Review Article

Ethnomedicinal, Pharmacological and Phytochemistry of *Aegle marmelos* (linn.) Corr: A Review

Sanyogita Singh*, Ajeet Singh, Navneet
Department of Botany and Microbiology, Gurukula Kangri University Haridwar 249404 Uttarakhand, India.
***Corresponding author's E-mail:** sanyogita.14611@gmail.com

Received: 12-01-2019; **Revised:** 25-02-2019; **Accepted:** 05-03-2019.

ABSTRACT

Aegle marmelos is one of the important plants with several medicinal and nutraceutical properties. It is very often known as wood apple plant. *A. marmelos* is a member of Rutaceae family. It has several medicinal properties which are used in traditional medicinal system and use to cure a variety of diseases. In last few decades this plant is extensively studied for its medicinal properties by advanced scientific techniques and a variety of bioactive compounds have been isolated from the different part of plant and were analyzed pharmacologically. The medicinal properties of this plant represent it as a valuable source of medicinal compound. This report is summarized information concerning the morphology, distribution, phytochemistry, pharmacological and ethno-botanical uses of *A. marmelos*.

Keywords: *Aegle marmelos*, traditional medicine, pharmacological activities, phytochemistry.

INTRODUCTION

Aegle marmelos, a plant of Indian origin having tremendous therapeutic potential, it belongs to family Rutaceae, it is known by the several other names in the different parts of the country and also outside of the country[1]. The bael (*A. marmelos)* fruit is having lots of pharmacological activity; fruit is used to cure fever, mental disease diarrhea, dysentery and diabetes. It has several pharmacological uses i.e. hypoglycaemic, antifungal, antimicrobial, analgesic, anti-inflammatory, antipyretic, antidyslipidemic, immunomodulatory, anti-proliferative, wound-healing, antifertility, and insecticidal activities[2]. Every part of plant such as fruit, seed, bark, leaves and root are important ingredients of several traditional formulations. Due to its curative properties, it is one of the most useful medicinal plants of India. The product obtained from bael, being highly therapeutic and is getting popularized in India and international market [3].

It is subtropical plant which grows in the dry forest of hilly and plain area and found in Bihar, Chhattisgarh, Uttar Pradesh, Uttarakhand, Jharkhand and Madhya Pradesh[4]. Bael is scared tree of Hindu as its leaves are offered to Lord Shiva for fulfillment of wishes. The tree is symbol of fertility[5]. In bilva patra Sattva component is present due to which it emits and absorbs Sattivaik frequencies. So it reduces raja-tama particles form environment. A person suffering from distress, negative energy when brought in contact of bilva patra the black energy present within him is reduced[1]. The importance of bael is mentioned in ancient system of medicine[6]. In Ayurvedic medicine the fruit is used to cure Vatha and Kaphay in the body. Mainly half ripen fruits are used in preparation of medicine then the fully ripened fruit[7].

Classification

Kingdom	-	Plantae
Order	-	Spaindales
Family	-	Rutaceae
Subfamily	-	Aurantioidea
Genus	-	*Aegle*
Species	-	*marmelos*

Vernacular Name

Hindi	:	Bael, Bel, Belgiri
Sanskrit	:	Bilva, Shivdurma, Shivpala
English	:	Bengal Quince
Urdu	:	Belk, Belk ham
Guajarati	:	Bilvaphala
Malayalam	:	Marredy
Tamil	:	Vivla Marum Vivama

Botanical Description

Aegle marmelos is a slow-growing, medium sized tree, up to 12 to 15m tall. The stem is short, thick, soft, flaking bark, and spreading, sometimes spiny branches, the lower ones drooping. Young suckers bear many stiff, straight spines. There are sharp, axial long spikes on this tree. The leaflets are oval or lancet shaped, 4-10 cm long, 2-5 cm wide. Leaves composed of 3 to 5 leaflets in it. The lateral leaflets are without petiole and the terminal one has a long one. Tree is armed with straight sharp axillaries thorns, 2.5 cm long, terete, and leaflets 5-10 by 2.5-6.3 cm, ovate or ovate-lanceolate, flower greenish white, and sweet scented about 2.5 cm across. New foliage is glossy and pinkish-maroon in colour. Mature leaf emits a

disagreeable dour when bruised. Fragment flowers, in clusters of 4 to 7 along young branch lets, have 4 recurred, fleshy petals, green outside, yellowish inside and 50 or more greenish-yellow stamens. The fruits are round, pyriform oval, or oblong, 5-20 cm in diameter, may have a thin, hard, woody shell or a more or less soft rind, grey green until the fruit is fully ripe, when it turns yellowish. Seeds numerous, oblong, compressed, testa mucous.

