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# Comparative Investigation of Nutrients and Valuable Minerals in Various Parts of Horseradish (Moringa oleifera. Lam) Plant

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**Abstract**
The present study was carried out to assess and evaluate the distribution of minerals and nutritional composition of various parts of *Moringa oleifera* plant (Horseradish or Drumstick tree popularly called Ewe-igbale in Yoruba language) which were investigated with the aim of ascertaining the various compositions of nutrients and nutritionally valuable minerals. The *Moringa oleifera* plant used in this work was obtained from Afao-Ekiti, Ekiti State, Nigeria. The proximate composition was carried out using the AOAC methods while minerals were analysed using x-ray diffraction fluorescence spectroscopic technique as Sodium and potassium were determined using flame atomic spectroscopy. The results of the analyses showed that the various parts of the plant contained high percentage of nutritional components as well as macro and micro elements of nutritional important. The respective plant parts contained higher concentration of one important nutritional component or the other. The nutritional composition showed that Protein and Fat content of the seed (33.87% and 40.61%) respectively are higher than other parts of the plant as ash content of the root (15.04%) is far higher than all the other parts of the plant. Sodium and potassium proportions were higher in the bark (3150mg/100mL and 7690mg/100mL) and root (3160mg/100ml and 6740mg/100ml) respectively than in the other parts of the plant. Calcium, another important element and manganese were higher in the leaf than other parts of the plant. These results actually showed that the *Moringa oleifera* plant is a rich source of nutritionally valuable minerals, protein and fat, which are of great nutritional importance.
**Keywords:** *Moringa oleifera,* plant parts, nutritional composition, elements composition.

## 1. Introduction

The useful products obtained from plants directly or indirectly, demonstrate their importance to man, Plants serve as a source of food (Saka and Msonthi, 1994; Katsayal *et al.,* 2004; Kawo, 2007), medicinal product (Adoum *et al.,* 1997; Ezeamuzie et al., 1996; Caceres *et al.,* 1992), energy (Oladele and Yisa, 1989) and shelter to man and his livestock (Ogunkunle and Oladele, 2004). In the earlier stage man depended on wild food, which is much abundant within his immediate environment. As the population grows, however, sources of food became more difficult to him, which necessitated domestication of many plants. Although more than 250,000 plant species have been described worldwide as sources of food, man depends only on a few species mainly cereals, particularly rice, wheat and corn as the major sources of his food and collectively supply nearly 60% of the world's food supply (Parvathin and Kumar, 2002; Oliveira *et al.,* 2000).

*Moringa oleifera* belongs to a monogeneric family of shrubs and tree, Moringaceae and is considered to have its origin in Agra and Oudh, in the northwest region of India, south of the Himalayan Mountains. Although the name "Shigon" for *M. oleifera* is mentioned in the "Shushruta Sanhita" which was written in the beginning of the first century A.D., there is evidence that the cultivation of this tree in India dates back many thousands of years. The Indians knew that the seeds contain edible oil and they used them for medicinal purposes. It is probable that the common people also knew of its value as a fodder or vegetable. This tree can be found growing naturally at elevations of up to 1,000 m above sea level. It can grow well on hillsides but is more frequently found growing on pastureland or in river basins. It is a fast growing tree and has been found to grow to 6 – 7 m in one year in areas receiving less than 400 mm mean annual rainfall (Odee, 1998). In the Dravidian language, there are many local names for this tree but all are derived from the generic root "Moringa". In English it is commonly known as Horseradish tree, Drumstick tree, Never Die tree, West Indian Ben tree, and Radish tree (Ramachandran *et al*., 1980). It is now cultivated throughout the Middle East, and in almost the whole tropical belt. It was introduced in Eastern Africa from India at the beginning of 20th century. In Nicaragua the Marango (local name for *Moringa oleifera*) was introduced in the 1920, as an ornamental plant and for use as a live fence. The tree grows best and is most commonly found in the Pacific part of Nicaragua but can be found in forest inventories in every part of the country. As a non-cultivated plant it is known for its resistance to drought and diseases. The plant possesses many valuable properties which make it of great scientific interest, these include

 

the high protein content of the leaves twigs and stems, the high protein and oil contents of the seeds, the large number of unique polypeptides in seeds that can bind to many moieties, the presence of growth factors in the leaves, and the high sugar and starch content of the entire plant. Equally important is the fact that few parts of the tree contain any toxins that might decrease its potential as a source of food for animals or humans.

