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MORINGA OLIFERA PLANT AND THE NUTRITIONAL AND MEDICINAL PROPERTIES OF *Moringa olifera* LEAVES

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ABSTRACT

Moringa olifera is the most widely cultivated species in *Moringaceae* family and is mostly distributed in subtropical regions of the world. Unfortunately, those are the areas where most of the people suffering from malnutrition and micronutrient deficiencies. Hence the purpose of this article is to summarize some literature regarding the *Moringa olifera* plant and the numerous nutritional and medicinal properties of leaves and also to mention some examples for application of *M. olifera* leaves in food industry to make the public aware of this valuable plant. Since, *M. olifera* is a multipurpose and exceptionally nutritious vegetable tree with variety of potential uses, it is known as the "Miracle tree". Lots of researchers have found that, *M. olifera* leaves is an excellent source of β -carotene and other vitamins, minerals and amino acids that can combat the effects of malnutrition. Especially, *M. olifera* leaves contain all the essential amino acids as well as polyunsaturated fatty acids including α -linolenic acid. Apart from the numerous nutritional properties, *M. olifera* leaves are rich sources of phytochemicals which possess biological functions having potent anticancer and hypotensive activity and are considered full of medicinal properties. Therefore, *M. olifera* leaves can be processed in different ways and can be applied in food industry as a functional food ingredient.

Keywords: *Moringa olifera*, leaves, nutritional properties, medicinal properties, malnutrition

1. INTRODUCTION

Moringa oleifera is identified as the most widely cultivated species among the 13 known species of *Moringaceae* family^[1]. *Moringa* has spread throughout the tropical and sub-tropical regions of the world while native to the Indian sub-continent. There can be over 400 names for the plant *Moringa* that have been found around different parts of the world including, Benzolive tree (Haiti), Horseradish tree (Florida), Nébéday (Senegal), Drumstick tree (India), Kelor, Marango, Mlonge, Mulangay, Saijihhan, Sajna etc.^[2]. In Sinhala it is called “Murunga” and in Tamil it is called “Murungakai”^[3].

Apart from that, it is known as ‘mother’s best friend’ (in Philippines) because of its utilization to increase woman’s milk production and is sometimes prescribed for anemia^[4,5] and in the Nile valley, it is called ‘Shagara al Rauwaq’, which means ‘tree for purifying’.

M. Oleifera is considered as “The Miracle Tree” because it is a multipurpose and exceptionally nutritious vegetable tree with numerous potential uses. All parts of the tree are useful, especially due to their pharmacological, nutritional, water purifying properties (seeds) and also as an alley crop in the agro-forestry industry, livestock feed, vegetable dyes, foliar spray, cosmetics and oil production etc.^[6,7].

M. oleifera fruits (pods) can be mainly used in condiments, medicines or can be cooked as vegetables. Usually, the seeds yield 38-40% of non-drying oil (Ben oil), and seeds are also used for lubricating machines and other delicate machinery and for medicinal purposes. The seed cake (remaining after oil extraction) utilized as a fertilizer or as a flocculent to purify water. Flowers may produce nectar that has anti-inflammation properties. The flowers can also be used for the production of pesticides because they contain certain natural chemicals that the insects and other pest cannot withstand. The wood can be used to produce a blue dye and it is also used for live fences. *M. olifera* woods contains certain medicinal qualities as well to treat diabetes, to enrich anemic blood, to staunch a skin infection, to heal gastric ulcers, to care eyes and as an antibiotic. The roots are shredded and used as a medicine and also as a condiment. The roots can contain an alkaloid called spirochim which can be a potentially fatal nerve paralyzing agent^[6]. Leaves can be used successfully in its dehydrated powdered form to produce several types of meals and porridge diets for pregnant expectant mothers, nursing mothers, infants and young children, as well as adults of all age groups mostly due

to their nutritional and medicinal properties. Apart from that, lots of recent studies have proved that the leaves of *Moringa oleifera* is an excellent source of β -carotene and other vitamins as well as minerals and amino acids that can combat malnutrition ^[1,8,9].

