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PHYTOCHEMICALSTUDIESAND MULTIPURPOSEUSESOF SEED OIL OF MORINGA OLEIFERA

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Abstract

Moringa is the single genus under the family Moringaceae. The colour of the refined Moringa Seed Oil is clear, light yellow and odorless. The powerful and exceptional anti-aging properties of this oil provide nutrition to the skin and relieve ageing signs. Moringa Oil contains four times as much collagen as carrot oil, thus helping to rebuild the skin's collagen fibers, which reduces wrinkling and removes skin blemishes. Many antioxidants and nutrients present in Moringa oil inhibit activities of free radicals on the skin causing damage to skin tissue paving the way for skin wrinkles. It cleans acne-prone skin, reduces signs of aging, firms' skin and promotes elasticity. Moringa contains a range of unique phytochemicals containing simple sugars, rhamnose and rich in compounds called glucosinolates and iso-thiocyanates. The seeds of Moringa oleifera contain phytochemicals like glycolides, alkaloids, flavonoids and carbohydrates. Seed coat of Moringa oleifera contains alkaloids, triterpenoids, flavonoids, diterpenoids, cardiac glycoside, phytosterols and tannins. Anthraquinones, a group of naturally occurring phenolic compounds, showing laxative propertiesare plentily available in M. oleifera leaves. The seeds contain Moringyne, 4-(α-L-rhamnosyloxy) benzyl isothiocyanate & several amino acids. Moringa oleifera oil is considered as potential feed stock for biodiesel. Moringa seed oil is well suited for cosmetics production as it is exceptionally stable at high temperatures. The oil contain a percentage yield of 26.9%, specific gravity of 1.1827, saponification value 187.5, indicatingthe presence of long carbon chain and can be used in making soap.Due to its resistance to rancidity and enfleurage property, it is highly valuedin the perfume industry and hair dressings. 74% oleic acid content in Moringaoil enables it for improved oxidation stability and thus act as a good base fluids. Moringa oleifera also has numerous medicinal uses, which have long been recognized in the Ayurvedic and Unani systems of medicine. The presence of flavonoids in the oil is recognized to have antioxidant and anti-proliferative effects which may protect the body from various diseases and disorders. M. oleifera also have many pharmacological activities such as: anti-cancer, anti-inflammatory, antidiabetic, anti-fungal, anti-bacterial, strongly inhibiting the growth of Staphylococcus aureus, Salmonella typhi, Shigella species and Candida albicans. It is also hepatoprotective.

Key words: *Moringa Oil, anti-aging properties, collagen, antioxidants, phytochemicals, sugars, rhamnose, glucosinolates, iso-thiocyanates, glycolides, alkaloids, flavonoids, diterpenoids, cardiac*

glycoside, phytosterols, tannins. Anthraquinones, Moringyne,biodiesel, enfleurage property, perfume industry, oleic acid, base fluids, and pharmacological activities.

