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A Scientific Review on Aegle Marmelos : A Multiefective Medicinal Tree for Holistic Healing

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Abstract: *This review article is focused to explore the different pharmacological activity of Aegle marmelos. Aegle marmelos is one of the most important plants in the medicinal field, with different medicinal properties, belonging to the family Rutaceae. The Aegle marmelos is also known as Bael, a wooden apple and bilva plant. It contains various bioactive components in leaves, fruits, flowers, wood, root, and bark which have different biological activities and high therapeutic importance. Uses of bael in day to day life has great nutritional, environmental and commercial importance. This review article aims to complete the study of biological activities, insecticidal properties and phytochemistry of the Aegle marmelos plant.*

Keywords: Bael (Aegle marmalos), medicinal plant , astringent , pythochemicals , Traditional medicine.

I. INTRODUCTION

Bael plant is one of the important plants in the medicinal field.The bael is one of the sacred trees of the Hindus. Leaves are offered in prayers to Shiva and Parvathi since ancient times.It is also known as Shivadurme, the tree of Shiva. The tree belongs to Kingdom: Plantae, Order: Sapindales, Family: Rutaceae, Subfamily: Aurantioideae, Genus: Aegle, Species:Aegle marmelos[1].It is important in traditional medicine, especially in Ayurveda, where it is used for many health benefits, including treating diarrhea.The fruit, leaves, and roots of Aegle marmelos contain various natural chemicals, like tannins and flavonoids,alkaloids, saponins, terpenoids, steroids, phenols, cardiovascular glycosides that help with health issues.It extensively planted near Hindu temples for its leaves and wood which are used for worship, and for its edible fruits which are valued in indigenous medicine[2].Aegle marmelos is used to prepare different traditional medicines for treatment of various diseases like respiratory tract infections, tumors, nausea, smallpox, mental illness, eye disorders, bronchitis, leprosy, asthma, abdominal problems, fever, inflammation, burning sensation, diarrhea, jaundice, constipation, acute bronchitis, snakebite, acidity, leucoderma, thyroid disorders, burning sensation, epilepsy, spermatorrhoea etc [3].

Traditionally, bael has been used to alleviate digestive ailments, with its astringent properties helping to reduce stool frequency and severity. Recent scientific studies have begun to validate these traditional uses, highlighting the plant's potential as an effective, .natural alternative to conventional anti-diarrheal medications[4].This introduction will explore the historical significance, phytochemical composition, and emerging research surrounding Aegle marmelos, underscoring its promise as a natural remedy for managing diarrhea and promoting gastrointestinal health.Traditionally, unripe bael fruit is especially prized for its ability to manage diarrhoea. In Ayurvedic and other traditional systems of medicine, it is often recommended to treat both acute and chronic diarrhoea, dysentery, and irritable bowel syndrome (IBS). The dried or powdered form of the fruit pulp is commonly used in herbal formulations for these conditions[5].The pulp of the bael fruit is often made into drinks or remedies to help with digestive problems. Its astringent properties can help reduce how often and severely someone experiences diarrhea, making it a useful natural treatment. Bael fruits and leaves are used to treat dysentery, dyspepsia, mal-absorption, neurological diseases, edema, vomiting, and rheumatism .

In addition to the essential medicinal values, bael is reported as an important item in industrial food processing and an excellent source for extracting pharmaceuticals and many other economically important herbal compounds.

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Unfortunately, bael is still considered and underutilized tree fruit species in South Asian countries, and its real economic potentials have not been exploited[6].The Aegle marmelos is a little variety of three species circulated in tropical Asia and Africa. Thetree of A. marmelos starts from Eastern Ghats and focal India and tracked down for the most part in lower regions of Himalayas, Uttar Pradesh,Madhya Pradesh, Rajasthan, Chhattisgarh and Bihar[7].In India countless things are prepared from bael normal items, for instance, bael sherbet, murabba or syrups. In various countries, for instance, Indonesia and Thailand prepared bael results of the dirt cut pieces are gobbled up as food and syrups are used in making cake ingredients. The treatment of bael natural items moreover produce many waste materials like seeds, fibers, strip, etc[8].This introduction looks at the natural chemicals in Aegle marmelos, how it has been used traditionally. In the modern era, Aegle marmelos continues to gain attention for its potential in pharmaceutical development and alternative medicine,embodying a holistic approach to healing that integrates physical, mental, and spiritual well-being[9].

