



A Systematic Review of *Crateva* Species for Its Traditional and Modern Medicinal Uses

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Abstract

Crateva religiosa /*C. magna*/ *C. adansonii* is a medicinal plant belonging to Capparaceae family which was traditionally it is used to treat many disorders. Here an attempt has been made to collect the information regarding its usages pharmacological action with its phytochemical isolates. Studies give evidences have various activities like diuretic, laxative, lithonotriptic, antirheumatic, antiperiodic, bitter tonic, rubifacient, anti mycotic anti spasmodic, hypotensive, anti inflammatory, hypoglycemic, anti protozoal, analgesic, anti diabetic diuretic, antiinflammatory, contraceptive, antipyretic, antilithitic, antihelminthic, rubifacient etc. It is studied extensively in various countries for the estimation of its properties. Acute toxicity and phytochemical studies of aqueous and methanolic leaf extract of *Crateva adansonii* are also investigated. The phytochemical screening and acute toxicity studies are conducted using standard procedure and methods. The phytochemical properties of different extracts of *Crateva magna* were assessed.

Keywords: *C. religiosa*, *C. magna*, *C. adansonii*, *Capparaceae*, phytochemical analysis

1. INTRODUCTION

In *Crateva religiosa* also known as *Crateva adansonii*, *Crateva magna* is called as Sacred Garlic Pear or Temple plant and belongs to the family Capparaceae. *C. tapia*, *C. nurvala* are sometimes considered to be synonyms of this species. It is native to Japan, Australia, Southeast Asia and several south Pacific Islands. In India it is found in Pennisular India, Western India, Gangtetic Plains, and Eastern India upto Tripura and Manipur. It is a rare medicinal plant in Maharashtra. It is an important medicinal plant and has been used in Indian Ayurvedic medicine for various ailments. The name *Crataeva* is given in the honor of Crataevus, a Greek botanist, who was living in the time of Hippocrates and the name *religiosa* indicates its growth near the places of worship. *Crataeva religiosa* is much branched deciduous tree belonging to the family capparidaceae, commonly called as Varuna. The capparaceae or capparidaceae, commonly known as the caper family, are a family of plants in the order brassicales. This family contains 33 genera and about 700 species. The largest genera are capparis (about 150 species), maerua (about 100 species), boschia (37 species) and cadaba (30 species).

Taxonomical classification:

Kingdom Plantae (plants)

Subkingdom Tracheobionta (vascular plants)

Superdivision Spermatophyta (seed plants)

Cultivation details

Grows best in a rich, slightly acid soil

Prefers a position in full sun or light shade

Established plants are moderately drought tolerant

The flowers are curiously garlic-scented which succeeds in the tropics and subtropics.

Propagation

Seed are best sown as soon as it is ripe

Flowering season : From February to June.

Fruiting season : From July to January.

Seeding season : From July to January.

Leaves falling : During the hot season.

Reproduction and Dispersal

Sex distribution : *Crateva religiosa* is bisexual (each flower of each individual has both male and female structures).

Mode of pollination

Crataeva religiosa is pollinated by a wide variety of insects.

Seed dispersal

The seeds of *Crataeva religiosa* are mainly dispersed by birds and mammals.



Fig 1



Fig 2



Fig 3



Fig

Garlic pear is a moderate sized deciduous tree, 15m (50ft) tall and 9m (30ft) wide. It grows well in sun or partial shade and normally prefers moist, rich, neutral to acid soil .Bark is grey, and the wood is yellowish-white, turning light-brown when old. These are clustered at the ends of branchlets, with a common petiole 5 to 10 centimeters long, at the summit of which are tree leaflets. Leaflets are ovate-lanceolate or ovate, 7.5 to 12 centimeters long, 4 to 6 centimeters wide, and pointed at the base, with a rather slender point at the tip Flower. They occur in terminal corymbs, are about 5 centimeters in diameter, greenish-yellow, and the stamens are purplish. Fruit Garlic pears are rounded or ovoid shaped fruit, and are 3 to 5 centimeters in diameters. The fruit has hard and rough rind and has unpleasant smell and burning taste. The seeds are about 10 centimeters in length, numerous, kidney-shaped, and embedded in a yellow pulp.

Lodhas (local Tribe in Vidarbha region) prescribe stem bark paste with paste of 3-9 peppers (3:1) as laxative. The decoction of bark is useful in fevers, to relieve vomiting and symptoms of gastric irritation. It is also used in snake bite. Juice of bark is given to women after childbirth. Powdered bark is useful in urinary and renal tubules, gastro-intestinal and uterine affections. Fresh juice of stem bark with seed powder of black peppers (3:1) is given to women as contraceptive. Other ethnic communities use fresh bark paste to stimulate appetite. Externally the bark and leaves pounded and tied in a cloth are applied as fomentation.

