Review Article

PRESENT REVIEW ON PHYTOCHEMISTRY, NEUTRACEUTICAL, ANTIMICROBIAL, ANTIDIABETIC, BIOTECHNOLOGICAL AND PHARMACOLOGICAL CHARACTERISTICS OF MORINGA OLEIFERA LINN.

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ABSTRACT

Nature has provided a complete store-house of remedies to cure all ailments of mankind. Records of pre-historic civilization in different parts of the world revealed considerable range of medicinal plants to cure human ailments. M. oleifera belongs to family Nyctaginaceae. M. oleifera has been extensively used in almost all folklore remedies around the world for treating a variety of conditions. It has been reported that indigenous Mexican population uses various decoctions and preparations of M. oleifera for muscular pain, diarrhoea, dysentery, and abdominal colic. The plant has been extensively studied for a variety of bioactive principles and screened for different pharmacological activities. The ethanolic extract of the leaves and the stem was found to have potent antinociceptive activity in experimental mice. The plant has also proved to possess antibacterial, antiviral and antioxidant activity. This article briefly reviews the botany, pharmacology, biochemistry and therapeutic application of the plant. This is an attempt to compile and document information on different aspects of M. oleifera and highlight the need for research and development.

KEYWORDS: M. oleifera, Drumstick, Phytochemical, Pharmacology, Phytophysiological.

INTRODUCTION

Moringa oleifera is the most widely cultivated species of the genus Moringa, which is the only genus in the family Moringaceae. English common names include: moringa Drumstick (The appearance of the long, slender, triangular seed-pods), horseradish tree (The taste of the roots, which resembles horseradish), ben oil tree, or benzoil tree (The oil which is derived from the seeds) [1]. It is a fast-growing, drought-resistant tree, native to the southern foothills of the Himalayas in northwestern India, and widely cultivated in tropical and subtropical areas where its young seed pods and leaves are used as vegetables. It can also be used for water purification and hand washing, and is sometimes used in herbal medicine [2].

DESCRIPTION

M. oleifera is a fast-growing, deciduous tree [3]. It can reach a height of 10–12 m (32–40 ft) [4], and the trunk can reach a diameter of 45 cm (1.5 ft) [5]. The bark has a whitish-grey colour and is surrounded by thick cork. Young shoots have purplish or greenish-white, hairy bark. The tree has an open crown of drooping, fragile branches and the leaves build up feathery foliage of tripinnate leaves. The flowers are fragrant and bisexual, surrounded by five unequal, thinly veined, yellowish-white
petals. The flowers are about 1.0–1.5 cm (1/2") long and 2.0 cm (3/4") broad. They grow on slender, hairy stalks in spreading or drooping later flower clusters which have a length of 10–25 cm [6]. Flowering begins within the first six months after planting. In seasonally cool regions, flowering only occurs once a year between April and June. In more constant seasonal temperatures and with constant rainfall, flowering can happen twice or even all year-round [6]. The fruit is a hanging, three-sided brown capsule of 20–45 cm size which holds dark brown, globular seeds with a diameter around 1 cm. The seeds have three whitish papery wings and are dispersed by wind and water [7]. In cultivation, it is often cut back annually to 1–2 m (3–6 ft) and allowed to regrow so the pods and leaves remain within arm’s reach.

**BREEDING**

In India, from where *moringa* most likely originated, the diversity of wild types is large [8]. This gives a good basis for breeding programs. In countries where *moringa* has been introduced, the diversity is usually much smaller among the cultivar types. Locally well-adapted wild types, though can be found in most regions. Because *moringa* is cultivated and used in different ways, there are different breeding aims. The breeding aims for an annual or a perennial plant are obviously different. The yield stability of fruits is an important breeding aim for the commercial cultivation in India, where *moringa* is cultivated as an annual. On less favorable locations, perennial cultivation has big advantages. Erosion is much smaller with perennial cultivation [8]. In Pakistan, varieties have been tested for their nutritional composition of the leaves on different locations [9]. The different breeding aims result in a different selection. India selects for a higher number of pods and dwarf or semidwarf varieties. Breeders in Tanzania, though, are selecting for higher oil content [10].

The leaves are the most nutritious part of the plant, being a significant source of B vitamins, vitamin C, provitamin A as beta-carotene, vitamin K, manganese, and protein, among other essential nutrients [3, 9, 10]. When compared with common foods particularly high in certain nutrients per 100 g fresh weight, cooked *moringa* leaves are considerable sources of these same nutrients. Some of the calcium in *moringa* leaves is bound as crystals of calcium oxalate [11]. The leaves are cooked and used like spinach and are commonly dried and crushed into a powder used in soups and sauces. The immature seed pods, called "drumsticks", are commonly consumed in South Asia. They are prepared by parboiling, and cooked in a curry until soft [12]. The seed pods/fruits, even when cooked by boiling, remain particularly high in vitamin C [13]. (Which may be degraded variably by cooking) and are also a good source of dietary fiber, potassium, magnesium, and manganese [13].

The seeds, sometimes removed from more mature pods and eaten like peas or roasted like nuts, contain high levels of vitamin C and moderate amounts of B vitamins and dietary minerals. Mature seeds yield 38–40% edible oil called ben oil from its high concentration of behenic acid. The refined oil is clear and odorless, and resists rancidity. The seed cake remaining after oil extraction may be used as a fertilizer or as a flocculent to purify water [14]. Moringa seed oil also has potential for use as a biofuel [15]. The roots are shredded and used as a condiment with sharp flavor qualities deriving from significant content of polyphenols [16].

**Figure 1:** Seeds, Green Pods, Dry Pods, Flower, and branches of *M. oleifera*
**Malnutrition relief**

*Moringa* trees have been used to combat malnutrition, especially among infants and nursing mothers [3,17]. Since *moringa* thrives in arid and semiarid environments it may provide a versatile, nutritious food source throughout the year. Dunt-dalun chin-yei, Burmese drumstick sour soup *Moringa* has numerous applications in cooking throughout its regional distribution. It may be preserved by canning but is often made into a variety of curry dishes by mixing with coconut, poppy seeds, and mustard or boiled until the drumsticks are semisoft and consumed directly without any further processing or cooking. It is used in curries, sambars, kormas, and dals, although it is also used to add flavor to cutlets and other recipes.

The fruit meat of drumsticks, including young seeds, is used for soup. Young leaves can either be fried with shrimp or added as a topping in fish soup. Several traditional dishes use leaves (sluç) of the *moringa* tree known as daum m’rum [19]. Such as korko (a mixed vegetable soup). As it is a favorite vegetable, Cambodians traditionally grow *moringa* trees close to their residences. Tender drumstick leaves, finely chopped, are used as garnish for vegetable dishes and salads. The long *moringa* seed pods are cut into shorter lengths and stewed in curries. These pods, green pods, and flowers are used in a variety of *Thai* dishes, such as curries, stir-fries, soups, omelets, and salads. A traditional dish is sour *Thai* curry made with drumstick pods and fish. *Moringa* leaves are commonly added to broth as a simple soup. The leaves may also be used as a typical ingredient in tinola, a traditional chicken dish consisting of chicken in a broth, *moringa* leaves, and either green papaya or another vegetable or in the all vegetable dish known as utan. The leaves can also be processed with olive oil and salt for a pesto-like pasta sauce. *Moringa* juice may be mixed with lemonsito juice to make ice candies or cold drinks. In Indonesia, the leaves are commonly eaten in a clear vegetable soup, often with corn, spinach and coconut milk.

