Review Article

International Journal of Pharmaceitics and Drug Analysis

Avvilabe at www.ijpda.com ISSN: 2348:8948

Moringa oleifera: A Nutrional tree with immense medicinal value-Ethonobotanical and Pharmacological review

Sanjay K Gowda[1], Rupesh Kumar M[1], Abhishek K[1], Shamal Badhusha P A[1], Blainy Baby[1], B Ramesh[2].

[1] Department of Pharmacology, Sri Adichunchanagiri College of Pharmacy, Sri Adichunchanagiri College of Pharmacy, Adichunchanagiri University, B. G Nagara, Mandya-571448, India

[2] Department of Pharmaceutical Chemistry, Sri Adichunchanagiri College of Pharmacy, Adichunchanagiri University, B. G Nagara, Mandya-571448, India

Article History:

Received on: 29-11-2019
Accepted on: 30-01-2020
Published on : 31-01-2020

***Corresponding Author**
Rupesh Kumar M
Department of Pharmacology, Sri Adichunchanagiri College of Pharmacy, Sri Adichunchanagiri College of Pharmacy, Adichunchanagiri University, B. G Nagara, Mandya-571448, India
E mail: manirupeshkumar@yahoo.in
Contact: +91-7348828206

Abstract

Moringa oleifera Lam commonly called horse-radish is a pan-tropical species which is abundantly found in now become naturalized Asia Minor, Africa, the Indian subcontinent (Bangladesh, India & Pakistan). It has been used due to its excellent nutritional value in all its parts, It also offers various medical benefits. Traditionally it is used for treating various ailments.M. oleifera possess several phytoconstituents which are of interest because of their medicinal value. Extensive scientific investigations have been carried over in past decades to give evidence to claimed traditional and folklore uses. Many Pharmacological works have undertaken to screen its various parts fordigestive disorders, heart complaints, antioxidant, fevers, inflammation,antihypertensive, analgesic,diuretic anti-inflammatory,and anti-tumor activities.Additionally, all parts of M. oleifera claimed some beneficial use which gave great value to the plant.This review provides latest compilation of the published scientific evidence on Pharmacological activities of Extracts and nanoparticles.

Keywords: Moringa oleifera, Chemical constituents, Ethonopharmacology, Nanoparticles

Introduction

Moringa oleifera is one among the highly nutritious cultivated tree all over world because of its medicinal value. It belongs to the family *Moringaceae* and genus Moringa has 14 species, which includes shrubs as well as trees. The accepted botanical name of the species is Moringa oleifera Lam. It has many names depend on the region including Ben oil tree, Horseradish tree and Drumstick tree [1]. *M. oleifera* nativated in Indian,Asia Minor, Africa, Bangladesh, Pakistan and widely distributed many countries like Philippines, Caribbean Islands,Cambodia, South America Central America, North America. Its height may range from 5 - 12 m and the fruits are approximately 50 cm long. After maturation, the fruit becomes brown in color and has 10 to 50 seeds inside the pod [2]. Traditionally, it has been used as diuretic, stimulant, antispasmodic and expectorant. Fresh root is vesicant and acrid. Internally has been used as anti lithic, diuretic and stimulant. Gum is mucilaginous and bland in nature. Seeds arestimulant and acrid. Bark is anti bacterial, abortifacient, antifungal and evenem menogogue. Flowers are used to rise the bile flow and as cholagogue, diuretic, stimulant. The plant can also be used as cardio tonic and as antiseptic [3]. Pods are antipyretic and anthelmintic; fried pods are used in diabetes. Juice prepared from pod is usedas cardiac tonic and to treat epilepsy. Used forasthma,

to treat inflammed liver as well as spleen, nervous debility and as diuretic to treat calculus infection. Pods decoction gargled to overcome sore throat. Root and fruit are antiparalytic.

Juice prepared from leaves employed to reduce hiccough can also be used as emetic (in high doses); cooked leaves are given to treat catarrhal affections and influenza. Bark obtained from Roots is used as analgesic, anti-inflammatory and antiviral. flowers are employed in hypoglycemicconditons. Seed infusion is antispasmodic, anti-inflammatory and diuretic, may also giveto treat various venereal diseases. The *Ayurvedic Pharmacopoeia of India*specified the use of the dried root bark in lipid disorders, goitre and glycosuria, and leaf,root bark, seed and stem bark in internal abscess, and piles[4].

