PRIMARY IDENTIFICATION OF CERTAIN PHYTOCHEMICAL CONSTITUENTS OF AEGLE MARMELOS (L.) CORR. SERR RESPONSIBLE FOR ANTIMICROBIAL ACTIVITY AGAINST SELECTED VEGETABLE AND CLINICAL PATHOGEN

Naresh Chavda*

Adarsh Mujapara*

S. K. Mehta*

P.P. Dodia*

Abstract:

A lot of research on the antimicrobial activity in plants has been carried out. However no studies on the *aegle marmelos* and it s antimicrobial activity in India have been reported. The current study focuses on analyzing phytochemical constituts of *aegle marmelos* and its repond against the different bacteria which is found as an plant pathogen and also agaist the clinical pathogens. All type of analysis shows that extaraction of plant if very effective against the selected bacteria.

Key words: - ***Aegle marmelos,*** **antimicrobial**

* Sir P. P. Institute of science, Bhavnagar University, Bhavnagar.

Introduction:

World is endowed with a rich wealth of medicinal plants. Man cannot survive on this earth for long life without the plant kingdom because the plant products and their active constituents played an important role. Herbs have always been the principal form of medicine in India and presently they are becoming popular throughout the world, as people strive to stay health in the face of chronic stress and pollution, and to treat illness with medicines that work in count with the body's own defense (Perumalsamy et al., 1998). There is a widespread belief that green medicines are healthier and more harmless or safer than synthetic ones (Parvathi et al., 2003). Medicinal plants have been used to cure a number of diseases. Though the recovery is slow, the therapeutic use of medicinal plant is becoming popular because of its inability to cause side effects and antibiotic resistant microorganisms (Rawat, 2003).

Antibacterial properties of various plants parts like root stem leaves, seeds, flowers, fruits have been well documented for some of the medicinal plants for the past two decades (Levan et al., 1979). Medicinal and aromatic plants and essences are rich in antibacterial compounds could be an alternate way to combat against bacterial diseases (Abramowize, 1990; Samy et al., 1998; Meera et al., 1999). Since the 1940's, but many bacteria are now becoming resistant to them. According to Braunter and Grein (1994) natural plant products may offer a new source of antibacterial agents. In recent years antimicrobial properties of Indian medicinal plants have been increasingly reported (Aswal et al., 1996; Ahmad et al., 1998). The traditional treatment approach is of much significance, especially in India due to the endemic presence of infective gastro intestinal diseases which are the major causes of infant and adult mortality (Miranda et al., 1993).

Aegle marmelos is belongs to the family Rutaceae, commonly called as Bael (English), Vilvam (Tamil) and is found throughout India . Bael is a medium sized decidous tree bearing strong axillary thorns. Leaves with 3 or 5 leaflets. Bael leaves are extremely useful for treating diabetes, jaundice, cholera and asthma. Bael leaves are made into a poultice and used in the treatments of ophthalmic. Bael leaf poultice is applied to inflammations–with black pepper for edema, constipation, and jaundice. Lawsonia inermis is belongs to the family Lythracea, commonly called as Henna (English), Marudhani (Tamil) and it occurs in several parts of India, chiefly in the drier parts. The paste of leaves is largely used in Indian homes in headache, burning

sensation in feet etc. The leaves also have some action against tubercular and other bacteria, and in typhoid and haemorrhagia. Albizzia libeeck is belongs to the family Mimoseae, commonly called as Raintree (English), Vagai (Tamil). It is found throughout India and the leaves are used for the treatment of diarrhoea, dysentery and pruritis.

Against this background information and appreciating the knowledge of medicinal plants an effect has been made in this study to evaluate the antibacterial efficacy of three selected medicinal plants and also characterizing them by screening preliminary by phytochemical analysis. The study also pertains to inculcate the subject about the utilization of natural flora as therapeutic agents.

Introduction to *Aegle marmelos*:

CLASSIFICATION:

Class : Dicotyledon

Sub class: Polypetalae

Series : Disciflorae

Order : Geraniales

Family : Rutaceae

Genus : Aegle

Species: marmelos (L.) Corr. Serr.