Occurrence and Habitat

A. marmelos commonly known as bael, Bengal quince and wood apple is native to India. *A. marmelos* adapt wide range of habitat and can be cultivated worldwide. It is subtropical plant and can grow up to altitude of 1200 m from sea level. It is found mainly in dry forest of hilly and plain areas. It is native to India and has origin form Eastern Ghats and central India. The tree is mentioned in the writing dating back to 800 B.C[8]. Bael is found growing along the foothills of Himalayas, Uttar Pradesh, Chhattisgarh, Uttarakhand, Jharkhand, Madhya Pradesh and along East coast[9]. The bael tree is also found in many South East Asian countries including Pakistan, Sri Lanka, Nepal, Myanmar, Bangladesh, Vietnam, Cambodia Thailand, Malaysia, Java, Philippines and Fiji. The trees are of great importance to the environment as they act as climatic purifier that is they release greater percentage of oxygen in comparison to other trees. They also act as a sink for chemical pollutants as it absorbs toxic gases from the atmosphere and make them inert or neutral[10].

ETHNOBOTANICAL USES

Root decoction is given with sugar and boiled rice for curing diarrhoea in children[11]. Extract of bael root, Pyaz and Haldi mixed in equal proportion and is put in ear to relive earache[12].

Leaves are used in Abscess and backache[13]. Decoction of the leaves is used in eliminating fever and also helps in removal of mucous secretion from bronchial tubes[14]. Small amount of leaf is grind and taken with one glass of water in morning for few days to control diabetes[15]. The leaves are soaked overnight in water and this water is strained and drinks in the morning for few weeks to cure peptic ulcer[16]. The juice of leaf is mixed in warm water with little peeper and taken as drink to relief from wheezing cough and respiratory spasm[17]. The decoction of leaves is useful in jaundice[18]. Extract of leaves is applied on injuries caused by animal bite[13]. Paste of fresh bael leaves is kept on infected part and tied with bandage to cure[19]. Poultice made from leaves is used in treatment of Ophthlmia[20]. Leaves tea is prepared and used for gastrointestinal problem[21].

Ripe fruit juice is very useful in treating inflammation of rectum[22]. Dry powder of fruit is mixed with mustered oil is used in burn cases, one part of powder and two part mustered oil is mixed and applied externally[23]. Fresh fruit pulp juice is prepared and taken twice in chronic dysentery[24]. The fruit is when green, is sliced and dried in sun, the dried fruit slices are grind to make powder and is preserved in bottle and it is taken in diarrhoea and dysentery[25]. Ripe fruit Sharbat is prepared from pulp milk and sugar may be added and taken to relieve from constipation[26].

Fine powder of unripe fruit is taken with water to cure intestinal parasites like *Entamoeba histolytica*[27]. Unripe fruit pulp mixed with boiled rice water and taken twice a day to cure vomiting in Pregnancy[28].

We have conducted an ethnobotanical survey communities inhabiting in Rajaji National Park, Uttarakhand and found that A. marmelos is being used for treating jaundice, diarrhea, fever, diabetes etc. Rural people use the extract of leaves juice in empty stomach early morning against diabetes. Leaf juice is taken with honey is helpful in prevention of fever. Fruit juice is useful in treatment of diarrhea and dysentery. Extract of bael leaves taken with honey to cure jaundice for one week. Taking a teaspoon of dried and powdered bael leaves for three days help in increasing appetite. In a teaspoon of crushed bael leaves add a pinch of black pepper and consume this mixture then drink a cup of buttermilk. Follow this treatment three times a day to cure jaundice. To reduce peptic ulcer soak few bael leaves in a cup of water over night and drink this solution early in the morning.