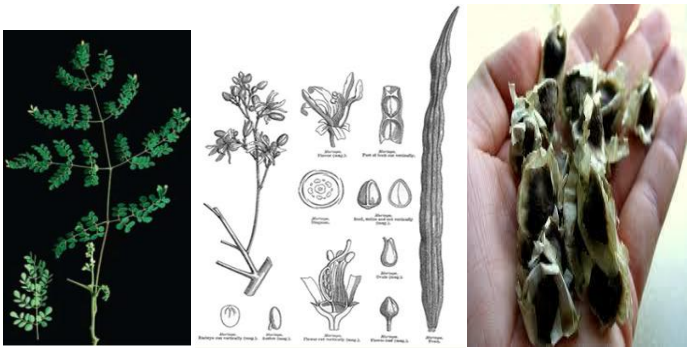
1. Introduction

Moringa, belonging to family Moringaceae is originated from India (Lim, 2012). The edible parts of the plant are leaves, flowers, young capsules, seeds, fruits and roots. It is cultivated mainly for its nutritive pods containing approximately 20 seeds per pod (Somali *et al*., 1984), (Jamieson, 1939). *Moringa oleifera* seeds have been studied by many researchers as coagulant. The seed extracts serve as the most effective clarifiers (Kumar*et al*., 2012). Biodiesel from *Moringa oleifera* oil is a substitute for petroleum-based conventional diesel fuel (Rashid*et al*.,2008). *M. olefeira* oil has evaluated by a standard transesterification procedure which demonstrates a high cetane number of approximately 67 which is good for biodiesel (Rashid*etal*., 2008). Presence of 74% oleic acid in this oil improves thermo-oxidative property and stability to low temperature enables this oil to be used for biodiesel production (Sharma*et al.,* 2009).The seeds contains Morigyne, 4-(α-L-rhamnosyloxy)benzyl isothiocyanate and many amino acids (Mishra*et al*.,2011).

2. Botanical Description Of Moringa

Taxonomic classification: (Arora*et al.*, 2013)

Kingdom : Plantae
Subkingdom : Tracheobionta
Super Division: Spermatophyta
Division : Magnoliophyta
Class : Eudicots
Subclass : Rosids
Order : Brassicales
Family : Moringaceae
Genus : *Moringa*
Species : oleifera



a) Compound leaf b)Flower and Frui c)Seeds

3. General Properties Of Moringa Seed Oil

The colour of the refined Moringa Seed Oil is clear, light yellow and odorless. It has powerful antioxidant capacity (Lalas*et al.*, 2001). The exceptional anti-aging properties of this oil provide nutrition to our skin and relieve ageing signs. Combined with its high oleic acid content of more than 70% (Jamieson, 1939) the oil rejuvenatesthe facial tissue and strengthens the overall health of skin cells (Mulugeta*et al.*, 2014) and helps the skin to retain moisture. It also deals with acne and keeps it under control with the good nutrients from Moringa Oil. Moringa Oil contains four times as much collagen as carrot oil, thus helping to rebuild the skin's collagen fibers, which reduces wrinkling and removes skin blemishes. Many antioxidants and nutrients present in Moringa oil inhibit the activities of free radicals on the skin. Free radicals can cause damage to skin tissue and pave the way for skin wrinkles (Lalas*et al*,2002; Banerji*et al.*, 2003). The oil is rich in healing properties (Mulugeta*et al.*, 2014) such as cleansing the acne-prone skin, reduces the signs (the visibility) of aging, tightens skin and promotes elasticity, making the skin younger and fresh looking, increasing skin radiance along with controlling skin-oil and reducing skin pores.

4. Physical And Chemical Characteristics Of Moringa Seed Oil

Table-1

Physical and Chemical Characters	*Moringa peregrina*(Fiori Oil) Somali *et al.*, 1984	*Moringa concanensis* (NimmoOil) Manzoor*et al.*, 2007	*Moringa oleifera* (Ben Oil) Ashfaq. *et al.*, 2012
Refractive index	1.4610	1.4648±0.02	1.4571
Iodine Value	69.5	67.00±0.70	68.63
Saponification Value mg KOH/g	182.9	179±1.15	181.4
Acid Value	0.04	0.34±0.05	0.81
Unsaponifiable Matter %	0.3	0.78±0.04	0.74
Saturated Acids %	14.7	25.15	12.4
Myristic (C14:0)	Trace		_
Palmitic (C16:0)	9.3	11.04±0.1	2.97
Stearic (C18:0)	3.5	3.58±0.12	3.97

Behenic(C22:0)	2.6	7.09±0.25	4.86
Lignoceric(C24:0)	_		0.6
Unsatured Acids %	84.7		82.44
Oleic (C18:1)	78.0	68.00±0.80	81.73
Linoleic (18:2)	0.6	1.83±0.10	0.71