LOCAL NAMES

Burmese (opesheet,ohshit); English (bael fruit,Indian bael,holy fruit,golden apple,elephant apple,Bengal quince,Indian quince,stone apple); German(Belbaum,Schleimapfelbaum,Baelbaum);Gujarati(bili);Hindi(baelputri bela, sirphal,siri-phal,kooralam); Indonesian (maja batuh,maja); Javanese (modjo); Khmer (bnau); Lao (Sino-Tibetan) (toum); Malay (bilak,bel,bila,maja pahit); Portuguese (marmelos); Thai (matum,mapin,tum); Vietnamese (trai mam,mbau nau)

BOTANIC DESCRIPTION

Aegle marmelos is a slow-growing, medium sized tree, up to 12-15 m tall with short trunk, thick, soft, flaking bark, and spreading, sometimes spiny branches, the lower ones drooping. Young suckers bear many stiff, straight spines. A clear, gummy sap, resembling gum arabic, 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. The deciduous, alternate leaves, borne singly or in 2's or 3's, are composed of 3 to 5 oval, pointed, shallowly toothed leaflets, 4-10 cm long, 2-5 cm wide, the terminal one with a long petiole. New foliage is glossy and pinkish-maroon. Mature leaves emit a disagreeable odor when bruised. Fragrant flowers, in clusters of 4 to 7 along the young branchlets, have 4 recurved, fleshy petals, green outside, yellowish inside, and 50 or more greenish-yellow stamens. The fruit, round, pyriform, oval, or oblong, 5-20 cm in diameter, may have a thin, hard, woody shell or a more or less soft rind, gray-green until the fruit is fully ripe, when it turns yellowish. It is dotted with aromatic, minute oil glands. Inside, there is a hard central core and 8 to 20 faintly defined triangular segments, with thin, dark-orange walls, filled with aromatic, paleorange, pasty, sweet, resinous, more or less astringent, pulp. Embedded in the pulp are 10 to 15 seeds, flattened-oblong, about 1 cm long, bearing woolly hairs and each enclosed in a sac of adhesive, transparent mucilage that solidifies on drying.

ECOLOGY

The tree grows wild in dry forests on hills and plains of central and southern India and Burma, Pakistan and Bangladesh, also in mixed deciduous and dry dipterocarp forests. A. marmelos is a subtropical species. In the Punjab, it grows up to an altitude of 1,200 m where the temperature rises to 48.89º C in the shade in summer and descends to -6.67º C in the winter, and prolonged droughts occur. It will not fruit where there is no long, dry season, as in southern Malaysia.

Soil type: A. marmelos is said to do best on rich, well-drained soil, but it has grown well and fruited on the oolitic limestone of southern Florida. It also grows well in swampy, alkaline or stony soils having pH range from 5 to 8. In India it has the reputation of thriving where other fruit trees cannot survive.

PRODUCTS:

Food: A. marmelos fruits may be cut in half, or the soft types broken open, and the pulp, dressed with palm sugar, eaten for breakfast, as is a common practice in Indonesia. The pulp is often processed as nectar. Beating the seeded pulp together with milk and sugar makes a popular drink called sherbet in India. A beverage is also made by combining bael fruit pulp with that of tamarind. Mature but still unripe fruits are made into jam, with the addition of citric acid. Confection, bael fruit toffee, is prepared by combining the pulp with sugar, glucose, skim milk powder and hydrogenated fat. Indian food technologists view the prospects for expanded bael fruit processing as highly promising. The young leaves and shoots are eaten as a vegetable in Thailand and used to season food in Indonesia. They are said to reduce the appetite. An infusion of the flowers is a cooling drink. The food value per 100 g of fresh bael fruit as analyzed in India and the Philippines is: water 54.96-61.5 g, protein 1.8- 2.62 g, fat 0.2-0.39 g, carbohydrates 28.11-31.8 g, ash 1.04-1.7 g, carotene55 mg, thiamine 0.13 mg, riboflavin1.19 mg, niacin 1.1 mg, ascorbic acid 8-60 mg and tartaric acid 2.11 mg.

Fodder: The leaves and twigs are lopped for fodder.

Timber: The wood is strongly aromatic when freshly cut. It is gray-white, hard, but not durable; has been used for carts and construction, though it is inclined to warp and crack during curing. It is best utilized for carving, small-scale turnery, tool and knife handles, pestles and combs, taking a fine polish.

Gum or Resins: The gum enveloping the seeds is most abundant in wild fruits and especially when they are unripe. It is commonly used as household glue and is employed as an adhesive by jewelers. Sometimes it is resorted to as a soap-substitute. It is mixed with lime plaster for waterproofing wells and is added to cement when building walls. Artists add it to their watercolors, and it may be applied as a protective coating on paintings.

