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Review

Moringa oleifera (Shajna): the wonderful indigenous medicinal plant

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Abstract: 'The Tree of Life' or 'Miracle Tree' is the name of the plant of *Moringa oleifera (Shajna). Moringa oleifera* is one of the important plants in plant kingdom. Its leaves and fruits are used as vegetable in Indian sub continent, at the same time each part of the plant rich with some important medicinal values. It is now considered as a valuable source of several unique products for the medicines against various diseases. The present review is to focus on the nutritive values, physico-chemical properties, phyto-chemicals and pharmacological activities of *M. oleifera*. Various parts of the plant like seeds, leaves, flowers, bark and fruits have been investigated for their significant pharmacological activity. Phyto-chemicals like flavanoid, anthraquinone, alkaloids, essential oils, tannic acid, carotene, glucose have been reported for significant antioxidant, hepatoprotective, anticancer, aphrodisiac, antiinflammatory, antihyperlipidaemic, antihyperglycaemic and antiulcer activities of Drumstick tree and emphasizes the need for further exploring available information.

Keywords: *Moringa oleifera*; physico-chemical properties; phyto-chemicals and pharmacological activities

1. Introduction

M. Oleifera is commonly referred to as either Horse Radish tree (referring to the taste of its roots) or Drumstick tree (describing the shape of its pods) (Shih *et al*., 2011) while less frequently referred to as 'The Tree of Life' or 'Miracle Tree' due to its economical importance and versatility (Abe and Ohtani 2013; Bakre *et al*., 2013). A single genus with 14 known species, M. oleifera is the most widely known and utilized of these (Morton, 1991). *Moringa oleifera* is referred to as "Moringa", it is considered one of the world's most useful trees. Almost every part of moringa tree can be used for food or other beneficial applications (Quattrocchi and Umberto, 2000). It is native in Asia Minor, Africa, the Indian subcontinent (Bangladesh, India & Pakistan) (Somali *et al*., 1984), and is also distributed in the Philippines, Cambodia, Central America, North and South America, and the Caribbean Islands (Morton, 1991). The tree ranges in height from 5 to12 m and the fruits (pods) are around 50 cm long. When mature, the fruit of *M. oleifera* becomes brown and has 10–50 seeds inside. Fully mature dry seeds are round or triangular in shape and the kernel is surrounded by a light woody shell with three papery wings (Abdulkarim *et al*., 2005; Vlahov *et al*., 2002). All parts of the Moringa tree–leaves, flowers, fruits, and roots are edible and have long been consumed as vegetables (Anwar and Bhanger, 2003; Siddhuraju and Becker, 2003). *Moringa oleifera* is esteemed as a versatile plant due to its multiple uses. The leaves, fruits, flowers and immature pods of this tree are edible and they form a part of traditional diets in many countries of the tropics and sub-tropics (Siddhuraju and Becker, 2003; Anhwange *et al*., 2004). Moringa is rich in nutrition owing to the presence of a variety of essential phytochemicals present in its leaves, pods and seeds. In fact, moringa is said to

provide 7 times more vitamin C than oranges, 10 times more vitamin A than carrots, 17 times more calcium than milk, 9 times more protein than yoghurt, 15 times more potassium than bananas and 25 times more iron than spinach (Rockwood *et al*., 2013). Various parts of the plants such as leaves, roots, seeds, barks, fruits, flowers and immature pods act as cardiac and circulatory stimulants, possess antipyretic, antiepileptic, anti-inflammatory and antiulcer (Pal *et al*., 1995).