The trade name given for this tree is three leaved capper . The leaves are trifoliolate, glabrous, and ovate. Flowers are whitish to milky white in colour in terminal dense corymbs. Fruit is berry, globose or some times oblong with woody rind, embedding seeds in the yellow pulp. The outer surface of bark is wrinkled and greywhite in colour, covered with large number of lenticells. Tree flowers and fruits in the month of Dec-May *Crataeva religiosa* is globally distributed in India, Myanmar, Sri Lanka, Malaysia, Indonesia and China. In India, it is found in Peninsular India, Western India, Gangetic Plains, and Eastern India, up to Tripura and Manipur. It is also found in Sikkim and Andman and Nicobar Island. It is found mostly along the bank of the river and streams and near to temple side.

The plant *Crateva magna* belonging to family Capparaceae is a well known plant in herbal world for its wide range of use in medicinal purposes. It is used as an anti spasmodic, hypotensive, anti inflammatory, hypoglycemic, anti protozoal, Anthelmintic, analgesic purposes. The major constituent is the Triterpenes, which has been shown to have these various activities. Other constituents are the Alkaloids, minor flavonoides, sterols, Triterpenes and the isothiocyanate glucosides. *Crataeva magna* is a potent medicinal plant in the Indian systems of medicine. Traditionally used for inflammation, fever, arthritis, bronchitis, urinary calculi and cough. Medicinal usage has been reported in traditional systems of medicine, such as Ayurveda and Unani, wherein the plant is frequently preferred in the treatment of urinary disorders that reoccur owing to development of antibiotic resistance by the infecting organism. It has lithotriptic, diuretic, demulcent and tonic properties . It is one of the medicinal plants in India, which possess anti-inflammatory and anti-arthritic activity. Various parts of this plant, including the root, stem, flower and leaves are recommended for the treatment of fever in combination and separately. The root juice is given for the relief of fever in whole part of India. It is also useful in disorders of urinary organs, urinary tract infections, pain, intermittent fever, asthma, bronchitis, renal and vesicle calculi. Bark yields triterpenoids (α and β - amyrin, ceryl alcohol, lupeol, friedelin, betulinic acid, 4-taraxasterol, lupenone), flavonoids (rutin, catechin, quercetin) and alkaloids (cadabicine) 6, However, it has been best known for its action on urinary calculi and it has an official status in the Indian herbal pharmacopoeia-2002, as an anti-lithiatic drug.

The plant is used ethnopharmacologically as diuretic, laxative, lithotriptic, antirheumatic, antiperiodic, bitter tonic, rubifacient and counterirritant In folklore the bark is specifically used in urinary disorders including kidney and bladder stones, antiemetic and calculous affection and as an antidote in snake bite .

The crude drug contains an active principle lupeol, a triterpenoid which is mainly involved in the pharmacological activities of this plant. The present review summarizes Ethnobotanical, pharmacological and phytochemical aspects of this medicinal plant.

2. REVIEW OF LITERATURE

Antimycotic potential of *crataeva religiosa* hook and forst against some selected fungal pathogens

C. religiosa was selected based on its ethnomedicinal importance in Indian traditional system of medicines and the various extracts of the bark were screened *in vitro* for their antifungal properties. The results revealed that ethanolic extract among all extracts of *C. religiosa* exhibited significant activity comparable to standard antifungal agents against all test fungal pathogens. The ethanolic followed by chloroform extracts showed better effect against the

test fungal pathogens thus indicating the presence of higher contents of active phytoconstituents having antifungal potential.

Further studies will aim at isolation and characterization of active phytoconstituents with antifungal potential.

Phytochemical and Pharmacological Screening of the Plant *Crateva Magna* Against Alloxan Induced Diabetes in Rats.

The plant *Crateva magna* belonging to family Capparaceae is used in anti spasmodic, hypotensive, anti inflammatory, hypoglycemic, anti protozoal, analgesic purposes. The present study was carried out to evaluate the effect of *Crateva magna* whole plant (ethanolic and aqueous extract p.o.) on alloxan induced diabetes in appropriate animal model. The study was carried out on alloxan induced diabetic model. The aqueous extract of leaves of *Crateva magna* results maximum yield value than that of petroleum ether extract, chloroform extract and alcohol extract through successive maceration process. The aqueous extract of leaves of *Crateva magna* showed maximum control of blood sugar in hyperglycemic Wistar rats than other experimental extracts. The test extract also reduces the blood sugar level to a maximum extent in case of normal animals. So it was concluded that the plant *Crateva magna* increases healing of diabetes and prevents the development of experimentally induced diabetes in Wistar rats.

