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PHYTOCHEMISTRY, PHARMACOLOGY AND ETHNOMEDICINAL PROPERTIES OF *AEGLE MARMELOS*

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ABSTRACT

Aegle marmelos is widely used by the traditional healers for treatments of various diseases like diarrhea, dysentery, diabetes, ulcer, inflammation etc. The variety of secondary metabolites are present in this plant which impart its medicinal uses. Further number of active constiuetns has been isolated from the *Aegle marmelos*. Present review focused on traditional uses, phytochemistry, pharmacology and toxicology of *Aegle marmelos* to support potential scope for advance ethnopharmacological study. The extract of *Aegle marmelos* is reported to have numerous significant pharmacological activities like antihyperglycemic, anti-inflammatory, antipyretic, analgesic, anticonvulsant, antihistaminic, anxiolytic, antidepressant, antioxidant, hepatoprotective, antimicrobial, analgesic, antifungal, neuroprotective etc evaluated by using various animal models. The present study summaries selected scientific evidence on phytochemistry, pharmacological properties and ethnomedicinal uses of *Aegle marmelos*. The data was gathered via the Internet (using Scopus, PubMed, Google Scholar, Elsevier, Springer, Science Direct, Researchgate and Web of Science) as well as from libraries and local books. The aim of the current review article is to compile all the relevant published information regarding traditional uses, phytochemistry and therapeutic potential of *Aegle marmelos*.

KEYWORDS: *Aegle marmelos,* Phytochemistry, Pharmacology, Ethnomedicinal uses.

INTRODUCTION

Medicinal plants are considered as a rich resources of ingredients which can be used in drug development either Pharmacopoeial, non-pharmacopoeial or synthetic drugs. A part from that, these plants play a critical role in the development of human cultures around the whole

world. Moreover, some plants are considered as important source of nutrition and as a result of that they are recommended for their therapeutic values. Some of these plants include ginger, green tea, walnuts, Aloe, pepper and turmeric etc. Some plants and their derivatives are considered as important source for active ingredients which are used in aspirin and toothpaste etc.

Medicinal plants and their components possess a range of beneficial preventive properties. They show many promising effects for various health problems, such as colds, coughs, throat irritations, stomachache, indigestion, and gastrointestinal diseases, and have also positive protecting activities such as spasmolytic, sedative, antiviral, anti-inflammatory, antiseptic, hepatoprotective, antihyperglycemic, and immunostimulating.[1]

Traditional systems of medicine continue to be widely practiced on many accounts. Population rise, inadequate supply of drugs, prohibitive cost of treatments, side effects of several synthetic drugs and development of resistance to currently used drugs for infectious diseases have led to increased emphasis on the use of plant materials as a source of medicines for a wide variety of human ailments.

Recently, WHO (World Health Organization) estimated that 80 percent of people worldwide rely on herbal medicines for some aspect of their primary health care needs. According to WHO, around 21,000 plant species have the potential for being used as medicinal plants.

As per data available over three-quarters of the world population relies mainly on plants and plant extracts for their health care needs. More than 30% of the entire plant species, at one time or other were used for medicinal purposes. It has been estimated, that in developed countries such as United States, plant drugs constitute as much as 25% of the total drugs, while in fast developing countries such as India and China, the contribution is as much as 80%. Thus, the economic importance of medicinal plants is much more to countries such as India than to rest of the world.[2] Presently the uses of natural products for the treatment of various diseases has been increased in globe. The review paper highlighted the phytochemistry, pharmacology and ethnomedicinal properties of *Aegle marmelos*.

Aegle marmelos

Aegle marmelos, commonly known as Bael or wooden apple belongs to the Rutaceae family. The leaves of *Aegle marmelos* are offered to Lord Shiva, whose worship cannot be completed

without the leaves of this tree.[3] All parts of this tree, viz. root, leaf, trunk, fruit and seed are useful in several ailments. It has been used in Ethno-medicine to exploits its medicinal properties including antidiarroheal, antidysentric, antipyretic and anti inflammatory activities. Compounds purified from bael fruit have been proven to have biological potential against several diseases like diabetes, gastric ulcer and hyperlipidaemia. It should also be indicated that the therapeutic activities of few isolated constituents have also proven to possess antibacterial, antiviral, antioxidant and radioprotective activities.[4]

Phytochemistry of *Aegle marmelos*

Various chemical constituents like alkaloids, coumarins (marmelosin, marmesin, marmin, imperatorin, scopoletin), steroids, polysaccharides, phenylpropenoids, tannins, flavonoids, carotenoids, saponin, etc have been isolated from various parts of tree such as leaves, fruits, wood, root and bark.