5. Phytochemical Studies Of Moringa Seed Oil

Phytochemicals are the chemicals which may affect health, flavor and textureof the plants. Moringa contains a range of unique phytochemicals containing simple sugars, rhamnose and rich in compounds called glucosinolates and iso-thiocyanates (Ashfaq, *et al.,* 2012).Out of the 13 species of Moringa, *Moringa oleifera* has been given much publicity due to its phytoconstituents. Exhaustive research work is needed to establish the comprehensive phytoconstituents of these and other Moringa species, and further explore and exploit their antimicrobial properties not forgetting to ascertain the safety of the active principles (Arora *et al.,* 2013). The seeds of *Moringa oleifera* are reported to contain phytochemicals like glycolides, alkaloids, flavonoids and carbohydrates. Seed coat of *Moringa oleifera* contains alkaloids, triterpenoids, flavonoids, diterpenoids, cardiac glycoside, phytosterols and tannins (Arora *et al.,* 2013). Anthraquinones are a group of naturally occurring phenolic compounds and are present in *M. oleifera* leaves which showed laxative properties (Sinha, 2012). The seeds contain Moringyne, 4-(α-L-rhamnosyloxy) benzyl isothiocyanate & several amino acids(Mishra *et al.,* 2011). The seeds of *M. peregrine* contain 4(α-L-rhamnosyloxy)benzyl isothiocyanate, 4-(4'-*O*-Acetyl -α-L-rhamnosyloxy)benzyl isothiocyanate, 2-Propyl-isothiocyanate, 2-Butyl-isothiocyanate, 2-Methylpropyl-isothiocyanate, 5,5-Dimethyl-oxazolidine-2-thione(Arora *et al.,* 2013). The seeds of *M. oleifera* contained a number of phytochemicals such as alkaloids, glycerides, flavonoids, steroids, terpenoids, and anthraquinone. These data corroborated the findings of other authors where these compounds exhibited antimicrobial activities (Sinha, 2012). Isolation of 4(α-L-Rhamnosyloxy) benzyl isothiocyanate from seeds of Moringa oleifera was reported by Eilert*et al.,* (1981).

Phytochemical studies on *Moringa oleifera* reveals major polyphenols such as quercetin, glucosides, rutin, kaempferol, glycosides and chlorogenic acids in *Moringa oleifera* powder by HPLC analysis(Mishra *et al.,* 2011). The phytoconstituents of *Moringa stenopetala* are polyphenols, saponins, physteroids and withanoids, flavonoids, tannins, alkaloids, anthraquinone and glycosides. Prescence of α-, γ, and δ-tocopherols in *Moringa concanensis*in high concentration(Manzoor*et al.,* 2007) is reported,in which the content of α-tocopherol (72.11 mg kg^{-1}) has greatest vitamin E potency, γ-tocopherol(9.26 mg kg^{-1}) and δ-

tocopherol (33.87 mg kg^{-1}), has greater antioxidant activity. It contains alkaloids, tannins, terpenoids, flavonoids, glycosides and saponins.