Figure : Aegle marmelos fruit and triplet leaves(72)

Scientific classification and vernacular names of aegle marmelos in india :

Table No. 1 :Plant Profile : -[10]

Kingdom	Plantae
Super-Division	Spermatophyta
Division	Magnoliophyta
class	Magnoliopsida
Sub-Class	Rosidae
Order	Sapindales
Family	Rutaceae
Genus	Aegle
Species	Marmelos

• Vernacular Names:[11]

English: Bengal quince, Bael fruit, Golden apple, Indian quince, Stone apple. Tamil: Aluvigam , Lyalbudi, Kuvilam, Muvilangai, Vilwam, Villuvam.

Telugu: Bilvamu, Maluramu, Maredu, Sailushamu, sandiliyamu. Hindi: Bel, Bili, Sirphal, and Bela.

Sanskrit: Adhararutha, Asholam, Atimangaliya, Bilva.

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Bengal: Bael, Bel. Gujarat: Billi.
Kannada: Bela, Bilva. Malayalam: Koovalam, Vilwam. Orissa: Belo.

Table No.2 : Different name of Aegle marmelos:[11]

Language	Name
Latin	Aegle marmelos
English	Wood/Stone apple, Bengal Quince, Indian Quince
Vietnamese	Mbau Nau, Trai Mam
Nepali	Bel, Gudu
Lao (Sino-Tibetan)	Toum
Khmer	Bnau
Javanese	Modjo
French	Oranger du Malabar
Burmese	Ohshit, opesheet
Indonesian	Mojo tree
Marathi	Kaveeth
Urdu	Bel
Thailand	Maplin,Matum,Tum
Orissa	Belo

Parts of plants :(13)

The bael plant is highly regarded in traditional medicine, and each of its parts serves different purposes. These plant has several important parts, each with its own significance:(14)

1. Bark
2. Leaf
3. Flower
4. Fruit
5. Seeds

Bark:

Fig. Bark of Aegle marmeloes.[14]

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The bark is pale brown or grayish, smooth or finely fissured and flaking, armed with long straight spines, 1.2–2.5 cm 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.

Leaf :

Fig. Leaves of Aegle marmelos.[13]

Bael leaves are trifoliate, alternate, each leaflet 5-14 x 2–6 cm, 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.

Fruit:

Fig. Fruit of Aegle marmelos.[14]

The fruit is spherical, and typically has a diameter of between 5 and 12 cm. 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) flattenedoblong seeds each about 1 cm long, bearing woolly hairs and each enclosed in a sac of adhesive, transparent mucilage that solidifies on drying.

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Seeds:

Fig. Seeds of Aegle marmelos.[15]

The bael seeds embedded in the pulp of the fruit. They are small,flat,and oval-shaped. seeds numerous, oblong, compressed, embedded in sacs covered with thick, orange coloured sweet pulp root bark is 3 to 5 cm thick covered, with creamy yellowish surface.(15)

Flower:

Fig. Flower of Aegle marmelos.[72]

The flowers of the bael tree are small (1.5 to 2 cm), pale green or yellowish,and have a pleasant fragrance. 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 mm overlap in the bud.

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Roots:

Fig. Root of Aegle marmelos.[72]

The roots are woody and brownish, often used in powdered or dried form in traditional medicine. They act as a febrifuge.

PHYTOCHEMICALCONSTITUENT:

Various chemical constituents were found in bael like alkaloids, coumarins, steroids, polysaccharides, tannins, carotenoids etc. A. marmelos is contains various active phytoconstituents mainly marmenol, marmin, marmelosin, marmalade, psoralen, isoimperatorin, rutaretin, scopoletin, aegelin, marmelin, fagarine, anhydromarmelin, limonene, â-phellandrene, betulinic acid, marmesin, imperatorin, marmelosin, luvangentin andauraptene.(16)

The leaf of bael contains Skimmianine, Aeglin, Rutin, -sitosterol, -sitosterol, Flavone, Lupeol, Cineol, Citral, Glycoside, O-isopentenyl, Hallordiol, Mameline, Citronellal, Cuuminaldehyde phenylethyle cinnamamides, Eugenol and the fruit contain Psoralen, Marmalade, Tannin, Phenol, Marmelosin, Luvangetin, Aurapten, Tannin, Phenol, Tannin, Tannin, Tannin, Tannin, Tannin, Tannin, Tannin. The seed of bael contain D-limonene, A-D- phellandrene, Cineol, Citronellal, Citral, P-cymene, Cumin aldehyde are essential oils.and bark contain Alkaloids, Fagarine, Marmin, Furoquinoline and root contain Terpenes, Halopine, Coumarins, and Alkaloid.(17)

