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## Validating Phytomedicinal Potentials of *Moringa Oleifera*: Comparative Evaluation of Nutrients and Phytochemical Groups of Nigeria-Bred *Moringa Oleifera* Plant Parts

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**Abstract** *Moringa oleifera* is arguably the most popular and useful specie of the very useful moringacea family of plants that have become well known due to their economic values and phytomedicinal and nutritional qualities. However, there is the need for adequate and thoroughly scientific information about the several acclaimed potential benefits of the plant. It is however worthy of note that most recent publications on the acclaimed potential benefits of the plants parts components and their usefulness have been positive, thus, confirming several available traditional and past literatures available on the plant's usefulness. While scientists in different walks of life work to explore the values of this plant that has been dubbed the Miracle Tree in certain places, there is no doubt that the understanding and validation of the distribution of components and phytochemicals across the plant parts is vital towards exploring optimal benefits of the plant. This investigation was conducted to assess the distribution of nutrients and phytochemical groups in the various parts of the plant and to observe the pH values of each part extract- ethanolic and aqueous. Results will be very important in guiding researchers and product developers as well as farmers, the consumers, policies makers and the general public towards appreciating the possible variations in the usefulness and benefits of the various plant parts. Aqueous and ethanolic extracts of the plant were prepared from the various parts of the same plants which were air-dried at maintained room temperature, thereafter macerated and powdered with the grinder. The available of nutrients including carbohydrates, fats, proteins and steroids as well as phytochemical groups including alkaloids, anthraquinones, flavonoids, glycosides, saponins, tannins and terpenoids were assayed in the ethanolic and aqueous extracts of each plant parts. Plant parts that were tested included the root, bark, leaf, whole pod, seed and flower. The pH value of each extract sample was also tested. Results showed that all extracts were acidic except aqueous extract of the bark that was slightly alkaline. Nutrients and phytochemicals' distribution in the various plant parts also vary considerably. Researchers, users and product developers should be considerate of these variations.

**Keywords** *Moringa*, Nutrients, Phytochemicals, Extracts, Nigeria

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## Introduction

### **Moringa oleifera**

*Moringa oleifera* [literarily referred to as moringa] belongs to the family Moringaceae. There are several reports of its high nutritional and medicinal value; hence, it is widely used as a nutritive and medicinal herb. Its various parts including leaves, roots, barks, flowers, pods and seeds are used for various purposes. Moringa is a small sized tree, cultivated in many parts of the world due to its multiple utilities. In-depth research on this plant may lead to the development of novel agents for medicinal, nutritional and industrial purposes. Moringa is an aboriginal of Indian subcontinent and has become naturalized in the tropical and subtropical areas around the world. Nearly thirteen species of Moringa are included in the family Moringaceae [1]. In India, moringa parts have been used as regular components of conventional foods for about 5000 years [2-4].

Moringa tree can grow well in the humid tropic or hot dry land with average height that ranges from 5 to 10 m. It can survive in harsh climatic condition including destitute soil without being much affected by drought [5]. It can tolerate wide range of rainfall requirements estimated at 250 mm and maximum at over 3000 mm and a pH of 5.0 to 9.0. Its tripinnate compound leaves bear several small leaf legs. The flowers are white and the three wings seeds are scattered by the winds. The flowers, tender leaves and pods are eaten as vegetables. Moringa is popularly referred to as the 'drum stick tree' or the 'horse radish tree', kelor, marango, mlonge, moonga, mulangay, nebeday, saijhan, sajna or Ben oil tree [3, 6].

### **General uses**

*Moringa oleifera* has been reported by the Indian Bureau of plant industry as an outstanding source of nutritional components. Its leaves (weight per weight) have the calcium equivalent of four times that of milk, the vitamin C content is seven times that of oranges, while its potassium is three times that of bananas, three times the iron of spinach, four times the amount of vitamin A in carrots, and two times the protein in milk [7]. Moringa is also suggested as a viable supplement of dietary minerals, the pods and leaves contains high amount of calcium (Ca), Magnesium (Mg), Potassium (K), Manganese (Mn), Phosphorus (P), Zink (Zn), Sodium (Na), Cupper (Cu), and Iron (Fe) [8]. Although, minerals content of Moringa shows variation in composition with changes in location [9]. Moringa has enormous medicinal potential, which has long been recognized in the Ayurvedic and Unani system [10]. Nearly every part of this plant, including root, bark, gum, leaf, fruit (pods), flowers, seed, and seed oil have been used for various ailments in the indigenous medicine [11].