The purpose of this article is to focus on the literature that covers a brief introduction of *Moringa oleifera* plant itself and description of nutritional and medicinal properties of *Moringa oleifera* leaves and also to mention some examples for application of *M oleifera* leaves in food industry to make the public aware of this valuable crop.

2. *Moringa oleifera* plant

2.1 Taxonomic classification and of *Moringa oleifera* plant

The taxonomy classification of *Moringa oleifera* can be declared as in table 1,

Table 1: taxonomy classification of *Moringa oleifera*^[10]

Kingdom	Plantae
Sub kingdom	Tracheobionta
Super division	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Dilleniidae
Order	Capparales
Family	Moringaceae
Genus	Moringa
Species	oleifera

Synonyms: *Moringa pterygosperma* Gaertner ^[11]

2.2 Origin and Distribution

Moringa oleifera is indigenous to south Asia, where it grows mostly in the Himalayan foothills from northeastern Pakistan to northern West Bengal (India) (Figure 1). Meanwhile, it has then been introduced and widely distributed in many sub-tropical regions in other parts of India, Pakistan, Afghanistan, Bangladesh, Sri Lanka, West Asia, the Arabian peninsula, east and west Africa, southern Florida, throughout the West Indies, and from Mexico to Peru, Paraguay and Brazil ^[12]. But yet according to Kar et al.^[13] India is the largest producer of *Moringa*.

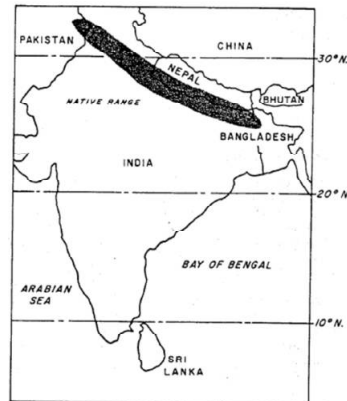
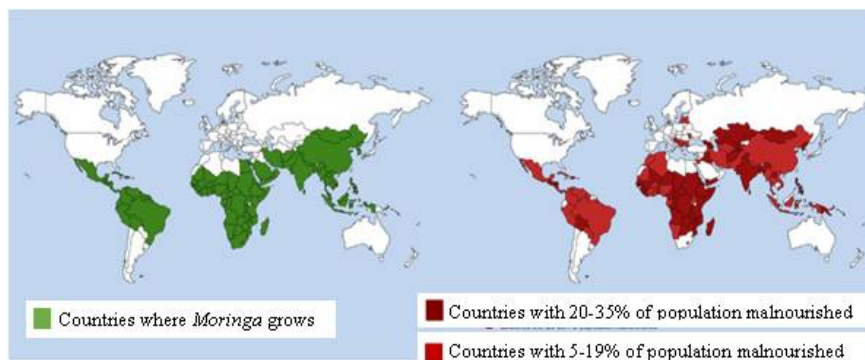


Figure 1: Native range of *Moringa olifera* as indicated by shaded area. ^[12]



The Moringa tree grows...

...precisely where people need it most.

Figure 2: Places where *Moringa* grows (green) and malnutrition is high (red) ^[14]

As shown in figure 2, *Moringa olifera* grows mostly in sub-tropical regions of different countries throughout the world, where most of those countries have the problem of malnutrition. The major reason for this is that most of the people won't consume this valuable crop due to lack of knowledge regarding the nutritional and medicinal properties and as it is still an underutilized crop in most of these countries. Hence, lots of researches are being carried out throughout the world (specially in particular countries that those plants are grown more such as Nigeria, India and Sri Lanka).

a. Varieties

There are only a few named varieties of *Moringa olifera*. A type named *Jaffna* produces fruits that are 60-90 cm in length and with a soft

flesh of good taste which is grown in parts of south India. *Chavakachcheri murunga*, (also a *Jaffna* type) bears fruits as long as 90-120cm and *Chemmurunga* (red-tipped fruits) has flowers throughout the year and yields heavy crops ^[15].

