Title: “Phytochemical analysis of six anti-venom medicinal plants”

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ABSTRACT

This present investigation was conducted to identify and screen the most common medicinal plants used to treat snake bites in Ankpa local government area of Kogi state, Nigeria. After an ethnobotanical survey, only the roots of six medicinal plants were analysed for their qualitative and quantitative phytochemical properties. Roots were pulverised and extracted using methanol solvent. Alkaloids were investigated using Mayer and Dragndorff test; Tannins - Ferric-Chloride test; Total Phenol - Dennis test; Glycosides - Fehling A and B test; Saponins - Frothing test; Flavonoids - NaOH-HCl test; and quantitative constituents were identified using spectrophotometric method. The phytochemical screening indicated the existence of different classes of secondary metabolites, specifically alkaloids, flavonoids, saponins, tannins, total phenols and glycosides, at different levels. Statistical analysis was investigated by Analysis of Variance (ANOVA), and the means were distingushed according to Duncan's New Multiple Range Test (DMRT) at 5% probability level. Alkaloid contents obtained were 0.5mg/g, 0.8mg/g, 0.8mg/g, 0.5mg/g, 0.6mg/g, 2.2mg/g of the extract; Flavonoids - 20.8mg/g, 42.2mg/g, 30.9mg/g, 20.7mg/g, 30.5mg/g, 23.6mg/g of the extract; Saponins - 16.5mg/g, 23.1mg/g, 29.6mg/g, 18.8mg/g, 28.8mg/g, 20.7mg/g of the extract; Tannins - 22.8mg/g, 32.7mg/g, 34.4mg/g, 10.6mg/g, 28.8mg/g, 30.2mg/g of the extract; Total phenols - 710.4mg/g, 704.2mg/g, 715.6mg/g, 719.6mg/g, 719.7mg/g, 718.1mg/g of the extract for the six medicinal plants *Annona sengalensis, Khaya senegalensis, Uvaria chamae, Lophira lanceolata, Phyllanthus muellerianius* and *Securidaca longipedunculata* respectively. The results of the study revealed the presence of valuable bioactive compounds with medicinal properties in the aqueous and organic solvent extracts of these plants. Thus, supporting their use in traditional medicine for treating various ailments, such as snakebites.

Keywords: phytochemicals, snakebites, saponins, alkaloids, medicinal plants, *Khaya senegalensis*

INTRODUCTION

All of human lives and survival would be challenging and even impossible without the symbiotic relationship with the enormous diversity of plants for sources of food, shelter, fragrance, clothing, flavours, fertilisers and even medicines (anti-inflammatory, anti-venom, anti-cancer, diuretic, anti-plasmodic, anti-hypertensive, anti-diabetic, laxative and anti-microbial function) [1,2,3,4,5]. From time immemorial, medicinal plants have actively contributed to the progress of new drug discovery, while remaining essential in healthcare, and representing the optimal and secure reservoir for generating forthcoming medicines that are both safe and effective [6,7,8].

Clearly defined by the WHO, the term "medicinal plant" refers to any kind of plant whose organ(s) contain substances that possess the potential to be utilised for the treatment and prevention of particular ailments or diseases, or valuable for synthesising pharmaceutical medicines [9,10,11]. And the therapeutic features of most plant parts, such as bark, root, seed, fruit and leaf utilised, have been associated with significant origins of bioactive compounds and secondary metabolite productions [12,13,14,15]. Plants produce secondary metabolites to protect themselves, but several researchers have demonstrated that these phytochemicals can protect against disease, even snakebites [16,17,18,19]. These bioactive substances include flavonoids, lignans, terpenoids, carbohydrates, tannins, cytogenic glycosides, saponins, lignins, alkaloids, phenolic compounds, steroids and flavonoids [20,21,22,23,24,19,25].

Meanwhile, snakebites represent an overlooked tropical injury that impacts numerous individuals globally, primarily concentrated in South Asia and sub-Saharan Africa, where the highest incidence is observed [26,27,28]. Annually, the occurrence of snakebites can reach up to an estimated five million cases, leading to approximately 2.5 million poisonings and fatalities between 20,000 to 125,000 [29,30]. According to the World Health Organisation's (2008) analysis of mortality data, snakebites contribute to 35% of all child deaths globally, and no single country in the world is free from the risk. In these settings, there is limited access to healthcare services, scarcity of anti-venom and high cost of treatment that often lead to poor outcomes, considerable unwholesomeness or mortality that exacerbates the challenges associated with snakebites [31,32]. However, the use of plants against the effects of snake bites seems to be the best alternate preferred solution to snakebites for people living in remote places; hence, more scientific attention has to be given to it [33]. Sadly, the potential use of these highly valued medicinal plants, which act as a better alternative to conventional synthetic drugs, is still poorly explored, especially as regards the phytochemicals associated with them [34,35,36].

