NILE UNIVERSITY OF NIGERIA
HONORIS UNITED UNIVERSITIES

Received: April 12, 2023

Revised: September 05, 2023

Accepted: September 06, 2023

Nutritional Potentials and Acute-Toxicity Studies of *Securidaca Longipedunculata* (Fresen) Polygalaceae Leaves

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ABSTRACT

Securidaca longipedunculata have not only served as therapeutic agents for a long time but also provided basic nutrients like protein, carbohydrates, fat, etc. These nutrients have essential role in supporting human body requirements for energy, used in different physiological functions. The leaves of *S. longipedunculata* were analyzed for proximate, minerals, anti-nutritional content, and acute toxicity study using standard methods. The results showed that the leaves contain moisture (10.38±0.43%), ash (6.21±0.23%), crude protein (5.85±0.29%), crude lipid (3.96±0.12%), crude fiber (3.00±0.18%), non-fiber carbohydrate (80.98±0.51%), and energy value (377.11±1.82 kJ/100g). The anti-nutritional content of the leaves in (mg/100g) were found to have oxalate (0.0214±0.0001), phytate (4.0406±0.0241), nitrite (2.6733±0.0757), cyanide (0.0285±0.0061) and tannins (0.3507±0.0004). The leaves of this plant were analyzed and found to possess an appreciable amount of mineral contents, such as K, Na, Ca, Mg, Cu, Fe, Mn, Zn, Cr, Cd and Pb. The results of acute oral administration of *S. longipedunculata* leaves extracts on mice showed that the LD_{50} of *S. longipedunculata* leaves extracts is greater than or equal to 5000 mg/kg bw. In conclusion, the nutritional analyses of *S. longipedunculata* have revealed valuable insights into the potential benefits and nutritional value of the plant.

KEYWORDS: Protein content, Anti-nutritional, Mineral contents, Acute-toxicity, Median Lethal Dose.

DOI: *https://doi.org/*10.5455/NJEAS.149400

NJEAS
NILE JOURNAL OF ENGINEERING & APPLIED SCIENCE

1 | INTRODUCTION

The current economic realities around Africa and other developing countries show that there is food scarcity and inadequate health care, which if care is not taken can become regionally pandemic. The available portion for a densely populated nation like Nigeria is to explore other affordable nutritional bio-products such as plants to overcome malnutrition (Rathod and Valvi, 2011). Plants have played and continued to play significant roles in human health, nutrition, food security and economic welfare of rural communities in developing world. The consumption of plants, through various seasons, is associated with potential health benefits (Isabelle *et al.,* 2010).

Research has shown that the deterioration of human health may correlate with food products and food additives (Dodo *et al.,* 2020). Even though plants are not eaten as real foods but as supplements, their nutritional ability should not be abandoned. They are significant sources of proteins, carbohydrates, vitamins, minerals, fats, and oils, and therefore contribute to the nutritional improvement of food in their little way. To bridge the space of alarming food shortage in human and animal nutrition, the relevance of plants and the need to introduce more plant-based foods have awakened the interests of various researchers all over the world especially in Nigeria, in the evaluation of nutrition, anti-nutrition, vitamins, minerals, heavy metals and phytochemical status of multiple plants.

Securidaca longipedunculata (Figure 1), which belongs to the family *Polygalaceae* is a shrub that grows up to 10 cm high, 2 - 9 cm long, and has 0.5 - 2.5 cm broad leaves. In Northern Nigeria, it is locally known as *"uwar magunguna"* in the Hausa language. It grows in varying climatic environment, from hot arid to humid climates, and in broad vegetation range, from semi-arid to dense forest. It is common in sub-Saharan Africa in Savannah and Sahel environments (Anjarwalla *et al.,* 2015). The plant is commonly used in Hausa-speaking communities in Nigeria as flavour, food (sauces) and medicine (Chanda, 2006). *S. longipedunculata* has gained attention for its various uses, including consumption as a food source and utilization in traditional medicine. The plant's nutritional information has drawn interest due to its potential profile as a source of essential nutrients (Hassan *et al.,* 2018). Therefore, this study is aimed to determine the nutritional potentials and acute-toxicity studies of *securidaca longipedunculata* leaves.

