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An overview: *Citrus maxima*

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ABSTRACT

Plants have been used as traditional medicine for several thousands of years. Herbal medicine is still a mainstay of about 70-80% of the world's population as they are easily available source for healthcare purposes in rural and tribal areas. India being the largest producer of medicinal plants it is correctly known as "Botanical garden of the world". The plant *Citrus maxima* (J. Burm.) Merr. is a widely distributed indigenous plants found in Indian subcontinent. Which is been widely used. The present study was aimed to review the ethanobotanical properties, pharmacognostic, phytochemical and pharmacological properties of Citrus maxima. The various parts of this plant are widely used by different tribal communities. The leaves of plant are used in Epilepsy, chorea, Convulsive cough and also in the treatment of hemorrhage disease. Oil from fresh leaves posses anti dermatophytic activity and Fungicidal activity. Flower are Used as sedative in nervous affection. Fruits acts as cardiotonic and are used in Leprosy, Asthma, Cough, hiccough, mental aberration, Epilepsy. Rind are Antiasthmatic, sedative in nervous affection, Brain tonic and Useful in vomiting, griping of abdomen, diarrhea, Headache and eye troubles. Root and Bark: Antimicrobial activity. Following various claims for cure of numerous diseases, efforts have been made by researchers to verify the efficacy of the plant through scientific biological screening. A scrutiny of literature reveals some notable pharmacological activities of the plant such as activity on CNS, anti diabetic and cholesterol reducing property, analgesic, anti inflammatory, hepatoprotective, antioxidative property, cytotoxic activity, and many more medicinal values.

Keywords: *Citrus maxima*, Etthanobotanical, Pharmacognosic, Phytochemical, Pharmacological.

INTRODUCTION

Man relies on plants for their basis needs of food clothing and shelter. These plants provides medicines, crafts, cosmetics and also used as a source of income for rural areas [1]. For about thousands of year plants have been used as medicine and WHO has reported that over 50% of the poorest part of Asia and Africa still lacks regular access to essential drugs. Traditional medicine offers the major and accessible source [2]. About 80% of the population in developing countries yet relies on plant based medicines to obtain primary health care WHO 1978 [3].

A genus of *Citrus* (Linn) of Rutaceae an evergreen aromatic shrub and small trees occupies an important place in the medicine and also in the fruit economy of India. Scientifically it is also known as *Aurantium maximum* Burm. Ex Rumph, *Citrus aurantium* L. Var *grandis* L., *Citrus Decumana* L, *Citrus grandis* Osbeck & *Citrus pamplemos*. *Citrus grandis* (Linn) Osbeck is a crop plant of India, China, Indonesia, America, Thailand etc. The pummelo tree is normally about16 to 50 ft tall. Pomelo is native plant of Malayu island and East of India. It is wide spread in China, Japan, Philipines, Indonesia, USA and Thailand [4, 5].

Citrus maxima are a perennial shrub commonly known as Papanus, distributed throughout India. Bark and root of *Citrus maxima* contain β-sitosterol, acridone alkaloid. Essential oil from the leaves and unripe fruits contain limonin, nerolol, nerolyl acetate and geraniol [6]. Like other citrus plant pommelos are rich in Vitamin C. They are generally used eaten as fruit. It has been used in indigenous system of medicine as sedative in nervous affections, convulsive cough and in the treatment of hemorrhagic diseases and epilepsy. It is said to poses appetizing, cardiac stimulant and antitoxic property [7]. *Citrus maxima* fruits also contains high amount of polyphenolic compound like hesperidin, naringin, caffeic acid, P-Coumaric acid, Ferulic acid and vanillic acid [6]. It shows various pharmacological activities which has been studied. In this work the review has been made on the reports of various studies on the plant *Citrus maxima.*

Taxonomy of plant:

Botanical name *Citrus maxima (Linn)*
Taxanomical Classification
Kingdom: Plantae

Phylum: Tracheophyta
Division- Magnoliophyta
Class: Magnoliopsida
Order: Sapindales
Family: Rutacea
Sub family: Aurantioideae
Genus: Citrus
Species: maxima

Common Names: Pamelo, Pomelo, Pommelo, Jabong, Shaddock, Chinese fruit, e**tc**
Vernacular name:
Hindi: Sadaphal, बतावी नीबू Batawi nimbu, चकोतरा Cakotaraa
Manipuri: Nobab
Tamil: Pambalimasu
Malayalam: Pamparamasan
Telugu: Pampara
Bengali: Chakotra
Konkani: Toranji
Sanskrit: Madhukarkati
French: Pamplemmousse
German: Pomelo
Japanese: Zabon.