**WATER PURIFICATION**

*Moringa* seed cake, obtained as a byproduct of pressing seeds to obtain oil, is used to filter water using flocculation to produce potable water for animal or human consumption [20, 21]. *Moringa* seeds contain dimeric cationic proteins [22]. Which absorb and neutralize colloidal charges in turbid water, causing the colloidal particles to clump together, making the suspended particles easier to remove as sludge by either settling or filtration. *Moringa* seed cake removes most impurities from water. This use is of particular interest for being nontoxic and sustainable compared to other materials in *moringa*-growing regions where drinking water is affected by pollutants [21].

**Ayurveda Treatment in 300 diseases has been reported from the drumstick**

There is a legume tree that year in the south. It is inserted into the sambar. Once a year, while in the north it is the same pod. Once the flowers also make winter vegetable is eaten. Then the soft vegetable bean is created. Pruning of trees and will be after this abdominal diseases and kapha diseases, arthritis and colic in a pod, leaf eye, sprains, Siatika, is useful in Ayurveda treatment in 300 diseases have been reported from the drumstick. The pods, green leaves and dry leaves, carbohydrates, protein, calcium, potassium, iron, magnesium, vitamin A, C and B complex is found in plenty. - The flowers in the arthritis etc. Mix honey in the bark of drumstick vata, kapha disease and become calm. The leaf decoction of arthritis, Siatika, stroke, air disorder early benefits. The decoction of its root in Siatika rapid velocity looks miraculous effects, - Sprains etc. drumstick leaf when making pulp and mustard oil and cook on low strain shortly benefit from putting in place of sounds.

Air drumstick eighty kinds of pain and 72 types of disorders have been reported suppressor. The vegetable from chronic arthritis, joint pain, accumulation of air, is useful in rheumatic diseases. Fresh drumstick leaves juice in the ear pain is putting Kidney and urinary stones slip drumstick vegetable leaves. Extract of the root bark, add rock salt and drink Hing is useful in the formation of gallstones. The juice of the leaves removes children Kidney stomach prevents diarrhea and vomiting. The juice is useful in hypertension early evening drink. Intake of the juice of its leaves gradually decreases obesity. To rinse teeth decoction of the bark worms are destroyed and in pain relief. - It eliminates constipation by eating greens soft leaves. Kade its root with the rock salt and Hing Consumption benefits in epileptic seizures. Grind the leaves from the wound and heal inflammation. It also has light eyes - Drumstick soup as you can drink the blood of the body is clean. Only then will the problems of Pimpalgaon will clean the blood from the inside.
Moringa oleifera is an interesting plant for its use in bioactive compounds. In this manuscript, we review studies concerning the cultivation and production of Moringa along with genetic diversity among different accessions and populations. Different methods of propagation, establishment and cultivation are discussed. However, there are still too few studies on humans to recommend Moringa leaves as medication in the prevention or treatment of diseases. Therefore, further studies on humans are recommended [26]. The influence of Moringa oleifera (MO) leaf extract as a dietary supplement on growth performance and antioxidant parameters was evaluated on broiler meat. The compounds responsible for the corresponding antioxidant activity were identified. 0.5%, 1.0%, and 1.5% w/w of MO leaf aqueous extracts (MOLE) were prepared, and nutritional feed supplemented with 0%, 0.5%, 1.0%, and 1.5% w/w of MO leaf meal (MOLM) were prepared and analysed for their antioxidant potential. Furthermore, the treated broiler groups (control (T1) and treatment (T2, T3, and T4)) were evaluated for performance, meat quality, and antioxidant status [27]. Metabolite extraction methods have been shown to be a critical consideration for pharmacometabolomics studies, and as such, optimization and development of new extraction methods are crucial. In the current study, an organic solvent-free method, namely, pressurised hot water extraction (PHWE), was used to extract pharmacologically important metabolites from dried Moringa oleifera leaves. The use of MS in combination with PCA was furthermore shown to be an excellent approach to evaluate the quality and content of pharmacologically important extracts [30]. Moringa oleifera is a medicinal plant and an excellent dietary source of micronutrients (vitamins and minerals) and health-promoting phytochemicals (phenolic compounds, glucosinolates and isothiocyanates). Glucosinolates and isothiocyanates are known to possess anti-carcinogenic and antioxidant effects and have attracted great interest from both toxicological and pharmacological points of view, as they are able to induce phase 2 detoxification enzymes and inhibit phase 1 activation enzymes. Second, LC-MS and LC-MS/MS qualitative and quantitative methods were used for the identification and determination of phenolics and glucosinolates in M. oleifera [31]. Fresh leaves of M. oleifera plants were analysed for nutritionally important phytoconstituents and feasible commercially used dehydration methods were evaluated to preserve these in dehydrated leaves. The product was evaluated using Quantitative Descriptive Analysis and was accepted with a high overall quality score. The present investigation explores the nutritional potential of M.oleifera leaves and suitable methods of drying that could be useful for processed food formulation [32].
DMBA (15 mg/kg bodyweight) [34]. *Moringa* is a mycorrhizal crop cultivated in the tropics and subtropics and appreciated for its nutritive and health-promoting value. As well as improving plant mineral nutrition, arbuscular mycorrhizal fungi (AMF) can affect plant synthesis of compounds bioactive against chronic diseases in humans. Rhizopagus intraradices and Funneliformis mosseae were used in a full factorial experiment to investigate the impact of AMF on the accumulation of glucosinolates, flavonoids, phenolic acids, carotenoids, and mineral elements in *moringa* leaves [35].

The antioxidant capacity and antimicrobial activity of the essential oil of *Moringa oleifera* (*Moringaceae*) grown in Mozambique was investigated. The antimicrobial activity of the essential oil was assayed against two Gram-positive strains (*Bacillus cereus*, *Staphylococcus aureus*), two Gram-negative strains (*Escherichia coli*, *Pseudomonas aeruginosa*), and five fungal strains of agro-food interest (*Penicillium aurantiogriseum*, *Penicillium expansum*, *Penicillium citrinum*, *Penicillium digitatum*, and *Aspergillus niger* sp.). *B. cereus* and *P. aeruginosa*, as well as the fungal strains were sensitive to the essential oil [36]. The present study determined the chemical composition, fatty acid (FA) content and antioxidant capacity of meat from goats supplemented with *Moringa oleifera* leaves (MOL) or sunflower cake (SC) or grass hay (GH). The meat from goatsupplemented with MOL had higher concentrations of total phenolic content (10.62±0.27 mg tannic acid equivalent E/g). The MOL significantly scavenged 2,2′-azino-bis-3-ethylbenzothiazoline-6-sulfonic acid (ABTS) radical to 93.51±0.19% (93.51±0.19%) and 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical to 58.95±0.3% than other supplements. The oxidative effect of MOL supplemented meat on catalase (CAT), reduced glutathione (GSH), superoxide dismutase (SOD) and lipid oxidation (LO) was significantly (P<0.05) higher than other meat from goat feed on grass hay or those supplemented with sunflower seed cake [37]. The purpose of this study was to determine the effects of an extract from *Moringa oleifera* (MO) on the development of monocrotaline (MCT)-induced pulmonary hypertension (PH) in Wistar rats. Chronic treatments with the MO extract reversed the MCT-induced changes. Additionally, the MCT group had a significant elevation in superoxide dismutase activity when normalized by the MO extract treatments. In conclusion, the MO extract successfully attenuated the development of PH via direct vasodilation and a potential increase in antioxidant activity [38].

