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MINERAL COMPOSITION AND ANTIOXIDANT ANALYSIS OF THE LEAVES OF MONKEY'S POTATO (*SOLENOSTEMON MONOSTACHYUS* (P. BEAUV) BRIQ).

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ABSTRACT

This study investigated the mineral composition and antioxidant potentials of the leaves of Monkey's Potato (*Solenostemon monostachyus* (P. Beauv.) Briq.) The leaves of *S. monostachyus* used in this study were collected from the Biological garden at College of Education, Warri, Delta State. Standard methods were employed to determine the composition of minerals and antioxidant capacity of *S. monostachyus*. The results from the mineral analysis revealed that calcium had the highest composition (2.64 ± 0.01 mg/kg) followed by manganese (1.74 ± 0.00 mg/kg) and zinc (1.02 ± 0.00 mg/kg). While the composition of iron, copper, nickel and lead were 0.83 ± 0.01 mg/kg, 0.64 ± 0.01 mg/kg, 0.04 ± 0.01 mg/kg and 0.02 ± 0.00 mg/kg respectively. Results from the antioxidant analysis (DPPH Assay) revealed a significant difference in the radical scavenging activity of *Solenostemon monostachyus* and Ascorbic acid, with *Solenostemon monostachyus* having a significantly higher DPPH radical scavenging activity with an IC_{50} value of 0.25ug/ml than Ascorbic acid with an IC_{50} value of 0.03ug/ml. The total antioxidant capacity of *Solenostemon monostachyus* was 0.6 ± 0.01 (AAE/g) indicative of strong antioxidant activity. These minerals and antioxidant properties may account for the various health benefits of *Solenostemon monostachyus*. Based on the result obtained, it is therefore recommended that *S. monostachyus* should be cultivated for its various nutritional and antioxidant potentials rather than being treated as a weed.

INTRODUCTION

The search for plants with minerals and medicinal properties has been ongoing for decades. However improper documentation has lead to the loss of the relevance of these plants in our present day health system. One of such plants is *Solenostemon monostachyus* (P. Beauv). This plant belonging to the Lamiaceae family is an important edible herb which can be found mostly within the topical countries. The plant is an erect, branched annual weed with a long inflorescence of violet flowers. It is slightly succulent, aromatic and grows up to 100cm tall [1].

Solenostemon monostachyus has been reported to possess numerous ethnobotanical uses. The aerial parts of the plant are used in various decoctions traditionally by the Ibibios of the Niger Delta area of Nigeria to treat stomach ulcer, fever/malaria [2], hemorrhoid, and other inflammatory diseases. The decoction of the plant is used to treat hypertension and as a diuretic [3]. It is commonly known as monkey's potato and locally known as Ebeame in urhobo. The leaves of *Solenostemon monostachyus* are eaten as a pot herb, used locally to treat dysmenorrhea, haematuria, female sterility, rheumatism, diabetes, kidney problems, food infections, snakebites, under developing pregnancy and heart failure. The leave sap is considered sedative and stomachic and is applied internally to treat colic, convulsions, fever, headache and cough, especially in children and externally against eyesight troubles [4]. Researchers such as Lemmens [4] reported that the plant has been traditionally used in the past for ritual purpose related to pregnancy; Ekundayo and Ezeogu, [5] reported that they possess antimicrobial activity; Koffi et al. [3] mentioned that the decoction of the leaves is taken as a diuretic. The ethanolic leaf extract of *Solenostemon monostachyus* has anticonvulsant activity, while the antisickling effect has been reported in experimental animals. *S. monostachyus* in a recent ethnobotanical survey carried out by Chijindu *et al.* [6] had the highest frequency of citation by respondents stating that a decoction of the leaves is used for the treatment of fever, convulsion, stomach ulcer and for the management of under developing pregnancies at Erhuwaren community in Ughelli-South local Government Area of Delta State.

Plate 1: Picture showing the morphological features of *S. monostachyus* (Monkey's Potato).

Minerals play important metabolic roles in the living system [7, 8] and they serve as cofactors for many physiological and metabolical functions [9]. Minerals are essential for proper tissues functioning and as a daily requirement for human nutrition [10]. It has been shown that potassium, calcium and magnesium take part in neuromuscular transmission and together with other elements like manganese, are involved in biochemical reaction in the body as well as physiological processes, such as co-factors for various

metabolic processes [11, 12]. Plants possessing these mineral compositions stand a chance to be used for medicinal purposes.

