



Comparative Analysis of the Pharmacological Attributes of *Moringa Oleifera* and *Acacia Nilotica*

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Abstract Series of research carried out in the area of pharmacognosy has led to identification of numerous medicinal plants. *Moringa oleifera* and *Acacia nilotica* are two highly nutritive plants with vast pharmacological properties. These plants are abundantly available in virtually all tropical and some sub-tropical countries. The medicinal properties of these two plants have not been fully studied in detail, hence, utilizing their full potentials in the main stream global orthodox medication is far from been achieved. In this review, we have put together a host of pharmacological activities of both plants, while analyzing their comparative advantages of their respective properties. Their medicinal properties include: anti-ulcer, anti-inflammatory, anti-epileptic, anti-bacterial, Analgesic, hepatoprotective, to mention a few. Also highlighted are the various parts of the plants namely leaves, stem, bark, root and their corresponding pharmacological properties providing interested researchers with useful information regarding the specific pharmacological activities elicited by extracts of the various parts. In conclusion, both *Moringa oleifera* and *Acacia nilotica* are suggested to possess similar pharmacological activities.

Keywords *Moringa oleifera*, *Acacia nilotica*, Plants, Medicinal, pharmacological, Ethnomedical

Introduction

Moringa oleifera, Lam syn. *M. pterygosperma*, Gaertn (Family – Moringaceae), is a small or medium-sized tree, attractive enough to be a focal point in the tropics and sub-tropics owing to its creamy – white, sweetly scented flowers and light-green, tripinnately compound foliage [1-3]. It is native to India, occurring wild in the sub-Himalayan regions of Northern India and cultivated throughout the country. It is commonly known as Sajina, sajna (Bengali); Horseradish tree, drumstick tree (English); Sahinjan, mungna (Hindi); Murinna, muringa, tishnagandha (Malyalam); Sevaga, segata (Marathi); Sohanjana (Punjabi); Sobhanjana, sigru, murungi, dvishiguru (Sanskrit) and Sehjan (Urdu) in varied Indian languages and regions [4-5]. It also thrives well in Pakistan, Bangladesh, Sri Lanka, tropical Africa, Arabia, Philippines, Cambodia and Central, North and South America [6-8].

Acacia nilotica Lam (Mimosaceae) indigenously known as 'Babul' or 'Kikar' is a proverbial, medium sized tree and is broadly scattered in tropical and subtropical countries. It has an inspiring range of medicinal uses with potential anti-oxidant activity. This plant contributes a number of groups among which are alkaloids, volatile essential oils, phenols and phenolic glycosides, resins, oleosins, steroids, tannins and terpenes. *A. nilotica* is a medicinal plant acknowledged to be rich in phenolics, consisting of condensed tannin and phlobatannin, gallic acid, protocatechuic acid, pyrocatechol, (+) -catechin, (-) epi- gallo catechin-7-gallate and (-) epigallocatechin-5, 7-digallate. Different parts of this plant such as the leaves, roots, seeds, bark, fruits, flowers, gum and immature pods act as anti-cancer, antimutagenic, spasmogenic, vasoconstrictor, anti-pyretic, anti-asthmatic, cytotoxic, anti-diabetic, anti-platelet aggregatory, anti-plasmodial, molluscicidal, anti-fungal, inhibitory activity against Hepatitis C virus (HCV) and human immunodeficiency virus (HIV)-I and antioxidant activities, anti-bacterial, anti-hypertensive and anti-spasmodic activities, and are also engaged for the treatment of different ailments in the indigenous system of medicine [9].

The medicinal and pharmacological activities of these plants include among others;



