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Nutritive evaluation of fresh *Moringa oleifera* leaves in Chhattisgarh region

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Abstract

Moringa oleifera, one of the miracle tree, is widely cultivated in different region throughout the India. *Moringa oleifera* belongs to *moringaceae* family and known with various name according to their origin and local dialect. Different parts of *Moringa oleifera* tree are widely used as source of nutrition, multi-vitamins and many other medicinal compounds. *Moringa* leaves are one of the edible parts of the tree carrying bundle of nutrients and multivitamins. Also, leaves of *Moringa* are fast growing and easily harvesting important parts of the tree available in abundant throughout the year. Fresh and healthy *Moringa* leaves were chosen for the study. Nutritional evaluation of locally available fresh *Moringa* leaves were carried out by determining the all proximate like moisture content of the leaves, protein, fat, fiber, ash, carbohydrate and minerals like calcium, magnesium, potassium, iron and zinc using standard methods. The fresh *Moringa* leaves were procured from the Department of Vegetable Science, College of Agriculture and Research Station, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). The proximate estimation and analysis were carried out using methods of Association of Analytical Chemist (A.O.A.C.). Experimental study shows that *Moringa* leaves possess are rich source of nutrients, minerals and vitamins like vitamins A, B, C and D. From the experiment it was found that the moisture content of fresh *Moringa* leaves ranges as 72-76% (wb). Also, other proximate and were recorded as crude protein 5-8%, crude fiber 1-2%, ash content 1.5-2.5%, fat content 1.5-2%, carbohydrate 12-16% in per 100g of fresh *Moringa* leaves. Similarly, minerals were found in following ranges as calcium 390-420mg, Iron 6-8mg, Magnesium 38-42mg, Potassium 350-400mg and Zinc 0.60-0.80mg per 100g of fresh *moringa* leaves.

Keywords: *Moringa oleifera*, proximate analysis, minerals analysis & moisture content

1. Introduction

Green leafy vegetables (GLV) are one of the essential food commodities required in daily diet for survival and growth of body building cells resulting human health. All GLV contains number of nutrients, minerals and vitamins such as calcium, potassium, zinc and iron and vitamins like A, B, & C. It has been proven that almost all the leafy vegetables are good sources of vitamins, proteins, fibers and minerals that are beneficial for human nutrition. A good variety of nutrients are found in commonly growing leafy vegetables like amaranth, spinach, fenugreek, *Moringa* and coriander leaves etc. ^[14, 28]. *Moringa* leaves and its various parts are being used since ancient times for nutritional as well medicinal purposes as naturally occurring nutrients, minerals and vitamins. *Moringa* leaves are full of essential disease-preventing nutrients and minerals like; potassium, calcium, magnesium, iron, zinc, copper and vitamins like β -carotene, vitamin B including folic acid, vitamin C, D and E ^[8, 9, 26]. Also, several researchers have reported the nutritional comparison of dried *Moringa* leaves with other important food commodities (Table 1) ^[11]. Malnutrition severely affects the socio-economic development of a nation because a work force that is stunted both mentally and physically may have a reduced work capacity. Thus nutrition plays an important role in the reproduction of poverty from one generation to the next ^[8, 13, 18]. *Moringa* leaves are one of the commonly using multi vitamins and nutritive potential leaves harvesting from *Moringa oleifera*. Morphologically *Moringa oleifera* are small, fast-growing drought resistant and evergreen tree that usually grows up to 10-12 m in height along with a wide canopy having enormous leaves. *Moringa* leaves are usually bipinnate or tripinnate in shape up to 45 cm long. These are compound leaves which leaflet size ranges as of 1.0 - 2.0 cm long and 0.6 -1.0 cm wide. The leaflets are finely hairy green, leaves of *Moringa* is hairless at the upper surface,

pale and hairless beneath with red tinged, mid-veins with the entire margins, and are rounded or blunt-pointed at the apex but short-pointed at the base [33].

