



E-ISSN: 2278-4136

P-ISSN: 2349-8234

<https://www.phytojournal.com>

JPP 2024; 13(2): 136-142

Received: 26-01-2024

Accepted: 28-02-2024

Shiva Kant ThakurDepartment of Pharmaceutics,
Nims Institute of Pharmacy,
Nims University Rajasthan,
Jaipur, India**Rahul Pal**Department of Pharmaceutics,
Nims Institute of Pharmacy,
Nims University Rajasthan,
Jaipur, India**Prachi Pandey**Department of Pharmaceutics,
Nims Institute of Pharmacy,
Nims University Rajasthan,
Jaipur, India**Ujwal Havelikar**Department of Pharmaceutics,
Nims Institute of Pharmacy,
Nims University Rajasthan,
Jaipur, India**Dr. Ravindra Pal Singh**Department of Pharmaceutics,
Nims Institute of Pharmacy,
Nims University Rajasthan,
Jaipur, India**Corresponding Author:****Shiva Kant Thakur**Department of Pharmaceutics,
Nims Institute of Pharmacy,
Nims University Rajasthan,
Jaipur, India

A systematic review on several therapeutics' activities and recent trends on *Moringa oleifera* an traditional medical plant

Shiva Kant Thakur, Rahul Pal, Prachi Pandey, Ujwal Havelikar and Dr. Ravindra Pal Singh

DOI: <https://doi.org/10.22271/phyto.2024.v13.i2b.14878>

Abstract

Moringa oleifera, is family member of the moringacea, is a remarkable plant. It is cultivated extensively in various regions of southern Asia. This plant, whether as a small evergreen or deciduous tree, holds great significance as a vital source of medicinal properties. The consumption of this food item offers numerous advantages, providing nourishment and serving as a preventive measure. It possesses a wide range of therapeutic properties, offering significant dietary benefits. The various components of the *M. oleifera* plants, such as leaves, flowers, fruits, seeds, and roots, contain specific quantities of protein, β -carotene, amino acids, essential minerals, and diverse phenolic compounds. The plant have several medicinal activities such as antitumor, antiulcer, anti-inflammatory, antiepileptic, antipyretic, antispasmodic, diuretic, antidiabetic, antihypertensive, cholesterol-level down, cell regeneration and hepatoprotective. This review explores the diverse range of health benefits and therapeutic properties associated with *M. oleifera* plants. These include their potential as anti-cancer, anti-diabetic, anti-inflammatory, anti-allergic, diuretic, antioxidant, anti-obesity, cardiovascular, anti-asthmatic, hematological, anti-ulcer, and anti-acrolithic agents. Furthermore, the review also delves into the recent applications of *M. oleifera*.

Keywords: *Moringa oleifera*, health benefits, therapeutics activities, recent application, medicinal plant, phyto-constituents, phytochemical studies

1. Introduction

The *M. oleifera*, commonly referred to as the drumstick plant, is a verdant tree belonging to the Moringaceae family. This nutrient-dense plant is cultivated in various regions across all over world, including the United States (US) [1]. In addition to its aliases, such as horseradish tree and drumstick tree, this plant serves a multitude of purposes, catering to both human and animal consumption, as well as finding applications in various industries [2].

The tree's leaves, fruit, flowers, and young branches are widely used as a highly nutritious vegetable in several countries, such as India, the Philippines, Hawaii, Pakistan, and numerous African nations. In particular, the people of India have incorporated it into their daily diet for nearly 5000 years [2-3]. Originating in the northern parts of India, its popularity easily spread to the southern parts, where "Murungai keerai" (*Moringa* leaves) and "Murungaikaai" (drumsticks) have become popular vegetable sources. The moringa tree has successfully established itself across Asia, most of Africa, South America, a small portion of North America, and has left a few marks in Europe [4].

They possess diverse functions as a nutritional supplement, enhancer of soil quality, and component of water purification systems. *M. oleifera* plants are also renowned for their oil production, making it a prominent and lucrative source of revenue. The mostly bioactive phenolic compounds found in these plants are classified as flavonoids, including quercetin and kaempferol. Numerous studies have reported that moringa leaves exhibit remarkable antioxidant properties, making them a potential natural source for protecting cells against harmful free radicals [5]. Additionally, the agglomeration properties of water, proteins, and fatty acid methyl esters derived from *M. oleifera* seeds are thoroughly examined to explore their potential applications in biodiesel production and water purification systems [6]. The leaves possess a rich nutritional profile, comprising of vitamins C and A, β -carotene, calcium, iron, potassium, and phosphorus. Additionally, they contain a substantial protein level of 27 percent [7]. *M. oleifera* leaves exhibit a calcium content equivalent to that of four glasses of milk, a vitamin C content comparable to that of seven oranges, and a potassium content three

times higher than that of bananas. Furthermore, these leaves contain three times the amount of iron found in spinach, four times the quantity of vitamin A present in carrots, and half the protein content of milk, as indicated by research findings [8].