Several varieties such as *Rann murunga* (local variety), *Jaffna* and *Chavakachcheri murunga* are the varieties that are mostly grown in Sri Lanka. In addition several hybrid types such as Kalpitiya, V 19 and V 16 have also been introduced ^[16] for local farmers.

b. Climate and growing conditions

The “*Moringa*” tree is a fast-growing, drought-resistant tree ^[17,18] which is grown mainly in semi-arid, tropical, and subtropical areas. In Sri Lanka, *Moringa* grows mainly in Jaffna, Kalpitiya, Mannar, Puttalam and Hambantota areas ^[16]. While it grows best in dry sandy soil, it tolerates poor soil, including coastal areas as well. The plant requires tolerant temperature up to 48°C, less moisture and rainfall of about 300-500mm for normal growth and grows mostly in low lands below 500m ^[19] and the soil pH has to be slightly acidic to slightly alkaline (pH 5-9) ^[20].

Trees can be propagated from seed or from mature cuttings. Seeds that are required for propagation can be collected from soaking mature and well developed pods in cow dung mixed water for about a day and sowing at the site of the seedbed directly. Hedge spaces can be recommended as, about 30cm apart for plants at close spacing and 4-5m away for trees. It is better to plant on the onset of rain to obtain a good harvest ^[19]. The *Moringa* tree bears usually for about 20 years where the pods start bearing around 6 to 8 months after planting and regular bearing commences from the second year onwards.

3. *Moringa olifera* leaves

3.1 Nutritional properties of *Moringa olifera* leaves

Various studies have proved that *Moringa olifera* leaves have immense nutritional value such as vitamins, minerals and amino acids making it a virtually ideal dietary supplement ^[21,22,23,24]. As such, the leaves have been used to combat malnutrition, especially for infants and nursing mothers ^[8,9,21]. Table 2 represents the different types and amount of nutrients present in dehydrated *Moringa oleifera* leaves.

Table 2: Nutritional profile of dehydrated *Moringa olifera* leaves (per 100g) ^[25]

Nutrient	Content in 100g of <i>Moringa</i> leaves powder
Moisture (%)	7.5
Calories (kcal)	205
Protein (g)	27.1
Fat (g)	2.3
Carbohydrate (g)	38.2
Fiber (g)	19.2
Ca (mg)	2,003
Mg (mg)	368
P (mg)	204
K (mg)	1,324
Cu (mg)	0.57
Fe (mg)	28.2
S (mg)	870
Oxalic acid (mg)	1.60%
Vitamin A - β -carotene (mg)	16.3
Vitamin B1 -thiamine (mg)	2.64
Vitamin B2 -riboflavin (mg)	20.5
Vitamin B3 -nicotinic acid (mg)	8.2
Vitamin C -ascorbic acid (mg)	17.3
Vitamin E -tocopherol acetate (mg)	113

According to some researches, the leaves contain all the essential amino acids ^[8,21] including threonine, tyrosine, methionine, valine, phenylalanine, isoleucine, leucine, histadine, lysine and tryptophan. Additionally *Moringa olifera* leaves may contain sulphur containing amino acids namely methionine and cystine which are often in short supply in most legumes ^[26] those are reported as powerful antioxidants that help in the detoxification of harmful compounds and protect the body from radiation ^[27]. Moreover, total protein digestibility of *Moringa* leaves is higher (80% to 90%) and its amino acid composition corroborates with the FAO reference protein for child growth ^[28].

According to the study done by Moyo et al.^[8] (table 3) and El Sohaimy et al,^[29] dehydrated *Moringa* leaves contain 19 amino acids (Only glutamine has not been detected from the common 20 amino acids. However, according to Misner^[30], glutamine can be derived from glutamic acid). Hence, the dehydrated *Moringa* leaves could act as a protein supplementary source in animal and human diets.