The leaves of *M. oleifera* are a good source of protein, vitamin A, B and C and minerals such as calcium and iron (Dahot, 1988). The leaves are outstanding as a source of vitamins A when raw as a source of vitamin C. They are also good sources of vitamin B and are among the best plant sources of minerals (Talhaliani and Kar, 2000). Moringa leaves have been consumed by Asian people for millennia as a healthy food product. Studies from other countries indicate that the leaves have immense nutritional value such as phytochemicals, vitamins, minerals, and amino acids (Anwar *et al*., 2007; Busani *et al*., 2011). Moringa leaves are known to have a high content of essential amino acids, proteins, minerals and vitamins, hence an ideal nutritional supplement (Fletcher, 1998). Many evidences exposed in which *M. oleifera* experienced several drug actions including antibacterial (Dayrit *et al*., 1990), antifungal, anti-inflammatory and diuretic activities (Cáceres *et al*., 1992). Moringa seeds have long been used by the public as a tasty vegetable and water purifier because of its coagulant properties (Ayotunde *et al*., 2011). Other moringa plant parts like flowers, roots, and bark also have good nutritional and therapeutic value (Olushola, 2006).

Moringa oleifera seed oil is pleasant tasting, highly edible (Lowell, 1999) and resembles olive oil in its fatty acid composition (Ramachandran *et al*., 1980). The characteristics of *M. oleifera* seed oil can be highly desirable especially with the current trend of replacing polyunsaturated vegetable oils with those containing high amounts of monounsaturated acids (Corb-ett, 2003). High oleic acid vegetable oils have been reported to be very stable even in highly demanding applications like frying (Warner and Knowlton, 1997).

The root from the young plant can also be dried and grounded for use as a hot seasoning base with a flavor similar to that of the horseradish. This is why Moringa tree has been given the name "Horseradish tree". A tasty hot sauce from the roots can also be prepared by cooking them in vinegar (Deleveau and Boiteau, 1980). The root bark of *Moringa oleifera* contains 2 additional alkaloids (total alkaloids, 0.1%), viz. moringine, which is identical to benzylamine, and moringinine, belonging to the sympathomimetic group of bases. In addition, traces of an essential oil with a pungent smell, phytosterol, waxes, and resins are found in the moringa plant, and it contains a rich and rare combination of zeatin, quercetin, beta-sitosterol, caffeoylquinic acid, pterygospermin, and kaempferol (Hsu *et al*., 2006). Fruit (pod)/drum sticks and leaves have been used to combat malnutrition, especially among infants and nursing mothers for enhancing milk production (Dillard and Bruce German, 2000; Estrella *et al*., 2000) and also regulate thyroid hormone imbalance (Pal *et al*., 1995), (Tahiliani and Kar, 2000).

2. Plant description

Moringa oleifera, known popularly as *drumstick tree*, is a tropical plant grown for its nutritious leafy-greens, flower buds, and mineral-rich green fruit pods. It is a well-recognized member in the Moringaceae family of trees, and thought to be originated in the sub-Himalayan forests of the Indian subcontinent. It possesses horseradish-like root and, hence, known to the western world as horseradish tree.

3. Classification of plant

Kingdom: Plantae
Order: Brassicales
Family: Moringaceae
Genus: Moringa
Species: *Moringa oleifera*
Synonyms: *Guilandina moringa* L.

4. Different vernacular name

Bengali: Sajina, Sajna, Sajne
Urdu: Sehjan
Hindi: Shajoma, Mungna
Gujarati: Sargavo, Sekato, Saragavo Parna
Kan.: Neegge, Nugge ele
Tamil: Murungai, Murungai Iali
Marathi: Sevaga, Segata, Segata pana, Shewgachi pane
Orissa: Sajana, Munga, Munika

Punjabi: Sohanjana
Telugu: Munaga Aku
Philippines: Malunggay
French: Acacia blanc, Neverdie, Moringa ailé, Ben ailé, Pois quenique
German: Pferderettichßaum, Meerrettichßau
Indonesian: kelor
Malay: Sajina, Merunggai
Nepali: Shobhanjan, Sohij

5. Distribution

Native to India, Arabia, and possibly Africa and the East Indies; widely cultivated and naturalized in tropical Africa, tropical America, Sri Lanka, India, Mexico, Malabar, Malaysia and the Philippine Islands.

6. Nutritive value of *M. oleifera*

Moringa (drumstick) pods and leaves, raw,
Nutritive value per 100 g. Percentages of daily-recommended values are marked in brackets.

