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Review Article

Comprehensive Review of Adenanthera pavonina: Botanical Description, Chemical Constituents, and Therapeutic Potential

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ABSTRACT

Adenanthera pavonina L., an important medicinal species within the Leguminosae (Fabaceae) family, is prevalent in tropical areas and has a long history of use in treating various health conditions. This study seeks to deliver a detailed examination of the plant's botanical characteristics, phytochemical composition, and pharmacological effects. A. pavonina is recognized for its wide array of chemical components, which include flavonoids, steroids, tannins, saponins, and triterpenoids. Phytochemical analyses have identified several compounds, such as pavonin, robenetin, butin, ampelopsin, and apigenin, across different plant parts. The leaves are noted for containing octacosanol, dulcitol, beta-sitosterol glucosides, flavones, and stigmasterol, while the bark is rich in stigmasterol glycosides, butein, chalcone, and saponins. The seeds are particularly abundant in non-protein amino acids and polysaccharides. Pharmacological research has confirmed the anti-inflammatory, analgesic, antibacterial, antioxidant, antidiabetic, antihypertensive, antihyperlipidemic, antifungal, anthelmintic, and antidiarrheal properties of extracts from A. pavonina. The anti-inflammatory and analgesic effects are linked to the inhibition of vascular permeability and a decrease in writhing responses. Additionally, the extracts exhibit notable antibacterial and antioxidant activities. A. pavonina extracts have demonstrated significant hypoglycemic effects and protective benefits for the kidneys in diabetic rat models. Antihypertensive and antihyperlipidemic effects have been recorded in normotensive and dyslipidemic rats, respectively. Moreover, the plant shows antifungal activity against Candida albicans and Saccharomyces cerevisiae, anthelmintic effects in crude bark extracts, and potential antidiarrheal effects in models induced by castor oil and magnesium sulfate. These results underscore the therapeutic promise of A. pavonina and its phytochemical constituents, highlighting the need for further investigation into its clinical applications and the development of innovative phytomedicines.

INTRODUCTION

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A medicinal plant is characterized by the World Health Organization as "any plant that possesses substances in one or more of its parts that can be utilized for therapeutic purposes or serve as precursors for the semi-synthesis of chemo pharmaceuticals." Through research and innovation, phytomedicines have started to connect traditional and contemporary medical practices. Approximately 75–80% of individuals continue to rely on herbal medicine, with the use of plant extracts and their active components being a key aspect of traditional healing methods. Various extracts from established medicinal herbs have been tested to uncover the sources of their therapeutic effects. Numerous studies have validated traditional practices by elucidating the mechanisms and modes of action of these herbs, as well as confirming the therapeutic efficacy of herbal or plant extracts in clinical trials. These medicinal plants possess therapeutic properties and value due to the presence of diverse phytochemical compounds. Traditional medicines are regarded as particularly significant because they are effective, safe, locally accessible, and generally free from side effects. The scientific name of Adenanthera pavonina L. is derived from the Greek words aden, meaning gland, and anthera, meaning anther. Commonly known as Red Sandalwood, Coral Wood, or Bead Tree, Adenanthera pavonina is a remarkable tropical tree indigenous to Southeast Asia, now widely found in tropical and subtropical areas globally. It is especially noted for its vibrant red seeds, which are frequently used as beads in jewelry and traditional decorations. As a member of the Fabaceae (legume) family, Adenanthera pavonina is a rapidly growing deciduous tree that can attain heights of 6–15 meters. It features compound leaves and produces fragrant yellow flowers that eventually develop into curved pods containing its distinctive red seeds. Its numerous pharmacological properties, particularly those associated with its leaves, bark, and seeds, render it an important therapeutic plant, often referred to as "rakta kombol." The red bead tree, classified within the subfamily Mimosaceae of the Leguminosae (Fabaceae) family, is a notable medicinal plant indigenous to the Indian subcontinent. This species is originally from tropical Asia and thrives in moist soil conditions. It has its roots in Southern China and India but has since proliferated across Malaysia, both Western and Eastern Africa, and many islands in the Pacific and Caribbean. The tree typically reaches heights of 6 to 15 meters. Various parts of this plant have been utilized in traditional medicine to address ailments such as asthma, boils, diarrhea, gout, inflammation, rheumatism, tumors, ulcers, and as a tonic. Research indicates that the seeds of this plant can effectively manage cardiovascular issues in pregnant women. Studies on Adenanthera pavonina have shown that its crude extract possesses antifungal, antioxidant, cytotoxic, and anti-inflammatory properties, along with the ability to lower blood pressure. Phytochemical analysis of this plant has revealed several secondary metabolites, predominantly flavonoids, steroids, saponins, and triterpenoids. The methanol-soluble fraction of Adenanthera pavonina has been found to contain sterols, including β-sitosterol and β-sitosterol-3β-D-glucoside, as well as saponins. Furthermore, it features a distinctive five-membered lactone called pavonin, which includes an exo-cyclic double bond.