1.1. Morphology of *Moringa oleifera*

- Leaves:** The length of the leaves can reach up to 45 cm, and they are either bipinnate or more commonly tripinnate. These leaves are composed of leaflets that are approximately 1-2 cm in length [9].
- Flowers:** The *M. oleifera* possesses fragrant bisexual flowers that are yellowish-white in color. These flowers are found on slender stalks, which are heavily distributed in spreading or drooping axillary clusters measuring 10-25 cm in length.
- Fruits:** The fruits of *M. oleifera* are characterized by their trilobed capsules and are commonly known as pods [11].
- Seed:** The seeds of *M. oleifera* exhibit a spherical shape and possess a brownish semi-permeable seed hull, accompanied by three delicate papery wings.
- Roots:** Seeds undergo a gradual development process, forming tuberous, white taproots that possess a distinct pungent scent and exhibit minimal lateral root growth [10].
- Bark and wood:** The bark of *Moringa oleifera* displays a whitish gray coloration, characterized by its thickness and softness. It exhibits a fissured and warty texture, which can also transform into a rough surface.

The analysis of various components of *M. oleifera* through phytochemical screenings has demonstrated the existence of

glucosinolates, isothiocyanates, carotenoids, vitamins, as well as substantial amounts of proteins and carbohydrates.



Fig 1: The view of *Moringa oleifera* tree with their various parts

Consequently, this plant possesses significant medicinal and nutritional properties that are beneficial to both humans and livestock. *M. oleifera* is extensively cultivated in various regions of India, where its medicinal potential has been widely acknowledged. In Nigeria, numerous institutions and organizations have established *M. oleifera* plantations for public utilization [12]. The brief discussion about the type of extract and medicinal effects mentioned in the given Table. 01 as below followings:

Table 1: The several types of Extracts Plant Parts with their Medicinal Effects [12-26]

Medicinal effects	Extraction type	Reference
Antioxidant	<i>Moringa olifera</i> leaf	[2]
<i>In vitro</i> antifungal activity	Ethanol extraction of the seeds of <i>Moringa olifera</i>	[5]
Antimicrobial activity	Acetone extraction of <i>Moringa olifera</i> leaf	[8]
Anti-inflammatory activity	Aqueous extraction of <i>Moringa olifera</i> root	[13]
Anti-diabetic activity	extraction of the seeds of <i>Moringa olifera</i>	[15]
Hypolipidemic and antioxidant activity	Hydro alcoholic extraction of <i>Moringa olifera</i>	[26]

1.2. Traditional use *M. oleifera*: The leaves of *M. oleifera* have long been employed in traditional medicine for their anti-diabetic, anti-bacterial, anti-headache, anti-hypertensive, anti-fever, and anti-inflammatory properties. Scientific research has also confirmed that different parts of the plant, including the root, flower, gum, seed, and stem bark, possess various medicinal properties. These include abortifacient effects in the root, flower, and gum, anti-hypertensive properties in the flower and seed, hypolipidemic effects in the flower, anti-inflammatory effects in the root and flower, and anti-ulcer genic potential in the stem bark. These findings highlight the diverse therapeutic potential of *Moringa olifera* as a valuable herbal drug [13].

1.3. Nutritional Value: *M. oleifera*, a versatile plant, possesses various parts that are abundant in both essential nutrients and anti-nutrients. The leaves of *M. oleifera* are particularly noteworthy for their mineral content, including

calcium, potassium, zinc, magnesium, iron, and copper. Additionally, these leaves contain vitamins and beta-carotene (a precursor to vitamin A), various B vitamins like folic acid, pyridoxine, and nicotinic acid, as well as vitamin C, D, and E. Moreover, *M. oleifera* leaves have a low calorific value, making them suitable for inclusion in the diet of individuals struggling with obesity.

Furthermore, the fibrous pods of *M. oleifera* hold specific value in the treatment of digestive issues and the prevention of colon cancer. Research indicates that immature pods contain approximately 46.78% fiber and 20.66% protein content. Moreover, these pods boast a 30% amino acid content. Interestingly, both immature pods and flowers exhibit similar amounts of palmitic, linoleic, and oleic acids, which further contribute to their beneficial properties [16]. The different biological properties and phytoconstituents of plant mention in the Table. 02 as below section:

Table 2: The list of several phytoconstituents & Biological properties of plant *M. oleifera* [49-53]

Parts of plant	Phytochemical constituents	Pharmacological properties	Reference
Seeds	Moringine, niazimicin, niazirin	Acts against asthma,	[49]
Leaf	Niazirin, Niazirinin, Niaziminin, Niazimicin A, Niazimicin B	Anticonvulsant, Antioxidant, Antihypertensive, antibacterial, anticancer	[50]
Root	Moringine, moringinine, spirachin, also p-cymene	Antifertility	[51]
Pods	Isothiocyanate, nitrites, beta- sitosterol.	Act against inflammation & helminthics	[52]

Flower	Present some chemical constituents like as quercetin, isoquercetin, kaempferol, kaempferitin	Act against inflammation	[48]
Barks	Benzylglucosinolate derivatives	Act against urolithiatic	[54]
Steam	Chemical constituents are extracted from stem Vanillin, beta- sitosterone	Act against inflammation	[53]

M. oleifera shows promise in various health aspects, various research is needed to fully understand its mechanisms of action and to establish its efficacy and safety in different contexts. Additionally, individual responses to Moringa may vary, and consulting with a healthcare professional is recommended, especially if incorporating Moringa supplements into the diet.

