



Moringa oleifera: Nutritive importance and its medicinal application, as a Review

Younis S. Mutar*, Khalid F. Al-Rawi*, Mustafa Taha Mohammed**

*Department of Chemistry, College of Science, University of Anbar, Anbar, Iraq

**Department of Chemistry, College of Science, Al-Mustansiriyah University, Baghdad, Iraq



Abstract

Moringa oleifera Lam (Moringaceae) can be defined as one of the plants which great medicinal and nutritional value. This plant is considered to be native to India, also it has been currently majorly distributed in sub-tropical and tropical world regions. The plant has various parts which are protein sources, minerals, vitamin, also presenting biotechnological and pharmacological possibilities. With this regard, the presented work is gathering information on the discussed plant and showing its pharmacological and nutritional potential, in addition to their chemical constituents. Due to the great nutritive values of the plant, each tree part is adequate for commercial or nutritional uses. The plant's leaves have a lot of vitamins, minerals, also other significant phytochemicals. The leaves' extracts are utilized for treating malnutrition, it has been applied as possible antioxidant.

Keywords: *Moringa oleifera*; antioxidant; Nutrition.

Introduction

The medicinal plants were specified for being natural resources of the compounds with nutritional and pharmacological possibilities which will aid humans in preventing and treating certain diseases [1]. From many plants assessed in the bio prospective researches, the *M. oleifera*, which is commonly indicated as “quiabo-de-quina”, “lirio branco”, or “moringa”, in certain world's regions, as horseradish tree or drumstick tree, were effective as alternate medical therapies, with efficiency in controlling a lot of illnesses [2,3]. Also, their medicinal potential comes from the secondary metabolites, including resins, coumarins, flavonoids, alkaloids, steroids, tannins, saponins, and quinones [3]. Seeds, flowers, leaves, and pods of the discussed tree have been specified as one of the food sources with great nutritional values in Africa and other nations, especially in Pakistan, Philippines, and India [1]. One might consume the plant's leaves fresh or cooked, and they might store them as dried powder which has been un-refrigerated without losing nutrition's, for many months. Certainly, the *M. oleifera* has been adding considerable benefits of health to nations in which the hunger has been an issue [3]. Furthermore, the *M. oleifera* is an excellent plant with a lot of medicinal applications [4]. It is indicated as 'Miracle Tree' or 'The

Tree of Life' due to its versatility and economic significance [5]. *M. oleifera* as shown in Fig.(1) Its medicinal potential derives from secondary metabolites in addition to the essential amino acids including lysine, tryptophan, methionine, vitamins, also mineral salts are existing in elevated quantities in leaves of the plant. Earlier researches indicated the possible therapeutic abilities regarding the *M. oleifera*, like anti-microbial, anti-cancer, anti-inflammatory, and anti-oxidant characteristics [6], anti-atherosclerotic [7].



*Corresponding author e-mail: y_s_m85@yahoo.com; (Younis S. Mutar).

Receive Date: 29 May 2021, Accept Date: 05 June 2021

DOI: 10.21608/EJCHEM.2021.78212.3823

©2021 National Information and Documentation Center (NIDOC)



Fig.(1): Moringa oleifera tree leaves[47].

Furthermore, the thyroid regulation impacts, also protecting against the oxidative damages [7,8]. A lot of epidemiological and experimental evidences suggesting that the plant have anti-oxidant impacts against the massive damage related to the oxidative stress [9,10]. Anti-oxidants existing in the plant's leaves, act in cooperation with anti-oxidant system exists in a body. A lot of researches are focusing on evaluating a lot of detoxication as well as anti-oxidant enzymes due to the treatment by *M. oleifera* or with the phytochemicals that is isolated from *M. oleifera* [11].