Diabetes Mellitus is one of the oldest & most prevalent chronic disease, which is a serious, costly and heterogeneous metabolic disorder characterized by altered carbohydrate, lipid and protein metabolism. This is affecting nearby 25% of the population. This is also characterized by a state of chronic hyperglycemia (peripheral insulin resistance), glucosuria, polydipsia, polyurea, ketoacidosis etc The name Diabetes Mellitus corresponds to the groups of disorders characterized by absent or deficient insulin secretion . Diabetes mellitus is an independent risk factor for the development of coronary artery disease, myocardial infraction, hypertension and dyslipidemia. The purpose of this investigation was to explore the potential effect of plant *Crateva magna*. The aqueous extract of the plant showed better result than the ethanolic extract.

The aqueous extract of leaves of *Crateva magna* results maximum yield value than that of petroleum ether extract, chloroform extract and alcohol extract through successive maceration process. Toxicological study revealed that the *Crateva magna* leaves was showed toxic effect at 2000mg/kg b. wt. and does not alter normal physiological and behavioural activities. The aqueous extract of leaves of *Crateva magna* showed maximum control of blood sugar in hyperglycemic Wistar rats than other experimental extracts. The test extract also reduces the blood sugar level to a maximum extent in case of normal animals. Among the study of effects of *Crateva magna* whole plant in both normoglycemic and hyperglycemic model through oral route. The oral route represents maximum therapeutic benefits. Hence, the oral route is most appropriate route for the test extracts. Administration of *Crateva magna* significantly reduces the elevated glucose level in alloxan induced diabetic rats confirms its anti-diabetic activity.

Anti Pyretic Activity of *Crateva Magna* Bark on Tabvaccine induced pyrexia

In the preliminary phytochemical screening *C. magna* revealed the presence of alkaloids, terpenoids, phytosterols, flavonoids and flavonones. Several traditional claims, the usefulness in pain, inflammation and fever. Hence, *C. magna* was considered that investigations for these

medicinal properties may give scientific authentication to the traditional claims. The antipyretic effect of *C. magna* indicated a likelihood of intervention with prostaglandin synthesis, as prostaglandins have been established as a common mediator in all these responses. However, this possibility remains to be investigated in detail. Moreover, the active compounds responsible for these pharmacological actions also remain to be identified. This result seems to support the view that the plant has some influence on prostaglandin biosynthesis, since prostaglandin is believed to be a regulator of body temperature 13. The preliminary phytochemical analysis reveals that the major chemical Constituents of the alcoholic extract of *C. magna* are terpenoids and flavonoids. The major chemical components of *C. magna* are known to be betulinic acid, lupeol, 4-taraxasterol, rutin and quercetin. Thus phytochemicals found in alcoholic extract, which might be responsible for the antipyretic activity. Thus, the results of the present study provide support to the traditional usage of *C. magna* in fever, even if further studies are needed to better evaluate these activities and the potential of the plant.

Scientific Investigation of Antitrypanosomal Activity of *Crateva Adansonii* DC

Leaves Extracts

Herbal products are gaining progressively attention due to less toxicity and high efficacy against free radical mediated diseases. At present, approximately 25% of drugs in modern pharmacopoeia were derived from plants (phytomedicines) and many others were synthetic analogues built on the compounds isolated from plants *Crateva adansonii* DC, also known as *Crateva religiosa* or sacred garlic pear especially its leaves for the treatment of ear infections. The bark is widely used for stomach troubles and held to have tonic properties. In Senegal the roots figure in several treatments for syphilis, jaundice and yellow fevers.

Phytochemicals and Acute Toxicity Profile of Aqueous and Methanolic Extracts of *Crateva adansonii* Leaves in Swiss Albino Rats

Acute toxicity and phytochemical studies of aqueous and methanolic leaf extract of *Crateva adansonii* were investigated. The phytochemical screening and acute toxicity studies were conducted using standard procedure and methods. The weights of the rat were monitored before and after the experiment. The phytochemical analyses of the aqueous and methanolic leaf extract of *Crateva adansonii* leaf showed the presence of alkaloids tannins, flavonoids, saponins cardiac glycoside and steroids in both aqueous and methanolic leaf extract of *Crateva adansonii*. Phlobatannins were absent in aqueous but present in methanolic leaf extract of *Crateva adansonii*, while anthraquinones were not detected. It is concluded that *Crateva adansonii* contain active phytochemicals of therapeutic potential and that the extract is safe for clinical application.

Flavonoid have been reported for their anti-mutagenic anticarcinogenic potentials due to their antioxidant and anti inflammatory properties. Saponin are use as adjuvant in the production of vaccine. Steroids are used in the stimulation of bone marrow and growth. It stimulates lean body mass and also play vital roles in the prevention of bone loss in elderly men. Alkaloid has been used as CNS stimulant, topical anesthetic in ophthalmology, powerful painkillers, antipyretic action among other use. The cardiac glycoside has been used for over two centuries as stimulant in cases of cardiac failure and diseases. The presence of tannin in the leaf extract of *Crateva adansonii* suggests the ability of these plants to play major roles as antifungal antidiarrheal, antioxidant and antihemorrhoidal agent .Tannin also have astringent

property, plant containing tannin has been reported to be used for healing of wounds, varicose ulcers, hemorrhoids, frostbite and burn in herbal medicine. The presence of all these phytochemicals in the leaf extract of *Crateva adansonii* is an indication that this plant if properly screened could yield a drug of pharmacological significance. However, the absence of phlobatannins in methanolic extract but present in aqueous extract and the absence of anthraquinone in both extracts agree with early studies which also found that not all phytochemicals are present in all plants and those present differ with the solvent used in the extraction process.

