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AILANTHUS EXCELSA ROXB (*MAHA NEEM*)- AN HOLISTIC INSIGHT OF THE MULTIPURPOSE TREE

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ABSTRACT: In recent years, Plants and herbal drugs obtaining from natural resources are again gaining importance throughout the world in maintaining the healthcare conditions of individuals. The regular use of natural sources and plant-derived products throughout the world has increased serious concerns over their quality, safety, and efficacy. Adding to the natural scientific resources and knowledge, the tree *Ailanthus excelsa* Roxb commonly known as the tree of heaven, belongs to the family Simaroubaceae indigenous to central, south India, and Srilanka. The tree has several uses in medicine as the gum, and bitter, aromatic leaves and stem bark of the tree are reported to have medicinal properties. A variety of active compounds are obtained from the plant, which is used in combating a variety of human illnesses, and it also leads the path to search out new active natural and novel semi-synthetic or synthetic compounds. In the present review, we have tried to explore the latest scientific attributes along with traditional knowledge, therapeutic applications, and future prospects of *Ailanthus excelsa* Roxb.

INTRODUCTION: During the past years, the indigenous system of medicine has gained importance in procuring the life of mankind. The use of herbal medicines has increased with the issues and aim regarding their quality, safety, and efficacy in industrialized and developing countries [1]. There is a need for screening their traditional claims because in this scientific era and everyone wants scientific support and proofs before using the traditional medicines for the desired therapeutic effect.

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In this review article, an attempt has been made to compile the scientific survey until the date of Ailanthus excelsa Roxb which is widely used in Indian traditional system of medicine for various medicinal purposes [2]. Different species of Ailanthus are present in the form of Ailanthus glandulosa which is present in china and Malay Peninsula and *Ailanthus malbarica* in Indo-China, and *Ailanthus excelsa* in India.

Ailanthus excelsa Roxb. (Maha neem) belongs to family Simaroubaceae, which consists of six subfamilies with 32 genera and over 170 shrubby species. *Ailanthus excelsa* Roxb. resemblance with the neem tree (*Azadirachita indica*) and Maharukha due to its large size. The plant is known by different names like tree of heaven in English, and other Indian local names are as [5, 3].

Common Names: Araluka, Aralu, Katvanga, Deerghavrinta, Putiveriksha, Mahaneem.

Biological Classification:

Kingdom	:	Plantae
Phylum	:	Magnoliophyta
Class	:	Magnoliopsida
Order	:	Sapindales
Family	:	Simaroubaceae
Genus	:	Ailanthus
Species	:	*Ailanthus excelsa*

Geographical Mapping: The tree is indigenous to central and southern India and is found across Madhya Pradesh in Panchmahal and Bharuch districts in Gujarat, some coastal districts in Andhra Pradesh, Ganjam and Puri districts in Orissa. It also grows in Sri Lanka, Japan, China, and Australia. It occurs in dry deciduous forests. It can be seen planted along the roadsides. The tree is known for its high economic and commercial importance [6, 7].

Morphological Specifications: *Ailanthus excelsa* can be raised in mixed plantations. It is a large deciduous tree with height of 18-25 m trunk straight, 60 to 80 cm in diameter; bark light gray-brown and rough on large trees, aromatic slightly bitter. The leaves are shed during the cold season, and the new leaves appear in March-April, 3-9 dm long, pinnate; leaflets 8-14 pairs, 10-15 cm long alternate or sub opposite, coarsely and irregularly serrate, oblique at base; petioles 5-8 cm long. The flowers are small in size, yellow in colour, and arranged in panicles, appear in February, March in Central India, and in the month of April in north India. The flowers appear in the large open clusters among the leaves, pedicels long, slender; sepals 5, ovate, pubescent; petals 5, ovate-lanceolate, reflexed; disc 10 lobed; stamens 10, inserted at the base disc; filaments shorter than anthers; anthers oblong; pistillode rudimentary; bisexual flowers: sepals, petals and disc as in male flowers; stamens 2 or 3; ovary 2-5, partite, superior, sparsely hairy, ovule 1 in each cell; style free or connate; stigmas curling. Fruit a samara, 5 × 1.3 cm, prominently veined, oblong, copper red, twisted at base. The fruits are formed after flowering. The fruits ripen in May-June, just before the onset of monsoon. (Sasidharan and Pal, KFRI).

