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The potential of Moringa tree for poverty alleviation and rural development: Review of evidences on usage and efficacy

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Abstract

Inadequate health care supply, poor nutrition, low income levels, use of trees and their by-products for provision of food, medicine and cosmetics are common among the rural people of the developing nations. Moringa Tree has been reported to be a wonder plant that is useful for human and animal nutrition, health, cosmetics, bio-gas and water purification among other uses. Empirical evidences on the economics of its production highlights its potential as a tool for enhancing the income of its producers. However, the level of awareness of its uses and evidence of its efficacy among resource-poor farmers in Nigeria is generally low. Therefore, canvassing for the cultivation and use of Moringa Tree among the resource-poor farmers is necessary for poverty alleviation and will make Moringa Tree and its by-products a tool for rural development. This paper reviews the myriads of evidences on the usage of Moringa Tree, leaves, flower, fruits, seed, root and their by-products as reported by various researchers worldwide. The reviews suggest that Agricultural Extension agents can play a vital role in disseminating information on the role Moringa Tree can play in wealth creation for poor farmers.

Keywords: Moringa tree, Poverty alleviation, Resource-poor farmers, Rural development

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1. Introduction

Poverty and hunger related issues have continued to occupy a prominent position on the front burner of economic discuss world over, and developing Nations are faced with a number of challenges regarding nutrition, health and standard of living. In ability of an individual to attain a minimum standard of living is poverty and it is a social condition characterized by in adequacy of access to basic human needs (food and non food) for the maintenance of socially acceptable standard of living in a given society. There is great poverty in the land, and this is evident from IFAD (2011) where it was reported that 1.4b people out of the world population of 6.8b live on \$1.25 a day or less, UNICEF (2010) reported that an average of 22,000 children die each day due to poverty related conditions, while FAO (2010) puts the number of hungry people in the world at 925million. Meaning that about one out every seven person is hungry. It further reported that 98% of the worlds hungry live in developing countries majorly Asia, Pacific and Sub-Saharan Africa. MDG report of 2010 confirmed that, a child dies from hunger related diseases every five seconds, while three out of every four persons worst hit by poverty and hunger live in the rural areas (HDR, 2010). Despite the fact that the rural communities have agriculture as their mainstay, FAO (2010) reported that 50% of hungry people are farm families in rural communities. It is argued that while poverty is the principal cause of hunger, hunger also causes poverty by bringing about poor health and low levels of energy thereby impeding productivity and resulting in poverty.

Lack of economic power for minimum standards of living among the poverty stricken people of the rural communities and the quest for survivability makes them rely on natural products and utilize them in all aspects of their life. Report gathered during personal interactions with some herb sellers at a local market in Kwara state, Nigeria revealed that many trees and their products are being utilized by the rural dwellers for phytotherapy, cosmetics, cooking, food and beverages etc. For examples; Neems Tree popular called 'Dongoyaro Tree' and its various parts (leaves, stem bark, roots), are used in preparation of traditional mixture for treatment of malaria, combination of cotton leaf and garlic onion mixture are used to suppress high blood pressure, mango tree bark, leaves and root are used for preparation of blood tonic. A product of shea butter tree fruits (popularly called ori among the Yorubas) is use as hair and body cream, Sobo drinks prepared from the Calyx of the roselling is a favourite drink among the rural dwellers, while Cashew leaf stalk and Jathropha gum are used as chewing stick and remedy for tooth decay, respectively. But the use of Moringa Tree and its products were rarely mentioned, this corroborates the findings of Odeyinka et al. (2008) that 61.87 % of farmers in southwestern Nigeria were not aware of the Moringa Oleifera plant.

