 5000 mg/kg of the leaf extract. However, doses above 3000 mg/kg caused mild symptoms including reduced locomotion and increased respiratory rate. The intraperitoneal LD_{50} was estimated at 3200 mg/kg. Root extracts have shown significant toxicity in aquatic organisms. Agwu et al. (2016) reported 100% mortality in *Clarias gariepinus* fingerlings at 75 mg/l aqueous extract, suggesting hematological and physiological disruptions. Additional studies revealed that root extracts could cause gastric erosion, hepatotoxicity, and nephrotoxicity, particularly when administered via non-oral routes (Ekanem et al., 2005; 2010; Morcos & Sarkis, 2013). The toxicity is largely attributed to high concentrations of alkaloids and saponins found in the roots (Ajibesin et al., 2002). Furthermore, the choice of solvent used in extraction influences toxicity levels, with non-polar solvents yielding more toxic components (Ogbonnaya & Uadia, 2016; Kirkman & Gaetani, 2007). Excessive intake of tannins may also lead to oxidative stress and lipid peroxidation (Taitzoglou et al., 2001; Nworgu et al., 2007). Although numerous studies have established the nutritional, medicinal, and pharmacological importance of *Telfairia occidentalis*, particularly its leaves and seeds, the root remains underexplored. Evidence points to the presence of potent bioactive compounds in the root, yet its toxicity raises safety concerns that warrant detailed investigation. There is a lack of comprehensive studies on the phytochemical characterization, dose-dependent effects, and toxicity thresholds of the root extract. Additionally, the influence of different extraction solvents on the phytochemical yield and toxicity of the root extract is not fully understood. Further research is essential to isolate and characterize bioactive compounds in the root, evaluate their specific pharmacological and toxicological effects and determine safe usage levels for potential therapeutic or agricultural applications. This underutilized plant part may hold promising applications if its bioactive profile is thoroughly understood and its toxic elements can be effectively managed or neutralized. This study aimed to determine the phytochemicals, mineral composition and toxicity level of the ethanolic root extract of *Telfairia occidentalis*

Materials and Methods

i. Apparatus and equipment: Weighing balance, Soxhlet extractor, sintered glass funnel, vacuum pump, high-speed electric grinding machine, laboratory sieve, rotary evaporator, dessicator, X-ray fluoresce refractometer etc.
ii. Reagent and chemicals: ferric chloride, acetic acid, sulphuric acid, ethanol etc. all chemical used are of analytical grade obtained from Sigma Aldrich chemical.

Sample Preparation

Samples of the plant's root were collected fresh from a vegetable farm in Ogwa, Esan West L.G.A. during the dry season with age between eight to nine months. The plant identified using Global Core Biodata Resource (https://www.gbif.org), was authenticated and registered with **VOUCHER NUMBER (UBH-T187)** by the

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Botany department of the University of Benin, Benin City. These samples were brought to the laboratory, washed to remove debris of stones, soil and grits and sundried for many days until they were completely dried. The dried samples were pulverized using a high-speed electric grinding machine and sieved. The sieved sample was kept in an airtight polyethylene bag and stored in a desiccator prior to analysis. In order to extract the phytonutrient from Pumpkin root, the following sequential steps were used; drying, size reduction, extraction, concentration and characterization.

Plate 1: Showing the stem, leaves, fruits and root of *Telfaria occidentalis*

A **B**

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Plate 2: A and B Showing the Dried Crude and Finely Grinded Root Crude Sample of *Telfaria occidentalis* respectively

Extraction of the Phytochemicals from Pumpkin Root

A  B. 

Plate 3: A and B showing the soxhlet extraction and the extraction product

Soxhlet or Hot continuous extraction methods was used to remove the soluble phyto-constituents from the finely pulverized root sample. 650g of finely pulverized dried root samples was placed in a porous bag or thimble and transferred into the chamber of the Soxhlet extractor. The ethanol used as menstruum was heated in the round bottom flask and the vapour condensed in the condenser. The condensed menstruum drips into the chamber where the sample was and extract it by contact. When the liquid content inside the chamber rises to the top of the siphon tube, the liquid contents of the chamber was siphoned into the flask. The process was continuous until clear solution of the menstruum was siphoned into the flask. After extraction the extracts was concentrated under reduced pressure in a rotary evaporator.