Principle	**Nutrient value-Pods**	**Nutrient value-Leaves**
Energy	37 Kcal (2%)	64 Kcal (3%)
Carbohydrates	8.53 g (6.5%)	8.28% (6%)
Protein	2.10 g (4%)	9.40 g (17%)
Total Fat	0.20 g (1%)	1.40% (7%)
Cholesterol	0 mg (0%)	0 mg (0%)
Dietary Fiber	3.2 g (8%)	2.0 g (5%)
Vitamins		
Folates	44 µg (11%)	40 µg (10%)
Niacin	0.680 mg (4%)	2.220 mg (14%)
Pyridoxine	0.120 mg (9%)	1.200 mg (92%)
Riboflavin	0.074 mg (6%)	0.660 mg (51%)
Thiamin	0.053 mg (4.5%)	0.257 mg (21.5%)
Vitamin A	74 IU (2.5%)	7564 IU (252%)
Vitamin C	141mg (235%)	51.7 mg (86%)
Electrolytes		
Sodium	42 mg (3%)	9 mg (0.5%)
Potassium	461 mg (10%)	337 mg (7%)
Minerals		
Calcium	30 mg (3%)	185 mg (18.5%)
Iron	0.36 mg (4.5%)	4.00 mg (50%)
Magnesium	45 mg (11%)	147 mg (37%)
Phosphorus	50 mg (9%)	112 mg (20%)
Selenium	8.2 µg (15%)	0.9 µg (1.5%)
Zinc	0.45 mg (4%)	0.60 mg (5%)

(Source: USDA National Nutrient data base)

7. Characteristic features of *Moringa oleifera*

Moringa oleifera is a tree that is sometimes called the Tree of Life or a Miracle Tree. *Moringa oleifera* is a small, graceful, deciduous tree with sparse foliage, often resembling a leguminous species at a distance, especially when in flower, but immediately recognized when in fruit. The tree grows to 8 m high and 60 cm dbh. Bole crooked, often forked from near the base. Bark smooth, dark grey; slash thin, yellowish. Twigs and shoots shortly but densely hairy. Crown wide, open, typically umbrella shaped and usually a single stem; often deep rooted. The wood is soft (Orwa *et al*., 2009).

7.1. Leaves

The large alternately arranged leaves are borne on petioles 4-15 cm long. These leaves are tri-pinnate and usually 25-60 cm long, but they may occasionally be as small as 6.5 cm long and as large as 90 cm long. The leaves have 5-11 main branches that are pulvinate.

7.2. Fruits

In appearance, the Moringa tree's fruit resembles long, thin beans or pea pods. During vegetative growth they are white in color, changing to brown when they reach maturity. The seeds inside, which are as highly prized by local populations as the fruit, number between 5 to 20 per fruit. The fruit itself is characterized by a taste that can be described as similar to asparagus. Moringa tree fruit look somewhat like drumsticks, which is why it is sometimes referred to as the "drumstick tree".

7.3. Flowers

The fragrant *Moringa oleifera* flowers are creamy white in color, with yellow stamens. The flowers average about one inch in diameter and they first bloom when the tree is eight months old, and after that, *Moringa oleifera* blooms every year from the month of April until September.

7.4. Seeds

Moringa seeds are obtained from the pods of the moringa tree (*Moringa oleifera*) or the drumstick tree. Fresh and raw moringa seeds are quite tender, but as soon as they get dried, they become hard and start resembling small beans. The grayish-white seeds with unique wing-like structures can be steamed, boiled or roasted for various purposes.

7.5. Other parts of *M. oleiferea*

It has a large underground rootstock and normally a single main trunk with a wide, open and typically umbrella-shaped crown. The trunk is generally 10-45 cm wide and covered in a pale-grey bark, but may occasionally reach up to 60 cm in diameter. Each of these branches is borne on a stalk 1-3 cm long and has 5-11 smaller branches.

Figure 1. Leafs and fruits of drum-stick.

8. Chemical constituents

Table 1. Phytochemical constituents isolated from *Moringa oleifera* Lam (Mehta *et al*., 2003).