Antioxidants are found in certain foods and may prevent some of the damages caused by free radicals by neutralizing them. These include the nutrient antioxidants, vitamins A, C and E, and the minerals like copper, zinc and selenium. Antioxidant molecules are essential to support the natural body antioxidant in eliminating the harmful effect of free radicals in consumers. The release of free radicals is a crucial process that takes place even in the normal body metabolism of humans, during which myriad of free radicals are generated by engaging the service of the enzymatic and non-enzymatic antioxidants supplemented in daily diets containing fruits and vegetables.

Antioxidants used in food products, either natural or synthetic, can interact among themselves and result in synergistic, additive, and antagonistic interactions. Naturally occurring antioxidants, including antioxidant vitamins (e.g., vitamin C and vitamin E) and phytochemical antioxidants (e.g., polyphenols and carotenoids), when combined, can result in synergistic interactions, thus favor application in food systems.

The search for plants with minerals and medicinal properties has been ongoing for decades. Several researches have been carried out to ascertain these benefits from various plants existing. However, there is still paucity of documentations regarding the mineral composition and medicinal properties of most existing plants especially weeds. This study was therefore designed to determine the mineral composition and antioxidant properties of the leaves of *Solenostemon monostachyus* (P.Beauv) Briq, a common weed.

RESULTS AND DISCUSSION

Mineral Analysis

The mineral composition of *Solenostemon monostachyus* leaves are shown in Table 1. The results show that calcium had the highest composition (2.64 ± 0.01 mg/kg) followed by manganese (1.74 ± 0.00 mg/kg) and zinc (1.02 ± 0.00 mg/kg). While the composition of iron, copper, nickel and lead were 0.83 ± 0.01 mg/kg, 0.64 ± 0.01 mg/kg, 0.04 ± 0.01 mg/kg and 0.02 ± 0.00 mg/kg respectively.

Table 1. Mineral composition of *Solenostemon monostachyus* (mg/kg)

	Zn	Fe	Mn	Pb	Ni	Cu	Ca
Solenostemon monostachyus	1.02±0. 00	0.83±0.01	1.74±0.00	0.02±0.00	0.04±0.01	0.64±0.01	2.64±0.01

Minerals play important metabolic and physiologic roles in the living system [7, 8] and they serve as cofactors for many physiological and metabolic functions [9]. Minerals are essential for proper tissue functioning and a daily requirement for human nutrition [10]. It has been shown that potassium, calcium and Magnesium take part in neuromuscular transmission and, together with other elements like Manganese, they are involved in biochemical reactions in the body. Minerals are known as constituents of biological molecules that play important roles in metabolic and physiological processes, such as co-factors for various metabolic processes [12].

The calcium content of 2.64±0.01 mg/kg was obtained in the study, which was lower than 22.57 mg/kg obtained by [1] for *Solenostemon monostachyus* leaves. Calcium plays an essential role in building strong healthy bones and teeth in the human body.

The iron content of 0.83±0.01 mg/kg was lower than the value (3.67 mg/kg) obtained in the works of [13]. Iron is a trace element essential for haemoglobin formation, normal functioning of central nervous system and oxidation of carbohydrates, protein and fats [14]. Iron in the body makes tendons and ligaments. Certain chemicals of the brain are controlled by the presence or absence of iron and it is also essential for the formation of haemoglobin which carries oxygen throughout the body [15].

The manganese content of 1.74±0.00 mg/kg was higher than 0.28mg/kg obtained for *S. monostachyus* by [16]. Manganese is an antioxidant and also known to boost the immune system [17]. The deficiency of Manganese element could cause skin damage, anaemia and hypercholesterolemia. It helps in eliminating fatigue and together with Fe, it can be used to treat anaemia [15].

Lead content was 0.02±0.00mg/kg and it has also been reported that lead is highly toxic even at low concentrations [18]. It causes adverse effect in several organ and organ systems including nervous, renal, cardiovascular, reproduction, haematological, and immune system [19].

Nickel content was 0.04±0.01mg/kg. Nickel is a micronutrient essential for proper functioning of the human body. It increases hormonal activity and is involved in lipid metabolism. Nickel is known to enter the human body through the respiratory tract, skin and digestive system [20]. It is toxic at high levels or concentrations.

