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# *Moringa oleifera*: a comprehensive review on the pharmacological profile, health benefits and traditional utilization

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## Abstract

Moringa oleifera, belonging to family Moringaceae, is commonly known as 'horseradish tree' or 'drumstick tree' and is native to India. It is grown in tropical and subtropical regions throughout the world. It is recognized as a 'miracle tree' owing to its multipurpose utility in medicines and therapeutics. It is an exceptionally good source of phytochemicals, macronutrients, vitamins and minerals. Moringa and its components are known to exhibit various pharmacological activities including antimicrobial, antioxidant, anti-inflammatory, antitumor, antiulcer, antidiabetic, antiproliferative, antispasmodic and many more. It helps to prevent many diseases related to eyes, gastrointestinal tract, respiratory tract, cardiovascular system, urinary tract, liver disease, renal disease, bone disorders, inflammatory diseases, malnutrition etc. It is also believed to be a promising wound healer. This is a comprehensive review on this miracle tree which aims to highlight its multifaceted aspects like nutritional composition, cultivation system, pharmacological aspects, health benefits, traditional utilization, its role in water purification and biodiesel production. It's enormous phytochemical potential, easy cultivation and wide availability offers a golden opportunity to attract the attention of the food processors and researchers.

**Keywords**

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Moringa oleifera, cultivation, pharmacological effect, health benefits, traditional use

## Introduction

*Moringa oleifera*, is a quick growing edible tree belonging to family *Moringaceae* and is known by different names such as drumstick tree, kelor tree, saragvo (Gujarati), Mulangay, Benzolive, Sajna (Bengali), Mlonge, Saijihan (Nepali), Shevga (Marathi), Marango, Sigru (Malayalam), horse radish tree (English), Soaanjna (Hindi), Shobhanjana (Sanskrit), Surajana (Punjabi), Murunga (Sinhalese), Nugge (Kannada), etc. (Anwar and Bhanger, 2003). It is well known Indian medicinal herb which is now common in tropical and sub-tropical countries. It is native tree of North West India, especially that of sub Himalayan region and is now grown in many countries such as Arabia, Africa, South East Asia, South America, Caribbean and Pacific Islands (Razis et al., 2014). The tree of *Moringa oleifera* grows well in almost every condition ranging from hot dry lands or in humid tropics to that in drought (Anwar et al., 2007). The herb is well known for its medicinal purposes and high nutritional value. Due to its high nutritive value, the leaves, fruits, immature pods and flowers of the plant are consumed in many countries, especially in India, Hawaii, the Philipines, Pakistan and some African countries (Valdez et al., 2015). The different parts of *Moringa oleifera* possess various pharmacological properties such as anti-cancerous, anti-diabetic, antifertility, hepatoprotective, antihyperlipidemic, anti-ulcer, anti-convulsant activity, etc. as well as it contains various phytochemicals such as flavonoids, glycosides, sterols, proanthocyanidin, anthocyanins, etc. (Kesharwani et al., 2014). Moringa

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oleifera is also known as miracle plant as it has ability to provide complete nourishment and healing of man in almost all aspects. The plant itself is capable of combating with malnutrition and is therefore advised for pregnant or lactating women and for growing children. The plant has potential to combat and end the problem of starvation, malnutrition and can heal many diseases worldwide (Bey, 2010). Certain report of the Bureau of plant industry states that the vitamin C content of leaves of *Moringa oleifera* is almost seven times that of oranges, the calcium content is four times that of milk, potassium, iron is thrice times that of banana and spinach respectively, whereas the content of vitamin A is four times as compared to that in carrots and the protein content is two times that of milk (Varmani and Garg, 2014). Moreover, the availability of nutrients from *Moringa oleifera* is in nontoxic form and can be digested easily (Bey, 2010). The plant due to its numerous benefits is sometimes also known as "Tree of life" due to ability to combat with malnutrition around the world (Volunteers and Silver). *Moringa oleifera* not only serves the health benefits to humans but it also helps in cleansing of water. Where the fresh leaves of plant are consumed in the form of vegetable, branches for fencing, roots for medication, the dried seeds are used for treating the water for clarification purpose (Bey, 2010). Traditionally, the plant is being used for curing and treatment of number of ailments such as skin diseases, diarrhoea, anxiety, blood pressure, headache, joint pain, wound healing, etc. Many clinical trials and studies have been done to validate these claims and in many cases, the claims are valid also. Now-a-days, *Moringa* is used in health care products such as conditioners, hair moisturizers, body moisturizers and has great cosmetic value. It was found that, since Egyptian times, the oil of *Moringa* was used in skin ointments. It is one of the most nutrient rich plants discovered yet (Abdull et al., 2014). The present review will focus on nutritional composition, pharmacological properties, health benefits, traditional uses, biodiesel production and cultivation of *Moringa oleifera.*