*Moringa oleifera*, Lam. (*Moringaceae*) is grown worldwide in the tropics and sub-tropics of Asia and Africa and contains abundant various nutrients. This study describes the effect of different parts (leaf, stem and stalk) and seasons (summer and winter) on the chemical compositions and antioxidant activity of *M. oleifera* grown in Taiwan. The *Moringa* extract showed strong hydrogen peroxide scavenging activity and high superoxide dismutase (SOD) activity except the stalk part [39]. To develop a rapid and sensitive liquid chromatography-tandem mass spectrometry (LC-MS/MS) method to analyze quercetin (QU), rutin (RU) and kaempferol (KA) simultaneously in the leaf extracts of *Moringa oleifera* Lam. and Raphinus sativus Linn. Samples were prepared by extracting the leaves of the *M. oleifera* and *R. sativus* by cold-maceration technique using 90% ethanol. The lower limit of quantitation achieved for QU, RU and KA was 5 ng/mL and the linearity was observed from 5 to 2000 ng/mL. The correlation coefficients of linear regression analysis were 0.9946, 0.9951 and 0.9969 for QU, RU and KA, respectively [40]. Two new caffeoyl quinic acid α-glucosides, together with three known caffeoylquinic acids and five known flavonoid glucosides, were isolated from the leaves of *Moringa oleifera* Lam. The structures of the new compounds were elucidated as 4-O-(4′-O-D-glucopyranosyl)-caffeoyl quinic acid (1) and 4-O-(3′-O-D-glucopyranosyl)-caffeoyl quinic acid (2) by spectroscopic analyses [41]. Epidemiological studies have revealed that a diet rich in plant-derived foods has a protective effect on human health. Identifying bioactive dietary constituents is an active area of scientific investigation that may lead to new drug discovery. This information may help understand the health benefits of *kaempferol*-containing plants and may contribute to develop this flavonoid as a possible agent for the prevention and treatment of some diseases [42].

**Antioxidant, Antiaging, Antifelgue, Antiflammetry**

The effects of the aqueous extract of *Moringa oleifera* on swimming performance and related biochemical parameters were investigated in male Wistar rats (130-132 g). Four groups of rats (16 per group) were fed a standard laboratory diet and given distilled water, 100, 200, or 400 mg/kg of extract, respectively, for 28 days. On day 28, 8 rats from each group were subjected to the forced swimming test with tail load (10% of body weight). *M. oleifera* extract increased maximum swimming time, blood hemoglobin, blood glucose, and hepatic and muscle glycogen reserves. In conclusion, the antifatigue properties of *M. oleifera* extract are demonstrated by its ability to improve body energy stores and tissue antioxidant capacity and to reduce the tissue build-up of lactic acid [43]. High fat diet (HFD) prompts metabolic pattern inducing reactive oxygen species (ROS) production in mitochondria thereby triggering multitude of chronic disorders in human. Antioxidants from plant sources may be an imperative remedy against this disorder. However, it requires scientific validation. Swiss mice were fed with HFD to develop oxidative stress model (HFD group) [44]. *Moringa oleifera* leaves are a well-known source of antioxidants and traditionally used for medicinal applications. In the present study, the protective action of soluble *M. oleifera* leaf extract (MOLE) against cadmium toxicity was investigated in the model eukaryote *Saccharomyces cerevisiae*. Our findings suggest the potential use of soluble extract from *M. oleifera* leaves as a dietary supplement for protection against cadmium accumulation and oxidative stress [45]. *Moringa oleifera* Lam. (*M. oleifera*) possess highest concentration of antioxidant bioactive compounds and is anticipated to be used as an alternative medicine for inflammation. In the present study, we investigated the anti-inflammatory activity of 80% hydroethanolic extract of *M. oleifera* flower on proinflammatory mediators and cytokines produced in lipopolysaccharide (LPS)-induced RAW 264.7 macrophages [46].
Menopause is a gradual three-stage process that concludes with the end of periods and reproductive life. The antioxidant enzyme system gets affected in postmenopause due to deficiency of estrogen, which has got antioxidant properties. The objective of the present study was therefore, to analyze the effect of supplementation of drumstick and amaranth leaves powder on blood levels of antioxidant and marker of oxidative stress. The results indicated that these plants possess antioxidant property and have therapeutic potential for the prevention of complications during postmenopause [49]. The leaves of *Moringa oleifera*, collected in different provinces in Thailand, were determined for the contents of total phenolics, total flavonoids, major components, and antioxidant activity. Treatment with isoquercetin significantly increased the mRNA expression levels of antioxidant enzymes such as superoxide dismutase, catalase, and heme oxygenase 1. These results confirm that *M. oleifera* leaves are good sources of natural antioxidant with isoquercetin as an active compound [50]. *Moringa oleifera* Lam. (*Moringaceae*) is a rich source of antioxidants. All parts of the plant are medicinally important and have been used as traditional medicine for a variety of human ailments in India. Therapeutic efficacy of adjuvants with *M. oleifera* (MO) root extract was investigated against beryllium-induced oxidative stress. Curcumin enhanced therapeutic efficacy of *M. oleifera* root extract and showed better antioxidant potential against beryllium toxicity [51].

*Moringa oleifera* Lam. is a fast-growing, tropical tree with various edible parts used as nutritious food and traditional medicine. This study describes an efficient preparatory strategy to extract and fractionate *moringa* leaves by fast centrifugal partition chromatography (FCPC) to produce polyphenol and disothiocyanates (ITC) rich fractions. These findings suggest that *moringa* leaves contain a potent mixture of direct and indirect antioxidants that can explain its various health-promoting effects [52]. Cyclophosphamide (CP), an alkylating antineoplastic agent is widely used in the treatment of solid tumors and B-cell malignant disease. It is known to cause urinary bladder damage due to inducing oxidative stress. Rats were sacrificed 24h after CP injection. Biochemical analysis showed significant elevation of malondialdehyde, while reduced glutathione activity was significantly lowered. From the results obtained in this work, we can say that *Moringa* leaves play an important role in ameliorating and protecting the bladder from CP toxicity [53]. *Moringa oleifera* is a tree belonging to *Moringaceae* family and its leaves and seeds are reported to have ameliorative effects against metal toxicity. In the blood, delta-amino levulinic acid dehydratase (ALAD) activity, RBC, WBC, hemoglobin, and hematocrit showed significant (p<0.05) decrease on lead exposure. However, administration of *M. oleifera* restored all the parameters back to control, tissue-specifically, and also showed improvement in restoration better than DMSA treatment, indicating reduction of the negative effects of lead-induced oxidative stress [54].