Parts	Phytochemical constituents
Roots	4-(α-L-rhamnopyranosyloxy)-benzylglucosinolate and benzylglucosinolate 10
Stem	4-hydroxymellein, vanillin, β-sitosterone, octacosanic acid and β-sitosterol 11
Bark	4-(α-L-rhamnopyranosyloxy)-benzylglucosinolate 10
Whole gum exudates	L-arabinose, D-galactose, D-glucuronic acid, L-rhamnose, D-mannose, D-xylose and leucoanthocyanin 12-13
Leaves	Glycoside niazirin, niazirinin and three mustard oil glycosides, 4-[4'-O-acetyl- α -L-rhamnosyloxy) benzyl] isothiocyanate, niaziminin A and B 14-15
Mature flowers	D-mannose, D-glucose, protein, ascorbic acid, polysaccharide 16
Whole pods	Nitriles, isothiocyanate, thiocarbanates, 0-[2'-hydroxy-3'-(2''-heptenyloxy)]-propylundecanoate, 0-ethyl-4-[(α -1-rhamnosyloxy)-benzyl] carbamate, methyl-p-hydroxybenzoate and β-sitosterol 14-15
Mature seeds	Crude protein, Crude fat, carbohydrate, methionine, cysteine, 4-(α-L-rhamnopyranosyloxy)-benzylglucosinolate, benzylglucosinolate, moringyne, mono-palmitic and di-oleic triglyceride 10
Seed oil	Vitamin A, beta carotene, precursor of Vitamin A 17-18

Table 2. Quantitative Phytochemical Result of the Aqueous and Ethanolic Leaf Extracts of *Moringa oleifera* (Nweze *et al*., 2014).

Phytochemical	Aqueous extract	Ethanolic extract
Flavonoid	3.56 ± 0.03	3.83±0.02*
Anthraquinone	11.68±0.04*	10.86±0.06
Alkaloids	3.07±0.00*	2.26±0.04
Saponins	1.46±0.03	1.72±0.05*
Steroids	3.21±0.00*	3.12±0.02
Terpenoids	4.84±0.05*	4.26±0.06
Cardiac glycoside	0.36±0.03*	0.19±0.02
Anthocyanin	0.06±0.00*	0.05±0.00
Tannins	9.36±0.04*	9.19±0.02
Carotenoids	1.16±0.05*	0.08±0.02

* significant at $P < 0.05$

9. Physico-chemical properties of *M. oleifera*

The *Moringa oleifera* was analyzed for proximate analysis and the results in showed in the following table.

Table 3. Proximate analysis of *Moringa oleifera* leaves (Sobhy *et al*., 2015).

Proximate analysis	Nutrient Conc. (g.100g-1)
Moisture	10.74g.100g-1±0.05
Ash	4.56g.100-1±0.13
Fiber	11.23g.100-1±0.16
Protein	9.38g.100g-1±0.23
Lipid	7.76g.100g-1±0.21
Carbohydrate	56.33g.100g-1±0.27
Energy (K Cal)	332.68±0.06

Table 4. Proximate composition (mg/100g) of raw and defatted *Moringa oleifera* seeds (Peter and Alikwe, 2014).

Nutrients	Raw samples	Defatted samples
Moisture contents	9.97±0.09a	9.40±0.10b
Protein	35.97±0.19a	17.13±0.13b
Crude fat	38.67±0.03a	8.57±0.18b
Ash	3.87±0.09a	3.47±0.07a
Crude fibre	2.87±0.03a	3.33±0.09a
Carbohydrates (By difference)	8.67±0.12a	57.77±0.12b

Values are means (±SEM) of triplicate samples. Means with different superscripts in the same row show significant difference ($P < 0.05$).