**Cultivation**

*Moringa oleifera* is cultivated under a variety of production systems in different parts of the world. Farmers established *Moringa* through seed and cuttings or a combination of both methods. Most farmers in all districts plant *Moringa* during the rainy season. Plant spacing used by farmers when growing *Moringa* ranged from 30 cm apart to as wide as 5 m apart. Plant

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spacing of 1m x 1m was popular with farmers and a spacing of 4m x 4m least popular (Gadzirayi et. al.2013).

The fact that *Moringa* is easily cultivable makes it a sustainable remedy for malnutrition. Countries like Senegal and Benin treat children with *Moringa* (Kasolo et al., 2010). *M. oleifera* can be grown in tropical and subtropical regions of the world with a temperature around 25–35 °C. It requires sandy or loamy soil with a slightly acidic to slightly alkaline pH and a net rainfall of 250–3000 mm (Fahey and Thurber, 2010).

**Nutritional profile of *Moringa oleifera***

The flowers, leaves, bark, stem, seedpod, stem, roots and seeds of *Moringa oleifera* possess a number of phytochemicals and physicochemical compounds making it a storehouse of essential nutrients. It contains macronutrients (protein, carbohydrates, fat, crude fiber), vitamins (A,B,C,E) and sufficient amount of minerals like calcium, phosphorus, sodium, potassium, magnesium, iron, zinc, copper and sulphur. The leaves are also rich in oxalates and tannins. The nutritional composition along with the amount present is given in Table 1.

Different phytochemicals present in the different parts of *Moringa oleifera* contributes to the pharmacological potential of this plant. These are sterols, terpenoids, alkaloids (moringine and moringinine), saponins, anthraquinones, glucosinolates, isothiocyanates, glycosides, carotenoids and tocopherols (Anwar et al., 2007; Gopalakrishnan et al., 2016). The various sterols present in *Moringa oleifera* oil are brassicasterol, cholesterol, campestanol, campesterol, stigmasterol, stigmastanol, ergostadienol, 24-methylenecholesterol, β-sitosterol, clerosterol, 28-isoavenasterol, $\Delta^5$-avenasterol, $\Delta^{7,14}$ Stigmastadienol, $\Delta^{7,14}$ Stigmastanol (Anwar et al., 2007). Some of the other selected phytochemicals from *Moringa oleifera* are niazinin A, niazirin, pterygospermin, niaziminin, 4-(-L-rhamnopyranosyloxy) benzyl isothiocyanate, 4-(4′-O-acetyl-α-L-rhamnopyranosyloxy) benzyl isothiocyanate, niazimicin, 4-(α-L-rhamnopyranosyloxy) benzyl glucosinolate, benzyl isothiocyanate, aglycon of deoxy-niazimicine (N-benzyl, S-ethylthioformate), β-sitosterol, 3-O-(6′-O-oleoyl-β-D-glucopyranosyl)-β-sitosterol, O-ethyl-4-(α-

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L-rhamnosyloxy) benzyl carbamate, glycerol-1-(9-octadecanoate), β-sitosterol-3-O-β-D-glucopyranoside (Saini et al., 2016).