The works of [21] confirmed that zinc deficiency causes an increase in the frequency of infections. Zinc content of *Solenostemon monostachyus* was 1.02 ± 0.00mg/kg, This is in contrast with the works of [22] with *S. monostachyus* having 150 mg/kg, *Phyllanthus amarus* (37.8 mg/kg), *Cassia alata* (13.2 mg/kg), *Ocimum gratissimum* (38.4 mg/kg) and *Abrus precatorius* (27.7 mg/kg). However, in spite of the low concentration of Zn, the presence of Zn in the plant suggests its possible use for the improvement of the immune system and treatment of microbial infections.

The copper content of *Solenostemon monostachyus* was 0.64±0.01 mg/kg. The adult human body contains approximately 1 mg of copper, 85% of which is in the form of Vitamin B12 [23]. Copper is an essential trace mineral necessary for survival. It is found in all body tissues and plays a role in making red blood cells and maintaining nerve cells and the immune system. It also helps the body form collagen, absorb iron, and plays a role in energy

production. Most copper in the body is found in the liver, brain, heart, kidneys, and skeletal muscle. Both too much and too little copper can affect how the brain works. Deficiency is rare, but it can lead to cardiovascular disease and other problems.

Antioxidant Activity

Results from the antioxidants analysis (DPPH Assay) (Figure 1) revealed a significant difference in the radical scavenging activity of *Solenostemon monostachyus* and Ascorbic acid with *Solenostemon monostachyus* having a significantly higher DPPH radical scavenging activity with an IC_{50} value of 0.25ug/ml than Ascorbic acid with an IC_{50} value of 0.03ug/ml (Figure 1).

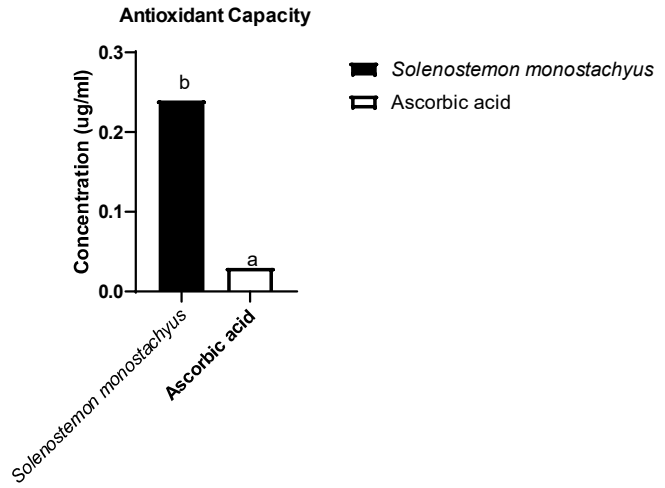

Figure 1: Antioxidant activities of extract of *Solenostemon monostachyus* and Ascorbic acid standard at different concentrations

The total antioxidant capacity of *Solenostemon monostachyus* was 0.6 ± 0.01 (AAE/g) as shown in Table 2 below.

Table 2: Total Antioxidant capacity of *Solenostemon monostachyus*

Sample	Concentration of Total Antioxidant Capacity (AAE/g) extract
Solenostemon monostachyus	0.61±0.01

An Antioxidant is a molecule capable of slowing or preventing the oxidation of other molecules. Oxidation reactions can produce free radicals, which start chain reactions that damage body cells. Antioxidants terminate these chain reactions by removing radical intermediates and inhibiting other oxidation reactions by being oxidized themselves. Antioxidants are often reducing agents such as phenolic compounds like flavonoids and tannins [24].

Antioxidant molecules are essential to support the body by eliminating the harmful effects of free radicals in consumers [25]. The release of free radicals is a crucial process that takes place even in the normal body metabolism of humans, during which a myriad of free radicals are generated as a byproducts. Free radicals are substances normally produced by the human body as one of the defense mechanisms against harmful substances. When the rate of their production exceeds the antioxidant capacity of the body, oxidative stress occurs. Oxidative stress carries harmful effects to all over the body systems and is implicated in the pathogenesis of various diseases including hypertension, atherosclerosis, Diabetes mellitus and cancer [26]. It is normal for all these free radicals to be neutralized in the body by engaging the service of the enzymatic and the non-enzymatic antioxidants. These biochemical actions are also enhanced by engaging the dietary antioxidants supplemented in daily diets containing fruits and vegetables.

CONCLUSION

The leaves of *S. monostachyus* possess minerals and high antioxidant capacity. It may, therefore, be useful in preventing oxidative stress generated by excessive free radicals and degenerative diseases. This leaf showed potential for being used as a medicinal plant (phytotherapeutic) as well as being used for nutrient optimization as mineral supplements.