### **Phytochemicals of medicinal values**

The basic constituents of Moringa plant are: deic, palmitic and stearic acid, saponins, glycoside, gum, protein Vitamins: A (8855 IU per 100g), B1, B2, B3, C Minerals: calcium, iron, phosphorus, magnesium. The leaves, flowers and pods are significant sources of vitamins A, B and C, riboflavin, nicotinic acid, folic acid, pyridoxine, ascorbic acid, beta-carotene, calcium, iron, and alpha-tocopherol [12-13]. The pods are considered good sources of the essential amino acids. A compound found in the flower and root of the moringa tree, pterygospermin, has powerful antibiotic and fungicidal effects [14-15]. The Ben oil (Moringa seed oil) has also been shown to be particularly effective in the manufacture of soap, producing a stable lather with high washing efficiency suitable for some African countries. The root bark contains two alkaloids: moringine and moringinine. It is vital to note that hardly had any particular investigation examined the relative distribution of these phytochemicals across the various parts of the same plants in the same geographical location at the same time. The currently available information and data have been pieced together from the various discrete publications available obviously from various parts of the world. This raises questions about the absolute acceptability of the existing information; thus, supporting the need for investigations such as the one being reported in this article.

### **Moringa in Nigeria**

Moringa has long been cultivated in Nigeria; and it has been found to thrive quite well in various regions of the country despite the variations in the climate- being predominantly tropical in the South and savannah in the North.



The ability of the plant to grow in the various parts of the country has made it a potential economic tree. The major Nigerian Ethnic Groups have various names for the plants as follows- **Fulani:** Gawara, Gaware, Habiwal hausa, Konamarade, Rini maka; **Hausa:** Bagaruwar maka, Bagaruwar masar, Barambo, Koraukin zaila, Rimin nacara, Rimin turawa, Samarin danga, Shipka hali, Shuka halinka, Zogall, Zogalla-gandi; **Ibo:** Odudu oyibo, Okwe oyibo, Okwe olu, Uhe, Oku-ghara-ite, Okochi egbu; **Nupe:** Chigban Wawa; **Yoruba:** Adagba malero, Ewele, Ewé ilé, Ewe igbálé, Idagbo monoyé [16].

The Federal Government of Nigeria, realising the economical value of the plant and the potential contribution it could make to the economy and the quality of life announced a special moringa cultivation programme; the Federal Government proposed plans projected to generate over N500 billion as revenue from moringa plant cultivation; this was also estimated to generate over one million jobs opportunities [17]. It is obvious that considering the current socio-economic conditions in Nigeria and other developing nations of the world; *Moringa oleifera* could provide a greatly valuable natural source of high quality nutrition that would be affordable for the masses. It would however be important to mention that thorough investigations should be done with respect to the peculiarities that could be associated with the strain of the plant grown in Nigeria for instance, as well as any peculiar environment-induced variations and features of the plant. More so, it is important that local researchers should embark on high quality research on the plant moringa bearing in mind the need of the society. Beyond Nigeria and Africa; it is important that global information, data and ideas with respect to the potential benefits of this plant is greatly needed. Scientists owe the world explanations for the current great publicity about the benefits of the plant.

### **Aim and objectives and justification**

This investigation was aimed at examining the distribution of nutrients and phytochemical groups in the various parts of the *Moringa oleifera*; to observe the pH values of the various parts in the popular forms of preparing the extract- ethanolic and aqueous. Results have potentials to contribute greatly to knowledge especially with respect to what nutrients and phytochemicals are contained in each part of the plant. Since moringa is becoming increasingly popular as a natural source of super-nutrients and products in forms of herbal drinks and preparations, supplements and nutrient-formulas are being developed from the plant; results will be very vital in helping researchers and product developers as well as farmers, the consumers, policies makers and the general public towards appreciating the possible variations in the usefulness and benefits of the various plant parts as well as the potential toxicity concerns.

### **Materials and Method: Phytochemical Screening**

The raw moringa plant parts were prepared under suitable conditions and environment as stated and recommended by the World Health Organisation [18-19] and standard laboratory practices [20].

#### **Tests for Flavonoids**

With Lead Acetate- To the small quantity of aqueous extract 10% of lead acetate solution was added. Formation of yellow precipitate showed the presence of flavonoid [21].