The leaves contain γ-sitosterol, aegelin, skimmianine (tannin), lupeol, rutin, marmesinin, β-sitosterol, flavone, glycoside, Limonene and phenylethyl cinnamamides. Fresh leaves contain alkaloid Shahidine, halfordino, ethylcinnamamide and marmeline.[5] Recently, series of phenylethyl cinnamides (anhydromarmeline, aegelinosides A and B), were isolated from *Aegle marmelos* leaves which are α-glucosidase inhibitors. Rutin flavon, flavon glycosides and flavon-3-ols are the major flavonoids of *A. marmelos* leaves. α-Phellandrene (Terpenoid) was found to be the common constituent of leaves, twigs and fruits.

The fruits comprise tannin (skimmianine also known as 4, 7, 8-trimethoxyfuro-quinoline), phenylpropanoids (hydroxycoumarins, phenylpropenes and lignans), Aegeline, Marmelosin, luvangetin, Aurapten, Psoralen, Marmelide, p-cymene.[6]

The seed oil incorporate palmitic, Stearic, oleic, linoleic and linolenic acid. Some of minerals, viz. phosphorus, potassium, calcium, magnesium and iron. The roots of the tree have also been found to contain psoralen, xathotoxinscoploletin, tembamide, containpsoralen, xathotoxinscoploletin and tembamide.[7,8] The bark exhibited the presence of Marmin, Skimmiamine Mature, Fagarine.[9] The structure of some isolated compounds are displayed in Fig 1.

Pharmacological activities of *Aegle marmelos*

Aegle marmelos is a medicinal plant and researchers scientifically documented the extract of various parts of plant demonstrated the different pharmacological activities such as Antihyperglycemic, Anti-inflammatory, antipyretic, analgesic, Anticonvulsant, Antihistaminic, Anxiolytic, antidepressant, Antioxidant, Hepatoprotective, Antimicrobial, Analgesic, Antifungal, Neuroprotective etc. Table 1 demonstrated the list of pharmacological activities till date performed on *Aegle marmelos* along with their findings.

Ethnomedicinal uses of *Aegle marmelos*

Leaves extracts of *Aegle marmelos* is traditionally used to treat jaundice, constipation, chronic diarrhea, dysentery, stomachache, stomachic, fever, asthma, inflammations, febrile delirium, acute bronchitis, snakebite, abdominal discomfort, acidity, burning sensation, epilepsy, indigestion, leporsy, myalgia, smallpox, spermatorrhoea, leucoderma, diabetes mellitus, eye disorders, ulcers, mental illnesses, nausea, sores, swelling, thirst, thyroid disorders, tumors, ulcers and upper respiratory tract infections. It is also used to treat Anaemia, Fractures, Healing of Wounds, Swollen Joints, High Blood Pressure, Diarrhoea, Healthy Mind and Brain Typhoid Troubles during Pregnancy.

Sweet drink prepared from the pulp of fruits produce a soothing effect on the patients who have just recovered from bacillary dysentery. The pulp of unripe fruit is soaked in gingelly oil for a week and this oil is smeared over the body before bathing. This oil is said to be useful in removing the peculiar burning sensation in the soles. Fresh fruit extracts lower blood pressure. Fine powder of unripe fruit can be an alternative medicine to cure intestinal parasites, like *Entamoeba histolytica, Ascaris lumbricoides*.

Root bark is used in remission of intermittent fevers fever, fish poison, remedy for heart palpitation and melancholia. Bark juice, mixed with cumin in milk, increases seminal fluid volume. Alcoholic root extracts cure hypoglycemia. It is also used in dog bite, gastric troubles, heart disorders, antiamoebic, rheumatism.

Flower extracts are used as a tonic for the stomach, intestine, antidysenteric, anti-diabetic, epilepsy, diaphoretic and local anesthetic.[57-62]

Future prospects

This review revealed that *Aegle marmelos* possesses significant pharmacological potential and chemical constituents and traditional healers use this plant to treat a wide spectrum of human ailments. It is necessary to accumulate this indigenous knowledge by proper documentation and preserve it for future research. In spite of having promising biological and pharmacological potentials, there are only few reports are available on this plant. More research is required on the phytochemical constituents of this plant. This review will help the future researchers in discovering new therapeutic agents as the plant possesses propitious biological and pharmacological potentials.

