

Many Uses of Moringa (*Moringa oleifera*) in Human and Animal Nutrition

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Mini Review Article

Received date: 24/01/2018

Accepted date: 03/04/2018

Published date: 10/04/2018

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Keywords: Moringa; Human; Animals

ABSTRACT

Many local names for moringa tree but all are derived from the generic root "Morunga". *Moringa* is commonly known as Horseradish tree, Drumstick tree, Never Die tree, West Indian Ben tree, and Radish tree. *Moringa* is one of the world's most useful trees, as almost every part of the tree can be used for food, medication and industrial purposes. It is a highly valued plant and it distributed in tropical and subtropical countries. It also known as the tree of life is used in human food and animal feed, medicine, industry, water purification, the so called "miracle tree". It is now growing worldwide. *Moringa* has for long been consumed by humans and all its parts are edible in many developing countries. This review was elaborated with the aim of discussing information on many uses of moringa in human and animal nutrition.

INTRODUCTION

Moringa or *Moringa oleifera* Lam (synonym: *Moringa pterygosperma* Gaertner) is the best known of *Moringa* tree (family Moringaceae). It is a fast-growing, drought-resistant tree native to sub-Himalayan tracts of northern India, Pakistan, Bangladesh and Afghanistan. It is now growing worldwide in the tropics and subtropics [1]. *Moringa* 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 *Moringa 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 [2-4]. In the Dravidian language, there are many local names for this tree, but all are derived from the generic root "Morunga". *Moringa* is commonly known as Horseradish tree, Drumstick tree, Never Die tree, West Indian Ben tree, and Radish tree [2,3]. Its leaves and pods have been reported to be of great nutritional value and yield many vitamins and minerals. The leaves and the young green pods can be eaten like other vegetables. *Moringa* has for long been consumed by humans and all its parts are edible in many developing countries [2]. It has a wide range of medicinal uses with high nutritional value, the so called "miracle tree" [3]. *Moringa* is a non-leguminous tree with a high crude protein in the leaves (251 g/kg DM) and negligible content of tannins and other anti-nutritional factors [5]. In Europe and Africa, it is grown for multiple uses, and its leaves, flowers, fruits and seed oil are used in human food, as well as its branches and leaves are used as fodder. It is also used for medicinal applications, live fencing and windbreaks, and the extract from its seeds is used in the treatment of turbid waters. *Moringa* is a perennial softwood tree with timber of low quality, but which for centuries has been advocated for nutritional, medicinal and industrial uses [6]. This paper will review available literature on feeding studies made on many uses of moringa human and animal nutrition.

ORIGIN, AGRONOMIC CHARACTERISTICS AND NUTRITION COMPOSITION OF MORINGA

Moringa (*Moringa oleifera*) belongs to the kingdom Plantae, division Magnoliophyta, class Magnoliopsida, order Brassicales, being the most popular species and belonging to the monogenic family Moringaceae of the genus *Moringa*. *Moringa* originates from the Agra and Oudh region of northwestern India, south of the Himalayan mountains, being widely cultivated in Asia, Africa, South America and other tropical regions of the world [7]. It is a fast growing, evergreen, deciduous tree of height 10-12 m. The leaves are bipinnate or more commonly tripinnate, up to 45 cm long, and are alternate and spirally arranged on the twigs. The

flowers are fragrant and bisexual, surrounded by five unequal thinly veined yellowish-white petals. Flowering begins within the first six months after planting. In seasonally cool regions, flowering will only occur once a year between April and June. In more constant seasonal temperature and with constant rainfall, flowering can happen twice or even all year-round. The fruits are pendulous (i.e. hanging), linear, three-sided pods with nine longitudinal ridges, usually 20 to 50 cm long, but occasionally up to 1 m or longer, and 2.0 to 2.5 cm broad. The pods, each usually containing up to 26 seeds, are dark green during their development, and take approximately 3 months to mature after flowering. *Moringa* tree can produce hundreds or even thousands of seed pods, yielding countless seeds each and every year (Figure 1)^[7]. The nutritional composition of fresh leaves and fruits of *Moringa* is presented in Table 1. *Moringa* is also postulated to have the highest antioxidant content in food and also has a remarkable range of medicinal uses and high nutritional value^[7,8].