6. Multipurpose Uses Of Seed Oil Of Moringa

6.1 Use in Bio-diesel Production:

Moringa oleifera oil is considered as potential feed stock for biodiesel (Rashid *etal.*, 2008). Considering the global scarcity of petroleum products and the related environmental hazards such as global warming resulting from the burning of petroleum products, a need for the use of alternative fuel i.e. biodiesel from *Moringa oleifera*(Biswas, 2008) is justified. Biodiesel is a renewable resource and can be produced domestically from agricultural oils(Biswas, 2008). The *Moringa oleifera* oil is extracted using a Soxhlet extractor fitted with a 2-L round bottomed flask and a reflux condenser. The acid value was 2.9, necessitating acid pre-treatment before transesterification. After acid pre-treatment, the acid value of *Moringa oleifera* oil was reduced to 0.953 by further methanolysis(alcoholysis using methanol) of*Moringa oleifera*oil, when conducted by a standard procedure employing a 6:1 molar ratio of methanol to vegetable oil (scale:100g *Moringa oleifera* oil) for 1hour at 60^0C with 1wt% $NaOCH_3$ as catalyst. After completion of the reaction, the mixture was cooled to room temperature without agitation, leading to separation of low phases. The upper phase consisted primarily of *M. oleifera* methyl esters (MOME) and the lower phase contained glycerol, excess methanol and catalyst. After separation of the two phases by decantation, most excess methanol was then removed from the upper MOME layer at 80^0C. The remaining catalyst was then removed by successive washes with distilled water. Finally residual water was removed by treatment with Na_2SO_4 followed by filtration(Rashid *etal*.,2008).Highest cetane number reported for a biodiesel fuel is MOME. *Moringa oleifera* derived biodiesels easily meet the minimum cetane number requirements i.e 67.07, using an ignition quantity tester (IQT)(Ashfaq*etal*.,2012). Cloud point of *Moringa oleifera* oil is higher (Rashid *et al*.,2008). The choice of *Moringa*as a source of bio-fuel justifies the fact that *Moringa*are biodegradable. Onekilo of seeds from the Moringa pods would yield 400 ml of bio fuels. From a hectare of land planted to *Moringa,* about 20,000 kilos of seeds could be collected (Mulugeta*etal.*,2014).The left over part even provides as a fertiliser or as a flocculant to purify water (Ofor *et al.*,2011).

6.2 Uses in Cosmetic Industry

The oil made from Moringa seed is well suited for cosmetics production as it is exceptionally stable at high temperatures (Mulugeta*et al.,* 2014). Efforts were also made to formulate sun creams using extracted *M. concanensis* seed oil with an sun protection factor (SPF) value of

1.46 (Padayachee*et al.,* 2012). The oil characterization for cream formulation and UV-visible spectrophotometer is generally used to carry out the antioxidant activity of the oil. The oil reported to contain a percentage yield of 26.9%, specific gravity of 1.1827, saponification value 187.5 (Banerji*et al.,* 2003) indicates that it has long carbon chain and can be used in making soap. The free fatty acid is 2.51 which is an indication that its rancidity is low and it should have a long shelf life. The oil is good in making cosmetics. Its acid value is 5.038620 mg/KOH/g and free fatty acid extracted is 2.51mg/KOH/g. The pH of the cream with Moringa seed oil is 5.70(Ojiako*et al.,* 2013) which is moderate and close to the range. The standard pH for a moisturizing body creamliesbetween 5.5 to 7. The cream produced from this oil has a good moisturisation and confirms to the standard. Available literature shows that the antioxidant inhibition property of this oil is above average indicatingits high antioxidant advantage. The oil is found to be good commercially, and its production and consumption is highly recommended (Ojiako*et al.,* 2013). Absence of lead, mercury and hydroquinone are reported in the cream produced with Moringa seed oil. This is an evident that its use in cream formulation is perfectly good for the body as it smoothens and moisturizes the skin. Emulsion type test has shown that the cream is good for dry skin as it contains oil and leaves the skin moist. Another interesting application of *Moringa* oil is in the production of expensive and natural perfumes and fragrances.

Moringa oil is highly valued in the cosmetic industry for its unique property. It is light and spreads easily on the skin. It is best for massage and aromatherapy applications. Moringa oil application is used in the following range of products.

- Anti ageing creams
- Hair care products
- Soaps and Liquid body wash
- Aromatherapy oils
- Massage oil
- Face creams
- Perfumes and Deodorants

Moringa oil has exceptional anti ageing properties. The antioxidants and the nutrients present in the Moringa oil help to curb the activity of the free radicals on the skin. The free radicals are the agents that cause damage to the skin tissues and pave way for skin wrinkles. Antioxidants rich Moringa oil curbs the activities of free radicals and hence finds a place in the anti ageing creams. Moringa oil can be used in creams, lotions, balms, scrubs, body oils, and hair care formulations at the ratio of 3-100%. It also has nourishing and emollient