PHARMACOLOGICAL ACTIVITIES

Anti-inflammatory

Aqueous extract of *A. marmelos* with the help of rat paw oedema model assured that *A. marmelos* have anti-inflammatory activity[29]. The various extracts of the leaves of bael were evaluated for anti-inflammatory activity[30]. The alcoholic extract of bael leaves antagonized the histamine–induced contractions and demonstrated positive relaxant effect in isolated guinea pig ileum and tracheal chain, suggesting inhibition of H1-receptor activity this extract may underlie these effects[31].

Antifertility activity

The antifertility effect of the aqueous extracts of leaves of *A. marmelos* was reported in male Albino rats. The rats were administered with aqueous extracts (250 mg/kg body weight) of leaves of *A. marmelos* for 45 days. Treatment resulted in reduction in the weights of testis, epididymes and seminal vesicle. The extract also resulted in reduction of testicular sperm count, epididymal sperm count and motility and abnormal sperm count[32].

Antidiarrheal activity

Antidiarrheal activity is one of the major medicinal properties of *A. marmelos* and traditionally it extensively used to control chronic diarrhea and dysentery. Recently, several in vitro and in vivo studies have been conducted to confirm the antidiarrheal property of *A. marmelos*. The in vitro antidiarrheal activity of dried fruit pulps of *A. marmelos* was reported. The ethanolic extract showed

good activity against *Shigella. boydii, S. sonnies and S. flexneri,* moderate against *S. dysenteriae*[33].

Antioxidant activity

Antioxidant activity of this plant is due to the presence of flavones, isoflavones, flavonoids, anthocyanin, coumarinlignans, catechins andisocatechins. *A. marmelos* is extensively reported to possess antioxidant activity against a variety of free radicals. Antioxidant activity and free radical scavenging activity of the ripe and unripe fruit of *A. marmelos* was compared. Results indicate that the enzymatic antioxidants increased in ripe fruit when compared to unripe fruit extract (except glutathione peroxidase). The percentage of free radical inhibition was also high in unripe fruit than that of the ripe fruit [34].

The antioxidant activity of the fruit of *A. marmelos* was reported. The aqueous extract of *A. marmelos* fruit was screened for antioxidant activity by the DPPH radical scavenging. The extract showed efficient antioxidant activity[35].

Hepatoprotective activity

The hepatoprotective effect of the leaves of *A. marmelos* was reported in alcohol induced liver injury in Albino rats. Rats were administered with 30% ethyl alcohol for a period of 40 days. The induced rats were fed with leaves of *A. marmelos* for 21 days. The TBARS values of healthy, alcohol intoxicated and herbal drug treated animals were 123.35, 235.68 and 141.85 g/g tissue respectively. This indicates the excellent hepatoprotective effect of the leaves of *A. marmelos* [36].

Antiulcer activity

Bael is known to show gastro protective activity. Unripe bael fruit extract serves the purpose. When used in rats, it produces a noteworthy inhibition of absolute ethanol induced gastric mucosal damage. This activity is shown due to the presence of a particular compound in the fruit, called, luvangetin. Gastric ulcer is usually mediated by progress of oxidative stress. This compound, luvangetin might act by inhibition of oxidative stress producing compounds in the gastrointestinal tract thus preventing ulcer formation[37].

Antidiabetic activity

Bael extract, when administered at a dose of 250 mg/kg of body weight, shows better result than glycenamide (antidiabetic drug). This antidiabetic effect may be due to the coumarins present in the fruit which induce the beta cells of islet of Langerhans to produce insulin. Aqueous extract of bael seeds reduces blood glucose level in case of severe diabetic patients[37, 38].

Antihyperlipidemic activity

Oral administration of aqueous extract of bael fruits and seeds separately at a dose of 250 mg/Kg of body weight to diabetes induced rats has shown significant decrease in the blood lipid level. The effect may be due to fat mobilization from deposits which is caused due to hydrolysis of triglycerides. The extract also increases glucose utilization[37-39].

Anticancer activity

Bael extract has been found successful in inhibition of *in vitro* proliferation of human tumor cell lines including Lecukenic K562, T-Lymphoid Jurat, Beta-Lymphoid Raji, Erythro Leukemic HEL[40].