**Table 1. Nutritional composition of *Moringa oleifera***

| **Nutrient** | **Nutrient amount per 100 g fresh, raw *Moringa oleifera* leaves** | **Reference** | **Nutrient amount per 100 g dried *Moringa oleifera* leaves** | **Reference** | **Nutrient amount per 100 g dried *Moringa oleifera* seeds** | **Reference** |
|---|---|---|---|---|---|---|
| Energy (kcal) | 86.6 | Ndong et al., 2007; Yang et al., 2006; Yameogo et al., 2011; Witt, 2013 | 304 ± 87 | Freiberger et al., 1998; Fuglie, 2001; Amaglo et al., 2010; Witt, 2013 | ND | Fuglie et al., 2005; Olagbemide, 2014; Gopalakrishnan et al., 2016 |
| Moisture (mg) | 76.4 ± 3.01 | | 7.4 ± 2.89 | | ND | |
| Protein (g) | 8.8 ± 3.72 | | 24 ± 5.8 | | 38.67 ± 0.19 | |
| Carbohydrate (g) | 7.6 ± 12.5 | | 36 ± 9.2 | | 8.67 ± 0.12 | |
| Fiber, crude (g) | 2.2 ± 1.01 | | 9 ± 7.45 | | 2.87 ± 0.03 | |
| Fat (g) | 1.5 ± 3.07 | | ND | | 38.67 ± 0.03 | |
| Oxalate (g) | ND | | 2.6 ± 1.25 | | ND | |
| Tannins (g) | ND | | 1.2 – 1.4 | | ND | |
| Calcium (mg) | 532 ± 378.8 | | 1897 ± 748.4 | | 45 | |
| Phosphorus (mg) | 90 ± 112 | | 297 ± 149 | | 75 | |
| Sodium (mg) | 16 | | 220 ± 180 | | ND | |

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| Potassium (mg) | 414 ± 302.7 | | 1467 ± 636.7 | | ND | |
| Magnesium (mg) | 26 - 151 | | 473 ± 429.4 | | 635 ± 8.66 | |
| Iron (mg) | 10.8 ± 6.04 | | 32.5 ± 10.78 | | ND | |
| Zinc (mg) | 0.3 - 1.3 | | 2.4 ± 1.12 | | ND | |
| Copper (mg) | ND | | 0.9 ± 0.48 | | 5.20 ± 0.15 | |
| Sulphur (mg) | ND | | ND | | 0.05 | |
| Thiamine (mg) | ND | | 2.6 | | 0.05 | |
| Riboflavin (mg) | ND | | 1.29 – 20.5 | | 0.06 | |
| Niacin (mg) | ND | | 8.2 | | 0.2 | |
| Vitamin $B_6$ (mg) | ND | | 2.4 | | ND | |
| Folate (µg) | ND | | 540 | | ND | |
| Vitamin A (µg RAE) | 1286 ± 689 | | 3639 ± 1979.8 | | ND | |
| Vitamin C (mg) | 162 ± 63.0 | | 172 ± 37.7 | | 4.5 ± 0.17 | |
| Vitamin E (mg) | 25 | | 56 - 113 | | 751 ± 4.41 | |

**Pharmacological profile and health benefits of *Moringa oleifera***

*Moringa oleifera* is believed to be a miracle tree owing to its high pharmacological profile and various health benefits. Several research studies animal strains have been conducted by different researchers in order to explore the pharmacological profile of *Moringa oleifera*. It has been reported to exhibit numerous biological activities such as anti-bacterial, anti-fungal, anti-viral,

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anti-microbial, anti-oxidant, anti-inflammatory, anti-ulcer, anti-tumor, anti-diabetic, anti-atherogenic, anti-proliferative, antipyretic, antispasmodic, antinociceptive, hepatoprotective, hypocholesterolemic and immunomodulatory properties (Pari and Kumar, 2002; Yang et al., 2006; Majhi, 2013; Aja et al., 2013; Varmani and Garg, 2014; Gopalakrishnan et al., 2016; Ajantha et al., 2018; Singh et al., 2019). Therefore, *Moringa oleifera* possess various health benefits owing to its pharmacological profile. It protects against cancer, cerebral ischemia, neurological disorders, renal dysfunction, gastric ulcers, HIV-AIDS, diabetes, cardiovascular diseases, rheumatoid arthritis, microbial infections, inflammatory diseases, liver disorders, night blindness, conjunctivitis, malnutrition, micronutrient deficiencies and also helps in wound healing. A complete detail of the same along with all the key findings has been presented in Table 2.