2. Therapeutics activity of *Moringa oleifera*

Moringa oleifera is attributed with various therapeutic activities due to its rich phytochemical composition. The effectiveness of Moringa in certain therapeutic areas may vary, some important therapeutic activity of plant discussed as below description:

- I. **Anti-cancer:** *M. oleifera* possesses the potential to serve as an effective anticancer agent due to its natural composition, reliability, and safety when used at appropriate concentrations. Numerous studies have demonstrated its ability to act as an anti-neoproliferative agent, effectively impeding the growth of cancer cells. Research has specifically highlighted the efficacy of *M. oleifera* as an anticancer agent against various types of cancers [17]. Notably, the extract derived from *M. oleifera* leaves has exhibited the ability to hinder the viability of hepatocellular carcinoma, acute lymphoblastic leukemia, and myeloid leukemia [18]. The inhibitory effects have been attributed to the presence of bioactive compounds such as niazimicin, β -sitosterol-3-O- β -D-glucopyranoside, and 4-(α -L-rhamnosyloxy) benzyl isothiocyanate [19].
- II. **Anti-inflammatory:** The various parts of the *M. oleifera* plant possess significant anti-inflammatory activity. For example, the root extract has been found to exhibit noteworthy anti-inflammatory activity in rats with carrageenan-induced paw edema. Additionally, the crude methanol extract of the root has shown a dose-dependent inhibition of carrageenan-induced paw edema after oral administration. Furthermore, the n-butanol extract of the seeds of *M. oleifera* has demonstrated anti-inflammatory activity against ovalbumin-induced airway inflammation in guinea pigs. The potent anti-inflammatory activity of the bioactive compounds found in *M. oleifera* suggests that it may have the potential to alleviate inflammation-associated chronic diseases. Consequently, this plant may have beneficial effects on conditions such as asthma, pain, and other symptoms that arise as a result of inflammation [21].
- III. **Analgesic activity:** The analgesic properties of various Moringa species have been documented. A study conducted on experimental animals utilized ethanolic extracts from the tender pod-like fruits of Moringa concanensis, revealing a notable analgesic effect. Additionally, the alcoholic extracts derived from the leaves and seeds of *M. oleifera* also exhibited significant analgesic activity, as demonstrated by the hot plate and tail immersion methods [22-23].
- IV. **Anti-diabetic:** The various medicinal plants have undergone assessment to determine their potential as therapeutic agents for diabetes. Among these plants, *M. oleifera* holds significant importance. Studies have shown that *Moringa oleifera* leaves have the ability to significantly reduce blood glucose levels in both Wistar rats and Goto-Kakizaki (GK) rats, which are models for type 2 diabetes. Additionally, research has indicated that the extract derived from moringa leaves effectively lowers blood sugar levels within three hours of ingestion. The anti-diabetic activity of *M. oleifera* is believed to be attributed to the presence of dark chocolate polyphenols and other polyphenols. Moringa leaves are rich in polyphenols, including quercetin-3-glycoside, rutin, kaempferol glycosides, and other polyphenols. Therefore, by developing appropriate technology, the potential antidiabetic properties of *M. oleifera* can be harnessed and commercialized, providing an alternative to conventional diabetes medications [25].
- V. **Diuretic activity:** *M. oleifera* leaves possess a variety of bioactive compounds that have a direct impact on blood pressure. These compounds, such as nitrile, mustard oil glycosides, and thiocarbamate glycosides, are found in the leaves of *M. oleifera* and contribute to the reduction of blood pressure. Furthermore, the roots, leaves, flowers, gum, and aqueous infusion of seeds of *Moringa oleifera* exhibit diuretic properties. Additionally, Moringa leaves content bioactive phytoconstituents, including β -sitosterol, which has been shown to have a cholesterol-lowering effect [27].
- VI. **Anti-oxidant:** *M. oleifera*, a plant known for its various health benefits, is recognized as a valuable source of antioxidants. Research has shown that the aqueous extracts obtained from the leaves, fruits, and seeds of *M. oleifera* possess antioxidant properties. In a study investigating the antioxidant potential of freeze-dried Moringa leaves using different extraction methods, it was observed that the methanol and ethanol extracts derived from *M. oleifera* of Indian origin exhibited the highest antioxidant activity, with percentages of 65.1% and 66.8% respectively. Furthermore, it was noted that the presence of phenolic compounds, such as quercetin and kaempferol, played a significant role in the antioxidant activity of *M. oleifera*. Another recent study comparing the antioxidant potential of palm oil and *M. oleifera* seeds revealed that *M. oleifera* seeds possess superior radical scavenging abilities [29].
- VII. **Cardiovascular activity:** Furthermore, apart from the previously mentioned Brady-cardiac effect of *M. oleifera* leaves, various parts of the *M. oleifera* have been found to possess cardiac and circulatory stimulant properties to some extent. The root bark of Moringa have an alkaloid called moringinine, Moringinine acts as a cardiac stimulant by affecting the sympathetic nervous system. This stimulation of the sympathetic nervous system contributes to the observed cardiac effects [30]. Additionally, the prevention of hyperlipidemia can also lead to these effects. Research has shown that *M. oleifera* can prevent hyperlipidemia in male Wistar rats by addressing iron deficiency [31].
- VIII. In a comparative study between *Moringa oleifera* leaf extract and atenolol (a selective β_1 receptor antagonist drug used for cardiovascular diseases), the effects on serum cholesterol level, serum triglyceride level, blood