1. **Antipyretic Activity;** The ethanolic extract of *Moringa oleifera* has a significant antipyretic effect on human body. A research conducted by [10] showed that at doses of 100mg/kg body weight, extract of *Moringa oleifera* caused a significant lowering of body temperature.
2. **Anti-bacterial activity;** Antimicrobial multi-resistant bacterial strains are a growing public health concern worldwide, and the search for alternative forms of treating infections induced by such bacterial pathogens has become a focus of many researchers. The ethanolic extract of *Moringa oleifera* efficiently inhibit the growth of *Staphylococcus aureus*, *Vibrio cholera*, and *Escherichia coli* isolated from shrimp samples.
3. **Anti-asthmatic activity;** *Moringa oleifera* has been reported by many research groups to have antiasthmatic effect. A research conducted by Agarwal and Mehta showed that the efficacy and safety of seeds kernels of *Moringa oleifera* in treatment of bronchial asthma greatly increases with no adverse effect. *Moringa oleifera* also possess some beneficial properties that act against chemically stimulated immune-mediated inflammatory responses that are characteristics of asthma in rat [11].
4. **Anti-inflammatory activity;** *Moringa oleifera* plant has substantial anti-inflammatory activity. It was found by Mehyan and colleagues [12] that n-butanol extract of *Moringa oleifera* seeds shows anti-inflammatory activity against ovalbumin-induced air way inflammation in guinea pigs. Contrary to *M. oleifera*, *A. nilotica* lacks anti-inflammatory activity, this was established when *A. nilotica* extract was administered in rats with egg albumin induced inflammatory edema. Absence of paw edema suppression indicates lack of anti-inflammatory activity [13].
5. **Analgesic activity;** The leaves and seed extracts of *M. oleifera* possess a marked analgesic activity as experimentally revealed in a hot plate and tail immersion method [14]. Analgesic activity of *A. nilotica* tested against acid induced pain in rat also reveals high percentages of analgesia [15].
6. **Hypocholesterolemic activity;** Methanolic extracts of *M. oleifera* was found to contain some alkaloids whose weekly moderate dose level treatment in mice change serum aminotransferase and plasma cholesterol level significantly [16].
7. **Wound healing;** The ethyl acetate extract of fresh and dried leaves of *M. oleifera* is reported to possess significant wound healing potentials. Bioactive fraction of *M. oleifera* containing Vicenin-2 compound enhances faster wound healing [17]. Also, the ethanolic extract of *A. nilotica* exhibit marked wound healing activity and significantly enhance the wound contraction and the period of epithelialization.
8. **Hepatoprotective activity;** The leaves and ethanol extracts of *M. oleifera* showed significant protection against liver damage induced by anti-tubercular drugs in rats [18]. Various studies reported the ethanolic extract of *M. oleifera* seeds and leaves to possess hepatoprotective reaction [19-20]. The root and flower extracts also showed antihepatotoxic activity [21]. Remarkable protective effect has been observed against CCl₄ – induced liver fibrosis in rats [21].
9. **Antispasmodic activity;** The root and leaves of *M. oleifera* contains several compound with spasmodic activity. The spasmolytic activity of the different constituents support for traditional uses of this plant in gastrointestinal motility disorder [22]. *A. nilotica* was found to have spasmodic activity on isolated guinea pig ileum [15].
10. **Antiulcer activity;** Wide spectrum pharmacological properties of *M. oleifera* as a versatile medicinal plant, includes its potent antiulcer activity. A research conducted by Debnath and Guha [23] reported the antiulcer effect of *M. oleifera* leaves aqueous extracts on adult Holtzman albino rats. The methanolic flower bud extract of *M. oleifera* also showed a decrease in ulcer index of aspirin-induced gastric ulcer in rats [24]. The leaf extract of *M. oleifera* also produced a significant reduction of stress-induced ulcers and cysteamine-induced duodenal ulcers. However, *A. nilotica* reportedly demonstrated a significant antiulcer activity in pyloric ligation, swimming stress and induced rat ulcer model [25].
11. **Anti-hyperglycemic effect;** An *in vivo* research [26] showed that 20mgkg⁻¹ dose of aqueous extracts of *M. oleifera* significantly reduce urine sugar and urine protein level in mice.
12. **Anti-diabetic;** Several medicinal plants including *M. oleifera* have been evaluated for their potentials as therapeutic agents for diabetes. The leaves of *M. oleifera* significantly decrease blood glucose concentration in Wistar rat and Goto-Kakizaki (GK) rats, modeled type 2 diabetes [27]. *A. nilotica* pods and tender leaves are also considered very beneficial in folk medicine to treat diabetes mellitus [28].
13. **Anti-tumor;** *M. oleifera* is a potent anticancer plant and several bioactive compounds with significant antitumor activity have been discovered from *M. oleifera*. Among bioactive compounds from *M.*



- oleifera*, niazimicin, a *M. oleifera* leaves thiocarbamate was found to have potent anticancer activity [29-30]. Beside leaves, *M. oleifera* seed extracts also have anticancer activity through its effect on hepatic carcinogen metabolizing enzyme [31]. *A. nilotica* has been reported to have chemoprotective and anti-mutagenic activity [33].
14. **Anti-plasmodia;** In vitro studies have depicted anti-protozoal effect of *M. oleifera*. Soluble lectin from the seed extract of *M. oleifera* was found to show larvicidal activity by delaying larval development and promoting mortality in *Aedes aegypti* possibly on account of its hemagglutinating activity [32]. The root extract of *A. nilotica* was found to have significant anti-plasmodic against chlorine sensitive strain of *Plasmodium bergheri* in mice [33].
 15. **Antioxidant;** Exploration of *M. oleifera* as a potential source of antioxidants has yielded affirmative results [34]. The aqueous extracts of leaf, fruit and seed of *M. oleifera* act as an antioxidants [35]. Also, the bark powder of *A. nilotica* is known to have antioxidant activity. A study by Amos and colleagues [36], reveals that *A. nilotica* is easily accessible source of natural antioxidants which can be used as a supplement to aid the therapy of free-radicals mediated diseases such as cancer, diabetes, inflammation and ,many more pathological disorders..
 16. **Anti-peroxidative;** The phenolic contents present in the leaves of *M. oleifera* imparts free-radicals scavenging property while the ethanolic fraction showed considerable metal chelation properties with potentials to protect against DNA nicking [37].
 17. **Anti-hypertensive;** *M. oleifera* leaf juice has been found to exert a stabilizing effect on blood pressure. The leaves of *M. oleifera* also contain bioactive compounds which exert direct effect on blood pressure and thus this can be used for stabilizing blood pressure [18]. A decrease in arterial blood pressure has been reported by use of methanolic extracts of *A. nilotica* pods and provides evidence of muscarinic receptor stimulation [18].
 18. **Cardioprotective;** Lyophilized hydroalcoholic extracts of *M. oleifera* was found to show myocardial preservatives effect in isoproterenol (ISP)-induced model of myocardial infraction [38].
 19. **Central Nervous System (CNS) Activities;** Chronic oral treatment of ethanolic extract of *M. oleifera* leaves were found to alter the brain monoamines in distinct areas of brain in rat model of Alzheimer's disease caused by intracerebral vertical (ICV) infusion of colchine and hence provide protection against monoaminergic defects associated with Alzheimer [39]. Protection against strychnine and leptazol-induced convulsion was also observed on pretreatment with methanolic root extract including a dose dependent CNS depressant effect [40,41,42].
 20. **Cardiac activity;** Histopathological findings of mycordial tissues have shown the protective role of *M. oleifera* in isoproterenol(ISO)-induced cardio toxicity. The stem bark of *M. oleifera* has been found to have prophylactic cardioprotective effect, and the leave extracts displayed hypolipidemic and antioxidant effect in ISO-induced cardiotoxicity [45].