The pulp of the bael fruit is rich in bioactive substance such as carotenoids,phenolics, alkaloids, pectins, tannins, coumarins, flavonoids, and terpenoids, according to studies. Methanol and water are the best solvent for extracting the metabolites of this plant, followed by ethanol.(18-21) The phythochemistry of A. marmelos has been extensively studied, and the plant has been found to contain a variety of biologically active compounds.some of the key phytochemicals found in A. marmelos include:Alkaloids,are nitrogen-containing compounds that are found in many plants and are known for their pharmacological activity. Several alkaloids have been identified in the leaves and roots of A. marmelos, including marmesin,marmelosin,and aegeline.(22)

Table No.3: Neutritional value of bael fruit(% or per 100g)(23)

Components	Value (%)	Components	Value (%)
Water (moisture)	64.2	Potassium	0.6
Protein	1.8	Iron	0.3
Fat	0.2	Vitamin A (IU)	186
Mineral	1.5	Vitamin B1	0.01
Fiber	2.2	Nicotinic acid	0.9
Carbohydrate	30.6	Riboflavin	1.2
Calcium	0.09	Vitamin C	0.01
Phosphorus	0.05	Calorific value	129

• Key Phytochemical Constituents:

Alkaloids:The alkaloids comprise the largest single class of secondary plant substances. New alkaloids from the leaves of Aegle marmelos were reported viz., ethyl cinnamamide, O-3,3-(di methylallyl) halfordinol, N-2-methoxy-2-[4-

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(3',3'-dimethylallyloxy) phenyl] ethyl cinnamamide(24,25) , Aegelenine, Aegeline, Aegelinosides , A Aegelinosides B Dictamine.chem(26,27)

Terpenoids: The essential oil of Aegle marmelos (L.) Correa leaves were studied very much extensively in India by various workers since 1950. α-Phellandrene was found to be the common constituent of the essential oil from leaves, twigs and fruits.α- Phellandrene (56%) and p-cymene (17%) were reported from leaf oil. Later, similar report was published on leaf essential oil by many workers. P-Menth-1-en-3,5-diol was isolated and characterized from Aegle marmelos leaves. Limonene (82.4%) was reported as the main constituent from Aegle marmelos leaves and it was shown that limonene is characteristic marker for identification of Aegle marmelos oil samples.(24,28) other chemical compound contain Caryophyllene, Cineol, Cubedol, Elemol, Epi-cubebal Hexanyl Hexanoate, Humulene Isosylvestrene Limonene, Linalool, Myrcene, Methyl perilate, Valencene.(29,30)

Flavonoids:Flavonoids are a group of compounds that are widely distributed in the plant kingdom and are known for their anti, anti-cancer,and antioxidant activities.(Flavonoids have been identified in the leaves and roots of A. marmelos, and some of these compounds have been shown to have antinociceptive(pain relieving) and antipyretic (fever reducing) activities. Mainly includes Rutin, Flavone-3-ols, Flavones, glycosides.(31,33)

Tannins :Tannins are a group of compounds that are widely distributed in the plant kingdom and are known for their astringent and antioxidant properties. The fruit of A. marmelos contains high level of tannins, which have been shown to have strong antioxidant and anti-inflammatory activities.(31)The maximum tannin content in bael fruit was recorded in the month of January. There is as much as 9% tannin in the pulp of wild fruits, less in cultivated type. Tannin is also present in leaves as skimmianine, it is also named as 4, 7, 8 - trimethoxyfuro- quinoline. It also contain 4,7,8-trimethoxyfuroquinoline.(32)

Coumarins: Marmelosin, marmesin, imperatorin,marmin,alloimperatorin,Isoimperatorin, methyl ether, xanthotoxol,zanthotoxol, scopoletin, scoparone, umbelliferone, psoralen and marmelide has also been reported.(34,35)

Glycosides: Glycosides are a group of compounds that are widely distributed in the plant kingdom and are known for their medicinal properties. Glycosides have been identified in the fruit and leaves of A. marmelos, and some of these compounds have been shown to have antinoceptive and anti-inflammatory activities.(36)

Polysaccharide: Galactose, arabinose, uronic acid and L-rhamnose was obtained on hydrolysis.(37)