*Moringa oleifera* is one of the most useful tropical trees. The relative ease with which it propagates through both sexual and asexual means and its low demand for soil nutrients and water after being planted makes its production and management easy. Introduction of this plant into a farm which has a biodiverse environment can be beneficial for both the owner of the farm and the surrounding eco-system. *Moringa oleifera* tolerates a wide range of environmental conditions; it will tolerate extremely high temperatures in the shade and can survive a light frost. The drought-tolerant tree grows well in areas that receive annual rainfall amounts ranging between 250 and 1500 mm, it prefers a well-drained sandy loam or loam soil, but tolerates clay. *Moringa oleifera* is planted either by direct seedling, transplanting, or using hard stem cuttings.

Nigeria is rich in nutritionally and medicinally important flora and there are series of plants for bioprospecting, *Moringa oleifera* is one of these important plants, it is commonly called horseradish tree or the miracle tree and locally known as 'Zogale-gandi' in Hausa, 'Eweigbale' in Yoruba and 'Okweoyibo' in Igbos (Dalziel, 1956).

It is mostly grown and widely cultivated in the northern part of Nigeria and many countries in tropical Africa. *M. oleifera* can be grown in a variety of soil conditions preferring well-drained sandy or loamy soil that is slightly alkaline (Abdul, 2007). Almost every part of *M. oleifera* can be used for food and as forage for livestock (Ram, 1994). The leaves can be eaten fresh cooked or stored as dried powder for several months the pods, when young can be cooked; eaten like beans (National Research Council, 2006). Its oil and micronutrients have been reported to contain antitumour, antiepileptic, antidiuretic, anti-inflammatory and venomous bite characters (Hsu, 2006). Virtually every part of the tree is beneficial in some way and both rural and urban people depend on it for their livelihood. Depending on the purpose and quantity, moringa is grown in nurseries, as a community project, or on a small scale at the family level. It can function as windbreaks, for land erosion control, live fences, as an ornamental, or intercropped to provide semi-shade to species requiring less direct sunlight. One theme surrounding the cultivation and use of moringa is the risk that the species may alter the land and its living systems. However, according to a recent study, a crucial transition must take place whereby destructive farming practices must be replaced by new and improved cultivation methods which raise moringa without destroying natural systems on which agriculture ultimately depends. In fact, the effective development and management of moringa can indeed contribute to sustainable growth and poverty reduction in developing countries. But for this to take place, a balance must be found between the short-term needs of the people for their social and economic development and the protection of the natural resource base.

## 2. Materials and Methods.

2.1. Sample Collection and Preparation.

Fresh samples of the plant *Moringa oleifera* were obtained from Afao- Ekiti, Ekiti-State, Nigeria. The plant collected was separated into leaf, seed, root, bark which were air dried, crushed, pounded and subsequently blended to powder separately with Marlex Excella laboratory blender.

2.2. Method

2.2.1. Proximate analysis

Proximate analyses were carried out according to the procedure of Association of Official Analytical Chemist (AOAC, 1990). The percentages moisture content, ash content, crude fat, crude fibre and protein were determined using this procedure.

2.2.1.1. Procedure for Protein Determination.

0.5g of the samples was accurately weighed using an analytical balance and wrapped in a filter paper. The weighed samples were dropped in a labeled kjedahl flask. 6M $H_2SO_4$ was added to the content of the flask and a disodiumsulphate was added to increase the boiling point of the $H_2SO_4$ and thus the digestion temperature. Copper catalyst was added. The mixture was heated until a clear coloured solution of the $H_2SO_4$ was observed and the flask was cooled for about 5-10 minutes 10 ml of deionized water was added to the cooled digestate in the flask, the mixture was then made basic by adding concentrated sodium hydroxide which is more dense then the digestate through the wall of the flask to allow it to settle at the base of the digestion apparatus anti bumbling agents such as zinc was also added to prevent bumbling, the content of the flask was mixed until it is basic to lithmus. About 10 mL of 40% NaOH and 5ml of deionized water was added into the distillation chamber.

The mixture was then distilled into a 100ml collection cup containing 30ml of boric acid. The distillate was back titrated with a 0.1M sodium hydroxide in a burette using methyl orange as indicator.