In this study, comprehensive qualitative and quantitative phytochemical analyses were conducted on six medicinal plants originating from Ankpa local government area (LGA) of Kogi state, Nigeria, namely: *Lophira lanceolata, Uvaria chamae, Khaya senegalensis, Phyllanthus muellerianus, Annona senegalensis and Securidaca longepedunculata*.

MATERIALS AND METHODS

Study Area

First, an ethnobotanical survey was conducted in Ankpa LGA, Kogi State, Nigeria. Ankpa LGA is situated at Latitude 7°26'N and Longitude 7°38'E of the equator with a population of 359,300 (in 2016) and a total land area of 1 200km^2 (500sq mi) [37]. Ankpa experiences a hot and humid climate throughout the year, characterised by an average annual temperature of 27°C. The vegetation in Ankpa exhibits typical characteristics of a derived savannah, with a toposequence predominantly covered by grasses and scattered shrubs. The topography of the area is notably undulating, featuring significant variations in elevation. The soil is very fertile and suitable for cultivating several medicinal herbs and food crops such as beans, maise,

yam, cassava, vegetables and cash crops like oil palm and cashew. Ankpa is characterised by a distinct seasonal pattern, comprising two main seasons: the wet season, spanning from April to October, and the dry season, occurring from November to March. The region receives an average annual rainfall of approximately 1300mm [37].