Percentage Yield of Extract

$$\% \text{ Yield} = \frac{\text{Weight of dried extract}}{\text{Weight of dried plant sample}} \times 100$$

$$= \frac{50 \times 100}{650}$$

$$= 7.69\ \%$$

Maceration Procedure for Root, Stems and Leaves of *T. occidentalis*

Two (2kg) each of the pulverized and sieved samples of root, stems and leaves of *T. occidentalis* were macerated in a 500 ml beaker using ethanol, water and n-hexane as solvent for 72 hours. The filtrate was concentrated using rotary evaporator at 40 0C to obtain the crude extract.

Qualitative Test for the presence of Phytochemicals

The different fractions of the root extracts of T. *occidentalis* were tested for the presence of phytochemicals using the following standard methods described by Sofowora (1983), Trease & Evans (1989) as well as Odebiyi & Sofowora (1978) with slightly little modification.

i. Test for phenols

The extract (1ml) was mixed with 5ml of a 90% ethanol and 1 drop of 10% solution of $FeCl_3$. A pale-yellow coloration indicated the presence of phenols.

ii. Test for Carbohydrate

The extract (1ml) was mixed with 2ml of Molisch's reagent and the mixture was shaken properly. After that, 2ml of concentrated sulphuric acid (H_2SO_4) was added along the side of the test tube. Appearance of a violet ring at the interphase indicated the presence of carbohydrate.

iii. Test for Tannins

The extract (2ml) was diluted with 10 ml of distilled water, boiled for 5 minutes and then filtered. The filtrate is divided into two portions.

a. Few drops of Ferric chloride solution were added to the first portion of the filtrate; formation of a bluish precipitate indicate the presence of hydrolysable tannins.
b. To the second portion of the filtrate was added 2 ml of dilute hydrochloric acid and boiled for five minutes. Formation of red precipitate indicate the presence of condensed tannins.

iv. Test for Flavonoids

The extract (2 ml) was boiled and mixed with 2ml of a 2% solution of NaOH. The formation of an intense yellow colour which turned colourless on addition of few drops of diluted HCl indicate the presence of flavonoids. Another test was carried out using few drops of 10 % Lead Acetate solution. Formation of yellowish precipitates indicate the presence of flavonoids.

v. Test for Saponin

The extract (2ml) was mixed with 5ml of distilled water in a test tube and shaken vigorously. The formation of a stable foam is an indication of the presence of saponins. Saponin rein Weiss supplied by merck was used as standard.

vi. Test for Glycosides

The extract (1ml) was mixed with 2ml of glacial acetic acid containing 1-2 drops of a 2% solution of $FeCl_3$. The mixture was then poured into another test tube containing 2ml of concentrated H_2SO_4. A brown ring at the interphase indicated the presence of cardiac glycosides.

vii. Test for Steroids

The extract (1ml) was mixed with 2ml of chloroform and concentrated H_2SO_4 was added sidewise. A red colour produced in the lower chloroform layer indicated the presence of steroids. Another test was performed by mixing the crude extract with 2ml of chloroform and then 2ml of each of concentrated H_2SO_4 and acetic anhydride were poured into the mixture. The development of a greenish colour indicated the presence of steroids.

viii. Test for Eugenols

The extract (2ml) was mixed with 5 ml of 5% KOH solution. The aqueous layer was separate and filtered with few drops of dilute HCl added to the filtrate. A pale-yellow precipitate indicates the presence of eugenol.

ix. Salkowski Test for Terpenoids

The extract (5ml) was mixed with 2 ml of chloroform and 3 ml of concentrated H_2SO_4 was carefully added sidewise to form a layer. A reddish brown colouration at the interphase indicates the presence of terpenoids.

x. Test for Alkaloids

Picric acid, Dragendoff's and Wagner's reagent were used to test for alkaloids. About 1 ml each of the root extract was transferred into three different test tubes with label A, B and C.

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Two (2ml) of Dragendoff's reagent was added to test tube A portion of the sample to give a reddish-brown precipitate indicative of a positive test.

Two (2ml) of Wagner's reagent was added to test tube B portion of the sample to give a reddish-brown precipitate indicative of a positive test.

Two (2ml) of picric acid was added to test tube C portion of the sample to give a yellowish precipitate indicative of a positive test.

Mineral Analysis of Fluted Pumpkin Leaves, Stem and Root

The fluted pumpkin leaves, stem and roots were air dried at room temperature in the laboratory for twenty-eight days. They were then pulverized into fine powder in preparation for further analysis. The Mineral Analysis of the fluted pumpkin leaves; stem and root were performed using standard operating procedures of X-Ray Fluorescence (XRF) Spectrometry.

