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REVIEW OF LITERATURE ON *AEGLE MARMELOS* (L) CORREA

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KEYWORDS:

Aegle marmelos, Beal, Rutaceae, Pharmacological activity.

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ABSTRACT

Traditional system of medicine consist large number medicinal plants, which conveyed their potential therapeutic utilities. *Aegle marmelos* (L) Correa. is commonly known as Bael belongs to Rutaceae Family, widely grown in India, tropical and subtropical countries. In India, *Aegle marmelos* (L) Correa. possess great mythological significance and medicinal significance in ancient system of medicine as well. A priceless tank of bioactive molecule of the plant exploit its medicinal properties such as Antibacterial, Antihistaminic, Antiinflammatory, Antipyretic, Analgesic, Hepatoprotective, Insecticidal, Hypoglycemic, Antioxidant, Immunomodulatory, Myocardial infarction, Testicular activity, Cardiotonic, Antidepressant, Anxiolytic, Wound Healing, Anticonvulsant, Antistress, Adaptogenic Antifertility, Antidiabetic, Antihyperlipidemic, Cardioprotective, Antidiarrhoeal, Antidysentric, Anticancer, Radioprotective, Antiviral, Antiulcer, Constipation, Antifungal, Antimalarial, Contractile activity, Antifilarial, Antiproliferative, Insect controlling properties, Antiarthritis activity, Acute and subacute toxicity studies. Thus the purpose of their abstract is to explore the pharmacological activity of some crude extracts of bael fruit.

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INTRODUCTION:

Aegle marmelos (L.) Correa commonly known as Beal or Bilva belonging to the family Rutaceae has been widely used in indigenous systems of Indian medicine due to its various medicinal properties [1]. *Aegle marmelos* (L.) tree is held sacred by Hindus and offered in prayers to deities Lord Shiva and Parvati and thus the tree is also known by the name Shivaduma (the tree of Shiva). The Bael tree has its origin from Easterb Ghats and Central India. It is Indigenous to Indian subcontinent and mainly found in tropical and subtropical regions. The tree is also found as a wild tree, in lower ranges of Himalayas up to an elevation of 500 meters. Bael is found growing along foothills of Himalayas, Uttaranchal, Jharkhand, Madhya Pradesh and the Deccan Plateau and along the East coast [2]. In India flowering occurs in April and May soon after the new leaves appear and the fruit ripens in 10 to 11 months from bloom March to June of the following year [3].

***Aegle marmelos* tree**

***Aegle marmelos* fruit**

TAXONOMICAL CLASSIFICATION [3]

Kingdom	Plantae
Order	Sapindales
Family	Rutaceae
Subfamily	Aurantioideae
Genus	Aegle
Species	*Aegle marmelos*
Botanical name	*Aegle marmelos*

VERNACULAR NAMES [3,4]

English	Bengal quince, Beal fruit, Golden apple, Indian quince, Stone apple
Tamil	Aluvingam, Iyalbudi, Kuvilam, Mavilangai, Vilwam, Villuvam
Telugu	Bilvamu, Maluramu, Maredu, Sailushamu, Sandiliyamu, Sriphalamu
Hindi	Bel, Bili, Sirphal and Bela
Old Hindi	Sir Phal
Sanskrit	Adhararutha, Asholam, Atimangaliya, Bilva
Bengal	Bael, Bel
Gujarat	Billi
Kannada	Bela, Bilva
Malayalam	Koovalam, Vilwam
Orissa	Belo
Latin	*Aegle marmelos*
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
Thailand	Mapin, Matum, Tum
Marathi	Kaveeth
Urdu	Bel

DESCRIPTION OF THE PLANT

Botanical Description:

Aegle marmelos is a slow-growing, medium sized tree, up to 12-15m tall with short trunk, thick, soft, flaking bark, and spreading, sometimes spiny branches, the lower ones drooping. Young suckers bear many stiff, straight spines. The deciduous, alternate leaves, borne singly or in group, are composed of 3 to 5 oval, pointed and shallowly toothed leaflets, 4-10cm long, 2-5cm wide, the terminal one with a long petiole[5].

Phytochemical composition of *Aegle marmelos*

Different organic extracts of the leaves of *Aegle marmelos* have been reported to possess alkaloids, cardiac glycosides, terpenoids, saponins, tannins, flavonoids and steroids [6,7]. Aegle marmelos fruit pulp reported for the availability of steroids, terpenoids, flavonoids, phenolic compounds, lignin, fat and oil, inulin, proteins, carbohydrates, alkaloids, cardiac glycosides and flavonoids[8].