properties giving it benefits for use in skin and hair care products. Moringa oil, as olive oil is useful in lifting dirt out of the hair and is an efficient natural cleanser. Good antioxidant properties, considered to be the factor behind its remarkable stability. By simply wetting the hair, massaging the oil into the scalp and rinsing can effectively clean and moisturize the scalp. It has nourishing and emollient properties, making it an excellent Massage Oil, which leaves the skin with a silky feeling. Rich in Palmitoleic, Oleic and Linoleic acids, Vitamins A and C and unsaturated fatty acid, Moringa oil has excellent moisturizing and nourishing qualities. Moringa oil blends easily with essential oils and this combined with its non-drying quality and its ease of dispensability on the skin makes it as perfect massage oil. Moringa seed oil contains antiseptic and anti-inflammatory properties, which help heal minor skin complaints such as cuts, bruises, burns, insect bites, rashes and scrapes quickly. Moringa oil is also helpful for purposes of tanning or maintaining a tan as this oil is rich in copper and calcium, the important nutrients for the skin.

6.3 Use in Perfume industry

Perfume manufacturers esteem the oil for its great power of absorbing and retaining even the most fugitive odours. This Moringa Oil is in demand because it is so stable and resistant to rancidity and it has long been valued for its enfleurage property by the perfume industry. Moringa oil is useful in the manufacture of perfume and hair dressings. The oil is known for its capacity to absorb and retain volatile substances and is therefore valuable in the perfume industry for stabilising scents. The addition of Moringa seed oil produces a rich and creamy lather and, unlike any other plant-based oil, actually increases the cleansing ability:

• It clears pimples and prevents recurrence, if used regularly

• It removes wrinkles & will prevent sagging of facial muscles

• Helps clearing black heads & spots.

• Makes face glow.

• Helps to tighten the skin pores.

• It is able to purify the skin, balance the secretion of oil & remove skin fatigue. Regular use diminishes the formation of blackheads for all skin type. It also counteracts the effect of pollution.

• It Keeps skin healthy and glowing. There are reports of Moringa being used in cosmetic preparations as far back as 1400 BC, wherein an allegedly successful remedies to treat wrinkles consisted of: gum of frankincense wax; fresh Moringa oil; Cyprus grass. The mixture was ground finely, mixed with fermented plant juice, and applied daily.

6.4 Uses as Lubricant

Lubricant reduces the wear by reducing friction between two surfaces in contact by providing a productive layer. Lubricants are being used in all sectors of the industries for lubricating the machine parts. Bio based lubricant has a greater potential as a substitute for conventional lubricant in industries (Nazri*etal*., 2013). Lubricants contain 90% base oil. Vegetable oils are used as base oils(Chandrakar*et al.*, 2014).According to available literature the production of vegetable oils is 125 million metric tons. *Moringa* seeds contain between 33 and 41%(w/w) of vegetable oils (Senguptа*etal*., 1970).Due to presence of 74% presence of oleic acid content in *Moringa*oil,it possesses improved oxidation stability and can act as a good base-fluid (Sharma*etal*., 2009). *Moringa* based lubricant can be a substitute to the petroleum based products as base fluids. These oils are the renewable resource and thus finding a way in to lubricant for industrial purpose for transportation medium. Biodegradibility (decay of any component by microorganism) of vegetable oils is 95-98%(Chandrakar*etal*.,2014).As the requirement of biodegradable synthetic oil is of utmost importance in industries, Moringa seed oil can be highly desirable with the current trend of replacing polyunsaturated vegetable oils with those containing high amounts of monosaturated fatty acids.

