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ANALYSIS OF NUTRITIONAL COMPONENTS OF THE LEAVES OF *MORINGA OLEIFERA*

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Abstract

Determination of proximate and mineral composition of the leaves of *Moringa oleifera* were carried out using standard methods of food analysis. The results of proximate composition revealed that the leaves contained 71.60±1.06 % moisture, 12.38 ± 0.14 % ash, 10.49±0.14% crude protein, 15.32±0.28% crude lipid and 36.51± 0.28 % available carbohydrate. The leaves also had high energy value of 284.16 0.11 kcal/100g. Mineral analysis showed that potassium (2722.05±0.02 mg/100g) and magnesium (75.63±0.04 mg/100g) were the dominant elements. The leaves also contained appreciable concentrations of Na (44.63±0.06 mg/100g), Ca (53.61± 0.02 mg/100g), P (12.03±0.15 mg/100g), Cu (3.38±0.04 mg/100g), Fe (18.69± 0.05 mg/100g), Mn (5.02±0.05 mg/100g) and Zn (2.61± 0.02 mg/100g) contents. Comparing the mineral content with recommended dietary allowance, it was showed that the plant leaves are good sources of K, Cu, Fe and Mn for all categories of people. From the analyses, it can be concluded that the leaves of *Moringa oleifera* could be used for nutritional purposes, due to the amount and diversity of nutrients they contained.

Keywords: *Moringa oleifera, Proximate, mineral elements, Leaf vegetable*

INTRODUCTION

Moringa oleifera, commonly referred to simply as Moringa is the most widely cultivated variety of the genus moringa. It is of the family moringaceae. It is an exceptionally nutritious vegetable tree with a varity of potential uses (Moringa oleifera,2008). Other name for the Moringa in English include: Drumstick tree, from the appearance of the long, slender, triangular seed pods; Horseradish tree, from the taste of the leaves, which can serve as a rough substitute for horseradish and Ben oil tree, from the oil derived from the seeds.The vernacular names include Zogallagandi (Hausa), Okwe oyibo (Igbo), Zogali (Nupe) and Ewe igbale (Yoruba) (Abdullahi *et al.,* 2003). A traditional food plant, this little known vegetable has potential to improve nutrition, boost food security, foster rural development and support sustainable landcare. It is used as a micronutrient powder to aid indigenous diseases.

The leaves of *Moringa oleifera* are highly nutritious, being a significant source of beta-carotone, vitamin C, protein, iron and potassium. The leaves are cooked and used like spinach. In addition to being used fresh as a substitute for spinach, its leaves are commonly dried and crushed into a powder and used in soups and sauces. The leaves are full of medicinal properties which include uses as an antiseptic and in treating rheumatism, venomous bites and other conditions. The leaves can be eated fresh, cooked, or stored as dried powder for many months without refrigeration, and reportedly without loss of nutritional value. Moringa is especially promising as a food source in the tropics because the trees is in full leaf at the end of the dry season when other foods are typically scare (Moringa oleifera, 2008).

Moringa oleifera leaves contain more calcium than milk, more iron that spinach, more potassium than bananas and that the protein quality of *Moringa oleifera* leaves rivals that of milk and eggs (Moringa oleifera, 2008). In the Philippines, Moringa is commonly grown for its leaves which are used in soup and eaten as a leaf vegetable (Moringa oleifera, 2008) .

In view of the potential beneficial attributes of leafy vegetables, there is a need to comprehensively establish the nutritional properties before advocating their increased utilization. Therefore the interest of this study was to conduct an investigation of the nutritional composition in this leafy vegetable in order to ascertain its suitability for use in human diets or animal feed.

MATERIALS AND METHOD

Sample collection and treatment: The sample of *Moringa oleifera* used in this study was collected from a farm site at Barkin-Saleh in Minna town, Niger State, Nigeria. The chemicals used were manufactured by M & B and BDH chemicals of England.

Prior to analysis, the leaves were separated from the stalk and washed with distilled water. The residual moisture was evaporated at room temperature thereafter the leaves were wrapped in large paper envelopes and oven dried at 60°C until constant weight was obtained (Fasakin, 2004). The dried leaves were then ground in porcelain mortar, sieved through 2 mm mesh sieve and stored in plastic container (Umar *et al.*,2007). The powdered sample was used for both proximate and mineral analysis. Moisture content was however, evaluated using fresh leaves.