Summary of documented research on Medicinal and Pharmacological properties of *Moringa oleifera* (MO) AND *Acacia nilotica* (AN)

S/n	Activities	Mo	An	Source in mo	Source in an	Extract	Reference
1	Anti-pyretic	✓	✓	Seed	Gum	Ethanolic(MO)	10, 42, 43
2	Anti-asthmatic	✓	✓	Seeds	Gum	Ethanolic (MO)	1, 44
3	Anti-inflammatory	✓	✓	Root	Tender leaves		45, 46
4	Anti-arthritis	✓		Root			44
5	Anti-analgesic	✓	✓	Root	Plant	Methanolic and Alcoholic (MO),extract(A N)	44, 47, 48
6	Hypocholesterotemic	✓		Leaf			8, 49, 50
7	Wound healing	✓		Leaves		Aqueous	51, 52
8	Anti-thyroid	✓		Leaves		Just extract	44, 53



9	Anti-microbial	✓	✓	Leaf, seed, Leaf and root, stem, stem back		Aqueous extract of seeds(MO), ethanolic(AN)	3, 44, 54, 55, 56, 57, 58, 59, 60
10	Anti-anaphylactic	✓		Seeds		Ethanolic	60
11	Hepato-protective	✓		Seeds and leaves		Ethanolic	44, 61, 62, 63 64, 65
12	Anti-hepatotoxic	✓		Root and flower		Just extract	61, 63, 64,
13	Radio-protective	✓		Leaves		Methanolic	44, 66
14	Anti-ulcer	✓		Flower bud		Methanolic	45, 51, 55
15	Anti-spasmodic	✓	✓	Roots and leaves	Plant	Ethanolic extract of leaves(MO), methanolic(AN)	44, 67, 68, 102
16	Anti-hyperglycemic	✓		Leaf		Aqueous	44, 69,
17	Anti-diabetic	✓	✓	Leaf	Pods &tender leaves	Aqueous(MO)	69, 70
18	Anti-tumor	✓	✓	Leaves	Root	Ethanolic(MO)	71, 72, 73
19	Chemo-protective	✓	✓	Leaves	Leaf flower	Leaf extract(AN)	61, 73
20	Anti-proliferative	✓		Plant			44, 72, 74, 75
21	Anti- plasmodia			Seed	Root	Just extract(mo),acetate methanolic(AN)	13, 76, 77, 116
22	Anti-progestational	✓	✓	Roots		Aqueous	44, 78, 79, 80
23	Anti-implantational characteristic	✓		Roots		Aqueous	78, 82
24	Anti-oxidant	✓	✓	Leaves	Plant	Methanolic	1, 30, 44, 83, 84, 85, 86,
25	Anti-peroxidative	✓		Seed		Ethanolic,seed powder	9, 87, 88, 89, 90,
26	Diuretic			Seeds, leaves, flowers, gums, root	Gum	Aqueous infusion os seeds(MO)	44, 91
27	Antiuro lithiatic	✓	✓	Root-wood		Alcoholic	91
28	Anti-hypertensive	✓	✓	Leaves and pods	Pods	Leaf juice and ethanolic(MO), methanolic (AN)	8, 9, 68, 92, 93, 94 , 95, 96, 97
29	Cardio-protective	✓		Leaves		Lyophilized hydroalcoholic	73
30	CNS activities	✓		Leaves		Ethanolic	98, 99
31	Cardiac and	✓		Root back,		Just extract	44



32	circulatory stimulant Anti-bacterial		✓	leaves	Leaf	Methanolic	44, 88, 89,100
33	Anti-fungal	✓	✓	Plant	Dried fruit	Methanolic and aqueous	44,101,102, 103, 104
34	Anti-viral		✓			Methanolic	105
35	Anti-biotic		✓		Plant	Just extract	56, 106
36	Anti-malaria		✓		Root	Extract, crude methanolic	13,
37	Anti-diarrhea		✓		Bark	Powdered bark, infusion	44, 107
38	Spasmogenic		✓		Seeds	Aqueous	92, 93, 94
39	Molluscicidal properties		✓		Stem bark and fruit	Acetone, alcohol and aqueous	44, 108, 109
40	Vasoconstriction		✓		Plant	Aqueous	8, 44
41	Anti-mutagenic		✓		Leaf and gum	Acetone	75
42	Cytotoxic		✓		Plant	Acetone	110
43	Anti- hepatocarcinogenic		✓		Bark	Extract	63
44	Anthelmintic		✓		Fruit and gum	Methanolic	110
45	Milk production		✓		Plant	Aqueous	112
46	Antiplatelet aggregatory		✓		Plant	Extract	113
47	Anti-cancer		✓		Root		76, 114
48	Astringent		✓		Gum and leaf		44
49	Aphrodisiac		✓		Gum and tender leaves		44
50	ulcer dressing / hemorrhagic ulcer wounds		✓		Tender leaves	Decoction of leaves	103
51	Liver tonic		✓		Gum		
52	Anti dysentery		✓		Stem bark &gum		44, 113
53	Antifertility	✓	✓	Root and bark	Pods	Aqueous extract (mo)	113
54	Mild laxative		✓		Leaf, fruit & seed		115, 116
55	Nutritive tonic		✓		Gum		115, 116
56	Gingivitis		✓		Gum		44



57	Expectorant	✓	Gum and pods	113
58	Demulcent	✓	Gum	44, 113
59	Piles, vaginitis and cystitis	✓	Bark	Decoction of bark
60	Gonorrhoea	✓	Tender growing tops	Aqueous 113
61	Hemorrhagic ulcer wounds	✓	Leaves	Decoction of leaves 103
62	Antiseptic	✓	Plant	48
63	Decongestant	✓	Plant	107, 113

Future Perspective

The ethno medical uses of this two plants cited in several scientific researches, has unveiled their wide spectrum of pharmacological properties. Most research conducted on these plants, are focused on identification and evaluation of their pharmacological activities through *in vitro* and *in vivo* study. Therefore, Emphasis should be placed on towards conducting clinical trials, which will eventually result in establishment of standard drugs obtainable from various parts of these plants, which can be safely administered for therapeutic purposes. It is also recommended to leverage on the high nutritive values of the plants by making it part of the dietary intake, while taking into consideration the appropriate quantity safe for consumption and also the consumers health status. Furthermore, despite their nutritive values, some patients under a particular medication might elicit adverse reaction when taken concurrently with such medications and might as well be out rightly contraindicated in certain group of candidates who do not well tolerate the use of the plants. Conventional treatments of conditions like cancer, employs chemotherapy and radiation therapy, which are often accompanied by series of adverse effects, hence, use ethno medical products such as *Moringa oleifera* and *Acacia nolitica* with little or no adverse effects, would be of great importance. It is highly recommended that more research be conducted to evaluate the combine effects of these plants, perhaps this could be more beneficial.