1. The sample cup was properly cleaned and placed rightly in the cup.

2. The sample was put into the sample cup to cover all filters at the bottom to at least 3mm thickness.

3. The instrument was turned on for 30 minutes to warm up.

4. Elemental composition was utilized.

5. The sample identity was leveled in the position of the selected sample and the reading analysis was accepted.

6. The start button was clicked, prompting the instrument to rotate to the position of the sample in the tray at the X-ray position and measure it.

7. The process was completed within 6-7 minutes and the X-ray was shut down. The intensities were then converted into concentrations in weight percentage.

8. The result was printed out after each analysis.

Experimental Grouping and Dosage of Ethanolic Root Extract of *T. ocidentalis* for Sub-Acute Test

Twenty four 24 Adult Wistar rat weighing between (160-185g) were used (4 groups of 6 rat each)

Group A-Control received 1 ml of distilled water

Group B: 1 mg/kg of ethanol extract

Group C: 2 mg/kg of ethanol extract

Group D: 3 mg/kg of ethanol extract

Duration of studies: 14 days

Experimental Grouping and Dosage of Ethanolic Root Extract of *T. ocidentalis* for Acute Toxicity Test

Group A-Control received 5 ml/kg of water, which was the diluent for the extract

Group B: 1 mg/kg of ethanol extract

Group C: 2 mg/kg of ethanol extract

Group D: 3 mg/kg of ethanol extract

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Duration of studies: 24 hours

Body Weight Determination

At the start of the experiment and at the end of the 14- day period, the rats were weighed to the nearest grams using the Metler PE 6000$^{(R)}$ digital weighing balance.

Acute Toxicity Test

Fifteen mice weighing (27-36 g) were purchased for acute toxicity test. All animals were kept in mice cages and was left to acclimatize in the animal house of the department of pharmacology and toxicology, Faculty of pharmacy, University of Benin for 14days. The animal house was well ventilated while pelleted feed (Premier feed mills Co limited) was made available to the mice. Water was made accessible ad libitum. The research was carried out in the University of Benin in accordance with the laws governing the use of laboratory animals as accepted internationally. Ethical clearance with No. **CMS/REC/2023/340** for animal study was obtained from the department of Anatomy, School of Basic Medicines, University of Benin. At the end of the 14 days acclimatization period, the mice were randomly put into groups and acute toxicity test was evaluated using (Uwumarongie & Oyiana, 2017) method with slight modification. Here, five groups were assigned three mice per group. Group A received 5 ml/kg of water which is the diluent for the extract while group B, C, D and E were administered 1000, 1600, 2900 and 5000 mg/kg of the root extract respectively. Observation were made after administration of the extract for the first 4hours (for immediate effect) and then 24hrs (for delayed effect), for acute effects such as weakness, drowsiness, aggressiveness, food refusal, weight loss, diarrhoea lacrimation, noisy breathing, tremors and mortality.

The mice were further monitored for 2 weeks to see if any delayed effects will emerged. Three extracts (aqueous, n-hexane and ethanol) were used for the toxicity test.

The acute toxicity test was conducted by new approach to Acute Toxicity Testing according to Igbe et al. (2010). The median lethal dose (LD_{50}) value was estimated by the application of the equation below:

$LD_{50} = \sqrt{\{LD_0 \times LD_{100}\}}$

Where: LD_0 = Maximum dose without death;

LD_{100} = minimum dose with death

Statistical Analysis

Graph Pad Prism was used to analyze and visualized the body weight changes of the Wistar rat after administration of ethanol extract of *T. occidentalis* root expressed as the mean ± SEM.

Results

Phytochemical Analysis Result

Table 1: Phytochemical Screening of *Telfairia occidentalis*

S/N	Constituents	Test	Water extract	Ethanol extract	Hexane extract
1	Alkaloids	Picric acid/ Wagner reagent	+	+	+
2	Saponin	Frothing effects	+	+	+
3	Phenolic	Ethanol/$FeCl_3$	+	+	+
4	Eugenols	KOH/HCl	-	-	-
5	Glycosides	General Test	+	+	+
6	Steroids	Acetic Acid/ H_2SO_4	-	-	-
7	Terpenoids	Salkowski Test	-	+	-
8	Flavonoids	Lead Acetate	+	+	+
9	Tannins	$FeCl_3$	-	-	-
10	Reducing Sugar	Fehling Solution A and B	-	-	-