**Table 2. Health benefits of *Moringa oleifera***

| Sr. no. | Health benefits | Key findings | References |
|---|---|---|---|
| 1 | Prevents cancer | ● *Moringa oleifera* is known to be an anti-cancer agent. | Gopalakrishnan et al., 2016 |
| | | ● It inhibits the growth of cancer cells due to the presence of certain compounds such as glucosinolates, niazimicin, benzyl isothiocyanate which cause intracellular ROS (reactive oxygen species) leading to apoptosis. | Nakamura et al., 2002; Miyoshi et al., 2004; Dhakar et al., 2011; Gopalakrishnan et al., 2016; |
| | | ● Bioactive compounds like niazimicin exhibit cytotoxic effects against cancerous cells and hence possess anti-cancer property. | Parvathy et al., 2007; Varmani and Garg, 2014; Razis et al., 2014 |
| | | ● Ingestion of *Moringa* seed pod extract has been reported to prevent skin cancer also. | Razis et al., 2014 |

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| 2 | Neuroprotective | ● *Moringa oleifera* reduces the ROS, thereby preventing reperfusion, lipid peroxidation and hence prevents cerebral ischemia. | Gopalakrishnan et al., 2016 |
| | | ● It promotes spatial memory. | |
| | | ● The extract of *Moringa* leaves improve cholinergic function by decreasing acetylcholine esterase activity. | |
| | | ● *Moringa oleifera* can be effectively used for the treatment of migraine. | Upadhye et al., 2012; Varmani and Garg, 2014 |
| | | ● The aqueous extract of *Moringa oleifera* has been reported to improve the imbalance between neurotransmitters in the brain. | Varmani and Garg, 2014 |
| | | ● It helps to prevent oxidative damage, brain damage and also improves locomotor behavior. | Ray et al., 2003; Varmani and Garg, 2014; Razis et al., 2014 |
| 3 | Prevents renal dysfunction | ● *Moringa oleifer*a helps in decreasing urea and creatinine levels in the blood. | Gopalakrishnan et al., 2016 |
| | | ● The aqueous and alcoholic extracts of root bark of *Moringa oleifera* has been reported to show antiurolithiatic activity. | Varmani and Garg, 2014 |
| | | ● *Moringa* extract helps in lowering down urinary excretion as well as prevents the retention of calcium, oxalate and | Varmani and Garg, 2014 |

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| | | phosphate in the body. | |
| 4 | Prevents ulcer | ● It helps to decrease gastric acidity and hence used as antiulcer agent. | Gopalakrishnan et al., 2016 |
| | | ● *Moringa oleifera* can be used to treat gastrointestinal mobility disorder. | Varmani and Garg, 2014 |
| | | ● It helps in healing chronic gastric lesions. | Varmani and Garg, 2014 |
| 5 | Immunoprotective | ● *Moringa oleifera* helps to boost immune system in case of HIV infected individuals. | Sudha et al., 2010; Varmani and Garg, 2014; Gopalakrishnan et al., 2016 |
| | | ● It helps to increase peripheral and splenocyte T-cell proliferations and hence enhance immune function. | Yang et al., 2006 |
| 6 | Prevents diabetes | ● Research studies revealed that the aqueous extract of *Moringa oleifera* has the potential to cure Type 1 and Type 2 diabetes. | Dhakar et al., 2011; Gopalakrishnan et al., 2016 |
| | | ● Another study revealed that *Moringa* seed powder causes a drop in fasting blood glucose level. | Gopalakrishnan et al., 2016 |
| | | ● It has been reported that terpenoids present in *Moringa oleifera* are involved in stimulating β-cells which helps to | Razis et al., 2014 |