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References

1. Agarwal B, Mehta A Antiasthmatic activity of *Moringa oleifera* Lam. A clinical study. *Indian J Pharmacol* 2008;40:28-31.
2. Al-Awwadi N, Azay J, Poucheret P, Cassanas G, Krosniak M, Auger G, Gasc F, Rouanet GC, Teissedre PL. Antidiabetic activity of red wine polyphenolic extract, ethanol, or both in streptozotocin treated rats. *J. Agric. Food Chem.* 2004;52:1008-1016.
3. Ali GH, El-Taweel GE, Ali MA. The cytotoxicity and antimicrobial efficiency of *Moringa oleifera* seeds extracts. *Int. J. Environ. Stud.* 2004;61:699-708.
4. Anjorin TB, Ikokoh P, Okolo S. Mineral composition of *Moringa oleifera* leaves, pods and seeds from two regions in Abuja, Nigeria. *Int. J. Agric. Biol.* 2010;12:431-434.
5. Anwar F, Ashraf M, Bhangar MI. Interprovenance variation in the composition of *Moringa oleifera* oilseeds from Pakistan. *J. Am. Oil Chem. Soc.* 2005;82:45-51.
6. Anwar F, Bhangar MI. Analytical characterization of *Moringa oleifera* seed oil grown in temperate regions of Pakistan. *J. Agric. Food Chem.* 2003; 51:6558-6563.
7. Anwar F, Latif S, Ashraf M, Gilani AH. *Moringa oleifera*: a food plant with multiple medicinal uses. *Phytother. Res.* 2007;21:17-25.



8. Ara N, Rashid M, Amran MS. Comparison of *Moringa oleifera* Leaves Extract with Atenolol on Serum triglyceride, Serum Cholesterol, Blood glucose, heart weight, body weight in Adrenaline Induced Rats. Saudi J. Biol. Sci. 2008;15:253-258.
9. Atif Ali, Naveed A, Barkat AK, Muhammad SK, Akhtar R, Shahiq-U, Nayab K, Khalid W, Tariq M, and Liaqat A. *Acacia nilotica*: A plant of multipurpose medicinal uses. Journal of Medicinal Plants Research. 2012;6(9): 1492-1496,.
10. Sutar NG, Patil VV, Deshmukh TA, Jawle NM, Patil VR, et al. Evaluation of anti-pyretic potential of seeds of *Moringa oleifera* Lam. Indian Journal of Green Pharmacy 3: 2009; 148-150.
11. Mahajan SG, Mehta AA. Inhibitory action of ethanolic extract of seeds of *Moringa oleifera* Lam. on systemic and local anaphylaxis. J Immunotoxicol 2007a;4: 287-294.
12. Mahajan SG, Mali RG, Mehta AA. Effect of *Moringa oleifera* Lam. Seed extract on toluene diisocyanate – induced immune-mediated inflammatory responses in rats. J Immunotoxicol 2007b;4: 85-96.
13. Ali A.J. Akanya H.O. and Dauda B.E.N. Polygalloyltannin isolated from the roots of *Acacia nilotica* Del. (Leguminosae) is effective against *Plasmodium berghei* in mice, J. Med. Plants. Res., 2010;4(12): 1169-1175.
14. Sutar N, Bonde CG, Patil VV, Narkhede SB, Patil AP, Kakade RT. Analgesic activity of seeds of *Moringa oleifera* Lam. International Journal of Green Pharmacy 2008;2: 108-110.
15. Malviya S, Swati R, Anil K, and Meena V. Medicinal attributes of *Acacia nilotica* Linn. - A comprehensive review on ethnopharmacological claims, Int. J. of Pharm. & Life Sci. (IJPLS), 2011;2(6): 830-837 830
16. Gupta M, Mazumder UK, Chakrabarti S. CNS activities of methanolic extract of *Moringa oleifera* root in mice. Fitoterapia 1999;70: 244-250.
17. Abubakar A., Muhammad NA, Pauzi S, Arulselvan P, Abas F, Fakurazi S. “In vitro wound healing potential and identification of Bioactive Compounds form *Moringa oleifera* Lam” Biomed Research Int. 2013;213(45): 726-731.
18. Farooq F, Meenu R, Avinash T, Abdul-Arif K, and Shaila F. Journal of Medicinal Plants Research., 2012;6(27): 4368-4374.
19. Hamza AA. *Curcuma longa*, *Glycyrrhiza glabra* and *Moringa oleifera* ameliorate diclofenac-induced hepatotoxicity in rats. Am J Pharmacol Toxicol. 2007;2: 80-88.
20. Kumar, NA and Pari L. Hepatoprotective activity of *Moringa oleifera* on antitubercular drug-induced liver damage in rats. J Med Food 2002;5: 171-177.
21. Ruckmani K, Kavimani S, Anandan R, Jaykar B. Effect of *Moringa oleifera* Lam on paracetamol-Induced Hepatotoxicity. Indian J Pharm Sci 1998;60: 33–35.
22. Gilani AH, Aftab K, Suria A, Siddiqui A, Salem R, Siddiqui BS, Faizi SS. Pharmacological studies on hypotensive and spasmolytic activities of pure compounds from *Moringa oleifera*. Phytother. Res. 1994;8:87-91.
23. Debnath S, and Guha D. Role of *Moringa oleifera* on enterochromaffin cell count and serotonin content of experimental ulcer model. Indian J Exp Biol. 2007;3(7):331–337
24. Devaraj VC, Asad M, Prasad S. Effect of leaves and fruits of *Moringa oleifera* on gastric and duodenal ulcers. Pharmaceutical Biotechnology 2007;45: 332-338.
25. Bansal, V.K., Goel, R.K. Gastroprotective effect of *Acacia nilotica* young seedless pod extract: role of polyphenolic constituents. Asian Pac. J. Trop. Med. 2012;5: 523-528
26. Jaiswal D, Kumar RP, Kumar A, Mehta S, Watal G. Effect of *Moringa oleifera* Lam. leaves aqueous extract therapy on hyperglycemic rats. J Ethnopharmacol 2009;123: 392-396. (1A107)
27. Ndong M, Uehara M, Katsumata S, Suzuki K.. Effects of oral administration of *Moringa oleifera* Lam on glucose tolerance in gotokakizaki and wistar rats. J. Clin. Biochem. Nutr. 2007;40:229-233.
28. Gilani A.H. Studies on Antihypertensive and Antispasmodic Activities of Methanol Extract of *Acacia nilotica* Pods. Phytother. Res., 1999;13: 665–669.
29. Guevara AP, Vargas C, Sakurai H, Fujiwara Y, Hashimoto K, et al. An antitumor promoter from *Moringa oleifera* Lam. Mutat Res 1999;440: 181–188.
30. Bharali R, Tabassum J, Azad MR. Chemomodulatory effect of *Moringa oleifera* Lam. on hepatic carcinogen metabolizing enzymes, antioxidant parameters and skin papillomagenesis in mice. Asian Pac J Cancer Prev 2003;4: 131-139.