Uses of *Aegle marmelos* unripe fruit

Fine powder of unripe fruit showed significant effect on intestinal parasites and also effective against *Entamoeba histolytica* and *Ascaris lumbricoides*. Unripe fruit is used as an astringent in dysentery, stomachache in diarrhea, tonic, digestive, demulcent, described as cardiacal, restorative, given in piles, Decoction of unripe fruit is astringent, useful in diarrhea and chronic dysentery[9,10].

LITERATURE REVIEW OF THE PLANT

1. **Antibacterial activity**

Antimicrobial activity of different leaf extracts, such as Petroleum ether, Dichloromethane, Chloroform, Ethanol and Aqueous extract of *Aegle marmelos* leaves were tested against selected Gram positive and Gram negative bacteria. Results depict that phytochemical extracts of *Aegle marmelos* exhibited

significant anti-bacterial activity. However, the inhibitory activity was found to be both organism and solvent dependent. Ethanol and chloroform leaf extracts of *Aegle marmelos* were found to be more active towards the bacterial species tested. Further, the aqueous leaf extract was moderately active followed by dichloromethane extract. However, petroleum ether extract was not effective against any of the organisms tested. Growth of *Lactobacillus bulgaris* and *Bacillus cereus* was not inhibited by any of the tested leaf extracts of *Aegle marmelos*[11].

2. Antihistaminic activity

Skimmianine is a quinoline alkaloid isolated from the roots of *Aegle marmelos*. In the study the effects of skimmianine on the histamine release from rat mast cells are tested. The study was performed by using two cell lines, rat basophilic leukemia (RBL-2H3) cell line, and rat peritoneal mast cells (RPMCs) DNP24-BSA, thapsigargin, ionomycin, compound 48/80 were used as inducers for histamine release from rat mast cell. Skimmianine markedly inhibited the histamine release from RBL-2H3 cells induced by DNP24-BSA, thapsigargin and ionomycin[12].

3. Anti-inflammatory, antipyretic and analgesic activity

The serial extracts of the leaves of *Aegle marmelos* were investigated for anti-inflammatory property. The analgesic and antipyretic properties were also evaluated. The most of the extracts derived from the plant. *Aegle marmelos* caused a significant inhibition of the carrageenan induced paw licking in mice. A significant reduction in hyperpyrexia in rats was also produced by the most of the extracts. This study was established anti-inflammatory, antinociceptive and antipyretic activities of the leaves of *Aegle marmelos*[13].

4. Hepatoprotective activity

The experiments were performed with four groups of animals. The experimental animals were administered with 30% ethyl alcohol for a period of 40 days and the fine crude plant leaves powder was fed to animals for next 21 days. The observed values of TBARS (Thiobarbituric acid reactive substances) in healthy, alcohol intoxicated and herbal drug silymarin (133.04 µg/g tissue). The experimental results indicate that, the *Aegle marmelos* leaves have hepatoprotective effect [14].

5. Insecticidal activity

Experiments were carried out to determine the potential of using essential oil from leaves of *Aegle marmelos* to control insect infestation of stored gram from *Callosobruchus chinensis* (L.) (Bruchidae) and wheat from *Rhyzopertha dominica* (F.) (Bostrychidae), *Sitophilus oryzae* (L.) (Curculionidae) and *Tribolium castaneum* (Herbst) (Tenebrionidae). After introducing the test insects, stored gram and wheat samples were fumigated with essential oil of *Aegle mermelos* at 500 µg/mL (ppm). The oil significantly

enhanced feeding deterrence in insects and reduced the grain damage as well as weight loss in fumigated gram and wheat samples infested with all insects except *T. castaneum*. The essential oil at different doses significantly reduced oviposition and adult emergence of *Callosobruchus chinensis* in treated cowpea seeds. The oil protected stored gram from *Callosobruchus Chinensis* and wheat from *Rhyzopertha dominica* and *Sitophilus oryzae* for two years. Limonene (88%) was found to be the major component in the oil through GC-MS analysis. Regression analysis of data on individuals in treated cowpea confirmed that significant reduction of oviposition and adult emergence of *Callosobruchus chinensis* decreased with increase in doses. The findings emphasize the efficacy of *Aegle marmelos* oil as fumigant against insect infestations of stored grains and strengthen the possibility of using it as an alternative to synthetic chemicals for preserving stored grains [15].