BOTANICAL DESCRIPTION

Botanical Name : Adenanthera pavonina L
Kingdom: Plantae
Sub-Kingdom : Phanerogamia

Division : Angiospermia
Class : Dicotyledons
Sub-Class : Archichlamydeae
Order : Rosales
Family : Leguminosae (Fabaceae)
Subfamily : Mimosaceae
Genus : Adenanthera
Species : Pavonina

Synonym: Adenanthera gersenii Scheffer, Barbados pride, coral-wood

Common name: - Coral seed Tree, Barricari seed Tree, Circassian seed Tree, Red-wood Tree, Coral wood Tree

HABITAT

The tree is commonly found in the tropical regions of the Old World. It has also been introduced to several countries in the Americas. In India, this species thrives in the Sub-Himalayan area, where it can be found at altitudes of up to 1,200 meters across Sikkim, West Bengal, Assam, Meghalaya, Gujarat, Maharashtra, and the southern regions of the country. Furthermore, it is present in Puerto Rico, Cuba, Jamaica, Trinidad, Venezuela, Brazil, Costa Rica, Honduras, and southern Florida. Besides open savannahs, Adenanthera species are occasionally found in both primary and secondary evergreen as well as dry deciduous rainforests. Biophysical limits include an elevation range of 300 to 400 meters and an average annual rainfall of 3,000 to 5,000 millimeters. This tree can adapt to various soil types, from shallow and rocky to deep and well-drained, although it prefers neutral to slightly acidic soils.

DESCRIPTION

Tree: A. pavonina is a medium to large deciduous tree that typically reaches heights between 6 and 15 meters. It usually grows in an upright manner, featuring bark that varies from dark brown to grayish, and possesses a broad, spreading crown.

Seeds: The seeds, which are hard-coated, possess a lens-like shape and are a bright scarlet hue, adhering firmly to the pods. Their seed coat is characterized by a smooth, shiny, and extremely hard texture, typically lacking any fracture lines. The pods themselves are leathery, curving and twisting upon dehiscence to expose 8 to 12 striking seeds.

Leaves: The leaves exhibit a bipinnate structure. The upper surface is a dark green, while the lower surface displays a blue-green hue. As they age, the leaves turn yellow.

Bark: The leaves exhibit a bipinnate structure. The upper surface is a dark green, while the lower surface displays a blue-green hue. As they age, the leaves turn yellow.

Flowers: The diminutive, yellowish blooms develop in compact, pendulous clusters resembling rat tails. These flowers are petite, creamy-yellow, and emit a pleasant fragrance. Each blossom features a star-like shape with five petals.

Wood: The wood exhibits a red hue and possesses remarkable hardness. Its durability makes it suitable for construction purposes, and it is also utilized in the production of furniture.

CHEMICAL CONSTITUENT

Additionally, various significant compounds such as pavonin, robenetin, butin, ampelopsin, apigenin, and others have been identified in different parts of A. pavonina L. The alcoholic extract of the leaves contains an alkaloid, along with tannins, terpenoids, flavonoids, octacosanol, dulcitol, and glucosides of beta-sitosterol, as well as flavones and stigmasterol. The bark is noted to contain glycosides, saponins, and flavonoids, particularly gallic acid, in addition to terpenoids, tannins, sterols, and triterpenoid saponins (sapogenins). The wood is composed of butein, chalcone, robenetin, and flavones. The seeds

contain methylene glutamine, a non-protein amino acid, along with trace amounts of ethylidene glutamic acid. They are reported to have a high concentration of sterols (including beta-sitosterol and beta-sitosterol-3β-D-glucoside), triterpenoids (such as nonacosane and hentriacontane), terpenoids, tannins, and flavonoids, predominantly gallic acid. Phytochemical studies indicate that the seeds and pods also contain glycosides, saponins, and steroids.