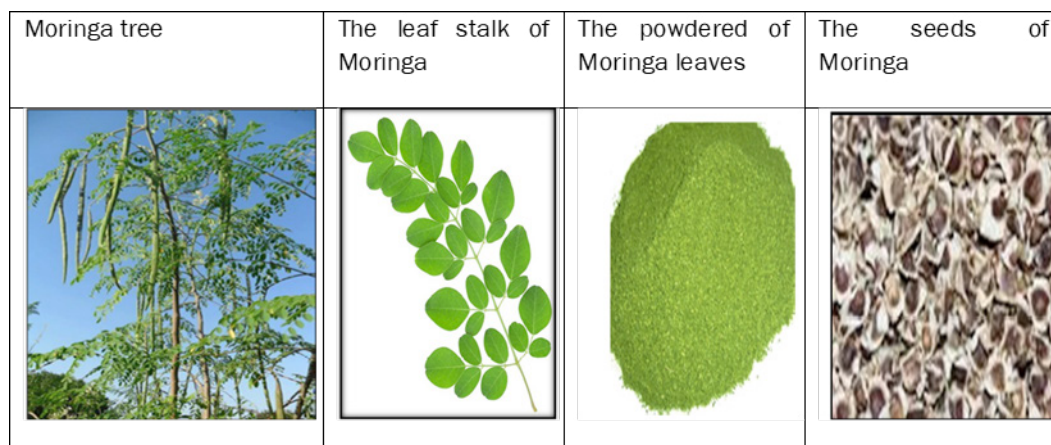


Figure 1. Moringa tree and its leaf stalk, leaf powdered and seeds^[8].

Table 1. Nutritional composition of fresh leaves and fruits of moringa from many parts of the world^[7]. Nutritional composition

| Nutritional composition (%) | Fresh leaves | | | Fruit | Type of leaves | |
|--|--------------|-----------|-------|-----------|----------------|-------------|
| | Bangladesh | Nicaragua | India | Sri Lanka | Extracted | Unextracted |
| Dry matter | 18.7 | - | - | 10.7 | - | - |
| Crude protein | 29.0 | 25.1 | 26.4 | 20.7 | 43.7 | 25.1 |
| Crude fibre | 19.1 | - | - | 27.0 | | |
| Lipid | - | - | - | - | 1.4 | 5.4 |
| Gross energy (MJ/kg DM) | | | | | 17.7 | 18.7 |
| Ash | - | - | - | - | 10.0 | 11.5 |
| Macro-elements (g kg ⁻¹ DM) | | | | | | |
| Calcium | 2.06 | 17.5 | 26.4 | - | - | - |
| Phosphorus | 0.24 | 1.16 | 1.36 | - | - | - |
| Magnesium | - | 0.11 | 0.11 | - | - | - |
| Sodium | - | 1.16 | 2.73 | - | - | - |
| Potassium | - | 19.1 | 21.7 | - | - | - |
| Micro-elements (kg ⁻¹ DM) | | | | | | |
| Iron | - | 582 | 175 | - | - | - |
| Zinc | - | 47.1 | 51.8 | - | - | - |
| Manganese | - | 13.5 | 13.7 | - | - | - |
| Copper | - | 11.2 | 7.1 | - | - | - |

MANY USES OF MORINGA FOR HUMAN AND ANIMALS

Moringa is one of the world’s most useful trees, as almost every part of the tree can be used for food, medicational and industrial purposes (Figure 2)^[7]. It also known as the tree of life is used in human food and animal feed, medicine, industry, water purification^[9]. Fuglie^[2] listed many uses of moringa could be summarized thus: alley cropping (biomass production), animal

forage (leaves and treated seed-cake), biogas (from leaves), domestic cleaning agent (crushed leaves), blue dye (wood), fencing (living trees), fertilizer (seed-cake), foliar nutrient (juice expressed from the leaves), green manure (from leaves), gum (from tree trunks), honey and sugar cane juice-clarifier (powdered seeds), honey (flower nectar), medicine (all plant parts), ornamental plantings, biopesticide (soil incorporation of leaves to prevent seedling damping off), pulp (wood), rope (bark), tannin for tanning hides (bark and gum).