Proximate analysis: The moisture content of the leaves were determined by drying 5 g of the leaves (in triplicate) in a Gallenkamp oven at 105°C until constant weight was attained (AOAC, 1990). Ash content was determined according to the method described by Ceirwyn (1998) and among others involved dry ashing in Lenton muffle furnace at 600°C until grayish white ash was obtained.Crude protein content was calculated by multiplying the value obtained from kjeldahl's nitrogen by a protein factor of 5.3, a factor recommended for vegetable analysis (Bernice and Merril, 1975). Crude lipid was quantified by the method described by AOAC (1990) using the Soxhlet apparatus and n-hexane as a solvent. Available carbohydrate was determined by Clegg Anthrone method using Jenway 6100 spectrophotometer at 625 nm with glucose and maltose as the standard (Idris *et al.*,2009). The sample calorific value was estimated (in Kcal) according to the formula: Energy = (g crude protein x 2.44) + (g crude lipid x 8.37) + (g available carbohydrate x 3.57) (Asibey Berko and Taiye, 1999).

Samples preparation. Six (6) gram of the powdered sample was weighed into a crucible and gently heated over a Bunsen burner until it charred. The charred sample with the crucible was transferred into a Lento muffle furnace at about 600°C and content ashed until grayish white ash was obtained. It was cooled first at room temperature and then in a desiccator. 5 cm^3 of concentrated HCl was added and heated for 5 minutes on a hot plate in a fume cupboard. The mixture was then transfer into a beaker and the crucible washed several times with distilled water. The mixture was made up to 40 cm^3 and boiled for 10 minutes over a bunsen burner. This mixture was then cooled, filtered into a 100 $cm^3$of volumetric flask and distilled water was used to rinse the beaker into the volumetric flask and solution made up the volume to 100 cm^3 (Ceirwyn,1998). The solution were prepared in triplicates.

Mineral analysis: Sodium (Na) and Potassium (K) were analysed by flame atomic emission spectrophotometer with NaCl and KCl used to prepare the standards. Phosphorus (P) was determined with Jenway 6100 spectrophotometer at 420 nm using vanadium phosphomolybdate (vanadate) colorimetric method with KH_2P0_4 as the standard (Ceirwyn, 1998). The concentrations of calcium (Ca), magnesium (Mg), copper (Cu), Iron (Fe), Manganese (Mn) and Zinc (Zn) in the solutions were determined with a Unicam 969 model atomic absorption spectrophotometer, with standard air acetylene flame (AOAC, 1990). $CaCl_2$, Mg metal, Cu metal, Fe granules, $MnCl_2.4H_20$ and Zn metal were used to prepare the standards.

Data Analysis: Data were generated in triplicates and the mean standard deviation determined according to Steel and Torrie (1980)

RESULTS AND DISCUSSION

Proximate Composition: The proximate composition of the leaves of *Moringa oleifera* was presented in Table 1. As it is common with most fresh leafy vegetables, the leaves had high moisture content (71.60 ± 1.06%). This value agrees with the 58.0 90.6% reported in some Nigerian green leafy vegetables (Ladan *et al.*,1996;Tomori and Obijole,2000) .The value is low compared to 83.7 87.1% recorded for sweet potato (*Ipomoea batatas)* leaves (Asibey Berko and Taiye, 1999; Ishida *et al.*,2000).

The ash content of the leaves (12.38 ± 0.14%) was high and indicated that the leaves contained important mineral elements. This values is within the range of 9.2 ± 1.5 28.0 ± 1.1% shown in greed leafy vegetables of Nigeria (Ifon and Bassir, 1980; Ladan *et al.,* 1996). It was however high when compared with the 10.83 ± 0.80% found in water spinach (*Ipomoea aquatica* Forsk) leaves (Umar *et al.,* 2007) and the 1.8 g/100g dry weight of *Ipomoea batatas* leaves reported by Asibey Berko and Taiye (1999).

The crude protein content of the leaves of *Moringa oleifera* (10.49 0.14 % dry matter) is high compared to 6.30 0.27 % recorded in water spinach (*Ipomoea aquatica* Forsk) leaves (Umar *et al., 2007) and the 4.25% dry weight in Ipomoea aquatica* leaves grown in Vietnam (Ogle *et al.*,2001) but lower than 11.67-18.00% recorded in *Ipomoea batatas* leaves (Ishida *et al.,* 2000). Furthermore, the protein content of this plant leaves can make significant contribution to dietary intake especially during pro-harvest period, when domesticated food are in short supply.

The sample crude lipid content (15.32 0.28%) was very high when compared with the values of 0.74% (Asibey Berko and Taiye, 1999) and 2.56 6.82% dry weight (Ishida *et al.,* 2000) reported in *Ipomoea batatas* leaves, but within the range 8.5 27.0% reported in some wild green leafy vegetables of Nigeria and Niger Republic (Ifon and Basir, 1980; Sena *et al.,* 1998).