The discovery of bioactive compounds in foods has changed the dietary lifestyle of many people. The DPPH inhibition activity of the beverages prepared with germinated tigernut extracts was significantly higher than the DPPH inhibition activity of the beverages prepared with fresh tigernut extract. The taste and overall acceptability of drinks containing the roasted tigernut extract were preferred, while the color and appearance of drinks with the germinated samples were preferred. Roasting or germinating tigernuts before extraction and addition of MOE or HSE extracts is another way to add value and enhance the utilization of tigernuts [55]. Anti-inflammatory, immuno-modulatory, and antioxidant properties of *Moringa* oleifera Lam. suggest that it might have beneficial effects on colitis. The present study was performed to investigate the anticolitis effect of *Moringa oleifera* seeds hydro-alcoholic extract (MSHE) and its chloroform fraction (MCF) on acetic acid-induced colitis in rats. Since the efficacy was evident even in lowdoses of MSHE, presence of active constituents with high potency in seeds is persuasive [56]. A study was under taken to assess variation in antioxidant, antimicrobial and phytochemical properties of thirteen *Moringa oleifera* cultivars obtained from different locations across the globe. Standard antioxidant methods including the DPPH scavenging, ferric reducing power (FRAP) and β-carotene-linoleic acid model were used to evaluate the activity. The information offers an understanding on variations between cultivars from different geographical locations and is important in the search for antioxidant supplementation and anti-ageing products [57].

*Moringa* (*Moringa oleifera* Lam.) is an edible plant used as both a food and medicine throughout the tropics. A *moringa* concentrate (MC), made by extracting fresh leaves with water utilized naturally occurring myrosinase to convert four *moringa* glucosinolates into moringa isothiocyanates. These results suggest apotential for stable and concentrated *moringa* isothiocyanates, delivered in MC as a food-grade product, to alleviate low-grade inflammation associated with chronic diseases [58]. The antioxidant and hepatoprotective activities of the extract of *Moringa oleifera* leaves were investigated against CCl₄-induced hepatotoxicity in rats. Hepatotoxic rats were treated with ethanol extract of *Moringa oleifera* for a period of 60 days at the following three dose levels; 100, 200 and 400 mg/kg bodyweight/day, orally. Results suggest that the
antioxidant and hepatoprotective activities of *M. oleifera* leaves are possibly related to the free radicals scavenging activity which might be due to the presence of total phenolics and flavonoids in the extract and/or the purified compounds β-sitosterol, quercetin and kaempferol, which were isolated from the ethanol extract of *M. oleifera*, leaves [59]. Free radicals trigger chain reaction and inflict damage to the cells and its components, which in turn ultimately interrupts their biological activities. High-performance liquid chromatography (HPLC) finger prints of the 90% gradient extract visually showed few specific peaks, which on further analysis, using HPLC-DAD-ESI-MS, were identified as flavonoids and their derivatives. These findings might help researchers to further scrutinize this high activity exhibiting gradient extract and its bioactive candidates for fruitful clinical/translational investigations [60].

To evaluate and compare the antioxidant potential and anti-inflammatory activity of ethanolic extract of flowers of *Moringa oleifera* (*M. oleifera*) grown in Oman. Flowers of *M. oleifera* were collected in the month of December 2012 and identified by a botanist. The results of our study suggest that flowers of *M. oleifera* possess potent anti-inflammatory activity and are also a good source of natural antioxidants. Further study is needed to identify the chemical compounds responsible for their anti-inflammatory activity [61].

African ethnomedicine is essentially based on the traditional use of vegetal extracts. Since these natural drugs have shown health-giving properties, in the present study we increased further the scientific basis supporting these data. These results, on the bioactivity and the biochemical characteristics of African plant extracts, may increase the comprehension of indigenious therapeutic practices and represent the first step for the individuation of new inexpensive and natural drugs able to prevent and contrast cancer onset [62].

Consumption of a high-fat diet (HFD) promotes reactive oxygen species (ROS) which ultimately trigger inflammation. The aim of this study was to investigate the role of *Moringa oleifera* leaf extract (MoLE) and its active component quercetin in preventing NF-κB-mediated inflammation by short-term HFD. All these changes were reversed in the MoLE/quercetin-treated groups with significant improvement of antioxidant activity compared to the HFD group. Thus, the present study concluded that short-term treatment with MoLE and its constituent quercetin prevent HFD-mediated inflammation in mice [63]. The present study aimed to evaluate the retino protective effects of *Moringa oleifera* (MO) in Streptozotocin-induced diabetic rats. The study was continued for 24 weeks and evaluated for inflammatory (tumor necrosis factor [TNF]-α and interleukin [IL]-1β), angiogenic (vascular endothelial growth factor [VEGF] and protein kinase C [PKC]-β) and antioxidant (Glutathione, Superoxide dismutase, and Catalase) parameters. Transmission electron microscopy was used to determine basement membrane (BM) thickness. Our result suggests that MO may be useful in preventing diabetes-induced retinal dysfunction [64].

The vegetables and fruits commonly consumed in Thailand have been suggested as rich sources of beneficial phytochemicals. The antibacterial assays showed that *Moringa oleifera* Lam., *Limnophila aromatica* (Lamk., Merr terminali achebula Retz. And *Phyllanthus emblica* Linn. That were extracted using 80% ethanol as solvent were found to have antibacterial activities against *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Streptococcus pyogenes* and *Propioni bacterium acnes*. The results in this study may be useful for future application of edible plants that are native to Thailand to be used as cosmetic or therapeutic products [65].

The aim of the study was to investigate the in vitro antioxidative properties of *Moringa oleifera* Lam. (MO) and its curative role in acetaminophen (APAP)-induced toxic liver injury in rats caused by oxidative damage. The total phenolic content and antioxidant properties of hydroethanolic extracts of different MO edible parts were investigated by employing an established in vitro biological assay. The results of this study strongly indicate the therapeutic properties of MO hydroethanolic extracts against acute liver injury and thereby scientifically support its traditional use [66].

Consumption of high-fat diet (HFD) induces nonalcoholic fatty liver disease (NAFLD) and may lead to multiple complications affecting human health. In the present study, effect of *Moringa oleifera* leaf extract (MoLE) in alleviating HFD-induced liver injury in mice has been reported. Moreover, significant increase in endogenous antioxidant parameters and lower lipid peroxidation were found in liver of all MoLE treated groups. Results of the study indicated that MoLE has both preventive as well as curative hepatoprotective activity [67].