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Present (+), Absent (-)

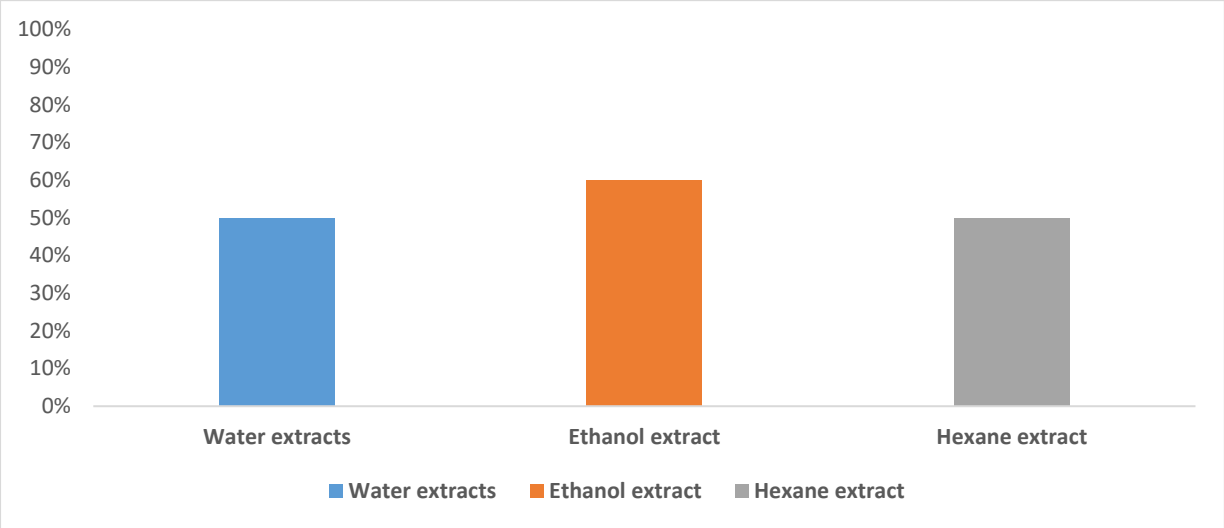

Fig. 1: Percentage Efficiency of the Extraction Solvent on *T. occidentalis* Root

Table 2: Mineral Analysis of Fluted Pumpkin Leaves, Stem and Root

Mineral Elements	**% Concentration in Leaves**	**% Concentration in Stem**	**% Concentration in Root**
Calcium	17.507	18.262	12.941
Potassium	25.157	36.175	20.166
Magnesium	5.725	0.000	8.412
Iron	1.301	0.693	3.939
Phosphorus	1.803	1.354	1.002
Manganese	0.186	0.168	0.461
Zinc	0.120	0.064	0.078

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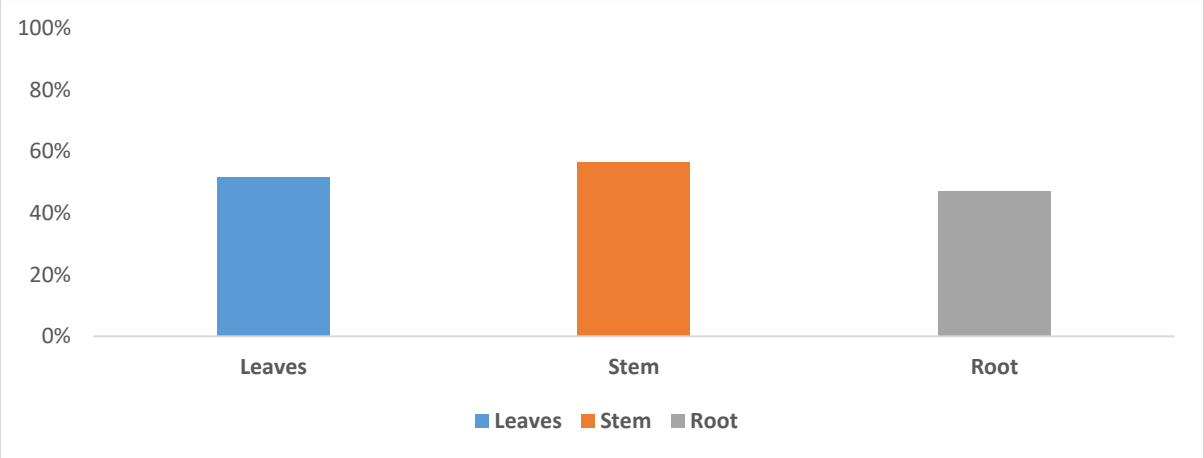