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| | | secrete preformed insulin. | |
| 7 | Prevents cardiovascular diseases | ● *Moringa* is believed to be an anti-atherosclerotic agent owing to its high antioxidant properties. | Varmani and Garg, 2014; Gopalakrishnan et al., 2016; Singh et al., 2019 |
| | | ● *Moringa* flowers possess hypocholesterolemic effect. | Gopalakrishnan et al., 2016 |
| | | ● It helps to reduce blood triglyceride levels. | Yang et al., 2006; Varmani and Garg, 2014 |
| | | ● It stimulates cardiac function by affecting sympathetic nervous system. | Varmani and Garg, 2014 |
| | | ● It prevents hyperlipidemia. | Varmani and Garg, 2014 |
| | | ● It helps to reduce raised blood pressure owing to the presence of bioactive compounds like nitriles, glycosides, sitosterol etc. | Varmani and Garg, 2014 |
| 8 | Prevents arthritis | ● Studies have found that the hydro-alcoholic extract of *Moringa* flowers have the potential to reduce rheumatoid factors like TNF-alpha and IL-1. | Gopalakrishnan et al., 2016 |

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| | | ● Methanolic extract of *Moringa oleifera* has been found to be effective for treating rheumatoid arthritis. | Kumar et al., 2013; Varmani and Garg, 2014; Dhakar et al., 2019 |
| 9 | Prevents bacterial, viral, fungal and other microbial diseases | ● *Moringa* possess antimicrobial, antiviral and anti-bacterial properties against *Bacillus subtilis, Staphylococcus aureus, Vibrio cholera, E coli, Salmonella, P aeruginosa* due to the presence of moringine, pterygospermin and benzyl isothiocyanate which accounts for its effect against these bacteria. | Viera et al., 2010; Aja et al., 2013; Razi et al., 2014; Gopalakrishnan et al., 2016; Ajantha et al., 2018 |
| | | ● It inhibits bacterial growth and hence prevents water borne illnesses and therefore, enhances the quality of life. | Razi et al., 2014; Gopalakrishnan et al., 2016 |
| | | ● *Moringa oleifera* exhibit antifungal activity against *Basidiobolus haptosporus and Basidiobolus ranarums*. | Varmani and Garg, 2014 |
| 10 | Prevents inflammation | ● *Moringa* possess anti-inflammatory properties and helps to relieve glandular swellings. | Dubey et al., 2013; Varmani and Garg, 2014 |
| | | ● *Moringa oleifera* pods improve the pathogenesis of certain chronic diseases associated with inflammation due to the presence of bioactive compounds. | Dhakar et al., 2011; Muangnoi et al., 2012; Varmani and Garg, 2014; Razis et al., 2014 |
| 11 | Prevents asthma | ● *Moringa oleifera* helps to treat bronchial asthma and also improves respiratory | Agrawal and Mehta, 2008; Dhakar et al., |

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| | | functions. | 2011; Varmani and Garg, 2014; |
| 12 | Hepatoprotective | ● The seed extracts of *Moringa oleifera* have significant effect on hepatic carcinogen metabolizing enzymes. | Bharali et al., 2003; Varmani and Garg, 2014 |
| | | ● *Moringa oleifera* has a significant effect on the activity of hepatic enzymes, bilirubin levels, lipids and lipid peroxidation levels. | Pari and Kumar, 2002; Varmani and Garg, 2014 |
| | | ● It helps to reduce liver fibrosis as per the immunohistochemical studies. | Hamza, 2010; Varmani and Garg, 2014; Razis et al., 2014 |
| 13 | Prevents eye diseases | ● The consumption of leaves of *Moringa oleifera* helps to prevent night blindness, conjunctivitis, cataract and other eye problems as the leaves are a rich source of vitamin A. | Pullakhandam and Failla, 2007; Varmani and Garg, 2014 |
| | | ● It is also useful to prevent retinal dysfunction induced by diabetes. | Kumar et al., 2013; Varmani and Garg, 2014 |
| 14 | Helps in wound healing | ● Its wound healing properties are significant due to the presence of phytosterols as well as phenolics compounds. | Hukkeri et al., 2006; Varmani and Garg, 2014 |
| 15 | Prevents malnutrition | ● *Moringa oleifera* is a rich source of crude protein and amino acids and hence helps to overcome protein deficiency. | Dhakar et al., 2011 |

