REVIEW
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A review of the phytochemical constituents and pharmacological activities of Nagkesar (*Mesua ferrea* Linn)

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Author contribution

Uddhav Patangia was responsible for design and concept of paper, Dr. Ankita Wal was responsible for writing of manuscript, Divyanshi Gupta was responsible for making figure and structures of chemical constituents, Indu Singh was responsible for literature survey, Dr. Pranay Wal was responsible for compilation and editing of the manuscript.

Competing interests

The authors declare no conflicts of interest.

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Abbreviations

DPPH, 2,2-diphenyl-1-picrylhydrazyl; CAT, catalase; GPX, glutathione; GR, glutathione reductase; MXA, mesua-xanthones-A; MXB, mesua-xanthones-B; CNS, central nervous system; MES, maximum electro-shock seizure; Hep-2, human laryngeal cancer; WBCs, white blood cells.

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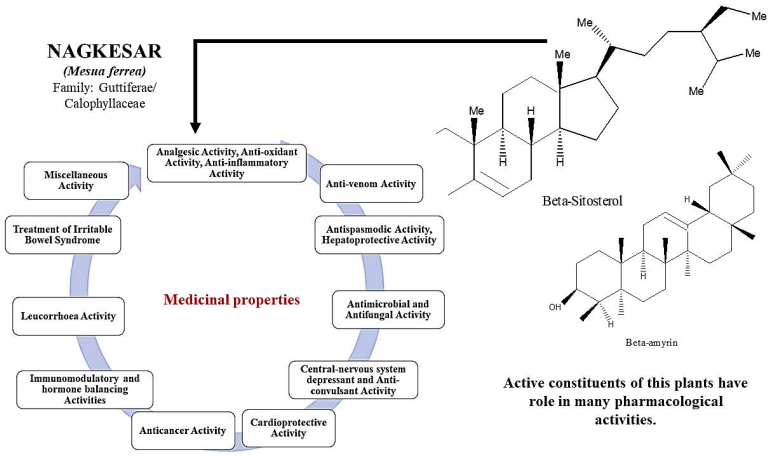
Abstract

Earth is a heritage of plants with an abundance of species, many of which are known among us, but many of them are still unknown for us. There are many traditional plants which have been used for medicinal purposes since ancient times, and Nagkesar (*Mesua ferrea* Linn) is one of them, which is grown in many countries like India, Indochina, Nepal, Thailand, Sri Lanka and many other countries. It is used to treat diseases like bleeding piles, renal disease, dysentery, fever, and asthma, as well as bacterial and fungal infections. It is known for its medicinal properties but has also been used as an ornamental plant since ancient times. It contains active phytoconstituents like steroids, coumarins and their derivatives, terpenoids, xanthones and their derivatives, flavonoids and pyranoxanthones, which act as precursors of other ailments. The goal of this study is to summarise the all-pharmacological activities of Nagkesar as well as some novel uses of Nagkesar. A thorough bibliographic investigation was launched by examining internationally recognized scientific databases such as Cochrane library, PubMed, ScienceDirect, Web of Science, Google scholar, and several data sets from Herbalist library. We searched several clinical trial databases of the recent past year and previous systematic reviews from 1980–2022. In this review article, all probable pharmacological effects of the Nagkesar plant, as well as the active components responsible for the biological role, are discussed. Nagkesar is important in the treatment of a variety of ailments. Inflammation, bleeding piles, bronchitis, severe infection, fungal growth, diarrhea, and kidney disease are among conditions that can be treated with the Nagkesar plant.

Keywords: Nagkesar; phytochemistry of Nagkesar; pharmacological profile of Nagkesar; miscellaneous activity of Nagkesar



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Highlights

1. In this study, we summarise all of the essential information regarding the Nagkesar (*Mesua ferrea* Linn) plant, including its morphology and phytoconstituents.
2. We also discuss the plant's pharmacological significance in the treatment of a variety of ailments.
3. The Nagkesar plant's negative effects and potential factors are also mentioned.

Medical history of objective

The Nagkesar plant has been used since very early times and is well known for its many therapeutic benefits. It has been shown to have a wide range of pharmacological effects, including anti-oxidants, anti-inflammatory, analgesics, anti-venom, anti-spasmodic, hepatoprotective, anti-microbial, anti-fungal, central-nervous system, depressive, anti-convulsant, cardio-protective, anti-cancer, immunomodulatory, and hormone balancing activity. Additionally, a recent literature review revealed that Nagkesar use in coesmaceuticals and numerous ayurvedic formulations has increased. This plant exhibits promising outcomes in a variety of pharmacological actions, which are indicative of recent developments in the treatment of disorders.

Background

Nagkesar (*Mesua ferrea* Linn) is one of the ethnobotanical plants. It is used traditionally and also much research is going on it for the exploration of more activities of Nagkesar. Plants that originated drugs are widely used due to social and cultural beliefs, and they are still used today due to ethnobotanical plants used since ancient times [1, 2]. Ayurveda, Siddha, Unani, Egyptian, and Chinese systems of medicine play an important role in the use of herbal or plant-based drugs from ancient era to the modern era [3]. Nowadays, formulation is either plant-based or contains some amount of herbal material with chemicals [4, 5]. It is used in the formulation of Chyawanprash, which contains plant material used in the improvement of the immune system [6]. It was originated by J. Mesue and its Latin meaning is "belonging to iron", which refers to very hard and durable timber. The Nagkesar belongs to the family of Guttiferae, which has different genera like Mesua, Cratoxylum, Garcinia, Hypericum, and Vismia. It contains a total of 46 genera with 100 species, which are mainly found in Asia, Polynesia, Brazil, Africa, and New Caledonia. Commonly, it is known as Indian rose chestnut, poached egg tree, Ceylon ironwood, ironwood tree, mesua, cobras saffron. It has been used since traditional or ancient times for the treatment of fever with cough and cold. Nagkesar leaves and the seeds of Nagkesar are useful in the treatment and therapy of various diseases.

In recent research, it was found that Nagkesar has many pharmacological therapeutic activities like antimicrobial, anti-inflammatory, anticancer, antifungal, and immunomodulatory effects. Nagkesar is used by Assamese tribes as a purgative, antiseptic, bitter tonic, worm control, and blood purifier [7]. Traditional Thai people used Nagkesar to treat fever, asthma, and colds, as well as as a cardio tonic, carminative, diuretic, expectorant, and antipyretic [8, 9]. According to folk remedies, every part of this plant is used in the form of herbal medicine for the prevention or treatment of diseases such as: leaves are used as antidotes for snake bite and scorpion sting and leaf ashes for sore eyes; flowers are used as antidotes, expectorant, astringent, and astringent; their extracted oil is used for poultice, sores, wounds, scabies, cutaneous infection, and rheumatism [10]. Its taxonomical classification is as follows in Table 1 [11].

Morphology

Its size ranges from medium to large, with a height of 20–30 m [12]. It is short-trunked with buttresses at the base of the plant. Leaves are red in colour during their mature phase and then turn green afterward [13, 14]. Flowers are white with a fragrance, and they contain yellow-colored stamens. Leaves look simple, ovate and narrow in shape, with a size of 3 to 5 inches long. Fruits are long, about 2.5 to 5.0, with an oblong shape, and their appearance is ovoid-globose, which has conical-point, striate, 1–10 loculed, 1–4 seeded [15]. Seeds are dark brown in colour, and the cotyledon is fleshy and oily [16]. Every part of this plant is edible and useful for us.