10. Pharmacological studies

10.1. Anti-inflammatory

Moringa oleifera seeds of hydro-alcoholic extract (MSHE) and its chloroform fraction (MCF) were effective to reduce weight of distal colon (8 cm) as a marker for inflammation and tissue edema. Three doses of MSHE and two greater doses of MCF (100 and 200 mg/kg) were effective to reduce ulcer severity, area, and index as well as mucosal inflammation severity (Mohsen Minaiyan *et al*., 2014). Hot water infusions of flowers, leaves, roots, seeds and bark also showed anti-inflammatory activity against carrageenan-induced hind paw edema. The seed infusion showed anti-inflammatory and diuretic activity at 1000 mg/kg (Caceres *et al*., 1992).

10.2. Antioxidant

Aqueous extract of *Moringa oleifera* exhibited strong scavenging effect on 2, 2-diphenyl-2-picryl hydrazyl (DPPH) free radical, superoxide, nitric oxide radical and inhibition of lipid per oxidation. The free radical scavenging effect of *Moringa oleifera* leaf extract was comparable with that of the reference antioxidants (Sreelatha and Padma, 2009). The oil from the dried seeds showed higher antioxidant activity than butylated

hydroxyl toluene and alpha-tocopherol (Lalas and Tsaknis, 2002). Aqueous, methanol (80%) and ethanol (70%) extracts of freeze-dried leaves showed radical scavenging and antioxidant activities. All the extracts were capable of scavenging peroxyl and superoxyl radicals. The major bioactive compounds of phenolics were found to be flavonoid groups such as quercetin and kaempferol. The drumstick leaves are found to be a potential source of natural antioxidants (Siddhuraju and Becker, 2003).

10.3. Antimicrobial activities

The aqueous and methanol extracts of the seeds of *Moringa oleifera* and the seeds of Mormordica charantia were screened for their antimicrobial activity against three human pathogenic bacterial strains and three fungal strains by agar-well diffusion assay. The pattern of inhibition varied with the solvent used for extraction and the microorganisms tested (Shoba *et al*., 2014). Moringa roots have antibacterial activity and are reported to be rich in antimicrobial agents. These are reported to contain an active antibiotic principle, pterygospermin which has powerful antibacterial and fungicidal effects (Fahey *et al*., 2001).

The antimicrobial activity of leaves, root, bark and seeds were also investigated against bacteria, yeast, dermatophytes and helminths pathogenic to man. The fresh leaf juice and aqueous extract of seeds inhibited the growth of Pseudomonas aeruginosa and Staphylococcus aureus (Caceres *et al*., 1991). The seed extract exhibited significant antibacterial activity against pyodermia (skin infection) causing bacterium, S. aureus in experimental mice (Caceres and Lopez, 1991).

10.4. Cardiovascular activities

Biochemical study of 15 days for evaluation of cardiac activity of methanolic extract of *Moringa oleifera* roots on cardiac enzymes and cytosolic Ca 2+ level was also performed. Methanolic extract of *Moringa oleifera* showed significant ($p<0.001$) increased in force of contraction and cardiac output in normal and hypodynamic heart preparations. These activities were inhibited by propranolol which indicates its sympathomimetic activity. It significantly increased cytoplasmic Ca 2+ level after 15 day treatment (Ganatra, 2012). The alkaloids obtained by fractionation of the water extract of the leaves converted into their salt form, were tested for their activity on the isolated frog heart. The total alkaloidal salts were found to produce a negative inotropic effect on the isolated perfused frog heart. This activity was further characterized by testing it on the isolated guinea pig ileum (Dangi, 2002).

10.5. Antihyperlipidaemic activities

Albino Wistar rats were fed with methanolic extract of *M. oleifera* (150, 300 and 600 mg/kg, *p.o*.) and simvastatin (4 mg/kg, *p.o*.) along with hyperlipidemic diet for 30 days. *Moringa oleifera* and simvastatin were found to lower the serum cholesterol, triacylglyceride, VLDL, LDL, and atherogenic index, but were found to increase the HDL as compared to the corresponding high fed cholesterol diet group (control) (Pankaj *et al*., 2010). Fruits of *M. oleifera* were reported to possess hypolipidaemic effect. They were found to lower the serum cholesterol, phospholipid, triglyceride, VLDL, LDL, cholesterol to phospholipid ratio and atherogenic index in hypercholesterolaemic rabbits, but were found to increase the HDL ratio (HDL/HDL-total cholesterol) as compared to the corresponding control groups (Mehta *et al*., 2003).