Analgesic and free radical scavenging activities of hydromethanolic extract of *Crateva adansonii* stem bark

The analgesic activity of *Crateva* extract was investigated using both chemical and thermal models of nociception in rodents while the antioxidant activity was evaluated using DPPH photometric model. The choice of the doses used in this study was based on the report of previous studies. Acetic acid-induced writhing test was used for detecting both the peripheral and central analgesia, whereas the tail flick test is most sensitive to centrally acting analgesic drugs.

Antioxidant Capacity and Phenolic Composition of *Crateva adansonii* DC. (Capparaceae)

Fractions obtained from the aqueous acetone extract of *C. adansonii* leaves were analyzed for their antioxidant capacity and their phenolic composition. The results obtained in the present study indicate that *C. adansonii* leaf fractions exhibit remarkable ferric reducing power, ABTS radical cation scavenging capacity, and free radical scavenging capacity.

The content and the type of phenolic compounds are responsible for this overall antioxidant activity. The leaves of *C. adansonii* were disclosed to be a rich source of phenolic compounds. Among the ten phenolic compounds, p-coumaric, ferulic and sinapic acids, isoquercitrin, quercitrin, quercetol and kaempferol were identified as major phenolic compounds. The finding was that *C. adansonii* leaves could be a potential source of natural antioxidants that could have great importance as a therapeutic agent in the prevention of cancer, aging, atherosclerosis, urolithiasis, inflammation and neurodegenerative diseases.

Elemental Composition and Phytochemical Screening of Aqueous Leaf Extract and Stem Bark Extract of *Crateva adansonii*

The elemental analysis was done using atomic absorption analysis with Perkin Elmer Analyst atomic flame spectrophotometer (FAAS) 400 models, India. Carbohydrate, anthraquinone, saponins, tannins, alkaloids, steroids, flavonoids, terpenoids and phlobatanins were determined using known standard methods. The phytochemical studies revealed the presence of saponins and flavanoids in both the leaf and stem bark extracts. Tannins, alkaloids, steroids and terpenoids were present only in the leaf extracts, while carbohydrate was found only in the stem bark extracts. Anthraquinone and phlobatanins were absent in both the leaf and stem bark extract. The anions and cations detected include sodium (Na⁺), potassium (K⁺), calcium (Ca²⁺), magnesium (Mg²⁺), manganese (Mn), copper (Cu²⁺), zinc (Zn²⁺), iron (Fe²⁺), lead (Pb²⁺), cobalt (Co²⁺), lithium (Li⁺), chloride (Cl⁻) and sulphate (SO₄²⁻) ions, suggesting that the plant contains pharmacologically active ingredients as well as metal cations found important in antioxidative stress roles. The phytochemical screening done in this work showed that *Crateva adansonii* contains saponins and flavanoids in both leaf and

stem bark extracts. The presence of flavonoids in both extracts may make the plant to be useful in the treatment of cancer, viral, thyroid and hormonal imbalance diseases. It has been reported by [6] that flavonoids may be useful in the treatment of the above mentioned diseases. Saponins have been known to have some antihypercholesterol, hypotensive and cardiac depressant properties. Presence of saponins in both extracts also make the plant to be useful in the treatment of hypercholesterol, low blood pressure and cardiac depressant. However, tannins, alkaloids, steroids and terpenoids were found present in the leaf extracts but absent in the stem bark of *Crateva adansonii*. This suggests that the leaf extracts of the plant may have some antibacterial potential most especially for antimalarial and antidiarrhoeal potentials because of the presence of alkaloids and tannins in the leaf extract of *Crateva adansonii* may have some antioxidant properties because of the presence of terpenoids and flavonoids. They have been isolated from African flora and found to be effective in treating malaria. Furthermore, the leaf extract of *Crateva adansonii* may have some antioxidant properties due to the presence of terpenoids and flavonoids in the extract.