The present study investigated the antioxidant properties of *Moringa oleifera* leaves in vitro systems using standard phytochemical methods. The antioxidant effect on the activities of superoxide dismutase (SOD), catalase (CAT), lipid peroxidation (LPO) and reduced glutathione (GSH) were investigated in goats supplemented with *M. oleifera* (MOL) or sunflower seed cake (SC). Lipid peroxidation was significantly reduced by MOL. The present study suggests that *M. oleifera* could be a potential source of compounds with strong antioxidant potential [68]. *Moringa oleifera* is an important source of antioxidants, tools in nutritional biochemistry that could be beneficial for human health; the leaves and flowers are used by the population with great nutritional importance. This work investigates the antioxidant activity of *M. oleifera* ethanolic (E1) and saline (E2) extracts from flowers (a), inflorescence rachis (b), seeds (c), leaf tissue (d), leaf rachis (e) and fundamental tissues of stem (f). In conclusion, *M. oleifera* ethanolic and saline extracts contain antioxidants that support the use of the plant tissues as food sources [69]. The antioxidant system of a plant comprises a group of chemicals that are highly diverse in their sources, effects and uses. These antioxidants are capable of contracting and damaging free radicals. This investigation deals with a screening and comparison of the antioxidant activity of 20 selected medicinal plants and their parts, individually and in combination with vitamins A, C or E, using the DPPH radical scavenging method. *Moringa oleifera* Lam and *S. album* have also shown fairly significant AE in a vitamin combination dose of 0.001 mM concentration [70].

The present study evaluated the hepatoprotective effect of aqueous ethanolic *Moringa oleifera* leaf extract (MoLE)
against radiation-induced oxidative stress, which is assessed in terms of inflammation and lipid peroxidation. Swiss albinomice were administrated MoLE (300 mg/kg of body weight) for 15 consecutive days before exposing them to a single dose of 5 Gy of $^{60}$Co γ-irradiation. Mice were sacrificed at 4 hours after irradiation. Liver was collected for immunoblotting and biochemical tests for the detection of markers of hepatic oxidative stress, CAT, GSH, and FRAP were observed in the mice treated with MoLE prior to irradiation. Therefore pretreatment with MoLE protected against γ-radiation-induced liver damage [71]. Studies have demonstrated that the induction of oxidative stress may be involved in oxidative DNA damage. The present study examined and assessed the hydrogenperoxide (H$_2$O$_2$)-mediated DNA damage in human tumor KB cells and also assessed the ability of *Moringa oleifera* leaf extracts to inhibit the oxidative damage. H$_2$O$_2$ imposed a stress on the membrane lipids which was quantified by the extent of thiobarbituric acid reactive substances (TBARS) formed [72]. The present study was designed to evaluate the efficacy of *Moringa oleifera* leaves against carbon tetrachloride (CCL$_4$)-treated liver slices in vitro. The study evaluated the antioxidant properties of *Moringa oleifera* leaves against (CCL$_4$)-induced oxidative damage in liver slices. (CCL$_4$) treatment significantly decreased the activities of antioxidatenzymes such as superoxide dismutase, catalase, glutathione peroxidase, glutathione reductase, and glutathione S-transferase and caused decreased glutathione content and increased the thiobarbituric acid reacting substances (TBARS). Our findings provide evidence to demonstrate that the possible mechanism of this activity may be due to the strong antioxidant property of the leaves [73].

Bioassay-guided isolation and purification of the ethyl acetate extract of *Moringa oleifera* fruits yielded three new phenolic glycosides; 4-[(2'-O-acetyl-alpha-l-rhamnopyranosyl) benzyl]isothiocyanate (1),4-[(3'-O-acetyl-alpha-l-rhamnopyranosyl)benzyl]isothiocyanate (2), and 4'-S-methyl-N-cinnamoyl-(3',6)-O acetyl-6, and decreased antioxidant enzyme in the serum and kidney tissue homogenate compared with that of the negative control group. Urine analysis showed also glucosuria and increased urinary ketone bodies. The present study investigated the role of antioxidant enzyme system following crude hydroethanolic extract of *Moringa oleifera* leaves (MO) in acute paracetamol (PCM) induced hepatotoxicity. The level of glutathione peroxidase (GPx), glutathione-Stransferase (GST) and glutathione reductase (GR) was restored to near normal in groups that were pretreated with MO. Histopathological studies have further confirmed the hepato protective activity of MO compared to group treated with PCM only. There was no significant difference in body weight among groups.

The antidiabetic activity of two low doses of *Moringa* seed powder (50 and 100 mg/kg body weight, in the diet) on streptozotocin (STZ)-induced diabetes mellitus was investigated. Forty rats were divided into four groups. The diabetic control (STZ treated) group showed increased lipid peroxide, increased IL-6, and decreased antioxidant enzyme in the serum and kidney tissue homogenate compared with that of the negative control group. Urine analysis showed also glucosuria and increased potassium, sodium, creatinine, uric acid, and albumin levels [79]. *Moringa oleifera* Lam. contains many active ingredients with nutritional and medicinal values. It is commonly used in folk medicine as an antidiabetic agent. The present study was designed to investigate how an aqueous extract from the leaves of *Moringa oleifera* reveals hypoglycemia in diabetic rats. This study revealed that the aqueous extract of *Moringa oleifera* leaves possesses potent hypoglycemic effect through the normalization of elevated hepatic pyruvate carboxylase enzyme and regeneration of damaged hepatocytes and pancreatic $\beta$ cells via its antioxidant properties [80]. *Moringa oleifera* has been regarded as a food substance since ancient times and has also been used as a treatment for many diseases. Recently, various therapeutic effects of *Moringa oleifera* such as antimicrobial, anticancer, anti-inflammatory, antidiabetic, and antioxidant effects have been investigated; however, most of these studies described only simple biological phenomena and their chemical compositions. These results suggest the potential therapeutic implications of the soluble extract from *Moringa oleifera* in the treatment of various types of cancers [81]. Medicinal plants attract growing interest in the therapeutic management of diabetes mellitus. *Moringa oleifera* from the family Moringaceae, is used as a source of vegetable and herbal medicine and in the treatment of various cancers in many African countries, including Kenya. The present study involved the phytochemical analyses of the crude extracts of *Moringa oleifera* and biological activities (antioxidant, cytotoxicity and induction of apoptosis in vitro) of selected isolated compounds. Apoptosis studies were carried out using the acridine orange/ethidium bromide staining method. Comparatively both compounds showed much lower cytotoxicity against the HEK293 cell line with IC$_{50}$ values of 186 µg mL$^{-1}$ and 224 µg mL$^{-1}$, respectively [76]. Renewed interest in natural materials as food flavors and preservatives has led to the search for suitable essential oils. *Moringa oleifera* seed essential oil was extracted by solvent-free microwave and hydrodistillation. Larva lethality was different significantly (P<0.05) between HDE and SME oils at different concentrations and incubation periods. The median lethal concentration (LC$_{50}$) of the oils was $>$1000 mg/ml recommended as an index for non-toxicity, which gives the oil advantage over some antioxidant, antimicrobial, therapeutic, and preservative chemicals [77]. *Moringa oleifera* Lam. (Moringaceae) is widely consumed in tropical and subtropical regions for their valuable nutritional and medicinal characteristics. Recently, extensive research has been conducted on leaf extracts of *Moringa oleifera* to evaluate their potential cytotoxic effects. Further, the IC$_{50}$ values obtained for MCF-7, Hela and HepG2 cells were 226.1, 422.8 and 751.9µg/mL respectively. Conclusively, the present investigation provides preliminary results which suggest that seed essential oil from *Moringa oleifera* has potent cytotoxic activities against cancer cell lines [78].
Moringa oleifera is a remarkably nutritious vegetable with several antioxidant properties. The histopathological damage of islet cells was also markedly reversed. Morphometrically, M. oleifera significantly increased the areas of positive purple modified Gomori stained β-cells (from 60% to 91%) and decreased the areapercentage of collagen fibers (from 199% to 120%) compared to control values. Experimental findings clearly indicate the potential benefits of using the aqueous extract of M. oleifera leaves as a potent antidiabetic treatment [82]. This study was conducted to determine the mechanism underlying the chemotherapeutic efficacy of an ethanolic Moringa oleifera leaf extract (MOLEE) against chromium-induced impairments of rat testes using biochemical methods. After the blood samples were collected, the animals were sacrificed to determine the testicular antioxidant status and sperm parameters. However, concurrent administration of chromium and MOLEE significantly alleviated the chromium effects on the sperm parameters, local immunity, inflammatory markers, and antioxidant enzymatic activities compared with rats exposed to chromium alone [83].