1.2 Local names of *S. longipedunculata* (Fresen)

English – Violet tree, Fiber tree, or Rhodesian violet;
Hausa – *"Sanya" or "Uwar magunguna"*
Yoruba – *"Ipeta"* and
Arabic- *"Saggat"* or *"Alali"*

Figure 1: *S. longipedunculata* in its Natural Habitat

2 | MATERIALS AND METHODS

2.1 Materials

2.1.1 Sample Collection and Identification

The samples of *S. longipedunculata* were collected from the Zuru local government area of Kebbi State in August, 2021. The sample was then transported to the laboratory and identified by a taxonomist at the Department of Pharmacognosy and Ethnopharmacy, Faculty of Pharmaceutical Sciences, Usmanu Danfodiyo University, Sokoto. The voucher specimen with the number PCG/UDUS/POLY/0001 was prepared and deposited for future reference at the herbarium of the department.

2.1.2 Sample preparation

Fresh leaves of *S. longipedunculata* were properly washed to remove earthy impurities. The leaves were shade dried and pulverized using a wooden pestle and mortar. The powdered sample was then stored in an air-tight container until it was needed for analysis.

2.2 Proximate Analysis

The sample was analyzed for proximate composition i.e Moisture, Ash, Crude protein, Crude lipid, Crude fibre, Available carbohydrate and Energy values (AOAC, 2016).

2.3 Minerals Analysis

The mineral elements (Ca, Mg, Mn, Zn, Cu, Fe, Co, Pb, and Cr) were analyzed using atomic absorption spectrophotometry technique as described by Hassan *et al.* (2018). Analyses were performed in triplicates.

2.4 Analysis of Sodium and Potassium using Flame Photometer

The method described by Amed *et al.* (2019) was adopted. To the digested sample, solution 0.5 cm^3 was pipetted into a 100 cm^3 standard volumetric flask and diluted to the mark. The spectrophotometer was switched on and allowed to stabilize for 30 minutes. Calibrated to zero with distilled water and then to full scale (100) using standard solution (25 ppm) of freshly prepared standards, respectively.

2.5 Determination of Anti Nutrients

The leaves of *S. longipedunculata* were subjected to Anti-nutritional analyses using standard procedure in order to determine Oxalic acid, Phytate, Nitrate, Hydrocyanic Acids and Tannins (Anhwange *et al*., 2006; Soetan, 2012; Unuofin *et al.,* 2017; Hassan *et al.,* 2018).

2.6 Extraction Procedure

In accordance with the maceration and exhaustive percolation method described by Nweze *et al.,* (2004), 200 g of the milled sample, *S. longipedunculata* leaves was soaked in about 2500 cm^3 of n-hexane (plant material to solvent ratio was 1:10, w/v) in a glass beaker. The beaker was tightly sealed and kept for 72 hours with regular agitation to release the soluble metabolites into the solvent. The mixture was filtered and pre-concentrated by evaporating the solvent. The same extraction procedures were repeated using ethyl acetate and methanol respectively. The respective extracts were dried and stored for further analysis.

2.7 Acute -toxicity Studies

2.7.1 Experimental animals

Swiss Albino Wistar mice (20 – 25 g) used in this experiment were obtained from the Department of Pharmacology and Toxicology, Usmanu Danfodiyo University, Sokoto. They were caged in a hygienic, conducive habitat with proper lighting. The animals were fed on a diet specially prepared from chick ultima poultry feed (Olam Company, Nigeria). The mice also had free access to water and were maintained following the provisions of the National Research Council guidelines for the Care and Use of Laboratory Animals (National Research Council, 2011). They were acclimated for one week before experimentation and no mortality was recorded.

2.7.2 Experimental design for Acute-toxicity Study

The acute toxicity study was conducted in harmony with Lorke's method (Lork, 1983).

2.8 Statistical Analysis

Statistical analyses were expressed using descriptive statistics in Minitab 17 software. Values are expressed as mean ± SD (standard deviation). Bar charts are also used to represent the obtained data.

