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Review Article

Aegle Marmelos: A Review Paper

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ABSTRACT

Introduction:

Plants and their products are a major source for food and medicine that are highly beneficial for various animals and humans. This article focuses on complete profile of Aegle marmelos L. which belongs to the family Rutaceae, is commonly known as bael, widely available in several places in India.

Ethnobotany:

Traditional use of A. marmelos for various diseases includes abdominal disorders, ulcer, cholera, diarrhea, nerve disorders, gonorrhea, heart disorders, dog bite, jaundice, snake bite and many more. A number of biologically active compounds isolated from various parts of A. marmelos which belongs to various chemical groups.

Phytochemistry:

The isolated components belong to Alkaloids, Terpenoids, Vitamins, Coumarins, Tannins, Carbohydrates, Flavonoids, Fatty Acids, Essential Oils and some other miscellaneous compounds.

Pharmacological Activities:

The plant also possesses various pharmacological activities such as Antioxidant, Antibacterial, Antifungal, Antidiarrheal, Antidiabetic, Antiproliferative, Cytoprotective, Hepatoprotective, Antifertility, Analgesic, Antiarthritis, Contractile, Antihyperlipidemic, Cardioprotective, Radioprotective, Anticancer, Antiviral, Anti-ulcer, Immunomodulatory and Wound Healing properties.

Conclusion:

Hence this review can be a good reference for researchers who are willing to undertake further investigation about A. marmelos.

INTRODUCTION

The journey of life for birds, animals and humans had started with utilization of plants or plant parts as food. Various plant parts like root, steam, leaf, flower and fruits are used by animal kingdom for survival of their lives. Humans are considered as

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most developed among all living species on earth. They are adopting plants not only as an origin of food but also to delight various ailments of mankind since ancient age. Several plants or plant parts are used to heal a number of physical and mental disturbances and helps us to with¬stand successfully. Ancient literature such as Rigveda, Yajurveda, Atharvaveda, Charak Samhita and Sushrut Samhita also describes the use of plants for the treat¬ment of various health problems (Balunas MJ, Kinghorn AD et al, 2005). The use of herbal or alternative system of medicine is increasing day by day because of its safety (Miller Lucinda G et al, 2005). All culture has long folk medicine histories that include the use of plants. Egyptian, Indian and Chinese traditional system are considered as oldest system of medicine (Sardana S et al, 2009). Aegle Marmelos belonging to family Rutaceae, is commonly known as Beal in indigenous system of medicine and has been regarded to possess various medicinal properties. The Beal is one of the sacred tree of the hindus. Leaves are offered in prayer to shiva and Parvathi since ancient time (Rajasekaran C et al, 2008). Bael is a much-known plant for the people of any part of India, as it is related to the Hindu Religious. It is believed that the bael fruit is the symbol of lord Shiva and its leaf is top of the demand in the season of 'Sawan'. The bael tree is mostly seen near the temple and other Hindu homes. The utility of bael is mention in the Indian ancient system of medicine, every part of the bael tree such as root, bark, leaf, flower, fruits, seed and even its latex are also important in several traditional system of medicine, that's why it is one of the most important plant in the India (Maity Pallab et al, 2009). The Bael tree acts as an indicator plant to trace the underground water. All the parts of the plant i.e. root leaf, trunk, seed and fruits carry various medicinal properties and are used to treat variety of diseases. The fruit of this plant is edible and is mostly used for medicinal purposes as it is a rich source of vitamins, minerals and antioxidants (Ghosh S et al, 1 Oct 2020). It also acts as a Climate Purifier that absorbs the poisonous gases from the atmosphere and making them inactive or neutral (Agarwal VS et al, 1997). The plant is associated with various bioactive compounds. The main active phytochemical constituents isolated from the fruit part of the plant include marmelosin (helps in curing stomach diseases), psoralen, luvangetin, tannins and marmin (Pandirao SS et al, 2020) (Mali SS et al, 2020). In Ayurveda, all the parts are used in the form of 'Panchang' to cure diseases like diarrhea, dysentery and ulcer. The plant is also used to cure diseases like asthma, fractures, anemia and swollen joints, wound healing, diabetes, high BP, jaundice, diarrhea, brain typhoid troubles during pregnancy, stomachache, cancer, malaria and gastroduodenal disorders (Seca Am et al, 11 JUN 2014) (Badam L et al, 2002) (Takase H et al, 1994) (Goel RK et al, 1 OCT 1997). Besides this, the plant extracts are associated with pharmacological properties like anti-diabetic, antiulcer, antioxidant, anti-hyperlipidaemic, anticancer, antipyretic, radio protective, analgesic, anti-inflammatory and anti-spermatogenic (Rastogi RP et al, 1991) (Pitre S et al, 1 Jul 1988) (Jain NK et al, 1977) (Banerjee AK et al, 1983) (Prakhar B et al, 22 FEB 2021).