31. Meena PD, Kaushik P, Shukla S, Soni AK, Kumar M, Kumar A. Anticancer and antimutagenic properties of *Acacia nilotica* (Linn.) on 7, 12-dimethylbenz (a) anthracene-induced skin papillomagenesis in Swiss albino mice. *Asian Pac. J. Can. Prev.*, 2006;7: 627-632.
32. Ferreira PM, Carvalho AF, Farias DF, Cariolano NG, Melo VM, et al. Larvicidal activity of the water extract of *Moringa oleifera* seeds against *Aedes aegypti* and its toxicity upon laboratory animals. *An Acad Bras Cienc* 2009;81: 207-216
33. Jigam AA, Akanya HO, Dauda Ben, Okogun JO. Polygalloyltannin Isolated from the roots of *Acacia nilotica* Del (Leguminosae) is effective against *Plasmodium bergheri* in mice. *J. Med. Plants. Res.* 2010;4(12) 1169- 1175
34. Chumark P, Khunawat P, Sanvarinda Y, Phornchirasilp S, Morales NP, et al. The in vitro and ex vivo antioxidant properties, hypolipidaemic and antiatherosclerotic activities of water extract of *Moringa oleifera* Lam. leaves. *J Ethnopharmacol.*, 2008;116: 439-446.
35. Singh B.N. Singh B.R. and Singh R.L. Antioxidant and anti-quorum sensing activities of green pod of *Acacia nilotica* L. *Food. Chem. Toxicol.* 2009;47(4):778–786
36. Amos S, Akah C.J. Odukwe K.S. and Wambede C. The Pharmacological Effects of an Aqueous Extract from *Acacia nilotica* Seeds, *Phyther. Res.*, 1999;13: 683–685.
37. Sreelatha S, Padma PR. Antioxidant activity and total phenolic content of *Moringa oleifera* leaves in two stages of maturity. *Plant Foods Hum Nutr* 2009;64: 303-311.
38. Nandave M, Ojha SK, Joshi S, Kumari S, Arya DS. *Moringa oleifera* leaf extract prevents isoproterenol-induced myocardial damage in rats: evidence for an antioxidant, antiperoxidative, and cardioprotective intervention *J. Med. Food* 2009;12 : 47-55
39. Pandey A, Rishabh DP, Poonam T, Gupta P.P, Jamal H, Saumya B and Singh A.V, *Moringa Oleifera* Lam. (Sahijan) - A Plant with a Plethora of Diverse Therapeutic Benefits: An Updated Retrospection. *Med Aromat Plants* , 2012;1:1(1A)
40. Ray K, Hazra R, Guha D. Central inhibitory effect of *Moringa oleifera* root extract: possible role of neurotransmitters. *Indian J Exp Biol* 2003;41: 12781284.
41. Ray K, Hazra R, Debnath PK, Guha D. Role of 5-hydroxytryptamine in *Moringa oleifera* induced potentiation of pentobarbitone hypnosis in albino rats. *Indian J Exp Biol* 2004;42: 632-635. (1A137)
42. Hukkeri VI, Nagathan CV, Karadi RV, Patil BS. Antipyretic and wound healing activities of *Moringa oleifera* Lam. in rats. *Indian J Pharm Sci* 2006;68: 124,126.
43. Sutar NG, Patil VV, Deshmukh TA, Jawle NM, Patil VR, et al. Evaluation of anti-pyretic potential of seeds of *Moringa oleifera* Lam. *Indian Journal of Green Pharmacy* 2009;3: 148-150.
44. Awanish P, Rishabh DP, Poonam T, Gupta PP, Jamal H, Saumya Band Singh A.V. *Moringa Oleifera* Lam. (Sahijan) - A Plant with a Plethora of Diverse Therapeutic Benefits: An Updated Retrospection. *Med Aromat Plants.*, 2012;1:1(1A)
45. Akhtar AH, Ahmad KU. Anti-ulcerogenic evaluation of the methanolic extracts of some indigenous medicinal plants of Pakistan in aspirin –ulcerated rats. *J Ethnopharmacol* 1995;46: 1-6.
46. Ezeamuzie IC, Ambakederemo AW, Shode FO, Ekwebelem SC. Antiinflammatory effects of *Moringa oleifera* root extract. *Int J Pharmacogn* 1996;34: 207-212. (1A130)
47. Sashidhara KV, Rosaiah JN, Tyagi E, Shukla R, et al. Rare dipeptide and urea derivatives from roots of *M. oleifera* as potential anti-inflammatory and antinociceptive agents. *Eur J Med Chem* 2009;44: 432 -436.
48. Sutar N, Bonde CG, Patil VV, Narkhede SB, Patil AP, Kakade RT. Analgesic activity of seeds of *Moringa oleifera* Lam. *International Journal of Green Pharmacy* 2008;2: 108-110.
49. Mehta K, Balaraman R, Amin AH, Bafna PA, Gulati OD. Effect of fruits of *Moringa oleifera* on the lipid profile of normal and hypercholesterolaemic rabbits. *J Ethnopharmacol* 2003;86: 191-195.
50. Zlatkis A, Zak B, Boyle GJ. A new method for direct determination of serum cholesterol. *Journal of Laboratory and Clinical Medicine* 1953;41: 486.
51. Debnath S, Guha D. Role of *Moringa oleifera* on enterochromaffin cell count and serotonin content of experimental ulcer model. *Indian J Exp Biol* 2007;45: 726-731.
52. Devaraj VC, Asad M, Prasad S. Effect of leaves and fruits of *Moringa oleifera* on gastric and duodenal ulcers. *Pharmaceutical Biotechnology* 2007;45: 332-338.
53. Tahir A.E. Satti G.M.H. and Khalid SA. Antiplasmodial Activity of Selected Sudanese Medicinal Plants with Emphasis on *Acacia nilotica*. *Phyther. Res.*, 1999;13: 474–478.