Table 1 Taxonomical classification of Nagkesar

Taxonomical classification	Taxon
Kingdom	Plantae
Division	Tracheophyta
Class	Mangoliopsida
Order	Malpighiales
Genus	Mesua L.
Family	Guttiferae/Calophyllaceae
Species	Mesua ferrea

Geographical distribution

It is an evergreen plant that is found in many countries like Indochina, Nepal, Sri Lanka, Myanmar, Thailand, Burma, Philippines, Cambodia, and India. It is mainly grown in Andaman, East Bengal, and Assam and covers the evergreen rain forest of the Western Ghats [17]. Studies conducted on the genome sequence of Nagkesar help in the competitive study with other topical forest plants, which helps in the study of demographic historical changes with climatic changes in the plants which are found in the topical forest and determine the evolutionary changes from the eras [18].

Basically, the plant contains phenyl coumarins, xanthones, steroids, flavonoids, terpenoids, and pyranoxanthones (Figure 1), which are secondary metabolites, some of which act as precursors. The following 4-phenylcoumarins are isolated from Nagkesar seed oil: mesuone, mesuagin, mammeigin, mesuol, and mammeisin [19–21]. 4-alkylcoumarins A and B, a lupeol-type triterpenoid-guttiferol, ferraxanthone, 1,6-trihydroxyxanthone, 1,5-dihydroxyxanthone, mesuaxanthones (A) and mesuaxanthones (B), 1-hydroxy-7-methoxyxanthones, 1,7-dihydroxyxanthone, and β-sitosterol were produced by the trunk. The kernel of the seed contains 75% of yellow oil, which consists of glycerides, linoleic, o-leic, stearic, and arachidic-acids, fatty acids, and Nahor is one of the oils which is extracted from the seed of Nagkesar [22]. A stamen contains mesuone, 1,5-dihydroxyxanthone, mesuaferrol, euxanthins, leucoanthocyanidin, β-sitosterol, mesuanic acid, euxanthins, 7-methyl ether, alpha and beta-amyrin, which help in the yielding of Nagkesar [23]. Xanthone derivatives like euxanthones and some essential oils are also extracted from part of the plant. Mesuaxanthones (A) and mesuaxanthones (B) are two new yellow pigments that have been found in Nagkesar heart wood [24].

Pharmacological profile

Figure 2 shows the active parts of the Nagkesar plant, which are used to treat and manage a wide range of health problems.

Anti-oxidant activity

According to the in vitro study conducted on 3 different species of Nagkesar, like *Cinnamomum wightii Meisin* from the family Lauracea, *Mesua ferrea* L. from the family Guttiferrea, and *Ochrocarpus longifolius* Benth & Hook F. from the family Guttiferrea, shows the presence of phenolic and flavonoid compounds or components in the Nagkesar, which are responsible for antioxidant property [25]. Nagkesar leaves show significant antioxidant activity, which shows activity against 2,2-diphenyl-1-picrylhydrazyl (DPPH) free-radical scavenging. Ethanol extracts show 70% of antioxidant activity [26]. Another study of antioxidants by using methanol extract of Nagkesar flower

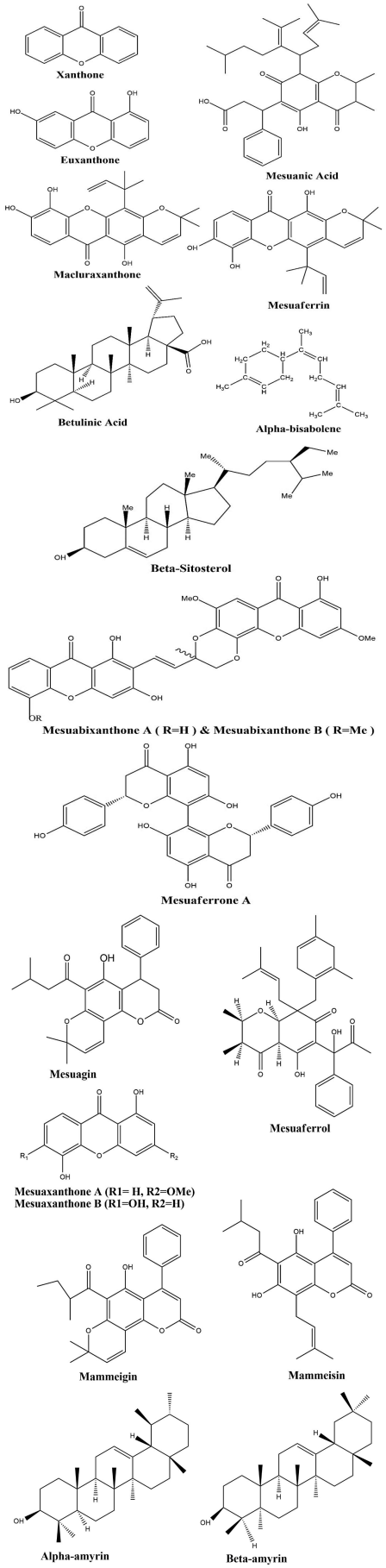

Figure 1 Chemical constituents of Nagkesar plant

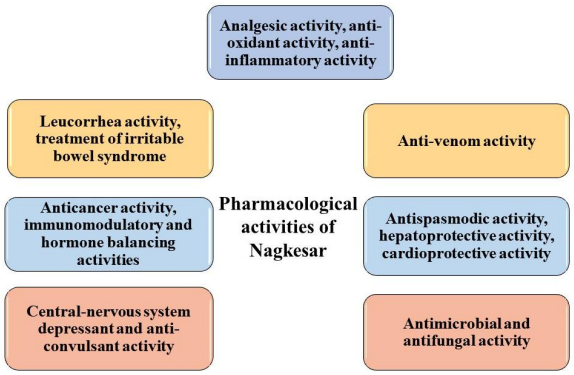

Figure 2 Pharmacological activities of Nagkesar plant

possesses activity against DPPH free-radical, super-oxide and hydrogen-peroxide in scavenging-assays [27]. A study on Nagkesar root methanol polar extract discovered that it was more active than less polar or non-polar extract [28]. Nagkesar flower extract in water and hot water shows stronger antioxidant activity against DPPH in a scavenging assay and these extracts are more effective than butylated hydroxytoluene, which is a standard antioxidant agent with an EC_{50} value of 6.95–7.49/mL [29]. Nagkesar stem bark extract in chloroform and methanol shows antioxidant activity in the in vitro models, and this study reported that it protects red blood cells (erythrocytes), hemoglobin and DNA from oxidative stress without damaging healthy cells of the body. Studies reveal that methanol extract is more effective than chloroform extract [30]. A recent study conducted on Nagkesar stamen extract in n-hexane solvents shows activity against free radicals with an IC_{50} value of 66.3 µg/mL [31]. Female Whistar rats showed that dried flowers of Nagkesar extracted in methanol have antioxidant and liver-protecting effects and this study has been done with the help of *Staphylococcus aureus*, which is administered in the form of drinking water for 24 hours during the experiment. The results revealed that reduction in the catalase (CAT), the glutathione (GPX), the glutathione reductase (GR) and the alanine aminotransferase while creatinine phosphokinase and creatinine remained the same, showed no activity in the mice [32]. At 100 g/mL, an ethanolic extract of Nagkesar flower has a strong inhibitory action (96.03%) against nitric oxide. Nagkesar leaf extract in a mixture of water-ethanol (1:1) shows significant inhibitory action on lipid peroxidation [33]. Some Ayurvedic formulations, i.e., Brahma rasayana & maharishi Amrit kalash-4 which contains Nagkesar, show significant antioxidant activity in the isolated rat heart and cold stressed chicken [34, 35]. Nagkesar extract shows the anti-oxidant activity by balancing the redox reaction and showing the direct antioxidant effect as shown in Figure 3.