Saponins: Saponins are a group of compounds that are widely distributed in the plant kingdom and are known for their foaming and emulsifying properties. Saponins have been identified in the fruit and leaves of A. marmelos, and some of these compounds have been shown to have antinociceptive and anti-inflammatory activities.(38)

Phenylpropanoids: These are naturally occurring phenolic compounds, which have an aromatic ring to which three-carbon side chain is attached. Among the phenylpropanoids are included hydroxycoumarins, phenylpropenes and lignans. The most widespread plant coumarin is the parent compound, coumarin itself, which occurs in over twenty-seven plant families. Marmesin was established as a new compound from leaves, which is also a constituent of heartwood and root.(39)

Parts of bael plants with their properties:

The Bael is a holy plant and its all parts are very useful, generally it is seen that if one part of any plant show any pharmacological effect then there is a major possibility that the other part give the same or related activity. The same principle is applied here with the bael tree.The pharmacological uses of different parts of Aegle marmelos are:(40-43)

Table No.4 : Properties of Bael plant

Sr.no	Parts of plant	Uses
1	Leaves	Anti inflammatory, Ulcer, Cause Sterility, or abortion, laxative, asthma,Opthalmia and eye, affection, expectorant, cold and respiratory infection, backache, abdominal disorder, vomiting, cut and wounds, dropsy, beriberi, weakness of heart, cholera, diarrhea, cardiac tonic, control blood sugar, nervous disorders, hair tonic,

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		acute bronchitis, veterinary medicine for wound healing, anti worms, stimulation of respiration.
2	Root- bark	Intermittent fever and fish poison, palpitation, melancholia, anti dog bite, gastric troubles, heart disorders, fever, antiamoebic, hypoglycemic, rheumatism.
3	Flower	Stomach tonic, anti dysenteric, Antidiabetic, diaphoretic and as a local anesthetic, epilepsy and as an expectorant.
4	Fruit	Dysentery, diarrhea, gastric troubles, constipation, laxative, tonic, digestive, stomachic, brain and heart tonic, ulcer, antiviral. Treatment of rectum inflammation, antiviral, sweet, cooling, aromatic, nutritive, dysentery. Astringent, dysentery, stomachache in diarrhea, tonic, digestive, demulcent, treatment of piles.
5	Seed	Antibacterial, antifungal.

Marketed products :

Several products derived from Aegle marmelos are marketed globally, particularly in Ayurvedic medicine and wellness industries. Some of these include:

1. Bael Fruit Juice: This is one of the most popular products made from Aegle marmelos. It is marketed as a refreshing, health-boosting drink that aids digestion, cools the body, and improves gut health.
2. Bael Powder: Dried bael fruit is ground into a fine powder that can be mixed with water or other drinks. It is marketed as a supplement for digestive health, helping to manage constipation, diarrhea, and other gastrointestinal issues.
3. Bael Leaf Extract: This extract is used in various supplements and medicines. It is believed to help in controlling blood sugar levels, making it a popular ingredient in products marketed for diabetic patients.(44)
4. Bael Candy: Made from the pulp of bael fruit, this is a sweet treat often marketed as a healthy snack. It provides the same digestive benefits but in a more palatable, convenient form.
5. Bael Herbal Tea: Bael fruit and leaves are often used to make herbal teas. These teas are marketed for their antioxidant properties, as a digestive aid, and as a cooling drink, particularly in hot climates.
6. Bael Capsules/Tablets: Some companies manufacture bael in capsule or tablet form for people looking for a concentrated dose of its benefits. These are often marketed as natural remedies for digestion and metabolism support.
7. Bael Jam/Marmalade: The fruit pulp is also processed into jams and marmalades. These are marketed as natural, nutritious spreads that offer the health benefits of bael along with a sweet taste.(45)

Fig. marketed product.(72)

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These products are marketed with various health claims, such as improving digestion, managing diabetes, reducing inflammation, and even boosting immunity due to their rich content of vitamins, minerals, and antioxidants. They are often sold in health stores, Ayurvedic shops,and online platforms.(46)

Pharmacological Activities :

Pharmacological activity is essential in herbal plants. A. marmelos is a medicinal plant follow the rutaceae family. This plant found be to be variety of therapeutic activity.