Tannin or dyestuff: There is as much as 9% tannin in the pulp of wild fruits, less in the cultivated types. The rind contains up to 20%. Tannin is also present in the leaves. The rind of the unripe fruit is employed in tanning and also yields a yellow dye for calico and silk fabrics.

Essential oil: The essential oil of the leaves contains d-limonene, 56% a-d-phellandrene, cineol, citronellal, citral; 17% pcyrnene, 5% cumin aldehyde. The limonene-rich oil has been distilled from the rind for scenting hair oil.

Poison: The leaves are said to cause abortion and sterility in women. The bark is used as a fish poison in the Celebes. Tannin ingested frequently and in quantity over a long period of time, is antinutrient and carcinogenic. Leaf extract from A. marmelos has been found to have insecticidal activity against the brown plant hopper (Nilaparvata lugens Stål), an important pest of rice plant in Asia.

Medicine: A decoction of the unripe fruit, with fennel and ginger, is prescribed in cases of hemorrhoids. It has been surmised that the psoralen in the pulp increases tolerance of sunlight and aids in the maintaining of normal skin color. It is employed in the treatment of leucoderma. Marmelosin derived from the pulp is given as a laxative and diuretic. In large doses, it lowers the rate of respiration, depresses heart action and causes sleepiness. For medicinal use, the young fruits, while still tender, are commonly sliced horizontally and sun-dried and sold in local markets. They are much exported to Malaysia and Europe. Because of the astringency, especially of the wild fruits, the unripe bael is most prized as a means of halting diarrhea and dysentery, which are prevalent in India in the summer months.

KEY MEDICINAL APPLICATIONS AS TRADITIONAL AND ARYUVEDIC FOMULATIONS:

Leaves	Fruit	Root
Laxative	Diarrhea	Dasmularis
Febrifuge and	Stomach pain	Diabetes
Expectorant	Stomach ulcer	Ear drop
Opthalmia	Heart and Brain	Fever (malaria)
Diabetes	Make a juice	Cure pain

Asthma	Washing clothes (Pulp) Pickle Water proofing powder Hair oil	Palpitation of the heart Anti-diarrhoetic Antidote to snake venom Vomiting and cholera Stomach, kidney and anti-viral activities

Other products: The fruit pulp has detergent action and has been used for washing clothes. The shell of hard fruits has been fashioned into pill- and snuff boxes, sometimes decorated with gold and silver. A cologne is obtained by distillation from the flowers. In the Hindu culture, the leaves are indispensable offerings to the 'Lord Shiva'.

Materials and method

COLLECTION OF PLANT MATERIAL:

Aegle marmelos was collected from kodinar near junagadh (Gujarat) on 25th December 2009. The plant parts collected were first washed and then treated to dry under an oven at 40 °C for 4-5 days.

Preparation of extract:

Leaves of Aegle marmelos were used to extract bioactive compounds (Fig 1, Fig 2). The samples were washed with distilled water to clean the adhering dust particles. Then they were dried in a shaded place. Sufficient leafsamples were cut into small pieces and placed in 250 ml conical flask. Methanol was used as a solvent to extract the bioactive compounds. 40 grams of each medicinal plant sample was cut into small pieces and further ground, placed in the Soxhlet extractor for the extraction of bioactive compounds, Methanol as used to extract the bioactive components of Aegle marmelos. Before extraction, the samples were flushed with organic

solvent, methanol for two times. Thus collected extracts were concentrated by exposing them in a laminar air flow and stored at 4□ C until further use.

Bacterial strains: bacterial strains were employed for the test which includes. Carrot pathogen, pathogen of pomegranate and chilly pathogen. The bacterial species were not identified however preliminary identification using grams staining were performed which revealed the presence of both Gram +ve and Gram –ve bacteria. These were isolated as pure culture on nutrient agar medium and the antimicrobial property of extracts of Aegle marmelos were checked.

Preparation of sterile disc:

Sterile disc of size 5 mm iameters were obtained by using Whatman filter paper No.1 used for the present investigation. The extracts of medicinal plants were incorporated into the sterile disc. Each sterile disc was incorporated individually with 50,100,200 ppm. The discs were allowed to dry in laminar air flow. Then another dose of extract was applied. Assay of the antibacterial activity of the medicinal plant extract were done by Disc diffusion technique. Disc Diffusion Technique

The nutrient agar plates were prepared and the test bacterial strain was smeared on the Nutrient agar surface using sterile cotton swab. The antibiotic disc loaded with plant extract was placed on the surface of the Nutrient agar plates. Controls were maintained by loading dimethyl sulfoxide on disc. Then the plates were incubated at 37*C for 12 to 18 hours.

