Review Article

Ethnopharmacological and phytochemical account of paradise tree (*Melia azedarach* L.: Meliaceae)

Huma Qureshi^{1*}, Muhammad Arshad¹, Abida Akram¹, Naveed Iqbal Raja¹, Sammer Fatima² and Muhammad Shoaib Amjad^{1,3}

1. Department of Botany, PMAS-Arid Agriculture University, Rawalpindi, 46300, Pakistan

2. Department of Botany, New Campus, Hafiz Hayat, University of Gujrat, Pakistan

3. Department of Botany, Women University of Azad Jammu and Kashmir Bagh, Pakistan

*Corresponding author's email: Humaqureshi8@gmail.com

Citation

Huma Qureshi, Muhammad Arshad, Abida Akram, Naveed Iqbal Raja, Sammer Fatima and Muhammad Shoaib Amjad. Ethnopharmacological and phytochemical account of paradise tree (*Melia azedarach* L.: Meliaceae). Pure and Applied Biology. Vol. 5, Issue 1, 2016, pp5-14. <http://dx.doi.org/10.19045/bspab.2016.50002>

Received: 28/06/2015

Revised: 26/11/2015

Accepted: 02/12/2015

Online First: 10/12/2015

Abstract

Plants being the prime source of medication since time immemorial have been consumed as a source of nutrition as well as therapy against different ailments and diseases. For Chinaberry (*Melia azedarach* L.), one of the important medicinal plants from *Meliaceae* family, medicinal properties by traditional practitioners are being quoted for each and every plant part. Pharmacological investigations verify different health maintenance activities of *M. azedarach* viz. anti-nephrolithiasis, hepatoprotective, antibacterial, anti-parasitic, antiulcer, anthelmintic, antioxidant and antipyretic action. There is also considerable literature available related to its chemistry. The present review presents an up to date literature survey of ethnomedicinal, phytochemical and pharmacological account of *Melia azedarach* L.

Key words: Dhrek; Traditional medicinal plant; Antioxidant; Pharmacological activities; Melianol; Active compounds.

Introduction

Melia azedarach L. is a small to medium, perennial, deciduous tree from the Meliaceae family (Fig.1) (available at: (i) <http://www.whitehorse.vic.gov.au/White-Cedar.html> (ii) <http://www.delange.org/ChinaBerry/ChinaBerry.htm> (iii) http://it.wikipedia.org/wiki/Melia_azedarach respectively) believed to derive its name from word *Melia* (Gr.) for the 'manna or flowering ash' pointing out the similarity of leaves of the tree to that plant and *azedarach* from the name of a poisonous plant

"azadaracht" [1]. The tree is an original species of the South Asia (South of China, Iran, and India) that was introduced, cultivated and naturalized in the New World. Now, the plant is widespread in Pakistan, Indonesia, India and Australia, Brazil, Argentine, Philippines and many African and Arab countries [2].

Synonym(s)

Melia japonica, *Melia australis*, *Melia sempervivens*.

Common name(s)

Dhrek, Bkain, Chinaberry, White Cedar, Paradise tree, Syringa, Bead tree.

Fig. 1. Paradise Tree (*Melia azedarach* L.) (i) Whole plant (ii) Flowering branch (iii) Drupes

Phytochemistry

The prevalence of herbal preparations and healthcare remedies of plants origin has been traced to the natural chemical compounds with medicinal properties. The phytochemistry of *M. azedarach* is complex.

Compounds purified and identified from different plant parts are given in Table 1. Structures of some of the lead components are illustrated in Fig. 2 and 3.

Table 1. Phytochemistry of Paradise Tree L. [1, 3-7]