Most of the research studies have found that mineral content in dehydrated *Moringa* leaves are higher than most of the other plant sources^[8,31] including Calcium, Iron, Magnesium, Zinc, Potassium and Phosphorous. And also they contain Copper which is considered to have strong effects on the immune system. Guo et al.^[32], stated that when copper combined with Zinc, it may plays a role in superoxide dismutase activity and the removal of oxygen free radicals. Hence we can conclude that the mineral composition in *Moringa* plays a significant role in nutritional, medicinal and therapeutic values.

Table 3: Amino acid profile of *Moringa olifera* leaves^[8]

Amino acid	Quantity (Mean %)
Arginine	1.78
Serine	1.087
Aspartic acid	1.43
Glutamic acid	2.53
Glycine	1.533
Threonine*	1.357
Alanine	3.033
Tyrosine*	2.650
Proline	1.203
HO-Proline	0.093
Methionine*	0.297
Valine*	1.413
Phenylalanine*	1.64
Isoleucine*	1.177
Leucine*	1.96
Histidine*	0.716
Lysine*	1.637
Cysteine	0.01
Tryptophan*	0.486

* General essential amino acids

As an average, almost 50% of the total calcium in *Moringa* leaves and almost 70% on the average of Zink are available for absorption in the body [23]. But even though, the iron content of *Moringa* leaves are higher than that of the amount of zinc, it is found to be less available for absorption in the body.

Certain research studies states that apart from oxalate and negligible amount of tannin, *Moringa* leaves do not contain any anti nutritional factor [8,13,25,33]. According to Vitti et al, [34] drying is reported to reduce or remove extractable condensed tannins by 15 to 30% relative to fresh foliage, and Makkar,[35] states that happens due to decomplexation between tannins and proteins and depolymerisation and oxidation of tannins.

Moringa leaves (specially dehydrated *Moringa* leaves powder) have been reported to be rich in vitamins including, β -carotene, thiamine, riboflavin, niacin, pyrodixine, biotin, ascorbic acid, cholecalciferol, tocopherol and vitamin K [36]. According to some researches, the high amount of ascorbic acid (vitamin C) in the leaves can overcome the action of calcium, zinc and iron absorption inhibitors (such as phytic acid and tannic acid) [23].

According to a study done by Moyo et al.,[8] (table 4), 17 fatty acids have been identified in dehydrated *Moringa* leaves, of which contains more dietary polyunsaturated fatty acids than the saturated fatty acids. It is recommended that the higher content of Polyunsaturated Fatty Acids (PUFA) and lower amount of Saturated Fatty Acids (SFA) is desirable [37] for promoting good health. As presented in table 4, three polyunsaturated fatty acids have been detected by Moyo et al.,[8] namely α -linolenic, linoleic and g-linolenic where, α -linolenic had the highest value of 44.57%.

Table 4: Fatty acid composition of dehydrated *Moringa olifera* leaves [8]

Fatty acid	Quantity (Mean %)
Ether extract	6.50
Capric (C10:0)	0.07
Lauric (C12:0)	0.58
Myritic (C14:0)	3.66
Palmitic (C16:0)	11.79
Palmitoleic (C16:1c9)	0.17
Margaric (C17:0)	3.19
Stearic acid (C18:0)	2.13

Oleic (C18:1c9)	3.96
Vaccenic (C18:1c7)	0.36
Linoleic (C18;2c9,12(n-6)	7.44
α -Linolenic (C18:3c9,12,15(n-3)	44.57
γ -Linolenic (C18:3c6,9,12 (n-6)	0.20
Arachidic (C20:0)	1.61
Heneicosanoic (C21:0)	14.41
Behenic (C22:0)	1.24
Tricosanoic (C23:0)	0.66
Lignoceric (24:0)	2.91
Total saturated fatty acids (SFA)	43.31
Total mono unsaturated fatty acids (MUFA)	4.48
Total poly unsaturated fatty acids (PUFA)	52.21
Total Omega-6 fatty acids (n-6)	7.64
Total Omega-3 fatty acids (n-3)	44.57
PUFA: SFA (PUFA:SFA)	1.21
n-6/n-3	0.17
PUFA: MUFA (PUFA:MUFA)	14.80

Breast feeding mothers can greatly benefit from fresh *Moringa* leaves as they are known to increase the volume of milk [9,20,38] and malnourished children have made significant weight gains [2,25,39]. Apart from that, Alakali et al.,^[40] states that, *Moringa* leaves can do much to preserve the pregnant and breast feeding mothers' health and pass on strength to the fetus or nursed child.