• Antidiabetic Activity :

A .marmelos has been use to control diabetes in traditional medicinal system. Many in vivo scientific studies have been conducted in animal models to evaluate the ant-diabetic activity of different organic extracts and fresh juice of A. marmelos. The aqueous and alcoholic extract of the fruit part showed hyperglycemia activity against rabbits at the dosage of 500 mg/kg body weight.(47) The fruit extract of the plant showed protective effects on pancreatic tissues in diabetic rats.(48)Leaf concentrate of A. marmelos is a significant medication for the treatment of diabetes. It additionally upgrades the capacity to use the outside glucose load in the body by excitement of glucose take-up like insulin. A. marmelos leaf remove further develops tissue cancer prevention agent protection framework and reestablishes histological changes of pancreatic B-cells in STZ- induced diabetic rodent.(49) Diabetes mellitus is a common metabolic disease around the world. A large percentage of the global population is suffering from the same.The modern life style like taking stress and several fast food consumption, and alcohol drinking are the responsible for it. Leaf extract has been used in Ayurvedic system of medicine for diabetes. It enhances the ability to utilize the external glucose load in the body by stimulation of glucose uptake similar to insulin.

Oral and intrperitonial administration of the aqueous extract of bael fruit shows hypoglycemic effect against streptozotocin induced diabetic rats. Oral administration of aqueous and alcoholic extract in dose of 500 mg/kg significantly induced hypoglycemia in normal fasted rabbit.(50) Hypoglycemic activity of bael is also proved in the alloxane induced diabetes in male albino rats.(51-54) Several other research workers had also proven the hypoglycemic activity of Aegle marmelos.(55-57)The aqueous extract of A. marmelos fruits lowers blood sugar in streptozotocin-induced diabetes rat model. It boosts insulin secretion by partial regeneration from the β-cells of pancreatic islets.(58) As a result, the various parts of A. marmelos plant could be beneficial as a portion of healthy food and in developing antidiabetic drugs. The active components in the leaf and callus materials reduce blood sugar levels in STZ-diabetic rabbits, and A. marmelos callus powder methanol extract is as powerful as the leaf extract in treating diabetes.(59)

• Anticancer Activity :

Cancer is a major public health problem, being the second highest cause of death in both men and women in developed as well as developing countries.(60) In 2008, approximately 12.7 million new cancer cases (56% of which were in developing regions of the world) and 7.6 million cancer deaths (63% in less developed regions) occurred. By the year 2020, predictions report the incidence of cancer will increase 3-fold, with a disproportionate rise in cancer cases and deaths in developing countries with limited resources to tackle the problem.(61)

Gastric ulcer resulted from persistent erosion and damage of the stomach wall that might become perforated and develop into peritonitis and massive haemorrhaage as a result of inhibition of synthesis of mucus, bicarbonate and prostaglandins.(62,63) Bael inhibits in vitro proliferation of human tumors cell lines including the lecukenic K562, T-lymphoid.(64) Most of the potent anti cancer drug are expensive, mutagenesis, and teratogenic. Administration of extract in 400 mg/kg has shown anticancer effect in animal model of Ehrich ascites carcinoma.(65,66) Researchers were evaluated the anticancer potential of folk medicine used in Bangladesh, India. Aegle marmelos for cytotoxic action using brine shrimp lethality assay. The extract of Aegle marmelos was found to be exhibited toxicity on all used assay.(67) The fruit extract of bael is also used to improve the immune system that will finally increase the anti cancer activity of the body.(68,69)Anticancer activity was due to leaves and fruit of bael which contain lupeol, eugenol, citral,

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and marmelin skimmianine.(70) It has been observed that ethanolic leaves extract of A. marmelos showed antiproliferative activity against ascites tumor in swiss albino mice.(71)

• Antimicrobial Activity:

Anti microbial drugs are used in medicinal practice for treating food borne disease. Use of medicinal plants extract that are rich in antimicrobial compound could be an alternative way to eliminate these bacteria. The extract of Aegle marmelosposses antimicrobial activity. It has been found active against various species such as Staphylococcus aureus, S. epidermidis, Proteus vulgaris. It has also been used for ranikhet disease virus and intestinal parasites. The essential oil obtained from the leaves of bael exhibits variable efficacy against different fungal isolates and cause concentration as well as time dependent inhibition of spore germination of all the fungi tested, including the resistance fungus, Fusarium udum.(72)

The essential oil from bael leaves may interfere with the ca+2 dipicolonic acid metabolism. Thus it inhibits the antifungal activity by lowering the vegetative fungal body inside the host or in solid medium.(73) Fungal disease including candidacies and ring worm infection are cosmetic problem that may become fatal due to secondary or super infection as commonly occurs in AIDS patients.(74) Other co worker reported the antifungal activity of ethanolic extract of bael leaves including antidiarrhoeal activity.(75)

