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Studies on Nutritional and Pharmacological Importance of Moringa *Oleifera*

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ABSTRACT

Moringa oleifera, is a native to India and growing in the tropical and subtropical regions of the world. It is commonly known as 'drumstick tree' or 'horseradish tree'. Moringa can withstand both severe drought and mild frost conditions and hence widely cultivated across the world. With its high nutritive values, every part of the tree is suitable for either nutritional or pharmacological purposes. The leaves are rich in minerals, vitamins and other essential phytochemicals. Extracts from the leaves are used to treat malnutrition, augment breast milk in lactating mothers. It is used as potential antioxidant, anticancer, anti-inflammatory, antidiabetic and antimicrobial agent. The chemical composition of the different parts of the moringa tree may vary depending on cultivar and source. Moringa leaf, seed and flower have found numerous applications in food. In this review it is summarized the present knowledge on the use of moringa as a food fortificant in amala (stiff dough), ogi (maize gruel), bread, biscuits, yoghurt, cheese and in making soups. The knowledge gap in the reported research was provided and possible future applications of moringa in foods as well as the need for a well-structured and planned experimental design were suggested. The review was examined the use of moringa various disciplines for its medicinal value and deals with cultivation, nutritional, commercial and pharmacological applications of this "Miracle Tree"

1. Introduction

Botany

Moringa oleifera, native to India, grows in the tropical and subtropical regions of the world. It is commonly known as 'drumstick tree' or 'horseradish tree'. Moringa can withstand both severe drought and mild frost conditions and hence widely cultivated across the world. With its high nutritive values, every part of the tree is suitable for either nutritional or commercial purposes (Lakshmipriya et al; 2016).

Moringa is a fast growing, deciduous tree (*Encyclopædia Britannica,2015)* that can reach a height of 10-12 m (32-40 ft) and trunk diameter of 45 cm (1.5 ft). The bark has a whitish grey colour and is surrounded by thick cork. The tree has an open crown of drooping, fragile branches and the leaves build up feathery foliage of tripinnate leaves. The flowers are fragrant and asexual, surrounded by five unequal, thinly veined, yellowish-white petals. Flowering begins within the first six months after planting. In seasonally cool regions, flowering only occurs once a year between April and June. In more constant seasonal temperatures and with constant rainfall, flowering can happen twice or even all year-round. The fruit is a hanging, three-sided brown capsule of 20-45 cm size which holds dark brown, globular seeds with a diameter around 1 cm. The seeds have three whitish papery wings and are dispersed by wind and water. In cultivation, it is often cut back annually to 1-2 m (3-6 ft) and allowed to regrow so the pods and leaves remain within arm's reach (*Parotta, John A.,1993).*

