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# Nutritional Qualities and Phytochemical Compositions of Solenostemon monostachyus (Family Lamiaceae)

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**Abstract**
The present study was conducted to evaluate the nutritional qualities and phytochemical constituents of *Solenostemon monostachyus* (SM) , a tropical non-conventional vegetable. The leaves of *Solenostemon monostachyus* were collected from Woji town in Obio-Akpor Local Government Area of Rivers State, South-South Nigeria. The leaves were removed, cleaned and air dried at 28$^{o}$C for 28days and then ground into powdered form. The powder was used for proximate, mineral, vitamins and phytochemical analysis. Proximate analysis revealed that the leaves of SM contained in percentage, carbohydrate (71.83±0.0), protein (10.11±0.0), ash (9.03±0.4), fibre (5.20±0.1) and fat (2.26±0.3). Among all the eight minerals and six vitamins analysed, potassium (1170.11mg/kg) and vitamin C (420mg/kg) respectively were the most abundant, calcium (22.57mg/kg), magnesium (34.49mg/kg), vitamin A (9.27mg/kg), vitamin $B_6$ (4.93mg/kg), vitamin E (12.35mg/kg) were found in lower concentrations, while others were found in trace quantities. Phytochemical analysis of the leaves showed in percentage the presence of tannins (4.66±0.02), saponins (14.82±0.31), alkaloids (19.69±0.31), flavonoids (14.77±0.22), cyanogenic glycosides (0.53±0.12) and phytate (2.10±0.00).
**Keywords:** Proximate, mineral, vitamin, phytochemical, analysis, Solenostemon monostachyus

## 1. Introduction

Various scientific approaches have been employed for exploration of large number of medicinal plants. These medicinal plants are used as vegetable species in human diets in different countries (Afolabi, 2012), in phytomedicine for the wellbeing of human populace (Fagbohun, 2012) as supplementary feeds to livestock such as rabbits, poultry, swine and cattle (Aletor and Adeogun, 1995), and for their therapeutic purposes which are precursors for synthesizing useful drugs (Sofowora,2008).

Solenostemon monostachyus which belongs to the family Lamiaceae is an important edible herb which can be found mostly within the tropical 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 100 cm tall (Mba and Menut, 1994). 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 and snakebites. The leaf 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 (Lemmens, 2004). Reaseachers such as Lemmens (2004) reported that the plant has been traditionally used in the past for ritual purposes related to pregnancy; Ekundayo and Ezeogu (2006) reported that they possess antimicrobial activity ; Koffi et al. (2009) mentioned that the decoction of the leaves is also taken as a diuretic. Afolabi (2012) highlighted that the ethanolic leaf extract of *Solenostemon monostachyus* has anticonvulsant activity, while the antisickling effect of *Solenostemon monostachyus* has been examined in experimental animals.

The presence of various types of phytochemicals in plants has been implicated in the health promoting properties of these plants and this beneficial activity is related to their antioxidant activity (Heim et al., 2002). The nutrients found in vegetables serve as indispensable constituents of the human diet supplying the body with minerals, vitamins, dietary fibre and certain hormone precursors, in addition to protein and energy and may also prevent certain types of cancers and promote heart health (Afolabi et al., 2012)

This study highlights the chemical properties, nutritional composition and phytochemical properties of the leaves of *Solenostemon monostachyus* through the evaluation of its proximate, phytochemical, mineral and vitamin compositions. The knowledge of the nutritional composition and phytochemical properties of this non-conventional leafy vegetable may improve its uses.

## 2. Materials and methods

2.1. Plant material

Fresh leaves of *Solenostemon monostachyus* were collected from Woji town in Obio-Akpor Local Government Area of Rivers State, South-South Nigeria. The plant material was identified by Prof. B.E. Okoli of the Department of Plant Science and Biotechnology, University of Port Harcourt, Rivers State, Nigeria.

2.2 Processing of plant material

The fresh leaves of *Solenostemon monostachyus* were cleaned and air dried at 28$^{o}$C for 28days. They were grounded into fine powder using an electric blender before use.

 

2.3. Ethics statement

For the collection of plants, no specific permits were required for the described field studies. For any locations/activities, no specific permissions were required. All locations where the plants were collected were not privately-owned or protected in any way and the field studies did not involve endangered or protected species.

2.4. Determination of mineral composition

The mineral composition was determined using Atomic Absorption Spectrophotometer. 10 g of each sample was weighed into a crucible and pre-ashed using a heater for about 10 minutes. The appearance of a black colour was used to indicate the end of the pre-ashing process. This was heated using murffle furnance (Carbolite model MA450) at 500 °C for about 20 hours. Nitric acid solution (1% v/v) was thereafter added to the ashed sample. The diluted sample was filtered using a whatmann filter paper. The filtrate was placed in a trace metal bottle for trace mineral analyses using a flame atomic absorption spectrophotometer (Schimadzu Model AA6800).