Moringa Tree is a perennial softwood tree of various species (*Moringa Oleifera*, *Moringa Pterygosperma*, *Moringa drouhardii*, *Moringa Stenopetala*, *Moringa Peregina*, *Moringa Cocanensis*). Its timber is of low quality, but it is an important tree in various parts of the world. Moringa Tree has been of many uses to human race ranging from consumption to domestic usage, animal forage, plant manure, bio pesticides and as ornamental plants. Its edible properties and evidence of its role in human health and nutrition made it a tree that is long consumed by man. The fruits are boiled and eaten whole, while the tender young pods that look like string beans are cooked and eaten whole or sliced , the pulp are extracted from the mature pods, called the drumsticks, and soft seeds from immature drumsticks are boiled and eaten like fresh peas (Livestrong, 2012).

The leaves are boiled and cooked like vegetables, or dried and ground into powder while the flowers are cooked to make tea, the roots are pickled or crushed into condiments. All parts of Moringa tree are edible and consumed by humans. Different parts of Moringa Tree are coming into limelight as a result of scientific proof that moringa is an important source of naturally occurring phytochemicals that provides basis for future feasible developments (Anwar and Bhangar, 2003). Moringa Tree has been canvassed recently to be an indigenous source of highly digestible protein, Ca, Fe, Vitamin C, and carotenoids suitable for utilization in many of the developing world and it can be used to combat malnutrition because it is a readily available and promising food source. While under-nutrition/malnutrition has been fingered in most deaths particularly of infants, various studies confirm the high nutritive and medicinal value of all parts of the moringa oleifera plant, A lot of researchers have worked on Moringa Tree and provided evidence on the multiple uses of Moringa plant. These are gathered in this report to show that the plant is a tool for poverty alleviation, and also to increase the awareness of the inherent benefits of Moringa plant.

2. Moringa tree

Moringa Tree, also known as Horseradish tree, drumstick tree, sujuna benzolive tree and ben oil tree is widely cultivated in the tropics and most grown in parts of the world most hit by malnutrition (United Nation Reports, 2004). The Hausa tribe of Northern Nigeria called Moringa Tree Zogali, Bagaruwa or Barambo, the Fulani of the same region named it Garawa, or Rimimaka, the Yoruba in the south western region called it Igi igbale, Igi Iyanu (Miracle Tree) and its leave 'Ewe Igbale', while the Ibo tribe of the Eastern region called it okwe oyibo, or odudu oyibo.

Moringa Tree is a medium sized tree that belongs to the family moringaceae of a single genus (Ramachandran et al., 1980). Moringa Oleifera Lam is a highly valued plant that is well distributed in many countries of tropics and subtropics (Anwar et al., 2007)c, widely distributed in the Phillipines, Canbodia, Central, North and South America and the Caribbean Islands (Morton, 1991). It is widely cultivated in the East and distinguished by shape and structure of its leaves, its mode of erection with stem bark that is whitish grey in colour, thick, soft and rough (Roloff et al., 2009). The stem has many branches that is capable of fast re-growth from the stem after being cut, damaged, it exudes a gum that is white in colour and which changes to reddish brown or brownish black on exposure. The mucilaginous gum exuded from cutting of the tree is used in leather tanning and calico printing (Ramachandran et al., 1980; Nautiyal and Venkaraman, 1987). Mild hydrolysis of the whole gum of Moringa tree with an acid revealed that it can produced a degraded-gum polysaccharide consisting of L- galactose, - glucuronic acid, and L- mannose, while purified whole gum exudates from moringa tree contain L- arabinose, galactose, - glucuronic acid, L- rhamnose, - manose and xylose (Bhattacharaya et al., 1982). Moringa gum has been reported to be useful in dental care, while the gum mixed with sesame oil is believed to relieve headaches, fevers, intestinal complaints, dysentery, asthma and sometimes used as remedy for syphilis and rheumatism (Fugile, 2000; Anwar et al., 2007).