Moringa Association of Ghana.,^[20] stated that 100 grams fresh *M. oleifera* leaves are enough to cover 30 to 100% of the daily recommended intake of calcium (80 to 100% for young children below 3 years old, 30 to 50% for teenagers, 40 to 60% for adults, children and pregnant and breastfeeding women) and 25 to 80% of the daily recommended intake of iron (25% for pregnant women, 50 to 100% for men and children, 40-60% for teenagers and women). As for vitamins, the recommended daily intake for vitamin A can be varied from 400 μ g retinol equivalents (young children) to 1,000 μ g retinol equivalents (breastfeeding women). Therefore, 100 grams of fresh *Moringa oleifera* leaves could theoretically cover 100% of daily

needs of vitamin A (but this be highly variable depending on storage conditions and the processing conditions, as vitamin A degrades over time as well as when exposed to light or heat). Apart from that, 100 grams of fresh *Moringa* leaves may cover 100% of the vitamin C requirements (but vitamin C can be degraded quickly with time and due to application of heat), for which the recommended daily intake varies from 60 mg (young children) to 130 mg (breastfeeding women) [20].

The nutritional contents of the leaves can vary depending on varieties, maturity level of the leaves, climate, season, soil conditions, soil pH, processing method etc. [14]. Thus, different analyses produce different figures which have been proved in researches.

As an example, Liyanage et al, [3] has done a research to determine the protein and micronutrient contents of *Moringa oleifera* leaves as a function of agro-climatic locations in Sri Lanka. Table 5 represents the results obtained from the study which proved that there can be variations in the ranges of protein and micronutrients in *Moringa* leaves collected from the different localities.

3.2. Phytochemistry of *Moringa olifera* leaves

Moringa leaves are a rich source of phytochemicals [9] which possess biological functions having potent anticancer and hypotensive activity and are considered full of medicinal properties. Additionally *Moringa* leaves are rich in compounds containing the simple sugar, rhamnose and a fairly unique group of compounds called glucosinolates and isothiocyanates [46,50].

Various polyphenols that can be mostly found in *Moringa* leaves, which having antioxidative, anti-inflammatory, antiviral and anti-carcinogenic properties [9] including, flavone (such as acacetin and a glycoflavone 4-OMe Vitexin), phenolic acids (such as melilotic acid, o-coumaric acid, p-coumaric acid, and vanillic acid) [41]. The flavonoids are Kaempferol, Quercetin and 3',4'-diOMe quercetin [42]. Quercetin is considered as an inhibitor for cancer cell growth within human body [43]. Apart from that, leaves contain α -tocopherol, carotenoids (especially β -carotene), saponins and tannins [44]. There are also some alkaloids can be present having with some pain relieving and tranquilizing properties [9].

Since *Moringa* leaves are a good source of natural antioxidants, it can enhance the shelf life of fat containing foods [22].

Table 5: Protein and micronutrient contents of *Moringa oleifera* leaves on different locations in Sri Lanka, [3]