Fig. 2: Percentage distribution of minerals in Leaves, Stem and Root of *T. occidentalis*

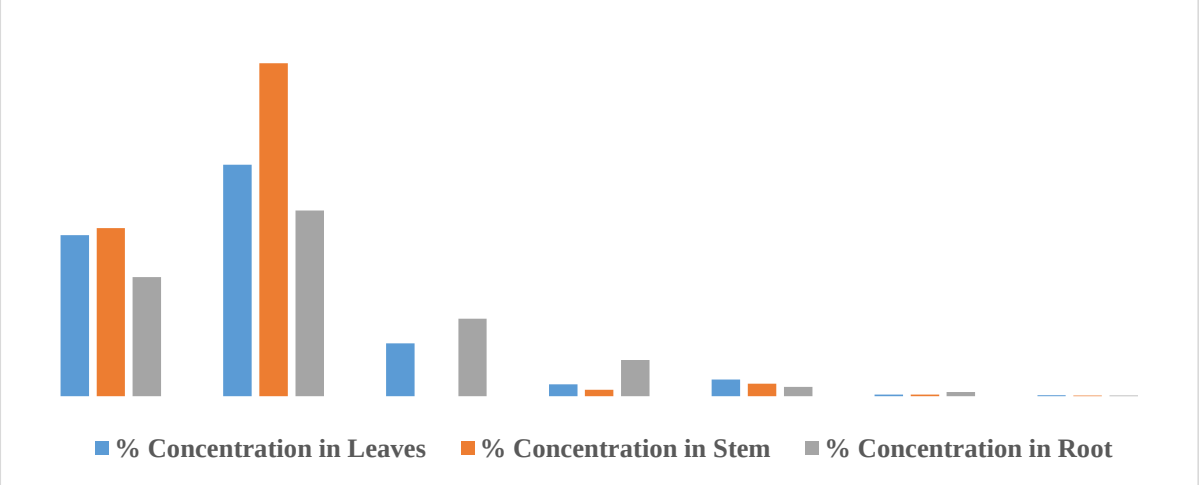

Fig. 3: Mineral Analysis of Fluted Pumpkin Leaves, Stem and Root

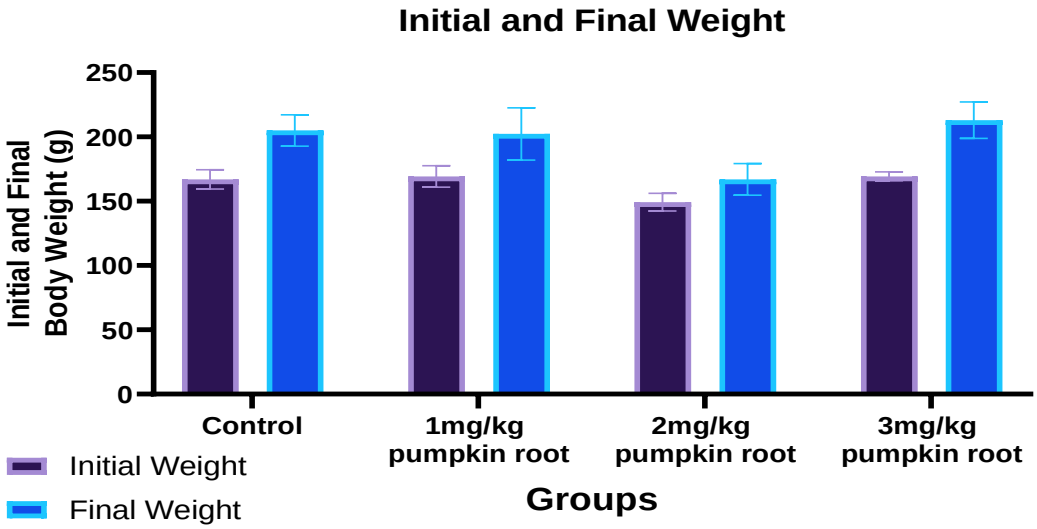

Fig. 4: Initial and Final Weight after Administration. Values are given as mean ± SEM.