The available carbohydrate of the leaves of *Moringa oleifera* is 36.51 0.28 % dry weight. This value is higher than 20% obtained in *Senna obtusfolia* leaves (Faruq *et al.,* 2002) and 23.7% in *Amaranthus incurvatus* leaves (Asibey Berko and Taiye, 1999) but lower than 51.8% reported for *Moringa stenopetala* leaves (Abuye *et al.,* 2003). Carbohydrates provide the body with a source of fuel and energy that is required to carry out daily activities and exercise. Carbohydrates are also important for the correct functioning of vital physiological systems of the body.

The calorific values of most vegetable are low (30 50 kca/100g) (Umar *et al.,* 2007). The result obtained for the leave of *Moringa oleifera* was however substantial (284.16 0.11 Kcal/100g on dry weight basis), but is within the range of 248.8 307.1 Kcal/100g reported in some Nigerian green leafy vegetables (Isong *et al.,* 1999). This values was higher compared to 283.1 Kcal/100g found in *Corchorus tridents* but lower than 288.3 Kcal/100g recorded in *Ipomoea batatas* leaves (Asibey-Berko and Taiye, 1999).

Mineral Content: Table 2 shows that potassium content (2722.05 0.02 mg/100g dry matter) in the leaves of *Moringa oleifera* is higher than 220 g/100g in the leaves of *Tribulus terrestris* (Hassan *et al.,* 2005) and the values in some green leafy vegetables consumed in Sokoto (Ladan *et al.,* 1996; Faruq *et al.,* 2002). Sodium is associated with potassium in the body in maintaining proper acid-base balance and nerve transmissions (Setiawan, 1996). The sodium *content in the leaves of Moringa oleifera* was 44.63 0.06 mg/100g dry matter. This value is high compared to 5.00 0.6 mg/100g found in *Tribulus terrestris* leaves (Hassan *et al.,* 2005) but lower than 45 mg/100g in *Senna obtusfolia* (Faruq *et al.,* 2002) and 195.0 mg/100g recorded in *Hibicus Sabdariffa* (Ladan *et al.,* 1996). From the result it was shown that the concentration of potassium was far greater than that of sodium. The high amount of potassium may be due to its abundance in Nigerian soil (Oshodi *et al.,* 1999). The K/Na ratio was also high (60.99). This is advantageous as potassium is only taken from diet unlike sodium which is added during cooking. Furthermore taken into consideration that potassium depresses while sodium enhances blood pressure, thus, high amount could be an important factor in prevention of hypertension and atherosclerosis (Yoshimura *et al.,* 1991)

Calcium content was found to be 53.61 ± [illegible] mg/100g dry matter. This value was high compare to the 33 and 38 mg/100g reported in lettuce and sickle pod respectively (Faruq *et al.,* 2002). Calcium is important for bone and teeth formation, the transmission of nerve impulses, for muscle contraction and blood clothing. The concentration of phosphorus in the leaves of 2.03

Moringa oleifera, (12.03 ± 0.15 mg/100g) was low compared to the 23.83 ± 0.9 mg/100g in *Tribulus terrestris* (Hassan *et al.*, 2005) leaves and the 166.0 640.0 mg/100g indicated in some green leafy vegetables consumed in Sokoto (Ladan *et al.*, 1996). Phosphorus is important for healthy bones and teeth. It is important for the utilization of nutrients in the body and in order to release energy inside the cells. According to Guil - Guerrero *et al.*, (1998), for good calcium and phosphorus intestinal utilization, Ca/P ratio must be close to unity. The leaves of *Moringa oleifera* had a high ratio (4.46), indicating that diet based on this leaves required to be supplemented in favour of phosphorus.

Magnesium is an important mineral in connection with circulatory diseases such as ischemic heart diseases and calcium metabolism in bone (Ishida *et al.*, 2000). The magnesium content of the leaves of Moringa *Oleifera* appeared to be high (75.63 ± 0.04 mg/100g), when compared to the 19 mg/100g in *senna obtusfolia* leaves (Faruq *et al.*, 2002) and other cultivated green leafy vegetables such as cabbage (4 mg/100g) and lettuce (6 mg/100g) (Turan *et al.*, 2003). Copper is known for the role its plays in hemoglobin formation and also contribution to iron and energy metabolism (Cabrera *et al.*, 1996; Adeyeye, 2002). The concentration of copper in the leaves of *Moringa oleifera* was found to be 3.38 ± 0.04 mg/100g. The value reported was high than 0.1 mg/100g in *Lesianthera africana* leaves (Isong and Idiong, 1997) and *Ipomoea batatas* leaves (Ishida *et al.*, 2000). From the result, the leaves of *Moringa oleifera* had good amount of copper relative to its recommended dietary allowance (RDA) set by the United States of America National Research Council, NRC (1989), which are 1.5-3 mg/day for adult male and female, pregnant and lactating mothers and 1-3 mg/day for children (7-10 years), respectively.