Anti-inflammatory activity and analgesics activity

Extract of Nagkesar stem bark in ethanol shows 80% anti-inflammatory activity in comparison with Indomethacin. During this study, it was found that the 100, 200 and 500 µg/mL concentration of ethanol extract shows a stronger effect of anti-inflammatory action in the in vitro bioassays [36]. Nagkesar with other herb combinations (Shishavaleha) shows activity against oedema in albino rat paw induced by carrageenam and mesua-xanthones-A (MXA) (37%) and mesua-xanthones-B (MXB) (49%), respective responses [37]. Nagkesar shows anti-inflammatory action because of the presence of xanthone derivatives like MXA, MXB, euxanthones, calo-phyllin-B, dehydro-cycloguanandin, jacareubin and the 6-desoxy jacareubin. MXA and MXB also inhibit the granuloma pouch test, with MXA showing 46% activity and MXB showing 49% activity when combined with the normal group. Xanthones show significant anti-inflammatory activity in normal rats and also show effective responses in adrenalectomized rats, showing MXA (38%) and MXB (22%) responses. Xanthone derivatives can also

reduce cotton pellet granuloma tests by up to 47% [38]. Nagkesar leaf extract (125 & 250 mg/kg) in different solvents such as n-hexane, ethyl-acetate, and methanol shows significant analgesic action against writhing-response and visceral pain in mice induced by acetic acid. The lower dose of different solvent extracts is 36.09%, 16.33% & 10.21% and the higher dose of different extracts is 42.21%, 19.63% & 17.06% [39, 40]. Nagkesar inhibits cytokines and mediators and aids in the inflammation and analgesics activity as shown in Figure 4.

Anti-venom activity

Nagkesar plays a significant role in toxicity which occurs during chemotherapy of breast cancer, Nagkesar is present in maharishi Amrit kalash-4, which is found to have a significant effect in reducing toxic levels [41]. Nagkesar leave extract in aqueous solvent shows activity against fibroblast cell lysis, which is induced with the help of *Heterometric laoticus* scorpion venom. Viability of fibroblast cell lysis shows result after 30 min when treatment with extract shows protective action against venom induced lysis in the mock-control group with 0.71 mg/mL and 0.41 mg/mL [42]. Anti-venom activity of Nagkesar extract was explained in Figure 5.

Antispasmodic activity

Nagkesar seed oil extract in petroleum possesses antispasmodic activity, in the rat ileum in in vitro studies. Acetylcholine and carbachol show contraction up to 2.61 cm and 3.2 cm. Different crude oil concentrations, such as 1:5 and 1:10, normally reduce acetylcholine contraction by up to 70% and 86%, respectively. Normally, atropine reduces the acetylcholine response by up to 55%. activity of the rat ileum was measured with the help of a kymograph [43].

Treatment of irritable bowel syndrome. Nagkesar Churna (contains whole plant of Nagkesar) shows effective results with Pranayama in the treatment of disease irritable bowel syndrome on patient with age group 20–40 and already affected with irritable bowel syndrome. It is functional disorder which causes cramps due to the intestinal wall become sensitized to the mild stimulus. According to the study report, a significant improvement was observed by the use of formulation [44]. It helps in reducing the colonic motility and thereby, helps in irritable bowel syndrome. Powder of Nagkesar aids digestion and also increased the vital capacity of lungs getting increased for the proper utilization of prana. Hence, it was assumed that the Nagkesar plant shows anti-spasmodic effect by inhibition the action potential generation in the acetyl choline and muscarinic receptor which is further responsible for the inhibition of myosin which results in the smooth muscles relaxation and therefore also relax colonic motility and cramps as shown in Figure 6.

Hepatoprotective activity

Methanol extract of Nagkesar stamen shows improvement in liver-enzymes like superoxide dismutase, CAT, GPX, and GR with a decrease in levels of alpha-1 antitrypsin and Aspartate aminotransferase enzymes. Dried flowers of Nagkesar extract in methanol have antioxidant and hepatoprotective activity, as demonstrated by female Whistar rats. The results revealed that reduction in the CAT, GPX, GR and the alanine aminotransferase, while creatinine phosphokinase and creatinine remained the same, showed no activity in the mice. At 100 g/mL, an ethanolic extract of Nagkesar flower has a strong inhibitory action or activity (96.03%) against nitric oxide. Nagkesar leaf extract in a mixture of water-ethanol (1:1) shows significant inhibition action on lipid peroxidation. Another hepatoprotective activity of different Nagkesar stamen extracts is found to be an effective decrease in oxidative stress on liver cell culture which is induced with the help of carbon tetrachloride in the in vitro model, but n-hexane and ethanol extract were found effective against oxidative stress [45, 46]. It was found that the due to the presence of phenolic compounds in different part of Nagkesar plant like leaf, flower & stamen which is extracted into different solvent system i.e., methanol, ethanol & water possess hepatoprotective property which involved mechanism that transferring of hydrogen atom, by transferring of a single electron, sequential loss of proton by electron transfer and by chelation of the transition of metals.

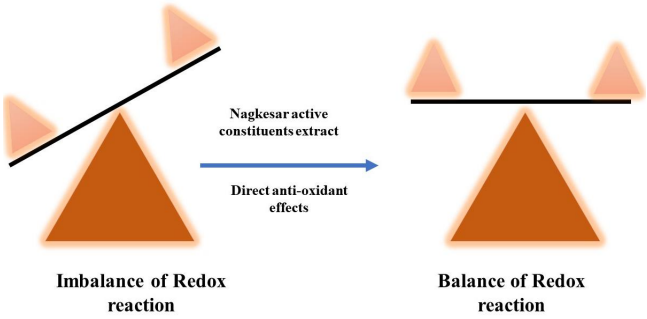

Figure 3 Nagkesar shows anti-oxidant activity

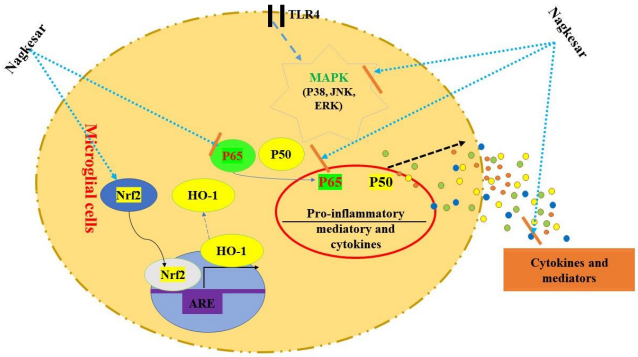

Figure 4 Nagkesar shows potent anti-inflammatory and analgesics activity. MAPK, mitogen-activated protein kinases; TLR4, Toll Like Receptor 4; JNK, C-Jun Kinase enzyme; ERK, extracellular signal-regulated kinase; HO-1, Heme oxygenase 1; Nrf2, Nuclear factor erythroid 2-related factor 2; ARE, Antioxidant response element.

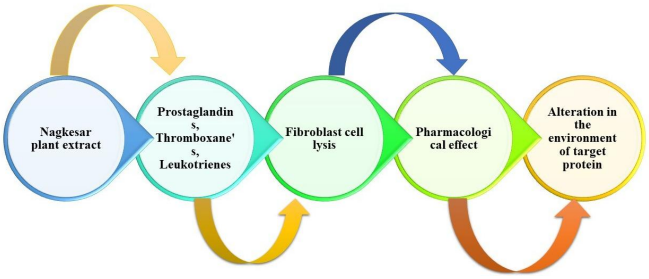

Figure 5 Nagkesar role in anti-venom activity

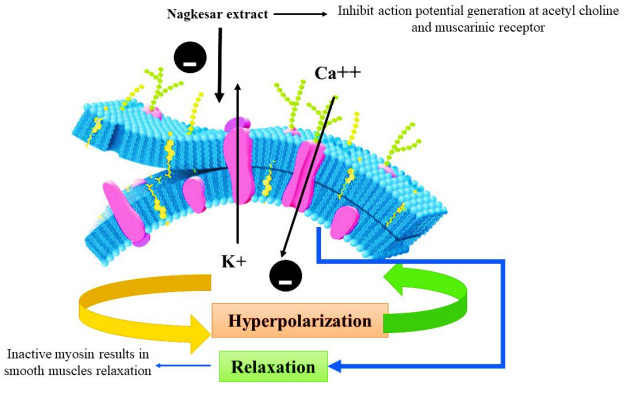

Figure 6 Anti-spasmodic activity of Nagkesar plant. Due to its relaxation property, it is also prefer in the treatment of irritable bowel syndrome.