This review provides latest compilation of the published scientific evidence on Ethonobotanical aspects and Pharmacological activities of Extracts and nanoparticles.

Botanical Description

Scientific Classification [5]

Kingdom : Plantae
Subkingdom : Tracheobionta
Super division : Spermatophyta
Division : Magnoliophyta
Class : Eudicots
Subclass : Rosidsae
Order : Brassicales
Family : Moringaceae
Genus : Moringa
Species : oleifera

Morphology

Moringa oleifera is a small and fast – growing tree may be evergreen and deciduous, typically grows up to 10 -12 m height. It has fragile branches which spreads like feather with tripinnate leaves, possess whitish gray bark.

Leaves: The leaflets appear to be hairy, green but almost hairless on the top surface, and are usually tripinnate and can grow up to 45 cm long. These are compound leaves with leaflets 1-2 cm long. The tree limbs are furry and green.

Flowers: The fragrant, bisexual, yellowish white flowers are hairy stalks with axillary panicles 10 - 25 cm long, spreading or drooping. Individual flowers are approximately 0.7 to 1 cm long and 2 cm broad and five unequal yellowish – white, thinly veined, spathulate petals, five stamens with five smaller sterile stamens and pistil composed of a 1-celled ovary and slender style.

Fruits: Fruits are of 3-lobed capsules which are referred as pods when dry 30-120 cm long, 1.8 cm wide fruit production occurs primarily in march and april, it is pendulous, brown triangular, and breaks into three sections lengthwise. During their growth period, fruits produce about 26 seeds. Immature pods are green in colour, and on adulthood they turn into brown.

Seeds: Seeds are rounded and diameter is 1cm. It has brownish semi-permeable seed hull with 3 seed hulls of papery wings awhich are brown - black in color, however if kernels are of low viability, they may be white. About 14 days, fertile seed germinates, each tree can grow between 15,000 to 25,000 seeds per year. The weight mean is 0.3 gm/seed [6].

Chemical Constituents:

leaves, Highly used part is rich in saponins ,vitamins, tannins, carotenoids, tannins polyphenols, phenolic acids, glucosinolates, flavonoids and alkaloids [7].The Moringa family is rich in phytochemicals such as isothiocyanates ,zeatin, g,lucosinolates quercetin, rhamnose ,β-sitosterol, rhamnetin ,caffeoylquinic acid, Isoquercitrin , kaempferol and kaempferitrin.Leaves Fruits and seed aqueous extracts analysed by HPLC and MS showed the presence of vanillin , gallic acid, quercetin, chlorogenic acid, kaempferol, ellagic acid and ferulic acid [8].M. olifera shows the presence of Polyphenols but Butanol fraction of the leaves and aqueous fraction of fruits shows more quatity of Polyphenols [9].The leaves were also informed to contain o-coumaricacid, niazirin, niazirinin, 4-[(4'-O-acetyl-Lrhamnosyloxy) benzyl] isothiocyanate, epicatechin , niaziminin A, 5- caffeoylquinic acid, 3-caffeoylquinic as well as carotenoids [10].M. oleifera seed oil found to consists of campesterol, stigmasterol, stigmastanol, clerosterol, â-sitosterol, and minor quantities of 24-methylenecholesteroland 28- isoavenasterol [11].Isolation of water soluble Poluysaccharides from aqueous extracts of Pods shown to have L-rhamnose, D-galactose, L-arabinose, 6-O-Me-D-galactose and D-galacturonicacid [12].The flowers of M. oleifera found to be rich in calcium and potassium as well as antioxidants like α- and γ-tocopherol [13,14].It also consists nine amino acids,kaempferat,quercetin ,wax, sucrose,traces of alkaloids, D-glucoseandThey have also been stated to contain flavonoid pigments such as rhamnetin, alkaloids,kaempferitrin, kaempherol and isoquercitrin [15]. A precipitate protein fractions from the flowers part consists a combination ofserine, aspartic, cysteineand Ca2+−dependent proteases which possess caseinolytic and milk clotting property [16]. Phytochemical inquiries displayed that water, ether and ethanolic extracts of the leaves comprise catechol gallic tannins, triterpenoids, saponins, flavonoids, anthraquinones, alkaloids,steroids and reducing sugars,tanninswhich may contribute the pharmacological effect of the plant/tree [17].Various investigations identified several Plant chemicals like palmitic acid ethyl ester,hexadecanoic acid, 2, 6-dimethyl-1, 7-octadiene-3-ol, 2-hexanone, ethyl palmitateand 3-cyclohexyliden-4-ethyl-E2-dodecenylacetatein leaves [18]. The gum of M. oleifera contains aldotriouronic acid (got from the acid hydrolysis of gum) and is characterized as O-(β-D-glucopyranosyluronic acid) (1 → 6)-β-D-galactopyranosyl (1 → 6)-D-galactose [19].Glucosinolates are also found in the bark of M. oleifera with only 4-(alpha-

