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The Miracle Tree in Focus: A Critical Review on the Uses and Benefits of *Moringa oleifera*

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ABSTRACT

Moringa oleifera Lam., native to the Indian subcontinent, is widely cultivated worldwidedue to itsecological, economic and cultural significance. Their roles in traditional medicine, adaptability to diverse climatic conditions and commercial purposes have garnered significant attention, backed by its mention in Ayurvedic texts. This reviewconsolidates available literature on thephytochemistry of bioactive compounds and their incorporation in numerous pharmacological activities exhibited by the plant. It is endowed with important phytochemicals such as flavonoids, phenolic acids, glycosides, glucosinolates and alkaloids,concentrated in thewhole plant, including leaves, fruits, flowers, seeds, roots and pods. A plethora of pharmacological activities, includinganti-inflammatory, antioxidant, antimicrobial, antihypertensive, antitumor, analgesic, anticancer, antidiabetic and antidiuretic activities, are exhibited by *Moringa oleifera*. This study also investigates the utilisation of *Moringa oleifera*in other non-medical fields such as water purification, biostimulant,and biofuel production.*Moringa oleifera*is therefore considered a huge ethano-botanical entity and needs to be extensively introduced into nutraceutical supplements.

Key words: Anti-inflammatory, Antioxidant, *Moringa oleifera*, Nutraceuticals, Pharmacological attributes, Phytoconstituents.

Moringa oleifera, a tropical tree native to the lower Himalayanrange, has now propagated across the tropical regions in Africa, Asia and South America (Dubey *et al*., 2013). This is a tree of small to medium size, usually reaching a height of 5 to 10 meters which belongs to the Brassicales order.This tree flourishes best in a tropical, insular climate and is often plentiful near the sandy river and stream beds (Garg, 1949). It spreads in humid tropical regions or arid areas, can withstand barren soils and demonstrates resilience to drought. The plant can withstand a broad spectrum of rainfall amounts, ranging from 250 mm to over 3000 mm. Due to its diverse properties, it has acquired the name “miracle tree.” *Moringa oleifera*was awarded the title “Botanical of the Year 2007” by the National Institutes of Health (Gupta *et al*., 2011). It has numerous traditional purposes throughout its regional distribution and culinary practices vary according to traditions and taste preferences.

It is referred to as various vernacular names such as horseradish tree, drumstick tree, kelor, sohajana, *etc* throughout the world and is conventionally used in traditional medicine across different cultures. The plant parts, such as leaves, fruits, flowers, immature pods and others, contain a significant amount of bioactive compounds, which result in many pharmacological properties as well as the high nutritive value. These factors corroborate to the medical benefits of *Moringa oleifera,* which strengthens its role in the herbal nutraceutical market such as vegan food, healthy snacks and plant based supplements (Singh *et al*., 2024). The exponential growth in new patents necessitates an updated assessment. This review aims to provide evidence for all the health promoting characteristic shown by various parts of the Moringa plant, by systematically assessing the previous knowledge and the recent research, while identifying existing research gaps to guide future enhancements.

To ensure a thorough review, a systematic literature search was conducted across diverse electronic databases, including Google Scholar, Scopus, Web of Science, Wiley and PubMed. Relevant key terms and combinations, such as antioxidant properties, anticancer, nutrition, bioactive compounds, pharmacology, etc were used to search extensively. Inclusion criteria included studies focused on the nutritional properties, phytochemistry and applications of *Moringa oleifera*in the medicinal and food industry. Exclusion criteria comprised of articles that were non-English, not peer reviewed, not directly confines in the domain of this review and lacking the primary health-related data. Citations were managed and duplicates removed using Zotero software to ensure consistent formatting.

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Nutritional value

The seeds, pods, flowers and leaves of *Moringa oleifera* are dense in bioactive compounds and nutrient-dense, thus favouringthe use of all the plant parts (Ravani *et al*., 2017). It has high concentrations of vitamins, protein, minerals, various phytoconstituents,amino acids, *i.e.,* tryptophan, methionine, cysteine andlysine, thereby making itnutritionally adequate for human consumption (Anwar *et al*., 2007; Rani and Arumugam, 2017). In the form of β-carotene, Vitamin A is found at levels four times that of carrots and thirteen times that of spinach (Gopalakrishnan *et al*., 2016). It has higher levels of the Vitamin B complex (B1, B2, B3, B6 and B12) and Vitamin C than those found in pork meat and oranges, respectively (Su and Chen, 2020). The levels of calcium, magnesium and iron surpass those found in conventional sources, with calcium being four times that of milk, magnesium 36 times that of an egg and iron 25 times that of spinach.The potassium levels are 63 times greater than in milk and 3 times higher than banana (Aregheore, 2012). The seeds are energy-dense due to a high amount of fat content at 44.78 mg per 100 g of fresh weight. This nutritionally potent super food is an excellent source to control malnutrition and ensure adequatenutrition (Prakash *et al*., 2012). Table 1 enumerates the nutritional composition of *Moringa oleifera* (per 100 g fresh weight).

Phytochemistry

Phenolic compounds

Polyphenols, a primary class of phytochemicals, are structurally defined by single (phenolic acids) or multiple phenolic rings (flavonoids). Polyphenols, a class of secondary metabolites comprising polyhydroxy phytochemicals in plants, serve as critical defences against pathogenic threats and ultraviolet radiation (Beckman, 2000). To date, over 8,000 polyphenolic compounds have been isolated, structurally characterised and documented, reflecting their vast diversity and functional significance in plant biology (Arts and Hollman, 2005; Scalbert *et al*., 2005). The Folin-Ciocalteu assay, widely employed to determine total phenolic content (TPC), reveals that leaves contain a high concentration range of 2,000 to 12,200 mg gallic acid equivalents (GAE)/100 g (Leone *et al*., 2015). The seed and flowers demonstrated markedly lower levels of Total Phenolic Content (TPC) (Alhakmani *et al*., 2013). Key phenolic acids include gallic (Singh *et al*., 2009), caffeic (Bajpai *et al*., 2005), chlorogenic (Leone *et al*., 2015), coumaric and ellagic acids (Leone *et al*., 2015).

Glycosides/glucosinolates

In most tissues,excluding roots and seeds, the predominant identified flavonoids are Kaempfero land Quercetin glycosides (glucosides, rutinosides, malonyl glucosides) (Saini *et al*., 2016). The Quercetin and Kaempferol concentrations in leaves range from 0.46-16.64 mg/g and 0.16-3.92 mg/g dry weight, respectively (Amaglo *et al*., 2010a; Bennett *et al*., 2003; Siddhuraju and Becker, 2003). The presence of minor flavonols, such as myricetin (Sultana *et al*., 2009), rutin (Bajpai *et al*., 2005) and epicatechin (Ma *et al*., 2020) is also observed. Geographical disparities are documented for flavonoid profiles, reflecting cultivar-specific adaptations (Coppin *et al*., 2013). Niazimicin, a thiocarbamate glycoside, was found as a major bioactive component in both neuroprotective activity and antitumor activity, along with Niaziminin, a thiocarbamate isolated from leaves (Abdelsayed *et al*., 2021).