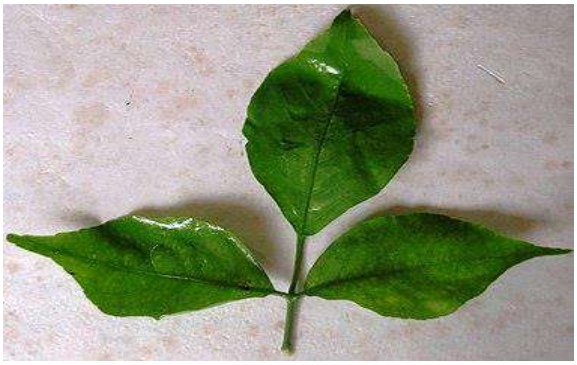

Fig.no. 1 Aegle marmelos Leaves

Fig.no. 2 Aegle marmelos Fruits

Fig.no.3 Aegle marmelos Flower

TAXONOMINAL CLASSIFICATION

Taxonomical Rank	Taxon
Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Order	Sapindales
Family	Rutaceae
Sub-family	Aurantioideae
Genus	Aegle
Species	A.marmelos
Common name	Bael Patra, Bael

VERNACULAR NAMES OF AEGLE MARMELOS

Tamil	Vilva marum
English	Golden apple, Bael fruit, Indian Bael, Holy fruit, Indian quince, Elephant apple, Stone apple
Himachal Pradesh	Bil
Bengal	Beal
Karnataka	Bilpatra, kumbala, malura
Andhra Pradesh	Maredu
Kerala	Kuvalum
Assamese, Marathi	Bel
Gujrati	Bilivaohal, Bili
Malayalam	Marredy
Oriya	Belo
Urdu	Bel, Bel kham
Telugu	Bilva pondu
Burmese	Opesheet, ohshit
French	Bel indien, cognassier du, Bengale, orange du Malab
German	Belbaum, Schleimapfelbaum, Baelbaum
Portuguese	Marmelo

BOTANICAL DESCRIPTION

A. marmelos belongs to the family Rutaceae. It is a slow growing medium to small size tree contains about 25 to 30 feet in height. The steam is soft, thick, a few spiny branches.7 The full botanical description of A. marmelos is given in Table.

Plant Part and Morphological characteristics:

Bark

The bark is pale brown or grayish, smooth or finely fissured and flaking, armed with long straight spines, 1.2–2.5 centimetres (1⁄2–1 inch) singly or in pairs, often with slimy sap oozing out from cut parts. The gum is also described as a clear, gummy sap, resembling gum arabic, which exudes from wounded branches and hangs down in long strands, becoming gradually solid. It is sweet at first taste and then irritating to the throat (Orwa, C et al, 2009).

Leaves

The leaf is trifoliate, alternate, each leaflet 5–14 cm (2–5+1⁄2 in) x 2–6 cm (3⁄4–2+1⁄4 in), ovate with tapering or pointed tip and rounded base, untoothed or with shallow rounded teeth. Young leaves are pale green or pinkish, finely hairy while mature leaves are dark green and completely

smooth. Each leaf has 4–12 pairs of side veins which are joined at the margin.