Free Radical Scavenging Activity of Lupeol Isolated from the Methanol Leaf Extract of *Crateva adansonii* Oliv. (Capparidaceae)

This study was aimed at investigating the antioxidant properties of lupeol isolated from the methanol leaf extract of *Crateva adansonii*. In the past decades, mechanisms of oxidative stress and the function of free radicals in living systems have gained increased attention. Oxygen and nitrogen uptake inherent to cell metabolism have been known to make reactive oxygen and nitrogen species (ROS and RNS) available. Reactions of these species with lipid molecules produce peroxy radicals and their interaction with nucleic acids and proteins results to certain alterations and, therefore, functional. ROS are continuously produced by the body's normal use of oxygen in metabolic respiration and some cell-mediated immune functions. ROS, which consists of free radicals in form of superoxide anion radicals $O_2^{\cdot-}$, hydroxyl radicals (OH^{\cdot}) and non-free-radical species such as hydrogen peroxide (H_2O_2) and singlet oxygen (1O_2), are various forms of activated radical oxygen²⁻⁴. On the other hand, antioxidants are compounds that can retard or prevent the oxidation of lipid or other molecules by retarding the initiation or production of oxidizing chain reactions. The harmful action of the free radicals can, however, be blocked by antioxidative substances, which scavenge and reduce the free radicals, detoxifying the organism⁵. Antioxidants act mainly by removing O_2 or decreasing local O_2 concentrations, removing catalytic metal ions, removing key ROS, e.g. $O_2^{\cdot-}$ and H_2O_2 , scavenging initiating radicals, e.g. OH^{\cdot} , RO^{\cdot} , RO_2^{\cdot} , breaking the chain of an initiated sequence, quenching or scavenging singlet oxygen, enhancing endogenous antioxidant defenses by up-regulating the expression of the genes encoding the antioxidant enzymes, repairing oxidative damage caused by radicals, increasing elimination of damaged molecules and not repairing excessively damaged molecules so as to reduce the introduction of mutations⁵. Plants are the most commonly known reservoir of natural antioxidants, which includes ascorbate, tocopherols, polyphenols and terpenoids. In order to assess the antioxidant effect of lupeol in vitro (1, 1-diphenyl-2-picrylhydrazyl radical (DPPH) spectrophotometric assay, Ferric reducing antioxidant power (FRAP) assay, Hydrogen peroxide scavenging assay, Hydroxyl radical scavenging assay, ABTS radical cation scavenging activity, Anti-lipid peroxidation assay, β -Carotene bleaching assay, Superoxide anion radical scavenging assay) and in vivo (Lipid peroxidation assay, Assay of catalase

(CAT) activity, Assay of reduced glutathione (GSH) concentration) experimental models were used. The results of this work show that Lupeol possessed strong ABTS scavenging activity and a lipid peroxidation inhibitory activity in the human body. Pretreatment with the lupeol increased the activities of CAT (catalase) which may be the mechanism of action of the observed reduction in lipid peroxidation. This assay revealed that the lupeol might prevent reactive radical species from damaging biomolecules such as lipoprotein, DNA, amino acids, sugar, proteins and PUFA in biological and food systems. The present investigation showed that lupeol has antioxidant properties by scavenging free radicals.

Profiling of secondary metabolites and antimicrobial activity of *Crateva religiosa*

G. Forst. Bark - A rare medicinal plant of Maharashtra India

In the present study Profiling of Secondary metabolites and Antimicrobial activity of Stem Bark of *Crateva religiosa* was carried out for validating the ethno medicinal claims. Stem Bark of this plant was analyzed for Physiochemical study, Organoleptic study and Fluorescent analysis. Qualitative and Quantitative analysis of major secondary metabolites was also carried out using standard procedures. Stem bark was extracted successively using Chloroform, Dichloromethane and 50% Ethanol as solvents which were analyzed by Gas Chromatography – Mass Spectrometry (GC-MS) method to separate and identify the individual compounds in extracts. Antimicrobial activities of all three extracts of understudy part was tested against 4 pathogenic bacterial strains and two fungal strains. The results of antimicrobial activity were compared with the results of standard antibiotics. The qualitative analysis showed presence of various secondary metabolites among which major groups were quantified. By GC-MS analysis the different phyto compounds were identified among which 9 were secondary metabolites and were placed as profile of secondary metabolite in Stem bark. All three solvent extracts showed significant activity against bacterial strains while as chloroform extracts were inactive against fungal strains at 10mg/ml concentration. The results suggest that this plant has vast variety of photochemical which can be used as effective remedy for various ailments and drug formulations in future. The ethnic claims of this plant were also verified by the present study.

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either alone or in combination with other suitable agents. The ethnic claims of this plant were also verified by

the present study as there was presence of phytochemicals which show these activities.

Evaluation of the angiogenesis activity of *Crataeva magna* Lour (DC) extract using the Chorio Allantoic membrane assay in Chick Embryos

Angiogenesis, the formation of new capillaries from pre-existing vessels, is an important natural process in the body used for healing and reproduction. In early 1970s, it was noted that solid tumors appear to be highly vascularized. Recruitment of new blood vessels plays an important role in tumor survival and growth. In 1971, a concept of anti-tumor strategy by controlling angiogenesis was hypothesized by Folkman, as tumor growth is angiogenesis dependent and every aspect of tumor growth requires increment in vascular growth.