6.5 Medicinal Values

Moringa oleifera also has numerous medicinal uses, which have long been recognized in the Ayurvedic and Unani systems of medicine (Anwar*et al.*, 2007). The presence of flavonoids is recognized to have antioxidant and anti-proliferative effects which may protect the body from various diseases and disorders (Lim, 2012).Seed extract exerts its protective effect by decreasing liver lipid peroxides, antihypertensive compounds thio-carbamate and isothiocyanate glycosids have been isolated from the acetate phase of the ethanolic extract of Moringa pods (Anwar*et al.*, 2007). Its different parts like leaves, flowers, fruit, seed, roots, bark and immature pods act as cardiac and circulatory stimulants, possess antitumor, antipyretic, antiepileptic, anti-inflammatory, antiulcer, antispasmodic, diuretic, antihypertensive, cholesterol lowering antioxidant, antidiabetic, hepato-protective, antibacterial and antifungal activities, and are being employed for the treatment of different ailments in the indigenous traditional system of medicine, particularly in South Asia (Lim, 2012). The seeds of *M. peregrine* are also used as medicine in the Middle East and Sudan and the leaves are described as "phytoactive" and it relieves abdominal pain (Padayachee*et al.*, 2012). *M. oleifera* also exert many pharmacological activities such as: anti-cancer, anti-inflammatory, antidiabetic, anti-fungal, anti-bacterial, strongly inhibiting the growth of

Staphylococcus aureus, *Salmonella typhi*, *Shigella* species and *Candida albicans* and hepatoprotective.

6.6 Other economic Uses

M. oleifera is a typical multipurpose tree species with a high economic potential (Anwar et al., 2007). It has multifarious uses besides as a medicinal and food plant. The tree is used for bee foraging, soil conservation, shade, windbreak, live fence, hedge tree, ornamental boundary marker and for fibers. Leaves and twigs can be used as livestock fodder especially for goats, camels and donkeys. The bark exudes a white to reddish gum ('Ben gum' or 'Moringa gum') with the properties of tragacanth, which serves for tanning and in calico printing. The soft, white wood burns smoke-free and yields a blue dye. In India its pulp has been used to make paper suitable for newsprint, wrapping, printing and writing papers, and for viscose rayon grade pulp for textiles and cellophane.Biological treatment by bio-degradation methods are fungal de-colorization, microbial degradation, adsorption by(living or dead) microbial biomass and bioremediation system. The seed also contained a natural polyelectrolytes nonprotein flocculants that was more effective in clarifying and purifying turbid waters(Lim, 2012). Seeds of *Moringa oleifera* contain small storage proteins able to flocculate particles in suspension in water and are used to improve water purification processes (Lim., 2012). It is able to aggregate montmorillonite clay particles as well as Gram-positive and Gram-negative bacteria. *Moringa oleifera* seed extract exhibits ability to remove an anionic surfactant. Sodium lauryl sulphate is usually removed from aqueous solutions up to 80% through coagulation/flocculation process using *Moringa oleifera* seed extract (Lim, 2012).

7. Conclusion

The Moringa seed oil is clear and odourless and remarkably the oil does not become rancid for several years after it is produced. Although Moringa oil is viable for use as cooking oil, its high demand and low levels of production do not make it conducive for everyday use as dietary product. Therefore the mass plantation of Moringa trees is required to meet the rising demands. However, a small amount of Moringa oil has been useful in terms of disease treatment and various other applications. Moringa oil has exceptional anti ageing properties due to the antioxidants and nutrients present in it which help to curb the activity of the free radical on the skin. Several medicinal values are assured such as cardiac and circulatory stimulants. Moringa has the potential not only for human food supplements but also has high economic benefits. The key challenge is to overcome the potential to increase the production of Moringa oil both by volume and quality, not only for their low cost but also for former

friendly behaviour. Due to its excellent substitute property of petroleum based products, its existing small scale activities need to be significantly expanded on a commercial scale inboth the developing and developed nations. Farmersneed to comply with the international regulations and standards, to be able to offer high quality and continuous export. Moreover the keys to a successful farm are pruning the trees to obtain bushy leaf-growth and using regular but limited amounts of water and organic manure. By following these recommendations, Moringa plantation can produce leaves in abundance all year-round. Processing is also an accessible activity. Sun drying is an inexpensive, efficient method used to obtain quality results. Moringa leaves can help decreasing the developing countries' dependence on imported goods, such as vitamin and mineral complexes that ward off nutritional deficiency but are too expensive to be used in a sustainable way. The increase in interest for local foods and culinary traditions is now an important worldwide trend. It is therefore essential to develop the production and consumption of this "green super food".

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