Antimicrobial activity:

All the three plants with four extracts were tested against six pathogenic bacterial strains, three Gram positive bacteria (*B.cereus, B. subtilis, S.aureus*) and three Gram negative bacteria (*E. coli, P .vulgaris,* and *P.aeruginosa*) by disc diffusion method (Bauer et al., 1986). 20ml of sterilized nutrient agar medium for *E.coli, P.aeruginosa, S.aureus, B.subtilis, B. aureus* and *P. vulgaris* were poured into each sterile petridish. After solidification, the sterile cotton swab was dipped into the broth of these bacteria. The entire agar surface of each plate was inoculated with this swab, first in the horizontal direction and then in a vertical direction, which ensure the even distribution of organism over the agar surface. The filter paper discs soaked in the plant extract were placed on the surface of the bacteria seeded agar plates and then the plates were incubated

at 370C for 24h. The antibacterial activity was recorded by measuring the width of the clear inhibition zone around each disc.

Antimicrobial assay:

The antimicrobial properties were evaluated by agar well diffusion method (Perez et al., 1990) using Mueller Hinton agar (Hi-media) for bacteria and Sabouraud`s dextrose agar for fungi. The microorganisms were activated by inoculating a loopful of the strain in the nutrient broth (25 mL) and Sabouraud`s dextrose broth (25 mL). The culture flasks were incubated at 37°C for 24 h (bacteria) and 25°C for 7 days (fungi), respectively.

One milli liter of inoculums was inoculated into the 45-50°C cooled agar and plated. Using the cork borer wells was made and different extracts having 100 µg mL-1 concentration were transferred using a micropipette. Then the plates were kept in the refrigerator for 5 min for diffusion and incubated at 37°C for 24 h and 25°C for 7 days, respectively. The control experiment was carried out with tetracycline. Zone of inhibition was measured in millimeter. The experiments were carried out for ten successive trials and the average values are presented.

Results

Culture 1

EXTRACT NAME	PLANT PART	ZONE OF INHIBITIN (mm)			
		1:01	1:02	CONTROL SOLVENT	CONTROL STANDARD
Toluene	Leaf	11.08	11.08	-	17.98
Toluene	Bark	10.62	-	-	23
Toluene	Root	11.11	13.3	9.04	23.6
Water	Leaf	16.38	7.06	-	17.48

Water	Bark	8.3	7.72	-	18
Water	Root	10.63	7.8	8.8	20.36
Methanol	Leaf	-	-	-	18.98
Methanol	Bark	-	-	-	19
Methanol	Root	-	-	-	19.22
Chloroform	Leaf	14.5	13	13.01	24.54
Chloroform	Bark	15	7	13.78	21.54
Chloroform	Root	18.23	14.24	12	23.55

Culture No. 2: Carrot pathogen (code NR-2)

EXTRACT NAME	PLANT PART	ZONE OF INHIBITI0N (mm)			
		1:01	1:02	CONTROL SOLVENT	CONTROL STANDARD
Toluene	Leaf	25.4	25.2	-	24.76
Toluene	Bark	10.8	-	-	28
Toluene	Root	15.06	18.7	-	24.92
Water	Leaf	-	-	-	23.5
Water	Bark	-	-	-	16.87
Water	Root	-	-	-	23.6
Methanol	Leaf	-	-	10.64	20.8
Methanol	Bark	10.8	-	-	17.6
Methanol	Root	-	-	-	20.2

Chloroform	Leaf	10.06	-	9.63	20.42
Chloroform	Bark	12.68	11.18	9.38	24.06
Chloroform	Root	18.23	14.24	12	23.55

EXTRACT NAME	PLANT PART	ZONE OF INHIBITION (mm)			
		1:01	1:02	CONTROL SOLVENT	CONTROL STANDARD
Toluene	Leaf	11.56	-	-	21.42
Toluene	Bark	12.56	-	9.07	14
Toluene	Root	-	-	-	18.46
Water	Leaf	-	-	-	19.44
Water	Bark	-	-	-	19.18
Water	Root	-	-	-	19.8
Methanol	Leaf	11.16	9.2	10	16.24
Methanol	Bark	10.18	-	-	19.18
Methanol	Root	10.4	-	-	19.07
Chloroform	Leaf	12.39	13.07	11	20
Chloroform	Bark	16.7	17.07	14	20.09