Habit And Habitat:
Tree of 16-50 ft (5-15 m) tall, with somewhat crooked trunk of 4-12 inches. North eastern region up to 1,500 m in Assam and Tirupura. It is indigenous to East of India [8].

Morphology:
Leaves: large evergreen oblong to elliptic leaves, 10.5 to 20 cm (4 to 8 in) long. Frequently emarginated, Pubescent beneath. Acute apex, Asymmetric base, entire margin, characteristic odour.
Petioles: broadly winged
Flowers: Large, White
Stamens: 16-24
Fruit: large, pale yellow, globose or pyriform, rind thick, pulp varying in colour from crimson to pale pink or yellow [9, 10].

TRADITIONAL USES:
Leaves: Epilepsy, chorea, Convulsive cough and also in the treatment of hemorrhage disease. Oil from fresh leaves posses anti dermatophytic activity, Fungicidal activity.
Flower: Used as sedative in nervous affection
Fruits: Leprosy, Asthma, Cough, hiccough, mental aberration, Epilepsy, cardiotonic.
Rind: Antiasthmatic, sedative in nervous affection, Brain tonic, Useful in vomiting, griping of abdomen, diarrhea, Headache and eye troubles.
Root and Bark: Antimicrobial activity [[3], 12].

Figure 1: Leaves

Figure 2: Flowers

Figure 3: Flowers and fruits

Figure 4: Fruits

Figure 5: Whole plant

Figure 6: Bark

PHARMACOGNOSTICAL STUDIES:
In Pharmacognostic study of plant macroscopy and microscopy of the leaf was performed. Macroscopic photographs of transverse sections of *Citrus maxima* leaves shown distinct presentation of arrangement of palisade cells, vascular bundles, oil globules, parenchymatous cell & trichomes.
Microscopy of the leaf shows abundant anisocytic stomata both surfaces of leaf, presence of vascular bundle in xylem vessels. Thick, ovoid, rectangular epidermal cells were present. Uniserate, multicellular, thin walled, unlignified, covering trichomes were present. Spongy parenchyma cells were present. Calcium oxalate crystals were present in the parenchymatous cells. Starch grains were present except vascular bundle. Oil globules were present in leaf. Stomatal number of upper and lower surfaces of the leaves was found to be 48±1 and 21±1, whereas the stomatal index of the upper and the lower surfaces were 68.6±0.5 and 34.28±0.5. Vein islet number was found to be 4±1 and vein termination number was 3±1.
Standardization of leaf was done with the help of extractive values [Water soluble extractives (18.8 % w/w), Alcohol soluble extractives (6.8 % w/w)], total ash value (4.66 % w/w), acid soluble ash value (0.316 % w/w), acid insoluble ash value (4.63 % w/w) and loss on drying (5.96 % w/w) [13].

PHYTOCHEMICAL SCREENING:

Alkaloids: 5-hydroxyacronycine, acriginine A, Atalafoline, Baiyumine A &B, Buntanine, Buntanmine, Grandisine I & II, Pumiline, honyumine, natsucrin, Prenyl citpressine, Citropone A & B, Glycocitrine I are present in the roots and the bark of the plant. Whereas the caffeine are present in the flowers of the *Citrus maxima* [14-19].
Amino Acids: Alanine, Asparigine, Aspartic acid, Coline, Glutamic acid, Glycine And proline are present in the leaves [20, 21].
Carbohydrates: Phytol, Synephrine, Methyl antralinate, Fructose, Glucose and Pectin are present in the Leaf, peel and flowers [22-25].
Carotenoids: Carotene [26] and Roseoside [27] present in the peels.
Coumarins: 5-Geranoxy-7-methoxy-Coumarin, Aurapte, Auraptene, bergamottin [28-30] are present in the peels and 5-methoxy seselin[18], 5-methyltodannol, 6-hydroxy methylherniarin are present in the roots and stem bark.
Flavonoids: acacetin, rutin, tangeretin, cosmosiin, diosmetin, diosmin, eriocitrin, hespeidin, naringin [31-33].