Antimicrobial activity

A. marmelos has been traditionally used for the treatment of various infectious diseases and been extensible reported to inhibit the broad range of pathogenic microorganisms. Many in vitro studies proved the antimicrobial potential of *A. marmelos* extracts towards the pathogenic microorganisms including bacteria and fungi. The antimicrobial activity of the leaves of *A. marmelos* was performed by agar well diffusion method. The aqueous, petroleum ether and ethanol extract of the leaves of *A. marmelos* exhibited efficient antimicrobial activity against *Escherichia coli, Streptococcus pneumoniae, Salmonella typhi, Klebsiella pneumoniae and Proteus vulgaris*. The ethanolic extract shows activity against *Penicillium chrysogenum* and the petroleum ether and aqueous extract shows activity against *Fusarium oxysporum*[41]. The antimicrobial activity of the leaves of *A. marmelos* was reported. The antimicrobial activity was checked by disc diffusion method. The petroleum ether extract of leaves was checked against multi resistant strains of *Staphylococcus aureus, Bacillus subtilis, Escherichia coli, Salmonella typhi, Proteus vulgaris, Pseudomonas aeruginosa and Klebsiella pneumoniae.* The antimicrobial activity against gram-negative strains was higher than that of gram positive strains[42]. The essential oil obtained from the leaves exhibited activity against *Aeromonas sp.*, *E.coli*, *Pseudomonas salanacearum* and *Xanthomonas vesicatoria*[43]. The ethanolic extract of the root has shown activity against *Vibrio cholerae, Salmonella typhimurium*, *Klebsiella pneumoniae*, *E. coli*, *Pseudomonas aeruginosa*, *Bacillus subtilis* and *Staphylococcus aureus*[44]. The ethyl acetate extract of the plant has exhibited activity against *Vibrio cholerae*, *S. typhi*, *S. aureus*, *Pseudomonas putida* and *Bacillus anthracis* [45].

Antiviral activity

Bael has antiviral activities in the early stages of viral replication with minimum host cytotoxicity in contrast to modern virucidal chemotherapeutic agents (that is ribavirin), which usually act in the later stages of viral replication and have potent side effect[46]. The 50% ethanolic extract of the fruits has shown antiviral activity against ranikhet disease virus[47].

Cytoprotective effect

The cytoprotective effect of the leaves of *A. marmelos* was reported in *Cyprinus carpio* (fresh water fish) exposed to heavy metals. *C. carpio* was exposed to heavy

metals followed by the treatment with the dried powder of *A. marmelos* leaves. Treatment resulted in cytoprotective effect by stabilization of plasma membrane and modulation of antioxidant enzyme system[48].

Anti-thyroid activity

Isolated, scopoletin (7-hydroxy-6-methoxy coumarin) from *A. marmelos* leaves and evaluate for its potential to regulate hyperthyroidism. It was observed that scopoletin (at 1.00 mg / kg, p.o. for 7 days) to levo-thyroxine treated animals, decreased serum thyroid hormones level. It was also proved that the scopoletin have superior therapeutic activity than the standard antithyroid drug, propylthiouracil[49].

Antimalarial activity

The alcoholic extracts of the Bael seeds and leaves have been tested in vivo and in vitro for antimalarial activity against the NK65 strain of *Plasmodium berghei*. The seeds have shown schizontocidal activity in both the system, whereas, the leaves have shown activity only in the in-vitro system[50].

PHYTOCHEMISTRY

A. marmelos leaves contained aegeline, rutin, lupeol, flavone, marmesinine, β-sitosterol, glycoside, oisopentenylhalforidol and phenylethylcinnamamides[51]. Some isolated compounds are classified as

Alkaloids

The alkaloids are secondary plant substances. The main four alkaloids of *Aegle marmelos* leaves are N-2- [4-(3', 3'-dimethylallyloxy) phenyl] ethylcinnamide, N-2-hydroxy-2-(4-hydroxyphenyl) ethylcinnamide, Marceline and Angeline[52]. Shahidine, an alkaloid having oxazoline core has been isolated as a major constituent from the fresh leaves of *Aegle marmelos* and it showed activity against a few Gram-positive bacteria[53].

Terpenoids

The essential oil of *A. marmelos* leaves was studied very much extensively in India, α-phellandrene and p-cymene were extracted from its leaves oil[54]. Limonene was reported as an important constituent from *A. marmelos* leaves and it was shown that limonene as marker for identification of bael soil samples[55].