Moringa Tree has a corky bark that yields a coarse fibre useful for making mats, ropes and paper. Bhatnagar et al. (1961); Siddhuraju and Becker (2003) and Anwar et al. (2007) reported that the stem bark is useful to cure eye diseases and for the treatment of fever, stem bark juice was reported to prevent enlargement of the spleen, destroy tumors and heal ulcers. Antifungal activity of the bark extract and the antibacterial effect of the juice from the stem bark against staphylococcus aureus has been reported by Bhatnagar et al. (1961) and Mehta et al. (2003), respectively. Moringa Tree wood is soft and light, with a density of 0.5 to 0.7 g/cm³. It is rarely used as a fuel wood and occasionally for light construction.

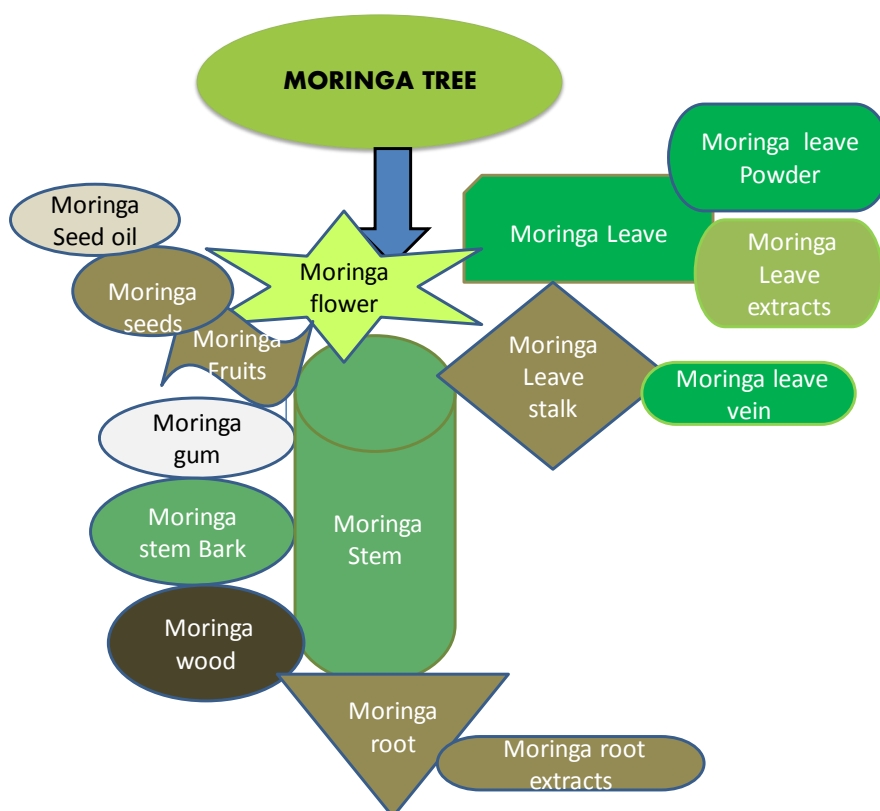


Figure1. Moringa Tree and its products

3. Moringa leaves

Moringa Leaves are either bipinnate or tripinnate, they are up to 45 cm long, alternate and spirally arranged on the twigs that are finely hairy and green with leaflets that are 1.3 to 2.0 cm long and 0.6 -1.0 cm wide. (Roloff et al., 2009). Moringa leaf lateral leaflets are elliptic, the terminal ones are obovate, petioles of lateral leaflets are 1.5 to 2.6mm long and the terminal ones are 3 to 6 mm long. The 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.