- **Fixed Oil**: Composed of saturated fatty acids (palmitic, stearic, arachidic, lignoceric) and unsaturated fatty acids (oleic, linoleic)
- **Steroids**: β-sitosterol, stigmasterol
- **Alkaloids**: O-acetylethanolamine
- **Other Compounds**: Pavonin (a new five-membered lactone ring compound)

Leaves

- **Flavonoids**: Quercetin 3-O-α-dirhamnopyranosyl-(1‴ → 2″,1‴″ → 6″)-β-glucopyranoside-4'-methoxy, kaempferol derivatives
- **Other Compounds**: Octacosanol, dulcitol, glucosides of β-sitosterol, and stigmasterol

MORPHOLOGICAL CHARACTERISTICS

In dense, drooping rat-tail flower heads that resemble catkins, the tiny, whitish flower blooms. The firm, red seeds are exposed when the curved, hanging pods, which have a bulge opposing each seed, split open into two twisted halves. The wood of this tree can be used to make a red dye and is used to make soap. The incredibly hard wood is also utilized for firewood, furniture, and boat building. The tree can be used as a shade tree and as an ornamental tree in big gardens or parks due to its rapid growth and appealing, spreading canopy. Nevertheless, it is also renowned for generating a lot of litter in the shape of leaves, twigs, and particularly seed pods that split open while still attached to the branch, releasing their seeds.

Ecological Importance

This species plays a role in **soil fertility improvement** due to its ability to fix atmospheric **nitrogen** through symbiosis with Rhizobium bacteria. It is often planted in degraded lands or used in agroforestry systems to improve soil quality and support sustainable land use.

Its flowers support **pollinators**, while birds and small mammals consume the seeds. Despite its ecological benefits, in some regions where it has been introduced, Adenanthera pavonina can behave like an **invasive species**, competing with native flora.

Environmental Tolerance and Growth Conditions

Adenanthera pavonina prefers **well-drained soils** and thrives in areas with **full sunlight**. It grows well in **tropical climates** with moderate to high rainfall and tolerates some drought once established. It is propagated through seeds, which have a hard coat and may require scarification to germinate effectively.

Cultural and Economic Uses

1. **Ornamental Value**: Due to its attractive foliage, bright red seeds, and moderate size, the tree is often used in landscaping, parks, and gardens.

2. **Seed Beads**: The vivid red seeds are commonly used in **jewelry**, **rosaries**, and **crafts**, often being referred to as "red lucky seeds" or "peacock seeds." Historically, the seeds were also used as units of weight measurement in India and Southeast Asia because of their remarkably consistent mass (about 0.25 grams each).

3. **Timber**: The **wood** is reddish, hard, and durable, making it useful for **carpentry**, **furniture**, **tool handles**, and **agricultural**

implements. However, due to the tree's moderate size, commercial exploitation for timber is limited.

4. **Medicinal Uses**: Various parts of the plant—seeds, bark, leaves, and roots—have been used in **traditional medicine**. Reported medicinal properties include:

- **Anti-inflammatory**
- **Analgesic**
- **Antioxidant**
- **Antimicrobial**

Decoctions made from the leaves or bark are sometimes used for treating **rheumatism**, **diarrhea**, and **skin conditions**, although caution is advised due to the **toxicity** of raw seeds.