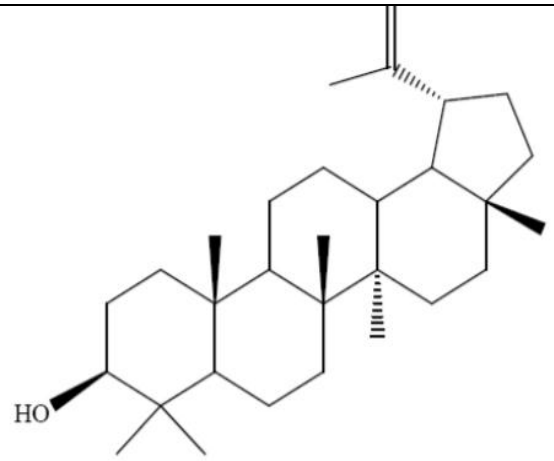
Compounds that are isolated from the *Aegle marmelos* has the potential to act as lead compounds for drug discovery. In spite of having enormous ethnomedicinal and folklore applications, these plants remain unexplored.

Since the plant possesses significant biological and pharmacological activity it should be explored for its medicinal value at molecular level by using various modern scientific techniques. The plant has a wide array of biological and pharmacological potentials and many of the isolated compounds and synthetic analogues of *Aegle marmelos* merit further research.

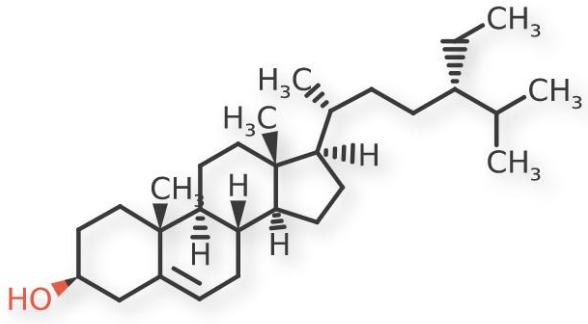
Table 1: Reported pharmacological activities of *Aegle marmelos.*

Pharmacological activity	Plant part	Results
Antihyperglycemic	Leaves	Decrease in glucose absorption and inhibition of both α amylase and intestinal disaccharidase enzyme activity due to presence of bioactive components, aegelin 2, scopoletin and sitosterol[10-12]; effective as insulin in restoration of blood glucose.[13]
Anti-inflammatory, antipyretic & analgesic	Leaves	Significant inhibit the carragenin-induced paw edema due to presence of lupeol, skimmianine.[14, 15]
Anticonvulsant	Leaves	Interfere with GABAergic mechanism to exert their anticonvulsant activity due to presence of flavonoid, Lupeollinoleate, Skimmianine, Eugenol.[16, 17]
Antihistaminic	Leaves	Inhibited the histamine release from rat leukemia cell line (RBL-2H3 cell) and also inhibit the histamine release and suppressed Ca^{2+} influx on RBL-2H3 cell line.[18-21]
Anxiolytic & antidepressant	Leaves	It enhances anxiolytic and antidepressant activity of imipramine and fluoxetine.[22, 23]
Antioxidant	Leaves	It has capability of protecting the cells in oxidative stress due to the presence of flavones, isoflavones, flavonoids, alkaloid, sterpenoids, phenolic content, anthocyanin, coumarin, lignans,