Flowers

The flowers are 1.5 to 2 cm, pale green or yellowish, sweetly scented, bisexual, in short drooping unbranched clusters at the end of twigs and leaf axils. They usually appear with young leaves. The calyx is flat with 4(5) small teeth. The four or five petals of 6–8 millimetres (1⁄4–3⁄8 in) overlap in the bud. Many stamens have short filaments and pale brown, short style anthers. The ovary is bright green with an inconspicuous disc.

Fruits

The fruit typically has a diameter of between 5 and 10 cm (2 and 4 in). It is globose or slightly pear-shaped with a thick, hard rind and does not split upon ripening. The woody shell is smooth and green, gray until it is fully ripe when it turns yellow. Inside are 8 to 15 or 20 sections filled with aromatic orange pulp, each section with 6 (8) to 10 (15) flattened-oblong seeds each about 1 cm long, bearing woolly hairs and each enclosed in a sac of adhesive, transparent mucilage that solidifies on drying. The exact number of seeds varies in different publications. The fruit takes about 11 months to ripen on the tree, reaching maturity in December (The Complete Guide to Edible Wild Plants. United States Department of the Army. New York: Skyhorse Publishing. 2009). It can reach the size of large grapefruit or pomelo, and some are even larger. The shell is so hard it must be cracked with a hammer or machete. The fibrous yellow pulp is very aromatic. It has been described as tasting of marmalade and smelling of roses. Boning (2006) indicates that the flavor is "sweet, aromatic and pleasant, although tangy and slightly astringent in some varieties. It resembles a marmalade made, in part, with citrus and, in part, with tamarind."Numerous hairy seeds are encapsulated in a slimy mucilage (Boning et al, Charles 2006).

ETHANOBOTANICAL INFORMATION

Plant parts	Ethnobotanical uses
Leaf	Abscess, backache, eye complaints, abdominal disorders, vomiting, cut & wounds, ulcer, dropsy, beriberi, weakness of heart, cholera, diarrhoea, cardio tonic, blood sugar, injuries caused by animals, nervous disorders, hair tonic, acute bronchitis, child birth (Anonymous et al, Kritikar KR et al, Jain et al, Gaur RD et al, Veerappan AK et al and George KV et al). Veterinary medicine for wounds, killing worms, fodder for sheep, goat and cattle, stimulation of respiration and contraction of denervosed nictitating membrane in anaesthetised cats [Anonymous et al, Gaur RD et al, Anonymous et al, (www.uclm.es/inabis2000/posters/files/133/index.htm)].
Fruit	Astringent, diarrhoea, gastric troubles, constipation, laxative, tonic, digestive, stomachic, dysentery, brain & heart tonic, ulcer, antiviral, intestinal parasites, gonorrhoea, epilepsy (Anonymous et al, Jain et al, Grieve M et al, Gaur RD et al and Veerappan AK et al). Toys, edible, jam, preserve (Parmar C et al, Gaur RD et al and Kaushik P et al).
Root	Dog bite, gastric troubles, heart disorders, intermittent fevers, antiamoebic, hypoglycaemic, rheumatism (Kritikar KR et al and Veerappan AK et al).
Bark	Stomach disorder, intermittent fevers, heart disorder (Veerappan AK et al and George KV et al).
Seed	Febrifuge (Anonymous et al).
Flower	Expectorant, epilepsy (Jain et al and Grieve M et al).
Whole plant	Abdominal pain, abscess, astringent, backache, dog bite, breast pain, cholera, constipation, convulsions, cramp, diabetes, diarrhoea, dysentery, fever, eye complaints, gastric trouble, abdominal disorders, jaundice, laxative, nausea, night fever, heart disorders, snakebite, stomach disorder, vomiting, tonic, cut & wounds