54. Banso A. Phytochemical and antibacterial investigation of bark extracts of *Acacia nilotica*. *J. Med. Plants Res.*, 2009;3(2): 082-085. (2A25)
55. Bhatnagar SS, Santapau H, Desa Jd, Maniar Ac, Ghadially Nc, et al. Biological activity of Indian Medicinal Plants. Part. Antibacterial, antitubercular and antifungal action. *Indian J Med Res.*, 1961;49: 799-805. (1A88)
56. Caceres A, Cabrera O, Morales O, Mollinedo P, Mendia P. Pharmacological properties of *Moringa oleifera* 1: Preliminary screening of antimicrobial activity. *J Ethnopharmacol* 1991;33: 213-216. (1A81)
57. Chea A, Jonville MC, Bun SS, Laget M, Elias R, Duménil G, *et al.* *In vitro* antimicrobial activity of plants used in Cambodian traditional medicine. *Am J Chin Med.* 2007;35:867-73.
58. Duke JA. *Handbook of Nuts.* CRC Press, USA 2001;214-217. (1B22)
59. Jeevam, R.A.; L. Bhakshu and R. Venkata. *In vitro* antimicrobial activity of certain medicinal plants from Eastern Ghats, India, used for skin diseases. *J. Ethnopharm.*, 2004;90: 353-357
60. Mahajan SG, Mali RG, Mehta AA. Effect of *Moringa oleifera* Lam. Seed extract on toluene diisocyanate – induced immune-mediated inflammatory responses in rats. *J Immunotoxicol* 2007;4: 85-96.
61. Fakurazi S, Hairuszah I, Nanthini U. *Moringa oleifera* Lam prevents acetaminophen induced liver injury through restoration of glutathione level. *Food Chem Toxicol* 2008;46: 2611-2615. (1A97)
62. Fozia F, Meenu R, Avinash T, Abdul Arif K and Shaila F.. *Journal of Medicinal Plants Research* Vol. 2012;6(27): 4368-4374.
63. Hamza AA. *Curcuma longa*, *Glycyrrhiza glabra* and *Moringa oleifera* ameliorate diclofenac-induced hepatotoxicity in rats. *Am J Pharmacol Toxicol.*, 2007;2: 80-88.
64. Pari L, Kumar NA. Hepatoprotective activity of *Moringa oleifera* on antitubercular drug-induced liver damage in rats. *J Med Food.*, 2002 ;5: 171-177.
65. Ruckmani K, Kavimani S, Anandan R, Jaykar B. Effect of *Moringa oleifera* Lam on paracetamol-Induced Hepatotoxicity. *Indian J Pharm Sci.*, 1998;60: 33–35.
66. Rao AV, Devi PU, Kamath R. *In vivo* radioprotective effect of *Moringa oleifera* leaves. *Indian J Exp Biol* 2001;39: 858-863.
67. Cáceres A, Saravia A, Rizzo S, Zabala L, De Leon E, et al. Pharmacologic properties of *Moringa oleifera* 2: Screening for antispasmodic, anti-inflammatory and diuretic activity. *J Ethnopharmacol.*, 1992;36: 233-237. (1A105)
68. Anwar H Gilani, Khalid Aftab1, Amin Suria1, Salimuzzaman Siddiqui, Rubeena Salem, et al. Pharmacological studies on hypotensive and spasmolytic activities of pure compounds from *Moringa oleifera*. *Phytother Res.*, 1994;8: 87-91. (1A106)
69. Jaiswal D, Kumar RP, Kumar A, Mehta S, Watal G. Effect of *Moringa oleifera* Lam. leaves aqueous extract therapy on hyperglycemic rats. *J Ethnopharmacol* 1994;123: 392-396.
70. Ndong M, Uehara M, Katsumata S, Suzuki K. Effects of Oral Administration of *Moringa oleifera* Lam on Glucose Tolerance in Goto-Kakizaki and Wistar Rats. *J Clin Biochem Nutr* 2007;40: 229-233.
71. Guevara AP, Vargas C, Sakurai H, Fujiwara Y, Hashimoto K, et al. An antitumor promoter from *Moringa oleifera* Lam. *Mutat Res* 1999;440: 181–188.
72. Murakami A, Kitazono Y, Jiwajinda S, Koshimizu K, Ohigashi H. Niaziminin, a thiocarbamate from the leaves of *Moringa oleifera*, holds a strict structural requirement for inhibition of tumor-promoter-induced Epstein-Barr virus activation. *Planta Med* 1998;64: 319–323.
73. Nandave M, Ojha SK, Joshi S, Kumari S, Arya DS. *Moringa oleifera* leaf extract prevents isoproterenol-induced myocardial damage in rats: evidence for an antioxidant, antiperoxidative, and cardioprotective intervention *Int J of Sci Stu* 2009;12 : 47
74. Meena PD, Kaushik P, Shukla S, Soni AK, Kumar M, Kumar A.. Anticancer and antimutagenic properties of *Acacia nilotica* (Linn.) on 7, 12-dimethylbenz(a) anthracene-induced skin papillomagenesis in Swiss albino mice. *Asian Pac. J. Can. Prev.*, 2006;7: 627-632.
75. Bose CK. Possible role of *Moringa oleifera* Lam. Root in epithelial ovarian cancer. *Med Gen Med* 2007;9: 26. (1A113)
76. Ferreira PM, Carvalho AF, Farias DF, Cariolano NG, Melo VM, et al. Larvicidal activity of the water extract of *Moringa oleifera* seeds against *Aedes aegypti* and its toxicity upon laboratory animals. *An Acad Bras Cienc* 2009;81: 207, 216 (1A116)
77. Tahir A.E. Satti G.M.H. and Khalid S.A. Antiplasmodial Activity of Selected Sudanese Medicinal Plants with Emphasis on *Acacia nilotica*. *Phytother. Res.*, 1999;13: 474–478.