lrhamnopyranosyloxy)-benzylglucosinolate being detected in the bark tissue. The roots of M. oleifera contain high concentrations of both 4-(alpha-l-rhamnopyranosyloxy)- benzylglucosinolate and benzyl glucosinolate [20].Sashidhara et al. isolated and characterized compounds; aurantiamide acetate 4 and 1, 3-dibenzyl urea 5 from the roots of M. oleifera, which was done for the first time from this species [21].Protective phytochemicals like reducing sugars, gallic tannins, anthraquinones, catechol tannins, steroids, saponins and triterponoids and alkaloidswere found in ether, ethanol and aqueous extracts of the roots [22].

Toxicological Profile

The Lethal dose 50 of M. Oleifera isestimated to be 1585 mg/kg. The extract did not elicit any significant difference ($P \geq 0.05$) in haematological as well as biochemical parameters and sperm quality and show no considerable differences in weight gain in control and treated animals eventhough a dose-dependent reduction in food consumption ofthe animals treated with 250 to 1500 mg/kg extract is exhibited [23].

Pharmacological Profile:

Table 01: Reported Pharmacological activities of Different Parts of *Moringa oleifera*

Sl No.	Part	Extract	Activity	Model	Significant findings	Reference
01	leaves,flowers, seeds, pods and stem)	Ethanol	acetaminophen (APAP)- induced toxic liver injury-invitro and invivo	FRAP, DPPH. and Acetaminophen induced male sprague dwaley rats	Elevation in oxidative biomarkers concentration like MDA and 4-HNE protein adduct. Decreased in GSH, CAT,SOD in hepatotoxic rats.	24.
02	Root and leaves	methanol	Analgesic	Complete Freunds adjuvant induced arthritis	Reduced thermal hyperalgesia as well as allodynia(mechanical)	25
03	Leaves	Ethanol	Antidiaarhoel	Castor oil induced	Produces significant Antidiaarhoel effect	26
04	leaves	Hexane Ethanol (kaempferol-3-glucoside present in the polar extract and fatty acids like chlorogenic acid, among others, in the non-polar extract)	Analgesic and antiinflammtory	The formalin test. Carrageenan-induced paw edema. Induction of experimental arthritis with subcutaneous injection of collagen.	Produces significant Antidiaarhoel effect Analgesic and antiinflammtory	27
05	Leaves powder	-	Matabolic syndrome	Oral glucose tolerance test (OGTT)	Produces significant effect on metabolic syndrome	28
06	Seeds	Hydroalchoholic	Anti-inflammatory	Acetic acid induced Colitis model	Produces significant Anti-inflammatory effect	29
07	Leaves	Mathanolic and Ethylacetate	Antifungal	Disc diffusion method	extract of ethyl acetate is more active against M. gypsum, R. stolonifer shown to be high sensitive to methanolic extract.	30