Moringa oleifera belongs to *moringaceae* family and considering as an aggressive invasive species. *Moringa oleifera* are native to tropical and sub-tropical regions across the India & many other countries of the South Asia [16]. Commonly two varieties of *Moringa oleifera* namely annual and perennial type are grown in tropical and subtropical region throughout the India. This rapid growing tree is also known as by their different names according to their appearance, locality and quality characteristics such as “drumstick tree” on the basis of its seed pods looks like sticks to hit the drum, “Miracle Tree” because of all its parts possess amazing quality characteristics and are using for nutritional and pharmaceutical purposes, “horseradish tree” in the west because of horseradish flavor of *Moringa* roots as well as bark and their taste as horseradish peeled root and the “ben oil tree” on the basis of oil which is derived from the *Moringa* pod seeds [30]. The leaves and fruits of *Moringa oleifera* are not only used as a rich source of nutrients and vitamins but also it is best suited to increase prolactin hormones in lactating women. Moreover, the consumption of *Moringa* leaves and their fruits are prescribed to treat the problems of anemia and malnutrition specially in lactating period of women. Since, it carries many health benefits in large quantities that's why it is also known as 'mother's best friend' [35]. In Chhattisgarh

region *Moringa* tree is known as “munga” in local dialect and their leaves and fruits are in common use in day today lives. *Munga* cultivation are mid in range in different parts of state. However, the area under *Munga* cultivation was 2468 ha with annual drumstick production of 16462 MT throughout the Chhattisgarh state. The highest area 783 ha covered for *Moringa* cultivation was observed at Korba district alone in Chhattisgarh with annual production of 7642 MT with an average productivity of 30 T/ha (Source: CG Horticulture statistics 2018-19). The harvesting and uses of leaves and fruits begins after few month of planting of sapling of *Munga* tree. After planting the sapling, it starts fast growing with enormous leaves and canopy with very little care. The *Moringa* leaves are ready for harvesting after 3-4 month of planting later the flowing stage occurs at around 8-9 months after planting. The white and yellowish *Moringa* flower turn into fruits called as “Drumstick” or “Sahjan” or “Munga” in different region. Almost, at the end of month to next month the fruits get matured and turn in large seed pod looks like sticks ready for harvesting and consumption. This process continues upto 2-3 month and repeats frequently throughout the year. Usually, an annual type *Moringa oleifera* tree yields around 200-250 fruits/tree/year whereas 80-90 fruits/tree/year in perennial type for initial two year later the fruiting yields increase upto 500-600 fruits/tree/year. In general, a single *Moringa oleifera* tree produces around 40-50kg of drumstick in single harvesting season [26].

Table 1: Comparison of 100g of different food commodities with dried *Moringa* leaves

Nutrients	Dried leaves	Nutrients	Dried leaves
Vitamin A	Four times (4X) of Carrots and Thirteen times of Spinach	Calcium	Four times (4X) of Milk
Vitamin B	Four times (4X) of Pork meat	Iron	Twenty five times (25X) of Spinach
Vitamin B ₂	Fifty times (50X) of Sarongs	Magnesium	Thirty six times (36X) of Egg
Vitamin B ₃	Fifty times (50X) of Peanut	Potassium	Sixty three times (63X) of Milk
Vitamin C	Seven times (7X) of Oranges	Amino acid	Two times (2X) of Black vinegar
Vitamin E	Six times (6X) of Rapeseed oil	R-Amino acid	Thirty times (30X) of Brown rice
Protein	Two times (2X) of Yoghurt/milk	Chlorophyll	Four times (4X) of Wheat grass

Moringa leaves provide more than 90 kinds of nutrients and 46 types of antioxidant which are extremely powerful tool in preventing diseases [10]. Because of nutritional and pharmaceutical properties *Moringa* leaves can cure almost three hundred health disease such as hyperglycemia, asthma, flu, heart burn, anti-Tumor, fever, external sores/ulcers, hepatic, prostate, radio protective, anti-Anemic, malaria, diarrhea, pneumonia, diuretic, hypocholestermia, dysentery, thyroid, hepatorenal, colitis, ulcer, gastritis, headache, carotenoids, rheumatism, iron deficiency, protein, minerals & vitamin deficiency skin diseases, eye and ear infections etc. [18, 22].