Antimicrobial and antifungal activity

Phytochemical, coumarins like (4-alkyl as well as 4-phenyl 5,7-dihydroxy-coumarins) and their derivatives 6-acyl 8-prenyl derivatives (mixtures of isomeric coumarins (MF)1 with MF2), 8-acyl-6-prenyl-derivatives (MF3 with MF4), 6-acyl-7,8-dihydro-furano-derivatives (MF5 with MF7), 6-acyl-7,8-pyrano derivatives (MF8 with MF9) which is obtained from Nagkesar flower having significant antimicrobial-action against gram-positive bacteria as well as Gram-negative bacteria and the strains of fungi like falciparum. MF5, MF8 & MF9 possess activity against genus of *Staphylococcus* & *Enterococci*. Mesua derivatives possess higher minimum inhibitory concentration 50% with 2–4 µg/mL dose [47]. Methanol extract of Nagkesar leaves possess antibacterial activity against different strain of bacteria like *Shigella*, *Salmonella*, *Staphylococcus aureus* and *Escherichia coli* tested in the mice [48, 49]. Nagkesar stem bark polar extract effective against both type of bacterial-strain i.e., Gram-positive and Gram-negative [50]. Nagkesar flowers also show activity against the five different-different strains of Salmonella species and the extracts was effective at 50 µg concentration on all five-type bacterial strain. The flower extract possesses in vivo anti-bacterial activity in the *Salmonella typhimurium*, national collection of type cultures 74 in the mice & shows significantly reduces the viable count of strains present in liver, spleen-en and heart-blood with 2–4 mg/mouse [51]. Methanolic extracts of Nagkesar seeds possess anti-fungal activity against different strains of fungi or fungus like *Candida-albicans*, *Mucor-hiemalis* and the other species [52]. Another study report shows that Nagkesar seed oil contains epoxy resin which is effective against the Klebsiella-pneumonia which is Gram negative & the *Staphylococcus aurens* which is Gram-positive strains of bacteria [53]. Gel formulation containing Nagkesar found effective against skin infection with resistant strains caused which is caused by Corynebacterium species, *Pseudomonas aeruginosa* & *Staphylococcus aureus* [54]. The different bio-oils extracts of Nagkesar effective against different strains of bacterial and fungal infection [55].

Due to the presence of coumarins derivative which is obtained from different part of Nagkesar plant like seed, stem, bark, flower & leaves which extract out into the methanol & other polar solvent system and it involves the inhibition action of coumarins derivatives which is depend upon the substitution pattern and it also work on apoptosis. Additionally, xanthones are prized for their powerful antibacterial and antifungal effects. These outcomes assist in preventing fungal and viral infections as well as the removal of some carcinogens from the body's systems. Additionally, the dried mangosteen rind's xanthones are beneficial for keeping good skin [56]. The mechanism of anti-microbial activity of Nagkesar plant was explained in the Figure 7.

Central-nervous system depressant and anti-convulsant activity

Phytoconstituent of Nagkesar, xanthones and their derivative found effective in central nervous system (CNS) depressant effects, like sedative-effect, loss of muscle-tone and reduced in spontaneous activities. CNS gross behavior screened in mice with a dose of ten, twenty-five, fifty, hundred, two-hundred & five hundred mg/kg. The changes in behavior were recorded at fifteen, thirty, sixty & hundred-twenty min. Results show CNS depressant activity at dose 200 mg/kg. Nagkesar flower extract shows anticonvulsant activity against Phenobarbital induced convulsant activity. Ethanolic extract of Nagkesar flower shows anticonvulsant activity in three different concentrations (200, 400 & 600 mg/kg. p.o.) by using maximum electro-shock seizure (MES) test with albino-mice. Extracts minimize the duration or time span of hind-limb-tonic-extension in a dose dependent act against the MES model and show activity against convulsions which is induced by MES model and results are 100% ($P < 0.01$) for 200 mg/mL, 60% ($P < 0.01$) for 400 mg/mL and 100% ($P < 0.001$) for 600 mg/mL. This study shows increment in onset time and decrement in duration of seizures by MES model [57].

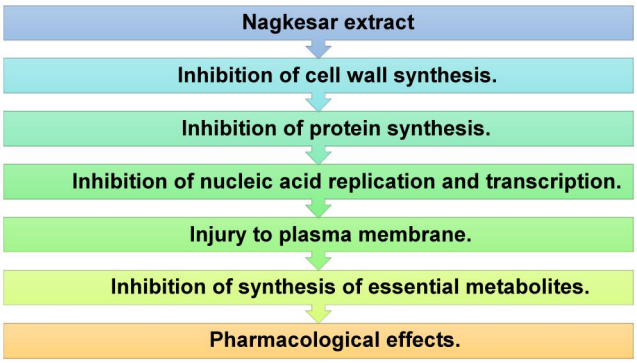

Figure 7 Anti-microbial activity of Nagkesar plant

Cardioprotective activity

Marketed polyherbal formulation (Ashwagandha Rishta) contains Nagkesar stamen shows activity against myocardial infarction in the albino-rat model which is induced by isoproterenol. Treatment with polyherbal shows significant changement in the levels of serum markers enzymes aminotransferase like alanine aminotransferase, aspartate aminotransferase, creatinine kinase & lactase dehydrogenase with the significant improvements in the serum lipid profile level and cardioprotective action of polyherbal formulations increased in the in vivo anti-oxidant level of Glutathione and the inhibition of lipid peroxidation of cardiac membrane in the treatment of rats [58].

Anticancer activity

Crude ethanolic extract of Nagkesar flower tested against human cancer cell i.e., human laryngeal cancer (Hep-2), cholangiocarcinoma, human hepatocarcinoma cell lines in the in vitro studies, but it found selectively against Hep-2 cell lines. Extract possess potent cytotoxic activity against Hep-2 & human hepatocarcinoma [59]. Essential oil obtained from Nagkesar leaves shows activity against cancer cell lines i.e., oral carcinoma, breast adenocarcinoma (michigan cancer foundation-7) and (metastatic lung carcinoma) neuronal ceroid lipofuscinoses [60]. Methanolic extract possess activity against the Ehrlich ascites carcinoma cells in mice and shows inhibitory action against tumor growth [61]. Muthu Marunthu is a polyherbal formulation which contains about 100 mg of Nagkesar which is found to be effective against anti-tumor effect on the experimental fibro sarcoma-cells in rats. Results revealed the remarkable reduction in the level of DNA, RNA, vitamin A, vitamin C & vitamin E, zinc and selenium and elevation in copper level. About 20 days treatment with polyherbal formulation shows normal level of trace element and finds no significant changement in blood level of urea, glucose, plasma protein & cholesterol and serum enzymes like lactate dehydrogenase, glutamate oxaloacetate transaminase and glutamic-pyruvic transaminase, alkaline as well as acid phosphate in comparison between normal rats with rat treat with polyherbal formulation [62].