FIG. 1: *AILANTHUS EXCELSA* ROXB TREE

FIG. 2: FLOWER, LEAVES AND BARK OF *AILANTHUS EXCELSA*

Climate and Cultivation: *Ailanthus excelsa* Roxb largely occurs in Rajasthan and central India and grows throughout the tropical and sub-tropical climatic conditions of the country, especially in dry tracts. It grows well in arid, semi-arid, and semi-moist regions of India. It grows well in regions with rainfall < 500 mm. The tree was found planted on riverine and Sandy soil. It is commonly found in mixed deciduous forests and some sal forests with heavy monsoons conditions. It grows at an altitude of 0-900m with annual temperature of 0-45 °C. The tree requires porous sandy, loamy soil for its optimum growth. The tree can be propagated by natural reproduction through seed and coppice. Natural regeneration through root suckers is applied for the propagation of the tree. Artificial regeneration can also be used through direct seedling or planting pre-germinated seeds. The tree grows in sufficient sunshine in open grounds and serves as a border for other plants [8].

Chemical Constituents: The tree contains a variety of chemical constituents, but the major content is Quassinoids, Ailantic acid, and sitosterol. The tree contains a high amount of steroidal compounds, triterpenes, alkaloids, and flavonoids.

Various parts of the tree contain chemical constituents with high oxygenated triterpenes and bitter principles called as quassinoids. The leaves were reported to contain different flavonoids like kaempferol (5', 4', 5, 7-Tetrahydroxy flavone), luteolin (3', 4', 5, 7- tetrahydroxy flavone), apigenin (4, 5, 7 -trihydroxy flavone) while fruits contain quercetin. The bark of tree contains wax-like, reddish-brown water-soluble bitter principle, known as ailantic acid. All the compounds present in different parts of tree are reported to have a variety of Pharmacological properties.

Medicinal Properties and Uses: The tree has Hypoglycaemic, anti-pyretic, anti-fungal, anticancer, antiviral, ant-imalarial, hepa to protective, anti-asthmatic, anti-fertility, and antibacterial activity. The bark of the tree is used as a tonic and a febrifuge. Leaves are a good source as a tonic after labor. Roots are used as a decoction for internal and external applications. It is also used in loss of appetite, bitter, astringent, appetizer, anthelmintic, dysentery, and amoebiasis. It is also used in the treatment of skin diseases, a complication of the rectum, and fever.

Phytochemical Investigations of *Ailanthus Excelsa* Roxb: The qualitative identification test revealed the presence of steroidal alkaloids and terpenoids in chloroform extract and absence in all extracts. Glycoside was present in ethanol and aqueous extract and absent in Petroleum ether and chloroform extract. Fat and oils were present in Petroleum ether and chloroform extract and absent in ethanol and water extract. Tannin was absent in all extracts. Saponin was present in ethanolic extract but absent in all extract. Flavonoids were present in ethanolic extract but absent in all three extracts. Alkaloids were present in chloroform and ethanol extract and absent in pet ether and water extract. Protein was present in chloroform and water extract and absent in ethanol and pet ether extract, and sugar was present in ethanol and water extract and absent in pet ether and chloroform extracts [9].

TABLE 1: QUALITATIVE CHEMICAL EVALUATION OF *AILANTHUS EXCELSA* ROXB.

Plant constituents	Petroleum Ether Extract	Chloroform Extract	Ethanol Extract	Aqueous Extract
Steroids & Terpenoids	-ve	+ve	-ve	-ve
Glycoside	-ve	-ve	+ve	+ve
Fats & oils	+ve	+ve	-ve	-ve
Tannins	-ve	-ve	-ve	-ve
Saponins	-ve	-ve	+ve	-ve
Flavonoids	-ve	-ve	+ve	-ve
Alkaloids	-ve	+ve	+ve	-ve
Proteins	-ve	+ve	-ve	+ve
Sugars	-ve	-ve	+ve	+ve

+ = Positive, - = Negative

Volatile Constituents of *Ailanthus Excelsa* Roxb: After exhaustive analysis reported, volatile oil content from fresh aerial parts of *Ailanthus excelsa* analysed by GC and GC-MS. The major fractions reported are fatty acids and their esters with concentration as (40.9%) of the obtained oil, out of which 9, 12, 15, octadecatrienoic acid methyl ester (linolenic acid) being the main component (13.7%). It also contains another oily component as phytol reported with a concentration of (26.7%).