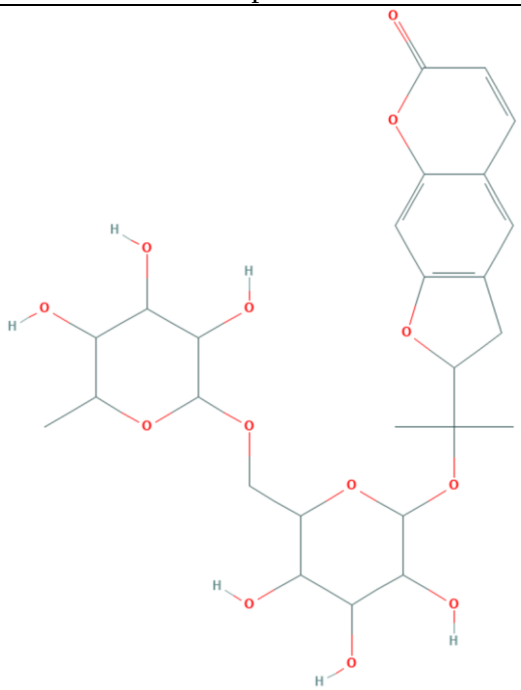
		catechins and isocatechins.[24-26]
Hepatoprotective	Leaves, Seed, Fruit	Showed significant decrease in the levels of serum markers, indicating the protection of hepatic cells against ethanol induced hepatocellular injury.[27-30]
Antimicrobial	Leaves & Fruit	Inhibit the broad range of pathogenic microorganisms. produced maximum inhibition zone of 11 mm and 9 mm.[31-33]
Analgesic	Leaves	Showed significant analgesic activity on acetic acid-induced writhing and tail flick test in mice.[34]
Antifungal	Leaves	Interfere with the Ca^{2+}-dipicolonic acid metabolism pathway and possibly inhibit the spore formation at concentration of 500 ppm.[35]
Neuroprotective	Leaves	Showed acetylcholinesterase (AChE) inhibitory activity in the brain which improves the symptoms of cognitive deficit by elevating the levels of acetylcholine.[36]
Anti-ulcer	Fruit	Reduced gastric ulceration and prevent the oxidative stress[37] due to the presence of luvangetin and quercetin which lowers oxidative stress in the gastro duodenal mucosa.[28, 38,39]
Antiviral	Fruit	Contain marmilide, which interferes with early events of replicating cycle.[40]
Anti-cancer	Leaves, Fruit & Bark	Inhibit the *in vitro* proliferation of human tumor cells, erythroleukemic HEL, melanoma colo38, MDAMB- 231 and breast cancer MCF7 cell lines.[41] Also showed antiproliferative activity against colon, breast carcinoma and leukaemia cell line.[42-44] Due to the presence of lupeol, eugenol, citral, and marmelin skimmianine.[28]
Immunomodulatory	Leaves	Stimulate cell mediated and antibody mediated immune responses in rats[45]; also high dose was best effective in humoral immunity.[46]
Antithyroid	Leaves	Decreased thyroid hormone level due to presence of scopoletin.[47]
cardioprotective effect	Leaves	Exhibited cardioprotective effect against isoproterenol induced myocardial infarction in rats due to the presence of aurapten.[48]
antidiarrhoeal	Fruit	Effective remedy for prevention of diarrhea[49] due to presence of tannins and flavonoids.[50-52]
Toxicology	Leaves	Chronic administration of leaf powder did not induce any short term toxicity. It have a high margin of drug safety.[53,54]
Anthelmintic	Fruit	Showed significant difference in paralysis and death time.[55]
Antifertility	Leaves	Showed significant reduction in the weights of testis, epididymes, seminal vesicle, testicular sperm count, epididymal sperm count and motility and abnormal sperm count.[56]