PHYTOCHEMISTRY

Previous phytochemical analyses revealed that the leaves contain flavones, stigmasterol, dulcitol, octacosanol, and glucosides of betasitosterol15,16,17. An alkaloid was also found in the alcoholic extract of the leaves. Along with stigmasterol glycosides, the bark also includes butein, chalcone, dihydromyricetin, 2, 4-dihydrobenzoic acid, robinetin, and saponins, which provide methyl echinocystate and methyloleanolate when hydrolysed and methylated. Butin, chalcone, robenetin, and flavones are all present in the wood. Methylene glutamine, non-protein amino acids, and trace amounts of ethledine glutamic acid are found in the seeds. It is said to have a high concentration of terpenoids, Tannis, sterols, triterpenoid's, saponins, and flavonoids, primarily gallic acid. Studies on phytochemistry reveal that seeds and pods include glycosides, saponins, and steroids. The methanol-soluble portion of A. pavonina was used to isolate pavonin, a novel five-membered lactone ring compound. O-acetylethanolamine, an anti-inflammatory active ingredient, is present in the seed. Octacosanol, dulcitol, betasitosterol glucosides, and stigmasterol are all found in the leaves. There is stigmasterol glucoside in the bark. Polysaccharide, dulcitol, stigmasterol glucoside, lignoceric acid, and HCN-glucoside are all found in seeds. A prospective source of polysaccharide and galactomannans is seeds. Previous phytochemical studies have identified a variety of bioactive phytoconstituents in this plant, including robinetin, chalcone, tannins, flavonoids, terpenoids, saponins, alkaloids, steroids, butin, flavonal ampelopsin, stigmasterol glucosides, oleanolic acid, echinocystic acid, sapogenins, and many others. Following the separation of hexane and ether-soluble fractions, the alcoholic extract of the roots produced a semi-solid substance that generated significant foam when mixed with water. Upon purification, the crude product yielded a saponin, which was subsequently hydrolyzed with acid to produce a mixture of genin acids. It was determined that the sugar component of the saponin consisted entirely of glucose. Additionally, the bark of Adenanthera pavonina Linn. was found to contain 1.01% glucose, classified as a reducing sugar. The composition of various amino acids in the crude protein (5.25%) was as follows: aspartic acid (0.10%), threonine (0.24%), glutamic acid (0.52%), glycine (0.09%), valine (0.10%), isoleucine (0.06%), tyrosine (0.27%), histidine (0.11%), lysine (0.88%), and arginine (0.25%). The identified fatty acid profiles included oleic acid (6.29%) and stearic acid (8.93%).

Ethnomedicinal use

A. pavonina is a species that has been historically utilized in herbal medicine for the treatment, prevention, and management of various ailments. Historical records indicate that this plant was employed in ancient Indian medicine, where crushed seeds were applied to address boils and inflammation (Olajide et al., 2004). Generally, the

literature highlights its traditional applications for conditions such as diabetes, lipid disorders, diarrhea, ulcers, gastrointestinal bleeding, hematuria, rheumatism, asthma, hypertension, respiratory infections, chronic eye conditions, and cancer, where it is recognized as a tonic. These traditional uses are predominantly reported in Asian countries. In terms of the specific parts of the plant that are commonly used, derivatives from the bark and/or leaves serve as anthelmintics and are utilized for conditions such as colonorrhea, ulcers, pharyngoplasty, gout, rheumatism, and various painful ailments. The heartwood is noted for its effectiveness in treating dysentery and haemorrhages, while redwood powder is employed as an antiseptic paste. The seed extract is utilized for treating boils, inflammation, blood disorders, arthritis, rheumatism, cholera, paralysis, epilepsy, convulsions, spasms, indigestion, gout, burning sensations, excessive thirst, vomiting, fever, and dizziness. Additionally, seed powder is applied as a poultice to promote the suppuration of abscesses.

TOXICITY STUDIES

The acute oral toxicity of the methanolic extract derived from A. pavonina seeds was evaluated in albino mice using a range of doses: 100 mg/kg, 200 mg/kg, 400 mg/kg, 800 mg/kg, 1600 mg/kg, and 3200 mg/kg, administered via intraperitoneal injection. Mortality rates were tracked over a 24-hour period for each dosage group, and the lethality percentage was determined by counting the number of deceased animals in each group. The acute toxicity assessment indicated an LD50 of 1360 mg/kg for the methanolic extract, suggesting that the extract may be relatively non-toxic at typical consumption levels. In a separate investigation, the acute oral toxicity of the methanolic extract from A. pavonina leaves was assessed in Swiss albino mice of both genders at doses of 50, 300, and 2000 mg/kg body weight. No fatalities or significant alterations in body weight were noted, indicating that the extract is safe at doses up to 2000 mg/kg. Further studies have been conducted to evaluate the toxicity of various derivatives from A. pavonina. Leaf extracts were tested for toxicity against brine shrimp (Artemia salina) and showed no cytotoxic effects. Conversely, extracts from the root and stem bark demonstrated cytotoxicity against A. salina. An acute oral toxicity test of the ethanol extract from A. pavonina leaves was also performed in mice, revealing no toxicity at doses up to 5000 mg/kg, thus confirming the safety of this extract. A recent study involving the ethanolic extract from the leaves of A. pavonina established that the median lethal dose (LD50) of the total ethanol extract was 5.8 g/kg (body weight), indicating that this plant extract is considered safe. As expected, no toxicity was observed with the ethanolic extract at a dosage of 2000 mg/kg. The acute oral toxicity evaluation of the methanolic extract of A. pavonina leaves was conducted following the OECD 425 guidelines from 2001, with results showing that the methanolic extract was safe at doses up to 2000 mg/kg, and the LD50 exceeded 8000 mg/kg. Additionally, a study by Melo has contributed to this body of research.