3 | RESULTS AND DISCUSSION

3.1 Results

3.1.1 Proximate Analysis

Proximate composition of plants provides valuable information about its nutritional quality. The values of moisture, ash, fats, protein and carbohydrate of *S. longipedunculata* leaves are shown in Table 1.

Table 1: Proximate composition *S. longipedunculata* leaves

Parameters	Concentration (% dw)
Moisture	10.38 ± 0.43
Ash Content	6.21 ± 0.23
Crude Protein	5.85 ± 0.29
Crude lipid	3.96 ± 0.12
Crude Fibre	3.00 ± 0.18
Non-Fibre Carbohydrate	80.98 ± 0.51
Energy Value (kJ/100g DW)	377.11 ± 1.82

The data are mean values ± standard deviation (SD) of three replicates.

3.1.2 Mineral analysis

From the result (Table 2), the leaves of *S. longipedunculata* have a high concentration of calcium (754.41 mg/100 g), potassium (523.32 mg/100 g), magnesium (221.37 mg/100 g), sodium (97.61 mg/100 g), while cadmium has the least concentration of 0.43 mg/100 g.

Table 2: Mineral and heavy metals Composition of *S. longipedunculata* leaves

Minerals	Concentration (mg/100g dw)
Potassium	523.32 ± 9.30
Sodium	97.61 ± 3.24
Calcium	754.41 ± 11.30
Magnesium	221.37 ± 1.13

Copper	3.23 ± 0.27
Iron	83.23 ± 2.15
Manganese	6.63 ± 0.55
Zinc	10.24 ± 0.23
Chromium	1.93 ± 0.19
Cadmium	0.43± 0.03
Lead	ND

. The data are means values ± standard deviation (SD) of three replicated. ND = Not detected

2.1.3 Anti-nutritive content

The results of the anti-nutritive composition of *S. longipedunculata* leaves are presented in Table 3. From the result, the leaves have a lower level of antinutritive content for which phytate brings the highest.

Table 3: Anti-nutritional Composition of *S. longipedunculata* leaves (mg/100 g DW)

Parameters	Composition
Oxalate	0.0214 ± 0.0001
Phytate	4.0406 ± 0.0241
Nitrite	2.6733 ± 0.0757
Cyanide	0.0285 ± 0.0061
Tannins	0.3507 ± 0.0004

The values are mean ± standard deviation of three replicates

To predict the bioavailability of some divalent elements specifically calcium, magnesium, zinc, and iron, anti-nutrients to nutrient molar ratios were calculated and the results are represented in Table 4.

Table 4: Anti nutrient to Nutrient Molar Ratio of *S. longipedunculata* leaves

Anti-nutrient to nutrient	Molar Ratio	
[Oxalate]/[Ca]	$1.02 X10^{-6}$	
[Oxalate]/[Ca+Mg]	$1.13 X 10^{-8}$	
[Phytate]/[Ca]	$2.11 X 10^{-4}$	
[Phytate]/[Fe]	0.03	
[Phytate]/[Zn]	0.30	
[Ca][Phytate]/[Zn]	0.14	-

3.1.4 Extraction

The percentage yield of the extracts used for the analysis is represented in Table 5. The methanol extract has the highest yield of 13.51 % while n-hexane yielded the least percent of 4.81.

Table 5: Percentage yield of *S. longipedunculata* leaves extracts

Extracts	Yield (g)	Yield (%)
n-Hexane	9.62	4.81
Ethyl acetate	16.41	8.21
Methanol	27.01	13.51

3.1.5 Toxicological Studies

Table 6, 7 and 8 shows the toxicity test of the plant extracts at different concentrations. All the rats given the extracts leaves of *S. longipedunculata* at different concentrations were able to survive without any sign of weakness or illness within 24 hours.