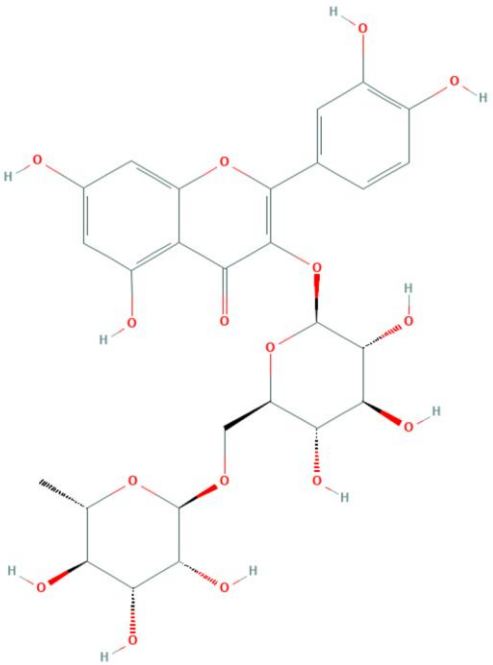
Lupeol



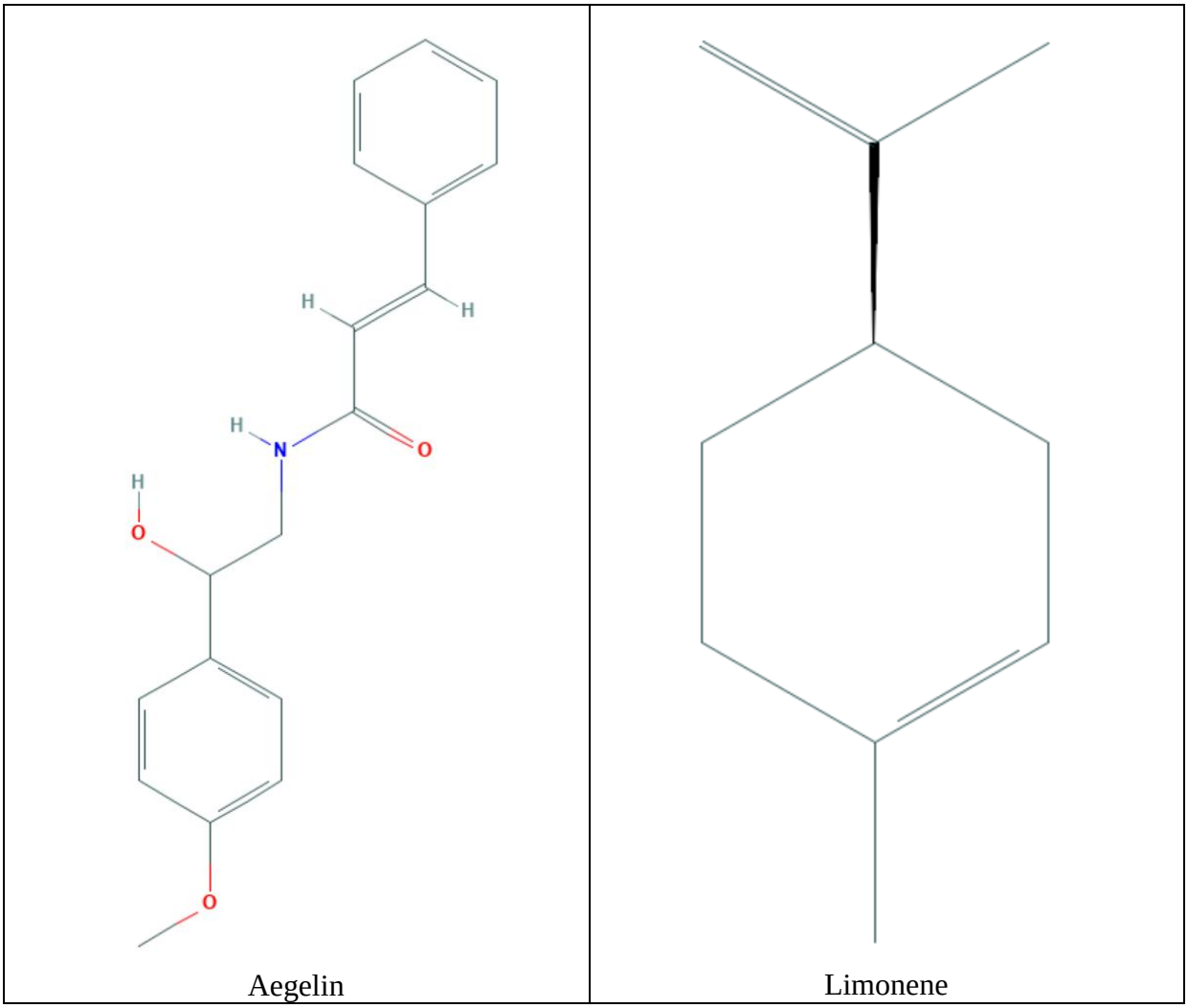
γ-sitosterol



Marmesin rutinoside



Rutin



Aegelin Limonene

Fig 1: Structures of some phytochemical constituents reported from *Aegle marmelos.*

CONCLUSION

The existing literature on *Aegle marmelos* has shown that it is an important medicinal plant used in a wide range of ethnomedical treatments, especially for diarrhea, dysentery, diabetes, ulcer, inflammation, fever and hyperlipidaemia. *Aegle marmelos* reported the presence of secondary metabolite such as alkaloids, coumarins (marmelosin, marmesin, marmin, imperatorin, scopoletin), steroids, polysaccharides, phenylpropenoids, tannins, flavonoids, carotenoids, saponin. The pharmacological studies of of *Aegle marmelos* extract hold antihyperglycemic, anti-inflammatory, antipyretic, analgesic, anticonvulsant, antihistaminic, anxiolytic, antidepressant, antioxidant, hepatoprotective, antimicrobial, analgesic, antifungal, neuroprotective etc. Therefore, considering its versatile medicinal uses. Further improvements are required to encourage research interest on *Aegle marmelos*.