Plant part	Phytochemistry
Stem	Kulinone, Melianin – A, 1,3,5,8-Tetrahydroxy-2-methyl anthraquinone; 8-Me ether, 12-Acetoxyamoorastatin, Galactopyranoside, α -Pinene, 7a-Acetoxy-14 β ,15 β -epoxygedunanol-ene-3-O- β -D-glucopyranoside, 4',5-Dihydroxy flavone-7-O-u-L-rhamnopyranosyl-(1-4)- β -D-glucopyranoside, Fraxinellone, Amoorastatin, Kulactone, 12-Hydroxyamoorastatin, 3:Hydroxyeupha-7,24-diene-21,16-olide, 1,8-dihydroxy-2-methyl anthraquinone-3-O- β -D, Methylkulonate, Melianin-B, α -Terpineol, 1,5-dihydroxy-8-methoxy-2-methyl-anthraquinone-3-O- α -L-rhamnopyranoside, Kulolactone, α -Terpinene, 3-O- α -L-rhamnopyranoside, β -Pinene,
Leaves	Palmitic acid, 1-Cinnamoyl-3-methacrylyl-11-hydroxy meliacarpin, 1-Cinnamoyl-3-acetyl-11-hydroxy meliacarpin, 1,3-Dicinnamoyl-11-hydroxy-rneliacarpin, Deacetylsalannin, α -Pinene, α -Terpinene, β -Pinene, Kaempferol-3-O- β -rutinoside, α -Terpineol, Rutin, Kaempferol-3-L-rhamno-D-glucoside
Roots	Azedarachin-A, Vanillic acid, 12-O-Acetyl azedarachin-A, 1-Tigloyl-3,20-diacetyl-11-methoxymeliacarpinin, 1,12-Diacetyl trichilin-B, Campesterol, 12-O-Acetyl azedarachin-B, 1-Cinnamoyl-3-hydroxy-11-methoxy meliacarpinin, Salannin, 1-Tigloyl-3-acetyl-11-methoxy meliacarpinin, 1-Acetyl-3-tigloyl-11-methoxy meliacarpinin, Cholesterol, Stigmasterol, Linoleic acid, Azedarachin-C, 12-O-Acetyl trichilin-B, Linolenic acid, 9-octadecenoic acid, 7,12-Diacetyl trichilin-B, 29-Isobutylsandanin, 3-Tigloyl-1,20-diacetyl-11-methoxymeliacarpinin, Apigenin-5-O- β -D-galactopyranoside, 1-Deoxy-3-methacrylyl-11-methoxy meliacarpinin, 1-Deacetyl nimbolin-B, 24-Methylenecydoartanol, Trichilin-B, 24-Methylenecydoartanone, Nimbolidin-B,

	Meliacarpinin E, 4-Stigmastanen-3-one, Trichilin-D, 1-Cinnamoyl-3-acetyl-11-methoxy meliacarpinin, 4-Campestene-3-one β -Sitosterol, 2 α -Acetyl-29-deacetyl-29-isobutyryl sendanin, 6- β -Hydroxy-4-Stigmasten-3-one, Trichilin-H, β -Sitosterol B-D-glucoside, Salannal, Azeclarachol, 6- β -Hydroxy-4-canpesten-3-one, Trans-cinnamic acid
Fruits	Ohchinin acetate, Amorastatone, Trans-cinnamic acid, 6-Acetoxy-14,15-epoxy-3,11-dihydroxymeliaca-1,5-diene-7-one, Meliatoxin-B1, 21- β - Acetoxymelianone, Meliandiol, Vilasinin, Melianoninol, Azedirachtin-A, 1-Cinnamoyl-3, Methyl kulonate, 11-dihydroxy- meliacarpinin, Nimbolinin-B, Cinnamoylmelianolone, 3-O-Tigloylohchinin, Meliatoxin-A2, Ohchinolide-B, 1-Cinnamoylmelianone, Compositin, Melianolone, Compositolide, Meliatoxin-A1, Nimbolidin-A, 29-Deacetyl sendanin, Meliatoxin-B2, Stearic acid, 1-Deacetyl nimbolinin-A, 1-O-Deacetyl ohchinolide-B, 3-Deoxymelianone, 21,23:24,25-Diepoxy-tirucall-7-ene-21-ol, 3-Epimelianol, Meliantriol, Sendandal, Ohchinin, 3- α -Tigloylmelianol, Melianone, Ohchinolide-A, Sendanin, 3-Epimeliantriol, Sendanal, Gedunin, 12-a-Hydroxyamoorastatin, Ohchinal, Amoorastatin, Melianol, Ohchinolal, Nimbolinin-A
Seeds	Oleic acid, ($\pm$) pinoresinol, Melianolmeliacin, Daucosterol, Vanillic acid, Meldenin, β -D- glucopyranose, Meliartenin, 3 β ,7 α -Dihydroxy-21,23-epoxy-apotirucalla-14,24-diene-21-one, Linolenic acid, Linoleic acid, Campesterol, Stigmasterol, Benzoic acid, hydroxyl-3-methoxycinnamaldehyde, β -sitosterol, Vanillin, Meliacarpin, 6,11 diacetoxy-7-oxo-14 β -epoxymeliacin (1,5-diene-3-O- β -D-glucopyranoside), Vanillin

Fig. 2. Highlighted ethnomedicinal and pharmacological activities of *M. azedarach* L.