78. Prakash AO, Pathak S, Shukla S, Mathur R. Uterine histoarchitecture during pre and post –implantation periods of rats treated with aqueous extract of *Moringa oleifera* Lam. *Acta Eur Fertil* 1987;18: 129-135.
79. Shukla S, Mathur R, Prakash AO. Antifertility profile of the aqueous extract of *Moringa oleifera* roots. *J Ethnopharmacol* 1988;22: 51–62.
80. Shukla S, Mathur R, Prakash AO. Histoarchitecture of the genital tract of ovariectomized rats treated with an aqueous extract of *Moringa oleifera* roots. *J Ethnopharmacol.*, 1989;25: 249-261.
81. Shukla S, Mathur R, Prakash AO. Biochemical and physiological alterations in female reproductive organs of cyclic rats treated with aqueous extracts of *Moringa oleifera* Lam. *Acta Eur Fertil.*, 1988b;19: 225-232.
82. Nath D, Sethi N, Singh RK, Jain AK. Commonly used Indian abortifacient plants with special reference to their teratologic effects in rats. *J Ethnopharmacol* 1992;36: 147–154.
83. Duke, J.A.. *Medicinal Plants of the Bible*. Trado-Medic Books, Buffalo, NY 1983.
84. Chumark P, Khunawat P, Sanvarinda Y, Phornchirasilp S, Morales NP, et al. The *in vitro* and *ex vivo* antioxidant properties, hypolipidaemic and antiatherosclerotic activities of water extract of *Moringa oleifera* Lam. leaves. *J Ethnopharmacol* 2008;116: 439-446. (1A77)
85. Bajpai M, Pande A, Tewari SK, Prakash D. Phenolic contents and anti oxidant activity of some food and medicinal plants. *Int J Food Sci Nutr.*, 2005;56: 287-291. (1A124)
86. Bharali R, Tabassum J, Azad MR. Chemomodulatory effect of *Moringa oleifera* Lam. on hepatic carcinogen metabolizing enzymes, antioxidant parameters and skin papillomagenesis in mice. *Asian Pac J Cancer Prev.*, 2003;4: 131-139. (1A109)
87. Sreelatha S, Padma PR. Antioxidant activity and total phenolic content of *Moringa oleifera* leaves in two stages of maturity. *Plant Foods Hum Nutr* 2009;64: 303-311.
88. Shalu A, karni G.T, Sharma V.N.A Comparative Study on the Antioxidant Activity of Methanol Extracts of *Acacia nilotica* and *Berberis chitria*, *Adv. in Nat. Appl. Sci.*, 2010;4(1): 78-84,.
89. Shittu, G.A. *In vitro* antimicrobial and phytochemical activities of *Acacia nilotica* leaf extract. *J. Med. Plants Res.*, 2010;4(12): 1232-1234.
90. Singh B.N. Singh B.R. and Singh R.L. Antioxidant and anti-quorum sensing activities of green pod of *Acacia nilotica* L. *Food. Chem. Toxicol.*, 2009;47(4):778–786.
91. Solomon G.O. and Shittu G.A. *In vitro* antimicrobial and phytochemical activities of *Acacia nilotica* leaf extract. *J. Med. Plants. Res.*, 2010;4(12):1232-1234
92. Karadi RV, Gadge NB, Alagawadi KR, Savadi RV. Effect of *Moringa oleifera* Lam. root –wood on ethylene glycol induced urolithiasis in rats. *J Ethnopharmacol.*, 2006;105: 306-311.
93. Gilani A.H. Studies on Antihypertensive and Antispasmodic Activities of Methanol Extract of *Acacia nilotica* Pods. *Phytother. Res.*, 1999;13: 665–669 (2A58).
94. Gilani A.H, Shaheen F and Zaman M. Studies on Antihypertensive and Antispasmodic Activities of Methanol Extract of *Acacia nilotica* Pods. *Phytother. Res.*, 1999b;13: 669–674.
95. Atif A, Naveed A, Barkat AK, Muhammad SK, Akhtar R, Shahiq-UZ, Nayab K, Khalid W, Tariq M and Liaqat A. *Acacia nilotica*: A plant of multipurpose medicinal uses. *Journal of Medicinal Plants Research.*, 2012;6(9), pp. 1492-1496, 9 March, 2012.
96. Gilani, A.H., Shaheen MM, Zaman K.H, Janbaz B.H, and Akhtar M.S. Study on antihypertensive and antispasmodic activity of methanol extracts of *Acacia nilotica* pods. *Phytother. Res.* 199;13(8): 665-669.
97. Faizi S, Siddiqui B, Saleem R, Siddiqui S, Aftab K, et al. Isolation and structure elucidation of novel hypotensive agents, niazinin A, niazinin B, niazimicin and niaziminin A plus B from *Moringa oleifera*: The first naturally occurring thiocarbamates. *J Chem Soc Perkin Trans I*: 1992;3237-3241.(1A48)
98. Faizi S, Siddiqui B, Saleem R, Siddiqui S, Aftab K, et al. Novel hypotensive agents, niazimin A, niazimin B, niazicin A and niazicin B from *Moringa oleifera*: Isolation of first naturally occurring carbamates. *J Chem Soc Perkin Trans I*: 1994;3035-3040. (1A47)
99. Faizi S, Siddiqui BS, Saleem R, Siddiqui S, Aftab K, et al. Isolation and structure elucidation of new nitrile and mustard oil glycosides from *Moringa oleifera* and their effect on blood pressure. *J Nat Prod* 1994;57: 1256-1261. (1A29)
100. Ganguly R, Guha D. Alteration of brain monoamines and EEG wave pattern in rat model of Alzheimer’s disease and protection by *Moringa oleifera*. *Indian J Med Res* 2008;128: 744-751. (1A135)
101. Ray K, Hazra R, Debnath PK, Guha D (2004) Role of 5-hydroxytryptamine in *Moringa oleifera* induced potentiation of pentobarbitone hypnosis in albino rats. *Indian J Exp Biol* 42: 632-635.
102. Singh B.N. Singh B.R. and Singh R.L. Antioxidant and anti-quorum sensing activities of green pod of *Acacia nilotica* L. *Food. Chem. Toxicol.* 2009;47(4):778–786.