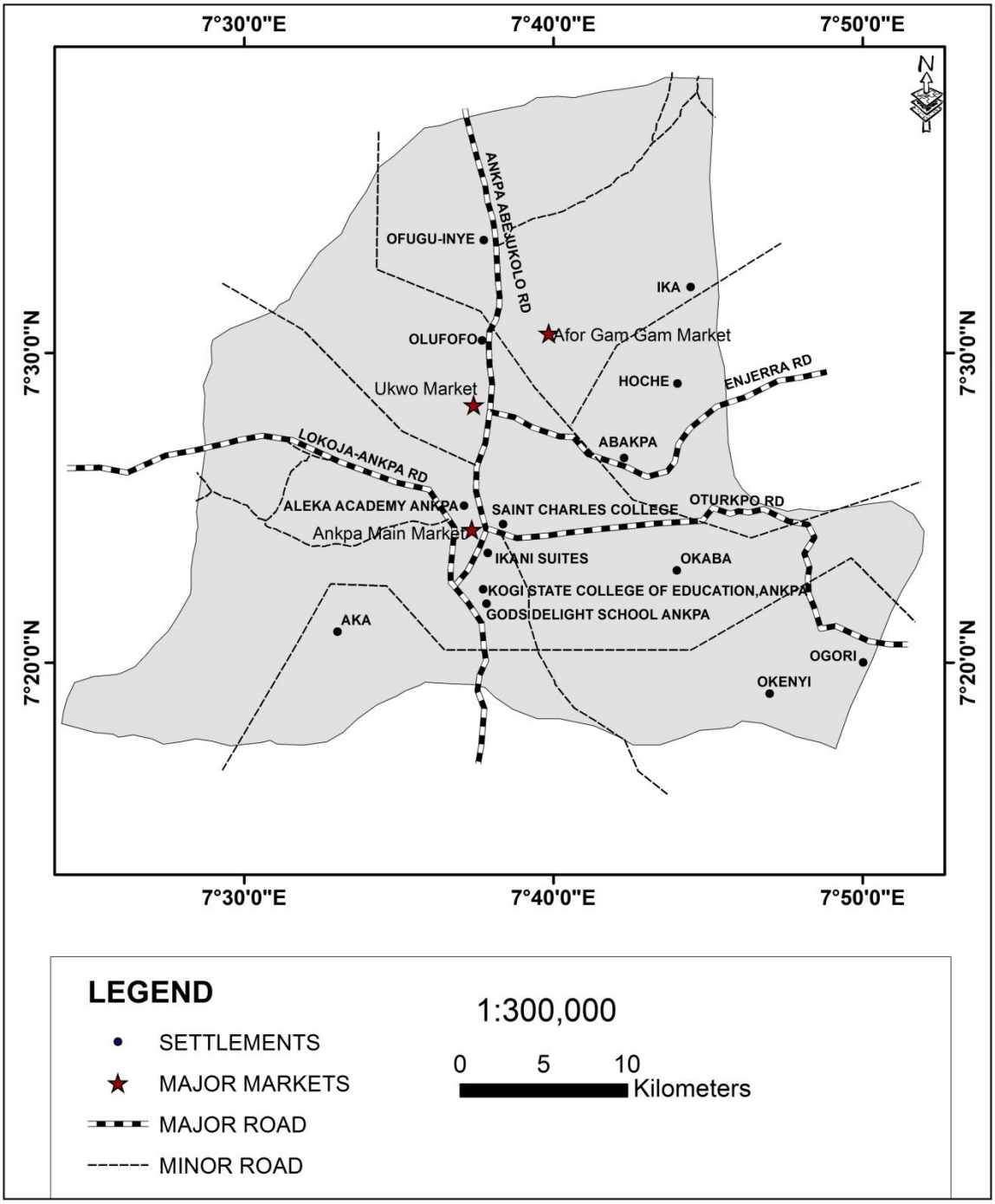

Figure 1: Map showing the location and extent of the study area

Collection and Identification of Plant Materials

Fresh parts (particularly roots) of the six medicinal plants highlighted from the ethnobotanical survey were collected using sterile cutlass. The plants *Annona senegalensis* Pers. (Ukpokpo-Igala tribal name), *Khaya senegalensis* (Odopala), *Securidaca longepedunculata* (Iche-oko) and *Uvaria chamae* P. Beaux (Awuloko) were collected by Mr Joseph Yamusa, a traditional snakebite healer in Ogodo-Atteh, Ankpa LGA Kogi State. *Phyllantus muellerianus* (Odegenehie) was collected by Mr Yakubu Akoja (Obo), a traditional snakebite healer in Akwu, Ankpa LGA, Kogi State. And *Lophira lanceolata* Van Tiegh (Okopi) was collected by Mr Samson Simon Ocholi, a traditional snakebite healer in Ogodo, Ankpa LGA, Kogi State.

The plant samples were taxonomically identified by Mr Theophilus Boniface Momoh at Botany Department, Kogi State University, Ayingba; six (6) plants were identified and used.

Sample preparation

The plant roots were cleaned with distilled water to remove soil dirt, dust and germs. The roots were cut into pieces using a sterile knife and were air-dried at room temperature before being pulverised using a mortar and pestle and then sieved. The powdered forms were kept in air-tight, properly labelled containers for further laboratory use.

Extraction Method

The crude extraction was done using ethanol as solvent. Two grams (2g) of each powdered plant sample were weighed accurately and macerated in 20 ml of 50% ethanol solvent in different conical flasks. Each sample was macerated in a separate conical flask with the solvent in such a way that the level of the solvent was above that of the plant powdered roots. The macerated mixtures were allowed to sit at room temperature for a duration of 48 hours.

The extracts were recovered from the macerated mixture through Whattman filter paper to remove the insoluble materials, and the following analyses were carried out on the filtrate.

Qualitative Phytochemical Screening of the Roots

The roots of *Annona senegalensis* Pers., *Khaya senegalensis, Phyllantus muellerianus, Uvaria chamae* P. Beaux, *Lophira lanceolata* Van Tiegh *and Securidaca longepedunculata* were subjected to phytochemical screening using established protocols to identify the constituents previously described by Harris *et al*. and Adeoye *et al*. [38,39].

1. Alkaloids

For the Mayer test, 0.2g of the extract was heated with 2% H_2SO_4 for a duration of two minutes. After filtration, a few drops of Mayer's reagent were added to the filtrate. The formation of a cream-colored precipitate indicated the presence of alkaloids [38].

In the Dragendorff test, 0.2g of the extract was heated with 2% H_2SO_4 for two minutes. The resulting mixture was filtered, and a few drops of Dragendorff's reagent were added to the filtrate. The appearance of an orange-red precipitate indicated the presence of alkaloids [38].

2. Tannins

For the Ferric Chloride test, a small amount of each extract was combined with water, heated using a water bath, and then filtered. To the filtrate, a few drops of ferric chloride were added. The formation of a dark green solution indicated the presence of tannins [39].

3. Glycosides

In the Fehling A and B test, the extract was first hydrolysed with HCl and subsequently neutralised with NaOH solution. A few drops of equal amounts of Fehling A and B reagents were then added. The formation of red precipitates indicated the presence of glycosides [39].

4. Saponins

In the frothing test, 0.2g of the extract was vigorously shaken with 5 ml of distilled water and subsequently filtered. The resulting filtrate was then boiled. The presence of a frothy appearance with creamy white bubbles indicated the presence of saponins [39].

5. Flavonoids

In the NaOH-HCl test, 0.2g of the extract was dissolved in diluted NaOH solution, followed by the addition of HCl. The formation of a yellow solution indicated the presence of flavonoids [39].

6. Total phenol

For the Dennis test, a small amount of the extract was heated with 35% NaCO3 for a duration of five minutes. Following this, a few drops of Folin-Ciocalteu reagent were added to the filtrate. The development of a blue-black color in the solution indicated the presence of total phenols [39].