08	Flowers	Ethanol	in- vitro anti-inflammatory activity in- vitro anti-inflammatory activity	DPPH Scavenging	Produces significant activity	31
09	Pod husks	hexane, butanol, chloroform, petroleum ether, acetone, methanol, ethyl acetate and water	Antimicrobial against Enterococcus faecalis, MRSAa Staphylococcusaureus, Staphylococcus epidermidis, Escherichia coli, Klebsiella pneumoniae, Klebsiella pneumonia, Pseudomonas aeruginosa, Salmonella typhimurium, Salmonella typhimurium, Shigella flexneri, Candida albicans, Candida tropicalis	Agar diffusion assay	All tested microorganisms showed sensitive to acetonic extract.	32.
10	Leaves	Ethanol	Neuropharmacology	Novelty induced behavior (NIB) hole-board test (Exploratory activity) Y-maze (learning and memory) elevated plus maze model(Antianxiety)	Produces significant Neuropharmacological activity	33
11	Seed	Aqueous and ethanol	Antihelminthic against H. contortus	egg hatch assay and larval motility test	Produces significantAntihelminthic against H. contortus	34
12	Root bark	Ethanolic	Antiulcer	ethanol-induced and pylorus ligation-induced gastric ulceration	Produces significant antihelminthic against Antiulcer activity	35
13.	Whole plant	Aqueous	cardiotoxicprotective	Aluminium phosphide-induced	Produces significant cardiac toxicprotactive activity	36
14	Leaves	Ethanolic ethyl acetate fraction	Wound healing	Wound Scratch Assay .	Shows good migratoryand proliferativeproperty on normalskin fibroblasts	37
15	dried leaves, bark, and seeds	Ethanol	Anticancer MDA-MB-231 and HCT-8 cancer cell lines, Breast and Colorectal Cancer Cell Lines	Motility assay In vitro Clonogenic survival assay Cell viability assay: Apoptosis assay Cell cycle assay	Produces significant Anticancer activity	38
16	Aerial Parts	Ethanol	Anti-obesity	obese female rat	down-regulated the expression of mRNA	39

					leptin and resistin, Up- expression in obese rats relative to untreated obese control regulated adiponectin gene counterparts. reduction in body weight improvement of the atherogenic index and coronary artery index, glucose level and insulin resistance value without adverse effects on liver or kidney functions, versus the untreated obese control ones.	
17	Roots	Methanol	Antidiarroheal	Castor oil-induced diarrhoea	Reduction in the frequency,severity of diarrheaand accumulation of intestinal fluid, Decreased volume of intestinal content as well as intestinal transit	40
18	Leaves	Aqueous	nicotine-induced neurobehavioral disturbances	open field apparatus	Improvementin the antioxidant level of neuronal cells, Maintains the integrity of the cerebellar neuronal cells.	41
19.	Leaves	N,a-L-rhamnopyranosyl vincosamide(an indole alkaloid isolate)	Cardioprotective activity	isoproterenol (ISO)-induced cardiac toxicity	Decrease innecrosis of myocardial cells	42
20	Leaves	Ethanol	Chemiluminescence and Chemotactic Activity of Phagocytes	Luminol-based chemiluminescence assay Chemotaxis assay modified 48- well Boyden chamber	Inhibitory activity on the oxidative burst of polymorphonuclear leukocytes	43
21	Leaves	Aqueos	Antidiabetic	streptozotocin-induced Diabetes mellitus	significantly ameliorated the altered FPG, reduced glutathione and malondialdehyde. Histopathological damage of islet cells is reversed.	44

Table 02: Reported activities of Different nanoparticle preparations of *Moringa oleifera*

Sl No.	Part	Fomulation	Activity	Model	Reference
01	Leaves	Silver nanoparticles	Antimicrobial against S. aureus, E. coli, B. cereus, C. albicans, C. tropicalis, C. krusei	Agar well diffusion assay	45
02	Leaves	Nickel oxide nanoparticles	Cytotoxicity HT- 29 (Colon Carcinoma) cell lines antibacterial activity against Gram negative bacterial strains like Escherichia Hermannii, Escherichia Coliand Gram-positive bacterial strains like Streptococcus Pnemoniae, Staphylococcus Aureus	MTT (Micro culture Tetrazolium) assay Disc diffusion (Recative oxygen species has led to the destruction of the cell protein, DNA and cell membrane resulting in cell death, leads to the formation of electron-hole pairs, thereby resulting in the production of hydrogen peroxide, which enters cell membrane and kills bacteria.)	
03	Leaf and Seeds	Iron nanoparticles	Antibacterial Gram negative Escherichia coli (E.coli)	Modified paper disc method	46
04	Leaves	Titanium dioxide	Wound healing	Excision induced wound	47
05	Stembark	Silver nanoparticles	Anticancer-human cervical carcinoma HeLa	Annexin V/PI double staining assay	48

Conclusion

Moringa oleifera one of the important trees with both excellent nutritional and medicinal values. As it can be grown easily with no expenses it can provide great alternative for nutrition and can also provides primary solution for various health conditions. Even though M. Oleifera has been extensively researched and used for its various medicinal purpose, additional studies are warranted to examine its beneficial as well as other potential advantages, as well as to overcome many of the remaining difficulties with regard to the scientific review of its medicinal uses. As it has immense nutritional and medicinal profile, There is a need ofclinical trials on order toefficiently establish toxicity profile of on human beings which enable its safe use. The therapeutic potential of this tree has to be explored based on isolated studies and experiments to make it more beneficial and commercial utility.