Traditional Significance of *Ailanthus Excelsa* Roxb: The ayurvedic properties of the plant are Rasa-Tikta, kashaya, Guna- Ruksha, Veerya-Sheeta C, Veepaka-Katu, which were extensively used in the preparation of ayurvedic formulations. The tree is an important ingredient in most of the ayurvedic formulations like Pusyanuga churna, a herbo-mineral Ayurvedic preparation of which *Ailanthus excelsa* is one of the major constituents was found effective in vataja and kaphaja pradara. Oils and Tailas are frequently prepared as part of the ayurvedic dosage form the bark of *Ailanthus excelsa*, which exhibits muscle relaxant property. The chemical constituents, chiefly quassinoids like ailanthinone and glaucarubinone present in *Ailanthus excelsa* Roxb are also applicable in the treatment of dysenteric complications and diarrhoea, intestinal complications, malaria, as an astringent to stop internal bleeding (stomach ulcers, hemorrhages). Different ayurvedic preparations common from the plant are Katabheyadi taila, asthadashanga kashaya, Hreeberadi kavatha. *A.*

excelsa bark infusions are some of the ayurvedic formulations that is used traditionally [10].

Pharmacological Review of *Ailanthus Excelsa* Roxb:

Antifungal Activity: The methanol extract of stem barks of *Alianthus excelsa* Roxb was partitioned with chloroform. The chloroform extract showed fungistatic and fungicidal activity against *Aspergillus niger, A. fumigatus*, *Penicillium frequentence, P. notatum,* and *Botrytis cinerea*. [11].

Anti Fertility Activity: The practice of traditional medicine for the control of fertility in Nilgris is based on the use of plant medicine for many years. The aim of the present study is to evaluate the effect of hydroalcoholic extract of stem bark of *Ailanthus excelsa* Roxb (Simaroubaceae) (HEA) has been studied in rats to explore its antifertility activity.

A strong anti-implantation (72%) and abortifacient activity (56%) were observed at the tested dose levels (200 and 400 mg/kg, p.o.). Furthermore, the extract shows a significant ($P < 0.05$) increase in uterine weight in immature ovariectomized rats. Simultaneous administration of extract with ethinyl estradiol causes significant antiestrogenic activity. All these observations suggest that hydro-alcoholic extract of *Ailanthus excelsa* has an anti-fertility effect [12].

A Novel Triterpenoid Isolated From The Root Bark of *Ailanthus Excelsa* Roxb. (Tree of Heaven), Chloroform Extract-1 As A Potential Anti-Cancer Agent: The present data demonstrate the activity of a triterpenoid AECHL-1 which possess a broad spectrum of activity against cancer cells. We propose here that AECHL-1 is a futuristic anti-cancer drug whose therapeutic potential needs to be widely explored for chemotherapy against cancer [13].

Anti- Plasmodial Activity: *Ailanthus excelsa* Roxb stem bark was investigated. The methanolic extract inhibited in vitro growth of chloroquine-sensitive (D10) and resistant strains (W2) of Plasmodium falciparum (IC_{50} 4.6 and 2.8 micro g/ml, respectively). The effect was retained in the chloroform fraction (3.1 and 2.1 microg/ml, respectively). The anti-plasmodial activity could be ascribed to the impairment of haemoglobin degradation through the inhibition of plasmepsin II activity (IC_{50} of 13.43+/-1.74 micro g/ml) and of the haem detoxification to haemozoin [14].

Protective Effect of Ethanolic Extract of Stem Bark of *Ailanthus Excelsa* Roxb. Against CCL_4 Induced Hepatotoxicity In Rats: Leaves ethanol extract of leaves showed protective effects against CCL_4 induced liver injury as evidenced by a significant reduction in the CCL_4 induced elevated enzyme levels of serum glutamate oxaloacetate transaminase, serum glutamate pyruvate transaminase, and serum alkaline phosphatase. The presence of phenolics might be the responsible factor for the above activity.

Stem bark: Ethanolic extract of stem bark of *Ailanthus excelsa* Roxb showed protective effects against CCL_4 induced hepatotoxicity in rats. [15].

Anti-bacterial Activity: Ethyl acetate fraction of dried stem bark inhibited the growth of *Staphylococcus aureus*, *Escherichia coli,* and *Bacillus subtilis* (MIC: 6 mg disc-1). Three active principles, excelsin, 13, 18-dihydroexcelsin and 1, 12- deoxy-13-formylailanthinol, isolated from bark, are said to be responsible for this activity. The antibacterial activity of all three compounds was more pronounced than the antifungal potency [16].