Glucosinolates are a group of secondary metabolites derived from glucose and amino acids that contain nitrogen and sulfur. The most prevalentglucosinolateis identified as 4-(α-L-rhamnopyranosyloxy) benzyl glucosinolate, commonly known as glucomoringin. Glucomoringin is primarily concentrated in seeds (up to 8,620 mg/100 g), followed by leaves (78 mg/100 g), stems, flowers and pods (Amaglo *et al*., 2010b; Maldini *et al*., 2014). Benzyl glucosinolate, also known as glucotropaeolin, a distinct structural variant, is primarily contained in the roots. Geographical disparities significantly influence glucosinolate profiles, with concentrations varying across cultivars and various areas (Bennett *et al*., 2003). Myrosinase-induced enzymatic hydrolysis of glucosinolates yields bioactive metabolites, including isothiocyanates, nitriles, thiocarbamates and glucose, all of which contribute to Moringa's biochemical and pharmacological properties (Waterman *et al*., 2014). Three derivatives of thiocarbamate (TC) and isothiocyanate (ITC) exhibited antitumor activity prominently,4-[(4′-O-acetyl-α-irhamnosyloxy) benzyl],a naturally occurring isothiocyanate, implying that the isothiocyanate group is a crucial structural factor for activity (Jiwajinda, 1998).

Carotenoids

Carotenoids, a class of phytochemicals responsible for imparting vibrant red, yellow, or orange pigmentation to vegetables and fruits, are abundant in *Moringa oleifera*. Fresh leaves exhibit exceptionally high β-carotene (provitamin A) concentrations (6.6-17.4 mg/100 g), exceeding levels seenincarrots, apricots and pumpkins (Kidmose *et al*., 2006). Dried leaves demonstrate even greater β-carotene content, ranging from 23.31 to 39.6 mg/

Table 1: Nutritional composition of *Moringa oleifera*.

Nutrient	Amount (mg/100 g)	Reference
Calcium	200 mg	(Azlan *et al*., 2022)
Iron	3.7 mg	
Magnesium	147 mg	
Phosphorus	112 mg	
Potassium	337 mg	
Vitamin C	220 mg	(Mali *et al*., 2022)
Vitamin E	2.72 mg	
Vitamin B1	0.257 mg	
Vitamin B2	0.66 mg	
Vitamin B3	2.22 mg	

100 g of dry weight (Glover-Amengor *et al*., 2017; Joshi and Mehta, 2010). Beyond β-carotene, studies of Indian commercial cultivars identify diverse carotenoids in foliage, flowers and immature pods (Saini *et al*., 2016). All-E-lutein dominates these tissues, constituting over 50% of total carotenoid content, while minor constituents include all-E-luteoxanthin, 13-Z-lutein, all-E-zeaxanthin and 15-Z-β-carotene, detected at lower concentrations.

Alkaloids

Alkaloids, nitrogen-containing organic compounds biosynthesised through amino acid metabolic pathways, are relatively rare in *Moringa oleifera*. However, studies confirm the presence of specific alkaloids, with the indole alkaloid N,α-L-rhamnopyranosylvincosamide being the most frequently extracted from leaves (Cheraghi *et al*., 2017; Panda *et al*., 2013). Leaves show the presence of unique pyrrole alkaloid glycosides, including pyrrolemarumine 4″ -O-α-L-rhamnopyranoside (marumoside A) and 4′-hydroxyphenylethanamide (marumoside B), having distinctive structural configurations (Sahakitpichan *et al*., 2011). Table 2 represents the phytochemicals and their activities and Fig 1 shows the structure of the phytochemicals mentioned.

Table 2: Phytochemicals and their activities shown in *Moringa oleifera.*

Phytochemical	Type	Activities shown	References
Phenols	Chlorogenicacid	Antidiabetic	(Leone *et al*., 2015)
	Ellagic acid	Antioxidant	
	Gallic acid		
	Vanillin		(Singh *et al*., 2009)
Alkaloids	Niazirin	Antidiabetic	(Bao *et al*., 2020)
	Moringinine	Hepatoprotective	(Ali *et al*., 2016)
Glycosides	Quercetin	Antioxidant	(Saini *et al*., 2016)
	Kaempferol		
	Niazimicin	Anticancer	(Abdelsayed *et al*., 2021)
	Rutin	Antioxidant	
Carotenoids	β-carotene	Antioxidant	(Ma *et al*., 2020)
Glucosinolates	Glucomoringin	Anti-inflammatory	(Amaglo *et al*., 2010b)
	4-[(4′-O-acetyl-α-L-rhamnosyloxy)benzyl] isothiocyanate	Anticonvulsant Antioxidant	
	Benzyl isothiocyanate	Anti-inflammatory	(Borgonovo *et al*., 2020)
	Moringine		

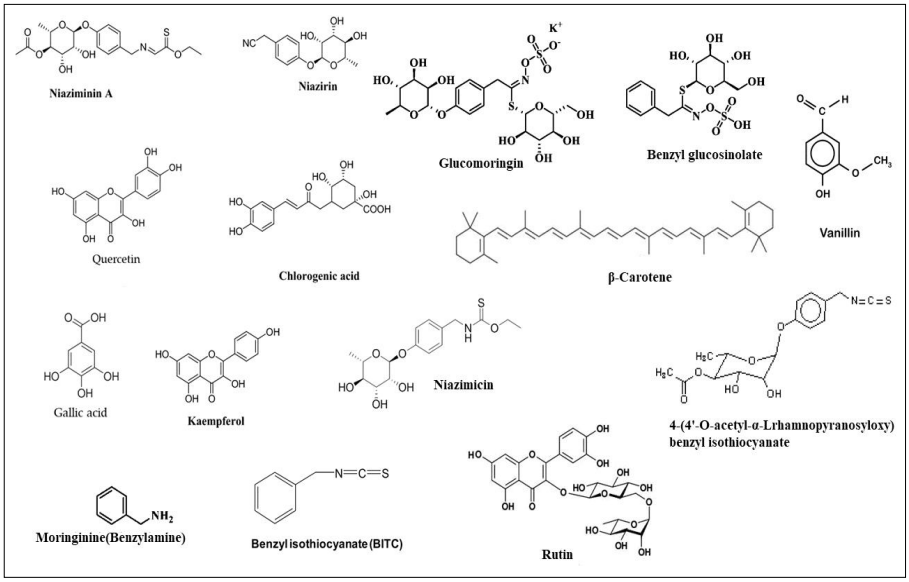

Fig 1: Structures of selected bioactive compoundsfrom *Moringa oleifera.*

Pharmacological attributes

Antioxidant and antiperoxidative

The antioxidant potential of *Moringa oleifera*is primarily attributed to the scavenging property of free radicals induced from radiation by antioxidants, such asphenolic compounds, ascorbic acid oxidase and vitamins A, C and E, as well as polyphenol oxidase, catalase, glycosidic glucosinolates, Isothiocyanates (ITCs), carbamates, nitriles and thiocarbamates (Fayazuddin and Kumar, 2013; Yang *et al*., 2006). Both the leaves and root extracts reportedantioxidant activity and radical scavenging activity (Singh *et al*., 2009; Sultana *et al*., 2009; Verma *et al*., 2009). This was supported by the prevention of oxidative damage exhibited by both young and mature leaves (Sreelatha and Padma, 2009) and adecreaseinthe OH-dependent damage byaqueous extracts of leaf, fruit and leaves (Singh *et al*., 2009). This aligns with the notable decrease in the level of hepatic marker enzymes and lipid peroxidation with an increase in the level of antioxidants (Ashok and Pari, 2003). Leaf extract demonstrated prevention of radiation-induced augmentation in hepatic lipid peroxidation and recovery of Glutathione in the liver (Sinha *et al*., 2012).