Chemical constituents

Moringa oleifera contains many important chemical compounds, such as vitamins, also secondary metabolites including vanillin, flavonoids, ferulic acids, gallic acids, ellagic acids, phenolic acids, chlorogenic acids, glucosinolates, quercetin, also kaempferol, that have nutritional, antimicrobial and/or pharmaceutical properties [12,13]. Yet, the amount of such metabolites in the extracts of *M. oleifera* is changing on the basis of climatic conditions, exposure to sun, soil, and location [14]. Also, the approach, also the utilized solvents for extraction might be modifying the contents related to compounds acquired from plant, majorly flavonoids and phenols [15].

Applications of *M. oleifera*.

Nutritional potential

The plant consists of over ninety nutritional chemical compounds, such as dietary fibers, lipids, proteins, and carbohydrates (**Table 1**). It has been utilized in tropics as source of food for overcoming malnutrition, particularly in infants and children [2,16]. From many

nutrients indicated in various *M. oleifera* parts, the proteins were the major abundant, which is responsible for about quarter of the dry weight [3]. Also, the plant consists of many vitamins and minerals (**Table 2**), also minimum of seventeen amino were indicated in the plant (**Table 3**).

The lipids have been considered to be abundant in the seeds, majorly oleic acid, saturated palmitic acid, and stearic acid, that will represent approximately 30% of dry weight [17]. Furthermore, the lipidic compounds linolenic acid in addition to the palmitic acid have been the major parts of plant's leaves. The elevated nutritional contents in the dried leaves indicating the significance of the plant as a source for food [18].

*Phytoconstituents and Pharmacological activity of *M. oleifera*.*

The *M. Oleifera* are a rich vitamin source. In addition, other compounds such as alkaloids, tannins, phenolics, saponins and steroids have also been reported to be present in the plant [25]. Which possesses the biological effectiveness of (**Table 4**). A research conducted by Ghasi et al. indicated certain hypocholesterolemic activity following administrating crude extract that is related to the leaves of *M. oleifera* to rats that have been fed on diet of high-fat, resulted in decrease of up to 14% in the levels of serum cholesterol [26]. The plant (*M. oleifera*) fruit consumption has been efficient to reduce low-density lipoprotein, high-density lipoprotein, and very-low-density lipoprotein serum levels [27]. Along with such impacts, the leaf extracts of *M. oleifera* was indicated for reducing the formation regarding atherosclerotic plaques [28]. Even with some researches in humans, some of the studies showed possible advantages of utilizing *M. oleifera* for treating dyslipidemia and hyperglycemia (**Table 4**). For example, a work involves 46 individuals experiencing type-2diabetes, treated with day-to-day 8g leaf powder of *M. oleifera* for 40days, indicated that fasting in addition to the postprandial glycemia decreased by 28% and 26%, in the case when put to comparison with the un-treated individuals, the very-low-density lipoprotein cholesterol, triglycerides, total cholesterol, as well as low-density lipoprotein have been low in comparison to those related to control individuals [29]. Other work with 35 individuals suffering from type-2 diabetic indicated that to consume 4.6g-tablets regarding the leaves of *M. oleifera* for 50days, had the ability for decreasing total cholesterol and increasing the high-

density lipoprotein [30]. Moreover, the scientific evidences suggesting a possible role related to the leaves of plant in reducing kidney and liver drug-induced damages in the animals (Table 4). The plant's anti-inflammatory activity was indicated following the treatment with certain extracts taken from seeds, flowers, stems, roots, leaves, and pods (Table 4). The plant's antioxidant activity has been especially high in seed, pod, and leaves extracts (Table 4). The elevated high content regarding phenols and flavonoids in various plant's parts, particularly leaves, favors the reducing oxidative damages the main bio-molecules via inhibiting lipid peroxidation, also the action which is related to nitric oxide and deoxyribose degradation induction, prevent free radical's generation [12,31].

Moringa oleifera Promotes Antioxidant activity.