REFERENCES

1. Madhuri S, Pandey G. Some anticancer medicinal plants of foreign origin. Current science, 2009; 779-783.
2. Swarnkar R, Singh D, Choudhary A Shweta A, Rathore A, Jediya HK. Pharmacological Properties of Aegle marmelos: A Review. Int. J. Curr. Microbiol. App. Sci., 2019; 8(05): 1600-1608.
3. Asha J, Krishan K. Tremendous Pharmacological Values of Aegle marmelos. International Journal of Pharmaceutical Sciences Review and Research, 2016; 36(2): 121-127.
4. Cragg GM, Newman DJ. Medicinals for the millennia. Annals of the New York Academy of Sciences, 2001; 953(1): 3-25.
5. Asha J, Krishan K. Tremendous Pharmacological Values of *Aegle marmelos*. International Journal of Pharmaceutical Sciences Review and Research, 2016; 36(2): 121-127.
6. Neeraj VB, Johar V. Bael *(Aegle marmelos*) Extraordinary Species of India: A Review. International Journal of Current Microbiology and Applied Sciences, 2017; 6(3): 1870-1887.
7. Rangari VD. Traditional Drugs of India: Pharmacognosy and Phytochemistry. Part- 2. 1st edn. 182-184. Carrier Publications, Nasik. 2004.
8. Farooq S. Medicinal Plants: Field and Laboratory Manual. 40-42. International Book Distributors, Dehradun, 2005.
9. Choudhary Y, Saxena A, Kumar Y, Kumar S, Pratap V. Phytochemistry, Pharmacological and Traditional Uses of *Aegle marmelos*. UKJPB, 2017; 5(5): 27-33.
10. Ansari P, Afroz N, Jalil S, Azad SB, Mustakim MG, Anwar S, Hannan JMA. Anti-hyperglycemic activity of *Aegle marmelos* (L.) corr. is partly mediated by increased insulin secretion, α-amylase inhibition, and retardation of glucose absorption. Journal of Pediatric Endocrinology and Metabolism, 2017; 30(1): 37-47.
11. Upadhya S, Shanbhag KK, Suneetha G, Balachandra Naidu M, Upadhya S. A study of hypoglycemic and antioxidant activity of *Aegle marmelos* in alloxan induced diabetic rats. Indian journal of Physiology and pharmacology, 2004; 48(4): 476-480.
12. Nigam V, Nambiar VS. *Aegle marmelos* leaf juice as a complementary therapy to control type 2 diabetes–Randomised controlled trial in Gujarat, India. Advances in Integrative Medicine, 2019; 6: 11–22.

13. Maqbool M, Gani I, Dar MA. Anti-Diabetic Effects of Some Medicinal Plants In Experimental Animals: A Review. Asian Journal of Pharmaceutical Research and Development, 2019; 7(1): 66-69.
14. Arul V, Miyazaki S, Dhananjayan R. Studies on the anti-inflammatory, antipyretic and analgesic properties of the leaves of *Aegle marmelos* Corr. Journal of Ethnopharmacology, 2005; 96(1-2): 159-163.
15. Sharma N, Dubey W. Bioactive Compounds Present In *Aegle marmelos* and Their Role In Medicinal Properties: A Review. International journal of pharma and bio sciences, 2016; 7(3): 170 –176.
16. Puthallath RE, Joseph L, Kademane K, Rao SN. Anticonvulsant activity of *Nigella sativa*, *Aegle marmelos* and *Benincasa hispida* in Pentylenetetrazole induced seizure in Swiss albino mice. Asian Journal of Medical Sciences, 2016; 7(3): 97-102.
17. Patel AR, Dipak G, Manodeep C, Jagdish KV. *Aegle marmelos* (L): A Therapeutic Boon For Human Health. International journal of research in ayurveda pharmacy, 2012; 3(2): 159-163.
18. Nugroho AE, Riyanto S, Sukari MA, Maeyama K. Effects of aegeline, a main alkaloid of *Aegle marmelos* Correa leaves, on the histamine release from mast cells. Pak J Pharm Sci., 2011a; 24(3): 359-367.
19. Nugroho AE, Riyanto S, Sukari MA, Maeyama K. Effects of skimmianine, a quinoline alkaloid of *Aegle marmelos* correa roots, on the histamine release from rat mast cells. Journal of Basic and Applied Sciences, 2010; 6(2).
20. Nugroho AE, Riyanto S, Sukari MA, Maeyama K. Anti-allergic effects of Marmin, a coumarine isolated from *Aegle marmelos* Correa: In vitro study. International Journal of Phytomedicine, 2011b; 3(1): 84.
21. Patkar AN, Nilesh DV, Akkatai RA, Kamlakar KS. 2012. A Review on *Aegle marmelos:* A Potential Medicinal Tree. International research journal of pharmacy, 2012; 3(8): 86-91.
22. Kothari S, Minda M, Tonpay SD. Anxiolytic and Antidepressant Activity of methanol extract of *Aegle marmelos* leaves in mice. Indian journal of physiology and pharmacology, 2010; 54(4): 318-328.
23. George M, Joseph L, Sreelakshmi R. Evaluation of Antidepressant and Antianxiety activity of Ethanolic leaf extract of *Aegle marmelos*. International Journal of Pharmaceutical Sciences Letters, 2016; 6(1): 12-14.