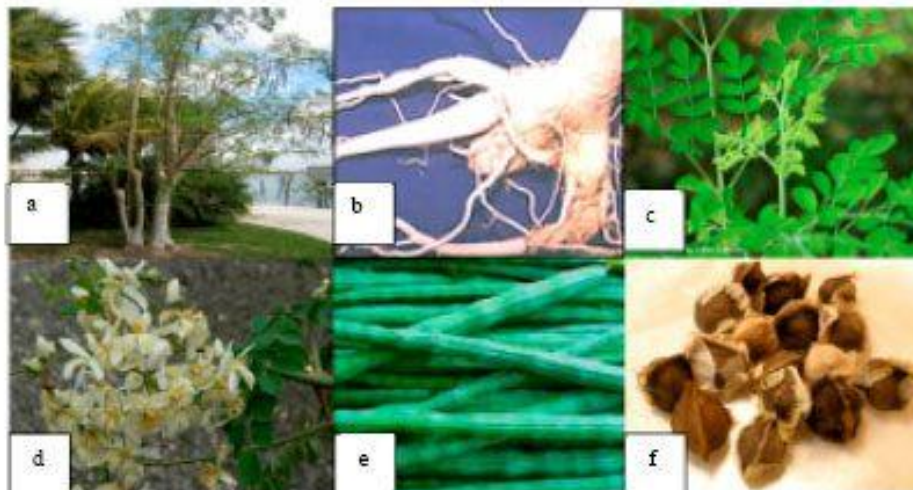


Plate 1. Moringa Tree products (Adapted from: Ritu et al., 2011).

a= Moringa tree, b= Moringa Roots, c = Moringa Leaf, d= Moringa Flower,
e= Moringa Fruits, f= Moringa Seeds

The leaves and twigs are used as fodder for cattle, sheep, goats and camels in many parts of its range (Mahatab et al., 1987; Negi, 1977). Moringa Leaves are rich in vitamin A and C and are considered useful in Scurvy and respiratory ailments, It is also used as an emetic remedy (Roloff et al., 2009). The juice extracted from the leaves has strong antibacterial and antimalarial properties. The leaf extracts of moringa have been found to increase *Rhizobium* root nodulation, nodule weight, and nitrogenase activity in mung bean (*Vigna munga* L.) when applied to the seeds or as root dressing (Bandana et al., 1987). Morton (1991); Fugile, (200); Mekonnen et al. (1999); Dhar (1987) and The Wealth of India (1962), reported that moringa leaves has a purgative properties and also serves as an antidote to piles, fevers, sore-throat, bronchitis, catarrh, eye and ear infections as well as sores healing and reliever of headaches. It was stated that the leave juice can be use to control glucose levels and have capacity to reduce swelling of an inflammation (The wealth of India, 1962). The wealth of India (1962) and Dhar (1987) stated that Moringa leaves juice has a stabilizing effect on blood pressure. Nitrile, mustard oil glycosides and thiocarbamate glycosides have been isolated from Moringa Leaves and were found to be responsible for its blood pressure lowering effect (Faizi et al., 1994a; 1994b; 1995).

Furthermore, it has been reported that moringa leaves acts as a good source of natural antioxidant due to the presence of various types of antioxidant compounds such as ascorbic acid, flavonoids, phenolics and carotenoids (Anwar et al., 2007; Makkar and Becker, 1996). Makkar and Becker (1996) also stated that Moringa leaves is an ideal dietary supplement because with high quality ascorbic acids, oestrogenic

substances, β sitosterol, iron, calcium, phosphorus, copper, vitamins A, B, and C, α -tocopherol, riboflavin, nitonic acid, folic acid, pyridoxine, B - carotene, protein and in particular essential amino acids like methionine cystine, tryptophan and Lysine (Anwar et al. 2003). The crude extracts of Moringa Leaves was reported to have a significant cholesterol lowering action in the serum of high fat diet fed to rats and this might be attributed to the presence of a bioactive phytoconstituent, i.e β -sitosterol as reported by Ghasi et al. (2000). Aqueous leaf extracts of Moringa leaves has been found to have anti ulcer properties and Pal et al. (1995) indicated that the Anti-Ulcer component is widely distributed in the Moringa Tree. The flesh and the leaf juice was found to inhibit the growth of *Pseudomonas aeruginosa* and *staphylococcus aureus* that are pathogenic to man (Caceres et al., 1991). The potential of Moringa leaves for anti-tumor activity was reported by Makonnen et al. (1997). The antioxidants effects and efficacy against hyperthyroidism through regulation of thyroid hormone has been reported by Pal et al. (1995a), (1995b); and Tahiliani and Kal, (2000). Its effective for the regulation of thyroid hormone status. Lipipun et al. (2003) showed that Moringa leaves may be applicable as a prophylactic or therapeutic against Herpes simplex virus type 1 and may be effective against the acyclovir - resistant variant (Lipipun et al., 2003). While Mekonnen et al. (1997) reported that an infusion of leaf juice reduced glucose levels in rabbits.