6. Hypoglycemic and Antioxidant activity

The hypoglycemic and antioxidant effect of aqueous extract of *Aegle marmelos* leaves (AEAM) carried out by using male albino rats. Glucose, urea and glutathione-S-transferase (GST) in plasma, glutathione (GSH) and malondialdehyde (MDA) levels in erythrocytes were estimated in all the groups at the end of four weeks. There was a decrease in blood glucose at the end of four weeks in group treated with AEAM, however it did not reach the control levels. There was an increase in erythrocyte GSH and a decrease in MDA in group treated with AEAM as compared to diabetic rats. The plasma GST levels were raised in diabetic rats when compared to controls. In the group treated with AEAM, there was a decrease in GST as compared to diabetic rats. Owing to hypoglycemic and antioxidant properties, AEAM may be useful in the long term management of diabetes [16,17].

7. Immunomodulatory activity

The immunomodulatory action of methanolic extract of *Aegle marmelos* fruit (MEAM) in experimental model of immunity was carried out by neutrophil adhesion test and carbon clearance assay, whereas, humoral immunity was analysed by mice lethality test and indirect haemagglutination assay. MEAM dose was selected by Stair case method (up and down) and administered at 100 and 500 mg/kg, p.o) was orally. The Ocimum sanctum (OSC, 100 mg/kg, p.o) was used as standard. MEAM at 100 and 500 mg/kg produced significant increases in adhesion of neutrophils and an increase in phagocytic index in carbon clearance assay. Both high and low doses of MEAM significantly prevented the mortality induced by bovine *Pasteurella multocida* in mice. Treatment of animals with MEAM and OSC significantly increased the circulating antibody titre in indirect haemagglunation test. Among the different doses, low one was more effective in cellular immunity models than the high. However, all the doses exhibited similar protection in humoral immunity procedures. From the above findings, it is

concluded that MEAM possesses potential for augmenting immune activity by cellular and humoral mediated mechanisms more at low dose (100 mg/kg) than high dose (500 mg/kg) [18].

8. Myocardial infarction

The effect of *Aegle marmelos* leaf extract (AMLE) and alphatocopherol on plasma lipids, lipid peroxides and marker enzymes in rats with isoproterenol (ISO) induced myocardial infarction was carried out. Rats were pre-treated orally for 35days with different doses of an aqueous AMLE (50mg/kg, 100mg/kg and 200mg/kg) prior to ISO-induced myocardial infarction. The effects on creatine kinase, lactate dehydrogenase, plasma thiobarbituric acid reactive substances, lipid hydroperoxides, serum lipids and lipoproteins were studies. Pretreatment with AMLE at doses of 100mg/kg and 200mg/kg body weight for 35 days showed a significant effect on the activities of marker enzymes, lipid peroxidates, lipids, lipoproteins and antioxidant enzymes in ISO-treated rats. The effects of AMLE 2000mg/kg was found to be equal to the effect of alpha-tocopherol 60mg/kg [19].

9. Testicular activity

The aqueous extract of leaf of *Aegle marmelos* at the dose 50mg/100g body weight 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 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 [20].

10. Cardiotonic activity

Fresh fruit juice of *Aegle marmelos* plant with different dilutions were used for cardiotonic activity. The activity was tested by using isolated frog heart assembly. The present preliminary studies confirm the better cardiotonic activity of *Aegle marmelos* than digoxin. Further studies can confirm the reduced toxicity and this will be the advantage of *Aegle marmelos* over digitalis [21].

11. Antidepressant and Anxiolytic activity

The antidepressant and anxiolytic activities of methanol extract of *Aegle marmelos* (L.) corr. Leaves and its interaction with conventional anxiolytic and antidepressant drugs using elevated plus maze and tail suspension test in mice was carried out. Effects were observed on, a) Time spent on, b) Number of entries into, c) Number of stretch attend postures and d) Number of head dips in arms of elevated plus maze and on duration of immobility in tail suspension test. It is concluded that *Aegle marmelos* (L.)

Corr. Possess potential anxiolytic and antidepressant activities and it also enhances the anxiolytic and antidepressant activities of imipramine and fluoxetine [22].

12. Wound healing activity

Effect of topical and intraperitoneal administration of methanolic extract of *Aegle marmelos* ointment and injection was studied respectively on two types of wound models i.e. the excision and the incision wound models in rats. Both the injection and the ointment of the methanolic extract of *Aegle marmelos* produced a significant response in both of the wound type tested. In the excision model the extract treated wounds were found to epithelialize faster and the rate of wound contraction was higher, as compared to control wounds. The extract factilitated the healing process as evidenced by increase in the tensile strength in the incision model. The results were also comparable to those of a standard drug nitrofurazone [23].