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| | | ● It also helps to prevent diseases associated with micronutrient deficiencies, being a rich source of various phytonutrients. | Dhakar et al., 2011 |
| 16 | Miscellaneous | ● It has also been reported to cure multiple health problems like cough, anxiety, hysteria, anemia, flu, black heads, cholera, diarrhea, sore throat, pneumonia, tuberculosis, back pain, syphilis, scurvy, angina, fever, thyroid and semen deficiency. | Dhakar et al., 2011; Mishra et al., 2012; Singh et al., 2019 |
| | | ● *Moringa oleifera* promotes milk production in lactating mothers and preserve the mother's health. | Dhakar et al., 2011 |

**Traditional utilization of *Moringa oleifera***

It is well known that mother nature has provided us with the cure of almost all ailments, however there is a need to explore the same. Since ancient times, humans use plants and their various parts for curing of various ailments in one form or the other such as decoction, laxative, etc. *Moringa oleifera* is one among those plants, every part of which has its own medicinal uses. Different countries claims to have different effect of *M.oleifera* such in India, it is used for anaemia, asthma, bronchitis, chest congestion, diarrhoea, cough, blood pressure, pain in joints, scurvy, etc., in Malaysia, it is used for intestinal worms, in Philippines, it is used for lactation, glandular swelling, anaemia, in Venezuela, it is used for gonorrhoea, jaundice, dropsy, dysentery, etc., whereas it is commonly used for malaria, tumours, wounds, urinary disorders, stomach ulcers in many countries (Bey, 2010; Alhakmani et al., 2013). Some of the traditional uses of different parts of *Moringa oleifera* are listed in table 3.

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**Table 3. Traditional uses of different parts of *Moringa oleifera***

| Sr. No. | Plant part | Traditional use | References |
|---|---|---|---|
| 1. | Leaves | ● Leaves of *M.oleifera* possess various properties because of which it is given in bacterial or normal infections.<br>● It is effective during toothache or dental caries.<br>● It is effective against urinary tract infection.<br>● It is antiviral and is effective against Helminths, Herpes Simplex virus, Epstein Barr virus and HIV-AIDS.<br>● It is also effective against Bronchitis, Hepatic, ulcers or external sores.<br>● Leaves of *M. oleifera* possess anti-cancerous properties against prostate cancer.<br>● Leaves of *M.oleifera* possess anti-anaemic properties. It is anti-hypertensive and can be given in diabetic condition (hypoglycemic condition), thyroid infection, hepatorenal condition.<br>● It is given as lactation enhancer and during headache. | Kalogo et al., 2000; Kar et al., 2003; Babu and Chaudhuri, 2005; Anwar et al., 2007; Bey, 2010; Dhakar et al., 2011; Peixoto et al., 2011; Tende et al., 2011; Verma et al., 2012; Arora et al., 2013, Alhakmani et al., 2013; Kesharwani et al., 2014 |

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| 2. | Flowers | • Flowers of *M.oleifera* are employed in case of bacterial and normal infection.<br>• These are also anti-microbial, anti-tumour, anti-inflammatory in nature.<br>• Flowers are used as a diuretic.<br>• Flowers are effective against viral fever (common cold), helminths, ulcers, throat infection, rheumatism, hysteria, headache, catarrh, nervous disorders, etc.<br>• Flowers are known to possess good effect on reproductive health. | Guevara et al., 1999; Kalogo et al., 2000; Anwar et al., 2007; Williams et al., 2008; Bey, 2010; Arora et al., 2013; Verma et al., 2012; Alhakmani et al., 2013; Kesharwani et al., 2014; Dafaalla et al., 2016 |
| 3. | Seeds | • Seeds of *M.oleifera* possess antimicrobial, antibacterial activity, anti-viral (Warts, Schistosomes), anti-tumour, antispasmodic, antipyretic activity.<br>• It is effective against common fever.<br>• Seeds are used in case of digestive disorders such as gastritis, ulcers, inflammation, arthritis, rheumatism.<br>• Seeds are useful for persons suffering from scurvy, iron deficiency, various skin disorders, bladder infection, etc.<br>• Oil from seeds is effective against mycoses, dermal infection, scurvy. | Guevara et al., 1999; Kalogo et al., 2000; Bennett et al., 2003; Fahey, 2005; Anwar et al., 2007; Verma et al., 2009; Bey, 2010; Mbikay, 2012; Alhakmani et al., 2013; Kesharwani et al., 2014 |