PHARMACOLOGICAL ACTIVITIES:

ANTI-INFLAMMATORY AND ANALGESIC ACTIVITY

Animal models were employed to evaluate the anti-inflammatory effects of the methanolic extract from A. pavonina seeds at doses of 50 and 200 mg/kg of body weight. The extract significantly inhibited both acetic acid-induced vascular permeability in mice and carrageenan-induced paw oedema in rats. Investigations into acute toxicity revealed a reduction in motor activity following administration of the extract. This research indicated that the extract possesses analgesic and anti-inflammatory properties, which were assessed at doses of 50, 100, and 200 mg/kg. Thirty minutes post-administration, the subjects received an intraperitoneal injection of 10 mg/kg

of a 0.6% w/v acetic acid solution in water. A notable decrease in the frequency of writhing was observed in comparison to the control group in a separate study, Mayuren and Ilavarasan (2009) investigated the anti-inflammatory effects of the ethanolic extract from the leaves of A. pavonina in Wistar rats, using doses of 250 and 500 mg/kg in tests for carrageenan-induced hind paw edema. Chronic inflammation was assessed through the cotton pellet-induced granuloma formation assay. The extract exhibited a significant reduction in paw edema, with notable effects beginning at the third hour for the 250 mg/kg dosage and at the second hour for the 500 mg/kg dosage. Both dosages resulted in a substantial decrease in the wet and dry weights of the cotton pellets. Additionally, castor oil-induced diarrhoea tests were performed to explore whether the anti-inflammatory mechanism was associated with the inhibition of prostaglandin synthesis, using indomethacin as a standard reference drug. The extract significantly postponed the onset of castor oil-induced diarrhoea, suggesting a potential involvement of prostaglandins in its mechanism of action. Both acute and chronic inflammatory models confirmed the anti-inflammatory effects of the leaf extract, indicating that active compounds such as β-sitosterol and stigmasterol may play a role in its anti-inflammatory properties.

ANTIBACTERIAL ACTIVITY

The antibacterial activity of three medicinal Thai plants studied against *Campylobacter jejuni* and other food borne pathogens. The disc diffusion experiment was used to optimize the techniques and solvents used to extract the active ingredients. By using broth microdilution, the minimal bactericidal and inhibitory concentrations were ascertained. A. pavonina was the most effective extract against Campylobacter jejuni, containing flavonoids, terpines, and tannins that inhibited growth at 62.5–125 microgram/ml.

ANTIOXIDANT ACTIVITY

To determine its capacity to prevent oxidative damage, the scavenging activity of a methanolic extract of Adenanthera pavonina Linn leaves was assessed. Ascorbic acid was used as a standard in DPPH free radical and nitric oxide anion scavenging experiments to assess scavenging activity. It was discovered that when extract dosage increased, so did the total decreasing power.

ANTIDIABETIC ACTIVITY

The glycaemic regulatory effects of hot water extracts from mature leaves of Adenanthera pavonina were investigated using rats. Various doses, along with tolbutamide, were administered orally to normoglycaemic rats. Fasting serum glucose levels were measured at hourly intervals over a period of four hours, following standard protocols. The findings indicated that the leaf extract exhibited significant hypoglycaemic effects ($P < 0.05$) in both fasted and fed rats. Additionally, the renal protective properties of the aqueous extract from A. pavonina seeds were examined in rats with STZ-induced diabetes. The extract notably decreased proteinuria, albuminuria, and lipid accumulation in diabetic rats, suggesting a potential benefit in mitigating the progression of diabetic nephropathy. Normal rats' blood glucose levels were assessed in response to an aqueous solution of A. pavonina leaves. To ascertain the glucose tolerance activity, an oral glucose tolerance test was conducted. According to the findings of the oral glucose tolerance test, the test group that received an aqueous solution of A. pavonina leaves 30 and 120 minutes after loading 2g/kg of glucose saw a considerable drop in blood glucose levels. The test group's glucose tolerance activity was noticeably higher than that of the control group. According to the study, an aqueous solution of A. pavonina leaves can control blood glucose levels.

Antimalarial activity

Adedapo et al. (2014) conducted a study examining different concentrations of methanol seed extract from A. pavonina (100, 200, 400, 600, and 800 mg/kg, administered orally) in mice infected with Plasmodium berghei, with chloroquine serving as a control. The findings revealed a significant decrease in percentage parasitemia in the group treated with the crude extract, indicating a dose-dependent effect. Remarkably, the extract at a dosage of 800 mg/kg achieved an antimalarial efficacy of 92.11%, which exceeded the efficacy of chloroquine, recorded at 88.73%.