Fig. 3. Chemical structure presentation of some of the phytochemicals in *M. azedarach* L.

Pharmacological Activities

According to data presented in a report by world health organization (WHO), in tropical countries, infectious diseases account for 50 % of the deaths; about 80 % of population from developing countries use traditional medicine [8], emphasizing such

plant species to be investigated for a better understanding of their safety and efficacy. A quick overview of the traditional uses of *Melia azedarach* plant is given in Table 2. A synopsis of pharmacological activities of *M. azadarch* is given below (Table 2).

Table 2. Ethnomedicinal uses of *M. azedarach* L.

Plant part	Ethnomedicinal use(s)
Leaves	Diuretic, Anthelmintic, Resolvent. Effective in skin diseases, hysteria, toothache, fever, rheumatic pain. Extract from fresh leaves is applied for burns externally. Five ml extract from leaves is orally administered three times a day for piles. Five –Ten ml leaf extract is orally taken two times a day for seven days in pyrexia. Extract from leaves is used to cure the eruption on the scalp and also for headache [28,42-45]
Stem	Administered in asthma [46-48]
Gum	Effective in enlargement of spleen [48]
Bark	Prescribed in fever to relieve thirst, nausea, vomiting and loss of appetite. Thirty-

Plant part	Ethnomedicinal use(s)
	Fifty ml infusion from stem bark is used orally two times a day for gonorrhea [28,47]
Roots	Deobstruent and resolvent [49,50]
Flowers	Astringent, diuretic, anodyne, resolvent, deobstruent. Refrigerant and alexipharmic, vermifugal, stomachic, valuable in killing lice and eruptive skin diseases [51]
Fruits	Anthelmintic, purgative and emollient [52, 53]
Seeds	Bitter, aphrodisiac, expectorant, anthelmintic, used in typhoid fever, scrofula, helminthiasis and in pelvic region pain [52]
Seed oil	Antiseptic for sores and ulcers, skin diseases, e.g., ringworm, scabies and rheumatism. The oil is used internally in malaria fever and leprosy [54]

Hepatoprotective Activity

The liver is vital organ, injury susceptible to various drugs and chemicals. Ethanol extract from leaves of *Melia azedarach* has reported to decrease the serum enzymes including Serum glutamic pyruvate transaminase (SGPT) and Serum glutamic oxaloacetic transaminase (SGOT) intoxicated by carbon tetrachloride (CCl₄) in rats thus shown significant hepatoprotective activity [9]. Liver transaminases viz. Glutamic Pyruvic Transaminase (SGPT), Serum glutamic oxaloacetic transaminase (SGOT), Liver biliary duct enzyme alkaline phosphatase (ALP) and serum bilirubin are widely taken as useful biomarkers for liver injury. In a study liver protective activity of the plant against CCl₄ chemical induced liver injury was conducted against the mentioned parameters. All the four biochemical parameters were significantly improved while histological changes (steatosis and fibrosis); pragmatic in CCl₄ intoxicated group, were reduced to normal levels after treatment [10]. There are few other reports available compiling data on hepatoprotective activity of *M. azedarach* [11-15].

Wound healing Activity

While suffering from diabetes mellitus, impaired immune defenses, increased blood sugar impairing the blood flow and oxygen

release, and microbial infections are the possible reasons of interruption in the wound healing process. Topical application of methanol extract from leaves of *M. azedarach* has shown noteworthy wound healing activity in alloxan induced diabetic rats analogous with povidone iodine standard [16]. There are other reports dealing with wound healing activity of *M. azedarach* [17-20].