Micronutrient deficiencies are now recognized as an important contributor to the global burden of disease. *Moringa* trees are known to overcome protein deficiency in developing countries as the leaves of the tree contain high amount of crude proteins and amino acids compared with soybean and other leafy vegetables. *Moringa* is an excellent non-animal source of protein for vegans as well as non-vegetarians. It is very rare for a vegetable to contain all of these amino acids, *Moringa* leaves contain all of the essential amino acids, which are the building blocks of proteins and *Moringa* leaves contains these amino acids in a good proportion, so that they are very useful to human bodies. *Moringa* leaves could be a great boon to people who do not get protein from meat. Moreover *Moringa* leaves possess arginine and histidine two amino acids which is most essential

for infants. In the view of all the nutritional and pharmaceutical properties *Moringa* leaves could be considered as extremely valuable food source [10, 13, 19, 35].

In view of inherent *Moringa* leaves are one of the major source of nutrition, vitamins and minerals. Finding the potentials uses of *Moringa* leaves has a good research scope requiring a detailed study about nutritional profiling and value addition. In view of research need and considering nutritional enrichment of *Moringa* leaves, the present study was conducted to document the nutritional values of locally available fresh *Moringa* leaves.

2. Materials and Methods

Freshly harvested *Moringa* leaves were procured from the Department of Vegetable Science of College of Agriculture and Research Station, Indira Gandhi Krishi Vishwavidyalaya and locally available in Raipur (CG). Healthy green and matured leaves were selected on the basis of their physical properties and visual examine for study. Mostly morning hours were preferred to harvest the *Moringa* leaves from tree to avoid differences and bias. The *Moringa* leaves were detached from the branches and tiny stems later individual leaves manually. Further green and healthy *Moringa* leaves were cleaned and washed thoroughly using tap water and spread it on tissue paper in order to remove the surface moistures. After washing fresh and clean *Moringa* leaves were stored in HDPE zip lock polythene till further use.

■ Proximate analysis of *Moringa oleifera* leaves

Usually fresh and matured *Moringa* leaves were taken to estimate the proximate compositions using standard procedure as follows:

2.1. Moisture content

The Moisture content of fresh *Moringa* leaves was determined by using standard hot air oven method. First of all, three empty moisture dishes were weighted separately using precision weighing balance. Further 2-3g fresh *Moringa* leaves was taken in each moisture dish and kept in hot air oven whose temperature was previously fixed at $103\pm 2^\circ\text{C}$ for 24 hours. Next day, moisture dishes were taken out from oven and kept in a desiccator allowing cool upto room temperature. After attaining room temperature, the weight of the moisture dishes along with sample was recorded. The moisture content of the sample was calculated using the following Formula ^[1].

$$\text{Moisture content \% (wb)} = \frac{\text{Initial weight sample} - \text{final weight of sample}}{\text{Total weight of sample}} \times 100$$

2.2. Protein content

Crude protein was determined following by Micro-Kjeldahl method. Fresh and matured *Moringa* leaves were chopped in fine pieces. Finely chopped 0.5g *Moringa* leaves was taken and transfer to the 500 ml kjeldhal digestion tube. Further, 20 ml of sulphuric acid (H_2SO_4) was added into the tube followed by adding the containing catalyst mixture (K_2SO_4 : CuSO_4). Sample containing digestion tubes were fixed in digestion chamber and covered by fume suction panels. The main power of digestion unit was switched and left it for 3 - 4 hrs in progressive temperature upto 420°C . Digested sample in tube was distilled with 40 percent NaOH using distillation unit and collecting 4 percent boric acid containing Methyl red indicator and liberated ammonia in a flask. Further the it was titrated with 0.1N HCL till light pink color appears. Nitrogen percent was calculated and protein percentage was estimated in the sample by multiplying with appropriate factor (6.25). Protein content and Nitrogen% was determined by given formula ^[1].