13. Anticonvulsant activity

The anticonvulsant effect of ethanolic extract from the leaves of *Aegle marmelos* on maximal electroshock (MES) or pentylenetetrazole (PTZ) in male mice examined in this study. The extract of *Aegle marmelos* (orally) was administered in mice at the doses of 100 and 200mg/kg. The extract suppressed hind limb tonic extensions (HLTE) induced by MES and also exhibited protector effect in PTZ induced seizures, at 200 mg/kg dose. Since the ethanolic extract of *Aegle marmelos* delayed the occurrence of MES and PTZ convulsions, it is concluded that it interfere with gabaergic mechanisms to exert their anticonvulsant effect in addition it reveals the presence of flavonoid attributed to their anti-convulsant action. The activity reported was done dependent [24].

14. Anti stress and Adaptogenic activity

The standardized dried aqueous extracts of *Aegle marmelos* (SDEAM) were evaluated for anti stress and adaptogenic activities using Swimming endurance and post-swimming motor function test, Cold swimming endurance test and forced swim test in rats. The extracts showed the presence of phenolics, flavonoids, carbohydrates and volatile oils in preliminary phytochemical screening. In present study the test extracts when subjected to forced swim model for adaptogenic activity in rats does not showed an increase in serum cholesterol and serum triglyceride level, but the increase was not sustained on subsequent groups. It also increases the swimming endurance time significantly along with the post motar function like Rota rod falling time and spontaneous motar activity. The test extract also increase the cold swimming endurance time significantly. The test extracts could restrict the increase in the level of these markers during stress [25].

15. Antifertility activity

The study was carried out to evaluate the effective concentration of aqueous extract of *Aegle marmelos* leaves on male reproductive system of albino rats. The study was divided into three groups of six animal each. The first group (I) received distilled water serve as control. The second and third groups (II and III) of animals were administered the aqueous leaf extract daily at 250mg/kg body wt and 350mg/kg body wt., respectively for a period of 45days. Significant decreases in the weights of testis, epididymes and seminal vesicle were observed. A dose related reduction in the testicular sperm count, epididymal sperm count and motility and abnormal sperm count were observed. The results showed that *Aegle marmelos* has effects on male rat reproduction, affecting the sexual behavior and epididymal sperm concentration [26].

16. Antidiabetic activity

The effect of *Aegle marmelos* fruit extract in streptozotocin induced diabetes, a histopathological study was evaluated for its antidiabetic property. This study was designed to elucidate the protective effect of an aqueous extract of *Aegle marmelos* fruits on the histopathology of the pancreas in streptozotocininduced diabetic rats. Oral administration of *Aegle marmelos* fruit extract at doses of 125 and 250 mg/kg twice daily to diabetic rats for a period of 30 days resulted in a significant increase in body weight, weight of the pancreas and insulin levels associated with a significant decrease in fasting blood glucose levels. The fruit extract treated groups showed improved functional state of the pancreatic βcells and partially reversed the damage caused by streptozotocin to the pancreatic islets. The findings of our study indicate that *Aegle marmelos* fruit extract exhibits protective effects on the pancreas. The effects observed in the fruit extract treated animals were better those in animals treated with glibenclamide (300µg/kg) [27-30].

17. Antihyperlipidemic activity

Oral administration of aqueous extract of *Aegle marmelos* fruits and seeds separately to a dose of 250 mg/kg to streptozotocin induced diabetic rats significantly lowered the serum triglycerides, fat metabolism, blood cholesterol and tissue lipid profile. [30-32].

18. Cardioprotective effect

Unripe fruit alcoholic extract have found to produce cardioprotective effect in isoproterenol induced myocardial infarction. This activity is due to the presence of a potent compound known as aurapten [33].

19. Antidiarrhoeal and Antidysentric activities

The unripe or falf riped fruit is the most effective remedy for chronic diarrhea and dysentery without fever. The *Aegle marmelos* fruit pulp has been shown to possess antiprotozoal 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 gradually disappears and the stool resume a more feculent and solid form. The mucous also disappears after continued use for sometimes [34-36]

20. Anticancer activity

Most of the potent antineoplastic drugs available are expensive, mutagenic and teratogenic inducing drugs derived from natural sources (paclitaxel). Hence attention is being given to develop inexpensive and nontoxic drugs from alternate sources. The extracts of *Aegle marmelos* were tested for cytotoxicity using brine shrimp lethality assay; sea urchin eggs assay, and MTT assay using tumor cell lines. The extract of *Aegle marmelos* exhibited toxicity on all used assays [37,38].