Monoterpenes: α-pinene, α-terpineol, anethole, β-pinene, Camphene, camphor, citral, citronellal, citroonellol, farnesol, geraniol, myrcene, neral, terpinene [34-36].
Sesquiterpenes: α-Bisabolol, α-cadinene, α-copaene, elemol [37-39].
Steroids: β-Sitosterol, Campesterol, daucosterol, stigmasterol[40-41].
Miscellaneous: α- tocopherol, ascorbic acid, chlorophylls, decyl acetate, Malonic acid, Fumaric acid, succinic acid and Citric acid [21].

PHARMA COLOGICAL ACTIVITY OF CITRUS MAXIMA:

Antioxidant activity

Anti oxidant potential was tested for the juice of citrus maxima in rats. The enhanced antioxidant status observed in *C. maxima* treated rats and its protective role against H_2O_2, STZ and nitric oxide generating system induced DNA damages might be due to the effect of different types of active principles acting individually or synergistically, each with a single or a diverse range of biological activities against oxidative stress [42].

Analgesic and Anti Inflammatory Activity

Ethanolic, acetone and aqueous extracts were obtained by soaking the leaves, stem bark and fruit peel of citrus maxima for 72 hrs. These extracts were evaluated for the analgesic activity in Acetic acid induced writhing in mice, Tail flick method in rats, Hot plate method in mice and Acute and Chronic anti inflammatory activity was evaluated by Formalin-induced Paw oedema in rats. Ethanolic extracts citrus maxima leaf, stem bark, fruit peel showed significant decrease in the writhes in comparision to control group in Acetic acid induced model and a significant increase in the tail flicking time. Hot plate method showed the increase in the reaction time of the thermal stimulus.
Anti Arthritic and anti inflammatory activity were studied using Formalin induced paw oedemas in rats. The ethanolic extract was found to compatible with the standard drug diclofenac [43, 44].

Anti Diabetic Activity

Ethanolic extract of stem bark of citrus maxima was obtained by continuous hot peculation method. Acute toxicity studies were done as per the OECD-425 Guidelines. Anti diabetic activity was studied in the Alloxan induced anti diabetic activity, Streptozotocin induced anti diabetic activity and Oral glucose tolerance test. Acute toxicity study showed that LD_{50} values were too high thus it showed the safety of the extract. Fasting blood glucose level in the Alloxan and Streptozotocin induced rats were within the normal range and Citrus maxima extracts showed increase in the body weight in these models when compared to diabetic control group. Oral glucose tolerance test in rats showed the significant decrease in the blood glucose level. Serum biomarker SGPT, SGOT were decreased significantly in the Glibenclamide treated and citrus maxima extract treated animals.

Fruit juice of citrus maxima was studied for the Glucose Tolerance and the Lipid profile in the Type II Diabetic Rats. Fresh Fruit juice were obtained which was centrifuged to obtain the clear supernatant shaddock juice. Treatment with the 50% Shaddock fruit juice has reduced the food and water intake of diabetic rats. Oral glucose tolerance were improved in the streptozotocin induced Type II Diabetes in rats. Significant increase in the cholesterol, VLDL and tiglycerides level. Significant decrease in the HDL level were observed [45, 46].

CNS Activity

Central Nervous System activities were studied with the extracts of Citrus maxima leaf on the Rodents. Acute toxicity studied were performed, which was observed after 5 hours of administration, and for 14 days. It was reported to be safe even at 2000mg/kg and no delayed toxicity was observed. Various parameters like Anti depressant activity, Anxiolytic, Anti convulsant, Hypnotic, Muscle relaxant activity were studied for the CNS activity.

Anti depressant activity were studied with Forced Swim test and Tail suspension test. There was significant decrease in the immobility time and increase in the climbing behavior were observed with the ethanolic extract of citrus maxima leaf.

Light-Dark Box test, Elevated plus Maze, Locomotor activity and Hole board test. The Light and dark test measured the increase in the number of crossing. Ethanolic extract of citrus maxima showed increase in the frequency of open arm entry and the time spent in the open arm. No of entries in the closed arm was decreased due the effect of extract. Significant decrease in the number of head dips in hole board test was observed. The effect of extract was comparable with the standard Diazepam in the each test.

Anti convulsant study was done Pentylenetetrazole induced convulsion, Strychnine induced convulsion and Electro shock induced seizure model. Increase in the latency of the seizure, dose dependant increase in anticonvulsant activity, Dose dependant increase in the delay of seizure respectively was observed on the administration of the ethanolic extract of Citrus maxima leaf.
Hypnotic activity was studied using the pentobarbitone induced sleeping time. Significant increase in the duration of the sleep was observed with the Ethanolic extract of Citrus maxima.