Table 6: Median Lethal Dose of n-Hexane Leaves Extract of *S. Longipedunculata*

EXPERIMENT	Dose (mg/kg bw)	No. of mice used	No. Died mice after 24 hrs
Phase 1	10	3	0/3
	100	3	0/3
	1000	3	0/3
Control	0	3	0/3
Phase 2	1600	1	0/1
	2900	1	0/1
	5000	1	0/1

(Experiment was conducted in two phases; each dose group of phase-1 made up of 3 mice while those in phase 2 have 1 mice per group)

Table 7: Median Lethal Dose of Ethyl acetate Leaves Extract of *S. longipedunculata*

EXPERIMENT	Dose (mg/kg bw)	No. of mice used	No. Died mice after 24 hrs
Phase 1	10	3	0/3
	100	3	0/3
	1000	3	0/3
Control	0	3	0/3
Phase 2	1600	1	0/1
	2900	1	0/1

	5000	1	0/1

(Experiment was conducted in two phases; each dose group of phase-1 made up of 3 mice while those in phase 2 have 1 mice per group)

Table 8: Median Lethal Dose of Methanol Leaves Extract of *S. Longipedunculata*

EXPERIMENT	Dose (mg/kg bw)	No. of mice used	No. Died mice after 24 hrs
Phase 1	10	3	0/3
	100	3	0/3
	1000	3	0/3
Control	0	3	0/3
Phase 2	1600	1	0/1
	2900	1	0/1
	5000	1	0/1

(Experiment was conducted in two phases; each dose group of phase-1 made up of 3 mice while those in phase 2 have 1 mice per group)

3.2 Discussion

The proximate composition of the dried crushed leaves of *S. longipedunculata* was evaluated and presented in Table 1. The results indicated that *S. longipedunculata* has a significant amount of moisture content. The moisture content (10.38 ± 0.43) of the plant leaves is important for storage purposes to put off some micro-organisms (Ugbaja *et al.,* 2017). The ash content of the leaves (6.21 ± 0.23) was found to be higher than some medicinal plants (Hassan *et al.,* 2018), which indicates a higher mineral concentration in the leaves. The protein content of the leaves was found to be moderately available (5.85 ± 0.29). Protein is vital for various body functions such as body development, maintenance of fluid balance, formation of hormones, and enzymes, and sustaining strong immune function (Achi *et al.,* 2017).

The crude lipid yield is low (3.96 ± 0.12) when compared to the leaves of *Aspilia africana* (Asteraceae) which is also a medicinal plant (Ibidunni, 2019) and also similar to that of Aloe vera (4.2%) and (4.9%) *Euphorbia radians* (Sotelo *et al.,* 2007). Fibre content (3.00 ± 0.18) of this plant could aid in the assimilation of trace elements in the gut and therefore increases intestinal bowel movement (Amed *et al.,* 2019). Diets rich in fibre have a positive effect on health, it decreases the risk of numerous diseases like diabetes, coronary heart disease, colon cancer, hypertension, constipation obesity, and various digestive disorders (Hassan *et al.,* 2011; Adamma *et al.,* 2014; Achi *et al.,* 2017) and maintains normal peristaltic movement of the intestinal tract (Oloye *et al.,* 2014). Thus, the *S. longipedunculata* leaves could be valuable sources of dietary fibre.

S. longipedunculata had an appreciable amount of nutrients with 377.11 ± 1.82 energy value (kJ/100 g DW) and 80.98 ± 0.51 % available carbohydrate. This means that in every 100 g of *S. longipedunculata* leaves, there is 80.98 g of carbohydrate. Carbohydrate serves as stored forms of energy as glycogen in the liver. It also provides a primary source of energy and is responsible for breaking down fatty acids and preventing ketosis (Hassan *et al.,* 2018). This is an indication that the plant is a good source of energy for both human and animal use.