Acknowledgement

Authors are thankful to the management of Sri Adichunchanagiri College of Pharmacy, B. G
Nagara for extending their support and cooperation for writing this article.

Conflictof Interest

None

References

1. Mohammed S, Manan FA. Analysis of total phenolics, tannins and flavonoids from Moringa oleifera seed extract. J Chem Pharm Res. 2015;7(1):135-7.
2. Taher MA, Nyeem MA, Ahammed MM, Hossain MM, Islam MN. Moringa oleifera (Shajna): the wonderful indigenous medicinal plant. Asian Journal of Medical and Biological Research. 2017;3(1):20-30.
1. 3.K.M. Nadkarni. Indian Materia Medica. Bombay Popular Prakashan, 2009, Vol.I, 811-816.
2. 4.C.P. Khare. Indian medicinal plants. Springer, 2007, 422-423.
3. 5.Sachan D, Jain SK, Singh N. In Vitro and In Vivo Efficacy of Moringa oleifera Plant Constituents in Urolithiasis as Antilithiatic Drugs. International Journal of Pharma Sciences and Research. 2011;2(7):1638-44.
4. 6.Paikra BK. Phytochemistry and pharmacology of Moringa oleifera Lam. Journal of pharmacopuncture. 2017;20(3):194.
5. 7. Vergara-Jimenez M, Almatrafi MM, Fernandez ML. Bioactive components in Moringa oleifera

leaves protect against chronic disease. Antioxidants. 2017;6(4):91.