In this study, we evaluated the anti-inflammatory effects of moringa (Moringa oleifera Lam.), a natural biologically active substance, by determining its inhibitory effects on pro-inflammatory mediators in lipopolysaccharide (LPS)-stimulated macrophage RAW264.7 cells resulting in lower levels of NF-κB transactivation. Collectively, the results of this study demonstrate that moringa fruit extract reduces the levels of pro-inflammatory mediators including NO, IL-1β, TNF-α and IL-6 via the inhibition of NF-κB activation in RAW264.7 cells. These findings reveal, in part, the molecular basis underlying anti-inflammatory properties of moringa fruit extract [84]. The present study was aimed at evaluating the antiulcer activity of the polyherbal formulation (PHF) containing the leaf extracts of Moringa oleifera, Raphinus sativus, and Amaranthus tricolor in rats. he antiulcer activity of the polyherbal formulation (PHF) was evaluated using different models of gastric ulcers: ethanol-induced, indomethacin-induced and ischemia-reperfusion-induced gastric ulcers. Efficacy was assessed by determining the ulcer index. [85]. To evaluate the antioxidant activity of aqueous extract of Moringa oleifera (M. oleifera) young leaves in vivo as well as in vitro assays. On the other hand, FRAP assay results of M. oleifera leaves was (85.00 ± 5.00) μM/g of extract powder. The significant antioxidant activities of M. oleifera leaves from both in vivo as well as in vitro studies suggest that the regular intake of its leaves through diet can protect normal as well as diabetic patients against oxidative damage [86].

Oxidative stress is a common mechanism contributing to initiation and progression of hepatic damage in a variety of liver disorders. Hence there is a great demand for the development of agents with potent antioxidant effect. Pretreatment with the Moringa oleifera (200 and 400 mg/kg) orally for 14 days significantly reversed the DMBA induced alterations in the liver tissue and offered almost complete protection. The results from the present study indicatetha Moringa oleifera exhibits good hepatoprotective and antioxidant potential against DMBA induced hepatocellular damage in mice that might be due to decreased free radical generation [87]. Moringa oleifera, a widely cultivated species in India, is an exceptionally nutritious vegetable with a variety of potential uses in treating rheumatism, venomous bites, and microbial infections. Histologic examination of the pancreas from diabetic rats showed degenerative changes in β-cells; MOME treatment significantly reversed the histoarchitectural damage to the islets cells. In conclusion, M. oleifera exerts protective effects against STZ-induced diabetes. The MOME exhibited significant antidiabetic and antioxidant activity and active constituents may be isolated from the extract for evaluation in future clinical studies [88]. Dietary polyphenols are antioxidants that can scavenge biological free radicals, and chemoprevent diseases with biological oxidation as their main etiologic factor. In this paper, we review our laboratory data vis-à-vis available literature on prostate cancer chemopreventive substances in Nigerian foodstuffs. Thus, the high incidence of prostate cancer among males of African extraction can be dramatically reduced, and the age of onset drastically increased, if the population at risk consumes the right kinds of foods in their diet, beginning early in life, especially as prostate cancer has an latency period of about 50 years [89]. Moringa oleifera Lamark is commonly consumed for nutritional or medicinal properties. Inhibitor of proteins such as cytochrome c oxidase (COX-2) and NOS are potent antiinflammatory and cancer chemopreventive agents. Majorupstream signaling pathways involved mitogen-activated protein kinases and nuclear factor-κB (NF-κB). RBITC inhibited phosphorylation of extracellular signal-regulated kinase and stress-activated protein kinase, as well as ubiquitin-dependent degradation of inhibitor of NF-κB (IκBα). These data suggest RBITC should be included in the dietary armamentarium of isothiocyanates potently capable of mediating anti-inflammatory or cancer chemopreventive activity [90]. Moringa oleifera Lam (horseradish tree; tender pod or fruits) is a majoringredient in Thai cuisine and has some medicinal properties. The PCNA index was also significantly decreased in Group 8 whereas iNOS and COX-2 protein expression were significantly decreased in Groups 7 and 8. The findings suggest that M. oleifera Lam pod exerts suppressive effects in a colitis-related colon carcinogenesis model induced by AOM/DSS and could serve as a chemopreventive agent [91].

Nutritional Health benefits

Moringa oleifera is a plant that grows in tropical and subtropical areas of the world. Its leaves are rich of nutrients and bioactive compounds. However, several differences are reported in the literature. Nevertheless, these leaves are agood and economical source of nutrients for tropical and sub-tropical countries. Furthermore, M. oleifera leaves are a source of flavonoids and phenolic acids, among which salicylic and ferulic acids, and therefore they could be used as nutraceutical and functional ingredients [92]. We evaluated the physicochemical properties and oxidative stability of the oil extracted from the seeds of Moringa oleifera during its refining process. Refining is accomplished in three stages: neutralization, degumming, and bleaching. Nine fatty acids were detected in all four samples, and there were no significant differences in their composition. Oleic acid was...
found in the largest amount, followed by palmitic acid and behenic acid. The crude, neutralized, and degummed oils showed high primary oxidation stability, while the bleached oil had a low incidence of secondary oxidation [93]. *Moringa oleifera* L. is a medicinal plant with potential antioxidant property. This study was aimed at investigating the chemoprotective effect of *Moringa oleifera* leaf extract (MOE) on cyclophosphamide (CP)-induced testicular toxicity. Two-week-old male Swiss albino mice were intraperitoneally injected with phosphate-buffered saline, 50 mg kg(-1) of CP and 25 mg kg(-1) of MOE. In conclusion, MOE may have potential benefit in reducing the loss of male gonadal function following chemotherapy [94]. Aphrodisiacs are required to improve male sexual function under stressful conditions. Due to the effects of oxidative stress and dopamine on male sexual function, we hypothesized that *Moringa oleifera* leaves might improve male sexual dysfunction induced by stress. The increased sexual performance during the intromission phase might have been due to the suppression of MAO-B and PDE-5 activities and increased testosterone. Therefore, *M. oleifera* is a potent aphrodisiac, but further research concerning the precise underlying mechanisms is still needed [95].