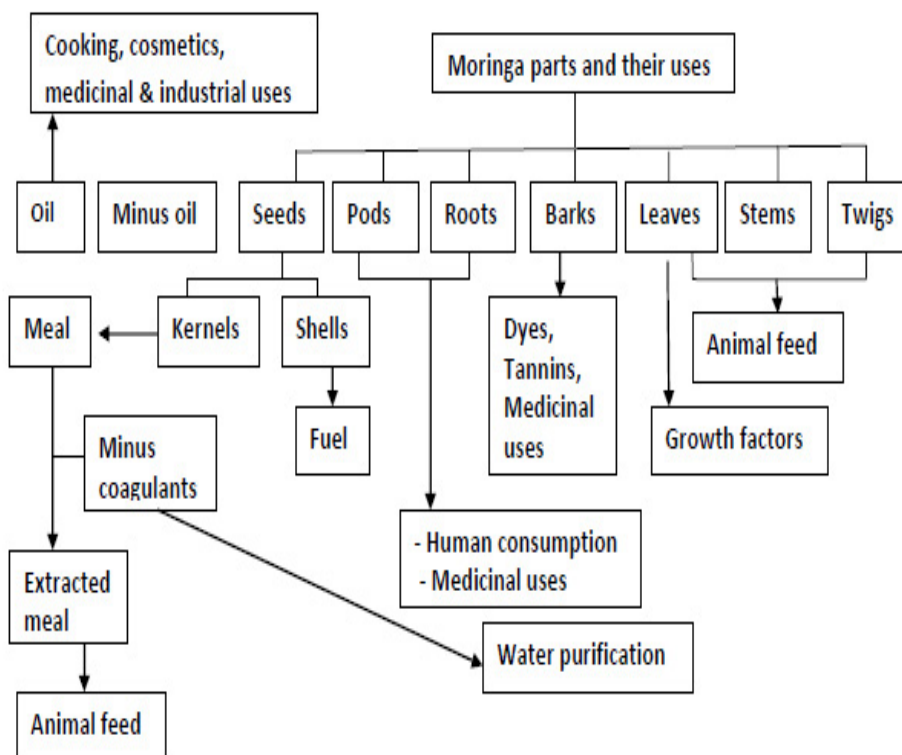


Figure 2. Many uses of different parts of Moringa [7].

Chukwubuka [8] added that moringa seed oil has been used in making salads, fine machine lubrication, and in the manufacture of perfume and hair care products. Powdered seed of moringa has been used to flocculate contaminants and purify drinking water. The seeds also eaten green, roasted, powdered and for tea or used in curries. Moringa leaves would be of great use in treating malnutrition, in pregnant women and nursing women. Moreover, since its leaves have high nutritive potential, they are used to combat child malnutrition [10]. Chukwubuka [8] also listed medicinal benefits of moringa as follows: the treatment of ascites, rheumatism, venomous bites and as cardiac and circulatory stimulants in folk remedies (the flowers, leaves and roots), skin diseases (moringa oil), rubefacient and vesicant (young tree and root bark), hiccough (leaf juice), influenza (cooked leaves), antiviral, anti-inflammatory, analgesic (root-bark), hypoglycemic (stem-bark and flowers), anti-inflammatory, antispasmodic and diuretic (seed). Moringa leaves had been reported to contain 7 x the Vitamin C of Oranges, 4 x the Calcium of Milk, 4 x the Vitamin A of Carrots, 3 x the Potassium of Bananas, and 2 x the Protein of Yogurt (Table 2). The leaves of Moringa have also been reported to be rich in protein, carotene, macro/micro elements while the leaves are rich in amino acids (Table 3) [7]. These excellent nutritional characteristics would also make suitable as forage for feeding animals (Table 4).