Quantitative Phytochemical Screening of the Roots

1. Alkaloid determination using Harris *et al.* [38] method

A 5g portion of each sample was weighed and placed into a 250 ml beaker. To this, 200 ml of 20% acetic acid in ethanol was added, and the beaker was covered. The mixture was then left to stand for a period of 4 hours. Following this, the solution was filtered, and the volume of the extract was reduced to one-quarter of its original volume by concentrating it in a water bath. Concentrated ammonium hydroxide was slowly added drop by drop to the sample until precipitation was complete. The entire solution was allowed to settle, and the resulting precipitate was collected by filtration and weighed. The percentage of the total alkaloid was determined by calculating the weight of the precipitate relative to the original sample weight:

$$\text{Weight of Alkaloid} = \frac{\text{Residual Weight } (W_1 - W_2)}{\text{Weight of the Sample}} \times 100$$

$$W_1 = \text{Weight of Filter Paper} + \text{Alkaloid}$$

$$W_2 = \text{Weight of Filter Paper}$$

2. Total Phenol determination by spectrophotometric method

The determination of total phenolic content was conducted using the Folin-Ciocalteu method. A 20µl sample of the extract solution was mixed with 1.16ml of distilled water, and 100µl of Folin-Ciocalteu

reagent was added. Following this, 300µl of a 20% Na2CO3 solution was introduced to the mixture. The resulting solution was incubated in a shaking incubator at 40ºC for 30 minutes, and its absorbance at 760nm was measured using a UV/visible spectrophotometer. Gallic acid served as the standard for the calibration curve. The total phenolic content was expressed as gallic acid equivalent (GAE) and was calculated using a linear equation based on the calibration curve [40].

$A = 0.98C + 9.925 \times 10^{-3}$ $(R^2 = 0.9998)$

A= Absorbance

C = Concentration mg $GAEg^{-1}$

3. Tannins determination using spectrophotometric method

Tannins were determined using the Folin-Ciocalteu method. A 0.1ml aliquot of the sample extract was added to a 10ml volumetric flask containing 7.5ml of distilled water and 0.5ml of Folin-Ciocalteu tannin reagent. To this mixture, 1ml of 35% Na2CO3 solution was added, and the flask was then filled to the 10ml mark with distilled water. The solution was thoroughly shaken and left at room temperature for 30 minutes. Reference standard solutions of gallic acid (20, 40, 60, 80, and 100µg/ml) were prepared using the same procedure as described earlier. The absorbance of the test samples at 725nm was measured using a UV/visible spectrophotometer, and the absorbance of the standard solutions against a blank was also measured at 725nm. The tannin content was expressed as milligrams of gallic acid equivalent (GAE) per gram of extract [40].

4. Saponins determination using the Spectrophotometric method

The total saponin content was determined following the method described by Makkar et al. with some modifications. To 50ml of the sample extract, 250ml of distilled water, 250ml of vanillin reagent (800mg vanillin in 10ml of 99.5% ethanol), and 2.5ml of 72% sulphuric acid were added. The mixture was thoroughly mixed and placed in a water bath at 60°C for 10 minutes. Subsequently, the solution was cooled in ice-cold water, and the absorbance was measured at 544nm. The values obtained were expressed as diosgenin equivalent (mg/DEg) extract, derived from a standard curve [40].

Extract: 1g of sample in 50ml of distilled water

absorbance × gradient factors × dilution factors

5. Flavonoids determination using the Spectrophotometric method

Flavonoid determination was performed using the aluminum chloride colorimetric method. A 0.5ml aliquot of each plant extract was mixed with 1.5ml of methanol, 0.1ml of 10% aluminum chloride, 0.1ml of 1M sodium acetate, and 2.8ml of distilled water. The mixture was left at room temperature for 30 minutes to allow the reaction to occur. The absorbance of the reaction mixture was measured at 510nm using a double-beam Perkin Elmer UV-Visible Spectrophotometer. To generate a calibration curve, quercetin solutions ranging from 12.5 to 100µg/ml were prepared in methanol [40].

Statistical Analysis

The mean levels of phytochemicals among different plant categories were analysed using One-way Analysis of Variance (ANOVA) with a confidence level of 95%. The upper and lower confidence limits

were also calculated. The statistical analysis was performed using IBM SPSS Statistics version 21.0 software. An interaction term was included in the model, and Post-hoc Tukey tests were conducted to assess the significance of the results using R Studio [41]. The data were presented as mean ± standard deviation, based on three determinations. A p-value of ≤0.05 was considered statistically significant to determine differences between the groups.

RESULTS

Ethnobotanical survey results

Based on the conducted survey, the study area identified six plant species that were commonly used for the treatment of snake bites. Table 1 presents the common and scientific names of these plant species:

Table 1: Plants used for the treatment of Snakebite in Ankpa LGA

S/No	Common Names	Scientific Names	Igala Names	Family	Habit	Most frequent plant part used
1	Wild Sour Sop	*Annona senegalensis* Pers.	Ukpokpo	Annonaceae	Shrub	Roots
2	African Mahogany Red Oak Tree/ Red	*Khaya senegalensis*	Odopala	Meliaceae	Tree	Roots
3	Iron Wood	*Lophira lanceolata* Van. Tiegh	Okopi	Ochnaceae	Tree	Roots
4	Chewing Stick Plant	*Phyllanthus muellerianus*	Odegenehie	Euphorbiaceae	Climbing Shrub	Roots
5	Violet Tree/ Fibre Tree	*Securidaca longepedunculata Fers.*	Iche-oko	Polygalaceae	Shrub	Roots
6	Bush Banana	*Uvaria chamae* P. Beaux.	Awuloko	Annonaceae	Climbing Shrub	Roots

Phytochemical present (qualitative analysis)

Below is Table 2 summarising the phytochemical characteristics of the six medicinal plants. The results of the study demonstrated the presence of medically active compounds in the six plants examined. Table 2 indicates that total phenols, glycosides, flavonoids, and saponins were detected in all of the plants. However, tannins were not found in *Khaya senegalensis*, while alkaloids were exclusively present in

Uvaria chamae. These findings highlight the diverse phytochemical composition of the studied plants and suggest their potential therapeutic value.