2.5 Determination of vitamin composition

The vitamin composition was determined using uv-visible spectrophotometer. To 10mls of methanol was added 0.5g of sample. It was filtered and poured into a cuvette for analysis using uv-visible speed for various vitamins based on their standard calibration curves.

2.6 Determination of proximate composition

The moisture content, ash content, crude fibre content, crude lipid content, and total carbohydrate content, were determined by the method of Association of Official Analytical Chemists, AOAC (2006), while crude protein content was by Kjeldahl method.

2.7 Determination of phytochemical composition

Quantitative phytochemical analysis to determine the presence of alkaloids, tannins, saponins , phytate, flavonoid and cardiac glycosides using standard methods as described by Trease and Evans (1985), Harbone (1984) and Sofowora (2008) were carried out.

## 3. Results

**Table 1: Proximate composition of leaf of *Solenostemon monostachyus.***

| Parameter | Composition (%) Dry weight |
|---|---|
| **Crude protein** | **10.11±0.00** |
| **Crude fibre** | **5.20±0.10** |
| **Moisture** | **1.92±0.44** |
| **Total ash** | **9.03±0.14** |
| **Crude lipid** | **2.26±0.10** |
| **Total carbohydrate** | **71.83±0.00** |

**Table2: Phytochemical composition of the leaves of *Solenostemon monostachyus.***

| Parameter | Composition (%) Dry weight |
|---|---|
| **Tannin** | **4.66±0.02** |
| **Phytate** | **2.10±0.00** |
| **Saponin** | **14.82±0.31** |
| **Alkaloid** | **19.69±0.31** |
| **Flavonoid** | **14.77±0.22** |
| **Cyanogenic Glycoside** | **0.53±0.12** |

 

**Table3: Mineral composition of the leaves of *Solenostemon monostachyus.***

| Element | Composition (mg/kg) Dry weight |
|---|---|
| **Calcium** | **22.57** |
| **Iron** | **3.67** |
| **Manganese** | **0.28** |
| **Potassium** | **1170.11** |
| **Magnesium** | **34.49** |
| **Chromium** | **0.73** |
| **Lead** | **2.31** |
| **Zinc** | **0.50** |

**Table4: Vitamin composition of the leaves of *Solenostemon monostachyus.***

| Vitamins | Composition (mg/kg) Dry weight |
|---|---|
| **Vitamin A** | **9.27** |
| **Vitamin $B_3$** | **1.12** |
| **Vitamin $B_6$** | **24.93** |
| **Vitamin $B_{12}$** | **2.79** |
| **Vitamin C** | **420.0** |
| **Vitamin E** | **12.35** |