4. Moringa flower

The flower of Moringa is yellowish-white in colour, slender, with hairy stalks in spreading or dropping auxiliary clusters (Panicle). The flower is scented, bisexual and measures about 10-25 centimeters long. Individual flowers are set in a basal cup (Hypanthium) that is 3 millimeters long and are approximately 0.7 to 1 cm long and 2cm broad with five unequal yellowish -white, thinly veined, spatulate petals, five stamens with five smaller sterile stamens (staminode) and a pistil composed of one celled ovary and slender style (Little et al., 1964; Ramachandran et al., 1980).

Moringa Flower contain nine amino acids, sucrose, D-glucose, traces of alkaloid, wax, and is rich in potassium, calcium and some flavonoid pigment (Ruckmani et al., 1998, Anwar et al., 2007). Lizzy et al. (1968) reported that Moringa Flower contain pterogosperrin, an antibiotic that is highly effective in the treatment of cholera. Moringa flowers was extracted using alcohol and aqueous extract solution and it was discovered that it contains quercetin, a known flavonoid with hepatoprotective activity (Gilani, et al., 1997), which indicates a significant hepatoprotective effects (Ruckmani et al., 1998). Moringa flowers are used as a tonic and diuretic (Rollof et al., 2009), they are a good source of pollen for honeybees (Booth and Wickens., 1988). The curative ability of moringa flower over inflammations, muscle diseases, tumours, and enlargement of the spleen, and ability to reduce serum cholesterol, phospholipid, triglyceride, make it useful for regulation of cholesterol to phospholipid ratio and also as a stimulant and it could be said to be of high medicinal value (Faizi et al; Bhattacharya et al. 1982; Dahot 1998; Siddhuraju and Becker, 2003; Mehta et al., 2003), while Anwar et al. (2005) reported higher fecal cholesterol and reduction of lipid profile of liver heart and aorta in hypercholesteromic rabbits.

5. Moringa fruits

These are pendulous linear three-sided pods with nine longitudinal ridges, usually 20 – 50 cm long, but seldom up to 1m or longer and 2.0 to 5.0 cm broad. (Rolloff et al., 2009). Each pod usually contains up to 26 seeds which are dark green during their development and take up to 3 months to mature after flowering (Palanisamy et al., 1985). They turn brown on maturity and spilt open longitudinally along the three angles, releasing the dark brown trigonous seeds. (Rolloff et al., 2009). The pod is tender and edible with taste similar to asparagus (a succulent spring vegetable of high dietary fibre). Moringa Fruits are eaten as a nutritious vegetable either cooked or pickled. They are rich in minerals thiamine, protein, beta- carotene, riboflavin, vitamin A and C (Verma, 1976., Peter, 1979; FAO, 1982., Sreeramule et al., 1983 ; 1988 Gupta et al., 1989; Barra et al., 1989). Thiocarbamate and isothiocyanate glycoside was isolated through acetate phase of ethanol extract of Moringa pod, making the pods to have antihypertensive effects because those compounds have an antihypertensive ability (Faizi et al., 1998). The fruits have cytokinins (Makkah and Becker, 1997). While Mehta et al. (2003) reported that moringa fruits has ability to lower the serum cholesterol, phospholipid, triglycerides, low density lipoprotein (LDL), Very low density lipoprotein (VLDL), cholesterol to phospholipid ratio, atherogenic index lipid, and it was stated that the fruits also has ability to increase the fecal cholesterol and reduce the lipid profile of liver heart and aorta in hypercholesteromic rabbit.