Table 2: Qualitative phytochemicals constituents of six medicinal plant roots analysed

Plants	Alkaloids	Tannins	Flavonoids	Saponins	Total phenols	Glycosides
Lophira lanceolata	-	+	+	+	+	+
Uvaria chamae	+	+	+	+	+	+
Khaya senegalensis	-	-	+	+	+	+
Phyllanthus muellerianus	-	+	+	+	+	+
Annona senegalensis	-	+	+	+	+	+
Securidaca longepedunculata	-	+	+	+	+	+

- = Absent

+ = Present

Mean level of phytochemicals in each plant

The mean levels of five (5) important phytochemicals were examined from the roots of the six (6) selected plants under study—namely, alkaloids, total phenols, saponins, flavonoids and tannins.

The level of alkaloids was highest in the root of *Uvaria chamae* with a mean of 2.233 mg/g, which was statistically significant from the levels observed in the roots of *Lophira lanceolata* (0.833 mg/g), *Securidaca longepedunculata* (0.807 mg/g), *Phyllanthus muellerianus* (0.620 mg/g), *Khaya senegalensis* (0.513 mg/g) and *Annona senegalensis* (0.511 mg/g) ($F_{5,30}$ 165.9; $p < 0.001$) (Figure 2). The level of alkaloids in *Khaya senegalensis* and *Phyllanthus muellerianus* were not significantly different from that of *Annona senegalensis* ($p = 0.574$).

Similarly, the level of flavonoids was highest in the root of *Lophira lanceolata* with a mean of 42.153 mg/g, which was significant from the levels observed in the roots of *Securidaca longepedunculata* (30.893 mg/g), *Phyllanthus muellerianus* (30.483mg/g), *Uvaria chamae* (23.550 mg/g), *Annona senegalensis* (20.813 mg/g) and *Khaya senegalensis* (20.670 mg/g) ($F_{5,30}$ 4047; $p < 0.001$) (Figure 3). The level of flavonoids in *Annona senegalensis* was not significantly different from that of *Khaya senegalensis* ($p = 0.826$).

The level of saponin was highest in the root of *Securidaca longepedunculata* with a mean of 29.537 mg/g, which was significant from the levels observed in the roots of *Phyllanthus muellerianus* (28.800 mg/g), *Lophira lanceolata* (23.033 mg/g), *Uvaria chamae* (20.693 mg/g), *Khaya senegalensis* (18.760 mg/g) and *Annona senegalensis* (16.457 mg/g) ($F_{5,30}$ 1.913; $p < 0.001$) (Figure 3).

The root of *Securidaca longepedunculata* exhibited the highest level of tannins among the tested plant samples with a mean of 34.370 mg/g, which was significant from the levels observed in the roots of *Uvaria chamae* (30.163mg/g), *Phyllanthus muellerianus* (28.733 mg/g), *Annona senegalensis* (22.770 mg/g) and *Khaya senegalensis* (10.567 mg/g) but was not significantly different from the level observed in the roots of *Lophira lanceolata* (32.723 mg/g) ($F_{5,30}$ 4095; $p < 0.001$) (Figure 3). The level of tannins in *Lophira lanceolata* was not significantly different from that of *Uvaria chamae* ($p = 0.675$).

The root of *Phyllanthus muellerianus* with a mean of 719.72 mg/g, exhibited the highest level of phenols among the tested plant samples which was significant from the levels observed in the roots of *Uvaria chamae* (718.11 mg/g), *Securidaca longepedunculata* (715.61 mg/g), *Annona senegalensis* (710.43 mg/g) and *Lophira lanceolata* (704.23 mg/g) ($F_{5,30}$ 37.77; $p<0.001$) (Figure 4). But it was not significantly different from the level observed in the roots of *Khaya senegalensis* (719.61 mg/g) ($p = 0.991$).

Overall, phenols had the highest level among the five phytochemicals with a mean of 714.618 mg/g, followed by flavonoids (28.094 mg/g), tannins (26.554 mg/g), saponins (22.880 mg/g) while alkaloids had the least level (0.919 mg/g) ($F_{9,20}$ 7116; $p<0.001$).