glucose level, heart weight, and body weight of adrenaline-induced rats were examined. The study revealed that *Moringa oleifera* leaf extract induced significant changes in cardiovascular parameters. Specifically, it was found to have hypolipidemic properties, reducing body weight, heart weight, serum triglyceride level, and serum cholesterol level in the experimental animals. These findings further support the beneficial effects of *Moringa oleifera* on cardiovascular health [32]. Moreover, in addition to the aforementioned studies, the leaves of *M. oleifera* have also been found to possess anti-atherosclerotic and hypo-lipidemic effects [32-33].

- IX. Anti –asthmatic activity:** A considerable amount of time ago, there was a report indicating that the alkaloid found in the *M. Oleifera* plant bears a striking resemblance to ephedrine in terms of its effects and can potentially be utilized for the treatment of asthma. This alkaloid, known as moringine, has the ability to relax bronchioles, which are small air passages in the lungs [33]. Furthermore, a study conducted to assess the effectiveness and safety of *Moringa oleifera* seed kernels in managing asthmatic patients demonstrated promising results. The research revealed a significant reduction in the severity of asthma symptoms and an improvement in respiratory functions [34].
- X. Neuro-pharmacological activity:** *M. Oleifera* exhibits its effects on the central nervous system (CNS) and possesses anti-convulsant properties. This activity is attributed to its impact on a central mechanism that influences the release of γ -amino butyric acid (GABA). Consequently, *M. oleifera* has been widely utilized for the treatment of epilepsy. Additionally, *M. oleifera* demonstrates protective effects against degenerative and chronic neuronal disorders such as Alzheimer's disease. It enhances memory by acting on the neurons in the hippocampus. Moreover, it induces the differentiation of myeloid cells and photoreceptors, while promoting the development of neurons in the hippocampus [35-36].
- XI. Antimicrobial and anti-helminthic effects:** The inhibitory effects of *M. oleifera* antimicrobial components have been confirmed following their discovery. In a recent investigation, it was found that aqueous extracts of *M. oleifera* exhibited inhibitory properties against various pathogenic bacteria, including *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli*, and *Pseudomonas aeruginosa*, in a dose-dependent manner. Additionally, *M. oleifera* extracts were also found to inhibit the growth of *Mycobacterium phlei* and *B. subtilis* [37]. The leaf extract of *M. oleifera* was effective in controlling the growth of fungi *Basidiobolus haptosporus* and *Basidiobolus ranarums*. Another study investigated the antimicrobial activity of aqueous methanolic extract and fixed oil against microorganisms such as *Scenedesmus obliquus* (green algae), *E. coli* ATCC 13706, *P. aeruginosa* ATCC10145, *S. aureus* NAMRU 3 25923, *Bacillus stearothermophilus*, Herpes Simplex virus type 1 (HSV 1), and Polio virus type 1 (sabin vaccine). The antimicrobial activity varied, with *B. stearothermophilus* being sensitive and *P. aeruginosa* being resistant [38]. In addition to its antibacterial properties, *M. oleifera* oils also possess antifungal activity. A study comparing the relative antimicrobial activity of seed extracts against bacteria (*Pasturella multocida*, *E. coli*, *B. subtilis*, and *S. aureus*) and fungi

(*Fusarium solani* and *Rhizopus solani*) revealed that *P. multocida* and *B. subtilis* were the most susceptible strains, and their activity was influenced by cations (Na^+ , K^+ , Mg^{2+} , and Ca^{2+}) [39].