Iron is required for hemoglobin formation and its deficiency leads to anemia (Turan *et al.*, 2003). The assay indicated that the leaves of *Moringa oleifera* contains 18.69 ± 0.05 mg/100g of iron. This value is higher compared to 2.8 mg/100g in *Tribulus terrestris* leaves (Hassan *et al.*, 2005), 1.6 mg/100g in spinach, 0.7 mg/100g in lettuce and 0.3 mg/100g in cabbage (Turan *et al.*, 2003). When comparing with the RDA for iron which are 10 mg/day for adult male and children (7-10 years), 13 mg/day for pregnant and lactating mothers and 15 mg/day for adult female (NRC, 1989), it can be concluded that the leaves of *Moringa oleifera* are good source of iron. Manganese is a mineral element that is nutritionally essential. The manganese content of the leaves of *Moringa oleifera* is 5.02 ± 0.05 mg/100g. This value was high compared to 2.14 ± 0.22 mg/100g reported in *Ipomoea aquatica* Forsk leaves (Umar *et al.*, 2007) but agree with 4.83 10.03 mg/100g in *Ipomoea batatas* leaves (Ishida *et al.*, 2002). The RDA for manganese are 2-5 mg/day for adult male and female, pregnant and lactating mothers and 2-3 mg/day for children (7-10 years) (NRC, 1989), based on the RDA, it is clearly indicated that the leaves of *Moringa oleifera* are good sources of manganese. Zinc is known to play a role in gene expression, regulation of cellular growth and participates as a co-factor of enzymes responsible for carbohydrates, protein and nucleic acid metabolism (Camara and Amaro, 2003). The concentration of this element was found to be 2.61 ± 0.02 mg/100g which was high compared to 0.1 mg/100g in *Tribulus terrestris* leaves (Hassan *et al.*, 2005) and 1.75 2.58 mg/100g reported in some famine foods of republic of Niger (Sena *et al.*, 1998). This shows that the leaves of *Moringa oleifera* are poor source of these mineral element compared to the zinc RDA of 10 mg/day for children (7-10 years), 12 mg/day for adult female, 15 mg/day for adult male and 19 mg/day for pregnant and lactating mothers respectively.

The contribution of the leaves of *Moringa oleifera* to the dietary intake of essential elements was evaluated as follows;

Contribution to RDA (%) = concentration of the element x 1000

RDA (Hassan *et al.*, 2005)

RDA = recommended dietary allowance (NRC, 1989).

This is presented in Table 3. The leaves were rich sources of iron, copper, potassium and manganese, moderate source of zinc and magnesium and poor source of phosphorus, sodium and calcium when compared with their respective recommended dietary allowances. This indicated that the leaves supplement other dietary sources of copper, iron, manganese, zinc, potassium and magnesium.

Table 1: Proximate composition of the leaves of Moringa oleifera

Parameter	Concentration (% Dry Weight)
Moisture Content[a]	71.60 1.06
Ash	12.38 0.14
Crude protein	10.49 0.14
Crude lipid	15.32 0.28
Available carbohydrate	36.51 0.28
Calorific value (Kcal/100g)	284.16 0.11

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

[a]value expressed as % wet weight

Table 2: Mineral Composition of the leaves of *Moringa oleifera*

Mineral elements	Concentration (mg/100g dry matter).
K	2722.05 ± 0.02
Na	44.63 ± 0.06
Ca	53.61 ± 0.02
P	12.03 ± 0.15
Mg	75.63 ± 0.04
Cu	3.38 ± 0.04
Fe	18.69 ± 0.05
Mn	5.02 ± 0.05
Zn	2.61 ± 0.02
K/Na	60.99
Ca/P	4.46

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

Table 3: Contribution to the dietary intake to some mineral element by the *Moringa oleifera* leaves.

Minerals	RDA(mg)	Contribution to RDA(%)
K	2000	136
Na	500	9
Ca	1200	5
P	1200	1
Mg	350	22
Cu	1.5-3	113-225
Fe	10-15	125-187
Mn	2-5	100 251
Zn	12-19	14-22

CONCLUSION

Results indicated that the leaves of *Moringa oleifera* are good source of carbohydrate, energy and minerals. The leaves are good sources of iron, potassium, copper and manganese which meet the recommended daily allowances. The results suggests that the plant leaves if consumed in sufficient amount could contribute greatly towards meeting human nutritional requirement for normal body growth and adequate protection against diseases arising from malnutrition.

The study also demonstrated clearly that the leaves of *Moringa oleifera* are recommended for continues used for nutritional purposes, considering to the amount and diversity of nutrients it contains

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