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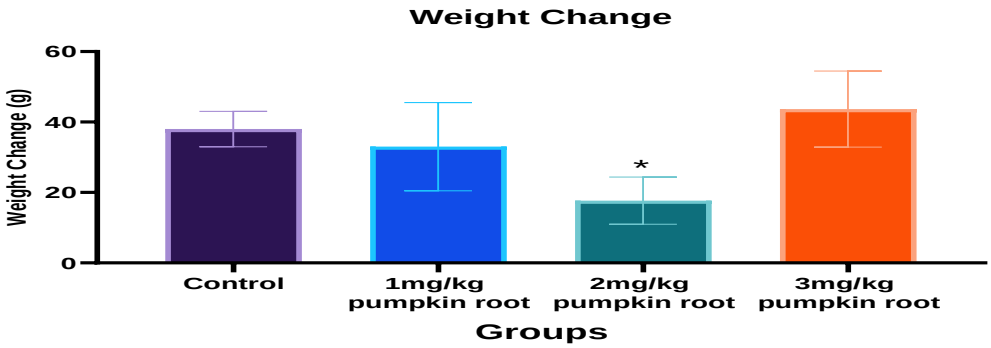

Fig. 5: Weight Change after Administration. Values are given as mean ± SEM. $^{*}p< 0.05$ compared with the Control Group.

Table 3: Oral Acute Toxicity Results of Aqueous Root Extract of *T. occidentalis*

Group	Doses (mg/kg)	Number of lethality	Percentage mortality
Control	DW (5ml/kg)	0/3	0
Aqueous	1000	0/3	0
Aqueous	1600	0/3	0
Aqueous	2900	0/3	0
Aqueous	5000	1/3	33

DW = Distilled water

LD_{50} ≤ 1 mg/kg (Extremely toxic); 1 mg/kg ≤ LD_{50} ≤ 50 mg/kg (Highly toxic);

50 mg/kg ≤ LD_{50} ≤ 500 mg/kg (Moderately toxic);

500 mg/kg ≤ LD_{50} ≤ 5000 mg/kg (Slightly toxic)

5000 mg/kg ≤ LD_{50} ≤ 15000 mg/kg (Non-toxic or harmless). Hodge and Sterner scale in Unuigbe et al. (2021).

Table 4: Oral Acute Toxicity Results of Hexane Root Extract of *T. occidentalis*

Group	Doses (mg/kg)	Number of lethality	Percentage mortality
Control	DW (5ml/kg)	0/3	0
Hexane	1000	0/3	0
Hexane	1600	0/3	0
Hexane	2900	0/3	0
Hexane	5000	0/3	0

DW = Distilled water

LD_{50} ≤ 1 mg/kg (Extremely toxic); 1 mg/kg ≤ LD_{50} ≤ 50 mg/kg (Highly toxic);

50 mg/kg ≤ LD_{50} ≤ 500 mg/kg (Moderately toxic);

500 mg/kg ≤ LD_{50} ≤ 5000 mg/kg (Slightly toxic)

5000 mg/kg≤LD_{50} ≤ 15000 mg/kg (Non-toxic or harmless). Hodge and Sterner scale in Unuigbe et al. (2021)

Table 5: Oral Acute Toxicity Results of Ethanol Root Extract of *T. occidentalis*

Group	Doses (mg/kg)	Number of lethality	Percentage mortality
Control	DW (5ml/kg)	0/3	0
Ethanol	1000	0/3	0
Ethanol	1600	0/3	0

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Ethanol	2900	1/3	33
Ethanol	5000	1/3	33

DW = Distilled water

$LD_{50} \leq 1$ mg/kg (Extremely toxic); 1 mg/kg $\leq LD_{50} \leq 50$ mg/kg (Highly toxic);

50 mg/kg $\leq LD_{50} \leq 500$ mg/kg (Moderately toxic);

500 mg/kg $\leq LD_{50} \leq 5000$ mg/kg (Slightly toxic)

5000 mg/kg$\leq LD_{50} \leq 15000$ mg/kg (Non-toxic or harmless).

Hodge and Sterner scale in Unuigbe et al. (2021).