Coumarins

The coumarins present in bael fruit includes marmelosin, marmesin, imperatorin, marmin, alloimperatorin, methyl ether, xanthotoxol, scoparone, scopoletin, umbeliferone, marmelide and marmenol[10].

CONCLUSION

Aegle marmelos is one of the important plants with several medicinal and nutraceutical properties. It is very often known as wood apple plant. It has several medicinal properties which are used in traditional medicinal system and used to cure several diseases. In last few decades this plant is extensively studied for its medicinal properties by advanced scientific techniques and a variety of bioactive compounds have been isolated from the different part of plant and were analyzed pharmacologically. The medicinal properties of this plant represent it as a valuable source of medicinal compound. This review summarized its various ethno-botanical and pharmacological activities i.e. antibacterial, antifungal, antiviral, antidiabetic, antimalarial, antioxidant etc.

Acknowledgement: The authors are thankful to the Head of Department of Botany and Microbiology, Gurukul Kangri University, Haridwar, Uttarakhand (India) for their constant support, encouragement and library facility.

REFERENCES

1. Sharma GN, Dubey SK, Sharma P, Sati N, Medicinal Values of Bael (*Aegle marmelos*) (L) Corr: A Review, Int. J. Curr. Pharmaceut. Rev Res., 1 (3), 2011, 12-22.
2. Rana BK, Singh UP, Taneja V, Antifungal activity and kinetics of inhibition by essential oil isolated from leaves of *Aegle marmelos*, Journal of ethnopharmacology, 57(1), 1997, 29-34.
3. Sharma VK, In: Wasteland Horticulture, A.P.H. Publishing corporation, New Delhi, 1997, 40, 89.
4. Singh S, Standardization of processing technology of bael (*Aegle marmelos* Correa): Thesis Doctor of philosophy in horticulture, college of agriculture CCS, HAU, Hisar, 2003.
5. Jain SK, Sastry ARK, Threatened Plants in India, Botanical Survey of India, Calcutta, 1979.
6. Patel PK, Jyoti S, Lokesh S, Narendra KP, Dubey BK, *Aegle marmelos*: A Review on its Medicinal Properties, Int. J. Pharm. Phytopharmacol. Res., 1(5), 2012, 332-341.
7. Kumar Sampath KP, Umadevi M, Debjit Bhowmik, Durgesh Mohan Singh, Dutta AS, Recent Trends in Medicinal Uses and Health Benefits of Indian Traditional Herbs *Aegle marmelos*, The Pharma Innovation, 1(4), 2012,70-77.
8. Sambamurthy AVSS, Subrahmanyam NS, Fruits and Nuts, A Text Book of Economic Botany, Wiley Eastern Limited, New Delhi, 4, 1989, 697-698.
9. Purohit SS, Vyas SP, In: *Aegle marmelos* Correa ex Roxb. (Bael), Medicinal Plant Cultivation- A Scientific Approach, Agrobios, Jodhpur, 2004, 280-285.
10. Sharma PC, Bhatia V, Bansal N, Sharma A, A review on Bael tree, Natural Product Radiance, 6(2), 2006, 171-178.
11. Rajadurai M, Prince PSM, Comparative effects of *Aegle marmelos* extract and alpha-tocopherol on serum lipids, lipid peroxides and cardiac enzyme levels in rats with isoproterenol-induced myocardial infarction, Singapore Med. J., 46(2), 2005, 78-81.