District	Mineral Concentration (mg per 100 g)					Protein
	Fe	Zn	K	Ca	Mg	
Anuradhapura	9.11±2.58 ^c	2.99±1.41 ^b	1747.75±254.57 ^d	1755.04±290.68 ^a	412.13±134.52 ^{cd}	33.87±2.85 ^{ab}
Galle	5.77±3.37 ^c	4.41±0.54 ^a	1936.87±342.98 ^b	1157.55±218.38 ^d	471.15±141.57 ^c	35.00±0.49 ^{ab}
Hambantota	5.95±5.03 ^c	2.68±1.09 ^b	1613.75±198.60 ^d	1555.76±400.84 ^b	375.21±222.81 ^d	34.66±0.24 ^{ab}
Jaffna	8.85±2.44 ^c	3.42±2.65 ^b	2215.87±186.96 ^a	1645.64±289.34 ^{ab}	290.89±133.99 ^f	33.13±1.80 ^{ab}
Kandy	8.02±4.05 ^c	2.73±2.25 ^c	1607.00±254.57 ^d	1300.00±318.26 ^c	451.92±112.51 ^c	29.45±1.48 ^b
Kurunegala	13.09±6.93 ^b	4.97±2.68 ^a	1747.62±204.18 ^c	1589.83±253.52 ^b	818.28±204.95 ^a	31.68±6.19 ^b
Matara	6.50±3.12 ^c	0.92±1.09 ^d	1851.62±422.32 ^{bc}	1579.12±314.44 ^b	331.74±135.24 ^{ef}	30.43±1.24 ^b
Polonnaruwa	26.99±12.0 ^a	4.21±0.97 ^a	2428.00±476.12 ^a	1673.37±514.56 ^{ab}	569.71±127.07 ^b	40.84±0.62 ^a

3.3. Medicinal uses and pharmacological properties of *Moringa olifera* leaves

Based on some of the antioxidant and phytochemical properties in *Moringa olifera*, leaves, it is capable of being identified for containing numerous medicinal properties, which have been recognized in the Ayurvedic and Unani systems of medicine ^[45] by considering as a natural anticancer, antihypertensive, diuretic, antispasmodic, antiulcer, antihelminthic, antibiotic, detoxifying and immune building agent and also as a source that possess some cholesterol lowering activities ^[9].

Moringa leaves have neither known negative side effect, nor toxic elements. Hence, those are considered as a completely safe plant source for consumption. People in many countries have used *Moringa* leaves as a treatment in traditional medicine for common ailments such as asthma, catarrh, chest congestion, cholera, conjunctivitis, cough, fever, headaches, diarrhea, eye and ear infections, abnormal blood pressure, scurvy, semen deficiency, sore throat, tuberculosis etc. Since, it is a good source of high density lipoprotein, it can be a good source that reduces the cardiovascular diseases ^[38]. Additionally, *Moringa* leaves are also known to be helpful for people with diabetes mellitus ^[13].

4. Application of *Moringa olifera* leaves in Food industry

Fresh leaves are used as a vegetable in cookery, soups, salads, fried foods, curd etc. ^[46]. Other than that, the dehydrated leaves can be stored for a long time and can be used regularly without refrigeration, without loss of nutritional value ^[47]. Even though dehydration is a more convenient and common method, there can be lots of losses takes place during dehydration process effecting nutritional, physical and chemical composition of the leaves ^[43]. Therefore, to minimize drying losses various pre-treatments like blanching can be used.

Blanching is important mainly for the purpose of inactivating certain enzymes that can cause undesirable changes for reducing the quality of the final product as well as modifying texture while preserving color, flavor, and nutritional value of the product (retain certain nutrients such as vitamins) and removing trapped air ^[22].

There are lots of research studies have been conducted in covering different aspects and applications of *Moringa olifera* leaves including, nutritional property analysis (for different processing conditions such as sun drying, shade drying, oven drying at different temperatures, steam

blanching, fermentation etc.), medicinal property analysis, research regarding application of *M. olifera* leaves in different products etc. Below are some examples for researches conducted regarding application of *Moringa olifera* leaves in food industry.

According to a research done by Rathnayake and Navaratne, ^[7], dehydrated *Moringa olifera* leaves (collected from western province, Sri Lanka) is a good source of minerals. Steam blanching prior to dehydrating the *M. olifera* leaves, can improve protein and β -carotene content over the un-blanching dehydrated *M. olifera* leaves (table 6). Reason for this consequence can be described as the concentrating effect of protein in the blanched leaves due to the loosing of moisture during blanching process that imparts in reduction of cell wall integrity. Increment of β -carotene concentration can be described due to inactivation of certain enzymes (that can oxidize β -carotene) during blanching process. Apart from that, steam blanching can also affect sensorial properties of dehydrated *Moringa olofera* leaves by darkening the colour and altering the flavour profile of the leaves ^[48].