Discussion

Phytochemical Screening of *Telfairia occidentalis*

The phytochemical screening results in Table 1 indicate that *Telfairia occidentalis* roots contain several beneficial bioactive compounds that could contribute to their medicinal value. The positive tests for alkaloids, saponins, phenolics, glycosides and flavonoids highlight the potential health benefits associated with this plant. All extracts tested negative for Eugenols, Steroids, Tannins and Reducing Sugars. The absence of these compounds may indicate limited medicinal applications related to those specific compounds. The ethanol extract showed a broader range of positive results compared to water and hexane extracts for certain compounds (e.g., terpenoids were only present in ethanol) (Fig. 1). This indicates that ethanol is an effective solvent for extracting a wider variety of bioactive compounds from *Telfairia occidentalis*. Akindele et al. (2018) reported that the leaves of *Telfairia occidentalis* tested positive for tannins, flavonoids, saponins and phenolic compounds. A study also reported the presence of oils and phlobatannins in addition to these compounds. In contrast to the roots, which lacked tannins, the leaves exhibit a richer profile that includes these beneficial compounds. Research indicates that seeds contain alkaloids, flavonoids, saponins, terpenoids and glycosides and possess higher antioxidant activities compared to both leaves and roots (Tamanji et al., 2023). Furthermore, the effectiveness of ethanol as a solvent for extracting a wider range of phytochemicals suggests that future studies should focus on optimizing extraction techniques to fully utilize the medicinal properties of *Telfairia occidentalis* roots.

Mineral Analysis of Fluted Pumpkin Leaves, Stem and Root

The mineral analysis of *Telfairia occidentalis* (fluted pumpkin) was conducted using X-Ray Fluorescence (XRF) Spectrometry. The results presented in Table 2, Fig. 3 revealed variations in mineral composition across different parts of the plant (leaves, stem and root). The percentage distributions of minerals shows that the stems has the highest concentrations of minerals followed by the leaves and the stem (fig. 2). Mineral elements are chemical elements in plants that are important for proper functioning of the body. The key minerals analyzed include calcium, potassium, magnesium, iron, phosphorus, manganese and zinc. Calcium plays a crucial role in bone health, muscle function and enzymatic activities. Potassium is essential for maintaining electrolyte balance, nerve signaling and muscle contraction. Magnesium is important for enzymatic reactions, nerve function and muscle relaxation, Iron is essential for oxygen transport in the blood and enzymatic functions, Phosphorus is critical for bone health, ATP production and cell signaling, Manganese supports bone formation, metabolism and antioxidant enzyme function and Zinc is crucial for immune function, wound healing and enzymatic reactions. Calcium (Ca) was highest in the stem (18.262%), followed by the leaves (17.507%) and lowest in the root (12.941%). Potassium (K) was highest in the stem (36.175%), followed by the leaves (25.157%) and the root (20.166%). The root (8.412%) contains the highest amount of Magnesium (Mg), while the leaves contain 5.725%. Interestingly, the stem had no detectable magnesium. The root (3.939%) showed the highest iron (Fe) content, followed by the leaves (1.301%) and stem (0.693%). Phosphorus (P) was in higher amounts in the leaves (1.803%) compared to the stem (1.354%) and root (1.002%). The root (0.461%) contains the highest manganese (Mn) concentration compared to the stem (0.168%) and leaves (0.186%). The leaves (0.120%) had the highest zinc (Zn) content, followed by the root (0.078%) and stem (0.064%). Idris (2011) reported that *Telfairia occidentalis* leaves are rich in essential minerals such as calcium, iron, potassium, phosphorus and zinc, supporting its use in overcoming malnutrition. The present study aligns with this, particularly in showing high calcium and potassium levels in the leaves and stem. Usunobun and Egharebva (2014) reported that iron, calcium and potassium were the dominant minerals in *T. occidentalis*. However, their study showed higher iron levels in the leaves compared to the current study, where the root had the highest iron content. Akwaowo et al. (2000) analyzed the mineral and anti-nutrient content of fluted pumpkin and reported that the plant is an excellent source of magnesium and calcium, particularly in the leaves and stem. The absence of magnesium in the stem in the current study presents an interesting variation. Aisegbu (1987) highlighted that fluted pumpkin roots contain significant levels of iron and manganese, which is

consistent with the present findings that the root has the highest iron (3.939%) and manganese (0.461%) content. Eseyin et al. (2014) emphasized the presence of essential minerals like zinc and phosphorus in the plant's leaves and stem, further confirming the high nutritional value of *T. occidentalis*.