Plant extracts showed high efficacy with regard to fight oxidative stress[48]. The biological significance of the *M. oleifera* plant lies in effective anti-oxidants (which have been molecules against the free radicals with the ability to secure or deactivate free radicals prior to damaging the cells). There have been a lot of antioxidant systems which are synergistically working with each other for protecting the organs of body as well as the organ systems from free radical damages. Where the results showed containment the extract a number of important vitamins from antioxidants (C, E and A) [47]. Which are considered to external antioxidants and are a dietary supplement that promotes with internal antioxidants in fighting free radicals that break down the cell. Also, the extract contains a number of trace elements such as zinc, manganese and magnesium that activate a number of internal antioxidant enzymes that work inside the body [48]. The lacks of iron, manganese, zinc, and copper might be contributing to tissue oxidative damages. They have been considered as active components related to certain recognized antioxidant enzymes like Catalase (CAT), Glutathione S-transferase (GPx), and Superoxide dismutase (SOD), are of high importance in human growth, also the development acting as antioxidant synthesis [49].

TABLE 1. The macro-nutrients of seeds, pods and leaves of *M. oleifera* [18-22].

Nutrients	M. oleifera (g/100g of plant)		
	Leaves	Pods	Seeds
Proteins	25–30.30	6.70–43.50	29.4–38.3
Lipids	0.10–10.	0.10–5.10	30.80–41.20

Carbohydrates	0.10–43.90	0.1–38.20	0.10–21.10
Fibers	0.10–28.50	0.10–27	0.10–7.20

TABLE 2. Vitamins and minerals for seeds, pods, and leaves of the *M. oleifera* [16, 18,21,23,24].

Minerals	M. oleifera (mg/100g of plant)		
	Leaves	Pods	Seeds
Calcium	440–3650	30.0–237.7	263.5
Magnesium	24–1050	9.6–83.4	78.4
Sulfur	137–925	137	ND
Sodium	164–272	210.50	ND
Potassium	259–20616	259–2097	ND
Phosphor	70–300	110–194.30	ND
Iron	0.85–126	4.4–15.5	44.8
Zinc	0.16–3.3	ND	ND

Vitamins	M. oleifera (mg/100g of plant)		
	Leaves	Pods	Seeds
Vit.A	6.78–18.90	ND	ND
Vit.B2	0.05–20.5	ND	ND
Vit.B3	0.8–8.2	ND	ND
Vit.B7	423	ND	ND
Vit.B12	0.06–2.64	ND	ND
Vit.C	17.30–220	ND	ND
Vit.E	77	ND	ND

ND: Not determined.

TABLE 3. Amino acids of the seeds, pods, and leaves of *M. oleifera* [16,18–20,22].

Amino acids	M. oleifera (g/100g)		
	Leaves	Pods	Seeds
Essential			
Arginine	0.40–1.80	0.36	4.50
Histidine	0.1–0.7	0.11	2.3
Leucine	0.4–2.2	0.65	6.7
Lysine	0.3–1.4	0.15	1.5
Methionine	0.1–0.5	0.15	2.4
Phenylalanine	0.3–1.6	0.43	4.0
Threonine	0.1–1.3	0.39	3.1
Tryptophan	0.1–5.2	ND	1.6
Valine	0.4–1.4	0.54	4.3
Non-Essential			
Alanine	1.8–3.0	ND	6.9
Aspartate	1.4–2.2	ND	5.0
Cysteine	0.01–0.10	ND	2.0
Glutamate	2.5–2.5	ND	20.9
Glycine	1.3–1.5	ND	10.9
Proline	1.2–1.4	ND	4.5
Serine	1.0–1.2	ND	4.4
Tyrosine	0.01–2.60	0.08	1.6

ND: Not determined

TABLE 4. Pharmacological activity of various plant's parts.