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| | | • Seed oil is used as purgative and is rich in antioxidants. | |
| 4. | Roots | • Roots possess antimicrobial, antispasmodic activity.<br>• Effective in case of toothache or dental caries, common cold, ulcers or external sores, fever, Asthma, kidney failure.<br>• Roots are used as a diuretic.<br>• Used in case of digestive disorder, flatulence, inflammation, rheumatism, edema, epilepsy, hysteria, headache, splenomegaly.<br>• Roots are considered good for reproductive health. | Bennett et al., 2003; Fahey, 2005; Anwar et al., 2007; Bey, 2010; Mbikay, 2012; Alhakmani et al., 2013; Arora et al., 2013; Kesharwani et al., 2014; Dafaalla et al., 2016 |

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| 5. | Bark | • Bark of *Moringa oleifera* possess antimicrobial activity, anti-tumour activity.<br>• Effective in case of toothache or dental caries, common cold.<br>• Bark is deployed in case of common fever, ulcers, scurvy, snake bite or scorpion bite.<br>• It helps in detoxification of body.<br>• Bark is used to cure digestive disorders, nervous disorders, epilepsy, hysteria, headache, etc. | Guevara et al., 1999; Anwar et al., 2007; Bey, 2010; Arora et al., 2013; Verma et al., 2012; Alhakmani et al., 2013; Kesharwani et al., 2014 |
| 6. | Gum | • Gum obtained from *Moringa oleifera* possess anti-microbial activity.<br>• Effective in case of earache, toothache or dental caries, syphilis, typhoid, asthma.<br>• Gum is used as diuretic.<br>• Used in case of digestive disorder, dysentery, inflammation, rheumatism, headache, skin and nervous disorders. | Bennett et al., 2003; Fahey, 2005; Anwar et al., 2007; Bey, 2010; Mbikay, 2012; Alhakmani et al., 2013; Arora et al., 2013; Kesharwani et al., 2014 |

**Water purification**

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Studies have revealed that Moringa oleifera can be utilized for the purification of water as the waste husk of the tree can be used to prepare activated carbon of very fine quality (Pollard et al., 1995; Kumar, 2017).

**Biodiesel production**

Biodiesel is an alternative fuel produced for the sake of combating the severe shortage of fossil fuels. It is produced from renewable sources including animal fats, vegetable oils and agricultural waste products in the presence of either a homogenous or heterogenous catalyst (Gnanaprakasam et al., 2013; Esmaeili et al., 2019). *Moringa oleifera* being an indigenous, easily available and inexpensive resources, is quite ideal for biodiesel production. Nawi (2015) and Esmaeili et al. (2019) produced biodiesel from *Moringa oleifera* seeds using MgO (magnesium oxide) as a nanocatalyst by employing transesterification method. Another researcher, Yahya (2013) produced biodiesel by using *Moringa oleifera* seeds oil through transesterification process and utilizing CaO (calcium oxide) and $Fe_2(SO_4)_3$ (ferric sulphate) as a catalyst. This is an effective way of utilizing agricultural sources as an alternative fuel in order to save energy and fossil fuels for future use (Yahya, 2013).

**Conclusion**

*Moringa oleifera* aids in the treatment of various diseases since ancient times. Each and every part (seed, flower, roots, bark, stem, leaves) of *Moringa* possess numerous pharmacological properties and health benefits such as anti-inflammatory, analgesic, anti-diarrhoeal, anti-cancerous, etc. It is an additional inexpensive plant that provides wide range of medicinal and therapeutic uses. Various studies show that the plant is an excellent source of micro as well as macronutrients and is itself capable of combating with nutritional deficiency prevailing all around the world. However, further studies are needed while some are still in progress that may help in development of incredible pharmacological products and nutritional supplements for welfare of mankind.

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