Gastroprotective and Antisecretory Activity: *Ailanthus excelsa* Roxb, an Egyptian medicinal species highly important for treating numerous diseases, was investigated against experimentally induced gastric ulcers in rodents. We evaluated the gastroprotective effect of four extracts (petroleum ether, diethyl ether, chloroform, and methanol) of *A. excelsa* bark by using the ethanol-induced gastric lesion model.

The pretreatment of animals with methanolic, petroleum ether and chloroformic extracts (100 mg/kg, oral (p.o.)) from *A. excelsa* significantly reduced gastric lesion induced by ulcerogenic agent (56, 47, and 70%, respectively) when compared with animals pretreated with vehicle. However, the diethyl ether pretreatment led to the least gastric lesion damage (83%), similar to the standard antiulcer drug, cimetidine, at the same dose (100 mg/kg, p.o.). The lower effective dose of diethyl ether extract, as well as cimetidine, given by the intraduodenal route, significantly increased the pH

values and reduced the acid output of gastric juice. Sterols, triterpenes, and quassinoids are present in the diethyl ether extract of *A. excelsa* stem bark, which presented the best gastroprotective action among the studied extracts. Our study confirmed the traditional indications of *A. excelsa* for the treatment of gastric ulcers [17].

Bronchodilator Activity: Biologically active compounds from natural sources are of interest as possible new drugs for infectious diseases. *Ailanthus excelsa* Roxb. has been used in the Indian system of medicine in the treatment of asthma, bronchitis, cold, colic pain, *etc*. The stem bark of *A. excelsa* Roxb. has been used as a decoction in traditional claims. So, our traditional claims enforced us to evaluate its bronchodilator activity. We have evaluated its bronchodilator activity in milk-induced leukocytosis and eosinophilia, clonidine-induced mast cell degranulation, bronchoalveolar lavage fluid (BALF), and lung histopathology models. The aqueous extract of stem bark in doses of 100, 200, 400 mg/kg showed significant activity [18].

Antidiarrhoeal Activity: *Ailanthus excelsa* Roxb (Family: *Simarubaceae*) is commonly known as Mahanimba and Arlu. The root bark is traditionally used as anti-diarrhoeal agent. Antidiarrhoeal activity of methanolic extract of root bark of *A. excelsa* (MEA) was evaluated by castor oil-induced diarrhoea and small intestinal transit method at three doses *i.e*. 100 mg/Kg, 150 mg/Kg and 200 mg/Kg of the bodyweight of the mice. The percentage of inhibition of castor oil-induced diarrhoea in MEA treated mice was 55.27%, 66.33%, and 63.81% at 100 mg/Kg, 150 mg/Kg, and 200 mg/Kg, respectively. Mean distance travelled by charcoal, as % total length of the small intestine (cm) is less at 150 mg/Kg of the dose of MEA and is comparable with standard drug atropine sulphate, which is used as positive control and statistically significant ($P < 0.01$) [19].

Anti-inflammatory Activity: Present study deals with membrane stabilizing activity of petroleum ether, ethyl acetate and methanol fractions of leaves of *Ailanthus excelsa*. The phytochemical screening of the leaves of *Ailanthus excelsa* revealed the presence of alkaloids, sterols, saponins, flavonoids, phenolic compounds, carbohydrates, and proteins. The inhibition of heat-induced HRBC membrane lysis was taken as a measure of the anti inflammatory activity. The methanol fraction showed the most significant membrane-stabilizing action on the HRBC membrane as compared to other fractions. The maximum membrane stabilization of methanol fraction of *A. excelsa* was found to be 91.13% at a dose of 1000 µg/ml [20].

Pharmacological Study on *Ailanthus Excelsa*-Ardusa: *Ailanthus excelsa* Roxb is commonly known as Ardusa, which is found in various parts of India. It is used as a folk medicine remedy for inflammation and rheumatoid antipyretic, anti-fertility, antifungal, anti-malarial and antibacterial, diabetes, antioxidant activity, anti-cancer activity. The present review is, therefore, an effort to give a detailed survey of the literature on its botanical details, phytochemical reports, the pharmacological activity of *Ailanthus excelsa* Roxb [21].

Physico-Chemical Characterization and Bio-Diesel Preparation From *Ailanthus Excelsa* Seed Oil: *Ailanthus excelsa* seed oil is identified as minor seed oil from forest origin for biodiesel production. The seed oil was initially characterized for various physicochemical properties following standard protocols. The extracted oil was further refined and transesterified to produce biodiesel. The prepared biodiesel was evaluated for fuel properties such as the iodine value, free fatty acids, phosphorous content, flash point, cloud point, pour point, viscosity at 40 °C, oxidative stability at 110 °C, density, and trace metals. The properties were compared with international specifications, and it was found that the oxidative stability of the prepared biodiesel was better compared to most of the biodiesels reported [22].

