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Nutritional Evaluation of *Mucuna flagellipes* Leaves: An Underutilized Legume in Eastern Nigeria

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ABSTRACT

The aim of the study was to determine the nutritional composition of *Mucuna flagellipes* leaves and thus discover the potentials of this underutilized legume in nutrition. The leaves were analyzed for their proximate, mineral compositions and some anti-nutritive factors and toxic metals. Various standard methods were used in the proximate analysis; nitrogen was determined by Kjeldahl method, available carbohydrate was calculated by difference while mineral analysis was carried out after acid digestion (2:1 v/v HNO_3/$HClO_4$) with spectrophotometers. The proximate content on % dry matter were moisture content (10.33±1.04), crude fibre (10.67±1.04), ash content (7.80±0.20), crude lipid (0.83±0.29), crude protein (1.16±0.13) and available carbohydrate (69.20±1.82). The leaves have low estimated energy value (256±7.97 kcal/100 g). The mineral analysis of the leaves gave the following in mg/100 g: Na (3.29±0.70), K (42.74±1.00), Ca (313.30±9.97), Mg (112.73±1.06), P (5.72±0.001), Zn (5.38±3.14), Cr (0.34±0.42), Cu (1.33±0.33) and Fe (57.08±8.44) while anti-nutritive content gave phytate (2.34±0.02), nitrate (1.66±0.03) and toxic metals gave Pb (0.03±0.04) and Cd (0.04±0.06). *Mucuna flagellipes* leaves can supplement the recommended dietary intake (RDI) of Fe, Ca and Cu.

Key words: *Mucuna flagellipes*, proximate, mineral, anti-nutritive, toxic metal, recommended dietary intake

INTRODUCTION

Mucuna is a genus of around 100 accepted species of climbing vines and shrubs of the family fabacea found worldwide in the woodlands of tropical areas (Hutchison and Dalziel, 1973). The specie *Mucuna flagellipes* commonly known as 'agbara' in Ibo part of Eastern Nigeria is a very strong forest climber, having a long stalk of about 4 inches and hanging downwards. The flowers are creamy white or yellowish, subtended by grey-hairy bracts and are attached to the last 3 inches where the stalk zig-zags. The fruit is a pod covered with stinging hairs which readily dislodge and cause skin irritation and itching due to the presence of mucanian. The leaves are greenish and trifoliate with leaflets broadly ovate, elliptic and unequal at the base (Hutchison and Dalziel, 1973).

Mucuna plants have been reported to possess useful phytochemicals of high medicinal value of human and veterinary importance and also constitute as an important raw material in Ayurvedic and folk medicines (Sridhar and Bhat, 2007). The seeds constitute as a good source of several alkaloids, antioxidants, antitumor and antibacterial compounds and are the major source of L-DOPA which serve as a potential drug in providing symptomatic relief for Parkinson's disease

(Sridhar and Bhat, 2007). Roots of *Mucuna* are used in Ayurveda and in indigenous medicines to relieve constipation, nephropathy, strangury, dysmenorrhoea, amenorrhoea, elephantiasis, dropsy, neuropathy, consumption, ulcers, helminthiasis, fever and delirum while the leaves are aphrodisiac, anthelmintic and useful in treating ulcers, inflammation, helminthiasis, cephalalgia and general debility (Sridhar and Bhat, 2007).

Iyayi and Egharevba (1998) has reported that seeds of mucuna constitute source of food for some tribes and ethnic groups in Asia and Africa. The immature pods and leaves serve as vegetable while the seeds are used as condiment and main dish by some ethnic groups in Nigeria (Adebowale and Lawal, 2003). Several workers have reported the use of seeds of mucuna accessions as food (Afolabi *et al*., 1985; Wanjekeche *et al*., 2003; Diallo *et al*., 2002; Egounlety, 2003) and feed (Muinga *et al*., 2003; Castillo-Caamal *et al*., 2003; Emenalom *et al*., 2004). Data available on the use of seeds of *Mucuna flagellipes* are scanty. Ezueh (1997) reported that the seeds are cracked, cooked, hulled, ground and mixed with red oil to obtain a yellow paste used as soup thickener. The use of polysaccharide gum extracted from seeds of *Mucuna flagellipes* in the preparation of raw beef burgers has been reported by Onweluzo *et al*. (2004) but no data were available on the use of the leaves of the plant.

It is a common practice by the rural dwellers in Eastern Nigeria to squeeze the leaves of *Mucuna flagellipes* in water and take it orally in order to boost the blood level. This study was therefore designed to investigate the nutritional composition of the leaves of the plant in order to evaluate the proximate and mineral composition, some anti-nutritive factors and toxic metals. The data obtained could show the potentials of this underutilized legume in nutrition, agricultural development and medicinal purposes.