Plant part	Pharmacological activity
Leaves	Anti-atherosclerotic [28] Anti-inflammatory [32] Anti-cancer [33] Anti-microbial [34] Hepatoprotective [35] Hypocholesterolemic[36] Hypoglycaemic[37] Hypolipidaemic[28] Immunomodulatory[36] Nephroprotective[37]
Roots	Anti-inflammatory [38] Antimicrobial [39] Hepatoprotective [40] Nephroprotective [35]
Flowers	Antimicrobial [41] Hepatoprotective [40] Nephroprotective [35]
Pods	Anti-inflammatory [42] Antimicrobial [3] Antioxidant [12] Hypocholesteromic [43]
Flowers	Antimicrobial [41] Hepatoprotective [40] Nephroprotective [35]
Seeds	Anti-inflammatory [44] Anti-cancer [33] Antimicrobial [45] Antioxidant [12] Immunomodulatory [38]

These antioxidant enzymes are synthesized by the body but the trace elements needed cofactors must be supplied by the diet.

The plant's antioxidant activity has been especially high in seeds, pod, and leaves extracts. The great contents related to phenols and flavonoids in various plant's parts, particularly the leaves, favors the decrease in oxidative damages to main bio-molecules via inhibiting the lipid peroxidation in addition to the action of nitric oxide and deoxyribose degradation induction, prevent free radical's generation [12,50,51]. Researches with diabetic and normal rats indicated that the treatment with the use of aqueous *M. oleifera* leaf extract

considerable elevated the activity related to enzyme superoxide dismutase, catalase and glutathione S-transferase, while decreasing the lipid peroxidation, It was indicated that elevated flavonoid and phenolic content in extracts might be protecting against the oxidative damage in diabetic and normal persons [54]. Also, a study conducted with 60 post-menopausal women specified that supplementations with the use of *M. oleifera* leaf powder for a period of three months considerable reduced the serum levels related to malondialdehyde, created via lipid peroxidation, also elevated levels of superoxide dismutase, ascorbic acid, and glutathione peroxidase that have been specified as indicators regarding the plant's antioxidant property [53].

Moringa oleifera Promotes brain health

Research and studies have shown the potential therapeutic potential regarding the *M. oleifera* in protecting brain health, as *M. oleifera* by its antioxidant scans reduces reactive oxygen species, thus protecting the brain [54]. The phytochemical of *M. oleifera* are protecting the brain from cerebellar degeneration and experimental nicotine-induced neurobehavioral disturbances [55]. Another study also showed that *M. oleifera* extract reduces rat brain hypoxia by poisoning elements CoCl_2 [56]. and AlCl_3 [57]. Ginseng and *M. oleifera* ameliorated cognitive impairments Alzheimer disease in rat [58]. *M. oleifera* has been utilized for treating dementia, since it was indicated for being one of the promoters of spatial memory, leaf extracts were decreasing the acetylcholine esterase activity, thus enhancing the memory and cholinergic function, indicated that leaf extracts of *M. oleifera* have been neuro-protective against the dementia that is related to age in the case when being administered to the rats [25]. Other research indicated that the attenuation regarding lead-induced oxidative stress in rat brain of male wistar rats by *M. oleifera* seed powder [59]. *M. oleifera* leaves are containing nootropic activity and therefore might be enhancing the memory [60].

Conclusions

The current economic recession being experienced world-wide, especially in low income countries, is likely to make people seek out the use of herbal medicine more, thereby necessitating the need for further research on this plant. This review showing this plant's versatility. On the basis of certain scientific reports, the plant is eco-friendly, cheap, also socially

valuable alternate, particularly for the socially neglected population, experiencing malnutrition and poverty and people find it hard to use the technological resources. There is an abundance of data on using *M. oleifera* to treat conditions relating to diabetes, hyperlipidemia, hypertension, hypoglycaemia and some other related conditions.