Fig:1 Moringa Plant

Fig:2 Moringa Plant with Drumstick

2. Nutritional Aspects of Moringa

Every part of m*oringa* is a storehouse of important nutrients and antinutrients and the leaves are rich in minerals like calcium, potassium, zinc, magnesium, iron and copper (Kasolo et al; 2010). Vitamins like beta carotene of vitamin A, vitamin B such as folic acid, pyridoxine and nicotinic acid, vitamin C, D and E also present in plant *(*M. Mbikay, 2012). Phytochemicals such as tannins, sterols, terpenoids, flavonoids, saponins, anthraquinones, alkaloids and red4ucing sugar present along with anti-cancerous agents like glucosinolates, isothiocyanates, glycoside compounds and glycerol-1-9-octadecanoate (Berkovich, 2013). Moringa leaves also have a low calorific value and can be used in the diet of the obese. The pods are fibrous and are valuable to treat digestive problems and thwart colon cancer (Oduro et al, 2008). A research shows that immature pods contain around 46.7% fiber and around 20.6%protein content. Pods have 30% of amino acid content, the leaves have 44% and flowers have 31%. The immature pods and flowers showed similar amounts of palmitic, linolenic, linoleic andoleic acids (Sánchez-Machado, 2010). Moringa contains lot of minerals that are essential for growth and development among which, calcium is considered as one of the important minerals for human growth. While 8 ounces of milk can provide 300-400mg, moringa leaves can provide 1000mg and moringa powder can provide more than 4000mg. Moringa powder can be used as a substitute for iron tablets, hence as a treatment for anemia. Beef has only 2mg of iron while moringa leaf powder has 28mg of iron. It has been reported that moringa contains more iron than spinach (L.J. Fuglie, 2005). A good dietary intake of zinc is essential for proper growth of sperm cells and is also necessary for the synthesis of DNA and RNA. moringa leaves show around 25.5-31.03mg of zinc/kg, which is the daily requirement of zinc in the diet (J.T. Barminas, M. Charles ,1998). PUFAs are linoleic acid, linolenic acid and oleic acid; these PUFAs have the ability to control cholesterol. Research show that moringa seed oil contains around 76% PUFA, making it ideal for use as a substitute for olive oil (S. Lalas, J. Tsaknis, 2002). A point to note is that the nutrient composition varies depending on the location. Fuglie revealed that seasons influence the nutrient content. It was shown that vitamin A was found abundantly in the hot wet season, while vitamin C and iron were more in the cool dry season (Yang et al, 2006). The difference in results can be attributed to the fact that the location, climate and the environmental factors significantly influence nutrient content of the tree (B. Moyo, P. Masika , 2010).

Moringa tree is a plant rich in a number of nutrients such as proteins, fibre and minerals (Jongrungruangchok et al., 2010; Moyo et al., 2011) that play important role in human nutrition. Many of the studies have reported that moringa leaves are exceptionally high in protein compared to other leaves consumed as food. The nutritional value of moringa leaves may vary with cultivar and source. For instance, Jongrungruangchok et al. (2010) observed variations in the protein (approx. 19-29%) and fibre (16-24%) contents of moringa leaves grown in 11 different provinces in Thailand. The protein content of the leaves reported by these authors is similar to those reported in Brazil (28%) and South Africa (approx. 30%) (Moyo et al, 2011). The calcium, iron and potassium contents of the leaves were also found to show substantial variations (Jongrungruangchok et al, 2010). Yang et al, (2006) working with four cultivars of moringa reported that it had the highest amount of β-carotene, ascorbic acid (Vitamin C), α-tocopherol (Vitamin E) and iron. Fresh leaves of moringa have been found to be good sources of carotenoids such as trans-Lutein (approx. 37 mg/100 g), trans-β-carotene (approx.18 mg/100 g) and trans-zeaxanthin (approx. 6 mg/100 g) (Saini et al., 2014d). These authors similarly reported relatively high amounts of ascorbic acid (271mg/100 g) and tocopherols (36.9mg/100 g) in the fresh moringa leaves (Saini et al., 2014d) it has also been found to contain significant

amount of essential amino acid and are rich in alpha linoleic acid (Moyo et al., 2011). The leaves are known to be excellent source of a wide range of dietary antioxidants (Moyo et al., 2012; Qwele et al., 2013; Saini et al., 2014d, 2014e; Yang et al., 2006). According to Yang et al. (2006), moringa leaves have significantly higher antioxidant contents when compared to fruits such as strawberries known for high antioxidant contents. Other authors have similarly reported the antioxidant potential of the leaves of moringa (Saini et al., 2014b, 2014d). Other studies showed that moringa plant may find application in livestock industry for improving meat quality in terms of chemical composition, colour and lipid stability (Nkukwana et al., 2014a, 2014b, 2014c; Qwele et al., 2013). A recent study showed that iron from moringa can overcome iron deficiency and modulate the expression of iron-responsive genes better than conventional iron supplements (Saini et al., 2014a). Similarly, Saini et al. (2016) found that the relative bioavailability of folate from moringa leaves using rat model was very high (approx.82%) suggesting that the moringa leaves can be a potential source of dietary folate. It is also important to mention that the moringa leaves, flower and tender pods are potential sources of polyunsaturated fatty acids, which may have some beneficial effects in moringa based products (Saini et al., 2014c). Many of the aforementioned nutritional benefits of moringa suggest that these plants can serve as a functional ingredient in the food and allied industries.