ANTIHYPERTENSIVE ACTIVITY

At doses of 50, 100, and 200 mg/kg body weight, the impact of A. pavonina seed extract on the blood pressure of normotensive rats was assessed. The study demonstrated the antihypertensive properties of A. pavonina seed extract. Changes in serum biochemistry could indicate that the extract has a tonic impact on the liver and kidneys, which are important organs for drug processing.

ANTI HYPERLIPIDEMIC ACTIVITY

Triton and diet-induced hyperlipidemic models of wistar albino rats were employed to examine the antihyperlipemic effects of A. pavonina barks. At 400 mg/kg dose levels, the ethanolic extract's ethyl acetate and n-butanol fractions prevented the rats administered Triton WR 1339 from experiencing an increase in their serum cholesterol and triglyceride levels. In rats with hyperlipidaemia brought on by a high-fat diet, the extract fractions at the same dosage level markedly reduced the increased serum levels of triglycerides and total cholesterol. Studies using the normal dosage of atorvastatin revealed somewhat superior results. The study's conclusions show that by preventing the manufacture of cholesterol and the use of lipids, the ethyl acetate and n-butanol fractions of ethanolic bark can successfully regulate blood lipid levels in dyslipidaemia circumstances.

ANTIFUNGAL ACTIVITY

Peptides isolated from Adenanthera pavonina seeds were evaluated for their antifungal properties. Chromatography was used to extract and fractionate the peptides. Tested for activity against Candida albicans and Saccharomyces cerevisiae. There have been many studies on antimicrobial activity of parts of *A. pavonina* species, and one of the oldest found was the work of Chourasia and Rao (2005) that evaluated the antimicrobial activity of fixed oil from seeds. The findings indicated that the seed oil exhibited limited effectiveness against B. anthracis and S. paratyphi, while it was ineffective against other tested Gram-positive and Gram-negative bacteria, including B. mycoides. Rodrigo et al. (2007) showed evidence of antifungal activity of methanolic extracts of roots, bark, and seeds of *A. pavonina*.

ANTIHELMINTIC ACTIVITY

The anthelmintic properties of the crude bark extract from Adenanthera pavonina were examined. Phytochemical analysis revealed the presence of flavonoids among the chemical constituents, which demonstrated notable anthelmintic activity at concentrations of 25, 50, and 100 mg/mL when compared to the standard drug, piperazine citrate. The effectiveness of the ethanolic extracts from A. pavonina bark was assessed against Pheretima posthuma and Ascaridia galli. A bioassay was conducted to measure the time taken for paralysis and death of the worms at the aforementioned concentrations of the ethanolic extract, with piperazine citrate used as a positive control. The results showed that the ethanolic extract caused paralysis and mortality in the worms within a timeframe comparable to that of piperazine citrate, especially at the highest concentration of 100 mg/mL. Dash et al. (2010)

proposed that the phenolic compounds present in the bark extracts of A. pavonina may interfere with energy production in the parasites by uncoupling oxidative phosphorylation, potentially resulting in paralysis and eventual death of both worm species.

ANTIDIARRHEAL ACTIVITY

Adenanthera pavonina seed aqueous extract's antidiarrheal properties were examined in experimental animals to prevent rat diarrhoea caused by magnesium sulphate and castor oil. Loperamide 3 mg/kg was utilized as a reference standard to evaluate the impact of the extract on gastrointestinal transit utilizing charcoal and castor oil-induced enter pooling. In rats with castor oil and magnesium sulphate-induced diarrhoea, oral treatment at dosages of 50, 100, and 200 mg/kg demonstrated dose-dependent considerable antidiarrheal potential. When compared to the reference standard Loperamide, it also significantly decreased the propulsive action in rats' gastrointestinal transit caused by castor oil and charcoal diet.