Phytomedicines are believed to have benefits over conventional drugs and are regenerating interest in current research. *Moringa oleifera* is a multi-purpose herbal plant used as human food and an alternative for medicinal purposes worldwide. An important factor that accounts for the medicinal uses of *Moringa oleifera* is its very wide range of vital antioxidants, antibiotics and nutrients including vitamins and minerals. Almost all parts from Moringa can be used as a source for nutrition with other useful values. This mini-review elaborates on details its health benefits [96]. Medicinal plants are believed to be a precious natural reservoir as they are assumed to have paranasal anti-inflammatory effects for the mankind. *Moringa oleifera* growththroughout most of the tropics and has numerous industrial and medicinal uses. It has an enormous nutritional worth due to existence of vitamins and proteins. *M. oleifera* leaves, gums, roots, flowers as well as kernels have been unamniously utilized for managing tissuetenderness, cardiovascular and liver maladies, normalize blood glucose and cholesterole. It has also profound antimicrobial, hypoglycemic and anti-tubercular activities [97]. *Moringa oleifera* Lam. (MO) has been reported to harbor anti-oxidation and anti-inflammatory activity and useful in the treatment of inflammatory diseases. An ethyl acetate fraction of MO (MOEF) was prepared from fresh leaves extract of *Moringa* and shown to contain of high levelsof phenolic and antioxidant activities. The findings highlight the ability of MOEF to inhibit cytokines (IL-8) which promote the infiltration of neutrophils into the lungs and others (TNF, IL-6) which mediate tissue disease and damage [98]. *Moringa oleifera* Lam. (M. oleifera) from the monogenic family Moringaceae is found in tropical and subtropical countries. The present study was aimed at exploring the in vitro wound healing potential of *M. oleifera* and identification of active compounds that may be responsible for its wound healing action. The study included cell viability, proliferation, and wound scratch test assays. The HPLC and LC-MS/MS studies revealed kaempferol and quercetin compounds in the crude methanolic extract and a major bioactive compound Vicenin-2 was identified in the bioactive aqueous fraction which was confirmed with standard Vicenin-2 using HPLC and UV spectroscopic. These findings suggest that bioactive fraction of *M. oleifera* containing Vicenin-2 compound may enhance faster wound healing in vitro [99].

To date, the preventive strategy against dementia is still essential due to the rapid growth of its prevalence and the limited therapeutic efficacy. Based on the crucial role of oxidative stress in age-related dementia and the antioxidant and nootropic activities of *Moringa oleifera*, the enhancement of spatial memory and neuroprotection of *M. oleifera* leaves extract in animal model of age-related dementia was determined. Therefore, our data suggest that *M. Oleifera* leaves extract is the potential cognitive enhancer and neuroprotectant. The possible mechanism might occur partly via the decreased oxidative stress and the enhanced cholinergic function. However, further explorations concerning active ingredient(s) are still required [100]. The protection against ischemic stroke is still required due to the limitation of therapeutic efficacy. Based on the role of oxidative stress in strokepathophysiology, we determined whether *Moringa oleifera*, a plant possessing potent antioxidant activity, protected against brain damage and oxidative stress in animal model of focal stroke. The protective effect of medium and low doses of extract in all areas occurred mainly via the decreased oxidative stress. The protective effect of the high dose extract in striatum and hippocampus occurred via the same mechanism, whereas other mechanisms might play a crucial role in cortex. The detailed mechanism required further exploration [101]. While anti-oxidant effects of *Moringa oleifera* in much oxidative stress related diseases have been well reported, cryptorchidism on the other hand has been shown to cause oxidative stress. MEMO had nosignificant effect on testicular weight and MDA concentration, while significantly increased sperm count, germ cell count, testicular SOD and totalprotein in the cryptorchid rats. The present study suggests that MEMO ameliorates cryptorchidism associated germ cell loss and oxidative stress [102].

*Moringa oleifera* is a multipurpose tree, cultivated in the tropics and subtropics for its nutritional and therapeutic properties. Owing to these adverse factors, the effect of soaking the seeds for 30 min and then compounding it as feeds was done. Its effect on growth rate and the level of some biochemical parameters on rat were investigated. The Wistar albino rats were fed for 21 days and their weights measured at 2 days interval. Aspartate and Alanine transaminases, Alkaline phosphatase and total bilirubin levels were assayed using Automated Vitros 350 [103]. The unknown protective effect of N,a-L-rhamnopyranosyl vicosamide (VR),isolated from *Moringa oleifera* leaves in isoproterenol (ISO)-induced cardiotoxicity was evaluated in rats. A reduction in myocardial necrosis was furtherreconfirmed by the triphenyl tetrazolium chloride (TTC) stain in isolated test drug pretreated rats. These findings suggest the cardio-protective potential of the isolated alkaloid and possibly the beneficial action is mediated through its free radical scavenging property [104]. To investigate the potential of hydroethanolic extract...
of Moringa oleifera (MOHE) against 7, 12-dimethylbenz[a]anthracene (DMBA)-induced toxicity in male Swiss albino mice. Experimental mice were respectively pretreated with 200 and 400 mg/kg of MOHE, and 0.5% and 1% of butylated hydroxyanisole (BHA) for two weeks prior to the administration of 15 mg/kg of DMBA, respectively [105]. Fruit pods contain various beneficial compounds that have biological activities and can be used as a source of pharmaceutical and nutraceutical products. Although pods or pericarps are usually discarded when consuming the edible parts of fruits, they contain some compounds that exhibit biological activities after extraction. [106]. *Moringa oleifera* Lam. (*Moringaceae*) is a rich source of essential minerals and antioxidants; it has been used in human and animal nutrition. The leaves and flowers are being used by the population with great dietary importance. These results indicated the possible therapeutic action of flower and leaf extract from MO in protecting liver damage in rats given an over dosage of APAP [108].