S. longipedunculata leaves were analyzed for mineral elements and the values expressed in mg/100g dry weight were shown in Table 2. The results show that *S. longipedunculata* is a good source of K, Na, Ca, Mg, Zn, Fe, Cu, and Zn. This makes it a major source of essential elements and can be used as one of the potential sources of essential minerals in the diet. Among the elements evaluated in the current study, calcium is the most abundant, followed by potassium and magnesium, while cadmium is present in the lowest amount and lead was not detected. However, potassium content was found to be highest in many wild edible plants (Kibar and Temel, 2015). The potassium content (523.32 ± 9.30 mg/100g) in the current study was within the range of 272–5579.1 mg/100 g for many other wild edible plants (Kibar and Temel, 2015; Seal and Chaudhuri, 2015; Tuncturk and Ozgokce, 2015). The minimum daily intake of Potassium is 3.5 g (Adamu *et al.,* 2016). Therefore, *S. longipedunculata* leaves with a considerable amount of potassium could help to provide the daily potassium requirement of an adult and could be useful in the management of hypertension and other cardiovascular diseases.

The sodium content (97.61 ± 3.24 mg/100g) is relatively low compared to potassium in the current study. However, it is within the range (32–633.2 mg/100 g) of other wild plants studied (Kibar and Temel, 2015; Tuncturk and Ozgokce, 2015). The minimum daily intake of sodium is 2.4 g (Adamu *et al.,* 2016). Therefore *S. longipedunculata* leaves can contribute to daily sodium consumption. The concentration of calcium in *S. longipedunculata* leaves was found to be 754.41 ± 11.30 mg/100g which is the highest among the minerals analyzed. In previous studies related to some wild edible plants, the calcium concentrations were found in a wide range from 27.0 - 7775.2 mg/100 g (Kagale and Sabale, 2014; Kibar and Temel, 2015; Seal and Chaudhuri, 2015). Calcium constitutes a large percentage of the bone, human blood, and extracellular fluid. It is also very much required for the normal functioning of the cardiac muscles, blood coagulation, milk clotting, and the regulation of cell permeability (Seal *et al.,* 2017). The result shows that *S. longipedunculata* is a good source of calcium and its presence indicates that it will help to build and maintain strong bones when consumed (Omale *et al.,* 2021). Magnesium is involved in more than 300 biochemical reactions in the body (Kibar and Temel, 2015). The concentration of magnesium in *S. longipedunculata* was found to be 221.37 ± 1.13 mg/100g, which is slightly above the permissible level of 200 mg/100g set by FAO/WHO (Adamu *et al.,* 2016). Magnesium contents of various wild edible plants varied from 30.33 to 864.3 mg/100 g (Turan *et al.,* 2003; Demir, 2006; Coruh *et al.,* 2007; Seal and Chaudhuri, 2015; Tuncturk and Ozgokce, 2015). The necessary daily intake is 350 mg/day for men and 300 mg/day for women (Adamu *et al.,* 2016). *S. longipedunculata* can serve as a good source of magnesium; however, it should be consumed in moderation as the concentration is a bit higher than the WHO/FAO limit.

A sufficient amount of Cu (3.23 ± 0.27 mg/100g) was present in the leaves of *S. longipedunculata*. A lower amount of copper (0.0103 ± 0.0000 mg/Kg) was reported in the root bark (Abdullahi *et al.,* 2019) and stem bark (0.0700 ± 0.20 mg/Kg) (Abubakar *et al.,* 2020) of *S. longipedunculata* collected in Jigawa state. However, the maximum allowable limit for Cu in edible plants has been set by WHO/FAO at 3 mg/100g (Onyedikachi *et al.,* 2018). This means that *S. longipedunculata* leaves should be consumed with caution as their Cu content is slightly above the WHO limit.

The concentration of Iron (Fe) in *S. longipedunculata* leaves was found to be 83.23 ± 2.15 mg/100g. It is a component of muscle and blood and is essential for transporting oxygen around the body. The limit for iron in medicinal plants has not been established therefore 20 mg/100g set by WHO/FAO for edible plants has been used (Onyedikachi *et al.,* 2018). In the current study, the concentration of iron was found to be more than three times higher than the WHO/FAO limit. The high concentration of iron could be attributed to low soil pH as some plants secrete acid from the roots. These plants can take up too much iron which could lead to toxicity (Ancuceanu *et al.,* 2015). Iron is a very important element in the diet of pregnant women, nursing mothers, and infants to prevent anemia and other related diseases. Therefore, *S. longipedunculata* leaves could be recommended as alternative food in diets to reduce anemia albeit with great caution.