Antipyretic Activity

Hydro-methanolic extract from leaves of *M. azedarach* exhibited significant reduction in elevated temperature in comparison to that of paracetamol standard drug in yeast induced pyrexia in experimental animals ascribable to the flavonoid components and/or alkaloids in the plant extract [21]. Other investigators also commented on antipyretic action of this plant [22-24].

Antimicrobial Activity

Isolated from leaves of *M. azedarach*, 'Meliacine' was found to restrain the growth of foot and mouth disease virus [25]. Another compound purified from leaves of *M. azedarach* 'Meliacarpin' inhibit *in vitro* the Vesicular stomatitis and Herpes simplex virus mushrooming without any cytotoxic effects [26]. Significant inhibition of different bacterial strains including the gram negative as well as gram positive bacteria was shown by the aqueous and ethyl acetate

extracts of *M. azedarach* [27]. Extracts of different polarity from *M. azedarach* seeds showed inhibitory action against eighteen different human pathogenic bacteria. Methanol, benzene, ethyl acetate and aqueous extracts from seeds of the plant showed significant antibacterial activity against experimental pathogens. The ethyl acetate extract exhibited the highest inhibition rates among all the others [28]. There are more studies related to antimicrobial activity of the plant [29-34].

Antioxidant Activity

The total flavonoid contents (TFC) and total phenolic contents (TPC) in ambient dried plant parts were found to be in the range of 10.67-23.45 mg CE/g DW (Catechin equivalents per gram dry weight) and 66.89-103.34 mg GAE/g DW (Gallic acid equivalents per gram dry weight), while sun dried parts in the range of 13.32-28.11 mg CE/g DW and 74.43-112.10 mg GAE/g DW respectively. The diphenyl-picrylhydrazyl (DPPH) scavenging activity and linoleic inhibition capability of the sun dried material was found to be in the range of 35.57-52.11% and 55.43-63.86% while for the ambient dried plant parts it was in the range of 33.87-50.33% and 48.54-61.00% respectively. The reducing potential of sun dried and ambient dried plant parts at 10mg mL⁻¹ concentration was in the range of 0.727-1.211 and 0.601-0.890, showing the higher antioxidant activity for sun dried samples. Among different plant parts, the stem bark showed better antioxidant activity than those of others [35]. Antioxidant activity of plant by biological assays has been assessed by various researchers [36-38].

Antimalarial Activity

Antimalarial activity of methanol extract from leaves, bark and fruits of *M. azedarach* was studied against *Plasmodium berghei*, the malaria parasite, in experimental mice. Fruit and bark extracts showed a significant

growth inhibitory effect on the parasite. Although less significant than chloroquine standard, *M. azedarach* showed significant anti-malarial effect [39].

Anthelmintic Activity

The ethanol extract of *M. azedarach* is reported to be active against *Pheretima posthuma* (earthworm) and *Taenia solium* (tapeworm) with Piperazine phosphate control. The inhibitory result was better against *Taenia solium* than Piperazine phosphate standard [40]. Ethanol extracts from fruits of *Melia azedarach* checked the growth of hookworms (*Bunostomum trigonocephalum*), earthworms (*Pheretima posthuma*), tapeworms (*Taenia solium*), nodular worms (*Oesophagostomum columbianum*) better than piperazine phosphate and hexylresorcinol the standards against tapeworms and hookworms, respectively [41].

Conclusions

The renewed focus in plant based remedies is because of a few numbers of side effects. *M. azedarach* known for its cytotoxic value possesses potential medicinal attributes. For medicinal bioactivities, antimicrobial, antioxidant, antihelmintic, antimalarial and wound healing are more focused ones. Phytochemical studies reveal typical constituents of *M. azedarach* as alkaloids, terpenoids, flavonoids and anthraquinones. For better understanding of the molecular mechanism of interaction in the human body further investigations should be conducted at *M. azedarach* purified compounds in different diseases.

Authors' contributions

Review paper assigned: A Akram & NI Raja, Data collection: S Fatima & MS Amjad, Wrote: H Qureshi, Overlooked: M Arshad.