## 4. Discussion

The proximate composition of *Solenostemon monostachyus* leaves are shown in table 1. The results showed that the protein content of *Solenostemon monostachyus* was 10.1%. The protein value was found to be lower than 16.41% for *Amaranthus viridus* (Pandey et al., 2006), 20.59% for *Amaranthus caudatus* and 31.00% for *Talinum triangulare* [Akindahunsi & Salawu, 2005], but higher than *Ocimum gratissimum* (3.33%) (Idris et al., 2011) and 8.13% for *C. procera* (Mombouli et al., 2014), but close to *Momordica balsania* L. (11.29) (Isong and Idong, 1997). The Recommended Dietary Allowance (RDA) for protein is in the range of 28-65 g for children, lactating mothers, pregnant women and adults (Adinortey *et al*., 2012).The crude fibre value of 5.2% for *S. monostachyus* was lower than that for the leaves of *O. gratissimum, M. scandens* and *L. guinensis* which were (11.38, 12.66 and 9.61)% respectively (Fagbohun et al., 2012), *A. esculentus* with 14.71%, *M. charantia* with 16.62% *(*Hussain *et al.,*2009*)* but higher than that of *Gnetum africanum* 4.60%, *M. ureans* 4.00% (Ekpo, 2007). Adequate intake of dietary fibre can lower the serum cholesterol level, heart disease, hypertension, constipation, diabetes and breast cancer (Ishida *et al.,* 2000). The moisture content of 1.92% was lower than the moisture content (in %) values for the leaves of *O. gratissimum* (5.04), *M. scandens* (6.54) and *L.guineensis* (5.69) (Fagbohun et al., 2012) and *Xylopia aethiopia* (16.04) (Abolaji *et al.,* 2007. High moisture content is index of spoilage ( Dewole *et al*., 2013).The low moisture content of the leaf increases the storage life by hindering the growth of microorganisms. The ash content of 9.03% was lower than the values reported for the leaves of *A. viridus* (22.84%) [Pandey et al., 2006], *Ipomea batatas* with 11.10% and *Moringa oleifera* with 15.09% (Antia *et al.,* 2006), but higher than the values for *O. gratissinum*, *M. scandens* and *L. guineensis* leaves which were (5.11, 7.73 and 7.43) respectively (Fagbohun et al., 2012). The ash content represents the mineral contents of the food materials. The crude fat content of 2.26% was close to *Gnetum africanum* (3.15%) (Abolaji *et al.,* 2007) but lower than *O garanissimu, M. scandens* and *L. guineeensis* which were (7.57, 6.81 and 7.28) % respectively (Fagbohun, 2012). Dietary fat increases the palatability of food by absorbing and retaining flavours, but its excess consumption is implicated in certain cardiovascular disorders such as atherosclerosis, diabetes, cancer and ageing [Antia et al., 2006].The carbohydrate content of 71.83% is close to the value reported for *P. fistulosus* (62.39) (Hussain *et al.*, 2009), but higher than that of *O. gratissimum, M. scandens* and *L. guineensis* leaves content which were (56.16, 50.08 and 50.71)% respectively (Fagbohun et al., 2012), *Senna obstusfolia* (23.70%) and *Amaranthus incurvatus* (39.05%) (Faruq *et al.*, 2002). This value was however found to be very much higher than 2.36% for *B. Oleracea* (Emebu and Anyika, 2011). The leaf can serve as a good source of energy for both man and animal because of its high carbohydrate content which meets the Recommended Dietary Allowance (RDA) values (FND, 2002). Carbohydrate promotes the utilization of dietary fats and reduces wastage of proteins (Balogun and Olatidoye, 2012).

The phytochemical composition of *Solenostemon monostachyus* leaves are shown in table 2. Tannin is non toxic, but can be toxic to filamentous fungi, yeast and bacteria and may generate physiological responses in

 

animals that consume them (Scalbert, 1991). The presence of tannin suggests the ability of this plant to play major roles as antifungal, antidiarrheal, antioxidant, antihaemorrhagic and antihemorrhoidal agent (Asquith and Butter, 1986).Phytate has been linked to the prevention of kidney stone, dental decay and calcification of blood vessels. Saponins have been reported to be potentially useful for the treatment of hyperglycemia, hypercholesterol (Trease and Evans, 1985), hypertension (Olaleye, 2007) and to have anti-inflammatory property and aid healing (Krishnaiah *et al*., 2009). They also appear to kill or inhibit cancer cells without killing the normal cells in the process (Lewis and Elvin-Lewis, 1995). Alkaloids have been reported to be powerful pain relievers, exert an anti-pyretic, antihypertensive antifungal, antiinflammatory, antifibrogenic effect (Awoyinka *et al.,* 2007), stimulating, anesthetic action (Edeoga and Enata, 2001) and inhibiting activity against most bacteria (Al-Bayati and Sulaiman, 2008). Flavonoids are known to have antibacterial, anti-allergic, antiviral and anti-neoplastic activity (Ali, 2009) and have been reported to show anti inflammatory and antimicrobial activities (Cushnie and Lamb, 2005). They contribute to a variety of health problems, including cancer, heart disease and aging by acting as antioxidants that neutralize free radicals (Stauth, 2007). Flavonoids modify the body's reaction to allergens, virus and carcinogens. The cardiac glycoside has been used for over two centuries as stimulant in cases of cardiac failure and diseases (Trease and Evans, 1978; Olayinka *et al.,* 1992).