XII. Anti – pyretic activity: The antipyretic activity of *M. oleifera* bioactive constituents can be postulated due to their anti-inflammatory properties. In order to evaluate the antipyretic effect, a research study was conducted using yeast-induced hyperpyrexia method and various extracts of *M. oleifera* seeds including ethanol, petroleum ether, solvent ether, and ethyl acetate. Paracetamol was utilized as a control during the experiment. Interestingly, the ethanol and ethyl acetate extracts of the seeds exhibited noteworthy antipyretic activity in rats [40-41].

XIII. Anti –ulcer activity: *Moringa* root and leaves contain various compounds that exhibit spasmolytic activity. These compounds include 4-(α -L-rhamnosyloxybenzyl)-*o*-methyl thiocarbamate, which may be influenced by calcium channel blockade, as well as niazinin A, niazinin B, niazimicin, and others, all of which have hypotensive and bradycardiac effects. The presence of these different constituents supports the traditional use of this plant in treating gastrointestinal motility disorders. Furthermore, the methanolic extract of *M. oleifera* has shown the ability to protect experimental rats from gastric lesions induced by acetylsalicylic acid, serotonin, and indomethacin. Additionally, it aids in the healing process of chronic gastric lesions induced by acetic acid in experimental animals [42-42].

Anti-fertility activity: The efficacy of the aqueous extract of *M. oleifera* as an anti-fertility agent was observed in both the presence and absence of estradiol dipropionate and progesterone. Additionally, it was found to enhance the histoarchitecture of the uterine tissue, as indicated by the study conducted [44-45].

M. oleifera, known for its rich nutritional profile, exhibits various therapeutic activities. Its antioxidant and anti-inflammatory properties may contribute to cardiovascular health by reducing lipid levels and protecting against oxidative stress. With antimicrobial and antibacterial effects, *Moringa* could support the immune system and combat infections. The some studies suggest potential antidiabetic, immunomodulatory, and hepatoprotective effects, making it beneficial for managing diabetes, enhancing immune function, and protecting the liver. Additionally, *Moringa*'s neuroprotective properties and potential anticancer effects, attributed to compounds like quercetin and beta-carotene, warrant further investigation. While promising, it's essential to approach *Moringa*'s therapeutic potential with caution, emphasizing the need for additional research and consultation with healthcare professionals before integrating it into therapeutic regimens.

3. Recent approaches of *Moringa oleifera* as medicinal plant

In recent times, various approaches have been explored regarding the potential benefits of *M. oleifera*. These include its anti-cancer, anti-diabetic, anti-inflammatory, anti-allergic, diuretic, anti-oxidant, anti-obesity, cardiovascular, anti-asthmatic, hematological, anti-ulcer, and anti-acrolithic activities, which have proven to be significant in therapeutic treatments [46]. Particularly in the current scenario of the Covid-19 pandemic, *M. oleifera* has gained considerable attention for its ability to enhance and strengthen the immune

system. Notably, *M. oleifera* is not only valuable during this time^[47], but it is also available in various forms such as tablets, powders, and juices, making it a convenient dietary

product in the market. The recent approaches with their examples mentioned in the **Table. 03** as below followings:

Table 3: The list of recent approaches in the phytoconstituents with their example^[44-47]

Approach	Examples
Advanced Extraction Methods	Supercritical fluid extraction, ultrasound-assisted extraction
Biotechnological Enhancement	Genetic modification for increased nutrient content, metabolic engineering
Formulation of Functional Products	Moringa-based functional foods, nutraceuticals, supplements
Pharmaceutical Development	Moringa extracts for drug formulations, encapsulation technologies
Sustainable Agriculture	Integration into agroforestry systems, cultivation for soil improvement
Phytoremediation	Moringa's role in removing pollutants from soil and water
Nutraceutical Innovations	Development of Moringa-based products targeting specific health concerns

Recent approaches to *M. oleifera* have focused on harnessing its diverse bioactive compounds for innovative applications. The advanced biotechnological approaches, including genetic modification and metabolic engineering, aim to enhance specific bioactive compounds to optimize Moringa's therapeutic potential. Additionally, there is growing interest in formulating Moringa-based functional foods, supplements, and pharmaceuticals to address various health concerns. With an increasing emphasis on sustainable agriculture, Moringa is being studied for its role in agroforestry systems and phytoremediation, showcasing its potential not only as a nutritional powerhouse but also as a valuable resource in environmental conservation^[48-54].

4. Conclusion

This review examines the diverse therapeutic effects of *Moringa oleifera* in different parts of the plant, including antitumor, antiulcer, anti-inflammatory, antiepileptic, antipyretic, antispasmodic, diuretic, antidiabetic, antihypertensive, cholesterol-level lowering, cell regeneration, and hepatoprotective properties. Furthermore, the nutritional value of moringa plant, encompassing protein, β -carotene, amino acids, essential minerals, and various phenolic compounds, has been recognized for its usefulness in both modern and ancient times in everyday life. In conclusion, the systematic review on the therapeutic activities and recent trends of *M. oleifera*, a traditional medicinal plant, underscores its multifaceted potential in promoting health and wellness. The plant's rich phytoconstituents, including vitamins, minerals, antioxidants, and bioactive compounds, contribute to its diverse therapeutic activities. The review highlighted Moringa's antioxidative, anti-inflammatory, cardioprotective, antimicrobial, and potentially anticancer properties. Furthermore, recent approaches, such as advanced extraction methods, biotechnological enhancements, and the formulation of functional products, showcase the evolving nature of Moringa research. The systematic exploration of Moringa's traditional uses, coupled with contemporary scientific investigations, underscores its relevance in modern healthcare. Overall, the comprehensive analysis presented in this review consolidates the existing knowledge on *Moringa oleifera*, laying the foundation for future studies and applications that can harness its full potential for human health and environmental sustainability.