MATERIALS AND METHODS

Sample collection and pretreatment: Fresh leaves of *Mucuna flagellipes* were collected from the Green house area in the University of Nigeria, Nsukka during the month of December 2009. The leaves were identified at the Botany Department. The leaves were oven dried, milled with mortar and pestle into a fine powder, and passed through a 20 mm mesh sieve. The sample was later put in polyethylene bag and kept in a desiccator until analysis.

Sample analysis: Proximate analysis for moisture, ash, crude fibre and crude lipids content were carried out in triplicates according to the methods described by AOAC (1984). Nitrogen was determined by Kjeldahl method (Pearson, 1976) and converted to protein by multiplying by a factor of 6.25. Available carbohydrate was calculated by difference. The energy value was estimated in kcal/100 g as the sum of by % crude protein×2.44, % crude lipid×8.37 and % carbohydrate×3.57 (Martin and Coolidge, 1978).

Mineral analysis was carried out after acid digestion of 2 g of the ground leave sample with 10 mL of a mixture of nitric acid and perchloric acid (2:1 v/v) until a clear solution was obtained. The digest was allowed to cool and then transferred into a 20 mL standard flask and made up to mark with de-ionized water. Calcium, magnesium, copper, chromium, zinc, iron, cadmium and lead were analysed with atomic absorption spectrophotometer (GBC Avanta Ver 2.02 Model, Australia) equipped with air-acetylene flame. Phosphorus content was determined colorimetrically using Spectro 21D (PEC Medicals, USA) spectrophotometer while sodium and potassium were determined using a flame photometer (Gallenkamp flame analyser, UK).

Phytate was analysed using the method described by Pearson (1976) and nitrate by sodium salicylate method. This involve reacting the digested sample with sodium salicylate

in an acidic environment, giving nitrosalicylate acid transformed on alkalization into the coloured (yellow) ionized form. Both were determined with Spectro 21D (PEC Medicals, USA) spectrophotometer.

RESULTS AND DISCUSSION

The results of the proximate composition of *Mucuna flagellipes* presented in Table 1 shows that the leaves moisture content was 10.33%. This is low and could be attributed to the period of sampling. The sampling was in the harmattan period, a season characterized by intensive sunlight and dryness. Moisture content makes important contribution to the texture of the leaves and help in maintaining the protoplasmic content of the cells; it also makes leaves perishable and susceptible to spoilage by micro-organism during storage (George, 2003). This value was comparable to 9.6-10.8% reported for some indigenous leafy vegetables in Ebonyi state, Nigeria (Nnamani *et al.*, 2009) but lower than 15.58-30.90% reported for some Nigerian leafy vegetables (Onwordi *et al.*, 2009) and 78.85-89.01% reported for some Cameroonian leafy vegetables (Ejoh *et al.*, 2007).

The crude fibre content of *M. flagellipes* leaves (10.67%) was higher than 3.65-4.43% reported for seeds of 12 *mucuna* accessions in Nigeria (Ezeagu *et al.*, 2003); (8.61%) reported for *Aranthus hybridus* (Akubugwo *et al.*, 2007) but lower than 22.36% reported by Hassan and Ngaski (2007). However, the value is comparable to 6.7-11.70% reported by Onwordi *et al.* (2009); 4.50-12.70% reported by Nnamani *et al.* (2009) for some Nigerian leafy vegetables and 11.6% reported by Amata (2010) for leaves of *Myrianthus arboreus*. Adequate intake of dietary fibre can lower serum

Table 1: Proximate composition of *Mucuna flagellipes* leaves

Parameter	Concentration (% Dry matter)
Moisture	10.33±1.04
Crude fibre	10.67±1.04
Ash content	7.80±0.14
Crude protein	1.16±0.13
Crude lipid	0.83±0.29
Carbohydrate	69.20±1.82
Calorie value (kcal/100g)	256.86±7.97

Mean±SD; n = 3

Table 2: Mineral composition of *M. flagellipes* leaves

Minerals	Concentration (mg/100 g)
Sodium	3.29±0.71
Potassium	42.74±1.00
Calcium	313.30±9.97
Magnesium	112.73±1.06
Phosphorus	5.72±0.001
Zinc	5.38±3.14
Chromium	0.34±0.42
Copper	1.33±0.33
Iron	57.08±8.44
Na/K	0.08
Ca/P	55.00

Mean± SD; n = 3

Table 3: Some anti-nutritive factors and toxic metals in *M. Flagellipes* leaves

Parameter	Concentration (mg/100 g)
Phytate	2.34±0.02
Nitrate	1.66±0.03
Cadmium	0.04±0.04
Lead	0.03±0.06

Mean±SD; n = 3

cholesterol level, risk of coronary heart disease, hypertension, constipation, diabetes, colon and breast cancer (Rao and Newmark, 1998; Ishida *et al*., 2000).