21. Radioprotective activity

The hydroalcoholic extract of *Aegle marmelos* fruits have been studied for its radioprotective effect in mice expose to various doses of gamma radiation. The extract (20mg/kg) is administered intraperitoneally for 5 consecutive days before irradiation of gamma ray has been found to afford maximum protection as evidenced by highest number of survivors after 30 days post-radiation [38-40].

22. Antiviral activity

The *in vitro* antiviral activities of various parts of the *Aegle marmelos* tree have been evaluated for their efficacy against human coxsackie viruses B1 – B6. The IC_{50} of leaves, stem and stem bark, fruit, root and root bark and the pure compound marmelide are 1000, 500 – 1000, 250 – 500 and 62.5 µg/ml, respectively. whereas, the IC_{50} of ribavirin, a standard antiviral agent, is 2000 µg/ml for the same viruses and at the same time period. Marmelide is the most effective virucidal agent interfering with early events of its replicative cycle. It seems that *Aegle marmelos* has antiviral activities in the early stages of viral replication with minimum host cytotoxicity in contrast to modern virucidal chemotherapeutic agents (i.e. ribavirin), which usually act in the later stages of viral replication and have potent side effects. The effect of *Aegle marmelos* extracts also on the late protein synthesis need to be studies to evaluate its degree of potentiality as an antiviral agent. The 50% ethanolic extract of the fruits has shown antiviral activity against Ranikhet disease virus. The *Aegle marmelos* fruit extract has exhibited interferon – like activity against the same virus but not against vaccinia virus. Thus *Aegle marmelos* has better viricidal potential and may be exploited as a potent antiviral agent in near future [38].

23. Antiulcer activity

Aegle marmelos is Indigenous plant which also has prominent gastroprotective effect. Pretreatment of rats with *Aegle marmelos* unripe fruit extract produced a significant inhibition of absolute ethanol

induced gastric mucosal damage. This activity may be due to the compound luvangetin present in the fruit. Gastric ulcer is basically mediated by the development of oxidative stress in the gastroduodenal mucosa. The phenolic compounds are potent antioxidants and have powerful antiulcer activities. These compounds contain an OH group linked with the aromatic ring and thus may possess potent antioxidant and antiulcer activities [38]

24. Constipation

Aegle marmelos ripe fruit is regarded as best of all laxatives. It cleans and tones up the intestine. Its regular use for two to three months helps in evacuation of even the old accumulated fecal matter from the bowels. For best results, it should be taken in the form of Sherbat, which is prepared from the pulp of the ripe fruit [41].

25. Antifungal activity

The unsaponifiable matter of the seed has exhibited considerable *in vitro* activity against various fungi viz. *Trichophyton rubrum, Trichophyton terrestre, Epidermophyton floccosum, Aspergillus fumigatus, Aspergillus niger* and *Aspergillus flavus.* The ethanolic extract of the root has shown activity against *Aspergillus fumigatus* and *Trichophyton mentagrophytes*. The germination of any spore (i.e. bacterial or fungal) is related to Ca^{2+} - dipicolonate and/or free Ca^{2+} ions availability in the medium as well as within cytoplasm of microbes. The Ca^{2+} ion uptake and utilization by spore is one of the prime factors that determine whether the spore will germinate or remain dormant. The essential oil from the *Aegle marmelos* leaves may interfere with the Ca^{2+} - dipicolonic acid metabolism pathway and possibly inhibit spore germination. Thus it exhibits the antifungal activity by lowering the vegetative fungal body inside the host or in solid medium. This is the possible mechanism of the protective role of *Aegle marmelos* leaf oil against fungal infection. However, its curative role is yet to be explored [42].

26. Antimalarial activity

The alcoholic extracts of the *Aegle marmelos* 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 [43].

27. Contractile activity

The contractile activity of the alcoholic extract of the leaves of *Aegle marmelos* on guinea pig isolated ileum and tracheal chain was investigated, as this plant is used traditionally to treat asthma and related afflictions. After administration of alcoholic extracts, it showed complete relaxation of the guinea pig ileum and tracheal chain. The results were due to the presence of one or more antihistaminic constituents

present in the alcoholic extract of this plant, therefore supporting to the traditional use of *Aegle marmelos* in asthmatic complaints [44].