5. Acknowledgment

The corresponding author would like to thank for Department of Pharmaceutics, Nims Institute of Pharmacy, Nims University Rajasthan, Jaipur, 303121, India including their all members, students and faculty staff for their collaboration. Special thanks to my supervision, Dr. Ravindra

Pal Singh, Mr. Ujwal Havelikar as co-guide and Mr. Rahul Pal for providing the software for drafting, conceptualization and final as well as submission step, view for their guidance and support throughout the review compilation.

Author Contribution: This review was undertaken through a collaborative endeavor involving all four authors, encompassing the conceptualization and study, data collection, compilation, analysis and interpretations, as well as their composition and critical evaluation endorsement of the final manuscript.

Competing Interests: Nil.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

5. Reference

- Prajapati C, Ankola M, Upadhyay TK, Sharangi AB, Alabdallah NM, Al-Saeed FA, *et al.* *Moringa oleifera*: Miracle plant with a plethora of medicinal, therapeutic, and economic importance. *Horticulturae*. 2022;8(6):492.
- Kasolo JN, Bimenya GS, Ojok L, Ochieng J, Ogwaliokeng JW. Phytochemicals and uses of *Moringa oleifera* leaves in Ugandan rural communities. *J Med Plants Res*. 2010;4:753–757.
- Mahmood KT, Mugal T, Haq IU. *Moringa oleifera*: a natural gift-A review. *J Pharm Sci Res*. 2010;2(11):775.
- Tshabalala T, Ncube B, Madala NE, Nyakudya TT, Moyo HP, Sibanda M. Scribbling the cat: A case of the “miracle” plant, *Moringa oleifera*. *Plants*. 2019;8(11):510.
- Bashir KA, Waziri AF, Musa DD. *Moringa oleifera*, a potential miracle tree; A review. *IOSR J Pharm Biol Sci*. 2016;11:25-30.
- Biswas K, Sinha SN. The Miracle Plant—Moringa. In: *Bioresource Utilization and Management: Applications in Therapeutics, Biofuels, Agriculture, and Environmental Science*; c2021.
- George TT, Obilana AO, Oyenih AB, Rautenbach FG. *Moringa oleifera* through the years: A bibliometric analysis of scientific research (2000-2020). *S Afr J Bot*. 2021;141:12-24.
- Pal R, Pandey P, Anand A, Saxena A, Thakur SK, Malakar RK. The Pharmaceutical Polymer's; A current status in drug delivery: A Comprehensive Review. *J Survey Fish Sci*. 2023;3682-3692.
- Hassanein AMA, Al-Soqeer AA. Morphological and genetic diversity of *Moringa oleifera* and Moringa