In this review it has been referred as moringa a miracle tree due to its rich source of certain macro and micro nutrients of great importance in human nutrition. The chemical composition of the different parts of the moringa tree may vary depending on cultivar and source. Its leaves, seed and flower have found numerous applications in food. In this review it was summarized the present knowledge on the use of moringa as a food fortificant in amala (stiff dough), ogi (maize gruel), bread, biscuits, yoghurt, cheese and in making soups. The knowledge gap in the reported research was provided and possible future applications of moringa in foods as well as the need for a well-structured and planned experimental design were suggested (Adewumi et al; 2018).

It has been mentioned that the leaves moringa are rich in minerals, vitamins and other essential micronutrients. Extracts from the leaves are used to treat malnutrition, increase breast milk in lactating mothers. It find is used as potential antioxidant, anticancer, anti-inflammatory, antidiabetic and antimicrobial agent. Moringa seed, a natural coagulant is extensively used in water treatment. The scientific effort of this research provides insights on the use of moringa as a cure for diabetes and cancer and fortification of moringa in commercial products. The review was examined the use of moringa across disciplines for its medicinal value and deals with cultivation, nutrition, commercial and prominent pharmacological properties of this “Miracle Tree” (Lakshmipriya et al; 2016).

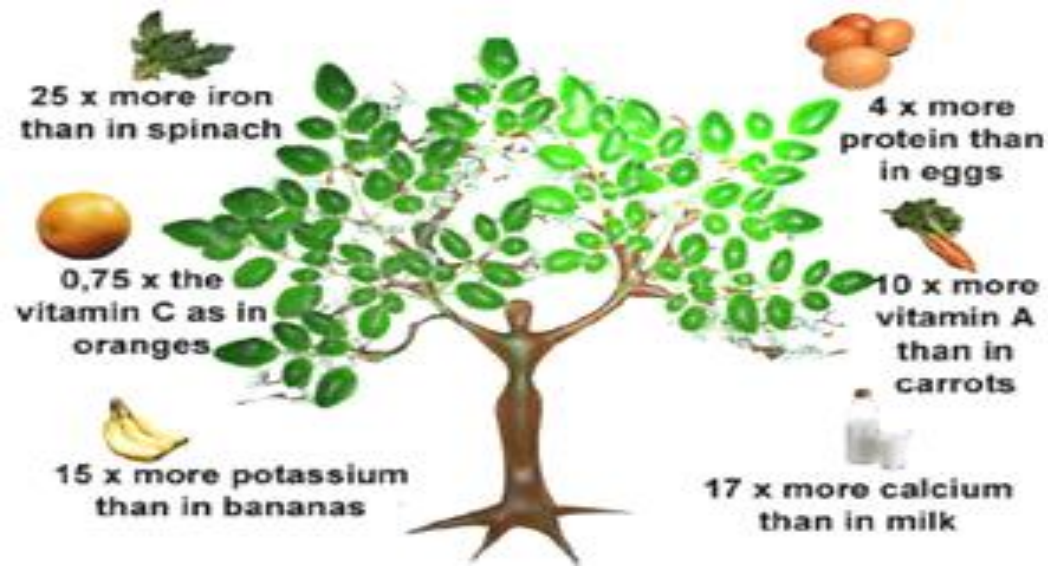

Fig: 3 Vitamin, mineral and protein contents in moringa

The various studies were revealed that deficiency of nutrient intake and infection are two direct factors of malnutrition towards baby and child (Sutomo, 2009, UNICEF. 1999). This, as a consequence, brings the effect on the lack of both macronutrient and micronutrient that are really required for the early child growth and development. Fulfilling the nutritional needs for infants at 0 to 6 months old is absolutely obtained from exclusive breastfeeding (Butte, Lopez, Garza, 2002, Kramer Kakuma, 2002, WHO 2003). A number of studies in many developing countries reveal that the main factor of malnutrition and the hindrance of growth of 3 to 5 month infants are tightly correlated to the low breastfeeding rate (Machado, et al., 2009, Shrimpton, 2001). In Indonesia, it is found that the rate of infant obtaining the exclusive breast feeding until 5 month was only at 14% and those obtaining the exclusive breastfeeding until 6 month was only 8% (Health Department of Indonesia Republic, 2003).