With Sodium Hydroxide- On addition of an increasing amount of sodium hydroxide, the aqueous extract showed yellow colouration, this decolorized after addition of Conc HCl [22].

#### **Steroids**

Salkowski Test - To 2 ml. of aqueous extract, 2 ml of chloroform and 2 ml of conc. H<sub>2</sub>SO<sub>4</sub> was added. The solution was shaken well. As a result chloroform layer turned red and acid layer showed greenish yellow fluorescence [23].

#### **Terpenoids**

Terpenoids were confirmed by formation of reddish brown colouration of the interface on addition of 2ml chloroform and concentrated sulphuric acid, 3ml to 5ml of the extract [21].

#### **Glycosides**

Glycosides were confirmed by formation of brown ring of interface on addition of 2ml glacial acetic acid containing 1 drop of ferric chloride solution and 1ml concentrated sulphuric acid [11].



**Proteins**

To 2 ml of aqueous extract two drops of millon's reagent was added, cream precipitates indicate the presence of protein [21].

**Alkaloids**

2 g of the dried extract was moistened in water and mixed with 2 g  $\text{Ca(OH)}_2$  to form a paste. It was allowed to stand for 5 minutes and evaporated to dryness on a water bath. 30 ml of chloroform was added, mixed and heated gently on a water bath for 30 minutes. The extract was filtered and more chloroform added to the mark, mixed and filtered again. The combined filtrates were then evaporated to dryness and residue dissolved in 5 ml 2% sulphuric acid and filtered using the reagents listed below to test for alkaloids [22].

Mayer's reagents (cream ppt)

Wagner's reagents (brick red ppt)

Drangendorff's reagents (orange red ppt)

**Tannins**

0.5g of the sample was boiled with 5ml of distilled water for 10minutes. The solution was filtered while hot and 1% of ferric chloride solution was added to the filtrate. A blue green ppt was observed or a brownish green [21].

**Saponins**

Saponin Test Using Frothing Method

About 1g of the powdered sample was boiled in 10ml of distilled water in a water bath for 10minutes and filtered. To 2.5ml of the filtrate 10ml of water was added and the solution was shaken vigorously. The frothing was mixed with 3 drops of olive oil and shaken vigorously, then observed for the formation of emulsion [22].

**Fatty acid**

0.5 ml of extract was mixed with 5ml of ether. These extract was allowed to evaporate on filter paper. The filter paper was dried. The appearance of transparency on filter paper indicates the presence of fatty acids [23].

**Carbohydrate****Fehling's test**

0.5g of the powdered sample was boiled with 3ml of water and filtered. To the filtrate 2ml of fehling's solution A and B was added. The solution was then heated in a boiling water bath for some minutes. A red precipitate at the base or orange precipitate with green solution indicates presence of carbohydrates [21].

**Barfoed's test**

Barfoed's reagent was added to 2ml of the sample solution and placed in boiling water. For a red precipitate at the base indicates presence of monosaccharides [21].

**Molisch's test**

To 3ml of aqueous extract was added two drops of 10% alpha naphthol reagent and 1ml of Conc  $\text{H}_2\text{SO}_4$ . A purple or violet ring at the interface indicates the presence of carbohydrate [11].

**Anthraquinones****i. Free Anthraquinones**

0.5g of the powdered sample was boiled in a water bath with 10ml hot water for 5 minutes. The solutions were filtered hot and allowed to cool. The filtrates were extracted with benzene. The benzene layers were taken off and shaken with 5ml dilute ammonia, a pink ammonia layer was formed [22].

**ii. Bound Anthraquinones**

0.1g of the powdered sample was boiled with 10ml of ferric chloride and 5ml hydrochloric acid they were hydrolysed by heating on the water bath for 10 minutes filtered hot and the cold filtrate was shaken with benzene to extract. The benzene layer was obtained by pipette, and 5ml dilute ammonia is added a pink ammonia layer was formed [22].