12. Jain SK, Dictionary of Indian Folk Medicine and Ethnobotany, Deep Publication, New Delhi, 1991, 311.
13. George KV, Mohanan N, Nair SS, Ethnobotanical investigations of *Aegle marmelos* (Linn.) Corr, In: Ethnbot. Med. Plants India and Nepal, by Singh V and Jain AP, (Scientific Publishers, Jodhpur), 2003, 29-35.
14. Kurian JC, Plants that heals, Oriental Publishing house, 1992, 26-27.
15. Gaur RD, Tiwari JK, Indigenous medicinal plant of Garhwal Himalaya (India): An Ethhnobotanical Study, In: Medicinal and poisonous plant of tropics, AJM Leeuwenberg (Ed), International book Distributors, Dehradun, 1988, 139-143.
16. Goel RK, Maiti RN, Manickan M, Ray AB, Antiulcer activity of naturally occurring pyrano-coumarin and their effect onprostanoid synthesis using human colonic mucosa, Indian J Exp Biol, 35(10), 2000, 1080-1083.
17. Reddy KN, Reddy CS, Trimurthulu S, Ethnobotancial survey on respiratory disorder in Eastern Ghats of Andhra Pradesh, Journal of ethnobotanical leaflets, 10, 2006, 139-148.
18. Devadi G, Importance of Bael and its use in health care, In: Kalyan Aarogaya Ank, Geeta Press Gorakhpur, 2, 2002, 401-402.
19. Anonymous. The Wealth of India - Raw Material Series, Publication and Information Directorate, New Delhi, 1989, 33-34.
20. Kirtikar KR, Basu BD, Indian Medicinal Plant, International Book Publication, 1, 1995, 499-502.
21. Veerappan AKS, Renganathan D, Cardiotonic effect of *Aegle marmelos* Corr. On amphibian heart in situ preparation, Proc. 6th Internet World Congress for Biomed. Sci., 2000.
22. Dhankhar S, *Aegle marmelos* (Linn.) Correa: A source of Phytomedicine, J Medicinal Plants Res, 5(9), 2010, 1497-1507.
23. Parmar C, Kaushal MK, *Aegle marmelos* Correa, In: Wild fruits of the sub- Himalayan region, Kalyani Publishers, New Delhi, 1982, 1-5.
24. Vyas DS, Sharma VN, Sharma HK, Khanua NK, Effect of labetalol, an alpha- & beta-adrenoceptor blocking agent on gastric acid secretion & gastric ulcers in pylorus-ligated rats, J. Res. Indian med. Yoga homeopath, 14, 1979, 63.
25. Lamba BV, Bhargava KP, Activity of some synthetic and natural product against experimental Ankylostomiasis, Indian J Pharmacol, 1969, 1.
26. Tiwari NN, Joshi MP, Medicinal plants of Nepal II, J. Nep Med Assoc.,28, 1990, 221-232, 266-279.
27. Trivedi VP, Nesamany S, Sharma VK, Ayurvedic herbs: a clinical guide to the healing plants of traditional medicine, J. Res. Indian med. Yoga homeopath, 28, 1978, 13.
28. Kala CP. Ethnobotany and Ethnoconservation of Bael, Indian J Traditional Knowledge, 5(4), 2006, 537-540.
29. Ghangale GR, Surve VS, Anbarasan K, Gatne MM, Evaluation of *Aegle marmelos* (Bael) for anti-inflammatory activity in rats, Journal of Bombay Veterinary College, 16(1), 2008, 15-16.
30. Dhuley JN, Investigation on the gastro protective and antidiarrheal properties of *Aegle marmelos* unripe fruit extract, Hindustan Antibiot Bull, 41, 2007, 45-46.
31. Arul V, Miyazaki S, Dhananjayan R, Mechanisms of the contractile effect of the alcoholic extract of *Aegle marmelos* Corr. On isolated gunia pig ileum and tracheal chain, Phytomed., 11 (7-8), 2004, 679-683.
32. Sathiyaraj K, Sivaraj A, Madhumitha G, Kumar PV, Saral AM, Devi K, Kumar BS, Antifertility effect of aqueous leaf extract of *Aegle marmelos* on male albino rats, International Journal of Current Pharmaceutical Research, 2(1), 2010, 26.
33. Joshi PV, Patil RH, Maheshwari VL, In vitro antidiarrheal activity and toxicity of *Aegle marmelos*, Natural Product Radiance, 8, 2009, 498-502.
34. Sharmila S, Devi PV, www. jpronline. info. Journal of Pharmacy Research 4(3), 2011, 720-722.
35. Gheisari HR, Amiri F, Zolghadri YALDA, Antioxidant and antimicrobial activity of Iranian Bael (*Aegle marmelos*) fruit against some food pathogens, Int J Curr Pharm Res, 3(3), 2011, 85-88.
36. Singanan V, Singanan M, Begum H, the hepatoprotective effect of bael leaves, International Journal of Science & Technology, 2, 2007, 83-92.
37. Maity P, Hansda D, Bandopadhaya U, Mishra DK, Biological activities of crude extracts and chemical constituents of Bael, *Aegle marmelos* (L.) Corr., Indian Journal of Experimental Biology, 47, 2009, 849-861.
38. Kamalakkannan N, Prince SM, Effect of *Aegle marmelos* fruit extract on tissue antioxidants in Streptozotocin diabetic rats, Indian Journal of Experimental Biology, 41, 2003, 1285.
39. Kesari AN, Gupta RK, Singh SK, Diwakar S, Watal G, hypoglycemic and antihyperglycemic activity of *Aegle marmelos* seed extract in normal and diabetic rats, Journal of Enhopharmacology, 107, 2006, 374-379.
40. Lampronti I, Martello D, Bianchi N, Borgatti M, Lambertini E, Piva R, Jabbar S, Choudhary MS, Khan MT, Gambari R, *In vitro* antiproliferate effect on human tumor cell lines of extract from Bangladesh medicinal plant, *Aegle marmelos*, Phytomedicine, 10(4), 2003, 300-308.
41. Sivaraj R, Balakrishnan A, Thenmozhi M, Venckatesh R, Antimicrobial activity of *Aegle marmelos*, Rutagraveolens, Opuntiadellini, *Euphorbia royleena* and Euphorbia antiquorum, Journal of Pharmacy research, 4(5), 2011, 1507-1508.
42. Gavimath CC, Ramachandra YL, Rai SP, Sudeep HV, Ganapathy PSS, Kavitha BT, Antibacterial activity of *Aegle marmelos* correa leaves extract, Asian journal of Bio science, 3(2), 2008, 333-336.
43. Pandey DK, Asthana A, Tripathi NN, Dixit SN, Volatile plant products vis-à-vis potato pathogenic bacteria, Ind. Perfum., 10, 1981, 25.
44. Pitre S, Srivastava SK, Pharmacological, microbiological and phytochemical studies on the roots of *Aegle marmelos*, Fitoterapia., 58, 1987, 197.