Chloroform	Root	12.07	10	-	19.7

Culture No. 3: Chilli pathogen (code NR-3)

Culture No. 4: Pomigranata pathogen (codeNR4)

EXTRACT NAME	PLANT PART	ZONE OF INHIBITION (mm)			
		1:01	1:02	CONTROL SOLVENT	CONTROL STANDARD
Toluene	Leaf	12.22	8.81	-	16
Toluene	Bark	-	-	-	18.2
Toluene	Root	-	-	-	19.67
Water	Leaf	-	-	-	17.1
Water	Bark	-	-	-	17.55
Water	Root	-	-	-	18.69
Methanol	Leaf	-	-	-	18.1
Methanol	Bark	-	-	-	21
Methanol	Root	-	-	-	22.01
Chloroform	Leaf	10.9	8.07	-	19.98
Chloroform	Bark	10.45	9.05	-	21.22
Chloroform	Root	8	7.98	7.89	20.23

The results of the experiments carried out on the antimicrobial effect on the plant Aegles marmelos of leaves and flower with solvent methanol against clinical pathogens Antibacterial activity of methanolic extracts of leaves and flower Aegle marmelos at different concentrations (50,100,200 ppm disc) against different clinical pathogens with controlThe leaves and flower extract proved to be active against five different clinical pathogens strains such as Staphylococcus aureus, Pseudomonas aeruginosa, Proteus mirabilis, Escherichia coli, Salmonella typhi. In this assay Escherichia coli was the most susceptible bacterium, on observation that may be attributed to the presence of Tannins alkaloids, inhibit the growth of microorganisms. The Aegle marmelos leaves extract, show highly active against the microorganisms. E. coli followed by Salmonella typhi, Staphylococcus aureus, Proteus mirabilis, Pseudomonas aeruginosa in all the concentration. In 200 ppm concentration of leaves methanol extract have no much difference between the organisms (Plate 2).

Discussion:

Historically, medicinal plants have provided a source of inspiration for novel drug compounds, as plant derived medicines have made large contributions to human health and well being. The traditional healers (or) practitioners make use of water primarily as a solvent, but our studies showed that methanol extracts of these plants were certainly much better and powerful. This may be due to the better solubility of the active components in organizing solvents. Both the leaf and flower methanol extracts was found to be more effective against all microorganisms. The flower extracts was found to induce maximum inhibitory effect against all these microorganisms. In the leaf methanol extracts of Aegel marmelos antibacterial activity was maximum in Salmonella typi followed by others. In the flower methanol extract Aegel marmelos antibacterial activity was maximum in Staphylococcus aureus followed by others. This due to astringent antipyretice and also contain tanniys. The results support earlier result as antibacterial activity of Amry card power (formulation) consists of Aegel marmelos against E. coli, Staphylococcus and Streptococcus. On the basis of the result obtained in this present investigation and conclude that the methanol extracts of Aegle marmelos leaves and flowers had significant in vitro antimicrobial activity. and the most active extracts can be farther subjected to isolation and identify therapeutic antimicrobials and undergo further pharmacological evaluation.

PHYTOCHEMISTRY:

Chemical constituents, characteristics and properties of various extracts of *Aegle marmelos*:

Chemical composition: Various compounds like umbeliferone, marmin, skimmianine and g-sitosterol have been isolated from young bark of Aegle marmelos. Chatterjee and Bhattacharya (1959) have characterized marmin as 7-(3:7-didydroxy-3: 7-dimethyloctyloxy) coumarin. It is the source of auraptene, marmin, umbelliferone, lupeol and skimmianine (Das & Das, 1995). Shoeb et al. (1973) have isolated psoralen, xanthotoxin, O-methylscopoletin, scopoletin, tembamide and skimmin from its root. A compound aegeline is isolated from the leaves. Bhadari and Gupta (1972) have reported that the essential oil distilled from leaves contains a-phellandren, P-cymene, cineole, d-limonene, ethyl n-amylketone, methyl n-heptyl ketone, citronellal, linalool, citral, eugenol, methyl eugenol, caryophyllene and cuminyl alcohol. Bajaj et al. (1975) explained that the leaves of A. marmelos contain condensed tannins, phlobatannins, flavan-3-ols, leuco anthocyanins, anthocyanins and flavonoid glycosides. Flavan-3-ols are converted into leuco anthocyanins which are then finally converted into phlobatanins. On hydrolysis, water soluble polysaccharide was isolated from the fruit pulp by Haq and Awal (1977), which yields 20.4% galactose, 10.7% arabinose, 25.2% uronic acid and trace of L. rahomnose. According to Basak et al. (1982), neutral polysaccharide isolated from the crude polysaccharide of the fruit pulp contains arabinose, galactose and glucose in molar rations of 2:3:14. In bael seeds, 40.7% oil was found. Pal et al. (1993) reported that palmatic acid (22.7%), linoleic (22.6%) and linolenic (19.6%) are the components of fatty acids and are beneficial for tumors. Ali and Pervez (2004) isolated marmenol, a 7-geranyloxycoumarin from the leaves. Ali & Qadry (1987) and Barthakur & Arnold (1989) studied the amino acids of this plant. Jain et al. (1991) isolated two new compounds, 2-(2-hydroxy-4-methoxyphenyl) vinyl acetate and xanthotoxol-8-O-beta-D-glucopyranoside from the heartwood of this plant along with beta-sitosterol and lupeol. From the bark of the plant, two new lignan-glucosides, (-)-lyoniresinol 2alpha-O-beta-D-glucoside and (-)-4-epi-lyoniresinol 3alpha-O-beta-D-glucoside, have been isolated together with two known lignan-glucosides, (+) lyoniresinol 3alpha-O-beta-D-glucopyranoside and (-)-lyoniresinol 3alpha -O-beta-D-glucopyranoside (Ohashi et al., 1994). Garg et al. (1995) analysed the leaf oil and afforded the identification of eight monoterpene hydrocarbons, ten oxygenated monoterpenes,

and four sesquiterpene hydrocarbons and one oxygenated sesquiterpne. P-menth-1-en-3 beta, 5 beta-diol was characterized as a new constituent. Srivastava et al. (1996) reported two new anthraquinones, 7, 8-dimethoxy-1-hydroxy-2-methylanthraquinone and 6-hydroxy-1-methoxy-3-methylanthraquinone along with beta-sitosterol, marmin and xanthotaxol from the heartwood.

Phyto-chemical analysis

The extracts were subjected to preliminary phytochemical screening and the results were tabulated in Table as shown below.

Phytochemical screening of *Aegle marmelos*	***Aegle marmelos***			
	1	**2**	**3**	**4**
Alkaloids	-	+	-	-
Carboxylic acid	-	+	-	-
Coumarins	-	-	-	-
Flavanoids	-	-	-	-
Anthocyanins	+	-	+	+
Phenols	+	+	+	+
Sterols	+	-	-	-
Xanthoproteins	-	+	+	-

Solvents: 1.toluene; 2. Chloroform; 3. methanol; 4.Aqueous

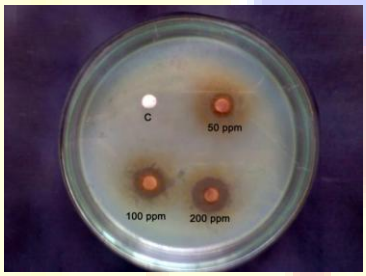
+ _ Positive

_ _ Negative

conclusion:

Development of resistance to chemotherapeutic agents shown by the microorganisms appears to be a continuous process since the time antibiotics were discovered. So every antibiotic has certain life span regarding its efficacy. Scientists have realized an immense potential in natural products from medicinal plants to serve as alternate source of combating infections in human beings which may also be of lower cost and lesser toxicity. Further work on isolation and characterization of active principles from medicinal plants and their pharmacodynamic study using latest techniques would be highly beneficial to human beings.

Antimicrobial activity and phytochemical constituents of an methanolic extract, toluene, water and chloroform extracts of *Aegle marmelos* were investigated. The phytochemical screening of the crude extract revealed the presence of Alkaloids, Cardiac glycosides, Terpenoids, Saponins, Tannis, Flavonoids, and Steroids. The crude ethanolic extract was tested for antimicrobial activity against plant pathogenic organisms on ducus carota, and capsicum spp. at different cereal concentrations levels of 0.15 mg/ml.



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