24. Sekar DK, Kumar G, Karthik L, Rao KB. A review on pharmacological and phytochemical properties of *Aegle marmelos* (L.) Corr. Serr. (Rutaceae). Asian Journal of Plant Science and Research, 2011; 1(2): 8-17.
25. Gupta AK, Verma S, Doshi N. Phytochemical Analysis and Antioxidant property of *Aegle marmelos* Extracts. International Journal of Current Microbiology and Applied Sciences, 2015; 4(9): 826-830.
26. Kumar S, Bodla RB, Bansal H. Antioxidant Activity of Leaf Extract of *Aegle marmelos* Correa ex Roxb. Pharmacognosy Journal, 2016; 8(5).
27. Modi H, Patel V, Patel K. Hepatoprotective activity of *Aegle marrmelos* against ethanol induced hepatotoxicity in rats. Asian J Pharm Clin Res., 2012; 5: 164-167.
28. Asha J, Krishan K. Tremendous Pharmacological Values of *Aegle marmelos*. International Journal of Pharmaceutical Sciences Review and Research, 2016; 36(2): 121-127.
29. Singh SK. *Aegle marmelos* protects hepatocytes from paracetamol induced hepatotoxicity. Indian Journal of Scientific Research, 2013; 4(1): 53.
30. Ramamurthy V, Gowri R. Hepatoprotective Study on *Aegle marmelos* Leaves Extract against *Staphylococcus aureus* Intoxicated Albino Rats. American Journal of Phytomedicine and Clinical Therapeutics, 2015; 3(2): 120-128.
31. Meena R, Pareek A, Meena RR. Antimicrobial activity of *Aegle marmelos* (Rutaceae) plant Extracts. International Journal of MediPharm Research, 2016; 2(1): 1-5.
32. Karumaran S, Nethaji S, Rajakumar R. Antimicrobial and antioxidant activity of leaf extracts of *Aegle marmelos*. Adv. Appl. Sci. Res., 2016; 7(3): 205-208.
33. Dahiya R, Tomar RS, Shrivastava V. Evaluation of Antimicrobial Potential of *Aegle Marmelos* Fruit Extract against Selected Microorganisms. J. Pharm. Sci. & Res., 2015; 7(9): 681-684.
34. Shankarananth V, Balakrishnan N, Suresh D, Sureshpandian G, Edwin E, Sheeja E. Analgesic activity of methanol extract of *Aegle marmelos* leaves. Fitoterapia, 2007; 78(3): 258-259.
35. Balakumar S, Rajan S, Thirunalasundari T, Jeeva S. Antifungal activity of *Aegle marmelos* (L.) Correa (Rutaceae) leaf extract on dermatophytes. Asian Pacific Journal of Tropical Biomedicine, 2016; 1(4): 309-312.
36. Raheja S, Girdhar A, Kamboj A., Lather V, Pandita D. *Aegle marmelos* leaf extract ameliorates the cognitive impairment and oxidative stress induced by intracerebro ventricular streptozotocin in male rats. Life sciences, 2016; 221: 196-203.

37. Ramakrishna YG, Savithri K, Kist M, Devaraj SN. *Aegle marmelos* fruit extract attenuates Helicobacter pylori Lipopolysaccharide induced oxidative stress in Sprague Dawley rats. BMC complementary and alternative medicine, 2015; 15(1): 375.
38. Singh P, Guha D. *Aegle marmelos* enhances gastric mucosal protection: relevance for NSAIDS-induced gastric mucosal injury. Al Ameen Journal of Medical Science, 2012; 5(3): 243-2255.
39. Sharma GN, Dubey SK, Sati N, Sanadya J. Ulcer healing potential of *Aegle marmelos* fruit seed. Asian J Pharm Life Sci., 2011; 1(2): 172-178.
40. Maity P, Hansda D, Bandyopadhyay U, Mishra DK. Biological activities of crude extracts and chemical constituents of Bael, *Aegle marmelos* (L.) Corr. Indian Journal of Experimental Biology, 2009; 47: 849-861.
41. Lampronti I, Martello D, Bianchi N, Borgatti M, Lambrtini E, Piva R, Jabbars S, Choudhuri MS, Khan MT, Gambari R. *In Vitro* antiproliferative effect on human tumor cell lines of extracts from the bangladesi medicinal plant *Aegle marmelos* Correa. Phytomedicine, 2003; 300-308.
42. Chockalingam V, Kadali SS, Gnanasambantham P. Antiproliferative and antioxidant activity of *Aegle marmelos* (Linn.) leaves in Dalton's Lymphoma Ascites transplanted mice. Indian journal of pharmacology, 2012; 44(2): 225–229.
43. Bhatti R, Singh J, Saxena AK, Suri N, Ishar MPS. Pharmacognostic standardisation and antiproliferative activity of *Aegle marmelos* (L.) Correa leaves in various human cancer cell lines. Indian journal of pharmaceutical sciences, 2013; 75(6): 628.
44. Gupta N, Agrawal RC, Sharma P, Narwariya A. Anticancer potential of *Aegle marmelos* bark extract against dmba induced skin papillomagenesis with reference to oxidative stress. European Journal of Pharmaceutical and Medical Research, 2016; 3(4): 309-314.
45. Choubey A, Choubey A, Mishra A, Mishra S, Patil UK. Evaluation of the immunomodulatory activity of the methanolic and ethanolic extract of leaves of *Aegle marmelos* in Rats. International Journal of Drug Development and Research, 2010; 2(4): 844-9.
46. Govinda HV, Asdaq SMB. Immunomodulatory potential of methanol extract of *Aegle marmelos* in animals. Indian journal of pharmaceutical sciences, 2011; 73(2): 235.
47. Sharma GN, Dubey SK, Sharma P, Sati N. Medicinal values of bael (*Aegle marmelos*) (L.) Corr.: A review. Int J Curr Pharm Rev Res., 2011; 2(1): 12-22.