HEPATOPROTECTIVE ACTIVITY

The hepatoprotective properties of A. pavonina leaves were examined in a study involving rats that experienced liver damage due to Isoniazid and Rifampicin. A 50% methanolic extract of A. pavonina was administered at doses of 100 and 200 mg/kg, while silymarin served as the reference drug at a dose of 100 mg/kg over a duration of 28 days. Various serum parameters were assessed, including serum glutamic oxaloacetic transaminase (SGOT), serum glutamate pyruvate transaminase (SGPT), alkaline phosphatase (ALP), bilirubin, total protein, albumin, and lactate dehydrogenase (LDH). Furthermore, the activities of superoxide dismutase (SOD), catalase, glutathione, and Thio barbituric acid reactive substances (TBARS) were analysed. A histopathological assessment was conducted to evaluate the degree of liver tissue damage. The findings revealed that the methanolic extract of A. pavonina leaves exhibited notable hepatoprotective effects against liver injury induced by Isoniazid and Rifampicin, demonstrating efficacy similar to that of the standard drug silymarin.

ANTICANCER ACTIVITY

While acetone seed extract has not demonstrated biological activity, methanolic extract of A. pavonina seeds and leaves has demonstrated effective antibacterial and anticancer action against a variety of infections and against bone cancer cell lines. A. pavonina methanolic extract was tested on Dalton's ascetic lymphoma at 125 and 250 mg/kg/day, p.o. Mice were given intraperitoneal injections of DAL cells (1X1000000 cells/mouse) to produce tumours. Using an in-vitro cytotoxic assay, the extract's anticancer impact was assessed by counting the number of viable and non-viable tumor cells, mean survival time (MST), tumor volume (TV), and percentage increase in life span (ILS). The findings of this study indicate that the MAP possesses significant antitumor activity In another study, the ethanolic (EtOH) leaves extract of *A. pavonina* showed significant cytotoxic activity against human hepatoma HepG2 cells (IC_{50} = 2.50 µg) compared to cisplatin (IC_{50} > 10 µg) (Mohammed et al., 2014). Sophy et al. (2016) evaluated the antiproliferative effect of the *A. pavonina* leaf extracts (chloroform, ethyl acetate, acetone, methanol, and ethanol) in four cancer cell lines (HCT116, NCIH460, U251, and MCF7) by sulphorhodamine B (SRB) assay with camptothecin used as a positive control. All the extracts presented better growth inhibition of breast cancer cell line (MCF 7) However, the chloroform extract showed the best growth inhibition. On the other hand, the ethanol extract showed low growth inhibition against all the cancer cell lines.

Araujo et al. (2019) investigated the effects of antiproliferative activity on cancer cells using A. pavonina seed powder that had been enzymatically treated with amylase, cellulase, and protease. Their findings indicated that the enzymatic treatment of A. pavonina seed powder with protease and cellulase enhanced antiproliferative activity in prostate (PC-3) and kidney (786-0) tumor cell lines.

ANTIEMECTIC ACTIVITY

Regarding the anti-emetic action, only one study was published. The anti-emetic properties of A. pavonina leaf crude methanol extract were evaluated in male chicks. 50 mg/kg body weight (p.o.) of copper sulfate caused emesis. By measuring the mean reduction in the number of retching episodes compared to the control, the anti-emetic activity was determined. The extract (150 mg/kg body weight orally) showed an anti-emetic activity of 50.17% when compared with standard chlorpromazine at the same dose (Hasan et al., 2012).

RENAL PROTECTIVE ACTIVITY

Rats with diabetes induced by streptozocin were utilized to evaluate the renal protective properties of an aqueous extract from A. pavonina seeds, administered at doses of 50, 100, and 200 mg/kg orally. The extract was given daily for a duration of 13 weeks. Treatment with the A. pavonina aqueous extract significantly reduced levels of proteinuria, albuminuria, lipids, and glycated hemoglobin (HbA1c) in the diabetic rats. In contrast, the streptozocin-induced diabetic rats exhibited severe hyperglycemia, along with significantly increased proteinuria and albuminuria after the 13-week treatment period. Consequently, the A. pavonina seed aqueous extract has been shown to mitigate the progression of diabetic nephropathy in rats with streptozocin-induced diabetes.

CNS DEPRESSANT AND ANTICONVULSANT ACTIVITY

Research on the CNS Depressant Effects of 100 and 200 mg/kg of A. pavonina Seed Methanolic Extract. At 200 mg/kg, the extract exhibited 80% protection against leptazol-induced convulsions in mice and a stronger depressive effect than the reference medication, chlorpromazine-10 mg/kg. The extract also demonstrated a dose-dependent decrease in spontaneous locomotor activity, suggesting a central nervous system depressive action in mice.