- peregrina genotypes. Hort Environ Biotechnol. 2018;59:251-261.
10. Khan I, Zaneb H, Masood S, Yousaf MS, Rehman HF, Rehman H. Effect of *Moringa oleifera* leaf powder supplementation on growth performance and intestinal morphology in broiler chickens. J Anim Physiol Anim Nutr. 2017;101:114-121.
 11. Thakur SK, Singh A, Yadav R, Parihar R, Malakar R, Chanana A. Various approaches on microsphere a drug delivery system. International Research Journal of Modernization in Engineering Technology and Science. 2023;5:2075-2083. DOI: 10.56726/IRJMETS38641.
 12. Dao MCE, Kabore KH. Morphological characteristic variation of eleven provenances of *Moringa oleifera* seedlings grown in the Northern Sudanese area of Burkina Faso. African Journal of Plant Science. 2015;9(10):401-411.
 13. Thakur SK, Pal R, Singh A, Pandey P, Malakar R, Chanana A. Recent approaches and various barriers involving in ocular drug delivery system. 2023;12:472. DOI: 10.20959/wjpps20232-24126.
 14. Matic I, Guidi A, Kenzo M, Mattei M, Galgani A. Investigation of medicinal plants traditionally used as dietary supplements: A review on *Moringa oleifera*. Journal of Public Health in Africa, 2018, 9(3).
 15. Ravani A, Prasad RV, Gajera RR, Joshi DC. Potentiality of *Moringa oleifera* for food and nutritional security-A review. Agricultural Reviews. 2017;38(3):228-232.
 16. Thapa K, Poudel M, Adhikari P. *Moringa oleifera*: A review article on nutritional properties and its prospect in the context of Nepal. Acta Sci Agric. 2019;3(11):47-54.
 17. Khor KZ, Lim V, Moses EJ, Abdul Samad N. The *in vitro* and *in vivo* anticancer properties of *Moringa oleifera*. Evidence-Based Complementary and Alternative Medicine; c2018.
 18. Tiloke C, Anand K, Gengan RM, Chuturgoon AA. *Moringa oleifera* and their phytonanoparticles: Potential antiproliferative agents against cancer. Biomedicine & Pharmacotherapy. 2018;108:457-466.
 19. Tiloke C, Anand K, Gengan RM, Chuturgoon AA. *Moringa oleifera* and their phytonanoparticles: Potential antiproliferative agents against cancer. Biomedicine & Pharmacotherapy. 2018;108:457-466.
 20. Xu YB, Chen GL, Guo MQ. Antioxidant and anti-inflammatory activities of the crude extracts of *Moringa oleifera* from Kenya and their correlations with flavonoids. Antioxidants. 2019;8(8):296.
 21. Bhattacharya A, Naik MR, Agrawal D, Rath K, Kumar S, Mishra SS. Antipyretic, anti-inflammatory and analgesic effects of leaf extract of drumstick tree. Journal of Young Pharmacists. 2014;6(4):20.
 22. Pandey P, Pal R, Bharath KS, Akilandeshwari A, Koli M, Rizwan M, Chawra HS. Design of Experiments (DoE) manipulation in the formulation and optimization of a traditional Ayurvedic medicine derived from dried extract of *Senegalia catechu* enhanced through statistical analysis. Journal of Pharmacognosy and Phytochemistry. 2023;12(6):159-169.
 23. Bhattacharya A, Agrawal D, Sahu PK, Kumar S, Mishra SS, Patnaik S. Analgesic effect of ethanolic leaf extract of *Moringa oleifera* on albino mice. Indian Journal of Pain. 2014;28(2):89-94.
 24. Tamrat Y, Nedi T, Assefa S, Teklehaymanot T, Shibeshi W. Anti-inflammatory and analgesic activities of solvent fractions of the leaves of *Moringa stenopetala* Bak. (Moringaceae) in mice models. BMC Complementary and Alternative Medicine. 2017;17(1):1-10.
 25. Aja PM, Igwenyi IO, Okechukwu PU, Orji OU, Alum EU. Evaluation of anti-diabetic effect and liver function indices of ethanol extracts of *Moringa oleifera* and *Cajanus cajan* leaves in alloxan induced diabetic albino rats. Global Veterinaria. 2015;14(3):439-447.
 26. Oriabi AG. *Moringa oleifera* *in vitro* culture and its application as anti-diabetic in alloxan induced diabetic albino mice. International Journal of Current Microbiology and Applied Sciences. 2016;5(2):43-49.
 27. Geleta B, Eyasu M, Fekadu N, Debella A, Challa F. Evaluation of diuretic activity of hydro-ethanolic extract of *Moringa stenopetala* leaves in Swiss albino mice. Clin Exp Pharmacol. 2015;5(190):2161.
 28. Geleta B, Eyasu M, Fekadu N, Debella A, Challa F. Evaluation of diuretic activity of hydro-ethanolic extract of *Moringa stenopetala* leaves in Swiss albino mice. Clin Exp Pharmacol. 2015;5(190):2161.
 29. Peñalver R, Martínez-Zamora L, Lorenzo JM, Ros G, Nieto G. Nutritional and antioxidant properties of *Moringa oleifera* leaves in functional foods. Foods. 2022;11(8):1107.
 30. Gupta R, Mathur M, Bajaj VK, Katariya P, Yadav S, Kamal R. Evaluation of antidiabetic and antioxidant activity of *Moringa oleifera* in experimental diabetes. Journal of Diabetes. 2012;4(2):164-171.
 31. Alia F, Putri M, Anggraeni N, Syamsunarno MRA. The potency of *Moringa oleifera* Lam. as protective agent in cardiac damage and vascular dysfunction. Frontiers in Pharmacology. 2022;12:724439.
 32. Popoola JO, Aworunse OS, Oyesola OL, Akinola OO, Obembe OO. A systematic review of pharmacological activities and safety of *Moringa oleifera*. Journal of Herbmed Pharmacology. 2020;9(3):174-190.
 33. Randriamboavonjy JI, Loirand G, Vaillant N, Lauzier B, Derbré S, Michalet S. Cardiac protective effects of *Moringa oleifera* seeds in spontaneous hypertensive rats. American Journal of Hypertension. 2016;29(7):873-881.
 34. Agrawal B, Mehta A. Antiasthmatic activity of *Moringa oleifera* Lam: A clinical study. Indian Journal of Pharmacology. 2008;40(1):28.
 35. Suresh S, Chhipa AS, Gupta M, Lalotra S, Sisodia SS, Baksi R, Nivsarkar M. Phytochemical analysis and pharmacological evaluation of methanolic leaf extract of *Moringa oleifera* Lam. in ovalbumin induced allergic asthma. South African Journal of Botany. 2020;130:484-493.
 36. Elhassan M, Taha KK. Assessment of acute toxicity and LD50 of *Moringa oleifera* ethanolic leave extract in albino rats and rabbits. Journal of Medical and Biological Sciences Research. 2015;1:38-43.
 37. Al-Abri M, Ashique M, Ramkumar A, Nemmar A, Ali BH. Motor and behavioral effects of *Moringa oleifera* leaf extract. Natural Product Communications. 2018;13(1):1934578X1801300126.
 38. Nepolean P, Anitha J, Emilin RR. Isolation, analysis and identification of phytochemicals of antimicrobial activity of *Moringa oleifera* Lam. Current Biotica. 2009;3(1):33-37.
 39. Saadabi AM, Zaid IA. An *in vitro* antimicrobial activity of *Moringa oleifera* L. seed extracts against different groups of microorganisms. Australian Journal of Basic and Applied Sciences. 2011;5(5):129-134.