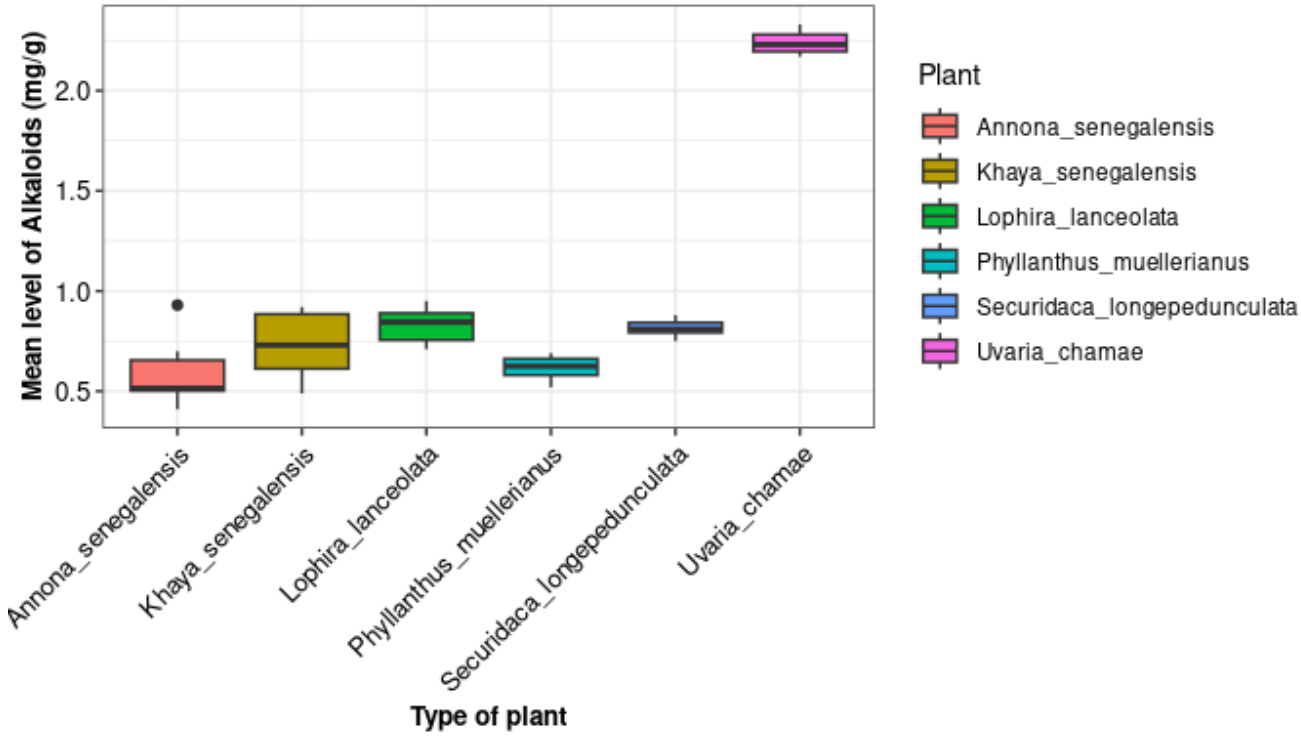

Figure 2: It shows the alkaloid contents of the roots of Annona senegalensis, Khaya senegalensis, Phyllantus muellerianus, Uvaria chamae, Lophira lanceolata and Securidaca longepedunculata, respectively