48. Ramachandra Y, Ashajyothi C, Padmalatha R. Cardio protective effect of *Aegle marmelos* on isoproterenol induced myocardial infarction in rats. International journal of Biology. Pharmacy and Applied sciences, 2012; 1: 718-729.
49. Brijesh S, Daswani P, Tetali P, Antia N, Birdi T. Studies on the antidiarrhoeal activity of *Aegle marmelos* unripe fruit: validating its traditional usage. BMC complementary and alternative medicine, 2009; 9: 47.
50. Miranda D, Pereira L, Sirsat SM, Antarka DS, Vaidya AB. *In vitro* action of Dadima (*Punica granatum* Linn.) against microorganisms involved in human gastrointestinal infections-isolation and identification of tannins. Journal of Research in Ayurveda and Siddha, 1993; 14(3-4): 154-164.
51. Rao HJG, Lakshmi P. Evaluation of Antidiarrhoeal activity of extract from leaves of *Aegle marmelos*. Journal of Applied Pharmaceutical Science, 2012; 2(2): 75-78.
52. Joshi PV, Patil RH, Maheshwari VL. *In vitro* anti-diarrhoeal activity and toxicity profile of *Aegle marmelos* (fruit) Correa ex. Roxb Natural Product Radiance, 2009; 8: 498-502.
53. Veerappan A, Miyazaki S, Kadarkaraisamy M, Ranganathan D. Acute and subacute toxicity studies of Aegle marmelos Corr., an Indian medicinal plant. Phytomedicine, 2007; 14(2-3): 209-215.
54. Porchelvan V, Venkatakrishnamurali R. Effect of *Aegle marmelos* leaf extracts and whole leaf powder chronic administration in experimental animals. Asian Journal of Research in Biological and Pharmaceutical Sciences, 2014; 2(3): 133-143.
55. Wagh P, Deshmukh L, Thakur P. Study of Anthelmintic Activity of *Aegle Marmelos* Fruit Extract on Indian Earthworm Model. J of Pharmacol & Clin Res., 2017; 2(3): 1-3.
56. 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. Int. J. Curr. Pharm. Res., 2010; 2: 26-29.
57. Parichha S. Bael (*Aegle Marmelos*): Nature`s Most Natural Medicinal Fruit. Orissa Review, 2004.
58. Kar A. Choudhry BK, Bandhopadhyay NG. Comparative evaluation of hypoglycemic activity of some Indian medicinal plants in alloxan diabetic rats. J Ethnopharmacol, 2003; 84: 105-108.
59. Karunanayake EH, Welihinda J, Sirimanne SR, Sinnadorai G. Oral hypoglycemic activity of some medicinal plants of Sri Lanka. J Ethnopharmacol, 1984; 11: 223-231.

60. Rahman A, Said HM, Ahmad VU. Pakistan encyclopaedia planta medica. Hamdard foundation press, 1986.
61. Trivedi VP, Nesamany S, Sharma VK. Ayurvedic herbs: a clinical guide to the healing plants of traditional medicine. J. Res. Ind. Med. YOGA Homeopath, 1978; 28: 13.
62. Rahman A, Said HM, Ahmad VU. Pakistan encyclopaedia planta medica. Hamdard foundation press, 1986s.