Antiasthmatic activity

Seed kernelsexhibitedanti- asthmatic activity through bronchodilator, mast cell stabilisation, showing efficacy comparable to the standard drug ketotifen (Mehta and Agrawal, 2008). The alcoholic extract of leaves suppressed the release of inflammatory mediators, including histamine and β-hexosaminidase, inhibited Mast cell degranulation and stabilised eosinophil count at varying levels compared to ketotifen fumarate (Abd Rani *et al*., 2019; Suresh *et al*., 2020; Palupi *et al*., 2021). Primary asthmatic symptoms showed a decrease alongside anotable increase in lung volumes and lung flow rates,thus validating the antiasthmatic activity.

Anti-inflammatory activity

Ethyl acetate fraction demonstrated potential anti-inflammatory activity by inhibiting the NF-κB signalling pathway activation, migration into the nucleus and the generation of various inflammatory proteins (Arulselvan *et al*., 2016). Aqueous extracts performed comparably to the anti-inflammatory drug, indomethacin, inhibiting carrageenan-induced oedema in rats (Ndiaye *et al*., 2002). Phytoconstituents such as Moringaisothiocyanate (MIC-1), including flavonoids, 4-hydroxymellein, β-sitosterol and vanillin are credited for the anti-inflammatory efficacy (Cheng *et al*., 2019).

Anti-arthritic activity

Methanolic extractof stem bark showed a dose-dependent pattern against all the models of inflammation (Formaldehyde and Freund's adjuvant-induced) (Kumar *et al*., 2013). Ethanolic and aqueous extracts displayed significant reduction inCRP levels, arthritis score, paw thickness andpawoedemavolumecomparable with diclofenac sodium (Fatima and Fatima, 2016). The use of flower extractresulted in a collective decline of paw oedemavolume, inflammation at non-injected sites of the left hind paw, body weight, arthritic index and a reduction in the cytokines tumour necrosis factor-α and interleukin-1 andserum levels of Rheumatoid Factor (RF) (Kumar *et al*., 2013).

Diuretic activity

Dose-dependent saluretic action of alcoholic extract of leaves was observed against the hydrochlorothiazide group (Tahkur *et al*., 2016). Aqueous and alcoholicextracts of root bark considerably reduce dkidney retention levels of phosphate, oxalate andcalcium and the urinary excretion (Karadi *et al*., 2008). Likewise, the aqueous seed extract increased urine output (Cáceres *et al*., 1992).

Antimicrobial activity

Antimicrobial efficacy of seeds is ascribed to lectinsthatbind to bacterial membranes, destabilise structural integrity and suppress microbial proliferation. Phenolic compounds present in leaves demonstrate efficacy against both Gram-positive and Gram-negative pathogens. N-benzylethylthioformate, a potent antifungal and antibacterial compound,is found in the roots, whereasflavonoids and phenolic acids present in fruitsshowed inhibition against clinically relevant microbial strains. Table 3 enlists the microbes and the parts of *Moringa oleifera*which show inhibition against the microbes (Dahiya and Purkayastha, 2012; Das *et al*., 2022; Moummou *et al*., 2024; Patel and Mohan, 2018; Raubilu *et al*., 2020).

Antitumor/anticancer activity

Anticancer activity of *Moringa oleifera*has been extensively researched and supported by various studies (Costa-Lotufo *et al*., 2005; Parvathy and Umamaheshwari, 2007). Compounds such as derivatives of thiocarbamate (TC) and isothiocyanate (ITC) and sterols were associated with the antitumour activity by inhibiting activation of tumour promoter-induced Epstein-Barr virus (EBV) (Jiwajinda, 1998). A two-stage model of 7, 12-dimethylbenzanthracene-induced skin papillomagenesis in mice was used to evaluate the chemoprotective efficacy of the hydro-alcoholic extract of drumsticks (Bharali *et al*., 2003). Despite promising in vitro data, clinical studies and in vivo experimentation are limited, highlighting a critical research gap.

Antihypertensive and cardio-protective activity

Seed protein hydrolysates and peptide fractions have shown antihypertensive effects, reducing blood pressure and heart rate (Randriamboavonjy *et al*., 2016; Aderinola *et al*., 2019), while leaf extracts exhibited cardioprotective effects against isoproterenol-induced myocardial damage (Nandave *et al*., 2009). Pharmacological evaluation attributed significant hypotensive effects to two nitrile glycosides (niazirin and niazirinin) and three mustard oil

glycosides: 4-[(4′-O-acetyl-α-L-rhamnosyloxy)benzyl] isothiocyanate (compound 4), niaziminin A and niaziminin B (Faizi *et al*., 1994).

Hepatoprotective activity

Ethanolic and crude aqueous extract of leaves was evaluated on drug inducedliver damage, with the alcoholic extract showing significant activity at a lower concentration compared to the aqueous extract (Pari and Kumar, 2002; Rameshvar *et al*., 2010). This aligns with the study on paracetamol-induced liver damage which reduced elevated liver enzyme level (Ranganathan *et al*., 2020). Fig 2 demonstrates various pharmacological properties exhibited by *Moringa oleifera*.

Antipyretic and analgesic activity

The ethanolic and ethyl acetate extractswere found to showantipyretic effects in a dose-dependent pattern as compared to the standard against yeast-induced hyperpyrexia model (Hukkeri *et al*., 2006), similar to the hydro-alcoholic extract of bark (Ahmad *et al*., 2014). The methanolic extract of leaves was considered highest in antipyretic effect as compared to the bark and root extracts throughout various regions of Punjab, Pakistan (Jamil *et al*., 2024). The extracts from leaves, seeds and bark exhibited analgesic potency in a dose-dependent pattern in different pain models such as the hot plate method (centrally mediated) and the acetic acid-induced writhing method (peripherally mediated) (Abdul *et al*., 2021; Kumbhare and Sivakumar, 2011; Sachan, 2012; Sutar *et al*., 2008).

Industrial uses

Moringa oleifera seeds are identified as a prominent, viable natural coagulant against their synthetic counterparts, such as alum (Kalogo *et al*., 2000). Traditionally, crude seeds were utilised to treat highly turbid Nile water, eliminating 98-99% of indicator bacteria,as confirmed by a study (Muyibi and Evison, 1995), offering an economic and sustainable solution. Seed oilshowed potential as biodiesel production through transesterification by the usage of different catalysts

Table 3: Microbes and part of which show inhibition.