References

1. Sharma D & Paul Y (2013). Preliminary and Pharmacological Profile of *Melia*

- azedarach* L.: An Overview. *J App Pharm Sci*, 3(12): 133-138.
2. Rubae AY (2009). The potential uses of *Melia Azedarach* L. as pesticidal and medicinal plant, review. *Am.-Eurasian J. Sustain. Agric*, 3(2): 185-194.
3. Kumar R, Singh R, Meera RS & Kalidhar SB (2003) Chemical components and insectisidal properties of bakyain (*Melia azedarach* L.), A Review. *Agric Rev*, 24: 101-115.
4. Carpinella MC, Ferrayolic CG & Palacios SM (2005). Antifungal synergistic effect of scopoletin, a hydroxycoumarin isolated from *Mesynergistic* effect of scopoletin, a hydroxycoumarin isolated from *Melia azedarach* L. fruits. *J Agric Food Chem*, 53(8): 2922-2927.
5. Sen A & Batra A (2011). *Melia azedarach* L.–A paradise tree. *J of functional and environmental Bot*, 1(1): 59-69.
6. Sen A & Batra A (2012). Chemical composition of methanol extract of the leaves of *Melia azedarach*. *Asian J Pharm Clin Res*, 5(3): 42-45.
7. Rupa BA, Azam MNK, Mannan MA, Ahmed MN & Hasan MN (2014). Phytochemistry and pharmacological appraisals of Persian Lilac (*Melia azedarach* Linn.): A quick comprehensive review. *American Journal of Ethnomedicine*, 1(3): 152-163.
8. Khan AV, Khan AA & Shukla I (2008). In vitro antibacterial potential of *Melia azedarach* crude leaf extracts against some human pathogenic bacterial strains. *Ethnobot Leaflets*. 12: 439-445.
9. Sumathi A (2012). Hepatoprotective activity of *Melia azedarach* L. against carbon tetrachloride induced hepatic damage in rats. *International Journal of Pharma Sciences and Research*. 3(5): 387-388.
10. Ahmed MF, Rao AS, Ahemad SR & Ibrahim M (2012). Phytochemical studies and hepatoprotective activity of *Melia azedarach* Linn, against CCl₄ induced Hepatotoxicity in rats. *Journal of Pharmacy Research*, 5(5): 2664-2667.
11. Rajeswary H, Vasuki R, Samudram P & Geetha A (2010). Hepatoprotective action of etahnolic extracts of *Melia azedarach* Linn. and *Piper lomgum* Linn. and their combination on CCl₄ induced hepatotoxicity in rats. *Indian J Exp Biol*, 49(4): 276-281.
12. Rao AS, Ahmed MF & Ibrahim M (2012). Hepatoprotective activity of *Melia azedarach* leaf extract against simvastatin induced hepatotoxicity in rats. *J App Pharm Sci*, 2(7): 144-148.
13. Ibrahim M, Shaik, RA, Ahmed MF. Proceedings of the British Pharmacological Society at <http://www.pA2online.org/abstracts/Vol6Issue2abst040P.pdf>.
14. Sumathi A (2013). Hepatoprotective activity of methanolic extract of *Melia azedarach* L on wistar rats. *Int J Pharm Bio Sci*, 4(2): 755 – 760.
15. Ahmed MF & Rao AS (2013). Comparative hepatoprotective activities of selected indian medicinal plants. *Global Journal of Medical Research*, 13(2): 14-22.
16. Veda VT, Srinivasan D & Sengottuvelu S (2012). Wound healing potential of *Melia azedarach* L. leaves in alloxan induced diabetic rats. *GJRMI*, 1(7): 265–271.
17. Al-Ezzy AIA, Nazar A, Khalaf FH & AL-Zuhairi AH (2015). Evaluation of the performance of *Melia azedarach* for skin wound healing in donkeys: clinical and histopathological study. *AJPCT*, 3(1): 1-9.
18. Sultana S, Asif HM, Akhtar N, Waqas M & Rehman S (2014). Comprehensive