Endothelial cells in tumour bed tend to be more susceptible to cytotoxic agents due to their high proliferation rate. In addition, endothelial cells, on the contrary to cancerous cells, are genetically stable as they do not undergo mutations and hence more sensitive to apoptotic effects of the cytotoxic agents. Thus, these features of endothelial cells make them a compelling target for antiangiogenesis treatment. It was estimated that medicinal plants in general and especially traditional plants as valuable and indispensable resources the vast majority of clinically established cancer drugs during the past three decades were based on natural product. This plant may provide a new source of antiangiogenesis agents which can be considered as potential candidates in the treatment of angiogenesis related diseases.

Screening of anti-inflammatory phytochemicals from *Crateva adansonii* leaf extracts and its validation by *in silico* modeling

Inflammation is a vital part of the human immune system. Inflammation is the body's immediate primary physiologic defense mechanism that helps body to protect itself against infection, burn, toxic chemicals, allergens and other noxious stimuli. The inflammatory reactions are protective and tightly regulated in the immune system. During the inflammation process, various inflammatory mediators including pro and anti-inflammatory mediators are synthesized and secreted from inflammatory cells and generate many cellular effect. The leaf extracts of *C. adansonii* are applied externally to treat various inflammatory conditions associated with pain and it also used for treating ear infections. Powder of bark is used in rheumatism, itch, epilepsy, asthma, gastrointestinal and uterine infection. The aim of the present study is to identify bioactive anti-inflammatory phytochemicals of *Crateva adansonii* leaf extracts through phytoconstituents screening and *in silico* molecular docking approaches.

The present study revealed that important bioactive phytochemicals of *C. adansonii* resolved by GC-MS analysis possess anti-inflammatory potential against inflammatory molecular targets. Thus this type of combinatorial analysis (*In vitro* Phytoconstituents analysis and *In silico* molecular docking study) helps to understand and reveal the bioactive principles of the medicinal plants, which will be useful for further fruitful logical research towards designing novel anti-inflammatory phytochemicals against multiple inflammatory molecular targets.

Phytochemical Investigation of the extracts of *Crateva magna* Lour

The phytochemical properties of different extracts of *Crateva magna* was evaluated. Alkaloid, Flavonoid and Terpenoid were present in all the extract of *Crateva magna* and also in all the plant parts. Phenols were present in Petroleum ether, Methanol extracts of leaf, stem and bark. Saponins were present in methanol and aqueous extract of leaf, stem and bark and also present in petroleum ether bark. Steroids were present in petroleum ether, chloroform, methanol extract of leaf, stem and bark and absent in aqueous extract. Tannins were present in petroleum ether and aqueous extracts of leaf, stem and bark and also found to be in methanol extract of bark. Anthocyanin and quinine were found to be high in methanol and aqueous extract of leaf and it was absent in stem and bark. Volatile oil were high in petroleum ether, chloroform and methanol extract of leaf, stem and bark and it was absent in aqueous extracts. Protein was found to be high in methanol and aqueous extract of leaf and

bark and aqueous extract of stem. The results obtained in the present study proved the efficacy of the plant *Crateva magna*.

From the observations it can be concluded that the plant extracts show the presence of several bioactive compounds which could be exploited further.

Analysis of volatile constituents in normal flower and insect induced flower gall of *Crataeva religiosa*

The “insect” galls are unique examples of complex interactions and mutual adaptation between the host and the pathogen, characterized by cellular hypertrophy and hyperplasia. *Crataeva religiosa* Hook and Frost, (Capparidaceae) is one of the herbal drug in urolithiasis. The present investigation was undertaken to evaluate the major and minor phytochemical compounds present in normal flowers and the changes that occur in flower galls of *Crataeva religiosa*. The methanolic extracts of both the tissues were analysed by Gas Chromatography-Mass Spectrometry technique for the study of major constituents. The GC-MS analysis of normal and galled flower of *Crataeva religiosa* showed the presence of eighty four and sixty four phytochemical compounds respectively. This analysis leads to the finding that under stressed conditions large no. of fatty acids and secondary metabolites were produced and the flower gall extract had a much higher unsaturated fatty acid content than normal flower extract. The fatty acids (oleic acid and palmitic acid) were found in higher amount in flower gall extract than normal flower extract. Whereas myristic acid could be detected only in gall extract. These compounds possess a wide range of proven industrial and medicinal values. This study will help in further investigation to predict the formula and structure of compounds which can be used as drugs and in industrial uses.

Immunomodulatory Potential of Chloroform Extract of *Crateva magna* (Lour.) DC

Number of medicinal plants has been exploited for modulation or alteration of immune system in the form of Ayurvedic formulations either alone or in combinations. Herbs used for Immunomodulation can provide potential non toxic alternatives to conventional chemotherapies, specially when the host defense mechanism needs to be activated. Variety of phyto constituents like lectins, polysaccharides, alkaloids, peptides, flavonoids, steroids and tannins have been reported to modulate immune system in various in vivo models.