**Nutritional, Health benefits**

In the present study, in vitro antioxidant, antioxidative stress and hepato protective activity of *Moringa oleifera* Lam. seed oil (Ben oil; BO) was evaluated against carbon tetrachloride (CCL4) induced lipid peroxidation and hepatic damage in rats. The oil at 0.2 and 0.4 mL/rat was administered orally for 21 consecutive days. In vitro DPPH radical scavenging and β-carotene-linolic acid assay tests of the BO exhibited a moderate antioxidant activity in both tests used. The possible mechanism(s) of the liver protective activity of Ben oil activity may deduce to free radical scavenging potential caused by the presence of antioxidant component(s) in the oil. Consequently, BO can be used as a therapeutic regime in treatment of some hepatic disorders [109]. Protective effect of *Moringa oleifera* leaf extract (MOLE) against irradiation-induced lipid peroxidation has been investigated. Phytochemical analysis showed that MOLE possesses various phytochemicals such as ascorbic acid, phenolics (catechin, epicatechin, ferulic acid, ellagic acid, myricetin) etc., which may play the key role in prevention of hepatic lipid peroxidation by scavenging radiation induced free radicals [110]. The purpose of this study was to determine the effects of an extract from *Moringa oleifera* (MO) on the development of monocrotaline (MCT)-induced pulmonary hypertension (PH) in Wistar rats. Chronic treatments with the MO extract reversed the MCT-induced changes. Additionally, the MCT group had a significant elevation in superoxide dismutase activity when normalized by the MO extract treatments. In conclusion, the MO extract successfully attenuated the development of PH via direct vasodilatation and a potential increase in antioxidant activity [111]. Oxidative stress due to abnormal production of reactive oxygen species has been implicated in the nephrotoxicity induced by gentamicin. The nephroprotective effect of aqueous-ethanolic extract of *Moringa oleifera* leaves (150 and 300mg/kg) was evaluated against gentamicin-induced (80 mg/kg) renal injury in rabbits. The present study indicates that aqueous-ethanolic extract of *M. oleifera* leaves attenuates renal injury in rabbits treated with gentamicin, possibly by inhibiting lipid peroxidation [112].

Alzheimer's disease (AD) is a devastating neurodegenerative disorder which needs adequate studies on effective treatment options. The extracts of plants and their effect on the amelioration of AD symptoms have been extensively studied. This paper summarizes the mechanisms like acetylcholinesterase (AChE) inhibition, modification of monoamines, amyloid aggregation effect, and antioxidative activity which are actively entailed in the process of amelioration of AD symptoms [113]. Oxidative stress due to abnormal production of reactive oxygen species has been implicated in the nephrotoxicity induced by gentamicin. At the end of the experiment, the kidneys of rabbits were excised for histological examinations and determination of lipid peroxidation levels. On histological examinations, kidney of intoxicated rabbits groups which received *M. oleifera* extract showed reparative tendencies. The present study indicates that aqueous-ethanolic extract of *M. oleifera* leaves attenuates renal injury in rabbits treated with gentamicin, possibly by inhibiting lipid peroxidation [114]. Alzheimer's disease (AD) is a devastating neurodegenerative disorder which needs adequate studies on effective treatment options. The extracts of plants and their effect on the amelioration of AD symptoms have been extensively studied. These effects are induced by extracts of a few plants of different origin like Yizhi Jianna, *Moringa oleifera* (Drumstick tree), Ginkgo Biloba (Ginkgo/Maidenhair tree), *Cassia obtusifolia* (Sicklepod), *Desmodium gangeticum* (Sal Leaved Desmodium), *Melissa officinalis* (Lemon Balm), and *Salvia officinalis* (Garden sage, common sage) [115].

**Others**

Present study was conducted to evaluate the effect of addition of different levels of *Moringa oleifera* leaves extract (MLE) and butylated hydroxytoluene (BHT) in raw and cooked pork patties during refrigerated storage. However, the results of published studies to date involving *M. oleifera* are very promising. Additional human studies using standardized extracts are highly desirable [116]. In Thai traditional medicine, *Moringa oleifera* is used for the treatment of diabetes and hyperlipidemia. Oxidative stress plays a major role in the pathogenesis of many degenerative diseases, such as hyperlipidemia, diabetes mellitus, and cardiovascular disease. We evaluated the antioxidant effect of *M. oleifera* extract (MOE) for reduction of advanced glycation end-product (AGE) formation, cell viability, oxidative stress, and lipid metabolism gene expression in HepG2 cells. Moreover, *M. oleifera* may reduce cholesterol and lipid synthesis by suppression of HMG-CoAR, PPARα, and PPARγ gene expression, thereby maintaining lipid homeostasis [117]. Phaseolus vulgaris plants were grown in the presence of NaCl and/or CdCl2 beginning from the second week, sprayed twice with *moringa* leaf extract (MLE) at 21 and 28 days after sowing (DAS), and were sampled at 35 DAS for growth and chemical analyses and yielded at the end of experiment. However, the foliar application of MLE in the absence of the stress improved the MSI and RWC and minimized plant Cd (2+) content but could not affect EL and lipid peroxidation. Proline content and the activity of antioxidant enzymes showed a significant increase in response to MLE as well as NaCl and/or CdCl2 stress.
The indiscriminate use of synthetic insecticides to control Aedes aegypti has led to the emergence of resistant populations. *Moringa oleifera* seeds contain the lectins WSMoL and cMoL. WSMoL has larvicidal activity on fourth-stage of A. In conclusion, Rockefeller and Rockefeller L4 may involve deregulation of digestive enzymes. cMo Linterfered mainly on SOD activity and thus it can be investigated as an synergistic agent for controlling populations whose resistance is linked to an increased detoxifying process mediated by this enzyme [119]. The main objective of this study was to assess whether recurring water stress occurring from seed germination to young plants of *Moringa oleifera Lam.* are able to mitigate the drought stress effects. Young plants were reseeded 50 days after germination under three osmotic potentials (0.0, -0.3 and -0.4 MPa). There was rapid recovery of the photosynthetic rate during the rehydration period. The stressed plants from the -0.3 and -0.4 MPa treatments showed higher tolerance compared to the control plants. The results suggest that seeds of *M. Oleifera* subjected to mild water deficit have had increased the ability for drought tolerance when young plant [120].

**CONCLUSION**

Major thrust by whole of the pharmaceutical industry is focused towards design and development of new plant based drugs through investigation of leads from traditional system of medicines. In the study of *M. Oleifera* L. alcoholic extracts of roots, leaves and flowers gives different pharmacological activities like antileprosy, anti-inflammatory, antihelminthic, antispasmodic, anti fungal, diuretic, anti microbial and antihyperlipidemic. Many important phytoconstituents responsible for the activity were isolated. The scientific research on *M. Oleifera* suggests a huge biological potential of this plant. Author also have various review and research articles on medicinal and Ayurvedic systems of plants, such as *Trubulus terrestris*, *Oxalis corniculata*, *Cuscuta reflexa* and *Solanum nigrum* [75.76.77]. These articles also have been provided very keen interest to students and researchers to make great achievements in medicinal plants research. It is also strongly believed that detailed information as presented in this review might provide detailed evidence for the use of this plant in different medicines. At the same time, the organic and aqueous extracts of *M. Oleifera* L could be further exploited in the future as a source of useful phytochemical compounds for the pharmaceutical industry.

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