Part of plant	Target microorganisms
Seeds	*Pseudomonas aeruginosa, Staphylococcus aureus, Candida albicans ,Candida albicans, Staphylococcus aureus, Enterococcus casseliflavus, Bacillus cereus, Mucor species, Aspergillus, Vibriocholera, Bacillus cereus, Bacillus megaterium, Micrococcus species, Pseudomonas species, Pseudomonas fluorescens, Pseudomonas stutzeri, Serratia marcescens*
Leaves	*Staphylococcus aureus, Enterococcus faecalis, Escherichia coli, Pseudomonas aeruginosa, Klebsiella pneumoniae, E. coli, B. subtilis, P. putida, Helicobacter pylori, Trichophyton rubrum Plasmodium falciparum, Schistosoma mansonis*
Roots	*E. coli, Candida albicans, Bacillus megaterium, Pseudomonas fluorescens, Citrobacter freundii, Staphylococcus aureus*
Flowers	*Streptococcus mutans, Candida tropicalis*
Pods	*Burkholderia pseudomallei, Entamoeba histolytica*

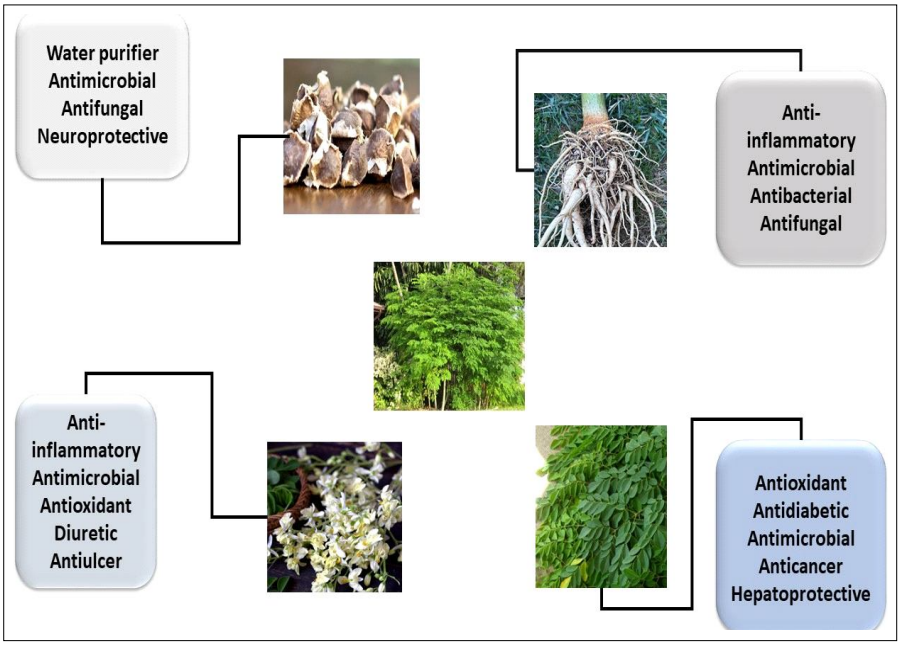

Fig 2: Pharmacological properties of parts of *Moringa oleifera.*

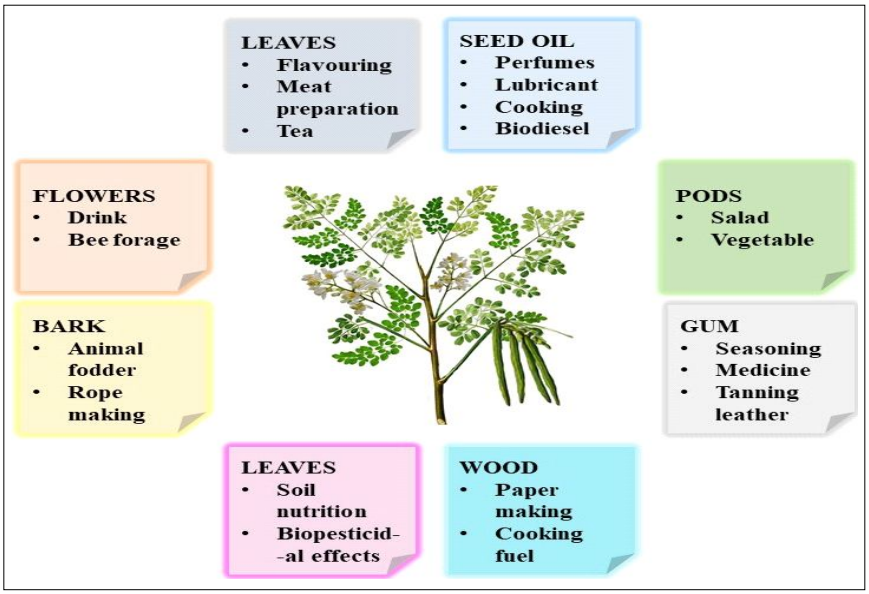

Fig 3: Other uses of *Moringa oleifera*.

Table 4: Patents based on *Moringa oleifera*.

Patent number	Year	Patent description
US 20060222682A1	2006	Nutraceutical Moringa composition
CN106606612A	2015	*Moringa oleifera*plant essence for lymphatic drainage
WO2017073473A1	2017	Moringa extract for drinks and food items
CN1052448820B	2015	Healthy composition of brown sugar and Moringa leaves
CN103976092B	2014	Preparation method of Moringa tea
CN106360698A	2014	*Moringa oleifera* solid drink

(Aqilah, 2013; Esmaeili *et al*., 2019), resultingin biodiesel exhibiting favourable properties (Haizum and Hassan, 2013). The production of rayon-grade pulp as a raw material for cellophane and textiles usage (Mahajan and Sharma, 1984) and the use of pulverised bark in ropes and mats manufacture demonstrate its industrial uses. Fig 3 illustrates other domestic uses of *Moringa oleifera*.

Patents

*Moringa oleifera*is known for itsutilisationin commercial applications, including pharmaceutical formulations, nutraceutical supplements andothersustainable products like water purifiers or cosmetics. Table 4 enlists a few patented innovations with their assigned patent number, year of approval and description.

Safety concerns and limitations

Moringa oleifera is widely consumed as commercially available foods, nutraceutical supplements and other formulations across the market. Therefore, it is essential to thoroughly study the concerns regarding its safety. Numerous toxicological studies, including in vitro and animal studies, have assessed that leaves and seeds are safe for consumption within dietary limits. However, high doses or prolonged intake might show anadverse influence on some bodily functions and metabolic pathways. A maximum ingestion of 70g of *Moringa oleifera* is considered safe to prevent cumulative toxicity of the essential elements over extended intake. Bioactive compounds such as alkaloids, glucosinolates and isothiocyanates can cause dose-dependent toxicity in some cases. Extracts prepared using organic solvents have shown higher toxicity compared to aqueous extracts, suggesting that safety outcomes are significantly influenced by extraction methods. Antifertility effects of root and bark extracts have raised concerns over their use during pregnancy. Inadequate processing or bad agricultural practices result in contamination with heavy metalsor other adulterants, poses safety risks during handling. Despite its broad therapeutic ability, dosage recommendations, standard extraction procedures and quality control measures should be taken.