Antiviral activity

Antiviral effect of the *A. pavonina* seed and fruits aqueous extracts were conducted by Chiang et al. (2003). Adenoviruses (ADV) and herpes simplex viruses (HSV) were tested against the extracts. It was found that the aqueous extracts were solely effective against ADV in the in vitro tests. Sulfated galactomannan from *A. pavonina* has also been shown to have a relevant antiviral activity against dengue virus (Marques et al., 2015). Other researches also have confirmed the antiviral activity of sulfated galactomannan from *A. pavonina* against herpes simplex virus (Godoi et al., 2015), or of native or sulfated galactomannan from *A. pavonina* against poliovirus type 1 (PV-1)

Antinociceptive activity

Pandhare et al. (2012b) evaluated the ameliorative effect of seeds of *A. pavonina* aqueous extract in attenuating neuropathic pain in streptozotocin-induced diabetic rats during twelve weeks of treatment. The test extract was administered orally to diabetic rats at doses of 50, 100, or 200 mg/kg daily along with pregabalin as a conventional medication. Rotarod tests, photo Actometer tests, and cold and hot water tail immersion tests were conducted. In addition to the sciatic nerve's histological assessment, techniques for measuring tissue superoxide anion and total calcium levels were carried out. Remarkably, the findings showed

that while the extract considerably improved tail-flick latency in diabetic rats, it had no discernible impact on the rats' spontaneous motor activity or motor coordination. Additionally, the extract decreased total calcium and superoxide anion levels in a dose-dependent way. Additionally, the extract reduced the sciatic nerve's histological alterations. According to this study, extract from A. pavonina may slow the growth of Additionally, the extract decreased total calcium and superoxide anion levels in a dose-dependent way. Additionally, the extract reduced the sciatic nerve's histological alterations. According to this study, A. pavonina extract may be useful in halting the growth of diabetic nephropathy and, when compared to pregabalin, may lessen the development of diabetic neuropathy in diabetic rats. In a separate investigation, Moniruzzaman et al. (2015) evaluated the antinociceptive properties of ethanol extracts from the leaves of A. pavonina at doses of 50, 100, and 200 mg/kg body weight (administered orally). This assessment utilized various nociceptive models in mice, including thermal tests (hot plate and tail immersion), acetic acid-induced writhing, and protocols involving glutamate and formalin-induced licking. Furthermore, the study explored the cyclic guanosine monophosphate (cGMP) signaling pathway and the role of naloxone to investigate the potential mechanisms of action, particularly the involvement of opioid receptors in the analgesic effects, using methylene blue. The findings revealed that the extract significantly diminished nociceptive responses in a dose-dependent manner. Specifically, acetic acid-induced visceral nociception was suppressed, and both glutamate and formalin-induced nociception were markedly reduced, as indicated by an increase in latency time during thermal tests and a reduction in the number of abdominal contractions induced by acetic acid across all doses tested. Concerning the mechanisms of action, the study suggests that the cGMP pathway and opioid receptors may play a role in the antinociceptive effects of the extract. These findings reinforce the traditional application of this plant in managing various painful conditions and indicate its antinociceptive activity, potentially linked to its chemical constituents, including alkaloids, carbohydrates, proteins, flavonoids, glycosides, saponins, steroids, and tannins.

CONCLUSION

Adenanthera pavonina, widely recognized as the red sandalwood tree, possesses considerable ethnobotanical and pharmacological significance. Classified within the Fabaceae family and the Genus Adenanthera, this plant is utilized in various regions for its medicinal properties. It is rich in bioactive compounds, such as alkaloids, flavonoids, and saponins, which enhance its therapeutic potential. Adenanthera pavonina L. is regarded as a valuable medicinal resource due to its extensive array of bioactive constituents. Its pharmacological profile includes a variety of activities, such as anti-inflammatory, antidiabetic, antioxidant, antimicrobial, and cytotoxic effects, highlighting its potential for therapeutic applications. Nevertheless, given its toxicity, caution is recommended in its application, and additional clinical research is essential to thoroughly assess its safety and efficacy. Pharmacological investigations reveal its multifaceted actions, indicating its promise as a candidate for future pharmaceutical innovations. Continued research is crucial to isolate specific compounds and gain a deeper understanding of their mechanisms, which may facilitate the development of novel treatments derived from this plant. The therapeutic potential of Adenanthera pavonina justifies ongoing exploration into its safe and effective integration into contemporary medicine. Consequently, it is anticipated that further studies on this species will yield prototype molecules suitable for the creation of new herbal medicines, leading to the filing of related patents in the foreseeable future.

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