The ash content is a measure of a plants mineral content. The ash content (7.80%) of *M. flagellipes* leaves indicates that the leaves contain appreciable amount of mineral elements. The value was higher than 3.25-4.16% reported for seeds of some species of mucuna (Ezeagu *et al*., 2003) but lower than 18.00% reported by Hassan and Umar (2006) for leaves of *Momordica balsamina* and 16.4% reported by Amata (2010) for leaves of *Myrianthus arboreus*. However, the value was comparable to 6.30-8.10% reported by Nnamani *et al*. (2009). The crude lipid content (0.83%) was low compared to 4.72-6.90% reported for seeds of some mucuna species (Ezeagu *et al*., 2003) and 3.7% reported by Adewolu and Adamson (2011) for *Amaranthus spinosus* leaf meal. It was also low compared to 2.66% reported by Hassan and Umar (2006) and 8.3-27.0% reported in some vegetables consumed in Nigeria and Republic of Niger (Ifon and Bassir, 1980; Sena *et al*., 1998). This value was higher than 0.45%, 0.21% and 0.32% reported for *A. cruentus, C. argenta* and *C. olitorius,* respectively (Onwordi *et al*., 2009) and 0.023% of *Gynura procumbens* reported by Puangpronpitag *et al*. (2010). However, the value compared well with 0.52-0.75% reported for some *Sonchus species* (Guil-Guerrero *et al*., 1998). Generally, the low value of crude lipid in *M. flagellipes* leaves agrees with the findings of many authors that leafy vegetables are poor sources of lipids (Ejoh *et al*., 2007). Thus consumption of vegetable leaves in large amount is a good dietary habit and may be recommended to individuals suffering from overweight and obesity.

The crude protein content was 1.16% quite lower than reported values for some Nigerian leafy vegetables (Hassan and Umar, 2006; Hassan and Ngaski, 2007; Nnamani *et al*., 2009; Onwordi *et al*., 2009) and 4.51% reported by Puangpronpitag *et al*. (2010). The crude protein content was also lower than the leaves of *Z. acanthopodium* (28.06%), *C. colebrookianum* (27.67%) and *O. linearis* (21.80%) reported by Seal (2011).This indicates that *M. flagellipes* leaves is a poor source of protein and would require dietary supplementation with proteins from cereal and legumes in order to achieve the daily requirement of 34-56 g for adults, 13-19 g for children and 17-71 g for pregnant women (FND, 2002).

The available carbohydrate (69.20%) was comparable to values reported by Nnamani *et al*. (2009) and Ejoh *et al*. (2007) for some Nigerian and Cameroonian leafy vegetables respectively. But higher than 48.25% reported by Hassan and Nagaski (2007) and 38.24-45.26% reported by Iniaghe *et al*. (2009) for leaves of some *Acalypha* species.

The estimated energy value in the leaves was 256.86 kcal/100 g of the dry sample. This value was low compared to the daily energy requirement of 2500-3000 kcal for adults (WHO/FAO, 1985). The value is higher than 133.34 kcal/100 g reported by Amata (2010) for leaves of *Myrianthus arboreus*. However, the value compared with 248.8-307.1 kcal/100 g reported in Nigerian vegetables (Isong *et al*., 1999) and 283.1 kcal/100 g and 288.3 kcal/100 g reported in some Ghanaian green leafy vegetables (Asibey-Berko and Tayie, 1999).This shows that the plant leave have low calorific values and can be classified as low energy foods.

The result of mineral analysis (Table 2) shows that calcium has the highest concentration (313.30 mg/100 g). Calcium is good for growth and maintenance of bones, teeth and muscles (Dosunmu, 1997; Turan *et al*., 2003). The phosphorus content was low (5.72 mg/100 g). Calcium and phosphorus are the minerals present in the largest quantity in the structure of the body and bones. The concept of Ca/P ratio as introduced by Shills and Young (1988), takes into cognizance that diets rich in animal proteins and phosphorus, promotes the loss of calcium in urine, resulting in a decrease of calcium levels in bones. Nieman *et al*. (1992) considered a food source good if the Ca/P is above 1 and poor if the ratio is less than 0.5. *Mucuna flagellipes* leaves with Ca/P = 55 is therefore a good source of minerals needed in bone formation.

M. flagellipes leaves have low amount of sodium (3.29 mg/100 g) with relatively high concentration of potassium (42.74 mg/100 g). This value is low compared to Na (95-320 mg/100 g) and K (1610-8440 mg/100 g) reported for leaves of some wild edible plants from India (Seal, 2011). The Na/K ratio in the body is important because it helps in controlling high blood pressure (Yusuf *et al*., 2007). Na/K ratio of less than one is recommended; hence, *M. flagellipes* leaves with Na/K = 0.08 is good and adequate use of the leaves as vegetables in diets could be useful in lowering blood pressure.