Conclusion and Future Prospects

The primary aim of this review was to systematically study the pharmacological propertiesand phytochemistry of *Moringa oleifera*so as to provide a comprehensive study for multi-disciplinary research. It attempts to aggregate the majority of the recent studies and previous knowledge of

therapeutic effects, bioactive compounds, nutritional value, or commercial value found in *Moringa oleifera*.

Pre-existing research has assessed that it possesses numerous pharmacological activities, which are contributed by the phytoconstituents present in the different parts of the plant. But the need for clinical trials and strong scientific evidence regarding the mechanism of action of the proposed activities is crucial for future prospects in thecommercial sector. *Moringa oleifera* has substantial socio-economic significance throughout the globe due to its cost-effectiveness and high accessibility. It is documented to have regional and ethanobotanical regular usage traditionally across various cultures, which facilitates its introduction in theroutine diet, therefore enhancing nutrient intake. Thus shows great potential to be a ubiquitous nutraceutical supplement as the need for plant-based dietary supplements is increasing in the market. The accessible cultivation criteria, drought resistance and easy growing capability of *Moringa oleifera* should be utilised for large-scale production. It will help farmers reduce their dependency on water-demanding species, as well as provideraw material for Moringa supplements, thus generating income. Readily available products, such as dissolvable tablets, incorporation in snacks, can be a huge advantage as the market for healthy and ready-to-use goods is constantly increasing. Nevertheless, *Moringa oleifera* lives up to its name, “the miracle tree”, through the evidence provided in the review and has immense potential to influence the nutraceutical market.Further research in this field is required to integrate its availability in pharmaceutical and nutritional development.

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Conflict of interest

The authors declare that they have no conflicts of interest.

REFERENCES

Abd Rani, N.Z., Kumolosasi, E., Jasamai, M., Jamal, J.A., Lam, K.W. and Husain, K. (2019). *In vitro* anti-allergic activity of *Moringa oleifera* Lam. extracts and their isolated compounds. *BMC Complementary and Alternative Medicine*. **19(1):** 361. https://doi.org/10.1186/s12906-019-2776-1.

Abdelsayed, E.M., Medhat, D., Mandour, Y.M., Hanafi, R.S. and Motaal, A.A. (2021). Niazimicin: A thiocarbamate glycoside from *Moringa oleifera* Lam. seeds with a novel neuroprotective activity. *Journal of Food Biochemistry*. **45(12):** e13992. https://doi.org/10.1111/jfbc.13992.

Abdul, H.M., Sarkhil, M.Z., Fayazuddin, M. and Ahmad, F. (2021). Peripheral analgesic activity of *Moringa oleifera* seeds-an experimental study. *Asian Journal of Pharmacy and Pharmacology*. **7(5):** 200-203. https://doi.org/10.31024/ajpp.2021.7.5.1.

Ahmad, S., Shah, S.M.A., Alam, M.K., Usmanghani, K., Azhar, I.N. and Akram, M. (2014). Antipyretic activity of hydro-alcoholic extracts of *Moringa oleifera* in rabbits. *Pakistan Journal of Pharmaceutical Sciences*. **27(4):** 931-934.

Alhakmani, F., Kumar, S. and Khan, S.A. (2013). Estimation of total phenolic content, *in vitro* antioxidant and anti-inflammatory activity of flowers of *Moringa oleifera*. *Asian Pacific Journal of Tropical Biomedicine*. **3(8):** 623-627.

Ali, F., Hassan, N. and Abdrabou, R. (2016). Hepatoprotective and antiproliferative activity of moringinine, chlorogenic acid and quercetin. *International Journal of Research in Medical Sciences*. **4(4):** 1147-1153. https://doi.org/10.18203/2320-6012.ijrms20160799.

Amaglo, N.K., Bennett, R.N., Lo Curto, R.B., Rosa, E.A.S., Lo Turco, V., Giuffrida, A., Curto, A.L., Crea, F. and Timpo, G.M. (2010a). Profiling selected phytochemicals and nutrients in different tissues of the multipurpose tree *Moringa oleifera* Lam., grown in Ghana. *Food Chemistry*. **122(4):** 1047-1054. https://doi.org/10.1016/j.foodchem.2010.03.073.

Anwar, F., Latif, S., Ashraf, M. and Gilani, A.H. (2007). *Moringa oleifera*: A food plant with multiple medicinal uses. *Phytotherapy Research*. **21(1):** 17-25. https://doi.org/10.1002/ptr.2023.

Aqilah, Y. (2013). Biodiesel production from *Moringa oleifera* seeds using heterogeneous acid and alkali catalyst (Master’s thesis). Universiti Malaysia Pahang.

Aregheore, E. (2012). Nutritive value and inherent Anti-nutritive factors in four indigenous edible leafy vegetables in human nutrition in Nigeria: A review. *Journal of Food Resource Science*. **1(1):** 1-14. https://doi.org/10.3923/jfrs.2012.1.14.

Arts, I.C. and Hollman, P.C. (2005). Polyphenols and disease risk in epidemiologic studies 2, 3. *The American Journal of Clinical Nutrition*. **81(1):** 317S-325S.https://doi.org/10.1093/ajcn/81.1.317S.

Arulselvan, P., Tan, W.S., Gothai, S., Muniandy, K., Fakurazi, S., Esa, N.M., Alarfaj, A.A. and Kumar, S.S. (2016). Anti-inflammatory potential of ethyl acetate fraction of *Moringa oleifera* in downregulating the NF-κB signaling pathway in Lipopolysaccharide-stimulated macrophages. *Molecules*. **21(11):** 1452. https://doi.org/10.3390/molecules21111452.

Ashok, K.N. and Pari, L. (2003). Antioxidant action of *Moringa oleifera* Lam. (Drumstick) against antitubercular drugs induced Lipid Peroxidation in rats. *Journal of Medicinal Food*. **6(3):** 255-259. https://doi.org/10.1089/109662003360716670.

Azlan, U.K., Mediani, A., Rohani, E.R., Tong, X., Han, R., Misnan, N.M., Jam, F.A., Bunawan, H., Sarian, M.N. and Hamezah, H.S. (2022). A comprehensive review with updated future perspectives on the ethnomedicinal and pharmacological aspects of *Moringa oleifera*. *Molecules*. **27(18):** 18. https://doi.org/10.3390/molecules27185765.

Bajpai, M., Pande, A., Tewari, S.K. and Prakash, D. (2005). Phenolic contents and antioxidant activity of some food and medicinal plants. *International Journal of Food Sciences and Nutrition*. **56(4):** 287-291. https://doi.org/10.1080/09637480500146606.

Bao, Y., Xiao, J., Weng, Z., Lu, X., Shen, X. and Wang, F. (2020). A phenolic glycoside from *Moringa oleifera* Lam. improves the carbohydrate and lipid metabolisms through AMPK in *db/db* mice. *Food Chemistry*. **311:** 125948. https://doi.org/10.1016/j.foodchem.2019.125948.

Beckman, C.H. (2000). Phenolic-storing cells: Keys to programmed cell death and periderm formation in wilt disease resistance and in general defence responses in plants. *Physiological and Molecular Plant Pathology*. **57(3):** 101-110. https://doi.org/10.1006/pmpp.2000.0287.