	(Anonymous et al, Bailey LH et al, Kritikar KR et al, Gaur RD et al, Veerappan AK et al and George KV et al).
Root, Bark	Fish poison (Gaur RD et al).
Seed mucilage	Plaster for walls (www.uclm.es/inabis2000/posters/files/133/index.htm).
Seed oil	Laxative (Grieve M et al).
Wood	Beads worn by low caste, special couches for rheumatic patients (Parmar C et al, Kaushik P et al and [www.uclm.es/inabis2000/posters/files/133/index.htm]).
Gum around seed	To improve adhesive strength of water paints (www.uclm.es/inabis2000/posters/files/133/index.htm).
Unripe fruit rind, Bark	Yellow dye (Kaushik P et al and [www.uclm.es/inabis2000/posters/files/133/index.htm]).
Stem	Pestles of oil and sugar mills (Kaushik P et al and Gaur RD et al).

PHYTOCHEMICAL CONSTITUENTS OF AEGLE MARMELOS

The chemical constituents isolated from the different parts of the plant are described below.

Fruit

The fruit part contains bioactive compounds, carbohydrates, minerals, vitamins, coumarins, phenolic acids alkaloids, flavonoids, organic acids, volatile compounds and fatty acids. Aegle marmelos plant is a rich source of various nutrients including carbohydrates (31.80 g/100 g) fibers (2.90 g/100 g), minerals (1.70 g/100 g), fats (0.39 g/100 g) and vitamins such as Vitamin A (0.05 mg/100 g), vitamin B2 (1.20 mg/100 g), Vitamin C (8.0 mg/100 g), riboflavin (0.03 mg/100 g), thiamine (0.13 mg/100 g) and beta-carotene (55.0 mg/100 g) Parichha S et al.

Coumarins

Coumarins extracted from the fruit part of the plant include 6-(2- hydroxy-3-hydroxymethyl-3-butenyl)-7-hydroxycoumarin, 6-formylumbilliferone, 6-(4-acetoxy-3-methyl-2-butenyl)-7- hydroxyl coumarin, 8 hydroxysmyrindiol, 8-[(3-methyl-2-oxo-3- buten-1-yl)oxy]-7H-furo[3,2-g]benzopyran-2-one, isofraxidin, isogosferol, alloimperatorin, decursinol, demethylsuberosin, marmelosin, isophellodenol C, psoralen, marmelonine, umbelliferone, scoparone, scopoletin,

Carbohydrates

xanthotoxin, xanthoarnol and xanthotoxol (Chakthong S et al, Sharma BR et al, Sharma BR et al, Chatterjee A et al, Pynam H et al, Shinde PB et al).

Phenolic acids and Flavonoids

Phenolic acids and flavonoids extracted from the fruit part include ellagic acid, quercetin, chlorogenic acid, gallic acid, ferulic acid, and kaempferol and protocatechuic acid (Bhattacherjee AK et al).

Alkaloids

Alkaloids isolated from the fruit part include aegelenine, aegelin, marmeline, marmesiline, O-(3,3-dimethylallyl) halofordinol and O-methylhalfordinol (Dhalwal K et al).

Volatile compounds

It includes 1,8-cineole, 3,5-octadiene-2-one, acetoin, (E)-2- octenal, €-6,10-dimethyl-5,9-undecadien-2-one, (E, E)-2-4- hepadoenal, carvone, citral, carvyl acetate, citronellal, caryophyllene oxide, dehydro-p-cymene, eugenol, hexanal, hexadecane, beta-ionone, humulene oxide, linalool oxide, limonene, p-cymene, verbenone, trans-p-mentha-2,8-dienol, alpha-humulene, beta-cubebene, beta-phellandrene and isoamyl acetate (Prakash D et al).

Organic acids

Malic acid, tartaric acid and oxalic acid.

Vitamins

Arabinose, fructose, galactose, sucrose and glucose.

Riboflavin and ascorbic acid (Rastogi RP et al).