Table 2. Nutritional comparison of Moringa fresh and dry leaves with common foods per 100 grams [2].

| Nutrient | Common foods | Moringa oleifera | |
|-----------|----------------|------------------|--------------|
| | | Fresh leaves | Dried leaves |
| Vitamin A | 1.8 mg Carrots | 6.8 mg | 18.9 mg |
| Calcium | 120 mg Milk | 440 mg | 20003 mg |
| Potassium | 88 mg Bananas | 259 mg | 1324 mg |
| Protein | 3.1 g Yogurt | 6.7 g | 27.1 g |
| Vitamin C | 30 mg Oranges | 220 mg | 17.3 mg |

Table 3. Amino acid composition of extracted and unextracted Moringa leaves ^[7].

| Amino acid | Amino acid composition | | | | FAO reference protein (g/16 g N) |
|---------------|------------------------|-----------|--------------------|-----------|-------------------------------------|
| | Extracted leaves | | Unextracted leaves | | |
| | (g/16 g N) | (g/kg DM) | (g/16 g N) | (g/kg DM) | |
| Lysine | 6.61 | 26.77 | 5.6 | 14.06 | 5.80 |
| Leucine | 9.86 | 42.89 | 8.70 | 21.84 | 6.60 |
| Isoleucine | 5.18 | 22.53 | 4.50 | 11.30 | 2.80 |
| Methionine | 2.06 | 8.96 | 1.98 | 4.97 | 2.50 |
| Cystine | 1.19 | 5.18 | 1.35 | 3.39 | 2.50 |
| Phenylalanine | 6.24 | 27.14 | 6.18 | 15.51 | 6.30 |
| Tyrosine | 4.34 | 18.88 | 3.87 | 9.71 | 3.50 |
| Valine | 6.34 | 27.58 | 5.68 | 14.26 | 1.90 |
| Histidine | 3.12 | 13.57 | 2.99 | 7.50 | 3.40 |
| Threonine | 5.05 | 21.97 | 4.66 | 11.70 | - |
| Serine | 4.78 | 20.79 | 4.12 | 10.34 | - |
| Glutamic Acid | 11.69 | 50.85 | 10.22 | 25.65 | - |
| Aspartic Acid | 10.60 | 46.11 | 8.83 | 22.16 | - |
| Proline | 5.92 | 25.75 | 5.43 | 13.63 | - |
| Glycine | 6.12 | 26.62 | 5.47 | 13.73 | - |
| Alanine | 6.59 | 28.67 | 7.32 | 18.37 | - |
| Arganine | 6.96 | 30.28 | 6.23 | 15.64 | - |
| Tryptophan | 2.13 | 9.26 | 2.10 | 5.27 | - |

Table 4. The uses of Moringa leaves as forage for feeding animals.

| Animal species | Results | | References |
|----------------|---|--------------------------|-----------------------------------|
| Cattle: | Range of weight gains | Average weight gain | Foidl et al. ^[7] |
| | (g/day) | (g/day) | |
| | -Pasture fed group -Experimental group | 750 – 980 1150 – 1450 | |
| Buffalo | Replacing up to 15% of calf starter by dry <i>Moringa oleifera</i> leaves (DMOL) improved growth performance of suckling buffalo calves, if compared with replacing 20% and control group. | | Elaidy et al. ^[11] |
| Broilers | <i>Moringa oleifera</i> leaves (MOL) can be safely included in broiler diets up to 10% without negatively affecting productivity. | | Olugbemi et al. ^[12] |
| Laying hens | Higher egg-laying rates, lower feed intake and a better feed conversion rate, as well as larger yolk size and better yolk color for the treatment with ration supplemented with moringa leaves <i>ad libitum</i> when compared to chickens fed only with control ration <i>ad libitum</i> . | | Mohammed et al. ^[13] |
| | Using <i>Moringa oleifera</i> leaves at 5% in the diets as protein source ingredient can improve egg production in laying hens. | | Raphaël et al. ^[14] |
| Rabbits | The supplementation of <i>Moringa</i> at 3% in the feed. Gives the best results in terms of gross weight, growth rate and survival of young rabbits. | | Djakalia et al. ^[15] |
| | <i>Moringa oleifera</i> leaf can be used to replace 60% of groundnut cake in the diets of grower rabbits. | | Adeniji and Lawal ^[16] |
| | The utilization of <i>Moringa oleifera</i> leaf meal (MOLM) can be used up to 60% in diets and increased income from diets of weaner rabbits. | | Zendrato et al. ^[17] |

CONCLUSIONS

Based on the reviewed literature, it was concluded that Moringa or *Moringa oleifera* is a plant with multiple uses for the nutrition of human and animals, since virtually all its parts present numerous possibilities of use. At the same time, the nutritive characteristics of moringa make this plant an excellent option to be used as fodder for human and animals in many countries.

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