Conflicts of interest

There are no conflicts to declare

References

1. El Sohaimy, S., Hamad, G., Mohamed, S., Amar, M., & Al-Hindi, R. Biochemical and functional properties of *Moringa oleifera* leaves and their potential as a functional food. *Global Advanced Research Journal of Agricultural Science*, 4(4), 188-199, (2015).
2. Fahey, J. *Moringa oleifera*: a review of the medical evidence for its nutritional, therapeutic, and prophylactic properties. Part 1. *Trees for life Journal*, 1(5), 1-15, (2005).
3. Anwar, F., Latif, S., Ashraf, M., & Gilani, A. H. *Moringa oleifera*: a food plant with multiple medicinal uses. *Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives*, 21(1), 17-25, (2007).
4. Vinodini, N., Chatterjee, P., Amemarsoofi, A., Suman, V., & Pai, S. Evaluation of liver functions with *Moringa oleifera* leaf extract in cadmium induced adult Wistar albino rats. *International Journal of Plant, Animal and Environmental Sciences*, 4(3), 104-106, (2014).
5. Abe, R., & Ohtani, K. An ethnobotanical study of medicinal plants and traditional therapies on Batan Island, the Philippines. *Journal of Ethnopharmacology*, 145(2), 554-565. (2013).
6. Farooq, F., Rai, M., Tiwari, A., Khan, A. A., & Farooq, S. Medicinal properties of *Moringa oleifera*: An overview of promising healer. *Journal of Medicinal Plants Research*, 6(27), 4368-4374, (2012).
7. Biswas, S., Chowdhury, A., Das, J., Roy, A., & Hosen, S. Pharmacological potentials of *Moringa oleifera* Lam.: a review. *International Journal of Pharmaceutical Sciences and Research*, 3(2), 305, (2012).
8. Chuang, P., Lee, C., Chou, J., Murugan, M., Shieh, B., & Chen, H. Anti-fungal activity of crude extracts and essential oil of *Moringa oleifera* Lam. *Bioresource technology*, 98(1), 232-236, (2007).
9. Abd Eldaim, M., Shaban Abd E., & Abd Elaziz, S. An aqueous extract from *Moringa oleifera* leaves ameliorates hepatotoxicity in alloxan-induced diabetic rats. *Biochemistry and Cell Biology*, 95(4), 524-530, (2017).
10. Vergara-Jimenez, M., Almatrafi, M., & Fernandez, M. Bioactive components in *Moringa oleifera* leaves protect against chronic disease. *Antioxidants*, 6(4), 91, (2017).
11. Kumar, M., Sharma, M., Saxena, P., & Kumar, A. Radioprotective effect of *Panax ginseng* on the phosphatases and lipid peroxidation level in testes of Swiss albino mice. *Biological and Pharmaceutical Bulletin*, 26(3), 308-312, (2003).
12. Singh, B., Singh, R., Prakash, D., Dhakarey, R., Upadhyay, G., & Singh, H. Oxidative DNA damage protective activity, antioxidant and anti-quorum sensing potentials of *Moringa oleifera*. *Food and Chemical Toxicology*, 47(6), 1109-1116, (2009).
13. Mbikay, M. Therapeutic potential of *Moringa oleifera* leaves in chronic hyperglycemia and dyslipidemia: a review. *Frontiers in pharmacology*, 3, 24, (2012).
14. Wink, M. Evolution of secondary metabolites from an ecological and molecular phylogenetic perspective. *Phytochemistry*, 64(1), 3-19, (2003).
15. Vongsak, B., Sithisarn, P., Mangmool, S., Thongpraditchote, S., Wongkrajang, Y., & Gritsanapan, W. Maximizing total phenolics, total flavonoids contents and antioxidant activity of *Moringa oleifera* leaf extract by the appropriate extraction method. *Industrial crops and products*, 44, 566-571, (2013).
16. Djakalia, B., Guichard, B., & Soumaila, D. Effect of *Moringa oleifera* on growth performance and health status of young post-weaning rabbits. *Research Journal of Poultry Science*, 4(1), 7-13, (2011).
17. Abdulkarim, S., Long, K., Lai, O., Muhammad, S., & Ghazali, H. Some physico-chemical properties of *Moringa oleifera* seed oil extracted using solvent and aqueous enzymatic methods. *Food chemistry*, 93(2), 253-263, (2005).
18. Moyo, B., Masika, P., Hugo, A., & Muchenje, V. Nutritional characterization of *Moringa (Moringa oleifera* Lam.) leaves. *African Journal of Biotechnology*, 10(60), 12925-12933, (2011).