Leaves

The chemical constituents extracted from the leaf part include coumarins (mermenol and praeltin), O-(3,3-dimthylally) halofordinol, N-4-methoxystyryl cinnamide, N-2-methoxy-2- [4-(3',3'-dimethyl allyloxy) phenyl] ethyl cinnamide.

Bark

Coumarins include aegelinol, mermesin, marmesin and umbelliferone and alkaloids include skimmianine, gammafagarine (Chatterjee A et al, Goswami S et al, Chatterjee A et al, Chatterjee A et al, Chatterjee A et al, Mookerjee A et al).

Root

The chemical constituent isolated from root parts include alkaloids which include disctamine, haplopine, tembamide, gamma-fagarine and tembamide and coumarins include aegelinol, marmesin, marmin, scopoletin, umbelliferone, xanthotoxin (Basu D et al, Shoeb A et al, Farooq S et al).

PHARMACOLOGICAL ACTIVITIES

The leaves of Aegle marmelos are made into poultice, used in the treatment of ophthalmia, and the freash juice is praised in catarrhs and feverishness. The fresh juice of leaves is given, with addition of black pepper, in anasarca with costiveness and jaundice. In external inflammations, the juice of the leaves is given internally to remove the supposed derangement of tumours Kirtikar K.R et al. Broadly the biological activity of the plant can be categorized as follows

1.	Hypoglycaemic Activity	Phuwapraisirisan et al. reported a series of phenylethyl cinnamides, where anhydroaegeline revealed the most potent inhibitory effect against α-glucosidase with IC50 value of 35.8 µM. Sabu et al. examined the action of Aegle marmelos against experimental diabetes as well as the antioxidant potential of the drug. Aegle marmelos extract effectively reduced the oxidative stress induced by alloxan and produced a reduction in blood sugar. Upadhya et al. found the hypoglycemic and antioxidant activity of aqueous extract of Aegle marmelos leaves by analyzing the glucose, urea & GST (glutathione-S-transferase) levels in plasma and GSH (glutathione) and MDA (malondialdehyde) levels in erythrocytes of alloxan induced diabetic rats. Sachdewa et al. tested the hypoglycemic effect of Aegle marmelos and Hibiscus rosa sinensis in glucose induced hyperglycemic rats. Aegle marmelos leaf extract for 7 consecutive days, @ 250 mg/kg oral dose showed the significant improvements in its ability to utilize the external glucose load. Average blood glucose lowering caused by Aegle marmelos was 67% (percent) and the efficacy of Aegle marmelos was 71% of glibenclamide. Hema et al. studied the effect of the aqueous, alcoholic and petroleum ether extracts of A. marmelos for the hypoglycaemic and other pharmacological actions and observed that the aqueous and alcoholic extracts at 500 mg/kg dose produce hypoglycaemia in normal fasted rabbits, but the petroleum ether extract did not. In a clinical trial, a branded formulation having leaves of Aegle marmelos as one of the constituents was found effective in mild to moderate diabetic patients, which included even the insulin dependent ones. The treatment, reportedly, tends to increase insulin secretion from pancreas Singh B., (1997). Das et al. studied the effect of leaf of Aegle marmelos on histological and ultrastructural changes in tissues of streptozotocin induced diabetic rats. The treatment of leaf extract on diabetic pancreas showed improved functional state of pancreatic beta cells. This study indicates the hypoglycemic nature of the leaf extract, helping in regeneration of damaged pancreas. Seema et al. investigated the potential of the leaf extract of Aegle marmelos as an anti-diabetic agent on the liver of streptozotocindiabetic rats. The leaf extract of Aegle marmelos was found to be as effective as insulin in