Using moringa as a foodstuff to expedite the breast milk secreted is coming to be a new challenge by considering that in Indonesia it has been viewed inferior taboo to be consumed for certain reasons (Suhardjo. 1989), used as an anti-

witchcraft plant or helpful to fight the black magic practices in Indonesia (Windadri, Rahayu, and Rustiami, 2006).

Moringa flour is one of foodstuffs used in the process of making dried noodles as an improvement of foodstuff that can enhance the productivity of mother breast milk. In Indonesia, noodles for the taste, practicality and satiation have been becoming a favorite food for walks of life started from children to elders. Having high carbohydrate content, noodles, instead of rice, then are used as the carbohydrate sources (Moyo, 2011).

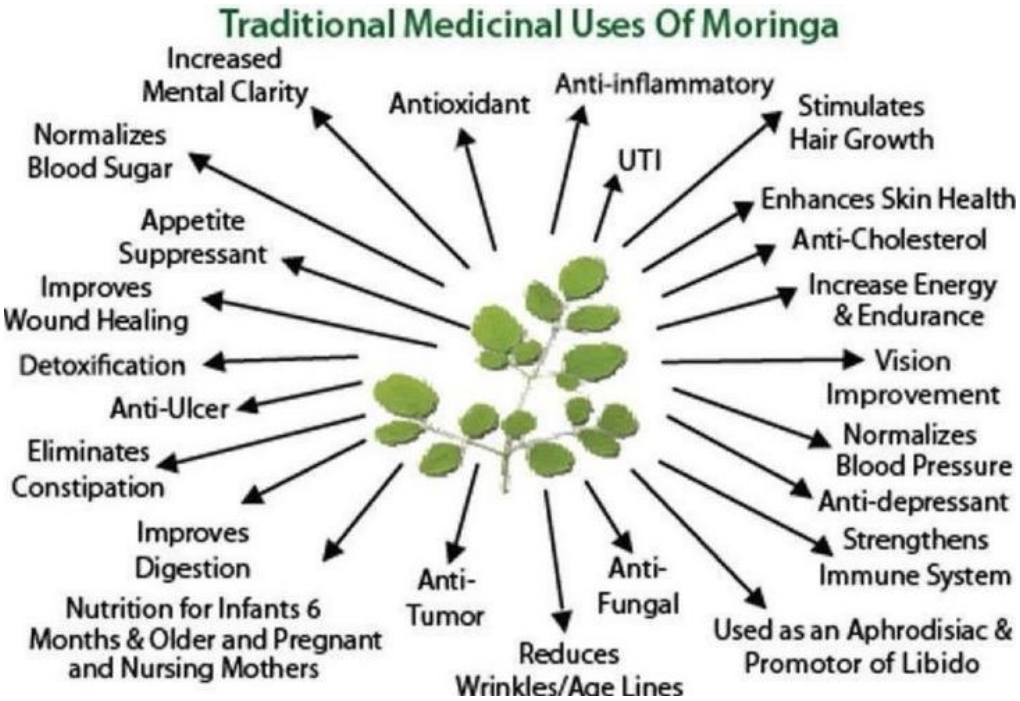

Fig: 4 Pharmacological/medicinal uses of Moringa

3. Value Added Products of Moringa

Most plants lose their nutritive properties when processed. When compared, the nutritive content of raw, germinated and fermented moringa seed flour, it was found that phytochemicals were higher in raw seed flour and amino acid content was at its peak in fermented and germinated seed flour (Ijarotimi et al, 2013; Mishra et al, 2012). This can be a result of the biochemical activities during germination and microbial activity during fermentation. In a study it was found that the effect of boiling, simmering and blanching to see the retention of nutrient content of moringa leaves. It has been observed that, boiling was the most effective to reduce the cyanide, oxalate and phytate contents, more significantly than the other methods. The presence of phytate and other anti-nutrients can reduce the bio availability of certain nutrients and processing can hence be done for maximum utilization of required nutrients from the seeds and leaves (Sallau et al, 2012; Kachik et al,1992). Some researchers were found that moringa seed flour can be used to treat malnutrition problems. However, some studies have shown that children refuse to take in moringa due to its slight bitter taste (V.S. Nambiar, S. Parnami, 2008). Kiranawati et al, (2014) designed moringa noodles by three methods of cooking noodles, sautéing, steaming and boiling. These noodles were tested on rats and the effects on mammary glands were studied. Interestingly, the sautéed noodles had a better effect on the mammary glands of rats and improved milk production. The effect of sautéing on the noodles improved lactogogum values, because the oil used was rich in sterols. Moringa have also been incorporated into chocolates. A recent report tested different percentages of moringa in the chocolate fortification and found that, 20% moringa incorporation in cocoa powder was ideal. Similarly, moringa incorporation in halawa tahinia also increased the nutrient value of the delicacy. Such studies have shown the potential for developing protein and minerals-rich chocolate and halawa tahinia (Abou-zaid and Nadir ,2014). Several such moringa fortifications are possible to ensure intake of adequate amounts of nutrients in children.