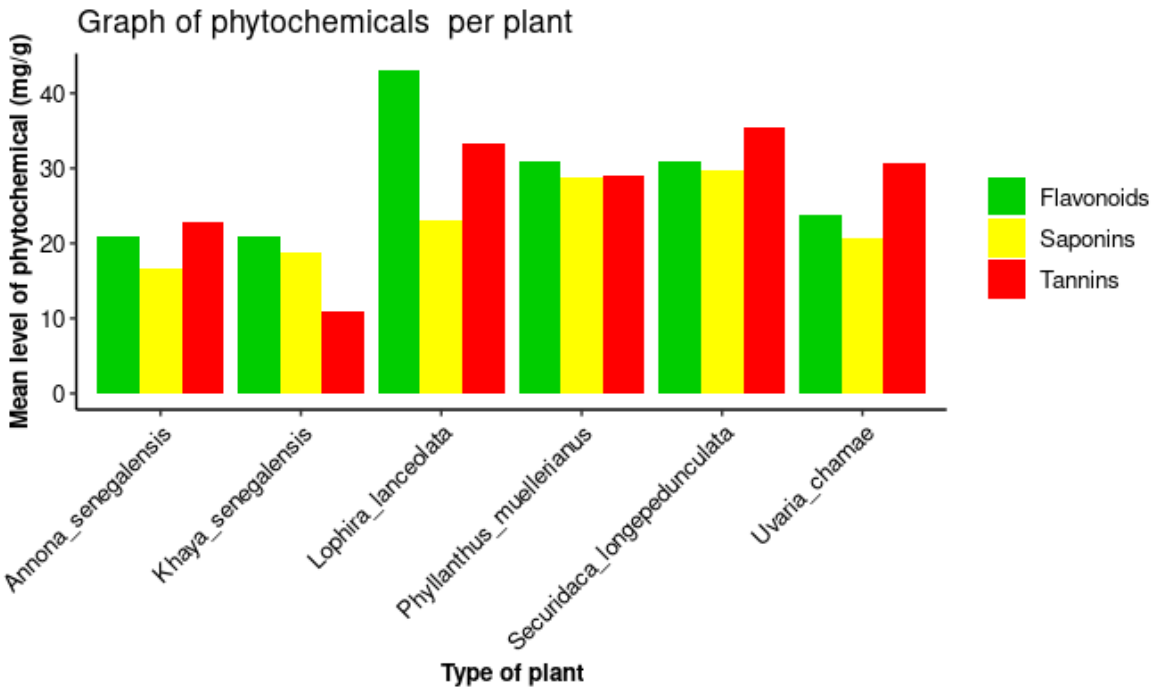

Figure 3: It shows the flavonoid, saponin and tannin contents of the roots of Annona senegalensis, Khaya senegalensis, Phyllantus muellerianus, Uvaria chamae, Lophira lanceolata and Securidaca longepedunculata respectively

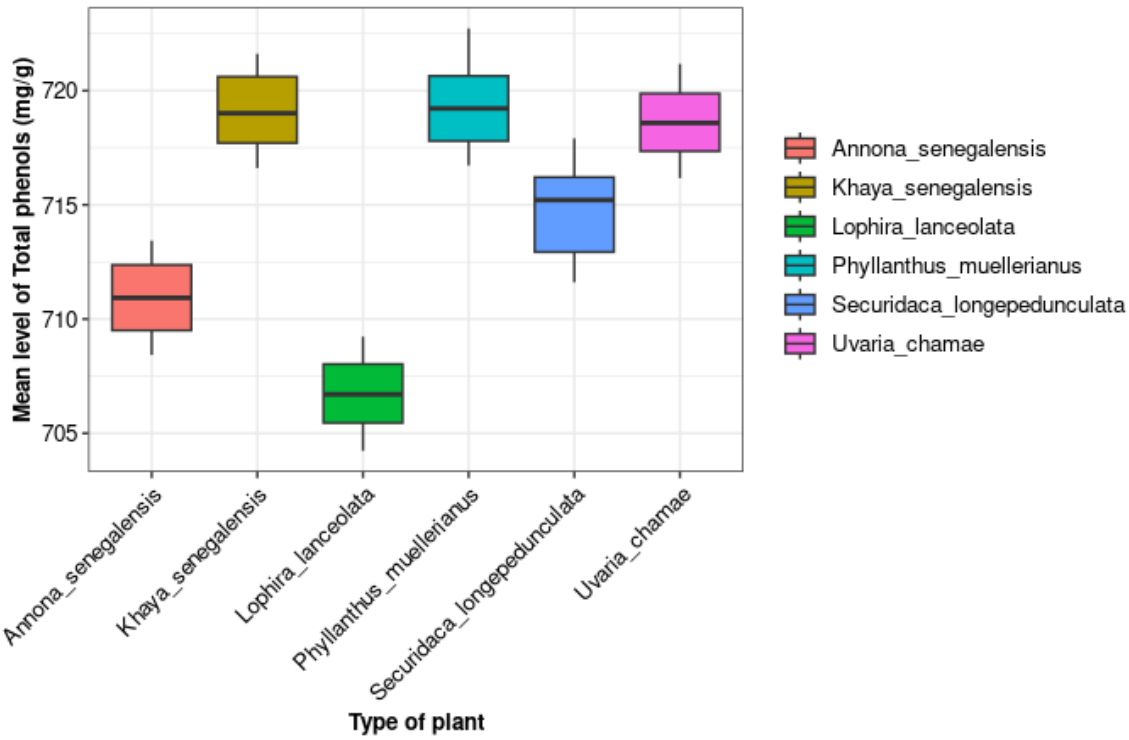

Figure 4: It shows the total phenolic contents of the roots of Annona senegalensis, Khaya senegalensis, Phyllantus muellerianus, Uvaria chamae, Lophira lanceolata and Securidaca longepedunculata, respectively

DISCUSSION

Plant extracts are known to be highly abundant in pharmacologically active compounds and often possess multiple biochemical and pharmacological properties. These compounds have the ability to interact with toxins or enzymes, thereby neutralising or inhibiting their biochemical activities. These interactions play a crucial role in the pharmacological activity exhibited by plant extracts [42,43,44]. Several researchers have highlighted the potential of medicinal plants as anti-venoms, attributing their efficacy to the presence of various forms of flavonoids, steroids, and tannins. It is important to note that the full activity of an extract cannot be replicated by a single substance alone. Instead, the combined action of multiple active constituents present in the plants acts synergistically on different target structures such as receptors and enzymes. These chemical constituents are often referred to as 'multifunctional' due to their ability to exhibit more than one pharmacological or biochemical property [45,46,47,48].