19. Makkar, H., & Becker, K. Nutritional value and antinutritional components of whole and ethanol extracted *Moringa oleifera* leaves. *Animal feed science and technology*, 63(1-4), 211-228, (1996).
20. Richter, N., Siddhuraju, P., & Becker, K. Evaluation of nutritional quality of moringa (*Moringa oleifera* Lam.) leaves as an alternative protein source for Nile tilapia (*Oreochromis niloticus* L.). *Aquaculture*, 217(1-4), 599-611,(2003).
21. Oduro, I., Ellis, W. O., & Owusu, D. Nutritional potential of two leafy vegetables: *Moringa oleifera* and *Ipomoea batatas* leaves. *Scientific Research and Essays*, 3(2), 057-060,(2008).
22. Ferreira, P., Farias, D., Oliveira, J., & Carvalho, A. *Moringa oleifera*: bioactive compounds and nutritional potential. *Revista de Nutrição*, 21(4), 431-437, (2008).
23. Aslam, M., Anwar, F., Nadeem, R., Rashid, U., Kazi, T., & Nadeem, M. Mineral composition of *Moringa oleifera* leaves and pods from different regions of Punjab, Pakistan. *Asian Journal of Plant Sciences*,(2005)..
24. Mensah, J. K., Ikhajiagbe, B., Edema, N. E., & Emokhor, J. Phytochemical, nutritional and antibacterial properties of dried leaf powder of *Moringa oleifera* (Lam.) from Edo Central Province, Nigeria. *J. Nat. Prod. Plant Resour*, 2(1), 107-112,(2012).
25. Sotalangka, C., Wattanathorn, J., Muchimapura, S., & Thukham-mee, W. *Moringa oleifera* mitigates memory impairment and neurodegeneration in animal model of age-related dementia. *Oxidative medicine and cellular longevity*, 2013,(2013).
26. Ghasi, S., Nwobodo, E., & Ofili, J. Hypocholesterolemic effects of crude extract of leaf of *Moringa oleifera* Lam in high-fat diet fed Wistar rats. *Journal of ethnopharmacology*, 69(1), 21-25, (2000).
27. Mehta, K., Balaraman, R., Amin, A., Bafna, P., & Gulati, O. Effect of fruits of *Moringa oleifera* on the lipid profile of normal and hypercholesterolaemic rabbits. *Journal of ethnopharmacology*, 86(2-3), 191-195, (2003).
28. Chumark, P., Khunawat, P., Sanvarinda, Y., Phornchirasilp, S., Morales, N., Phivthong-Ngam, L., & Klai-upsorn, S. The in vitro and ex vivo antioxidant properties, hypolipidaemic and antiatherosclerotic activities of water extract of *Moringa oleifera* Lam. leaves. *Journal of ethnopharmacology*, 116(3), 439-446,(2008).
29. Kumari, D. Hypoglycaemic effect of *Moringa oleifera* and *Azadirachta indica* in type 2 diabetes mellitus. *Bioscan*, 5(20), 211-214,(2010).
30. Nambiar, V., Guin, P., Parnami, S., & Daniel, M. Impact of antioxidants from drumstick leaves on the lipid profile of hyperlipidemics. *J Herb Med Toxicol*, 4(1), 165-172,(2010).
31. Sasikala, V., Rooban, B., Priya, S., Sahasranamam, V., & Abraham, A. *Moringa oleifera* prevents selenite-induced cataractogenesis in rat pups. *Journal of ocular pharmacology and therapeutics*, 26(5), 441-447,(2010).
32. Waterman, C., Cheng, D. M., Rojas-Silva, P., Poulev, A., Dreifus, J., Lila, M., & Raskin, I. Stable, water extractable isothiocyanates from *Moringa oleifera* leaves attenuate inflammation in vitro. *Phytochemistry*, 103, 114-122,(2014).
33. Al-Asmari, A., Albalawi, S., Athar, M., Khan, A., Al-Shahrani, H., & Islam, M. *Moringa oleifera* as an anti-cancer agent against breast and colorectal cancer cell lines. *PloS one*, 10(8), e0135814. (2015).
34. Elgamily, H., Moussa, A., Elboraey, A., El-Sayed, H., Al-Moghazy, M., & Abdalla, A. Microbiological assessment of *Moringa oleifera* extracts and its incorporation in novel dental remedies against some oral pathogens. *Open access Macedonian journal of medical sciences*, 4(4), 585,(2016).
35. Toppo, R., Roy, B. K., Gora, R. H., Baxla, S. L., & Kumar, P. Hepatoprotective activity of *Moringa oleifera* against cadmium toxicity in rats. *Veterinary world*, 8(4), 537 (2015).
36. Gupta, A., Gautam, M., Singh, R., Kumar, M., Rao, C., Goel, R., & Anupurba, S. Immunomodulatory effect of *Moringa oleifera* Lam. extract on cyclophosphamide induced toxicity in mice, (2010).
37. Ouédraogo, M., Lamien-Sanou, A., Ramdé, N., Ouédraogo, A., Ouédraogo, M., Zongo, S., & Guissou, P. Protective effect of *Moringa oleifera* leaves against gentamicin-induced nephrotoxicity in rabbits. *Experimental and Toxicologic Pathology*, 65(3), 335-339, (2013).
38. Mahajan, S., Banerjee, A., Chauhan, B. F., Padh, H., Nivsarkar, M., & Mehta, A. A. Inhibitory effect of n-butanol fraction of *Moringa oleifera* Lam. seeds on ovalbumin-induced airway inflammation