Immunomodulatory and hormone balancing activities

Nagkesar seed oil contains mesuol which shows immunomodulatory activities for both humoral and cellular immune system. Nagkesar flower extract shows activity like estrogen and progesterone which is beneficial during menstrual cycle by improvement in hormone level. Mesuol which is isolated from Nagkesar shows immunomodulatory effects in the animal experimental model by using the specific as well as non-specific immune responses. In case of humoral-immune responses, mesuol shows dose dependent increasement in the antibody values in cyclophosphamide (about 50 mg/mL in nineth and sixteenth day) induced immunosuppressant which was sensitized with sheep red blood cells on seventh and fourteenth day of experiment. And in case of cellular-immune response model, shows an increasement in paw volume recorded on twenty-third day in cyclophosphamides induced immunosuppressant effect rat treat with sheep red blood cells with 0.03 mL of 2% v/v, s.c. on the twenty-first day. Then mesuol help in restoring of hematological activity or profile in cyclophosphane-amide induced myelo-suppression modeling and mesuol increase in the

percent of neutrophil-adhesion test in rats and phagocytosis in carbon-clearance assay. All these above studies show immuno-modulatory effects of mesuol [63]. Polyherbal formulation containing Nagkesar flower buds shows activity against, immunomodulation effect on radiation induced immunosuppression. Result revealed increasement in amount of circulating antibody in animals treated with the ACII & dose are 250 mg & 1g/kg. No change will be seen in body weight of irradiated animals, no changement in hemoglobin content of the irradiated animal on comparison with normal or treated animal and no change in the count of lymphocyte-neutrophil ratio. Significant changes in the lower level of white blood cells (WBCs), increased the count of WBCs and improvement in bone-marrow cellularity with improvement in α-esterase positive-cells and weight of thymus increases in the ACII in comparison with treated animals to irradiated animals [64]. ACII found to have an immunomodulatory activity in normal and in cyclophosphamide treated animals [65, 66].

Leucorrhoea activity

Nagkesar (contains whole plant of Nagkesar) along with the Takra Odan used in the treatment of leucorrhoea (Swetapradar) which is common problem among the women. This study conducted by open controlled-randomized method on two different patient groups in which all patients were women and women with vaginitis or cervicitis, intrauterine contraceptive device or pelvic inflammatory disease and anemia and it also includes married women. This problem generally occurs during puberty of girls and it is also caused by much reason like excessive stress, improper diet and unhygienic conditions. According to the report, formulation stimulates astringent action in vaginal mucosa which helps in reduction of excessive vaginal discharge and pelvic congestion [67].

Miscellaneous activity

Diuretic activity of Nagkesar was shown by polyherbal formulation (Draksharishta-T and -M) contains stamen which shows activity against natriuretic, diuretic and kaliuretic in albino rats for 5 h with 2.0 mL/kg dosing. Antidiabetic activity of Nagkesar was shown by leaves extraction in methanol which significantly increases the level of insulin secretion from β-cells of pancreases as well as normalizes the blood glucose level in the diabetic-rats which induced by streptozotocin [68]. Herbal formulation of Nagkesar (Bresol) contains flower which shows activity against chronic obstructive pulmonary disease, which is induced by the help of cigarette smoke in rats. About 250–500 mg/kg rats were treated for 5 weeks which shows significant action with reduction in the inflammated tracheal, decreasement in TNF-α as well as protein levels of bronchoalveolar lavage fluid with normal cellular structure [69]. Nagkesar contains seed kernel oil which found to be effective against water disinfectant which is natural way to remove disinfectant from water and study result revealed that Nagkesar kernel seed oil shows significant disinfectant activity with 0.04 value of first order modeling [70]. Aerial parts ethanolic extract of Nagkesar contains tannins which shows wound healing action on rat models when applied as ointment on excision and incision wounds [71]. Xanthones like 6-desoxy jacareubin and jacareubin isolated from Nagkesar which shows antiulcer activity shows reduction in ulcer in rats in comparison with control group shows hemorrhagic spots with perforation. Different extracts of Nagkesar seed like alcohol, petroleum ether and ethyl acetate show activity against anti-arthritic which is induced by complete Freund's adjuvant as well as formaldehyde in the rats. Study result shows significant activity against anti-arthritic and shows normal level of red blood cells, WBCs and hemoglobin [72]. Polyherbal combination contains Nagkesar which shows activity against hemorrhoid (bleeding piles) in the 22 humans during clinical trial in 16 patient effective actions and improvement in their condition [73]. Herbal formulation like Roidosanal and Daflon which contains Nagkesar shows effective results against anorectal condition of grade 1 as well as grade 2 [74]. Recent study shows α-amylase and anticholinesterase inhibition action which is significant against Alzheimer [75, 76].

Nagkesar uses in ayurveda

There are several ayurvedic formulations which uses Nagkesar as active ingredients in their formulation. Several ayurvedic formulation of Nagkesar are shown in Table 2 [77].

Recent trends of Nagkesar uses in cosmeceuticals

Nagkesar is used as medicinal plant but it is also known for their cosmeceutical value. Nagkesar is beneficial for both skin as well as hair. Nagkesar rich in antioxidant due to this property its shows beneficial effect on skin like healing of scars and acne, reduce blemishes and spots, reduce pigmentation, and act as anti-aging. It provides deep nourishment to the skin, reduces the skin pores, renew the skin and moisture it. It helps in the healing of wounds, scabies as well as relief from burning sensation due to their astringent properties and provides natural healthy skin. Due to its anti-inflammatory action Nagkesar reduces skin swelling, itching, redness and revives the skin from inflammation. It prevents oily skin problem and remove tan from the skin surface. It maintains natural skin tone and elasticity. It controls excessive sweating due to which it prevents bad smell of body [78].

Nagkesar promotes the growth of hair and their thickness. It provides protection from heat damage, maintains the shine of hair, remove tangle from hairs and nourishes hair from root. It regenerates the hair from hair follicles, provide strength to the hair from root, prevent breakage of hair due to the presence of antistress property & antioxidant action which controls the loss of excessive hair and promote the growth of new hair and enhance the volume of hair naturally. Nagkesar help in stimulates the hair follicle or root which also improve the growth of healthy hair natural and strong from the scalp. There are several cosmeceuticals in the market (mentiond in Table 3) which uses Nagkesar as an ingredient in their cosmetics product [79].

Conclusion

Nagkesar is one of the traditional plants which is used from the ancient time. It is utilized in the treatment of disease like fever, bleeding pile, asthma, bacterial infection, fungal infection, dysentery and renal disease. Different pharmacological action shows positive results which reflect the new advancement in the treatment of disease. Presence of some essential phytochemical in Nagkesar likes coumarins with their derivatives and xanthones with their derivates help to exhibit their pharmacological action. In this review paper, we

Table 2 Ayurvedic formulations of Nagkesar plant

No.	Ayurvedic formulation	Uses
1	Mahanarayan oil	Pain Relieving oil.
2	Puga Khanda	Used in the treatment of irritable bowel syndrome Vomiting, abdominal colonic pain, gastritis.
3	Gulgulwasavam	Used in the treatment of liver and spleen related illness.
4	Mahadraksha	Used in the treatment of digestive disorder as well as respiratory problems.
5	Shringarabhra rasa	Used in the management of digestive diseases.

Table 3 Marketed cosmetics products of Nagkesar

No.	Marketed product	Ingredients
1	Forest essentials facial Ubtan Narangi and Nagkesar	Nagkesar, saffron Narangi, camphor, lemon peel
2	Forest essentials Mysore sandalwood & Nagkesar facial treatment Masque	Nagkesar, sandalwood, Kaolin clay, kokum butter, almond oil, wheat germ, turmeric extract, Arnica extract, Kachoor, organic honey
3	Keshmax Ayurvedic hair oil	Manjistha, Nagkesar
4	Baidyanath mahabringraj tel	Haridra, Bringraj, Nagkesar, manjistha
5	Zordan hair fall	Bringraj, Nagkesar, majeeth
6	Beauty relay-ithyia Mysore sandalwood & Nagkesar face mask	Nagkesar, sandalwood, olive oil, argan oil, vitamin-E
7	Rosenia Ayurveda Ubtan with Narangi, chandan and Nagkesar	Narangi, chandan, Nagkesar
8	My good hair Ayurvedic hair oil	Amla, bhringraj, jatamansi, brahmi, Shikakai, haldi, methi, manjihtha, lodra, chandan, Nagar motha, Nag kesar, babchi, kapur kachri, harad, Yashtimadhu, anant mul, rasot, rose flower, Vach, Aloe vera, gudhal, mehendi, neem, kadi patta, tulsi, baheda, giloy, olive oil, almond oil, argan oil, jojoba oil, tea tree oil, sunflower oil, sesame oil
9	Jezara hair oil with made natural herbs	Dudhi pulp, Aloe vera, kapoor, kachli, chanothi herbs, baheda, amla, tulsi, jatamansi, babchi, mardasing, akkal garo, neem leaves, tajpan, Nag kesar, Galo, rose patti, triphala, Valo kapoor, elachi, black til oil, olive oil, vitamin-E, argan oil
10	Tru naturelle moisturizing face cleanser	Honey, rose, Nagkesar, anantbel, Aloe vera

concluded the positive impact on the field of research but research is ongoing process which develops new method and techniques for the Nagkesar and other plants.