The results clearly indicate that the chloroform extract possess immune boosting properties in a dose dependent manner, and suggest usefulness in the disorder of immunological origin. However, mechanisms of immune-modulations are still to be investigated. The results moreover open scope for further exploration of the chloroform extract to isolate bioactive phyto-constituents with potent immunomodulatory activity.

Phytochemistry and biological activities of *crateva adansonii* extracts

This study aims to search the secondary metabolites of *Crateva adansonii* (leaves and bark) and evaluate some biological activities (antimicrobial, antioxidant and cytotoxicity's property) of these extracts. *Artemia salina* was the larvae used for measuring the activity.

The results of the phytochemical screening reveal the presence of polyphenols, triterpenoids, and glycosides in the both organs (leaves and bark) of *C. adansonii*. Only the ethanolic and hydroethanolic leaf's extracts inhibited respectively 20% and 10%, of the clinical strain *S. aureus*. The ethyl acetate leaf's extract shows the best antifungal activity (89,19%) with *A. clavatus*. All extracts present dose-dependent antiradical properties and are non-toxic for the cells of *Artemia salina*. *C. adansonii* bark extracts had the best reducing power. *C. adansonii*

is therefore an active principle source for the development of drugs to antimicrobial and antioxidant activities

Antioxidant and antimicrobial potential of *Crateva Magna* (Lour.) DC

In the present study, *Crateva magna* bark was extracted with various solvents in order to their standing in the polarity chart and the extracts were then subjected to preliminary phytochemical investigation. After that we have subjected the extracts to antioxidant assay using FTC, TBA, DPPH and Reducing Power assay as models and Antimicrobial assay. The Chloroform extract has shown potential antioxidant and antimicrobial. The Study has shown the potential of chloroform extract of *Crateva magna* bark as an antioxidant and antimicrobial agent. The bark of the plant can be explored further for isolation of bioactive compound and exploration of the isolated compound further towards preparation of pharmaceutical formulation from the herbal isolated which are safer in terms of their long use in traditional medicine. The ailing human race presently needs safer alternatives for healthy living, which was the prime reason for undertaking this piece of work. activity among all the extracts under evaluation. The findings here justify the ethnomedicinal claim against the plant under consideration.

Ethnopharmacological and pharmaco-toxicological data of *Sarcocephalus latifolius* and *Crateva adansonii* DC, two plants used in traditional malaria treatment in Benin

Antimalarial drug resistance is worsening the management of malaria in Africa, increasing the use of new alternatives, including medicinal plants. *Sarcocephalus latifolius* and *Crateva adansonii* DC are of paramount importance in dealing with various diseases, especially malaria. Therefore, this study aims at analyzing some ethnopharmacological and pharmacotoxicological data of these species as a starting point and orientation for the value addition to the treatment of malaria. A

bibliographic search was conducted in scientific databases and the Boolean operators AND and OR were used. From the Sixty studies, it appears that *Crateva adansonii* DC is known for the traditional treatment of malaria, boils, infections and gastrointestinal problems. Bioactive molecules such as flavonoids, alkaloids, triterpenes, fatty acids and steroids have been found in its organs. Pharmacologically, extracts of *Crateva adansonii* DC have been shown to be active on bacterial strains (*Shigella sonnei*, *Staphylococcus aureus*, *Pasteurella pestis*, *V. Cholerea* and *P. vulgaris*) and fungal (*Candida albicans*, *Aspergillus parasiticus*). *Sarcocephalus latifolius* traditionally is also used in the treatment of malaria, diabetes, ascites, hernias, fevers and convulsions. Tannins, flavonoids and cyanogenic glycosides, saponins and alkaloids have been found in its organs. Anti-inflammatory, analgesic and antipyretic, antihypertensive, antibacterial (*S. aureus*, *P. aeruginosa*, *S. aureus*, *Bacillus subtilis*, *P. aeruginosa*) and antifungal (*Aspergillus niger*) activities have been demonstrated. Both species inhibit

DPPH free radicals and show no toxicity. *Crateva adansonii* DC and *Sarcocephalus latifolius* may be good candidates for the discovery of new bioactive molecules. Their valorization in the management of malaria, through antiplasmodial activity tests is essential.

Hepatoprotective activity of ethyl acetate extract of *Crataeva magna* bunch ham stem bark on rats

The present study was conducted to evaluate the hepatoprotective activity of ethyl acetate extract of stem bark of *Crataeva magna* (CM) in CCl₄ induced toxicity in Wistar albino

rats. The extract at the dose of 200 mg/kg and 400 mg/kg b. wt. was evaluated by inducing hepatotoxicity with CCl_4 and using silymarin (100 mg/kg) as the reference standard. Biochemical parameters like, SGOT, SGPT, SALP and serum bilirubin level were analysed. A section of liver was subjected to histopathological studies. Based on the above studies, it is reported that the ethyl acetate extract of *Crataeva magna* possess significant hepatoprotection against CCl_4 induced hepatotoxicity in albino rats.