- in a guinea pig model of asthma. *International journal of toxicology*, 28(6), 519-527,(2009).
39. Nikkon, F. In vitro Antimicrobial Activity of the Compound Isolated from Chloroform Extract of Moringa oleifera Lam. *Pakistan Journal of Biological Sciences*, 6(22), 1888-1890, (2003).
 40. Ruckmani, K., Kavimani, S., An, R., & Jaykar, B. Effect of Moringa oleifera Lam on paracetamol-induced hepatotoxicity. *Indian Journal of Pharmaceutical Sciences*, 60(1), 33, (1998).
 41. Rocha, M. , de Aguiar, F. , Brilhante, R., de Aguiar Cordeiro, R., Teixeira, C., Castelo, D.,& Sidrim, J. Moringa oleifera and vernonia sp. extracts against candida albicans and microsporum canis isolates from dogs and cats and analysis of toxicity to artemia sp, (2011).
 42. Cheenpracha, S., Park, E. , Yoshida, W. Y., Barit, C., Wall, M., Pezzuto, J., & Chang, L Potential anti-inflammatory phenolic glycosides from the medicinal plant Moringa oleifera fruits. *Bioorganic & medicinal chemistry*, 18(17), 6598-6602 ,(2010).
 43. Mehta, K., Balaraman, R., Amin, A. H., Bafna, P., & Gulati, O. Effect of fruits of Moringa oleifera on the lipid profile of normal and hypercholesterolaemic rabbits. *Journal of ethnopharmacology*, 86(2-3), 191-195. (2003).
 44. Agrawal, B., & Mehta, A. Antiasthmatic activity of Moringa oleifera Lam: A clinical study. *Indian Journal of pharmacology*, 40(1), 28,(2008).
 45. Rocha, M. , Alencar, L. , Brilhante, R. , Sales, J. , Ponte, Y. , Rodrigues, P. ,& Sidrim, J. Moringa oleifera inhibits growth of Candida spp. and Hortaea werneckii isolated from Macrobrachium amazonicum prawn farming with a wide margin of safety. *Ciência Rural*, 44(12), 2197-2203,(2014).
 46. Kadhim, S. , Mohammed, M. , Abbood, S. M., & Jun, D. Biochemical studies of Ginkgo biloba extract on oxidative stress-induced myocardial injuries. *Drug Invention Today*, 14(6), 817-820,(2020).
 47. Younis S, Khalid F, Mustafa T, Study of some compounds in the extract of moringa oleifera leaves in iraq and its importance as an antioxidant. *J. Biochem. Cell. Arch.*; Vol. 20, No. 1, pp. 909-914, (2020).
 48. Pisoschi, A. M., & Pop, A. The role of antioxidants in the chemistry of oxidative stress: A review. *European journal of medicinal chemistry*, 97, 55-74, (2015).
 49. Kaur, M., Dangi, C. , & Singh, H. To study the haemoglobinopathies and ratio of copper and zinc in Sindhi community of Bhopal. *Int J Pharm Bio Sci*, 4(1), 672-691,(2013).