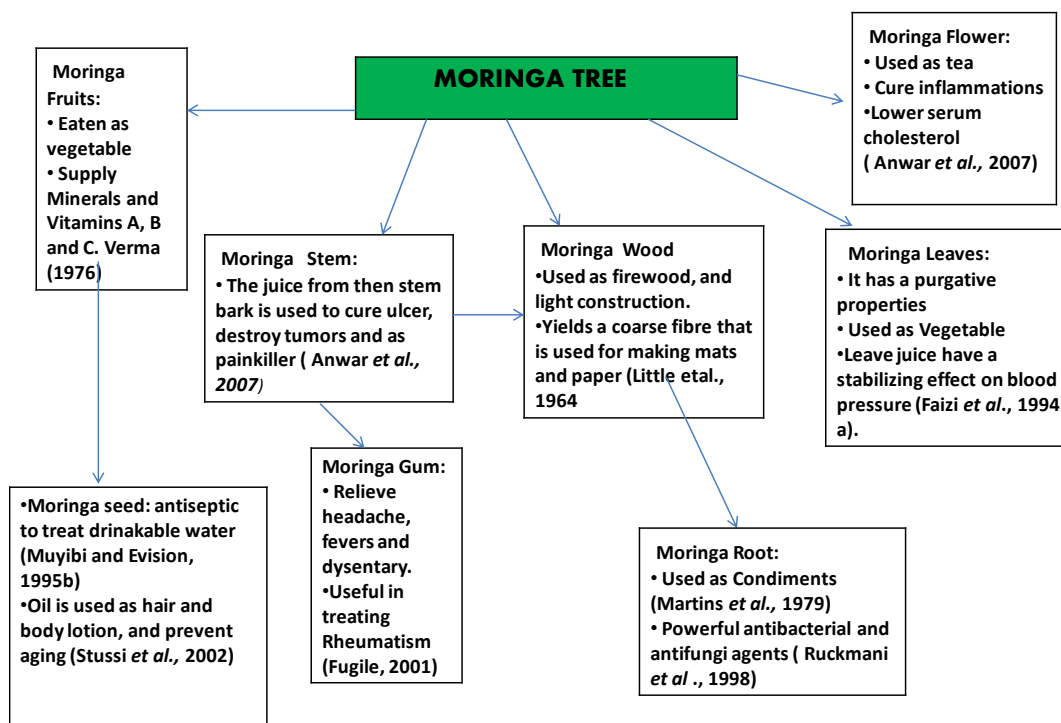


Figure 2. Components of Moringa Tree and its uses as reported by various Authors

6. Moringa seed

The seeds of moringa measure about 1 cm in diameter with three whitish papery wings on the angles. Seed weight differ among varieties ranging from 3000 to 9000 seeds per kilogram (Negi, 1977) and about 270g to 300g for 1000 seeds are reported at the University of Ilorin Moringa Plantation (Unpublished). Moringa seeds are considered to be antipyretic, acrid, bitter (Oliveira et al., 1999) and reported to have some antimicrobial activity. Moringa seed can be consumed fresh as peas, pounded, roasted, or pressed into sweet non-desiccating oil, commercially known as 'Ben oil' . It has a unique property of appearing dry, hard and crushable but can also be pressed into cake. The anticoagulant activity of crushed moringa seed indicated that it is one of the best natural coagulant with polypeptides that makes it useful for water treatment (Ndabignegneser and Nrasiah , 1998), while Kalago et al. (2000) reported that crushed seed are viable replacement of synthetic coagulant. In Sudan it is traditionally believed that alum causes gastrointestinal disturbances and Alhimezier disease, therefore Sudanese rural women used crushed moringa seeds to clear the highly turbid Nile water instead of alum (Crapper et al., 1973; Miller et al., 1984; Martyn et al., 1989; Muyibi 1994). Moringa seeds effectiveness against turbid water and same coagulation effects when compared with alum was reported by Muyibi and Evison (1995). The coagulation effectiveness of Moringa seeds varies depending on the initial turbidity of the water, and Muyibi and Evison, (1995) reported that Moringa seeds could reduce turbidity up to 99%. Moringa Seed also have softening properties in addition to alkalinity reduction as well as exhibiting a natural buffering capacity, which could handle moderately high to high alkaline surface and ground water. Obioma and Adikwu (1997) reported that Moringa Seed can be use as an antiseptic to treat drinkable water. Olsen, (1987) and Madsen et al., 1987 stated that Moringa Seed possess antimicrobial properties, while Broin et al. (2002) reported a recombinant protein in the seed that is effective against Gram-positive and Gram-negative bacteria cells, it was also stated that the seed may act directly upon microorganisms and results in growth inhibition while Sutherland et al. (1990) reported that Moringa seed could inhibit the replication of bacteriophages, and could be used as a less expensive biosorbent for the removal of Cadmium (Cd) from aqueous media, and useful in binding of some metals (Sharma et al.2011).

7. Moringa seed oil