28. Antifilarial activity

Methanolic extract of roots and leaves of *Vitex negundo* L. and leaves of *Ricinus communis* L. and *Aegle marmelos* were explored for possible anti filarial effect against *Brugia malayimicrofilariae*. It was observed that among the herbal extract, root extract of *vitex negundo* and leaves extract of *Aegle marmelos* showed complete loss of motility of microfilariae after 48 hrs of incubation. The presence of alkaloids, saponins and flavonoids in the roots of *V. negundo* and coumarin in the leaves of *Aegle marmelos* is responsible for antimicrofilarial activity [45].

29. Anti-proliferative activity

Hydroalcoholic extract of *Aegle marmelos* leaves has shown anticancer effect in the animal model of Ehrlich ascites carcinoma. Induction of apoptosis may be due to the presence of exhibits cytotoxicity against tumor cell lines in brine shrimp lethality assay and Methyl Thiazolyl Tetrazolium (MTT) based assay [46]. Extracts from *Aegle marmelos* are able to inhibit the in vitro proliferation of human tumor cell lines, including the leukemic K562, T-lymphoid Jurkat, Blymphoid Raji, erythroleukemic HEL, melanoma Colo38, and breast cancer MCF7 and MDAMB- 231 cell lines due to the bioactivity of butyl p-tolyl sulfide, 6- methyl-4chromanone and butylated hydroxyanisole [47].

30. Insect controlling properties

Essential oil from the leaves of *Aegle marmelos* was reported for showing insecticidal activity against four stored grain insect pests included *Callosobruchus chinensis* (L.), *Rhyzopertha dominica* (F.), *Sitophilus oryzae* (L.) and *Tribolium castaneum*. In the study grains were infected with test insects, and were fumigated with essential oil of *Aegle marmelos* (500 µg/mL). The oil treatment significantly reduced the grain damage as well as weight loss in fumigated grains samples infested with all insects except *Tribolium castaneum*. The essential oil at different doses significantly reduced oviposition and adult emergence of *Callosobruchus chinensis* in treated cowpea seeds. Essential oil from the leaves of *Aegle marmelos* was reported for insect repellent activity against *Sitophilous oryzae* and *Tribolium castaneum*. However *Aegle marmelos* essential oils didn't showed 100% repellent activity against the test insects [48].

31. Antiarthritis activity

Leaves of *Aegle marmelos* were reported to possess antiarthritis activity against collagen induced arthritis in Wistar rats. Methanol extract treatment of rats showed the reduction of paw swelling and

arthritic index. Radiological and histopathological changes were also significantly reduced in methanol extract treated rats [49].

32. Acute and sub-acute toxicity studies

This study was designed to elucidate the toxicity of the widely used plant *Aegle marmelos* in rats. The total alcoholic, total aqueous, whole aqueous and methanolic extracts isolated from the leaves of *Aegle marmelos* and studied their toxic effects. Acute, subacute and LD50 values were determined in experimental rats. The dead animals were obtained from primary screening studies, LD50 value determination experiments and acute studies subjected to postmortem studies. The external appearance of the dead animals, the appearance of the viscera, heart, lungs, stomach, intestine, liver, kidney, spleen and brain were carefully noted and any apparent and significant features or differences from the norm were recorded. Following the chronic administration of *Aegle marmelos* for 14 days, the vital organs such as heart, liver, kidney, testis, spleen and brain were carefully evaluated by histopathological studies and any apparent and significant changes or differences from the norm were studied. From the acute administration of *Aegle marmelos*, the LD50 values were determined using graphical method. The hearts stopped in systolic stand-still in the acute experiments. There were no remarkable changes noticed in the histopathological studies after 50 mg/kg body wt of the extracts of *Aegle 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, we found a broad therapeutic window and a high therapeutic index value for *Aegle marmelos* extracts. Intraperitoneal administration of the extracts of the leaves of *Aegle marmelos* at doses of 50, 70, 90 and 100 mg/kg body wt for 14 consecutive days to male and female Wistar rats did not induce any short-term toxicity. Collectively, these data demonstrate that the extracts of the leaves of *Aegle marmelos* have a high margin of drug safety [50].

CONCLUSION:

The extensive literature survey revealed that *Aegle marmelos* (L) Correa. having diverse pharmacological spectrum due to it possesses wide range of chemical entity. As a consequence of which it is conclude that *Aegle marmelos* (L) Correa. is an important herb in human life. The evaluation needs to be carried out on *Aegle marmelos* (L) Correa. in order to uses and formulation of the plant in their practical clinical applications, which can be used for the welfare of the mankind.

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