6. 8. Singh BN, Singh BR, Singh RL, Prakash D, Dhakarey R, Upadhyay G, Singh HB. Oxidative DNA damage protective activity, antioxidant and anti-quorum sensing potentials of Moringa oleifera. Food and Chemical Toxicology. 2009;47(6):1109-16.
7. 9. Panda S. Butanolic fraction of Moringa oleifera Lam.(Moringaceae) attenuates isoprotrenol-induced cardiac necrosis and oxidative stress in rats: an EPR study. EXCLI journal. 2015;
8. 14:64.
9. Muhammad HI, Asmawi MZ, Khan NA. A review on promising phytochemical, nutritional and glycemic control studies on Moringa oleifera Lam. in tropical and sub-tropical regions. Asian Pacific Journal of Tropical Biomedicine. 2016;6(10):896-902.
10. Anwar F, Latif S, Ashraf M, Gilani AH. Moringa oleifera: a food plant with multiple medicinal uses. Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives. 2007;21(1):17-25.
11. Roy SK, Chandra K, Ghosh K, Mondal S, Maiti D, Ojha AK, Das D, Mondal S, Chakraborty I, Islam SS. Structural investigation of a heteropolysaccharide isolated from the pods (fruits) of Moringa oleifera (Sajina). Carbohydrate research. 2007;342(16):2380-9.
12. 13Makkar HA, Becker K. Nutrional value and antinutritional components of whole and ethanol extracted Moringa oleifera leaves. Animal feed science and technology. 1996;63(1-4):211-28.
13. 14Sánchez-Machado DI, Lopez-Cervantes J, Vázquez NR. High-performance liquid chromatography method to measure α-and γ-tocopherol in leaves, flowers and fresh beans from Moringa oleifera. Journal of chromatography A. 2006;1105(1-2):111-4.
14. Siddhuraju P, Becker K. Antioxidant properties of various solvent extracts of total phenolic constituents from three different agroclimatic origins of drumstick tree (Moringa oleifera Lam.) leaves. Journal of agricultural and food chemistry. 2003;51(8):2144-55.
15. Pontual EV, Carvalho BE, Bezerra RS, Coelho LC, Napoleão TH, Paiva PM. Caseinolytic and milk-clotting activities from Moringa oleifera flowers. Food Chemistry. 2012;135(3):1848-54.
16. Kasolo JN, Bimenya GS, Ojok L, Ochieng J, Ogwal-Okeng JW. Phytochemicals and uses of Moringa oleifera leaves in Ugandan rural communities. Journal of Medicinal Plants Research. 2010;4(9):753-7.
17. Nepolean P, Anitha J, Emilin RR. Isolation, analysis and identification of phytochemicals of antimicrobial activity of Moringa oleifera Lam. Current biotica. 2009;3(1):33-7.
18. 19.Ram, P., Rastogi, B.N., Mehrotra, N., 2006. Compendium of Indian Medicinal plants. Vol II. Central Drug Research Institute, Lucknow and National Institute of Science Communication and Information Resources, New Delhi, p. 468.
19. Bennett RN, Mellon FA, Foidl N, Pratt JH, Dupont MS, Perkins L, Kroon PA. Profiling glucosinolates and phenolics in vegetative and reproductive tissues of the multi-purpose trees Moringa oleifera L.(horseradish tree) and Moringa stenopetala L. Journal of agricultural and food chemistry. 2003;51(12):3546-53.
20. Sashidhara KV, Rosaiah JN, Tyagi E, Shukla R, Raghubir R, Rajendran SM. Rare dipeptide and urea derivatives from roots of Moringa oleifera as potential anti-inflammatory and antinociceptive agents. European journal of medicinal chemistry. 2009;44(1):432-6.
21. Kasolo JN, Bimenya GS, Ojok L, Ochieng J, Ogwal-Okeng JW. Phytochemicals and uses of Moringa oleifera leaves in Ugandan rural communities. Journal of Medicinal Plants Research. 2010;4(9):753-7.
22. Awodele O, Oreagba IA, Odoma S, da Silva JA, Osunkalu VO. Toxicological evaluation of the aqueous leaf extract of Moringa oleifera Lam.(Moringaceae). Journal of ethnopharmacology. 2012;139(2):330-6.
23. Fakurazi S, Sharifudin SA, Arulselvan P. Moringa oleifera hydroethanolic extracts effectively alleviate acetaminophen-induced hepatotoxicity in experimental rats through their antioxidant nature. Molecules. 2012;17(7):8334-50.
24. Manaheji H, Jafari S, Zaringhalam J, Rezazadeh S, Taghizadfarid R. Analgesic effects of methanolic extracts of the leaf or root of Moringa oleifera on complete Freund's adjuvant-induced arthritis in rats. Zhong xi yi jie he xue bao= Journal of Chinese integrative medicine. 2011;9(2):216-22.
25. Misra A, Srivastava S, Srivastava M. Evaluation of anti diarrheal potential of Moringa oleifera (Lam.) leaves. Journal of Pharmacognosy and Phytochemistry. 2014;2(5):43-6.
26. Martínez-González CL, Martínez L, Martínez-Ortiz EJ, González-Trujano ME, Déciga-Campos M, Ventura-Martínez R, Díaz-Reval I. Moringa oleifera, a species with potential analgesic and anti-inflammatory activities. Biomedicine & Pharmacotherapy.2017;87:482-8.
27. López M, Ríos-Silva M, Huerta M, Cárdenas Y, Bricio-Barrios JA, Díaz-Reval MI, Urzúa Z, Huerta-Trujillo M, López-Quezada K, Trujillo X. Effects of Moringa oleifera leaf powder on metabolic