Seeing the importance of mother breast milk, the government attempts to campaign the significance of breastfeeding for mothers. It is found that not all mothers just giving a birth to baby are able to breastfeed at ease thus impelling to use any chemical or traditional medicines that are able to make breast milk smooth (i.e. having lactagogum effect). Moringa leaves have certain quality as lactagogum (i.e. increasing breast milk secretion) (Doer. B. and Cameron L. 2005, Estrella, Mantaring and David, 2000; Fuglie, 2001; Madrano and Perez, 2005) as containing phytosterol compound (Sa'roni, et al., 2004).

Long before prescription drugs, women throughout history have used certain herbs or foods to increase their milk supply. A strong heritage of traditional use coupled with the sharing of personal experience have given many mothers enough confidence to believe certain herbs are indeed effective at increasing milk supply. Studies have been conducted and found that the capsules of proven to increase milk supply in females.

The intention to result in food that can enhance the productivity of the mother breast milk must concern with some factors determining the lactagogum effects. Considering that more than 90% of manufacturing process can damage the content of lactagogum compound, it becomes essential to consider the effect of the process on lactagogum. A process, in this case, must concern to maintain the compound condition that can increase the production of breast milk.

In response to the discussion above, it is necessary to conduct a research on the stability of moringa in the manufacturing process in order to determine a number of parameters to control the handling process in hospitality industry. In this case, the methods of making noodles used in this research are by sautéing, steaming and boiling in order to measure the lactagogum effects of moringa noodles. The observed parameters are referred to the alveoli of lactated Wistar Rats (*Rattus norvegicus*) and the increase of the weight of rat offspring. To overcome the nutrition problem in noodles, we can fortify them with moringa powder. Moringa powder can enhance their protein and mineral content.

4. Conclusion

It can be concluded then that the moringa has various nutritional and essential element which is required basically to overcome nutritional deficiency and is able to increase the productivity of breast milk of female. Nowadays various value added products are being developed using moringa leaves and its bean (drumstick) and its seeds. In the US Moringa leaves demand has been raised and it is in various preparations and antidiabetic tea. The use of moringa leaves for the culinary of breastfeeding mothers still needs an application to daily dish in order to make it sustainably consumable. In addition, it also needs further socialization of moringa related to the myth of people towards such foodstuff.

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