The permissible limit set by FAO/WHO for Manganese was 2.00 mg/100g in edible plants (Onyedikachi *et al.,* 2018). However, the permissible WHO (2005) limits for Mn in medicinal plants have not yet been set. In Egypt 446 mg/100g to 338 mg/100g limit has been set for manganese in medicinal plants (Adamu *et al.,* 2016). The concentration of Manganese (6.63 ± 0.55 mg/100g) in *S. longipedunculata* was well above the limits for edible plants but within the limit set by Egypt for medicinal plants. The level of manganese in the stem bark of *S. longipedunculata* in a study by Abubakar *et al.* (2020) was found to be significantly lower than what was found in its leaves in the current study. Also, Lower concentrations of manganese in the root bark of *S. longipedunculata* have been reported (Abdullahi *et al.,* 2019). However, 10.15 mg/100g of manganese was found in the roots of *S. longipedunculata* (Ngonda, 2014). Despite the importance of manganese, a high level of it can cause harm to the nervous system, which, in turn, may cause insomnia, depression, or illusions and, eventually, progressive alterations in gait and balance and tremor and Parkinson-like symptoms (Punchay *et al.,* 2020). Its deficiency also causes reproductive failure in both males and females (Adamu *et al.,* 2016).

According to the reported balance food data of FAO, about 20 % of the world's population could be at zinc deficiency risk (Ullah *et al.,* 2017). The concentration of Zinc (10.24 ± 0.23 mg/100 g) in *S. longipedunculata* is appreciable and can supplement the element in the human diet. It is also found that the level of zinc in the current study is below the permissible limit set by FAO/WHO for zinc which is 27.4 mg/100g (Adamu *et al.,* 2016). An appreciable quantity of Zinc was found to be present in the wild edible plants studied by Seal *et al.* (2017) ranging from 0.43±0.001 mg/g to 1.53±0.001 mg/g. The levels of Zn in some vegetables studied in Kano ranged from 0.67 to 18.89 mg/Kg (Lawal and Audu, 2011). Zinc is an essential element in the nutrition of human beings where it functions as an integral part of some enzymes, which play a central role in nucleic acid metabolism. In addition, Zn is a membrane stabilizer and a stimulator of the immune response. Its deficiency leads to growth failure and poor development of gonadal function (Seal *et al.,* 2017).

Chromium has been reported to play a vital role in the metabolism of cholesterol, fat, and glucose, while at higher concentrations, chromium is toxic and carcinogenic (Abubakar *et al.,* 2020). The World Health Organization and other regulatory bodies have not yet decided on the permissible limits for Cr in medicinal plants but the permissible limit for chromium set by Canada was 2.00 mg/100g in raw medicinal plant material (Adamu *et al.,* 2016). However, the permissible limit set by FAO/ WHO in an edible plant for chromium is 0.02 mg/100g (Adamu *et al.,* 2016). The concentration of Chromium in this study (1.93 ± 0.19 mg/100g) is higher than the limit set for edible plants and slightly below that of raw herbal materials set by Canada. In a study by Abdullahi *et al.* (2019), Chromium was not detected in the root bark of *S. longipedunculata*. However, in another study conducted in Malawi, the roots of *S. longipedunculata* contained 2.76 mg/kg of chromium (Ngonda, 2014) which is higher than what was obtained in the current study. Chromium has been described to play a vital part in the breakdown of cholesterol, fat, and glucose, while at higher concentrations, chromium is poisonous and carcinogenic (Abubakar *et al.,* 2020).