The mineral composition of *Solenostemon monostachyus* leaves are shown in table 3. Minerals play important metabolic and physiologic roles in the living system (Enechi and donwodo, 2003; Ujowundu *et al*., 2010) and they serve as cofactors for many physiological and metabolic functions (Balogun and Olatidoye, 2012). Minerals are essential for proper tissue functioning and a daily requirement for human nutrition (Iniaghe *et al*., 2009). 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 physiologic processes, such as co-factors for various metabolic processes (Mayer and Vyklicky, 1989; Brody, 1994). The calcium content of 22.57 mg/kg was obtained in the sample, which is lower than 360.29mg/kg for *L. guineensis* and 510.44mg/kg for *O. gratissimum* ((Fagbohun et al., 2012). Calcium plays an essential role in building strong healthy bones and teeth in life. 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 (Vaughan and Judd, 2003). The iron content of 3.67mg/kg was lower than 109.30 mg/kg for *O. gratissimum,* 50.80mg/kg for *L. guineensis* and 88.80 mg/kg for *M. scandens* [Fagbohun et al., 2012]. Iron is a trace element essential for haemoglobin formation, normal functioning of central nervous system and oxidation of carbohydrates, protein and fats (Adeleye and Otokiti, 1999). The manganese content of 0.28mg/kg was lower than 20.00mg/kg for *C. aconitifolius* (Shittu et al., 2014) and 12.20 mg/1kg for *L. guineensis* [Fagbohun et al., 2012], but was high when compared to 0.08 mg/kg for *M. scandens* [Fagbohun et al., 2012]. Manganese is an antioxidant and also known to boost the immune system [Talwar, 1989]. The potassium content of 1,170.11mg/kg was higher than 64.20 mg/kg for *Diospyros mespiliformis* and 427.40 mg/kg for *Mucuna flagellipes* [Ihedioha and Okoye, 2011]. High potassium could be an advantage for people who take diuretics to control hypertension and who suffer from excessive excretion of potassium through the body fluids (Siddhuraju *et al*., 2001). The magnesium content of 34.49mg/kg was lower than 286.80mg/kg for *L. guineensis* (Fagbohun et al., 2012) but higher than 24.20 mg/kg of *Xylopia aethiopia* [Abolaji et al., 2007]. Magnesium is a constituent of chlorophyll and it is an important component in connection with Ischemic heart disease and calcium metabolism in bones [Ishida, 20007]. The chromium content of 0.73mg/kg was close to that of 0.6mg/kg for *C. aconitifolius* (Shittu et al., 2014). Lead content was 2.31mg/kg and it has also been reported that lead are highly toxic even at low concentrations (Asaolu *et al.,* 1997). It causes adverse effect in several organ and organ systems including nervous, renal, cardiovascular, reproduction, haematological, and immune system (Patil *et al*., 2006).

The vitamin composition of *Solenostemon monostachyus* leaves are shown in table 4. The vitamin A content of 9.27mg/kg was lower than 250.22mg/kg for *Ficus c*apensi) and 63.31mg/kg for *Cnidoscolus acontifolius* (Achikanu et al., 2013). Vitamin A is important for normal vision, gene expression, growth and immune function by its maintenance of epithelial cell functions (Lukaski, 2004). The vitamin C content of 420mg/kg was higher than 229.50mg/kg for *Heinsia crinite* (Emebu and Anyika, 2011), 5.6mg/kg for *Moringa oleifera* (Achikanu et al., 2013) and 23.00mg/kg for *Cnidoscolus acontifolius* (Achikanu et al., 2013) and close to 410mg/kg of *Brassica oleracea* (Hall, 1998). Vitamin C is a potent antioxidant that facilitates the transport and uptake of non-heme iron at the mucosa, the reduction of folic acid intermediates and the synthesis of cortisol. Its deficiency includes fragility to blood capillaries gum decay and scurvy (Achikanu et al., 2013). Vitamin E is a powerful antioxidant which helps to protect cells from damage by free radicals and it is vital for the formation and normal function of red blood cells and muscles (Lukaski, 2004). The vitamin $B_3$ content of 1.12mg/kg was lower than 5.12 mg/kg for *Momordica charantia* and higher than 0.51mg/kg for *Amaranthus viridis* . The vitamin $B_6$ complex of 24.93mg/kg was higher than 7.55 mg/kg of *Lagenaria vulgaris* and 1.52 mg/kg of *Amaranthus gangeticuss.* (Hasan et al., 2013). The vitamin $B_{12}$ of 2.790mg/kg was reasonably high. Vegetables

 

have been reported to be poor sources of vitamin $B_{12}$ (NIH, 2008). Vitamin $B_{12}$ is essential for the maintenance of healthy body where it plays a key role in the normal functioning of the brain and nervous system, and for the formation of blood.

## 5. Conclusion

This study revealed that the leaves of *Solenostemon monostachyus* can be considered as an alternate source of energy and other nutrients which are important in fighting against malnutrition in developing countries. *Solenostemon monostachyus* can play an essential role in the success of the World Health Organization's (WHO) global initiative on increased consumption of fruit and vegetables. It is recommended that *Solenostemon monostachyus* be taken in combination with other foodstuffs in order to satisfactorily meet nutritional needs. The presence of bioactive compounds is an affirmation of the use of *Solenostemon monostachyus* leaves in the management of various ailments, and can serve as a potential source of useful drugs.

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