MATERIALS AND METHODS

Sample Collection and Identification

Fresh leaves of *Solenostemon monostachyus* plant (Monkey's potato) used in the present study were harvested from the Biological Garden, College of Education, Warri, Delta State. The leaves were carefully examined and identified by Dr. Nodza George, a taxonomist at the Department of Botany, University of Lagos and deposited at Lagos University Herbarium (LUH) with the voucher number, 9015.

Sample Preparation

The identified leaves of *Solenostemon monostachyus* plant were properly washed with clean water to get rid of sand, air dried for two weeks and then pounded to powder. The powdered sample was stored in an air tight container for further analysis.

Elemental Assays

Chemicals and Sample Preparation

All chemicals and reagents used in this study were of analytical and trace metal grades. Trace metal grades 65 % HNO_3, 37 % HCl and 70 % $HClO_4$ were obtained from Fisher Malaysia. Stock standard solutions for each metal arsenic (As), cadmium (Cd), lead (Pb), nickel (Ni), zinc (Zn), and iron (Fe) with a concentration of 1000 ppm were supplied by Perkin Elmer USA. Deionized water was used throughout the study.

Method of Digestion

Samples were accurately weighed (0.5 g each) and placed in a 100-mL PTFE beaker. The samples were subjected to three different acid digestion methods to identify the most appropriate digestion method to determine the contents of As, Pb, Cd, Ni, Zn, and Fe in TM samples by AAS. (Nitric-Hydrochloric acid digestion 1:3).

To the sample, 9 mL of freshly prepared acid mixture of 65 % HNO3 was added, and 37 % HCl was added. Then, the mixture was boiled gently over a water bath (95 °C) for 4–5 h (or until the

sample had completely dissolved) [27].

During the digestion procedures, the inner walls of the beakers were washed with 2 mL of deionized water to prevent the loss of the sample, and at the last part of the digestion processes, the samples were filtered with Whatman 42 (2.5-ìm particle retention) filter paper. Then, a sufficient amount of deionized water was added to make the final volume up to 50 ml.

Mineral Analysis

Heavy metals were measured using a Perkin Elmer atomic absorption spectrometer (AAnalyst 800).

Determination of Antioxidant Composition

DPPH Radical Scavenging Activity

The antioxidant activity of the Leaf extracts were evaluated on the basis of the radical scavenging effect of the stable 1, 1 - diphenyl – 2 – picrylhydrazy (DPPH) – free radical activity, in comparison with Ascorbic acid standard, by a slightly modified methods employed by [28]. Ascorbic acid standard (Concentrations 10, 25, 50, 100, 200) was prepared from stock solution in triplicates using suitable dilution. 0.1mm of DPPH was prepared in methanol and 2ml of this solution was mixed with 3ml of the standard solutions in test tubes. These solutions were shaken, then they were allowed to stand for 30 minutes and absorbance was measured at 517nm using UV-VIS spectra photometer. Methanol (3ml) with DPPH solution (0.1mn, 2ml) was used as control. Methanol was used as blank. The same procedures as with the Ascorbic acid standard was carried out with each of the extract sample.

Result Calculation

% inhibition was calculated by the formula given below:

Inhibition of DPPH= (Ab –Aa)/Ab x 100%

Where: Ab is the absorbance of the blank sample and Aa is the absorbance of the extract sample.

Total Antioxidant Capacity (Phosphomolybdate Composition)

Total antioxidant capacity assay (TAC): the total antioxidant capacity of the extract was assessed spectrophotometrically by the phosphomolybdenum method according to the procedure described by [29, 30] which was used with slight modification. For sample preparation, 10mg plant extract was dissolved in 10ml methanol and sonicated for 5 min to get a homogeneous mixture.

One milliliter of each sample extract (0.5mg ml^{-1}) was mixed with 3ml reagent solution (0.6 M H_2SO_4, 28mM Sodium Phosphate and 4mM Ammonium Molybdate). The blank solution contained 4ml reagent solution only.

Ascorbic acid was used as a standard a stock solution of ascorbic acid (10mg/ml) was prepared in distilled water, from which dilutions were made ranging from 25ug/ml to 500ug/ml. the mixture was incubated at 95^{o}c for 9 min. after the mixture had cooled to room temperature, absorbance was measured at 69nm.

Total antioxidant capacity (TAC) was expressed as ascorbic acid equivalent (AAE).

Statistical Analysis

The data obtained from this study was analyzed using Graph pad Prism version 8.02. Values are expressed and presented as Mean ± SD (n = 3).

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