Cadmium is a toxic metal having functions neither in the human body nor plants (Adamu *et al.,* 2016). The present study has shown that Cd was detected (0.43± 0.03 mg/100g) in the leaves of *S. longipedunculata*. The permissible limit of Cd for medicinal plants was recommended to be 0.3 mg/kg, while the permissible limit of Cd in the European Pharmacopeia is 0.5 mg/kg (Abdullahi *et al.,* 2019). The concentration of cadmium in the present study is above the limit set for medicinal plants but within the limit set by the European Pharmacopeia. The presence of cadmium was also reported in the root bark of *S. longipedunculata* collected from the Zomba and Machinga Districts of Malawi (Ngonda, 2014). However, cadmium has not been detected in the root bark of *S. longipedunculata* (Abubakar *et al.,* 2020). Similarly, the presence of Cd was not reported in the stem bark of *S. longipedunculata* (Abdullahi et al., 2019). Accumulation of cadmium causes both acute and chronic poisoning; adverse effects on kidneys, liver, vascular and immune systems have been reported (Adamu *et al.,* 2016).

The presence of lead in the present study was not detected. Lead was also not detected in the stem bark (Abubakar *et al.,* 2020) and root bark (Abdullahi *et al.,* 2019) of *S. longipedunculata*. However, the presence of lead was reported in the roots of *S. longipedunculata* collected in Malawi (Ngonda, 2014). Lead is considered one of the most toxic elements, causing both acute and chronic poisoning with an adverse effect on various body systems such as kidney, liver, renal, digestive, and brain damage and disorder of the central nervous system (Umar *et al.,* 2016).

To avoid predation, plants synthesized a series of low and high-molecular-weight compounds. These compounds partake partly in defense against insects, pathogens, herbivores, or adverse growing conditions. Many of these compounds may be labeled as anti-nutrients in the human diet due to their occurrence in fresh foods and processed foodstuffs (Mousavi *et al.,* 2019). Such anti-nutrients found in the human diet include oxalate, phytate, nitrate, tannins as well as cyanide. Table 3 shows that the phytate content of *S. longipedunculata* leaves (4.0406 ± 0.0241 mg/100 g) is higher than some herbs used in the treatment of various ailments (Vincent *et al.,* 2019). Phytic acid can bind some essential mineral elements such as Calcium, Magnesium, Zinc, and iron in the digestive tract and render these mineral elements not bioavailable. According to Hassan *et al.,* (2018), phytate was known to be an effective anti-carcinogen that protects against colon- cancer, and it is known to be a potent antioxidant that inhibits Fenton reactions leading to lipid peroxidation and inhibition of polyphenol oxidase.

Oxalate is an anti-nutrient that occurs in scores of plants as calcium oxalate deposits, in the tissue. The leaves of *S. longipedunculata* were evaluated to have a deposit of calcium oxalate (0.0214 ± 0.0001 mg/100 g). The genetic roles of oxalate in plants include calcium regulation, maintenance of strong bones and teeth protection against herbivores, and helping in plant growth, but in humans, insoluble calcium oxalate may also precipitate around soft tissues such as the kidney, causing kidney stones that can block the kidney tubule (Amed *et al.,* 2019). Even though oxalic acid has low toxicity with a minimal lethal dose of 5 g for an adult (Morales *et al.,* 2014), a recommended dose not higher than 2.5 g in foods was suggested to avoid toxic effects (Amed *et al.,* 2019). The present finding, therefore, indicates that oxalate is safe for human consumption due to the limited amount detected.

The concentration of nitrate in *S. longipedunculata* (2.6733 ± 0.0757 mg/100 g dry weight) was below the acceptable daily intake of 3.7mg/100kg body weight equivalent to 220 mg for a 60 kg person (Elinge *et al.,* 2012). Cooking and Boiling can cause (a 62 % and 75 %) decrease in total nitrate (Hmelak Gorenjak and Cencič, 2013) respectively. The level of HCN in *S. longipedunculata* was 0.0285 ± 0.0061 mg/100g. Hydrogen cyanide is weakly acidic and partly ionizes in solution to give the cyanide anions CN- (Akpabio *et al.,* 2013). Hwange *et al.* (2006) reported that high cyanide ion content in the diet causes neurological, respiratory, cardiovascular, and thyroid debilities. The low hydrogen cyanide content of the leaves is an indication that it is a good source of diets.