Muscle relaxant studies were done using Rotarod model, Climbing test, inclined screen test. Ethanolic extract of citrus maxima showed potential muscle relaxant activity with all of models [47, 48].

Anti tumour activity

Citrus maxima leaves are tested for anti tumour activity in Ehrlich's Ascites carcinoma cell(EAC)-treated mice. EAC cells were obtained from Chittaranjan National Cancer Institute (CNCI), Kolkata, India and was transplanted into the Swiss Albino mice and maintained invivo. Intraperitonial administration Methanolic extract of Citrus maxima showed to increase the life span, nonviable tumour cell count and decrease in the tumour volume. Hematological parameters were towards normal level [49].

Hepatoprotective activity

Leaves of Pomelo or *Citrus maxima* were studied for hepatotoxicity in rats against paracetamol induced hepatotoxicity. Successive extraction was done and methanolic extract was evaporated to get crude extract. Paracetamol were used for liver damage in rats. Standard drug silymarin were compared with the methanolic extract of *Citrus maxima* leaves. The effect of the methanolic extract of *Citrus maxima* had significant effect on thiobarbituric acid reactive substances. Reduced levels of the glutathione and catalase activity were restored to normal levels using methanolic extract of *Citrus maxima* leaves. The histopathological studies have also shown that the hepatocellular vacuolization and focal hepatic necrosis in paracetomol control animals is significantly reduced in the MECM 400 mg/kg treated animals and silymarin treated animals.
CCl_4 induced hepatotoxicity model were used and Citrus maxima peels were found to posses the protective action against hepatic damage induced by CCl_4. Anti oxidant compound like caffeic acid and epicatechin are found to be responsible for the effectiveness of Citrus maxima peel powder against liver disorder [50, 51].

Anti bacterial activity

Anti bacterial activity of Pummelo against *Escherichia coli* and *Salmonella typhimurium* were tested. Ethanolic extract of the Pericarp, Mesocarp, Segment membrane were prepared and zone of inhibition of the various extracts using cup cylinder method were tested in the culture of *E.coli and S.typhimurium.* The pericarp, mesocarp and segment membrane extracts generated zone of inhibitions measuring 17.10, 18.00 and 17.03 mm for *S. typhimurium*, respectively at 100% concentration. *E. coli* was noted to be inactive in all three sample extracts at 100% concentration [52].

Hypocholesterolemic and ACE inhibitory activity

Citrus maxima and citrus paradisii juices were studied for inhibition of the Angiotensin converting enzyme and hypocholesterolemic activity. The interaction of the citrus fruit juices with ACE revealed that the juices inhibited ACE activity in a dose-dependent manner.

Shaddock juice had a significantly higher ($p < 0.05$) inhibitory effect on ACE activity than grapefruit juice. However, the juices had lower inhibition of the enzyme activity than captopril [53].
There was a decrease in the total cholesterol with increased quantities of citrus fruit juices when compared to the control. Significant increase in HDL, significant decrease in LDL, atherogenic index in rats.
Thus it inhibits the key enzyme linked with hypertension along with the hypocholesterolemia.

CONCLUSION

Since the beginning of this century, ethnobotanical and traditional uses of natural compounds, mainly of plant origin established much interest as they are well tested for their efficacy and generally believed to be safe for human use. Thorough screening of literature available on *Citrus maxima* depicted the fact that it is used as a cure for variety of ailments. Following the traditional and folk claims, very little efforts have been made by the researchers to explore the therapeutic potential of this plant. It is interesting to note that pure compounds and crude organic extracts of leaves of *Citrus maxima* have been screened for some pharmacological activities and found to possess analgesic, anti inflammatory, anti tumor, hepatoprotective activity and CNS activity Stem bark of the plant possess anti diabetic activity, and Juices are screened for hypocholesterolemic and anti oxidant activity. Peel were scientifically proved for hepatoprotective, anti bacterial, analgesic and anti inflammatory activity. *Citrus maxima* is a high value medicinal plant. In future study, the isolated principles from *Citrus maxima* needs to be evaluated in scientific manner using scientific experimental animal models and clinical trials to understand exact molecular mechanism of action, in search of lead molecule from natural resources

Conflict of interest: NIL

Source of support: NIL

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