The % Nitrogen for each sample was calculated from the titre value as

 

$$\%N = \frac{V \times 0.1 \times 0.014}{W}$$

The percentage protein was calculated by multiplying the percentage Nitrogen with a constant factor of 6.25.

2.2.1.2. Determination of Moisture

The aluminum dish were cleaned and placed inside a drying oven at 105°C for 2 hours. After that the crucible was placed in a desicator to cool constant, the dish was weighed, W1 and about 2g of each of the sample was weighed accurately into a dried preweighed clean crucible, and the Wight of the dish and flasks were recorded as W2. The dish and the sample were then dried to constant weight W3 at 105°C degree in a moisture extraction oven for about 3 hours; it was cooled in desiccators and weighed. The weighing, cooling and heating were continued until a constant weight was obtained.

The percentage moisture content is calculated as

$$\% \text{ moisture} = \frac{W3 - W2}{W2 - W1}$$

2.2.1.3. Determination of ash Content.

About 1g of the sample each was placed into a clean, dry ignited, cooled and weighed silica crucible. The crucible and the contents were ignited to char on a mild heat and then at 500 degree for 8 hours in a furnace, until fully ashed. The resulted ash was weighed and recorded accordingly.

2.2.1.4. Crude Fat Determination.

About 2.5g of the sample was weighed on an analytical balance and wrapped in filter paper, approximately 10 mL of the extracting solvent (hexane) was measured into a 25-mL round-bottomed flask. The Soxhlet extractor connector was placed on top of the flask and the thimble was placed with the sample in the extractor fitting. The condenser was connected on top of the Soxhlet extractor and turn on the water flow. It is advisable to flow the water in from the bottom outlet and out from the top outlet of the condenser. The round –bottomed flask was heated. The solvent was brought to the vaporization stage but not to a rolling boil. Ideally, solvent flushes through the sample and occur every 5–10 minutes. The extraction was allowed to continue for approximately 18–20 hours. The round bottom flask content was emptied the round-bottomed flask contents into a pre-weighed Erlenmeyer flask. Place the flask in the heated water bath of the concentrator apparatus, the solvent was removed by flowing a steady stream of nitrogen over the sample. Once all the solvent had been removed dry the excess water from the outside of the flask and the extracted fat was weighed.

The difference between the weights of the flask before addition of the sample and after concentration of the sample, multiplied by 100% and divided by the original weight of the sample, gave the percentage of fat from the sample at 100% extraction of fat from the sample.

2.2.1.5. Determination of Crude Fibre

1.5grams of sample was put into 250 mL conical flask and 1.25% Sulfuric acid solution was added. The sample was heated for about 30 min, filtered then washed until traces of acid could not be detected using pH paper. The Whatman paper 5B with 125 micrometer pore size was placed in the Buchner flask. The acid extracted was transferred into 250 mL conical flask and 1.25% NaOH solution was added subsequently. The sample was heated again for 30 min, filtered using vacuum filter and washed with water until base was undetected. The whole material was transferred into crucible and dried for 12hours at 120°C. After that the crucible was placed into muffle oven at 550°C for 12hours and weight of crucible was recorded.

$$\text{Crude fibre} = \frac{W_3 - W_4}{W_2 - W_1} \times 100$$

$W_1$ = weight of crucible, $W_2$ = weight of crucible + sample, $W_3$ = weight after oven drying, $W_4$ = weight after ashing

2.2.1.6. Determination of Minerals

All the metals except sodium and potassium were analysed using x-ray diffraction fluorescence spectroscopic technique. The sample was pressed into a pellet and placed in the sample holder of the instruments, primary x-rays emanating from the x-ray tube bombarded the sample and the sample produced fluorescence x-ray which was passed through a monochromator, the monochromator selected the required wavelength which was then detected by the silicon detector. The analyte line intensity was then compared with that from standards having the same form of the sample.

2.2.1.7. Determination of sodium and potassium.

Sodium and potassium were determined by flame emission spectroscopy, the sample was ashed in a muffle furnace and the ash dissolved in dilute nitric acid. Stock solution of potassium and sodium were prepared and a standard addition technique was applied to derive a calibration curve. The acid dissolved sample was sprayed as a fine mist into the flame, the gaseous atoms were excited in the flame and produces characteristic wavelength emission for the particular element. The concentrations of the elements in the samples were extrapolated from the standard calibration curves.