- review on ethanobotanical uses, phytochemistry and pharmacological properties of *Melia azedarach* Linn. *Asian J Pharmaceut Res Health Care*, 6 (1): 26-32.
19. Vetriselvan S, Basir R, Subasini U & Velmurugan C (2012). Wound healing activity of ethanolic polyherbal extract in wister rats. *IJRPNS*, 1(1): 19 - 26.
20. Subramanian R, Krishnasamy G, Devaraj A, Sethuraman P & Jakumarajaj R (2011). Wound healing ethnopharmacological potential of selected medicinal plants used by Malayali tribes. *Int Res J Pharm*, 2(5): 132-137.
21. Sultana S, Akhtar N & Asif HM (2013). Phytochemical screening and antipyretic effects of hydromethanol extract of *Melia azedarach* leaves in rabbits. *Bangladesh J Pharmacol*, 8: 214-217.
22. Duraisankar M & Ravichandran V (2012). Antipyretic potential of polyherbal ayurvedic products. *Asian J Pharm Clin Res*, 5(2): 146-150.
23. Maciel MV, Morais SM, Bevilaqua CML, Camurça-Vasconcelos ALF, Costa CTC & Castro CMS (2006). Ovicidal and larvicidal activity of *Melia azedarach* extracts on *Haemonchus contort*. *Vet Parasitol*, 140 (1-2): 98–104.
24. Valladares GR, Ferreyra D, Defago MT, Carpinella MC & Palacios S (1999). Effects of *Melia azedarach* on *Triatoma infestans*. *Fitoterapia*, 70(4): 421-424.
25. Wachsmann MB, Castilla V & Coto C (1998). Inhibition of foot and mouth disease virus (FMDV) uncoating by plant – derived peptide isolated from *Melia azedarach* L. leaves. *Arch Virol*, 143: 581-590.
26. Alche LE, Ferek GA, Meo M, Coto CE & Maier MS (2001). An antiviral meliacarpin from leaves of *Melia azedarach* L. *Verlag der Zeitschrift fur Naturforschung Tubingen*. 2001; 58: 215-219.
27. Rhaymah MSH (2006). Anticomplementary activities of aqueous extract of the fruit of *Melia azedarach* and *Cotoneaster prostrata* in rats. *J Anim Vet Adv*, 5:197-199.
28. Khan AV, Ahmed Q, Mir MR, Shukla I & Khan AA (2011). Antibacterial efficacy of the seed extracts of *Melia azedarach* against some hospital isolated human pathogenic bacterial strains. *Asian Pac J Trop Biomed*, 1(16): 452-455.
29. Khan MR, Kihara M & Omoloso AD (2001). Antimicrobial activity of *Horsfieldia helwigi* and *Melia azedarach*. *Fitoterapia*, 72: 423.
30. Khan N, Abbasi AM, Dastagir G, Nazir A, Shah GM, Shah MM & Shah MH (2014). Ethnobotanical and antimicrobial study of some selected medicinal plants used in Khyber Pakhtunkhwa (KPK) as a potential source to cure infectious diseases. *BMC Complement Altern Med*, 14:122.
31. Rani P & Khullar N (2004). Antimicrobial evaluation of some medicinal plants for their anti-enteric potential against multi-drug resistant *Salmonella typhi*. *Phytother Res*, 18(8): 670–673.
32. Kannahi M, Sangeetha K, Madhavan S & Umamaheshwari N (2009). Antimicrobial activity of *Azardirachta indica* A. juss and *Melia azedarach* L. against wound causing pathogenic microorganisms. *Adv Pl Sci*, 22(2): 605-606.
33. Marino G, Gaggia F, Baffoni L, Toniolo C & Nicoletti M (2015). Antimicrobial activity of *Melia azedarach* fruit extracts for control of