The concentration of tannins in *S. longipedunculata* leaves was 0.3507 ± 0.0004 mg/100g dry weight. It is usually found in dead or dying cells of plants and it exerts an inhibitory effect on many enzymes due to protein precipitation. It contributes to the protective function of the barks and heartwood of plants (Akpabio *et al.,* 2013). To evaluate the bioavailability of some mineral elements specifically Ca, Mg, Fe, and Zn, the anti-nutrients to nutrient molar ratios were calculated, and the result is obtainable in Table 4. It was observed that [Oxalate]/[Ca], [Oxalate]/[Ca + Mg] and [Ca][Phytate]/[Zn] ratios are all below the critical level known to impair calcium and magnesium bioavailability (Hassan *et al.,* 2011).

The results of the solvent extraction of the *S. longipedunculata* leaves showed comparable outline yield in the various solvents used for the extraction Table 5. The percentage yield of the extracts showed that methanol had the highest percentage yield, followed by ethyl acetate and then n-Hexane extracts, this variation could be due to the polarity of methanol which is superior to the other solvents. This is in line with the report of Hassan *et al.* (2018). The plant is more abundant in polar compounds hence methanol extracts more bioactive polar compounds which are useful in ethno medicine.

S. longipendunculata is commonly and widely used in Africa for various ailments (Anywar *et al.,* 2021). For these reasons, this research determined the acute toxicity of the n-Hexane, ethyl acetate, and methanol extracts of *S. longipedunculata*. From the findings of this study, acute toxicity of oral administration of *S. longipedunculata* leaves extracts on mice showed that the LD_{50} of *S. longipedunculata* leaves extracts was greater than equal to 5000 mg/kg bw as neither death nor any appreciable changes in physical or behavioral activities (weakness, aggressiveness, food refusal, loss of weight, diarrhea, discharge from eyes, ears, noisy breathing and mortality) was observed for 24 hours; it may therefore be considered nontoxic (OECD, 2001). Additionally, the findings from the acute toxicity study may explain the safe usage of *S. longipedunculata* by medicinal practitioners for malaria, headache, cancer, venereal diseases, and diabetes without the possibility of toxicity (Degu and Monash, 2015; Abubakar *et al.,* 2019) The LD_{50} value of the leaves extracts of *S. longipedunculata* was found to be lower than the LD_{50} (Oral) of *S. longipedunculata* root back extract; 771 mg/kg (Auwal *et al.,* 2012) and aqueous root extract of *S. longipedunculata*; 1130 mg/kg (Olaleye *et al.,* 1998). This indicates higher toxicity of the root bark of *S. longipedunculata* compared to that of leaves extracts of this plant and this may be more tolerated in larger classes like a man. This may explain the relatively unnoticeable toxic symptoms in high-rate local consumers.

4 | CONCLUSION

The outcomes of this study established that *S. longipedunculata* leaves contain an appreciable amount of carbohydrates, ash, crude fibre, crude protein, crude lipid, and minerals. The leaves also contain a substantial amount of nutrients with low levels of anti-nutritional content such as oxalate, phytate, nitrite, cyanide, and tannins. The plant leaves could serve as an alternative source of energy. From the findings of this study, acute toxicity of oral administration of *S. longipedunculata* leaves extracts on mice showed that the LD_{50} of *S. longipedunculata* leaves extracts was greater than or equal to 5000 mg/kgbw as neither death nor any appreciable changes in physical or behavioral activities (weakness, aggressiveness, loss of weight, food refusal, diarrhea, discharge from eyes, ears, noisy breathing and mortality) was observed; it may therefore be considered nontoxic.

Acknowledgement: We acknowledge the effort of the Chemistry Department, Sokoto State University for proving conducive environment to carry out the laboratory work.

Funding Statement: The author(s) received no specific funding for this study.

Author Contributions: The authors confirm contribution to the paper as follows:

Hassan, L. G. designed and supervised the whole research, Umar A. U carried out the work with the help of Umar, K. J. and Yusuf, A. J. Furthermore, all authors reviewed the result and approve the final version of the manuscript.

Availability of Data and Materials: Data available on request from the authors.

The data that support the findings of this study are available from the corresponding author, Umar A. U, upon reasonable request.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.

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