Bennett, R.N., Mellon, F.A., Foidl, N., Pratt, J.H., Dupont, M.S., Perkins, L. and Kroon, P.A. (2003). Profiling glucosinolates and phenolics in vegetative and reproductive tissues of the multi-purpose trees *Moringa oleifera* L. (horseradish tree) and *Moringa stenopetala* L. *Journal of Agricultural and Food Chemistry*. **51(12):** 3546-3553.https://doi.org/10.1021/jf0211480.

Bharali, R., Tabassum, J. and Azad, M.R.H. (2003). Chemomodulatory effect of *Moringa oleifera*, Lam, on hepatic carcinogen metabolising enzymes, antioxidant parameters and skin papillomagenesis in mice. *Asian Pacific Journal of Cancer Prevention: APJCP*. **4(2):** 131-139.

Borgonovo, G., De Petrocellis, L., Schiano Moriello, A., Bertoli, S., Leone, A., Battezzati, A., Mazzini, S., and Bassoli, A. (2020). Moringin, a stable isothiocyanate from *Moringa oleifera*, activates the somatosensory and pain receptor TRPA1 channel *in vitro*. *Molecules*. **25(4):** 976. https://doi.org/10.3390/molecules25040976.

Cáceres, A., Saravia, A., Rizzo, S., Zabala, L., De Leon, E. and Nave, F. (1992). Pharmacologic properties of *Moringa oleifera*: Screening for antispasmodic, antiinflammatory and diuretic activity. *Journal of Ethnopharmacology*. **36(3):** 233-237. https://doi.org/10.1016/0378-8741(92)90049-w.

Cheng D., Gao L., Su S., Sargsyan D., Wu, R., Raskin I. and Kong A.N. (2019). Moringa isothiocyanate activates Nrf2: Potential role in diabetic nephropathy. *The AAPS Journal*. **21(2):** 31. https://doi.org/10.1208/s12248-019-0301-6.

Cheraghi, M., Namdari, M., Daraee, H. and Negahdari, B. (2017). Cardioprotective effect of magnetic hydrogel nanocomposite loaded N, α-L-rhamnopyranosyl vincosamide isolated from *Moringa oleifera* leaves against doxorubicin-induced cardiac toxicity in rats: *In vitro* and *in vivo* studies. *Journal of Microencapsulation*. **34(4):** 335-341. https://doi.org/10.1080/02652048.2017.1311955.

Coppin, J.P., Xu, Y., Chen, H., Pan, M.H., Ho, C.T., Juliani, R., Simon, J.E. and Wu, Q. (2013). Determination of flavonoids by LC/MS and anti-inflammatory activity in *Moringa oleifera*. *Journal of Functional Foods*. **5(4):** 1892-1899. https://doi.org/10.1016/j.jff.2013.09.010.

Costa-Lotufo, L.V., Khan, M.T.H., Ather, A., Wilke, D.V., Jimenez, P.C., Pessoa, C., de Moraes, M.E.A. and de Moraes, M.O. (2005). Studies of the anticancer potential of plants used in Bangladeshi folk medicine. *Journal of Ethnopharmacology*. **99(1):** 21-30. https://doi.org/10.1016/j.jep.2005.01.041.

Dahiya, P. and Purkayastha, S. (2012). Phytochemical screening and antimicrobial activity of some medicinal plants against multi-drug resistant bacteria from clinical isolates. *Indian Journal of Pharmaceutical Sciences*. **74(5):** 443-450. https://doi.org/10.4103/0250-474X.108420.

Das, S.K., Bharanii, J., Pavitra, P., Das, S., Behera, S.P., Veilumuthu, P. and Christopher, J.G. (2022). Investigation on the phenolic content in *Moringa oleifera* and its antimicrobial activity. *Indian Journal of Agricultural Research*. **56(3):** 255-261. doi: 10.18805/IJARe.A-5636.

Dubey, D.K., Dora, J., Kumar, A. and Gulsan, R.K. (2013). A multipurpose tree: *Moringa oleifera*. *International Journal of Pharmaceutical and Chemical Sciences*. **2(1):** 415-423.

Esmaeili, H., Yeganeh, G. and Esmaeilzadeh, F. (2019). Optimization of biodiesel production from *Moringa oleifera* seeds oil in the presence of nano-MgO using Taguchi method. *International Nano Letters*. **9(3):** 257-263. https://doi.org/10.1007/s40089-019-0278-2.

Faizi, S., Siddiqui, B. S., Saleem, R., Siddiqui, S., Aftab, K. and Gilani, A.H. (1994). Isolation and structure elucidation of new nitrile and mustard oil glycosides from *Moringa oleifera* and their effect on blood pressure. *Journal of Natural Products*. **57(9):** 1256-1261. https://doi.org/10.1021/np50111a011.

Fatima, N., Fatima, S.J. (2016). Pharmacological screening for anti-arthritic activity of *Moringa oleifera*. *Asian Journal of Pharmaceutical and Clinical Research*. **9(6):** 106-111.

Fayazuddin, M., Ahmad, F., Kumar, A., Yunus, S.M. (2013). An experimental evaluation of anti-inflammatory activity of *Moringa oleifera* seeds. *International Journal of Pharmacy and Pharmaceutical Sciences*. **5(3):** 717-721.

Garg, K. (1949). The Wealth of India: A Dictionary of Indian Raw Materials and Industrial Products. Publications and Information Directorate Publisher, CSIR.

Glover-Amengor, M., Aryeetey, R., Afari, E. and Nyarko, A. (2017). Micronutrient composition and acceptability of *Moringa oleifera* leaf-fortified dishes by children in Ada-East district, Ghana. *Food Science and Nutrition*. **5(2):** 317-323. https://doi.org/10.1002/fsn3.395.

Gopalakrishnan, L., Doriya, K., Kumar, D.S. (2016). *Moringa oleifera*: A review on nutritive importance and its medicinal application. *Food Science and Human Wellness*. **5(2):** 49-56. https://doi.org/10.1016/j.fshw.2016.04.001.

Gupta, R., Sharma, A.K., Dobhal, M.P., Sharma, M.C. and Gupta, R.S. (2011). Antidiabetic and antioxidant potential of β-sitosterol in streptozotocin-induced experimental hyperglycemia. *Journal of Diabetes*. **3(1):** 29-37. https://doi.org/10.1111/j.1753-0407.2010.00107.x.

Haizum, S. and Hassan, A. (2013). *Moringa oleifera,* a possible source of biodiesel (Master's thesis). Universiti Malaysia Pahang.

Hukkeri, V., Nagathan, C., Karadi, R. and Patil, B. (2006). Antipyretic and wound healing activities of *Moringa oleifera* Lam. in rats. *Indian Journal of Pharmaceutical Sciences*. **68(1):** 124. https://doi.org/10.4103/0250-474X.22985.

Jamil, S., Turabi, T.H., Ahmad, S., Riaz, M., Wariss, H.M. and Akter, Q.S. (2024). Comparative investigation of the nutritional profiling and antipyretic activity of *Moringa oleifera* leaves, bark and root from different sites of Punjab, Pakistan. *Food Science and Nutrition*. **13(1):** e4706. https://doi.org/10.1002/fsn3.4706.