 

**3. Discussion.**

The result of the proximate analyses in the root, seed, bark and leaf of the Moringa plant is presented in Table 1. From the result of the proximate analysis, the moisture, ash, crude fibre, crude protein, carbohydrate, and fat in the root, seed, bark and leaf of the *Moringa oleifera* is reported. The moisture content of the leaf is the highest as indicated in the Table and lowest in the root of the *Moringa oleifera* plant.

The result revealed a high protein content in the *Moringa oleifera* seed 33.87±0.50%, 31.04±0.30% in the root and the lowest in the bark of the *Moringa oleifera* plant 14.11±0.30.

The crude protein content of the *Moringa oleifera* plant is higher than obtained when compared with the result of Akindahunsi and Salawu, (2005) for *Amaranthus caudatus* cassava leaves (*Manihot utilisima*), *Piper guineeses* and *Talinum triangulare*. This result show that *Moringa oleifera* is a rich source of protein and important as a body building block and for repair of worn out tissues in the body. The *Moringa oleifera* seeds when compared with the leaf, root and bark have the highest percentage of fat (40.61±0.51%) in the seed, 22.48±0.52% in the leaf, 9.24±0.45% in the root and 8.27±0.14% in the bark of the plant. Table 1.0 also revealed that seeds of *Moringa oleifera*, like any other legumes, are good source of fats. However, the fat content was observed higher than that reported for various soybean varieties (14.9 to 22.0 g /100 g) by Leffel and Rhodes, (1996), Vasconcelos *et al*., (1997) and comparable with those of peanut (44.0 to 54.7 g /100 g) by Grosso *et al.*, (1997); castor bean (47.91 g/100 g) by Polit and Sgarbieri, (1976); rapeseed (43.7 to 49.7g / 100 g) by Zhou *et al*., (1990); sunflower (45.54 to 47.85g / 100 g) by Saeed and Cheryan, (1988), Alza and Fernandez- Martinez, (1997) and mustard (24.0-40.0%), grown in the United States, Brazil, China and some other Asian and European countries as reported by Pritchard, (1991).

The ash content of the root was observed to be highest (15.04%) when compared with the leaves 9.86±0.91 though lower than that of some leafy vegetables commonly consumed in Nigeria such as *Talinum triangulare* (20.05%), *Acalypha marginata* (15.68%) but they compare favorably higher than some other vegetables such as *Occimum graticimum* (8.00%) and *Hibiscus esculentus* (8.00%) as reported by Akindahunsi and Salawu, (2005).

The leaves of *Moringa oleifera* appeared richer source of carbohydrate which supplies energy to the body than any other parts of the plant.

The result of the nutritional element is presented in Table 2.0, the micronutrient value in the level of potassium, sodium, cobalt, chromium, cadmium, sodium, nickel, lead, zinc, iron manganese and strontium in the leaves, bark, seed and root of the Moringa plant were reported.

The result of the elemental composition analyses in the root, bark, seed and leaf of the Moringa plant is presented in Table 2.0 with all the parts of the plants containing various concentrations of both macro and micro elements of valuable nutritional importance.

From the result of the analysis, potassium has the highest concentration. It is observed that the highest concentration of potassium is found in the bark of the *Moringa oleifera* plant (7690±10.0mg/g), with 7630±5.00 mg/g in leaves, 6740±10.00 mg/g in root and the lowest in the seed 5160±20 mg/g. Sodium is the second most abundant mineral in the *Moringa oleifera* plant. The root has the highest concentration of 3160±10.00mg/g, seed 3150±10.00mg/g, leaf 3090±15.00mg/g and the lowest is 2410±20.00mg/g in the seed of iron and silicon is moderately low silicon has the highest concentration of about 41.00±0.6mg/g, in the bark of the plant, 35±0.8 mg/g in the root, and a lowest of 19.00±0.4 mg/g in the *Moringa oleifera* seed. Iron is highest in the seed 17.3±0.4mg/g, 13.00±0.4mg/g, in the root and is lowest in the leaves 7.8±0.4mg/g, the concentration of calcium is highest in the Moringa leaf 21.00±0.5mg/g, 11.00±0.3mg/g in the bark , 9.500±0.2mg/g in the root and lowest in the *Moringa oleifera* seed. The concentration of calcium in the leaf is greater than that of the seed. The amount of cobalt, chromium, cadmium scandium and nickel are below detection limit of the method of analysis. The concentration of lead in the root, leaves and seed of the *Moringa oleifera* plant is below the detection limit of the analytical method employed but a concentration of about 41.00±0.7mg/g of lead is present in the seed. The presence of lead in the seed may be due to other environmental factors which are not accounted for in the scope of this study. The chemical composition of Moringa observed in the present studies compare well with that reported by Fuglie 2005. Highest concentration of potassium and sodium was observed in the Moringa plant.