- bacteria in inoculated in-vitro shoots of 'MRS 2/5' plum hybrid and calla lily and extract influence on the shoot cultures. *Eur J Plant Pathol*, 141(3), 505-521.
34. Sen A & Batra A (2012). Evaluation of antimicrobial activity of different solvent extracts of medicinal plant: *Melia azedarach* L. *Int J Curr Pharm Res*, 4(2): 67-73.
35. Munir A, Sultana B, Babar T, Bashir A, Amjad M & Hassan Q (2012). Investigation on the antioxidant activity of leaves, fruit and stem bark of Dhraik (*Melia azedarach*). *Europ J Appl Sci*, 4(2): 47-51.
36. Nahak G & Sahu RK (2010). *In vitro* antioxidative activity of *Azadirachta indica* and *Melia azedarach* leaves by DPPH scavenging assay. *Nature and Science*, 8(4): 22-28.
37. Munir A, Sultana B, Babar T, Bashir A, Amjad M & Hassan Q (2012). Investigation on the antioxidant activity of leaves, fruit and stem bark of dhraik (*Melia azedarach*). *Europ J Appl Sci*, 4(2): 47-51.
38. Ahmed MF, Ahmed MA, Thayyil H, Zameeruddin K & Ibrahim M (2008). Antioxidative activity of *Melia azedarach* Linn leaf extract. *IJPT*, 7(1): 31-34.
39. Raseroka CP & Ntshebe BH (2006). Evaluation of antimalarial activity of *Melia azedarach*. *Journal of Applied Zoological Research*, 17(1): 109-113.
40. Szezewuk VD, Mongelli ER & Pomilio AB (2003). Antiparasitic activity of *Melia azedarach* growing in Argentina. *Molecular Medicinal chemistry*, 1: 54-57.
41. Caboni, P, Ntalli NG, Bueno CE & Alche LE (2012). Isolation and chemical characterization of components with biological activity extracted from *Azadirachta indica* and *Melia azedarach*. Emerging Trends in Dietary Components for Preventing and Combating Disease. Chapter 4, pp 51-77. Chapter DOI: 10.1021/bk-2012-1093.ch004. ACS Symposium Series, Vol. 1093.
42. Joy PP, Thomas J, Mathew S & Skaria BP (1998). Medicinal Plants. Kerala Agriculture University. Aromatic and medicinal plants research station.
43. Husain SZ, Malik RN, Javaid M & Bibi S (2008). Ethnobotanical properties and uses of medicinal plants of Morgah Biodiversity Park, Rawalpindi. *Pak J Bot*, 40(5): 1897-1911.
44. Kaneria M, Baravalia Y, Vaghasiya Y & Chanda S (2009). Determination of antibacterial and antioxidant potential of some medicinal plants from Saurashtra region, India. *Indian J Pharm Sci*, 71(4): 406-412.
45. Rahmatullah MM, Khatun A, Morshed N, Neogi PK (2010). A randomized survey of medicinal plants used by folk medicinal healers of Sylhet division, Bangladesh. *Adv in Nat Appl Sci*, 4(1): 52-62.
46. Warriar PK, Nambiar VPK & Ramankutty C (1995). Indian medicinal plants, a compendium of 500 species, (Orient Longman Limited, Hyderabad. pp. 10-14.
47. Sharma PC, Yelne MB & Dennis TJ (2001). Database on medicinal plants used in Ayurveda, (Documentation and Publication Division, Central Council for Research in Ayurveda and Siddha, New Delhi. pp. 389-406.
48. Dhiman AK (2003). Sacred Plants and their Medicinal Uses, Daya publishing House, Delhi. pp. 125-127.
49. Mishra G, Jawla S & Srivastava V (2013). *Melia azedarach*: a review. *IJMCA*, 3(2): 53-56.
50. Azam MM, Mamun-Or-Rashid ANM, Towfique NM, Sen MK & Nasrin S

- (2013). Pharmacological potentials of *Melia azedarach* L. - A review. *American Journal of BioScience*, 1(2): 44-49.
51. Zhou H, Hamazaki A, Fontana JD, Takahashi H, Wandscheer CB & Fukuyama Y (2005). Cytotoxic limonoids from Brazilian *Melia azedarach*. *Chem Pharm Bull*, 53(10): 1362-1365.
 52. Sen A, Batra A & Rao DV (2010). Pivotal role of plant growth regulators in clonal propogation of *Melia azedarach* L. *Int J Pharm Sci Rev Res*, 5(2): 43-49.
 53. Rani M, Suhag P, Kumar R, Singh R & Kalidhar SB (1999). Chemical component and biological efficacy of *Melia azedarach* stems. *J Med Aromatic Plant Sci*, 21:1043-1047.
 54. Ramya S, Jepachanderamohan PJ, Alaguchamy N, Kalayanasundaram M & Jayakumararaj R (2009). In Vitro antibacterial prospective of crude leaf extracts of *Melia azedarach* Linn. against selected bacterial strains. *Ethnobotanical Leaflets*. 13: 254-258.