Moringa seed contain 19 to 47% oil (Ahamad et al., 1989, Szolnokinit, 1985) which is commercially known as ben-oil, it is similar to olive oil, rich in palmitic, stearic, and oleic acids (Nautiyal et al., 1987; Verma, 1976; Baneji et al., 1976). Moringa Seed oil is a sweet non-sticking, non drying oil that resists rancidity (Fahey, 2005). Rossell (1991) reported that the sterol composition of the major fractions of Moringa seed oil differs greatly from those in the convectional edible oils. Moringa seed oil is used for human consumption (Szolnokim, 1985; Delaveau et al., 1980). Moringa oil is applied externally to treat rheumatism and gout (Parrota, 2001) and is highly valued by perfumers and watchmakers for its power of absorbing and retaining odours, and as a lubricant, respectively (Ramachnadran et al., 1980). While Fugile (1990) reported that the oil is used for making hair care products, it also has specific protein fractions which make it useful for skin

and hair care. Stussi et al. (2002) reported the presence of peptides of moringa seeds in purisoft that protects human skin from environmental influences and prevent premature skin aging as well as dual activity of strengthening and conditioning of the hair, making the extract to be globally accepted as an inventive solution for hair care.

Moringa seed oil cake (defatted seed cake) is used as fertilizer (Fahey et al, 2001). Faizi et al. (1988) and Lalas and Tsaknis (2002) reported that the seed extracts exerts its protective effect by decreasing liver lipid peroxide. Bharali et al. (2003) stated that moringa seed oil cake is very efficient against action of hepatic carcinogen metabolizing enzyme in mice, has an antioxidant parameter and effective in treating skin papillogenesis in mice.

8. Moringa root

Moringa root is a swollen, tuberous white tap root which has a characteristics pungent odour, and very sparse lateral roots that developed from the seedlings. However if the trees are planted through seed a deep stout tap root with a wide-spreading system of thick, tuberous lateral roots will develop (Rolloff et al., 2009). According to Lahjie et al., (1987) tap roots do not develop from trees propagated from cuttings. Several compounds of proven medicinal value have been isolated from the roots and root bark (Booth and Wickens, 1988) and it has been reported that the roots possess anti-spasmodic activity (Caceres et al, 1992). Moringa root extracts is commonly applied externally to cure inflammatory swellings (Rolloff et al., 2009), and it contains pterogospersin, an antibiotic that is highly effective in the treatment of cholera (Lizzy et al, 1968) , while Ruckmani et al., (1998) reported that it has an hepaprotective activity, and the juice from the root bark can relieve earaches and toothaches.