The concentrations of essential micro-nutrients are in the order Fe>Zn>Cu>Cr. Iron is an essential trace element for haemoglobin formation, normal functioning of the central nervous system and oxidation of carbohydrates, proteins and fats (Adeyeye and Otokiti, 1999). The high percentage of iron in *M. flagellipes* could help in boosting of the blood level in anaemic conditions. Rural dwellers who use the leaves to treat such conditions have claimed huge success and % iron content tends to support their claim.

Zinc is an essential element in the nutrition of man where it functions as an integral part of numerous enzymes or as a stabilizer of the molecular structure of sub-cellular constituents and membrane (WHO, 1996). Zinc participates in the synthesis and degradation of carbohydrate, lipids, proteins and nucleic acids and has been shown to play an essential role in polynucleotide transcription and translation and thus in the process of genetic expression (WHO, 1996). The Zn content of *M. flagellipes* was higher than 3.18 mg/100 g reported by Hassan and Umar (2006) for *Mormordica balsamina* leaves but in the range of 5-9 mg/100 g reported by Onwordi *et al*. (2009) for leafy vegetables in Lagos. The leaves of this plant are therefore good sources of vegetables for human diet with respect to zinc.

Copper is an essential trace element in human body where it exists as an integral part of copper proteins ceruloplasmin which is concerned with the release of iron from the cells into the plasma and is involved in energy metabolism (McDonald *et al*., 1995; Adeyeye, 2002). The copper content of *M. flagellipes* was lower than 2.32 100 g reported by Ibrahim *et al*. (2001) for *Vernonia amygdalina* but comparable to 1.2-1.8 mg/100 g reported by Barminas *et al*. (1998) for some non-conventional leafy vegetables in Yola.

Chromium is an essential nutrient that potentiates insulin action and thus influences carbohydrate, lipid and protein metabolism (WHO, 1996). The chromium content (0.34 mg/100 g) was higher than 0.022 mg/100 g reported for spinach grown in the vicinity of an industrial area (Farooq *et al*., 2008).

The phytate content of *M. flagellipes* as shown in Table 3 is moderate compared to 8.2 mg/100 g reported by Hassan and Ngaski (2007) for *Cassia Siamea* leaves. However, the value is lower than 25 mg/100 g reported by Amata (2010) for leaves of *Myrianthus arboreus*. The negative effect of phytate in nutrition is the chelating of certain essential elements such as Ca,

Fe, Mg and Zn. This contributes to mineral deficiencies in people whose diets rely on some food rich in phytate for their mineral intake (Hurrell, 2003). Nevertheless, phytates are considered as phytonutrients providing an antioxidant effect and their mineral binding properties prevents colon cancer by reducing oxidative stress in the lumen of the intestinal tract (Vucenik and Shamsuddin, 2003). Researchers believe that phytate found in legumes and grains is the major ingredient responsible for prevention of colon cancer and other cancers Jenab and Thompson (2000). It has been shown that phytate is protective against Parkinson's disease in vitro (Xu *et al*., 2008). The compound significantly decreased apoptotic cell death induced by 1-methyl-4-phenylpyridinium in a cell culture model.

The concentration of nitrate in *M. flagellipes* is 1.66 mg/100 g, quite lower than 13.5 mg/100 g reported by Hassan and Ngaski (2007) for *Cassia Siamea* leaves and 30-450 mg/100 g reported by Asegbeloyin *et al*. (2008) for *Vernonia amygdalina* leaves. The potential hazard of nitrate for consumers is mainly associated with the generation of nitrites and carcinogenic N-nitrosamines (Fernlof and Darnerud, 1996). The concentration in *M. flagellipes* leaves cannot lead to any health hazard in consumers Cd (0.04 mg/100 g) and Pb (0.03 mg/100 g) were far lower than the maximum permissible limit of 2 mg/100 g and 3 mg/100 g of cadmium and lead, respectively for vegetables (FAO/WHO, 2001) and thus within safe limits for consumption of the leaves of *M. flagellipes* as vegetables in diets.

The variations in the results from this study and other reported works may be due to different types of leaves studied, geographical factors of the studied area, sampling period and other factors.

CONCLUSION

The results of this study indicate that *M. flagellipes* leaves are good sources of plant crude fibre and minerals especially calcium, magnesium, iron and potassium with moderate levels of phosphorus, sodium, phytate, nitrate, cadmium and lead. Comparing the mineral content with recommended dietary allowances of 260, 18 and 0.9 mg day^{-1} for Ca, Fe and Cu, respectively (FAO/WHO, 2001), *Mucuna flagellipes* can supplement the requirements of Fe, Ca and Cu in human diets.

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