Jiwajinda, S. (1998). Niaziminin, a thiocarbamate from the leaves of *Moringa oleifera*, holds a strict structural requirement for inhibition of Tumour-promoter-induced Epstein-Barr virus activation. *Planta Medica*. **64(4):** 319-323. https://doi.org/10.1055/s-2006-957438.

Joshi, P. and Mehta, D. (2010). Effect of dehydration on the nutritive value of drumstick leaves. *Journal of Metabolomics and Systems Biology*. **1(1):** 5-9.

Kalogo, Y., Rosillon, F., Hammes, F., Verstraete, W., (2000). Effect of a water extract of *Moringa oleifera* seeds on the hydrolytic microbial species diversity of a UASB reactor treating domestic wastewater. *Letters in Applied Microbiology*. **31(3):** 259-264. https://doi.org/10.1046/j.1365-2672.2000.00814.x.

Karadi, R.V., Palkar, M.B., Gaviraj, E.N., Gadge, N.B., Mannur, V.S. and Alagawadi, K.R. (2008). Anti-urolithiatic property of *Moringa oleifera* root bark. *Pharmaceutical Biology*. **46(12):** 861-865. https://doi.org/10.1080/13880200802367189.

Kidmose, U., Yang, R.Y., Thilsted, S.H., Christensen, L.P. and Brandt, K. (2006). Content of carotenoids in commonly consumed Asian vegetables and stability and extractability during frying. *Journal of Food Composition and Analysis*. **19(6):** 562-571. https://doi.org/10.1016/j.jfca.2006.01.011.

Kumar, V., Verma, A., Ahmed, D., Sachan, N., Anwar, F. and Mujeeb, M. (2013). Fostered antiarthritic upshot of *Moringa oleifera* Lam. stem bark extract in diversely induced arthritis in wistar rats with plausible mechanism. *International Journal of Pharmaceutical Sciences and Research*. **4(10):** 3894-3901. http://doi.org/10.13040/IJPSR.0975-8232.4(10).3894-01.

Kumbhare, M. and Sivakumar, T. (2011). Anti-inflammatory and analgesic activity of stem bark of *Moringa Oleifera*. *Pharmacologyonline*. **3:** 641-650.

Leone, A., Spada, A., Battezzati, A., Schiraldi, A., Aristil, J. and Bertoli, S. (2015). Cultivation, genetic, ethnopharmacology, phytochemistry and pharmacology of *Moringa oleifera* leaves: An overview. *International Journal of Molecular Sciences*. **16(6):** 12791-12835. https://doi.org/10.3390/ijms160612791.

Ma, Z.F., Ahmad, J., Zhang, H., Khan, I. and Muhammad, S. (2020). Evaluation of phytochemical and medicinal properties of Moringa (*Moringa oleifera*) as a potential functional food. *South African Journal of Botany*. **129:** 40-46. https://doi.org/10.1016/j.sajb.2018.12.002.

Mahajan, S. and Sharma, Y. (1984). Production of rayon grade pulp from *Moringa oleifera*. *The Indian Forester*. **110:** 303-306.

Maldini, M., Maksoud, S.A., Natella, F., Montoro, P., Petretto, G.L., Foddai, M., De Nicola, G.R., Chessa, M. and Pintore, G. (2014). *Moringa oleifera*: Study of phenolics and glucosinolates by mass spectrometry. *Journal of Mass Spectrometry*. **49(9):** 900-910. https://doi.org/10.1002/jms.3437.

Mali, S., Bendre, S. and Patil, S. (2022). Overview of pharmacognostical and pharmacological properties of *Moringa oleifera*. *Asian Journal of Pharmacy and Technology*. **12(1):** 77-83. https://doi.org/10.52711/2231-5713.2022.00013.

Mehta, A. and Agrawal, B. (2008). Investigation into the mechanism of action of *Moringa oleifera* for its anti-asthmatic activity. *Oriental Pharmacy and Experimental Medicine*. **8(1):** 24-31. https://doi.org/10.3742/OPEM.2008.8.1.024.

Moummou and H., Meftah, I., (2024). Natural Medicine: In-depth exploration of *Moringa oleifera's* bioactive compounds and antimicrobial effects. The Global Burden of Disease and Risk Factors-Understanding and Management. *Intech Open*. https://doi.org/10.5772/intechopen.1005046.

Muyibi, S.A. and Evison, L.M. (1995). Optimizing physical parameters affecting coagulation of turbid water with *Moringa oleifera* seeds. *Water Research*. **29(12):** 2689-2695. https://doi.org/10.1016/0043-1354(95)00133-6.

Nandave, M., Ojha, S.K., Joshi, S., Kumari, S. and Arya, D.S. (2009). *Moringa oleifera* leaf extract prevents isoproterenol-induced myocardial damage in rats: Evidence for an antioxidant, antiperoxidative and cardioprotective intervention. *Journal of Medicinal Food*. **12(1):** 47-55. https://doi.org/10.1089/jmf.2007.0563.

Ndiaye, M., Dieye, A.M., Mariko, F., Tall, A., Sall Diallo, A. and Faye, B. (2002). Contribution to the study of the anti-inflammatory activity of *Moringa oleifera* (moringaceae). *Dakar Medical*. **47(2):** 210-212.

Palupi, D.A., Prasetyowati, T.W., Murtiningsih, D. and Mahdiyah, D. (2021). Antiasthmatic activities of *Moringa oleifera* Lam. leaves extract on the eosinophil count and mast cells in BALB/c Mice. *Borneo Journal of Pharmacy*. **4(3):** 171-177. https://doi.org/10.33084/bjop.v4i3.1916.

Panda, S., Kar, A., Sharma, P. and Sharma, A. (2013). Cardioprotective potential of N, α-l-rhamnopyranosyl vincosamide, an indole alkaloid, isolated from the leaves of *Moringa oleifera* in isoproterenol induced cardiotoxic rats: *In vivo* and *in vitro* studies. *Bioorganic and Medicinal Chemistry Letters*. **23(4):** 959-962. https://doi.org/10.1016/j.bmcl.2012.12.060.

Pari, L. and Kumar, N.A. (2002). Hepatoprotective activity of *Moringa oleifera* on antitubercular drug-induced liver damage in rats. *Journal of Medicinal Food*. **5(3):** 171-177. https://doi.org/10.1089/10966200260398206.

Parvathy, M.V.S. and Umamaheshwari, A. (2007). Cytotoxic effect of *Moringa oleifera* leaf extracts on human multiple myeloma cell lines. *Trends in Medical Research*. **2(1):** 44-50. https://doi.org/10.3923/tmr.2007.44.50.

Patel, N. and Mohan, J.S.S. (2018). Antimicrobial activity and phytochemical analysis of *Moringa oleifera* Lam. crude extracts against selected bacterial and fungal strains. *International Journal of Pharmacognosy and Phytochemical Research*. **10(2):** 68-79. https://doi.org/10.25258/phyto.v10i02.11935.

Prakash, S., Singh, P. and Singh, S. (2012). Processing of *Moringa oleifera* leaves for human consumption. *Bulletin of Environment, Pharmacology and Life Sciences*. **2:** 28-31.