Gas Chromatographic Study of Bio-active Compounds in Methanolic Extract of Leaf of *Crateva adansonii* DC

This study investigates the volatile bioactive components in *Crateva adansonii* plant that has been applied in the treatment of diverse ailments in the Western part of Nigeria and in Africa. The methanolic leaf extract of *Crateva adansonii* was subjected to analysis using gas chromatographic-mass spectrometric technique. The mass spectra of the compounds were analysed and identity of the compounds confirmed using the data base of the National Institute of Standard and Technology (NIST) library. The compounds identified includes n-Hexadecanoic acid; 9,12-Octadecadienoic acid (Z,Z); 9-Octadecenoic acid; (Z,E)-2,13-Octadecadien-1-ol; 9,17-Octadecadienal; cis-9-Hexadecenal; cis-Vaccenic acid; Z,Z-10,12-Hexadecadienal; 13-Octadecenal; Hexadecanoic acid 2-hydroxy-1-(hydroxymethyl)ethyl ester; E-11-Hexadecenal. Most of the compounds identified have antibacterial, anti-oxidant, anti-inflammatory and hypocholesterolemic properties, which affirms the therapeutic applications of *Crateva adansonii* as a medicinal plant.

Antihyperglycaemic and antioxidant activities of *Crataeva adansonii* DC. ssp. *adansonii* leaves extract on ICR mice

Crataeva adansonii DC. ssp. *adansonii* is a medicinal plant belong to Cappariaceae family, used traditionally by Togolese to treat diabetes mellitus. The aim of this study was to evaluate the antihyperglycaemic and antioxidant activities of the plant leaves. The effect of hydroethanolic extract of *C. adansonii* ssp. *adansonii* leaves was assessed *in vivo* on blood glucose levels in fasting normal and glucose loaded hyperglycemic (oral glucose tolerance test) mice. The phytochemical screening has been done by coloring tests in chemistry. *In vitro* antioxidants assays had been performed by 2, 2'-azobis 2 amidinopropane dihydrochloride (AAPH) free radical scavenging assay, Ferric reducing antioxidant power (FRAP) assay, Fe^{2+} chelating assay and total antioxidant capacity (TAC) quantification. After 30 min glucose loading (4 g/kg), the extract 500 mg/kg was showed a significant ($p < 0.001$) decreased of the peak of blood glucose compared to the hyperglycemic control. The two doses of extract (250 and 500 mg/kg) did not act on the basic blood glucose compared to the normoglycemic control. Phytochemical screening revealed a presence of flavonoids, tannins, alkaloids and sterols. AAPH free radical scavenging activity, reducing power, Fe^{2+} chelating activity and total antioxidant capacity have shown dose-dependent antioxidant capacity and reducing power of extract compared to ascorbic acid and Butylated hydroxyl Toluene used as reference drug. These finding prove that *C. adansonii* ssp. *adansonii* leaves can be used in the treatment of diabetes mellitus and its complications related to oxidative stress and support the use of the plant in traditional medicine in diabetes treatment.

Evaluation of anti oxidant activities of *Crateva magna*

The present study was to compare the effects of in-vitro antioxidant activity between the various leaf extracts (Petroleum ether, Benzene, Ethyl acetate, Methanol and Ethanol) of

Crateva magna. The free radical scavenging activity was found to be high in ethanol and methanol extracts for DPPH, hydroxyl, superoxide, ABTS and reducing power assays in a concentration dependent manner followed by ethyl acetate, petroleum ether and benzene extracts. The present results recommend that the leaf extracts (methanol and ethanol) of *C. magna* could serve as potential alternative source antioxidants and can be explored as a good therapeutic agent in the free radical induced diseases.

3. CONCLUSION

It is concluded that *Crateva adansonii* contain active phytochemicals of therapeutic potential and that the extract is safe for clinical application. The results show that *Crateva adansonii* contains microelements which include Zn²⁺, Fe²⁺, Co²⁺, K⁺, Ca²⁺, Mg²⁺, Mn, Cu²⁺, Cl⁻, SO₄²⁻ and phytochemical constituents which include alkaloids, tannins, saponins, steroids, flavonoids and terpenoids. The plants therefore may have some therapeutic values. The current evaluation indicated that lupeol has antioxidant properties by scavenging free radicals, decreasing lipid peroxidation and increasing the endogenous blood antioxidant enzymes levels. The results suggest that this plant has vast variety of phytochemicals which can be used as effective remedy for various ailments and drug formulations in future either alone or in combination with other suitable agents. The ethnic claims of this plant were also verified by the present study as there was presence of phytochemicals which show these activities.

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