References

1. Rai LK, Prasad P, Sharma E. Conservation threats to some important medicinal plants of the Sikkim Himalaya. *Biol Cons*. 2000;93(1):27–33. https://doi.org/10.1016/s0006-3207(99)00116-0
2. Ayyanar M, Ignacimuthu S. Ethnobotanical survey of medicinal plants commonly used by Kani tribals in Tirunelveli hills of Western Ghats, India. *J Ethnopharmacol*. 2011;134(3):851–864. https://doi.org/10.1016/j.jep.2011.01.029
3. Thakur S, Choudhary S, Walia B. Tulsi–a review based upon its ayurvedic and modern therapeutic uses. *Int J Res Rev*. 2021;8(5):263–272. https://doi.org/10.52403/ijrr.20210534
4. Henry Johannes TE. Traditional medicine with plants–present and past. *Med Aromat Plants*. 2014;3(3):1–3. https://doi.org/10.4172/2167-0412.1000e151
5. Lifongo LL, Simoben CV, Ntie-Kang F, Babiaka SB, Judson PN. A bioactivity versus ethnobotanical survey of medicinal plants from Nigeria, West Africa. *Nat Prod Biopros*. 2014;4(1):1–19. https://doi.org/10.1007/s13659-014-0005-7
6. Sharma UK, Hazarika D. Study of ethno-medicinal plants used by the mishing people of Dhemaji District of Assam, India. *J Nat Ayurv Med*. 2018;2(4):1–12. https://doi.org/10.23880/jonam-16000135
7. Sharma A, Sharma S, RR, NN, Parashar B. Mesua ferrae linn: a review of the Indian Medical Herb. *Syst Rev Pharmac*. 2016;8(1):19–23. https://doi.org/10.5530/srp.2017.1.5
8. Chahar MK, Sanjaya Kumar DS, Lokesh T, Manohara KP. In-vivo antioxidant and immunomodulatory activity of mesuol isolated from Mesua ferrea L. seed oil. *Int Immunopharmacol*. 2012;13(4):386–391. https://doi.org/10.1016/j.intimp.2012.05.006
9. Gallop AT. The spirit of Langkasuka? Illuminated manuscripts from the East Coast of the Malay Peninsula. *Indonesia Malay World*. 2005;33(96):113–182. https://doi.org/10.1080/13639810500282417
10. Kumar VP, Chauhan NS, Padh H, Rajani M. Search for antibacterial and antifungal agents from selected Indian medicinal plants. *J Ethnopharmacol*. 2006;107(2):182–188. https://doi.org/10.1016/j.jep.2006.03.013
11. Thakur S, Kaurav H, Chaudhary G. *Mesua Ferrea* L. (Nagkesar): a potent antimicrobial plant species. *Int J Curr Pharmac Res*. 2021;13(4):6–13. https://doi.org/10.22159/ijcpr.2021v13i4.42734
12. Umaru IJ, Fasihuddin BA, Otitoju OO, Hauwa AU. Phytochemical evaluation and antioxidant properties of three medicinal plants extracts. *Med Anal Chem Int J*. 2018;2(2):000119. https://doi.org/10.23880/macij-16000119
13. Patidar T, Daniel K, Daniel V, Sharma S. Pharmacognostical and phytochemical studies on stamens of mesua ferrea as potent anthelmintic agent. *Indian Drugs*. 2015;52(1):40–43. https://doi.org/10.53879/id.52.01.10229
14. Puspitarini PMA, Pratama IS, Suryadi BF. Anti-diarrheal activity of aqueous extract of Nagasari flowers (*Mesua Ferrea* L.) In Balb/C mice induced by escherichia coli. *J Pharmac Sci Community*. 2020;16(2):50–55. https://doi.org/10.24071/jpsc.001814
15. Asif M, Jafari SF, Iqbal Z, et al. Ethnobotanical and Phytopharmacological attributes of *Mesua ferrea*: a mini review. *J Appl Pharmac Sc*i. 2017;7(4):242–251. https://doi.org/10.7324/japs.2017.70435
16. Baslas KK, Deshpandey SS. Edible medicinal and non-medicinal plants fruits. *J Indian Chem Soc*. 1951;28:19–22. https://doi.org/10.5860/choice.49-6280
17. Joshi RK, Sharma AK. Determination of seasonal variation of volatile organic constituents of the leaves of traditional herb *Ocimum sanctum* L. *Indian J Pharmac Sci*. 2021;83(4):750–757. https://doi.org/10.36468/pharmaceutical-sciences.826
18. Patil AB, Shinde SS, Raghavendra S, Satish BN, Kushalappa CG, Vijay N. The genome sequence of *Mesua ferrea* and comparative demographic histories of forest trees. *Gene*. 2021;769:145214. https://doi.org/10.1016/j.gene.2020.145214
19. Teh SS, Ee GCL, Mah SH. Chemical constituents and new xanthone derivatives from *Mesua ferrea* and *Mesua congestiflora*. *Asian J Chem*. 2013;25(15):8780–8784.