Earlier studies on the phytochemical screening of Annona senegalensis have reported the presence of diverse secondary metabolites, including tannins [49], flavonoids [49], saponins [50], glycosides [51], and alkaloids [52]. However, it is worth noting that the alkaloids isolated from the roots of *Annona senegalensis* did not exhibit any biological activity [53]. These findings provide insights into the chemical composition of *Annona senegalensis* and shed light on the potential pharmacological properties associated with its secondary metabolites.

In line with the aforementioned studies, Audu *et al.* [54] conducted research on the phytochemical screening of *Lophira lanceolata*, revealing the presence of flavonoids, glycosides, phenols, and saponins. However, alkaloids were found to be absent in this species. Another study focused on the phytochemical screening of the leaves and bark of *Khaya senegalensis*, demonstrating the presence of tannins, steroids, flavonoids, saponins, and alkaloids in the ethanolic extracts. However, alkaloids and saponins were not detected in the methanolic extracts [55]. In contrast, the ethanolic extract of the root of *Uvaria chamae* exhibited significantly higher levels ($p \leq 0.05$) of total phenols, tannins, flavonoids, and saponin content compared to the findings reported by Komes *et al.* [56] and Iroabuchi [57]. These variations could be attributed to factors such as seasonal variations, maturity stage of the plants, and environmental conditions affecting the plant samples.

Phenols and flavonoids, which are essential constituents found in plants, have been identified as key contributors to the anti-venom activity of these plants, either directly or indirectly [58]. The high presence of phenols and flavonoids in these plants may account for their potent anti-venom properties. Saponins, known for their bitter taste, foaming properties, and ability to cause hemolysis in red blood cells, are utilised as emulsifying agents and expectorants [59]. Phenolic compounds possess a wide range of medicinal properties, including antioxidant, anti-venom, anti-inflammatory, and anti-cancer activities [60,61,62,63,64,65]. Flavonoids, on the other hand, represent a diverse and widely distributed group of natural compounds, exhibiting various chemical and biological activities, including radical scavenging, anti-allergic, anti-microbial, anti-venom, anti-inflammatory and vasodilating effects [66,67,68].

Quercetin-3-O-α-rhamnoside, a flavonoid, has been identified as an inhibitor of phospholipase A2 (PLA2) activity, as well as the haemolytic and haemorrhage-inducing activities of *Naja naja* venom. It has been found effective when used in a ratio of 1:20 (venom to quercetin-3-O-α-rhamnoside) [69]. Morelloflavone, a flavonone-(C-3 C-8")-flavone biflavonoid, has also demonstrated inhibition of enzymatic, myotoxic, oedema-forming, and anticoagulant activities induced by *Crotalus durissus* cumanensis venom PLA2 [69]. Persimmon, which contains tannins, has been reported to exhibit activity against *Laticauda semifasciata* and *Trimeresurus flavoviridis* venoms. Ar-turmerone, a phenolic compound, has shown the ability to

neutralise haemorrhaging and lethality caused by *Bothrops jararaca* and *Crotalus durissus* terrificus snake venoms [70].

The methanol extract of the root bark of *Annona senegalensis* has been found to possess anti-venom properties against cobra (*Naja nigricollis* Wetch) venom in experimental rats. It showed a reduction in induced hyperthermia and detoxification of the snake venom by 16-33%. However, it did not restore liver functions [71]. The anti-venom properties of *Securidaca longepedunculata* root extract were evaluated by monitoring the levels of liver enzymes (ALT, AST, ALP), creatinine kinase (CPK), lactase dehydrogenase (LDH), and amylase in rats. The extract demonstrated a significant dose-dependent alteration in serum enzymes and urea levels [72]. A fraction of *Annona senegalensis* leaf methanol extract showed neutralising effects against lethal toxicity induced by *Echis ocellatus* venom. The key phytochemicals responsible for this activity were identified as flavonoids and tannins [73,74,75,76,77,78]. These findings suggest that the identified phytochemical compounds may be the bioactive constituents responsible for the observed effects. These plants hold promise as valuable sources of bioactive compounds with significant medicinal potential.

CONCLUSION

The outcomes of this investigation have demonstrated the presence of vital therapeutic components in the investigated plants. The found phytochemicals' bioactivity was supported by several findings from past investigations. Many studies have shown that the presence of these phytochemicals contributes to the pharmacological and physiological qualities of the plants investigated in the therapy of diverse ailments. Therefore, the extracts from these plants can be regarded as a trustworthy and dependable source for therapeutic medications. It is highly recommended to utilise these plants in native and modern medicine practices. It is also urged that additional research be done to identify, purify, and isolate the medicinal ingredients that give these plants their effects. Further research is also encouraged to clarify these extracts' potential mechanisms of action.

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