$$\text{Nitrogen \%} = \frac{\text{Normality of acid} \times (\text{Burrete reading} - \text{blank reading}) \times 14.01 \times 100}{\text{Wt. of sample in gm} \times 1000}$$

$$\text{Protein \%} = \text{Nitrogen \%} \times 6.25$$

2.3. Fiber content

Fiber content in *Moringa* leaves was estimated by using Fibra Plus Extraction unit. Fiber estimation process was completed mainly in two steps namely acid and alkali wash. Initially, one gram of defatted sample was taken in a crucible and 150 ml of 1.25% H_2SO_4 solution was added to beaker. Crucibles were placed on heating plate and allowed for boiling and refluxed simultaneously for 45-minute at 500°C and later after cooling it was filtered. The beaker and residue was washed with distilled water until the filtrate was neutral. In the second base wash, again residue was washing with 150 ml of 1.25% NaOH. Same steps were repeated almost three time. Afterward crucible with sample are dried in oven at 100°C for 1-2 hours, for removal of excess moisture and then cooled in a desiccator. After cooling the weight was recorded along with sample (weight sample A). Then the samples were transferred in ashing crucible and kept in muffle furnace at 550°C for 4 hr. After, the crucibles were cooled in a desiccator and reweighed (weight sample B). The fiber content was calculated by using following formula ^[1].

$$\text{Fiber \%} = \frac{(\text{weight of sample A}) - (\text{weight of sample B})}{\text{Sample weight}} \times 100$$

2.4. Fat content

2-3g fresh *Moringa* leaves was weighed accurately and then transferred in thimble and defatted with n-hexane using Soxhlet (SOCS-PLUS) apparatus at $75-150^\circ\text{C}$ for 2-3 hr. The resultant n-hexane extract was evaporated and fat content was calculated as ^[1].

$$\text{Fat \%} = \frac{\text{Final weight of flask} - \text{Empty weight of flask}}{\text{Weight of sample}} \times 100$$

2.5. Ash content

2-3 g fresh *Moringa* sample was weighed into silica crucible and heated at low flame till all the sample was completely charred and cooled. Then it was kept in muffle furnace for at 550°C for 4 hr. It was again cooled in desiccator and final weight was recorded. The ash percent was calculated by calculating the difference between the initial and final weight ^[1].

$$\text{Ash \%} = \frac{\text{Weight of crucible after ashing} - \text{Weight of empty Crucible}}{\text{Total weight of sample}} \times 100$$

2.6. Carbohydrate percentage

Carbohydrate percentage was determined by subtracting the sum of percentage of moisture content, crude fiber, protein, fat, and total ash from the hundred ^[1].

$$\text{Carbohydrate (\%)} = 100 - [\text{Moisture content (\%)} + \text{Ash content (\%)} + \text{Protein content (\%)} + \text{Crude fiber content (\%)} + \text{fat content (\%)}]$$

2.7. Energy content

The total energy in kilocalories/100g was determined by following formula:

$$\text{Energy content (Kcal/100g)} = [4 \times \% \text{ protein} + 9 \times \% \text{ fat} + 4 \times \% \text{ carbohydrate}]$$

■ Minerals analysis of *Moringa oleifera* leaves

The Atomic Absorption spectrophotometer element AS (Electronics Corporation of India Limited, model AAS 4141) was used to determine the concentration of potassium, magnesium, iron and zinc fraction in fresh sample of *Moringa* leaves and Flame photometer was used to the analyze the calcium content in *Moringa* leaves samples ^[27, 29].

3. Results and Discussion

This section of the paper deals with the outcomes obtained from experiment. Fresh *Moringa* leaves were taken for study and proximate composition as well mineral fraction were estimated using literature cited methods and formulas.

From the experimental observation it was found that the moisture content of fresh and healthy *Moringa* leaves varied from 72-76% on wet basis (Table 2). High moisture content of fresh leaves indicates their perishability and lower shelf life hence storage for longer time would lead to spoilage due to its susceptibility to microbial attack. The limitation in storage supports the practice of storage in dry form by users ^[25].

Proteins are required in diet in order to provide essential amino acids that cannot be synthesized by the body. Experimental result shows that the protein percentage of fresh *Moringa oleifera* leaves was found to be 5-8% of per 100g of fresh leaves (Table 2). The similar result was reported by ^[4].

Crude fiber in food or plant is an indication of the level of non-digestible carbohydrate and lignin. Fiber enhances the intestinal absorption of nutrient, prevents colon cancer, reduces the incidence of heart disease, lowers inflammation, diabetes, blood pressure [5]. Crude fiber of fresh *Moringa oleifera* leaves was recorded as 1-2% per 100g of fresh leaves (Table 2). Also, the similar result was mentioned by [34].