https://dx.doi.org/10.14233/ajchem.2013.15615
20. Verotta L, Lovaglio E, Vidari G, et al. 4-Alkyl- and 4-phenylcoumarins from *Mesua ferrea* as promising multidrug resistant antibacterials. *Phytochemistry*. 2004;65(21):2867–2879. https://doi.org/10.1016/j.phytochem.2004.07.001
21. Zar Wynn Myint K, Kido T, Kusakari K, Prasad Devkota H, Kawahara T, Watanabe T. Rhusflavanone and mesuaferrone B: tyrosinase and elastase inhibitory biflavonoids extracted from the stamens of *Mesua ferrea* L. *Nat Prod Res*. 2019;35(6):1024–1028. https://doi.org/10.1080/14786419.2019.1613395
22. Teh SS, Ee GCL, Mah SH. Evaluation of nitric oxide inhibition effect in LPS-stimulated RAW 264.7 macrophages by phytochemical constituents from *Mesua beccariana*, *Mesua congestiflora*, and *Mesua ferrea*. *Med Chem Res*. 2017;26(12):3240–3246. https://doi.org/10.1007/s00044-017-2017-4
23. Sharma RS, Mishra V, Singh R, Seth N, Babu CR. Antifungal activity of some Himalayan medicinal plants and cultivated ornamental species. *Fitoterapia*. 2008;79(7–8):589–591. https://doi.org/10.1016/j.fitote.2008.06.004
24. Paudel K, Ramamurthy ProfDrA, Sharma G. Some important hepatoprotective medicinal plants in Ayurveda-A review. *Int Res J Ayurveda Yoga*. 2020;3(8):138–150. https://doi.org/10.47223/irjay.2020.3815
25. Maier C, Basu P. In vitro antioxidant activities and polyphenol contents of seven commercially available fruits. *Pharmac Res*. 2016;8(4):258–264. https://doi.org/10.4103/0974-8490.188875
26. Prasad DN, Rao BG, Rao ES, Rao TM, Praneeth DV. Quantification of phytochemical constituents and in vitro antioxidant activity of *Mesua ferrea* leaves. *Asian Pac J Trop Biomed*. 2012;2(2):S539–S542. https://doi.org/10.1016/s2221-1691(12)60269-x
27. Sahu AN, Hemalatha S, Sairam K. Hptlc fingerprinting and in vitro antioxidant studies of argyreia speciosa sweet leaves and *Mesua Ferrea* L. flowers. *Int J Res Ayurveda Pharm*. 2013;4(4):499–502. https://doi.org/10.7897/2277-4343.04407
28. Teh SS, Ee GCL, Mah SH, et al. In vitro cytotoxic, antioxidant, and antimicrobial activities of *Mesua beccariana* (Baill.) Kosterm., *Mesua ferrea* L., and *Mesua congestiflora* extracts. *Biomed Res Int*. 2013;2013:1–9. https://doi.org/10.1155/2013/517072
29. Makchuchit S, Itharat A, Tewtrakul S. Anti-allergic activity of Thai medicinal plants. *Planta Med*. 2009;75(9):PD48. https://doi.org/10.1055/s-0029-1234527
30. Rajesh KP, Manjunatha H, Krishna V, Kumara Swamy BE. Potential in vitro antioxidant and protective effects of *Mesua ferrea* L. bark extracts on induced oxidative damage. *Ind Crops Prod*. 2013;47:186–198. https://doi.org/10.1016/j.indcrop.2013.03.008
31. K Kc, K Gv, Hagos Z, D GR. Mesuaferrin a-bioactive flavonoid isolated from the bark of *Mesua Ferrea* L. against phospholipase A2, cyclooxygenase and lipoxygenase: an in vitro, in vivo and in silico approach. *Int J Pharm Pharmac Sci*. 2018;10(2):102–106. https://doi.org/10.22159/ijpps.2018v10i2.23576
32. Jain H, Sharma YK. Hepatoprotective activity of methanolic extract of leaves parts of *Chenopodium album* L. on carbon tetrachloride induced hepatotoxicity in waster rats. *J Biomed Pharmac Res*. 2022;11(2):52–58. https://doi.org/10.32553/jbpr.v11i2.910
33. Yadav AS, Bhatnagar D. Inhibition of iron induced lipid peroxidation and antioxidant activity of Indian spices and acacia in vitro. *Plant Foods Hum Nutr*. 2010;65(1):18–24. https://doi.org/10.1007/s11130-009-0150-z
34. Ramnath V, Rekha PS. Brahma rasayana enhances in vivo antioxidant status in cold-stressed chickens (Gallus gallus domesticus). *Indian J Pharmac*. 2009;41(3):115–119. https://doi.org/10.4103/0253-7613.55209
35. Cullen WJ, Dulchavsky SA, Devasagayam TPA, Venkataraman BV, Dutta S. Effect of Maharishi AK-4 on H2O2-induced oxidative stress in isolated rat hearts. *J Ethnopharmacol*. 1997;56(3):215–222. https://doi.org/10.1016/s0378-8741(97)01526-2
36. Dakshayini PN, Basha PM. Phytochemical screening and in vitro antioxidant potential of tribulus terrestris fruit and *Mesua Ferrea* flower extracts: a comparative study. *Int J Pharm Pharmac Sci*. 2018;10(3):70–75. https://doi.org/10.22159/ijpps.2018v10i3.24021
37. Galib, Prajapati PK, Ashok BK, Yadav SS, Ravishankar B, Varun B. Anti-inflammatory activity of Shirishavaleha: an ayurvedic compound formulation. *Int J Ayurveda Res*. 2010;1(4):205–207. https://doi.org/10.4103/0974-7788.76781
38. Chaithanya KK, V K G, ZenebeHagos, et al. In vitro and in vivo anti-inflammatory activities of *Mesua ferrea* L. *Int J Pharmac Phytochem Res*. 2018;10(3):103–111. https://doi.org/10.25258/phyto.v10i03.11940
39. Sruthikrishna PK. Review on ethnobotany and phytopharmacology on *Mesua ferrea* L. *Res J Pharmac Phytochem*. 2021;13(4):195–199. https://doi.org/10.52711/0975-4385.2021.00034
40. Chanda S, Rakholiya K, Parekh J. Indian medicinal herb: antimicrobial efficacy of *Mesua ferrea* L. seed extracted in different solvents against infection causing pathogenic strains. *J Acute Dis*. 2013;2(4):277–281. https://doi.org/10.1016/s2221-6189(13)60143-2
41. Saxena A, Dixit S, Aggarwal S, et al. An ayurvedic herbal compound to reduce toxicity to cancer chemotherapy: a randomized controlled trial. *Indian J Med Paediatr Oncol*. 2008;29(2):11–18. https://doi.org/10.4103/0971-5851.51426
42. Uawonggul N, Chaveerach A, Thammasirirak S, Arkaravichien T, Chuachan C, Daduang S. Screening of plants acting against Heterometrus laoticus scorpion venom activity on fibroblast cell lysis. *J Ethnopharmacol*. 2006;103(2):201–207. https://doi.org/10.1016/j.jep.2005.08.003
43. Dutta S, Karak N. Blends of *Mesua ferrea* L. seed oil based polyurethane with epoxy resin. *Pigment Resin Technol*. 2007;36(2):74–82. https://doi.org/10.1108/03699420710733501
44. Darshana, Singh A. Comparative clinical study of Nagradya Churna and Bhunimbadya Churna in management of Grahani w.s.r. toIrritable bowel syndrome. *J Ayurveda Integr Med Sci*. 2020;5(1):87–97. https://doi.org/10.21760/jaims.5.1.15
45. Arora P, Ansari SH, Nazish I. *Mesua ferrea*: an ethnobotanically important plant. *Am J Pharm Tech Res*. 2019;9(5):31–39. https://www.researchgate.net/profile/Poonam-Arora-3/publication/343776412_Mesua_Ferrea_An_Ethnobotanically_Important_Plant/links/5f5f4ae1a6fdcc116410b703/Mesua-Ferrea-An-Ethnobotanically-Important-Plant.pdf
46. Jagan Mohan Rao L, Yada H, Ono H, Ohnishi-Kameyama M, Yoshida M. Occurrence of antioxidant and radical scavenging proanthocyanidins from the Indian minor spice Nagkesar (*Mammea* longifolia Planch and triana syn). *Bioorg Med Chem*. 2004;12(1):31–36. https://doi.org/10.1016/j.bmc.2003.10.052
47. Wang SY, Wang YX, Guo YP, et al. New cytotoxic 4-alkyl-dihydroxyfuran coumarins from *Mesua ferrea*. *Phytochem Lett*. 2020;38:121–127. https://doi.org/10.1016/j.phytol.2020.05.008
48. Mazumder R, Dastidar SG, Basu SP, Mazumder A, Singh SK. Antibacterial potentiality of *Mesua ferrea* L. flowers. *Phytother Res*. 2004;18(10):824–826. https://doi.org/10.1002/ptr.1572
49. Mazumder K, Dey ZC, Dey S, Kabir MdF, Rahman M, Sajon SR. Evaluation of anti-diarrheal and anti-nociceptive activity of