Phenological Behaviour and Reproductive Biology of *Ailanthus excelsa* Roxb: Studies on reproductive biology of Mahaneem (*Ailanthus excelsa*) indicated that mild defoliation started in mid of March and continued up to the end of February, the majority being from May 13-28. Leaf promodial started appearing after all the leaves had shed off. Within a week of new foliage appearance, the panicle with small protruding buds appeared. The floral buds took 9-13 days to come to bloom. More than 80 percent of floral buds opened between 0800-0900 h. The number of days required

from panicle initiation to fruit maturity ranged from 132-140. The fruit set under open-pollination was higher than the fruit set in self-pollinated, and a highly significant difference in growth characters of self versus open-pollinated progenies formed strong evidence for xenogamous behavior of Mahaneem [23].

Morphoanatomical and Physicochemical Studies On *Ailanthus Excelsa* Roxb Stem Bark: A Tree of heaven *Ailanthus excelsa* Roxb. (Simaroubaceae) is a traditional medicinal plant used widely in India and China in various health conditions. The morphology and microscopical evaluation are the most preferred quality control parameter; in order to establish its quality and purity, we report some important pharmacognostic profiles of *A. excelsa* stem-bark for the purpose of its identification and differentiation from related species.

The study of the fresh, powdered, and anatomical sections of the stem bark were carried out to determine the morphological, microscopical, some physicochemical, and phytochemical parameters. Presence of lignified multi cellular trichrome, stone cells, scleroids, lignified pericyclic fibre, phloem fibre, prismatic calcium oxalate, starch grains and uni to multi serrate non-lignified medullary rays observed as distinguishing microscopical characteristics in transverse section and powder studies. The result of preliminary phytochemical screening indicated the presence of alkaloids, glycoside, steroids, carbohydrates, proteins, phenolic compounds, tannins, flavonoids, and saponins. In addition, the quantitative phytochemical analysis revealed a significant amount of total phenolic and flavonoid content. The present study will be useful for its identification prior to carrying out further research work [24].

Hypolipidemic Activity: *Ailanthus excelsa* Roxb (Family-Simaroubaceae) commonly known as "Mahaneem" is a large deciduous tree with rough and light grey stem bark. It has a large panel of indications to evaluate its stem bark as it contains a variety of important phytoconstituents, which are used in treating diarrhoea, dysentery, cholera, astringent, febrifuge, anthelmintic, and liver tonic. Background: The stem bark of the *Ailanthus excelsa* Roxb was investigated for hyperlipidemia-related disorders, which is one of the major risk factor of coronary heart disease and atherosclerosis. Hypothesis / Purpose: The purpose of the present investigation is the reduction of elevated lipid profiles through various prepared plant extracts in triton WR 1339 induced hyperlipidemic model.

Study Design: In the present investigations, stem bark was collected, authenticated, extracted with a solvent, and *in-vivo* studies in correlation with triton injected experimental animals were carried out in decreasing the elevated lipid profiles. Methods: The study pertains to the hypolipidemic activity of ethanolic extract and its fractions of stem bark of *Ailanthus excelsa*, Roxb on triton WR 1339 induced hyperlipidemic model.

The results obtained are significant with fractionated part of ethanolic extract of *Ailanthus excelsa* Roxb (200 + 200 mg/kg) in lowering total cholesterol, triglycerides, High-density lipoprotein, low-density lipoprotein, and Very low-density lipoprotein. Conclusion: The observation enables to evaluation of the biological and molecular approaches to restrain the adverse effects of cardiovascular disorder, particularly complications related to lipidemia. [25].

CONCLUSION: This review article attempt to explore the importance of *Ailanthus excelsa* Roxb (A Tree of Heaven) serving as worthwhile in the treatment and mitigation of various internal and external disorders. The information furnished in the review article will help the plant researchers as well as herbal practitioners dealing with the plant to know its proper nature usage. The parameters such as identification, cultivation, collection, and processing of plant material in specific time are required for the maximum rational use and important to get maximum therapeutic benefits of the plant. We can use this plant in the future also to formulate a variety of Herbal medical products (HMP's) with proper screening of the isolated and identified chemical constituents present and further explore more biological markers to treat various acute and chronic diseases.

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