103. Chuang PH, Lee CW, Chou JY, Murugan M, Shieh BJ, et al. Antifungal activity of crude extracts and essential oil of *Moringa oleifera* Lam. *Bioresour Technol.* 2007;98: 232-236. (1A90)
104. Vijay K, and Goel RK. Gastroprotective effect of *Acacia nilotica* young seedless pods extract; Role of Polyphenolic constituents. *Asian Pacific J. Tropical Med.* 2012;523-528
105. Ayanbimpe GM, Ojo TK, Afolabi E, Opara F, Orsaah S, et al. Evaluation of extracts of *Jatropha curcas* and *Moringa oleifera* in culture media for selective inhibition of saprophytic fungal contaminants. *J Clin Lab Anal* 2009;23: 161-164. (1A91)
106. Mohamed L.T., Bushra E.I.S and Abdelrahman M.N. The antibacterial, antiviral activities and phytochemical screening of some Sudanese medicinal plants. *Eur. Asian. J. BioSciences.*, 2010;4: 8-16.
107. Erdogru, O.T. Antibacterial activities of some plant extracts used in folk medicine. *Pharmaceutical Biol.* 2002;40:269–273. (2B9)
108. Crowch CM, Okello EJ. Kinetics of acetylcholinesterase inhibitory activities by aqueous extracts of *Acacia nilotica* (L.) and *Rhamnus prinoides*. *Afr. J. Pharm. Pharmacol.*, 2009;3(10): 469-475. (2A OR 2B12)
109. Ayoub H.S.M. Molluscicidal properties of *Acacia nilotica* subspecies *tomentosa* and *astringens*. *J. Trop. Med. and Hyg.*, 1985; 88 (3): 201-203. (2A57)
110. Ayoub S.M. Molluscicidal Properties of *Acacia nilotica*. *Medica*, 1982;46: 181-183. (2A56)
111. Kalaivani, T, Rajasekaran C, Suthindhiran K and Mathew L. Free radical scavenging, cytotoxic and hemolytic activities from leaves of *Acacia nilotica* (L.) wild. ex. delile subsp. indica (benth.) brenan. *Evid. Based Complement. Alternat. Med.*, 2011;274741.
112. Bachayaa H.A. Zafar I and Nisar K.M. Anthelmintic activity of *Ziziphus nummularia* (bark) and *Acacia nilotica* (fruit) against *Trichostrongylid nematodes* of sheep, *J. Ethnopharmacol.*, 2009;123: 325–329. (2A62)
113. Eline M.B. Ouedraogo Z.L. and Heide D. Effect of aqueous extract of *Acacia nilotica* ssp *adansonii* on milk production and prolactin release in the rat, *J. Endocrin.*, 2004;182: 257–266. (2A63)
114. Zahraa A, Elah MA, Abdul-Latif MJ, Ayyad WR. Evaluation of Three Plant Extracts Activity to the Stopping of Bleeding in Albino Mice, Ministry of Higher Education & Scientific Research University of Baghdad College of Science. 2006
115. Costa-Lotufo LV, Khan MT, Ather A, Wilke DV, Jimenez PC, et al. Studies of the anticancer potential of plants used in Bangladeshi folk medicine. *J Ethnopharmacol.*, 2005;99: 21-30. (1A112)
116. Darmani, H.; T. Nusayr and A.S. Al-Hiyasat.. Effects of extracts of miswak and derum on proliferation of Balb/C 3T3 fibroblasts and viability of cariogenic bacteria. *Int J Dent Hyg*, 2006;4(2):62-66. (2B7)
117. Darout, I.A.; A.A. Christy, N. Skuag and Egeberg P.K. Identification and qualification of some potentially antimicrobial anionic components in miswak extract. *Ind J Pharmacol.*, 2002;32(1):114. (2B8)
118. Tahir A.E. Satti G.M.H. and Khalid S.A. Antiplasmodial Activity of Selected Sudanese Medicinal Plants with Emphasis on *Acacia nilotica*. *Phytother. Res.*, 1999;13: 474–478.