methanolic unripe fruit peels extract of *Masua ferrea* L. on mice models. *Pharmac J*. 2019;11(4):828–835. https://doi.org/10.5530/pj.2019.11.133
50. Ali MA, Sayeed MA, Bhuiyan MSA, Sohel FI, Yeasmin MstS. Antimicrobial screening of *Cassia fistula* and *Mesua ferrea*. *J Med Sci*. 2003;4(1):24–29. https://doi.org/10.3923/jms.2004.24.29
51. Sivakumar B, Koumaravelou K. An approach of the plant *Mesua Ferrea* L. for the venom induced consumption coagulopathy (VICC), caused by the snake Echis Carinatus (Russel viper). *Int J Pharmac Res*. 2020;13(1). https://doi.org/10.31838/ijpr/2021.13.01.173
52. Thomas JE. Uncovering the chemical benefits of medicinal plants and functional foods presents new challenges and untold opportunities. *Med Aromat Plants*. 2012;1(4):1 https://www.longdom.org/open-access/uncovering-the-chemical-benefits-of-medicinal-plants-and-functional-foods-presents-new-challenges-and-untold-opportunities-map.1000e116.pdf
53. .G, Kalita RD, Gogoi P, Buragohain AK, Karak N. Antibacterial activities of copper nanoparticle-decorated organically modified montmorillonite/epoxy nanocomposites. *Appl Clay Sci*. 2014;90:18–26. https://doi.org/10.1016/j.clay.2014.01.002
54. Aparna M, Gayathri V. Formulation of culinary plant medicine against bacterial skin infections caused by staphylococcus sps. and streptococcus sps. *J Pure Appl Microbiol*. 2018;12(3): 1607–1615. https://doi.org/10.22207/jpam.12.3.67
55. Bordoloi N, Narzari R, Chutia RS, Bhaskar T, Kataki R. Pyrolysis of *Mesua ferrea* and Pongamia glabra seed cover: characterization of bio-oil and its sub-fractions. *Bioresour Technol*. 2015;178:83–89. https://doi.org/10.1016/j.biortech.2014.10.079
56. Xanthones sources, health benefits and uses. *Nat Pedia Com*. 2017. https://naturalpedia.com/xanthones-sources-health-benefits-and-uses.html#:~:text=Moreover%2C%20xanthones%20are%20highly%20valued%20for%20their%20impressive
57. Nandy S, Tiwari P. Screening of anti-inflammatory activity of *Mesua ferrea* L. flower. *Int J Biomed Res*. 2012;3(5):245–252. https://doi.org/10.7439/ijbr.v3i5.509
58. Fan Y. Cardioprotective effect of rhapontigenin in isoproterenol-induced myocardial infarction in a rat model. *Pharmacology*. 2019;103(5–6):291–302. https://doi.org/10.1159/000496800
59. Plengsuriyakarn T, Viyanant V, Eursitthichai V, et al. Anticancer activities against cholangiocarcinoma, toxicity and pharmacological activities of Thai medicinal plants in animal models. *BMC Complement Alt Med Ther*. 2012;12:23. https://doi.org/10.1186/1472-6882-12-23
60. Effects of chromium ore tailings on growth and physiological activities of *Mesua ferrea* L. Scientia Agriculturae. 2015;12(1). http://dx.doi.org/10.1080/15320383.2016.1174668
61. Masud Rana AYKM, Khanam JA, Asad-Ud-Daula M. Antineoplastic screening of some medicinal plants against ehrlich ascites carcinoma in mice. *J Med Sci*. 2004;4(2):142–145. https://doi.org/10.3923/jms.2004.142.145
62. Manonmani S, William S, Subramanian S, Govindasamy S. Biochemical evaluation of the antiulcerogenic effect of Cauvery-100 (an ayurvedic formulation) in rats. *J Ethnopharmacol*. 1994;42(1):1–5. https://doi.org/10.1016/0378-8741(94)90015-9
63. Aslam M, Saxena P, Sarma AK. Green technology for biodiesel production from *Mesua ferrea* L. seed oil. *Energy Env Res*. 2014;4(2):11–21. https://doi.org/10.5539/eer.v4n2p11
64. Tharakan ST, Kuttan G, Kuttan R, Kesavan M, Austin Sr, Rajagopalan K. Effect of AC II, an herbal formulation in cyclophosphamide-induced immunosuppression in BALB/c mice—implication in HIV treatment. *Immunol Investig*. 2007;36(2):147–157. https://doi.org/10.1080/08820130600941153
65. Tharakan ST, Binitha PP, Kuttan R, Kuttan G. Antiviral activity of herbal immunomodulatory preparations Ncv I and Ac Ii–and their usefulness in Hiv infection. *Indian Drugs*. 2015;52(11):50–55. https://doi.org/10.53879/id.52.11.10257
66. Mawale MP, Pajai SV. Prevention and management of obesity. *Int J Res Ayurveda Pharm*. 2014;5(1):65–68. https://doi.org/10.7897/2277-4343.05114
67. Nagkesar-Properties, Health Benefits and Usage | Ath Ayurdhamah. Athayurdhamah.com. 2022. https://www.athayurdhamah.com/about-ayurveda/nagkesar
68. Umamahesh B, Ciddi V. Insulinotropic activity of methanolic extract of *Mesua ferrea* L. *J Basic Appl Sci*. 2015;11:410–417. https://doi.org/10.6000/1927-5129.2015.11.58
69. Rafiq M. A poly-ingredient formulation bresol® ameliorates experimental Chronic Obstructive Pulmonary Disease (COPD) in rats. *Scie Pharm*. 2013;81(3):833–842. https://doi.org/10.3797/scipharm.1212-06
70. Singha LR, Das MK. Effect of *Mesua ferrea* L. seed kernel oil on percutaneous absorption of Diltiazem hydrochloride through pig ear epidermis: a mechanistic study. *J Drug Deliv Sci Technol*. 2021;64:102628. https://doi.org/10.1016/j.jddst.2021.102628
71. Amutha K, Selvakumari U. Wound healing activity of methanolic stem extract of *Musa paradisiaca* L. (Banana) in Wistar albino rats. *Int Wound J*. 2014;13(5):763–767. https://doi.org/10.1111/iwj.12371
72. Jalalpure SS, Mandavkar YD, Khalure PR, Shinde GS, Shelar PA, Shah AS. Antiarthritic activity of various extracts of *Mesua ferrea* L. seed. *J Ethnopharmacol*. 2011;138(3):700–704. https://doi.org/10.1016/j.jep.2011.09.042
73. Paranjpe P, Patki P, Joshi N. Efficacy of an indigenous formulation in patients with bleeding piles: a preliminary clinical study. *Fitoterapia*. 2000;71(1):41–45. https://doi.org/10.1016/s0367-326x(99)00115-x
74. Aggrawal K, Dasgupta G, Dasgupta P, Nain P, Satija N, Sahu A. Efficacy of a standardized herbal preparation (Roidosanal®) in the treatment of hemorrhoids: a randomized, controlled, open-label multicentre study. *J Ayurveda Integr Med*. 2014;5(2): 117–124. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4061586/
75. Teh SS, Ee GCL, Mah SH, Ahmad Z. Structure–activity relationship study of secondary metabolites from *Mesua beccariana*, *Mesua ferrea* and *Mesua congestiflora* for anti-cholinesterase activity. *Med Chem Res*. 2016;25(5):819–823. https://doi.org/10.1007/s00044-016-1531-0
76. Buchholz T, Melzig MF. Medicinal plants traditionally used for treatment of obesity and diabetes mellitus-screening for pancreatic lipase and α-amylase inhibition. *Phytother Res*. 2015;30(2):260–266. https://doi.org/10.1002/ptr.5525
77. Hebbar DJ. Nagkesar-*Mesua ferrea* uses, research, side effects. *Easy Ayurveda*. 2012. https://www.easyayurveda.com/2012/09/22/nagkesar-mesua-ferrea-medicinal-qualities-ayurveda-details/
78. Forest essentials facial ubtan Narangi and Nagkesar review. *Makeupandbeauty*.2011. https://makeupandbeauty.com/forest-essentials-facial-ubtan-narangi-and-nagkesar-review/
79. Netke DS. Nagkesar: skincare uses & benefits. Forest Essentials. 2020. https://www.forestessentialsindia.com/blog/how-to-treat-oily-skin-naturally-with-nagkesar.html