Ash content is a measure of the total amount of minerals present within a food, ash in food contributes the residue remaining after all the moisture has been removed as well as the organic material (fat, protein, carbohydrates, vitamins, organic acid etc.) [24].

Ash content fresh *Moringa oleifera* leaves was recorded as 1.5-2.5% for per 100g fresh leaves (Table 2). The similar result was reported by [3].

Fats provides very good sources of energy and aids in transport of fat soluble vitamins, insulates and protects internal tissues and contributes to important cell formation process in some extent however excess fat plays a drawback [15, 25].

Moringa leaves also carries the fat content in some extent. From the experimental study it was found that the fat content of fresh *Moringa oleifera* leaves varies from 1.5 to 2%. Similar results of fat percentage were reported by many other researchers [2].

Carbohydrates are the key source of energy for growth and survival of human body. Carbohydrate could be gain from many plant based food commodities in significant quantity. *Moringa* leaves one of the food items including vegetables in order to supply the nutrition and multi-vitamins and minerals. Proximate composition data reveals that fresh *Moringa* leaves contains around 14-18% of carbohydrate which is good for daily requirement [4].

Several studies show that the plant and their parts are moderate source of carbohydrate when compared with the RDA of 130g [25].

The Energy value of fresh *Moringa oleifera* leaves was found to be 110-140 Kcal/100g per 100g of fresh leaves.

Table 2: Proximate composition of *Moringa oleifera* leaves

Parameter	Composition
Moisture content (%)	72-76%
Protein (%)	5-8%
Ash (%)	1.5-2.5%
Crude Fiber (%)	1-2%
Carbohydrate (%)	14-18%
Fat (%)	1.5-2%
Energy (kcal/100g)	110-140 Kcal

Minerals content in *Moringa oleifera* leaves

Various minerals play an important role in human body specially in bone formation and body growth. From the experiment it was found that *Moringa* leaves are nature gifted source of numbers of minerals in significant quantity. From the study it was found that calcium content of fresh *Moringa oleifera* leaves was range as 390-420mg/100g. The recommended Dietary Allowance (RDA) for calcium is 600-1400mg [7].

Iron is very important in the formation of hemoglobin in red blood cells and deficiency of iron leads to anemia. The iron content of fresh *Moringa oleifera* leaves was found to be 6-8mg/100g.

The potassium content of fresh *Moringa oleifera* leaves was found to be 350- 400mg/100g. According to National Research Council (1974), the RDA of potassium is 1875-

5625mg/kg for adults. Potassium is very vital in regulation of water and electrolyte balance and acid-base balance in the body, as well as responsible for nerve action and functioning of the muscles. Deficiency of potassium leads to muscle paralysis [21].

The zinc content of fresh *Moringa oleifera* leaves was found to be 0.60-0.80mg/100g. Zinc is essential in the activation of certain enzymes. The RDA for zinc is 13mg/kg [15].

Among all the mineral elements analyzed, calcium exhibited the highest value and zinc obtained lowest.

Table 3: Minerals composition of *Moringa oleifera* leaves

Parameter	Composition(mg/100g)
Calcium	390-420
Iron	6-8
Magnesium	38-42
Potassium	350-400
Zinc	0.60-0.80

4. Conclusion

The *Moringa oleifera* trees are easily available in all the regions of Chhattisgarh as well as throughout the India. *Moringa oleifera* leaves are very affordable, easily available, promising and alternate food sources for the human consumption. All parts of *Moringa oleifera* are extremely valuable source of nutrition for people of all the age group. Consumption of these plants could provide several health benefits and thus it can be used as the essential part of the diet as a whole and daily food. The present study on nutritional profile of *Moringa oleifera* indicates that, the leaves are highly nutritive and multi vitamins requires for human nutrition for body growth. Their uses can be viewed as a good source of nutritional and therapeutic elements that can be explored in the field of nutritional and pharmaceutical industry. At last it could be concluded that the present study was carried out to enable and explore the potential uses of *Moringa oleifera* leaves in food and pharmaceutical industries. Nutritional profiling of *Moringa oleifera* leaves offers the possibility of value added products and formulation of various dietary supplements.

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