		restoring of blood glucose and body weight to normal levels. Rao et al. reported that aqueous extract of leaves given in the dose equivalent to 1 gm powder/kg/day produced significant ($p<0.01$) anti-hyperglycemic effect within three days in alloxan induced diabetic rabbits while similar treatment in normal rabbits produced decrease upto 35.3% in blood glucose level after 4 hours of administration. Moderate hypoglyceamic effect was recorded even after 12 hours. Ponnachan et al. the potential antidiabetic effect of Aegle marmelos leaf extract in diabetic rats. The diabetic animals were given insulin injection and another group Aegle marmelos leaf extract orally. This study indicated that the active principle in Aegle marmelos leaf extract has similar hypoglycemic activity to insulin treatment
2.	Antimicrobial Activity	Rani et al. studied the 54 plant extracts (methanol and aqueous) for their activity against muti-drug resistant Salmonella typhi. The methanol extracts of Aegle marmelos, Salmalia malabarica, Punica granatum, Myristica fragrans, Holarrhena antidysenterica, Terminelia arjuna and Triphala showed strong antimicrobial activity. The antifungal activity of essential oil isolated from the leaves ALTERNATIVE MEDICINE / NUTRACEUTICALSTPR THE PHARMA REVIEW n NOV - DEC 2009 147 of Aegle marmelos was studied using the spore germination assay. Rana B.K et al. The oil exhibit variable efficacy against different fungal isolates and 100% inhibition of spore germination of all the fungi, the most resistant fungus, Fusarium udum was inhibited 80% at 400 ppm. Kinetic studies showed concentration as well as time dependent complex inhibition of spore germination by the essential oil. Pattnaik et al studied the essential oils of Aegle marmelos and some other plants for antibacterial activity against 22 bacteria (including Gram positive cocci and Gram-negative rods) and 12 fungi (3 yeast like and 9 filamentous) by the disc diffusion method. Aegle marmelos essential oil inhibited the 21 bacteria and all 12 fungi.
3.	Anti-Inflammatory Activity	Arul et al. studied the leaves of Aegle marmelos possess the anti-inflammatory, antipyretic and analgesic properties. The extract of leaves of Aegle marmelos caused a significant inhibition of the carrageenan-induced paw oedema and cottonpellet granuloma in rats. Jagtap et al. showed the effect of polyherbal formulation (of Aegle marmelos & some other plants) on experimental models of inflammatory bowel diseases (IBD).
4.	Radioprotective Activity	The radioprotective activity of a leaf extract of Aegle marmelos (AM) in mice exposed to different doses of gamma-radiation was investigated. Jagetia G.C et al. AM treatment reduced the symptoms of radiationinduced sickness and increased survival. The radioprotective action might be due to free-radical scavenging and arrest of lipid peroxidation accompanied by an elevation in glutathione.
5.	Anti-Oxidative Activity	Rajadurai et al. reported that pretreatment with Aegle marmelos leaf extract at doses of 100mg/kg and 200mg/kg body weight for 35 days showed a significant effect on the activities of marker enzymes, lipid peroxides, lipids, lipoproteins and antioxidant enzymes in isoproterenol treated rats. The effect of extract 200mg/kg was found to be equal to the effect of alpha-tocopherol 60mg/kg.
6.	Anti-Cancer Activity	Costa-Lotufo et al. studied the anticancer potential of 11 plants used in Bangladeshi folk medicine and found among all tested extracts, only the extracts of Oroxylum indicum, Moringa oleifera and Aegle marmelos showed potential anticancer cactivity. It was also reported that Aegle marmelos (L.) inhibits the proliferation of transplanted Ehrlich ascites carcinoma in mice. The anticancer effect of hydroalcoholic extract of Aegle marmelos (AM) was studied in the Ehrlich ascites carcinoma bearing Swiss albino mice. The spatial effect of