**4. Conclusion and Recommendation**

All the parts of *Moringa Oleifera* can be an extremely valuable source of nutrition for people of all ages. The outcome of this experiment revealed that different parts of moringa contain different compounds: such as beneficial nutrients, carbohydrates, protein, fat and the essential elements thus, making the tree a potential plant in minimizing malnutrition as well as source of household income in developing countries. In all, it could be concluded that *Moringa oleifera* tree contains different macro and micro elements. Every part of the tree has different nutritional potential, and becomes a source of protein, carbohydrate and fat when they are eaten as a staple food. Leaves are one of the main organs that can be used for human consumption over long seasons. And the significant quantity of fat in the seed also implies seed characteristics as oil crop. Therefore, the *Moringa*

 

*oleifera* tree as a multi-purpose plant warrants a special attention for further investigation.

*Moringa oleifera* plant should be taken by people of all ages, to supplement the deficiency of essential nutrients in the body. House hold cultivation of *Moringa oleifera* plants should be encouraged. *Moringa oleifera* Leaves can be dried and made into a powder by rubbing them over a sieve. This powder can be used in place of fresh leaves to make lead sauces, or few spoonfuls of the powder can be added to other sauces just before serving.

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**Results**

Table 1.0: The Percentage nutritional composition of various parts of *Moringa oleifera* (%) on dry matter basis

| Parameters | Moringa Root | Moringa Bark | Moringa Seed | Moringa Leaf |
|---|---|---|---|---|
| Moisture | 6.53±0.12 | 7.85±0.15 | 15. 62±0.46 | 18.27±0.46 |
| Ash | 15.04±0.4 | 8.13±1.15 | 2.73±0.32 | 9.86±0.91 |
| Fibre | 28.33±0.47 | 44.88±0.40 | 2.85±0.31 | 7.35±0.25 |
| Fat | 9.24±0.45 | 8.27±0.14 | 40.61±0.51 | 22.48±0.52 |
| Protein | 31.04±0.30 | 14.11±0.30 | 33.87±0.50 | 16.93±0.3 |
| Carbohydrate | 9.82±0.15 | 17.61±0.30 | 4.32±0.20 | 25.10±0.41 |

Table 2.0: Percentage elemental composition of the *Moringa plant* on dry matter basis (%)

| Element | Moringa root | Moringa bark | Moringa seed | Moringa leaf |
|---|---|---|---|---|
| Silicon | 35.00±0.8 | 41.00±0.6 | 19.00±0.4 | 21.00±0.4 |
| Calcium | 9.500±0.2 | 11.00±0.3 | 5.7±0.3 | 28.00 ±0.5 |
| Manganese | 0.6±0.4 | ND | ND | 1.7±0.03 |
| Iron | 13.00± 0.4 | 8.4±0.3 | 17.3_+0.4 | 7.8±0.4 |
| Copper | ND | 8.2±0.3 | ND | 4.4±0.1 |
| Zinc | ND | ND | 1.00±0.02 | 0.9±0.02 |
| Lead | ND | ND | 41.00±0.7 | ND |
| Cobalt | ND | ND | ND | ND |
| Chromium | ND | ND | ND | ND |
| Cadmium | ND | ND | ND | ND |
| Nickel | ND | ND | ND | ND |
| Hafnium | 27.00±.50 | 24.00±0.6 | 19.00±0.4 | 13.00±0.3 |
| Germanium | 2.00± 0.03 | ND | ND | 0.8±0.03 |
| Rhenium | ND | ND | 6.1±0.3 | 3.00±0.1 |
| Scandium | ND | ND | ND | ND |
| Europium | 7.00±0.3 | ND | ND | ND |
| Strontium | 5.2±0.06 | ND | ND | ND |
| Potassium | 0.674±0.001 | 0.769±0.001 | 0.516±0.002 | 0.763±0.001 |
| Sodium | 0.316±0.001 | 0.315±0.001 | 0.241±0.002 | 0.309±0.002 |