45. Rusia K, Srivastva SK, Antimicrobial activity of some Indian medicinal plants, Ind. J. Pharmaceut. Sci., 50, 1988, 57.

46. Fenner FJ, Gibs EPJ, Murphy FA, Rott R, Studdart MJ, White D, Veterinary virology, Academic press Inc, London, U.K., 2, 1993, 301.

47. Dhar ML, Dhar MM, Dhavan BN, Mehrotra BN, Ray C, Screening of Indian plant for biological activity, Indian J. Exp. Biol., 6, 1968, 232.

48. Vinodhini R, Narayanan M, Cytoprotective effect of *Nelumbo nucifera* and *Aegle marmelos* in common carp (*Cyprinus carpio* L.) exposed to heavy metals, International Journal of Integrative Biology, 7, 2009, 124-129.

49. Panda S, Kar A, Evaluation of the antithyroid, antioxidative and antihyperglycemic activity of scopoletin from *Aegle marmelos* leaves in hyperthyroid rats, Phytotherapy Research, 20(12), 2006, 1103-1105.

50. Mishra P, Pal NL, Guru PY, Katiyar JC, Tandon JS, Antimalarial activity of traditional plant against erythrocyte stages of *Plasmodium berghei*, Int. J. Pharmacog., 19, 1991, 29.

51. Govindachari TR, Premila MS, Some alkaloids from *Aegle marmelos*, Phytochemistry, 22(3), 1983, 755–757.

52. Pattnaik S, Subramanyam VR, Kole C, Antibacterial and antifungal activity of ten essential oils in vitro, Microbios, 86(349), 1995, 237-246.

53. Baslas KK, Deshpandey SS, Edible Medicinal and Non-Medicinal Plants Fruits, J. Indian Chem. Soc., 28, 1951, 19-22.

54. Kaur HP, Garg SN, Sashidhara KV, Yadav A, Naqvi AA, Khanuja SPS, Chemical composition of the essential oil of the twigs and leaves of *Aegle marmelos* (L.) Correa., Journal of Essential Oil Research, 18(3), 2006, 288-289.

55. Chakravorty RN, Dasgupta B, γ-Sitosterol from the leav es of *Aegle marmelos* Correa., J. Indian Chem. Soc., 35, 1958, 194-196.

Source of Support: Nil, **Conflict of Interest:** None.