Table 6: Nutritional profile of dehydrated *Moringa olifera* leaves ^[7]

Nutrient	Dehydrated without blanching	Dehydrated with blanching
Moisture content (g)	8.00 \pm 0.626 ^a	7.15 \pm 0.439 ^a
Energy (kcal)	280.97 \pm 2.62 ^a	289.59 \pm 4.19 ^a
Ash (g)	10.87 \pm 0.137 ^a	10.62 \pm 0.284 ^a
Crude protein (g)	35.42 \pm 1.77 ^a	40.61 \pm 1.628 ^b
Crude fat (g)	2.60 \pm 0.01587 ^a	2.91 \pm 0.3010 ^a
Crude fiber (g)	12.20 \pm 0.405 ^a	12.59 \pm 0.404 ^a
Carbohydrate (g)	30.91 \pm 1.535 ^a	26.12 \pm 2.58 ^a
β -carotene (mg/100g)	20.01 \pm 0.04 ^a	75.00 \pm 0.09 ^b
Minerals		
Ca (mg)	2493.27 \pm 0.53 ^a	2419.24 \pm 0.95 ^b
K (mg)	2288.11 \pm 0.50 ^a	2254.33 \pm 0.54 ^b
Fe (mg)	23.19 \pm 0.45 ^a	22.01 \pm 0.46 ^a

Additionally, Rthnayake and Navarathne, ^[7], have incorporated blanched dehydrated *Moringa olifera* leaves into biscuits and proved that the addition of *Moringa* leaves can improve the mineral content of the

biscuits while cutting down of the calorie value. Wijesiri et al, ^[49] have developed rice noodles by incorporating *Moringa oleifera* leaves for the purpose of calcium enrichment and have proved that dehydrating *M. olifera* leaves (to a moisture content of 7.6%) and incorporating into rice flour at 3% for manufacturing noodles, can provide higher amount of calcium than commercially available calcium enriched noodles. Tilakaratne et al, ^[16] had stated that a good quality bread spread can be prepared by using dehydrated *Moringa* leaves powder that can be stored for three months period at ambient and refrigerated condition in glass bottles without obtaining considerable quality deterioration.

As mentioned in tressforlife.org ^[14], the ability of *Moringa* leaves powder to prevent or cure malnutrition in pregnant or breast-feeding women in southwestern Senegal was studied in 1997-1998, by Alternative Action for African Development (AGADA) and Church World Service. During the test, doctors, nurses, and midwives have been trained in preparing and using *Moringa* leaf powder for treating malnutrition. Village women have also trained in the preparation and use of *Moringa* leaf powder in foods. According to the results of the study, children had maintained/increased their weight and improved overall health, pregnant women had reported to be recovered from anemia and delivered babies with higher birth weights and breast-feeding women had increased their milk production.

Various products of *Moringa* leaves have been manufactured in the industry by now. The most common products includes Nutritional supplement, Antioxidant rich tea, fortifying agent in different foods and in capsule preparation. Additionally, *Moringa* Soaps, *Moringa* oil, *Moringa* Face wash, some beverages are also available in market prepared by *Moringa* leaves ^[21]. In southern India, village people use the fresh leaves to prepare cow and buffalo ghee from butter fat which have reported to result a significant increase in the shelf life of ghee while the *Moringa* leaves being a good source of natural antioxidants ^[13].

5. CONCLUSION

Moringa olifera leaves is a good source of amino acids and micronutrients that can combats the effect of malnutrition and micronutrient deficiencies and also contain numerous medicinal properties due to the availability of several phytochemicals. Hence, *Moringa olifera* leaves can be applied in food industry as a functional food ingredient.

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