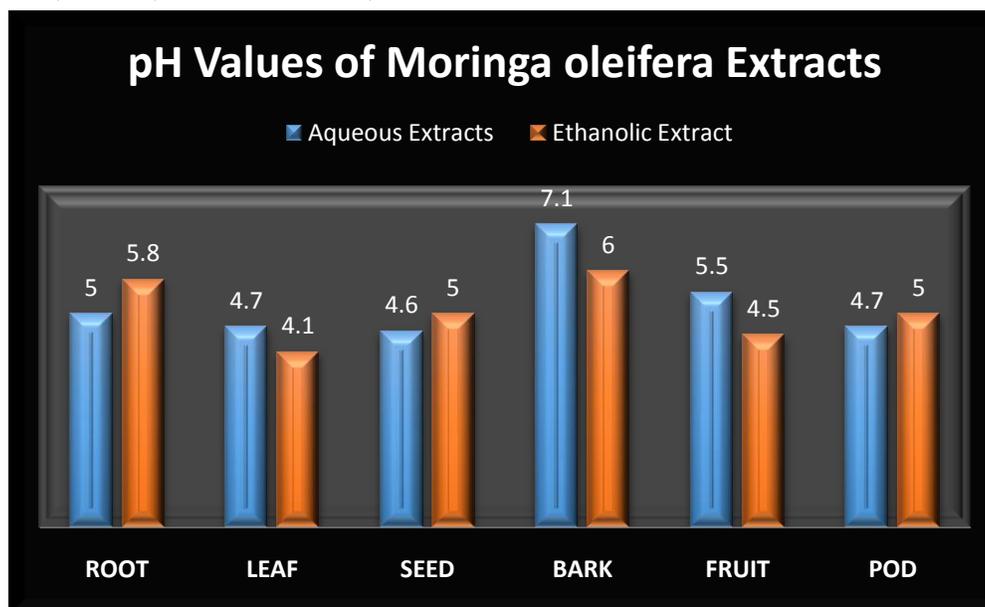
## Results

**Table 1:** Nutrients, Phytochemical Groups and pH of the aqueous and ethanolic extracts of the various parts of *Moringa oleifera* plant.

TESTS	AQUEOUS EXTRACTS						ETHANOLIC EXTRACTS					
	R	L	S	B	F	FS	R	L	S	B	F	FS
<b>Phytochemical Groups Distribution</b>												
ALKALOIDS	-	-	-	-	-	-	-	+	+	-	+	+
FLAVONOIDS	+	+	+	-	+	+	-	+	-	-	+	-
TANNINS	+	+	+	+	+	+	+	+	+	+	+	+
SAPONINS	-	-	-	-	-	-	-	-	-	-	-	-
ANTHRAQUINONES	-	-	-	-	-	-	-	-	-	-	-	-
GLYCOSIDES	-	-	-	-	-	-	-	-	-	-	-	-
STEROIDS	-	-	+	-	+	+	+	+	-	+	+	-
TERPENOIDS	+	+	+	+	+	+	+	+	+	+	+	+
<b>Nutrients Distribution</b>												
<b>PROTEINS</b>	+	+	+	+	+	+	+	+	+	+	+	+
<b>FAT</b>	-	+	+	-	+	+	-	+	+	-	+	+
<b>CARBOHYDRATES</b>												
FEHLINGS	-	+	+	+	+	+	+	-	+	+	+	+
MOLISHS	-	+	-	+	+	-	-	+	-	+	+	+
BARFORDS	-	+	-	-	+	-	+	-	+	-	-	+
<b>Acidity/Alkalinity</b>												
<b>PH</b>	5.0	4.7	4.6	7.1	5.5	4.7	5.8	4.1	5.0	6.0	4.5	5.0

## Key

R: Root; L: Leaf; S: Seed; B: Bark F: Flower; FS: Fruit+Seed

Figure 1: The pH values for extracts of various part of *Moringa oleifera* plant

## Discussion

### PH

All extracts of the various plant parts were acidic except the aqueous extract of the bark that was slightly alkaline. These values are however within the pH values range for many other herbs [24]. The pH values of consumable products (food and herbs inclusive) affect the solubility of its ingredients as well as the safety of its consumption. Naturally, foods and herbs could be toxic, producing deleterious effects at extremely high or low pH values. The solubility of protein has been reported to be pH dependent. It increased at pH 7 and 8. Many proteins are also soluble in alkaline pH [25]. Otu *et al.* had reported an approximate pH value of 4 [acidic] for moringa leaf juice which is closer to the ethanolic extract in the finding of this study than it is to the aqueous extract [26].