10.6. Antifertility activities

The work deals with antifertility effect of the alcoholic extract of *Moringa oleifera* stem bark in female albino rats. The effect of alcoholic extract of *M. oleifera* stem bark on estrogenic activity and estrous cycle was observed to confirm the antifertility activity (*Varsha and Dineshr, 2015).* Bark of drumstick tree was screened for its antifertility effect on early pregnancy in albino rats. The aqueous extract of root and bark at a dose of 200 mg/kg and 400 mg/kg, respectively showed post-coital antifertility effect in rat and also induced foetal resorption at late pregnancy (Prakash *et al*., 1987).

10.7. Anticancer activities

Paste of drumstick leaves has been screened for its influence on the carcinogen detoxifying glutathione-S-transferase (GST) in Swiss mice. It increased GST activity by more than 78% in the stomach, liver and oesophagus and show protective activity against carcinogenesis. The crude ethanolic extract of seeds exhibited anti-tumour activity against Epstein-Barr virus-early antigen (EBV-EA) (Guevara, 1999).

It has been found that niaziminin a thio-carbamate from the leaves of *M. oleifera*, exhibits inhibition of tumor-promoter-induced Epstein–Barr virus activation. On the other hand, among the isothiocyanates, naturally occurring 4-[(4′-O-acetyl-α-i-rhamnosyloxy) benzyl], significantly inhibited tumor-promoter-induced Epstein–

Barr virus activation, suggesting that the isothiocyano group is a critical structural factor for activity (Murakami *et al*., 1998).

10.8. Antitumor activities

Moringa leaves to be a potential source for antitumor activity. O Ethyl-4-(α-L-rhamnosyloxy) benzyl carbamate together with 4(α-L-rhamnosyloxy)-benzyl isothiocyanate, niazimicin and 3-O-(6′-O-oleoyl-β-D-glucopyranosyl)-β-sitosterol have been tested for their potential antitumor promoting activity using an in vitro assay which showed significant inhibitory effects on Epstein–Barr virus-early antigen (Makonnen *et al*., 1997). *Moringa oleifera* leaf extract revealed antitumor, antigenotoxic and anticytotoxic activities in EST-mice. (Wagdy *et al*., 2014).

10.9. Antihepatotoxic activities

The methanol fraction of *M. oleifera* leaf extract showed antiulcerogenic and hepatoprotective effects in rats (Pal *et al*., 1995a). Oral administration of an ethanolic extract of *M. oleifera* leaves showed a significant protective action made evident by its effect on the levels of glutamic oxaloacetic transaminase (aspartate aminotransferase), glutamic pyruvic transaminase (alanine aminotransferase), alkaline phosphatase, and bilirubin in the serum; lipids, and lipid peroxidation levels in liver (Pari *et al*., 2002). Treatment with *M. oleifera* @ 500 mg/kg significantly ($p<0.01$) decreased the elevated ALP, AST, ALT, LPO levels and increase in SOD levels, and as compared to cadmium chloride treated group (Reetu *et al*., 2015).

10.10. Antiulcer activities

The methanolic extract of drumstick leaves inhibited gastric lesion formation induced by aspirin, serotonin or indomethacin in rats (Kumar and Pari, 2003). The methanolic extract of flower buds showed antiulcerogenic activity against aspirin induced gastric ulcer at a dosage of 4g/kg body weight (Pal, 1995). The methanol fraction of *M. oleifera* leaf extract showed antiulcerogenic and hepatoprotective effects in rats (Pal *et al*., 1995a).