		various AM administration schedules showed that six-day administration increased the survival of tumor bearing mice. The best antineoplastic action of AM was obtained when AM administered through intraperitoneal route than the oral route at equimolar dose. Dose of 400 mg/kg was considered as the best dose Jagetia G.C et al. Lambertini et al. studied the effects of extracts from Bangladeshi medicinal plants on in-vitro proliferation of human breast cancer cell lines and expression of estrogen receptor alpha gene, according to this study extract from Aegle marmelos is antiproliferative on both cell line MCF7 and MDA-MB-231cells, but at a higher concentration.
7.	Chemo preventive Potential	The effect of hydroalcoholic (80% ethanol, 20% water) extract of leaves of Aegle marmelos on carcinogen-metabolizing phaseI and phase-II enzymes, antioxidant enzymes, glutathione content, lactate dehydrogenase and lipid peroxidation were studied. The changes in the levels of drug-metabolizing enzymes and antioxidative profiles are strongly indicative of the chemopreventive potential of this plant, especially against chemical carcinogenesis Singh R.P et al.
8.	Role in Heart Diseases	Prince et al. evaluated the preventive effects of an aqueous Aegle marmelos leaf extract (AMLEt) in isoprenaline (isoproterenol)- induced myocardial infarction in rats. Pretreatment with AMLEt decreased the activity of creatine kinase (CK) and lactate dehydrogenase (LDH) in serum and increased them in the heart, also AMLEt pretreatment increased the activity of Na+K+ ATPase and decreased the activity of Ca2+ATPase in the heart and aorta simultaneously and the levels of cholesterol and triglycerides decreased whereas phospholipids increased in heart and aorta of AMLEt-pretreated rats. All the deranged biochemical parameters were restored with 200 mg kg-1 AMLEt. Hema et al. studied the effect of the aqueous, alcoholic and petroleum ether extracts of A. marmelos for the hypoglycaemic and other pharmacological actions and observed that the aqueous extract acts as a cardiac stimulant, smooth-muscle relaxant and uterine stimulant while the alcoholic extract revealed cardiac depressant, smooth muscle relaxant and uterine relaxant properties.
9.	Effect on Testicular Activities	The aqueous extract of leaves of Aegle marmelos (Bael) at the dose 50 mg/100 g body weight in rats resulted a significant diminution in the activities of key testicular steroidogenic enzymes along with low levels of plasma testosterone and relative wet weights of sex organs in respect to control without any significant alteration in general body growth. Germ cells numbers in different generation at stage VII of seminiferous epithelial cell cycle were diminished significantly after the treatment of the above extract. The above-mentioned dose did not exhibit any toxicity in liver and kidney. Therefore, it may be predicted that the aqueous extract of leaf of Aegle marmelos has a potent antitesticular effect at a specific dose Das U.K et al.
10. .	Acute and Subacute Toxicity studies	Total alcoholic, total aqueous, whole aqueous and methanolic extracts of leaves of A. marmelos were used for the toxicity studies. Acute, subacute and LD50 values were determined in experimental rats. There were no remarkable changes noticed in the histopathological studies after 50mg/kg body wt of the extracts of A. marmelos when administered intraperitoneally for 14 days successively. Pathologically, neither gross abnormalities nor histopathological changes were observed. After calculation of LD50 values using graphical methods, researcher found a broad therapeutic window and a high therapeutic index value for A. marmelos extracts Veerappan A et al.

CONCLUSION

Several parts of A. marmelos have been reported as various traditional healers for treating various

ailments of mankind. These contains Anti¬oxidant, Antibacterial, Antifungal, Antidiarrheal, Antidiabetic, Antiproliferative, Cytoprotective, Hepatoprotective, Antifertility, Analgesic, Antiarthritis, Contractile, Antihyperlipidemic, Cardioprotective, Radio¬protective, Anticancer, Antiviral, Anti-ulcer, Immunomodulatory and Wound Healing properties. A number of biologically active compounds isolated from various parts of A. marmelos which belongs to various chemical groups. The isolated components belong to Alkaloids, Terpenoids, Vitamins, Coumarins, Tannins, Carbohydrates, Flavonoids, Fatty Acids, Essential Oils and some other miscellaneous compounds. This review mainly focused on several phytochemical and pharmacological studies which have explained phytoconstituents and therapeutic potential of A. marmelos.

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