Rameshvar, K.P., Patel, M.M., Kanzariya, N.R., Vaghela, K. and Patel, N. (2010). *In-vitro* hepatoprotective activity of *Moringa oleifera* Lam. leave on isolated rat hepatocytes. *International Journal of Pharmaceutical Sciences*. **2(1):** 457-463.

Randriamboavonjy, J.I., Loirand, G., Vaillant, N., Lauzier, B., Derbré, S., Michalet, S., Pacaud, P. and Tesse, A. (2016). Cardiac protective effects of *Moringa oleifera* seeds in spontaneous hypertensive rats. *American Journal of Hypertension*. **29(7):** 873-881. https://doi.org/10.1093/ajh/hpw001.

Ranganathan, V., Punniamurthy, N., Ahamad, D.B. and Kumar, S.S. (2020). Evaluation of hepatoprotective activity of *Moringa oleifera* in chicken. *The Journal of Phytopharmacology*. **9(3):** 175-177. https://doi.org/10.31254/phyto.2020.9304.

Rani, E.A. and Arumugam, T. (2017). *Moringa oleifera* (Lam)-A nutritional powerhouse. *Journal of Crop and Weed*. **13(2):** 238-246.

Raubilu, I., Usman, I., Ahmad, A. (2020). Antimicrobial activity of *Moringa oleifera*: A short review. *Bayero Journal of Pure and Applied Sciences*. **12:** 128-132. https://doi.org/10.4314/bajopas.v12i1.21S.

Ravani, A., Prasad, R.V., Gajera, R.R., Joshi, D.C. (2017). Potentiality of *Moringa oleifera* for food and nutritional security-A review. *Agricultural Reviews*. **38(3):** 228-232. doi: 10.18805/ag.v38i03.8983.

Sachan, D. (2012). Effect of the ethanolic extract of *Moringa oleifera* Lam. plant on ethylene glycol induced lithiatic albino rats. *International Journal of Toxicological and Pharmacological Research*. **4(3):** 26-28.

Sahakitpichan, P., Mahidol, C., Disadee, W., Ruchirawat, S. and Kanchanapoom, T. (2011). Unusual glycosides of pyrrole alkaloid and 4′-hydroxyphenylethanamide from leaves of *Moringa oleifera*. *Phytochemistry*. **72(8):** 791-795. https://doi.org/10.1016/j.phytochem.2011.02.021.

Saini, R.K., Sivanesan, I. and Keum, Y.S. (2016). Phytochemicals of *Moringa oleifera*: A review of their nutritional, therapeutic and industrial significance. *3 Biotech*. **6(2):** 203. https://doi.org/10.1007/s13205-016-0526-3.

Scalbert, A., Manach,C., Morand, C., Rémésy, C. and Jiménez, L. (2005). Dietary polyphenols and the prevention of diseases. *Critical Reviews in Food Science and Nutrition*. **45(4):** 287-306. https://doi.org/10.1080/1040869059096.

Siddhuraju, P. and Becker, K. (2003). Antioxidant properties of various solvent extracts of total phenolic constituents from three different agroclimatic origins of drumstick tree (*Moringa oleifera* Lam.) leaves. *Journal of Agricultural and Food Chemistry*. **51(8):** 2144-2155. https://doi.org/10.1021/jf020444+.

Singh, B.N., Singh, B.R., Singh, R.L., Prakash, D., Dhakarey, R., Upadhyay, G. and Singh, H.B. (2009). Oxidative DNA damage protective activity, antioxidant and anti-quorum sensing potentials of *Moringa oleifera*. *Food and Chemical Toxicology*. **47(6):** 1109-1116. https://doi.org/10.1016/j.fct.2009.01.034.

Singh, B., Yadav, M.P.S., Yadav, P., Prakash, V., Chandra, D.R. and Rathaur A. (2024). Development of *Chhana* spread by incorporating Moringa (*Moringa oleifera* L.) leaves extract as a source of antioxidants and phenolics. *Asian Journal of Dairy and Food Research*. **43(1):** 142-147. doi: 10.18805/ajdfr.DR-2082.

Sinha, M., Das, D.K., Datta, S., Ghosh, S. and Dey, S. (2012). Amelioration of ionizing radiation induced lipid peroxidation in mouse liver by *Moringa oleifera* Lam. leaf extract. *Indian Journal of Experimental Biology*. **50(3):** 209-215.

Sreelatha, S. and Padma, P.R. (2009). Antioxidant activity and total phenolic content of *Moringa oleifera* leaves in two stages of maturity. *Plant Foods for Human Nutrition*. **64(4):** 303-311. https://doi.org/10.1007/s11130-009-0141-0.

Su, B. and Chen, X. (2020). Current status and potential of *Moringa oleifera* leaf as an alternative protein source for animal feeds. *Frontiers in Veterinary Science*. **7:** 53. https://doi.org/10.3389/fvets.2020.00053.

Sultana, B., Anwar, F. and Ashraf, M. (2009). Effect of extraction solvent/technique on the antioxidant activity of selected medicinal plant extracts. *Molecules*. **14(6):** 2167-2180. https://doi.org/10.3390/molecules14062167.

Suresh, S., Chhipa, A.S., Gupta, M., Lalotra, S., Sisodia, S.S., Baksi, R. and Nivsarkar, M. (2020). Phytochemical analysis and pharmacological evaluation of methanolic leaf extract of *Moringa oleifera* Lam. in ovalbumin induced allergic asthma. *South African Journal of Botany*. **130:** 484-493. https://doi.org/10.1016/j.sajb.2020.01.046.

Sutar, N.G., Bonde, C.G., Patil, V.V., Narkhede, S.B., Patil, A.P. and Kakade, R.T. (2008). Analgesic activity of seeds of *Moringa oleifera* Lam. *International Journal of Green Pharmacy (IJGP)*. **2(2).** https://doi.org/10.22377/ijgp.v2i2.40.

Tahkur, R.S., Soren, G., Pathapati, R.M. and Buchineni, M. (2016). Diuretic activity of *Moringa oleifera* leaves extract in swiss albino rats. *The Pharma Innovation Journal*. **5(3):** 8-10.

Verma, A.R., Vijayakumar, M., Mathela, C.S. and Rao, C.V. (2009). *In vitro* and *in vivo* antioxidant properties of different fractions of *Moringa oleifera* leaves. *Food and Chemical Toxicology*. **47(9):** 2196-2201. https://doi.org/10.1016/j.fct.2009.06.005.

Waterman, C., Cheng, D. M., Rojas-Silva, P., Poulev, A., Dreifus, J., Lila, M.A. and Raskin, I. (2014). Stable, water extractable isothiocyanates from *Moringa oleifera* leaves attenuate inflammation *in vitro*. *Phytochemistry*. **103:** 114-122. https://doi.org/10.1016/j.phytochem.2014.03.028.

Yang, R.Y., Chang, L.C., Hsu, J.C., Weng, B.B.C., Palada, C., Chadha, M.L. and Levasseur, V. (2006). Nutritional and functional properties of Moringa leaves-from germplasm, to plant, to food, to health. AVRDC-The World Vegetable Center.