Body Weight Changes of the Wistar Rat after Administration of Ethanol Extract of *T. occidentalis* Root.
Fig. 4 showed the body weight changes by comparing the weight of the Wistar rat before and after administration of ethanol extracts of *T. occidentalis* root. Plant extract, which promote weight gain, enhances appetite like herbal tonics, improve nutrient absorption in the intestine and increase fat deposition or muscle growth through anabolic effects. Thus, most plants that are rich in nutrients and antioxidants, promote growth. While weight reduction is due to suppressing appetite and reduction in food intake, enhanced metabolism and fat breakdown (lipolysis) and inducing diuretic effects (weight loss via fluid loss). Some plants which contain catechins and hydroxycitric acid (HCA) inhibits fat synthesis and causes fat oxidation and thus causes weight loss. The 2mg/kg body weight causes weight loss for the Wistar rat group. However, the pattern of weight changes were not dose dependent (Fig. 5).

Acute Toxicity of Aqueous, Methanol and Ethanol extracts of *T. occidentalis* Root
The oral administration of root of *T. occidentalis* (aqueous, hexane and ethanol extracts) at graded doses of 1000, 1600, 2900 and 5000 mg/kg body weight are shown in Tables 3, 4 and 5. The oral administration of the respective three crude extracts of *T. occidentalis* at graded doses of 1000, 1600, 2900 and 5000 mg/kg body weight showed no indication of acute toxicity except the highest dose of aqueous and ethanol extract at 5000 mg/kg after 24 hours. There were no effect, toxic signs/symptoms and mortality even after 72 hours (3 days) of treatment and cautious observation for other groups of aqueous and hexane extracts. More so, there were no variation in shallow breathing, raised tails, salivation, paw licking and restlessness during the 24-hour period.

From the Hodge and Sterner scale, only hexane extract used in this study can be considered as relatively non-toxic (LD_{50} > 5000 mg/kg), because no deaths or significant behavioral changes were recorded. Some levels of toxicity were recorded for aqueous (LD_{50} = 2900-5000 mg/kg) and more for ethanol extracts (LD_{50} = 2900-5000 mg/kg) which gave 33% mortality after the 24 hours for the acute toxicity test. A previous study by Akindele et al. (2018) found no toxicity for *Telfairia occidentalis* leaves at doses up to 5000 mg/kg but noted behavioral changes at higher doses (3000-5000 mg/kg). Eseyin et al. (2007) reported nephrotoxic and hepatotoxic effects of the root extract at high doses due to alkaloids and glycosides. Ekanem et al. (2010) suggested that ethanol extracts of the root showed greater toxicity than aqueous extracts, which aligns with the observed 33% mortality at 5000 mg/kg**.** According to Eseyin et al. (2014), the root is believed to be hepatotoxic with a possibility of nephrotoxic effects, which may be due to the presence glycosides. The behavioral changes such as reduced movement, drowsiness, paw licking, body irritation and writhing are all similar to indications/symptoms of acute toxicity. The Hodge and Sterner toxicity scale places the ethanol extract in the slightly toxic range, similar to findings from the study by Unuigbe et al. (2021). The toxicity of *Telfairia occidentalis* extracts varies depending on the plant part, extraction method and dosage. While leaf extracts, particularly hydro-ethanolic preparations, are generally considered safe even at high doses, root extracts demonstrate moderate toxicity, especially at elevated concentrations.

Conclusion
This study provides valuable insight into the phytochemical, mineral, and toxicological properties of the ethanolic root extract of *Telfairia occidentalis* (fluted pumpkin). The presence of bioactive compounds such as alkaloids, flavonoids, saponins, phenolics, and glycosides supports the medicinal potential of the root suggesting promising application in phyto-medicine, particularly in the development of antioxidant, anti-inflammatory, or antimicrobial formulations. Mineral analysis further revealed that the root contains essential elements like iron, magnesium, calcium, and potassium, which underscore the nutritional potential of the root and its possible use in agriculture or addressing micronutrient deficiencies, especially in population vulnerable to mineral related health issues such as anemia and osteoporosis. However, the acute toxicity results suggest that while the root extract exhibits some beneficial effects, it also poses moderate toxicity risks at higher doses, especially in ethanolic form. These findings underscore the need for caution in the therapeutic use of *T. occidentalis* root and highlight the importance of proper dosage guidelines and understanding its pharmacodynamics and pharmacokinetics are essential steps toward safe integration into nutraceuticals or traditional medicine.

Recommendation

Further research is recommended to isolate specific compounds, evaluate their pharmacokinetics, and establish safe and effective therapeutic applications.

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