Condiments are made from Moringa Root for garnishing after peeling, drying and mixing it with vinegar (Martin et al, 1979). The wealth of India 1962; Dahot 1988; Ruckmani et al, 1998 reported that Moringa Root can act as anti inflammatory agent, stimulant in paralytic afflictions, and as a cardiac/ circulatory tonic. The Authors also reported that it can be used as a laxative, in treating rheumatism, inflammations, articular pains, lower back or Kidney pain and constipation. Rao et al. (2001) stated that Moringa Roots have antibacterial activity and are reported to be rich in antimicrobial agents, while Ruckmani et al., (1998) stated that Moringa root contains Pterygospersin a powerful antibacterial and fungicidal agents.

9. Moringa and economic development

Moringa Oleifera Tree have been reported to have high economic and cultural values as stated above by various authors. The acclaimed miracle tree is grown all over the world for economic purposes and on commercial scale. It is grown as single trees cultivated in homesteads, round cattle shed, on farm boundaries or as groups of trees on village waste lands, this has also led to emergence of Moringa Plantation , processing outfits with its resultant implication for the creation of employment and hence reduction in poverty. A good

number of families and particularly women engage in the distribution and sales of fresh moringa leaves deriving their living from ensuring daily supplies to the urban centers.

The average yield in wet leaves per Moringa Tree is given as 4.5kg per annum, this will equate to 1kg of dry leaf powder working on a ratio of 4.3kg per one kg of dry organic leaf powder. At an average, world buying price of 1.50p/kg, a hectare of moringa planted will yield 50,616kg of dry leaf powder and give a gross income of \$75,924 per year (IRD, 2011). It is important to note that the Moringa Plant produces for as long as seven years or more, saving the labour of fresh establishments and input cost while the plant continues to yield revenue for the farmer. With the need for alternative sources of biogas to meet the increasing demand, the potentials of Moringa Tree in the production of biogas is being explored. Foidl et al. (2001) estimated that more than 4,400 cubic meters of methane could be produced per hectare of moringa per year. This is up to twice as much as can be produced per hectare per year from sugar beet leaves, a common plant material for biogas.

Usage of Moringa seed for household water purification produced substitute for imported flocculant, thus reducing expenditure by rural poor population. It is completely biodegradable and will help the rural poor who suffer from a lot of water borne disease such as cholera, dysentery and typhoid in purification of their water and saved them from getting ill. Also, the uses of Moringa in water treatment and various evidence of its efficacy will increase demand for Moringa seed, thus economically empowering local Moringa farmers.

10. Conclusion

The potentials of Moringa Tree to combat the duo of poverty and hunger remain unassailable. However, the low levels of awareness of the inherent benefits of the plants have challenged the level of its cultivation in some parts of the world. Other challenges to the cultivation of the plant include uncertainty of markets in some developing countries and inadequate knowledge about its cultivation and uses.

Usage of our Moringa Tree to solve a lot of problems arising from nutrition, health and general well being of the masses will conserve the Foreign exchange presently used in the importation of synthetic vitamins and mineral, putrefying chemicals, convectional drugs, body and hair care products, and make more funds available for Rural Development programme.

All rural farmers need to be encouraged to embark in planting of Moringa Tree for their empowerment. Government can launch Operation Plant Moringa Tree (OPMT) by providing land and other resources for the resource poor rural farmers, assist them in harvesting and processing, and pay them according to their yield. This form of empowerment will reduce poverty in the land and make Moringa Tree available for every household.

Lastly, Agricultural extension and advisory services can play a big role in meeting the challenges and assisting rural farmers harness the enormous opportunities in the production and usage of Moringa Tree, this will make it available for all, reduce poverty in the land and improve the economic situation of our developing Nation.

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