40. Dahot MU. Antimicrobial activity of small protein of *Moringa oleifera* leaves. Journal of the Islamic Academy of Sciences. 1998;11(1):6.
41. Hukkeri VI, Nagathan CV, Karadi RV, Patil BS. Antipyretic and wound healing activities of *Moringa oleifera* Lam. in rats. Indian Journal of Pharmaceutical Sciences. 2006.
42. Paikra BK, Gidwani B. Phytochemistry and pharmacology of *Moringa oleifera* Lam. Journal of Pharmacopuncture. 2017;20(3):194.
43. Choudhary MK, Bodakhe SH, Gupta SK. Assessment of the antiulcer potential of *Moringa oleifera* root-bark extract in rats. Journal of Acupuncture and Meridian Studies. 2013;6(4):214-220.
44. Pal R, Pandey P, Rizwan M, Koli M, Thakur SK, Malakar RK, *et al.* The Utilization of Response Surface Methodology (RSM) In the Optimization of Diclofenac Sodium (DS) Liposomes Formulate through the Thin Film Hydration (TFH) Technique with Involving Computational Method. Journal of Advances in Medicine and Medical Research. 2023;35(22):287-300.
45. Zade V, Dabhadkar D. Antifertility effect of alcoholic extract of *Moringa oleifera* stem bark on estrous cycle and estrogenic activity of female albino rat. American Journal of Advanced Drug Delivery. 2015;3(3):223-235.
46. Paikra BK, Gidwani B. Phytochemistry and pharmacology of *Moringa oleifera* Lam. Journal of Pharmacopuncture. 2017;20(3):194.
47. Meireles D, Gomes J, Lopes L, Hinzmann M, Machado J. A review of properties, nutritional and pharmaceutical applications of *Moringa oleifera*: integrative approach on conventional and traditional Asian medicine. Advances in Traditional Medicine. 2020;20(4):495-515.
48. Thakur SK, Pal R, Pandey P, Singh A, Chanana A, Singh R. Approaches of drug-excipients interaction in pharmaceutical drug product formulation. 2023;12:347-366. DOI: 10.20959/wjpr20232-26923.
49. Granello SJ, Bechlin TR, Christ D, Coelho SRM, de Oliveira Paz CH. An approach to recent applications of *Moringa oleifera* in the agricultural and biofuel industries. South African Journal of Botany. 2021;137:110-116.
50. Pal R, Pandey P, Nogai L, Anand A, Suthar P, SahdevKesar M. The future perspectives and novel approach on gastro retentive drug delivery system (GRDDS) with current state. Journal of Population Therapeutics and Clinical Pharmacology. 2023;30(17):594-613.
51. Anwar F, Latif S, Ashraf M, Gilani AH. *Moringa oleifera*: a food plant with multiple medicinal uses. Phytotherapy Research. 2007;21(1):17-25.
52. Hussain S, Malik F, Mahmood S. Review: an exposition of medicinal preponderance of *Moringa oleifera* (Lank.). Pakistan Journal of Pharmaceutical Sciences. 2014;27(2):397-403.
53. Thakur SK, Pal R, Jha D, Dutta P, Pandey P, Tripathi BD. The Application of Response Surface Methodology (RSM) In the Computational Optimization of Sustained Release (SR) For Phenothiazine Derivative Matrix Tablet. Journal of Pharmaceutical Research International. 2023;35(35):13-27.
54. Wisitpongpan P, Suphrom N, Potup P, Nuengchamnon N, Calder PC, Usuwanthim K. *In vitro* Bioassay-Guided Identification of Anticancer Properties from *Moringa oleifera* Lam. Leaf against the MDA-MB-231 Cell Line. Pharmaceuticals (Basel). 2020;13(12):464.