• Antidiarrheal Activity :

The unripe or half riped fruit is the most effective remedy for chronic diarrhea and dysen- tery without fever. The Aegle marmelos fruit pulp has been shown to possess anti-protozoal activity in chronic dysentery condition accompanied by loose stool alternately with occasional constipation. The unripe fruit used in different formulations for treatment of chronic diarrhea. After the use of the fruit powder in these conditions, the blood grad- ually disappears and the stool resume a more feculent and solid form. The mucous also dis- appears after continued use for sometimes.(76)In a in vitro and in vivo study antidiarrhoeal potential of chloroform extract of the root of A. marmelos it was found that the extract was comparable to that of ciprofloxacin and mostly active against the strains of Vibrio cholerae, followed by Escherichia coli and shigella spp . Also it was found that methanol extract of the fruits of A.marmelos decreased the intestinal propulsion in rats.(77)

The crude aqueous extract of Aegle marmelos fruit has been reported to be non muta- genic to Salmonella typhimuriumstrain TA 100 in the Ames assay . In addition, acute toxicity studies have reported that a hydroalcoholic extract of Aegle marmelosfruit is non- toxic up to a dose of 6 g/kg body weight in mice . Pharmacologicalstudies on animal models involving repeated doses of Aegle marmelosfruit extract over a period of up to 30 days have not reported any adverse effect up to a maximum dose of 250 mg/kg body weight. Tannins and flavonoids in general have been reported to have antidiarrhoeal activity through inhibition of intestinal motility, antimicrobial action and antisecretory ef- fects . The anti diarrhoeal effect of unripe fruit extract of Aegle marmelosis inhibiting the intestinal mortality and secretion.(78)

• Immunomodulatory Activity :

The immunomodulatory activity of methanolic concentrate of Aegle marmelos a natural product (MEAM) in an experimental model of resistance was done by neutrophil attachment test and carbon freedom examine, whereas, humoral invulnerability was broken down by mice lethality test and circuitous haemagluatination measure. MEAM dose was chosen by Step case technique (all over) and directed at 100 and 500 mg/kg, p.o) was orally. The Ocimum sanctum (OSC, 100 mg/kg, p.o) was utilized as standard. MEAM at 100 and 500mg/kg delivered huge expansions in the grip of neutrophils and an expansion in phagocytic record in carbon leeway measure. Both high and low doses of MEAM altogether forestalled the mortality induced by ox-like Pasteurella multocida in mice. Treatment of creatures with MEAM and OSC essentially expanded the circling neutralizer titre in circuitous haemagglutination test.

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Among the various dosages, low one was more compelling in cell resistance models than the high. In any case, every one of the portions displayed comparative assurance in humoral resistance strategies. From the above discoveries, it is inferred that MEAM has potential for expanding resistant action by cell and humoral interceded systems more at low portion (100 mg/kg) than high portion (500 mg/kg).(79)It was discovered that methanolic leaves extract of Aegle marmelos stimulate cell mediated and antibody mediated immune responses in rats. However, a low dose of methanolic extract of Aegle marmelos was found to be most effective in cell mediated immune response, whereas a high dose was found to be most effective in humoral immunity.(80)

Antioxidant Activity :

Oxidative stress is produced during normal metabolic process in the body as well as induced by a verity of environmental and chemical factor, which cause a generation of a various reactive free radical and subsequent change in DNA and lipids.. The reducing capacity of a compound may serve as a significant indicator of its potential antioxidant activity There are two possible mode of work of antioxidant. One is by getting oxidized itself or by creating a protective layer around the active constituents of the material. The antioxidant activity present in the Aegle marmelos confirms the hepatoprotective activity in the same, and it has also been reported .(81)

Antioxidants are organic complexes that can safely interplay with free radicals and stop the chain reaction before harming fundamental molecules. Free radicals are highly reactive molecular species containing one or more unpaired electrons. They are generated from regular metabolism while using O2 to burn food for energy. Antioxidants are having free radicals scavenging activity and capability of protecting the cells in oxidative stress. Antioxidant activity of these plants is due to the presence of flavones, isoflavones, flavonoids, anthocyanin, coumarin, lignans, catechins and isocatechins .A.marmelos is extensively reported to possess antioxidant activity against a variety of free radicals.(82)

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