 50. Sreelatha, S., & Padma, P. Antioxidant activity and total phenolic content of Moringa oleifera leaves in two stages of maturity. *Plant foods for human nutrition*, 64(4), 303-311, (2009).
 51. Sasikala, V., Rooban, B., Priya, S., Sahasranamam, V., & Abraham, A. Moringa oleifera prevents selenite-induced cataractogenesis in rat pups. *Journal of ocular pharmacology and therapeutics*, 26(5), 441-447,(2010).
 52. Jaiswal, D., Rai, P. K., Mehta, S., Chatterji, S., Shukla, S., Rai, D. ,& Watal, G. Role of Moringa oleifera in regulation of diabetes-induced oxidative stress. *Asian Pacific journal of tropical medicine*, 6(6), 426-432,(2013).
 53. Kushwaha S, Chawla P, Khurana, D. Effect of supplementation of drumstick (Moringa oleifera) and amaranth (Amaranthus tricolor) leaves powder on lipid profile in postmenopausal women. *Int Sci Res Publ* ; 2(11): 162-168,(2012).
 54. Kirisattayakul, W., Wattanathorn, J., Tong-Un, T., Muchimapura, S., Wannanon, P., & Jittiwat, J. Cerebroprotective effect of Moringa oleifera against focal ischemic stroke induced by middle cerebral artery occlusion. *Oxidative medicine and cellular longevity*, 2013(2013).
 55. Omotoso, G., Gbadamosi, I., Olajide, O., Dada S., Arogundade, T., & Yawson, E. Moringa oleifera phytochemicals protect the brain against experimental nicotine-induced neurobehavioral disturbances and cerebellar degeneration. *Pathophysiology*, 25(1), 57-62, (2018).
 56. Mohamed, A. , Metwally, M., Khalil, S. R., Salem, G., & Ali, H. Moringa oleifera extract attenuates the CoCl₂ induced hypoxia of rat's brain: expression pattern of HIF-1 α , NF-kB, MAO and EPO. *Biomedicine & Pharmacotherapy*, 109, 1688-1697,(2019).
 57. Hegazi M, and Elebshany I. Ameliorative effect of Moringa oleifera on oxidative stress in male albino rat brain promoted by aluminium exposure; *J. Nature and Science* ;17(2), (2019).
 58. Abdelghany, A. ,Khalil, F., Azeem, N., El-Nahass, E., El-Kashlan, A., & Emeash, HGinseng and moringa olifera ameliorated cognitive impairments induced by aluminium chloride in albino rat. *Adv. Anim. Vet. Sci*, 7(7), 557-565, (2019).
 59. Manoj K, Lucius K, Angelica C, Attenuation of Lead-Induced Oxidative Stress in Rat Brain, Liver, Kidney and Blood of Male Wistar Rats by Moringa

-
- Oleifera Seed Powder. *J. of Environmental Pathology, Toxicology and Oncology*, 33(4);323-337 ,(2014).
60. Ganguly R., & Guha, D. Protective role of an Indian herb, *Moringa oleifera* in memory impairment by high altitude hypoxic exposure: Possible role of monoamines. *Biogenic amines*, 20(3-4), 121-133,(2006).