syndrome induced in male Wistar rats: a preliminary study. Journal of international medical research. 2018;46(8):3327-36.
28. Minaiyan M, Asghari G, Taheri D, Saeidi M, Nasr-Esfahani S. Anti-inflammatory effect of Moringa oleifera Lam. seeds on acetic acid-induced acute colitis in rats. Avicenna journal of phytomedicine. 2014;4(2):127.
29. Zaffer M, Ganie SA, Gulia SS, Yadav SS, Singh R, Ganguly S. Antifungal efficacy of Moringa oleifera Lam. AJPCT.2015;3:28-33.
30. Alhakmani F, Kumar S, Khan SA. Estimation of total phenolic content, in-vitro antioxidant and anti-inflammatory activity of flowers of Moringa oleifera. Asian Pacific journal of tropical biomedicine. 2013 Aug;3(8):623.
31. 32.Arora DS, Onsare JG. In vitro antimicrobial evaluation and phytoconstituents of Moringa oleifera pod husks. Industrial Crops and Products.2014;52:125-35.
32. Bakre AG, Aderibigbe AO, Ademowo OG. Studies on neuropharmacological profile of ethanol extract of Moringa oleifera leaves in mice. Journal of Ethnopharmacology.2013;149(3):783-9.
33. Cabardo Jr DE, Portugaliza HP. Anthelmintic activity of Moringa oleifera seed aqueous and ethanolic extracts against Haemonchus contortus eggs and third stage larvae. International journal of veterinary science and medicine. 2017;5(1):30-4.
34. 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):214-20.
35. Gouda AS, El-Nabarawy NA, Ibrahim SF. Moringa oleifera extract (Lam) attenuates Aluminium phosphide-induced acute cardiac toxicity in rats. Toxicology reports.2018;5:209-12.
36. Gothai S, Arulselvan P, Tan WS, Fakurazi S. Wound healing properties of ethyl acetate fraction of Moringa oleifera in normal human dermal fibroblasts. Journal of intercultural ethnopharmacology. 2016;5(1):1.
37. Al-Asmari AK, Albalawi SM, Athar MT, Khan AQ, Al-Shahrani H, Islam M. Moringa oleifera as an anti-cancer agent against breast and colorectal cancer cell lines. PloS one. 2015;10(8):e0135814.
38. Metwally FM, Rashad HM, Ahmed HH, Mahmoud AA, Raouf ER, Abdalla AM. Molecular mechanisms of the anti-obesity potential effect of Moringa oleifera in the experimental model. Asian Pacific Journal of tropical biomedicine. 2017;7(3):214-21.
39. Mahesh GS, Paras P, Manish P, Samresh PR, Asish NP. Antidiarrheal activity of methanolic extract of Moringa oleifera Lam roots in experimental animal model. Int J Pharm Res. 2010;2(2):35-9.
40. Omotoso GO, Gbadamosi IT, Olajide OJ, Dada-Habeeb SO, Arogundade TT, Yawson EO. Moringa oleifera phytochemicals protect the brain against experimental nicotine-induced neurobehavioral disturbances and cerebellar degeneration. Pathophysiology. 2018;25(1):57-62.
41. Panda S, Kar A, Sharma P, Sharma A. Cardioprotective potential of N, α-l-rhamnopyranosyl vincosamide, an indole alkaloid, isolated from the leaves of Moringa oleifera in isoproterenol induced cardiotoxic rats: In vivo and in vitro studies. Bioorganic & medicinal chemistry letters. 2013;23(4):959-62.
42. Vongsak B, Gritsanapan W, Wongkrajang Y, Jantan I. In vitro inhibitory effects of Moringa oleifera leaf extract and its major components on chemiluminescence and chemotactic activity of phagocytes. Natural Product Communications. 2013;8(11):1934578X1300801115.
43. Yassa HD, Tohamy AF. Extract of Moringa oleifera leaves ameliorates streptozotocin-induced Diabetes mellitus in adult rats. Acta Histochemica. 2014;116(5):844-54.
44. Prasad TN, Elumalai EK. Biofabrication of Ag nanoparticles using Moringa oleifera leaf extract and their antimicrobial activity. Asian Pacific Journal of Tropical Biomedicine. 2011 Dec;1(6):439.
45. Katata-Seru L, Moremedi T, Aremu OS, Bahadur I. Green synthesis of iron nanoparticles using Moringa oleifera extracts and their applications: removal of nitrate from water and antibacterial activity against Escherichia coli. Journal of Molecular Liquids.2018;256:296-304.
46. Sivaranjani V, Philominathan P. Synthesize of Titanium dioxide nanoparticles using Moringa oleifera leaves and evaluation of wound healing activity. Wound Medicine.2016;12:1-5.
47. Vasanth K, Ilango K, MohanKumar R, Agrawal A, Dubey GP. Anticancer activity of Moringa oleifera mediated silver nanoparticles on human cervical carcinoma cells by apoptosis induction. Colloids and surfaces B: Biointerfaces.2014;117:354-9.