### Basic Nutrients

Both the aqueous and ethanolic leaf extracts contained proteins and fat. While the aqueous leaf extract contained carbohydrates, only the Molish's test shows the presence of carbohydrate for the ethanolic extract. The result is in line with that of Otu [2013] about the moringa leaf juice [26]. This shows that moringa leaf contains all basic nutrients and may support its potential use for nutritional purposes. The availability of these nutrients for the body in the *in vivo* environment especially on the basis of pH values would however require further studies. The findings of this study further shows that all the analysed plant parts irrespective of the method of extraction [aqueous or ethanolic] contain proteins; fats and carbohydrates. Roy *et al.* (2007) reported the presence of a water-soluble polysaccharide from moringa pods aqueous extract while Anwar and Rashid (2007) reported sterols, tocopherols and fatty acids [27-28]. The presence of proteins in all the analysed parts support the advocacy of the plant as a reliable source of proteins and a good dietary supplement to combat hunger and protein malnutrition especially in the developing world as severally suggested in some previous publications [2-4, 29-32].

### Basic Phytochemistry

Aqueous extracts of the various plant parts did not contain alkaloids. However, the ethanolic extracts of the leaf, seed, fruits and pod contained alkaloids. This implies that consumers could determine the phytochemistry of their moringa preparations by choosing which method of extraction that would suitably extract the preferred phytochemicals. Alkaloids are popularly used in medicine; purified forms are often used as medicinal agents while herbal sources are popularly used in traditional medicine [33]. Some specifically identified alkaloids are also used as psychoactive drugs and CNS stimulants [34]. Despite the medicinal potentials of alkaloids, care must be taken about consuming them under various conditions; for instance cyclopia has been associated with the alkaloid cyclopamine [35]. This is because this alkaloid disrupts molecular expressions associated with the CNS differentiation including the Sonic Hedgehog Gene (SHH) [36]. In other instances, it is believed that spontaneous abortion might occur rather than cyclopia. The teratogenic effect of cyclopamine alkaloids is of serious concern. There is need for further studies to identify the specific alkaloids that are present in *Moringa oleifera*.

The aqueous extracts of the root, leaf, seed, flower and the whole pod contained flavonoids. Only the ethanolic extracts of the leaf and flower contained Flavonoids. However, both the aqueous and ethanolic extracts of the bark did not contain flavonoids. Flavonoids have enormous phyto-medicinal properties especially as anti-allergic, anti-inflammatory, antioxidant, anti-microbial, anti-cancer, and anti-diarrheal agents; and they also been shown to inhibit topoisomerase enzymes [37-45].

Tannins were present in all the analysed parts of the plant in either form of extracts. This shows that Tannins would be present and consumed in any of the concerned parts of the plant whether it is aqueous or ethanolic. Tannins have dietary and medicinal potentials as they have been suggested to reduce risks of cardiovascular diseases. They also have anti-cancer properties though they show little promise as antioxidants. There are however cautions about excessive consumption on neonates and conceptus [46-54].

Saponins, Anthraquinones and Glycosides were not present in both the aqueous and ethanolic extracts of the various plant parts. They were not significantly extracted from the plant *Moringa oleifera* using the extraction methods employed in this research. Though one might be tempted to conclude that glycosides might be totally absent in the plant; some reports of rare or special glycoside in moringa are available [55-56] suggesting that the availability could be extraction-method dependent. The methods employed here were however the most readily used by



researchers and regular consumers of the plants who might desire nutritional benefits. This may also provide helpful information to consumers who require phytochemistry details of the plant juice or extracts for nutritional and medical reasons.

Terpenoids were present in all plant parts and in both extract forms. Terpenoids contribute to flavours and colours in plants. Some terpenoids-containing herbs have medicinal properties [57].

### Conclusion

Protein, fat and carbohydrates were found in *Moringa oleifera*. Also, various phytochemicals such as Tannins, Terpenoids, alkaloids, flavonoids and steroids were found in *Moringa oleifera*. There were no variations in the distribution of Proteins, Tannins and Terpenoids in the various parts of the plants. Also, the distribution was extraction method dependent. However, there were variations in the distribution of the carbohydrates, fat, flavonoids, alkaloids and steroids which were extraction method dependent. There were variations on pH of the various parts of the plants. The pH of the various parts was also dependent on the extraction method. Saponins, Anthraquinones and Glycosides were not found in any of the extracts of the various parts. Thus, the distribution of some nutrients and phytochemicals varies from one part of the plant to another. Also, the extraction method plays a significant role in the distribution of some nutrients and phytochemicals available to consumers of moringa and researchers on moringa.

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