10.11. Antispasmatic activities

The antispasmodic activity was demonstrated using isolated duodenum. The seed infusion showed a significant inhibition of acetylcholine-induced contraction (Cáceres *et al*., 1992). *M. oleifera* roots have been reported to possess antispasmodic activity. Moringa leaves have been extensively studied pharmacologically and it has been found that the ethanol extract and its constituents exhibit antispasmodic effects possibly through calcium channel blockade. The antispasmodic activity of the ethanol extract of *M. oleifera* leaves has been attributed to the presence of 4-[□-(L-rhamnosyloxy) benzyl]- o-methyl thiocarbamate 3 (trans), which forms the basis for its traditional use in diarrhea. Moreover, spasmolytic activity exhibited by different constituents provides pharmacological basis for the traditional uses of this plant in gastrointestinal motility disorder (Gilani *et al*., 1994).

10.12. Antihyperglycaemic activities

The results showed that after one week of treatment, 77.78% and 88.9% of the animals in mistletoe and moringa treated diabetic groups became normoglycemic, respectively (Adeeyo *et al*., 2013). The blood glucose levels and the corresponding insulin levels in response to drumstick leaves in southern India were compared to the levels achieved in response to 75g of glucose in non-insulin dependent diabetes mellitus patients. The blood glucose response was 56% compared to 75g of glucose. It was concluded that the reduced blood glucose response to drumstick leaves is not due to insulin secretion (William *et al*., 1993).

10.13. Aphrodisiac activities

Aqueous, alcohol and chloroform extract of M. oliefera seed enhance sexual behaviour in male rats (Varsha *et al*., 2013). The effect of M.oleifera leaves extract on male sexual behaviors in animal model of sexual dysfunction. Moreover, the possible underlying mechanisms were also investigated. Approach: Male Wistar rats, weighing 200-250 g, had been orally given M.oleifera leaves extract at doses of 10, 50 and 250 mg kg−1BW once daily at 30 min before the exposure to 12-h immobilization stress for 14 days. They were assessed male sexual behaviors including mounting, intromission and ejaculation numbers and latencies after single administration and every 7 days until the end of experiment (Thawatchai *et al*., 2012).

10.14. Abortifacient activities

Dried powder of leaf extract of common Indian plant *Moringa oleifera* of Moringaceae family was tested experimentally in albino rats in our laboratory for its antifertility activity. Cant per cent abortifacient activity was found when administered orally in aqueous solution at dose of 175 mg/kg body weight daily to Charles foster strain albino rats from days 5-10 post mated (Sethi *et al*., 1988). *M. oleifera* leaves may be abortifacient and it abortifacient potential occur in the 1st trimester of pregnancy (Ekhator and Osifo, 2015).

10.15. Reduce Arsenic toxicity

M. oleifera leaves also prevented the arsenic-induced perturbation of serum butyryl cholinesterase activity, total cholesterol and high density lipoprotein cholesterol (Sheikh *et al*., 2014).

10.16. Hyperthyroidism activities

The aqueous leaf extract of *Moringa oleifera* was evaluated for its ameliorative effect in the regulation of thyroidism in rat model. Male albino rats of 120-150 g were treated orally with doses of 500mg/kg body weight (b.w.) and 250 mg/ kg b.w. of aqueous extract of *Moringa oleifera* leaf. Results show that T3 and T4 were increased and TSH was decreased significantly ($p>0.05$) at high doses compared to those in the control group (Wazida *et al*., 2013). *Moringa oleifera* leaf extract has been observed to decrease the conversion of T4 to T3 in female but not in male adult Swiss rats, therefore increasing the T4/T3 ratio (Tahiliani *et al*., 2000), indicating a potential use for therapy of hyperthyroidism. Similar effects were observed with *Aegle marmelos* extract, which was observed to decrease T3 with an increase in T4 serum concentration in male mice (Kar *et al*., 2002)

11. Conclusions

Moringa oleifera (Shajna) is a wonderful tree in plant kingdom. It is not only the possess the rich of nutritive values (e.g vitamin, mineral, protein, energy, carbohydrate and electrolyte) but contains a lot of medicinal value with important chemical constituents also. The present review shows the total description of moringa plants and their chemicals compositions, physico-chemical properties, pharmacological activities and how people are benefitted and how many experiments have been done by the drumstick. Different researches and studies for drumstick applications will be carried out in this regard.

Conflict of interest

None to declare.

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