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Review Article

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MEDICINAL IMPORTANCE OF *ADENANTHERA PAVONINA* -AN EVIDENCE BASED OVERVIEW

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ABSTRACT

Nowadays peoples using medicinal plants to treat various diseases. *Adenanthera pavonina* is considered to have different medicinal values which belong to the family Fabaceae. The review was carried out to discuss in detail about pharmacological activities of *Adenanthera pavoninaI*(AP).Various literature collection of this plant and collection of its pharmacological actions. The phytoconstituents of alkaloids, carbohydrates, flavonoids, sterols, terpenoids, and saponins are present in *Adenanthera pavonina*. In this review evaluated the various pharmacological activities of the AP. From the literature collections the *Adenanthera pavonina* had Anti-diabetic Activity, Hypolipidemic activity, Antihypertensive activity, Antidiarrhoeal activity, Anti-Cancer Activity, Antioxidant activity, Antiviral acitivity, Anti-inflammatory activity and Antimicrobial Properties.

KEYWORDS: Phytoconstituents, Fabaceae, *in vivo*, *in vitro*, red bead tree.

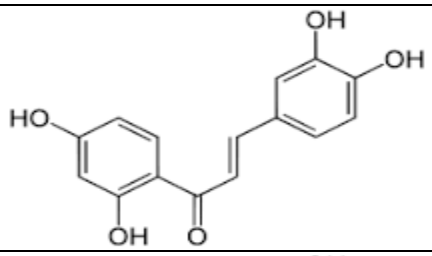
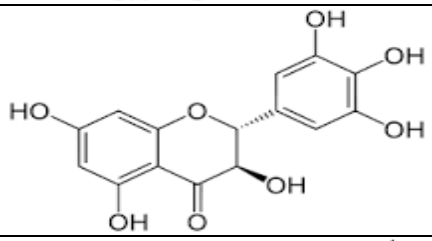
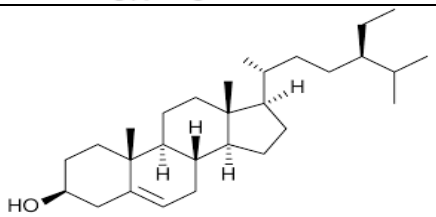
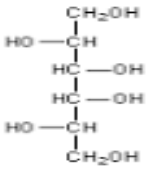
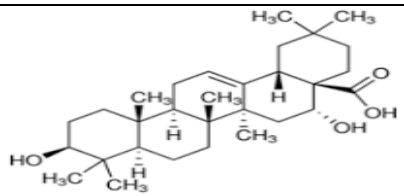
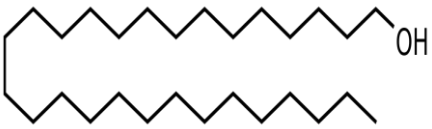
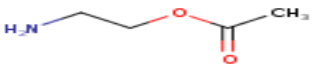
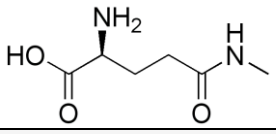
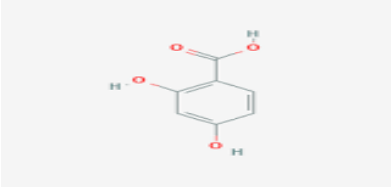
1. INTRODUCTION

'*Adenanthera*' derived from Greek terms ‘aden’ (sticky gland) and ‘anthera’ (anthers), referring to tree's flower anthers being tipped with sticky glands. Species epithet *pavonina* came from Latin word ‘pavo’, meaning peacock-blue. *Adenanthera pavonina* (AP) is commonly called as Red lucky seed and International common names of the tree are Crab's eyes, Coral wood, red bead tree, False Sandalwood, Peacock tree, manchadi, Aanai kundumani etc. AP belongs to the family Fabaceae. The subfamily Mimosoideae includes 82 genera and 3275 species distributed in tropical and warm temperature zones. *Adenanthera i*s a genus with about 13 species distributed in India, China, Singapore etc.; AP is endemic to Southern China and India. It has been widely introduced and naturalized in Malaysia, Western and Eastern Africa as well as most islands of Pacific. AP other scientific names are *Adenanthera gersenii Scheff*, *Adenanthera polita Miq*, and *Corallaria parvifolia Rumph*.[1]

Figure 1: Whole Parts of *Adenanthera Pavonina.*

2. CHEMICAL CONSTITUTION

Table 1: Chemical constituents in Adenanthera pavonina.

Constituents		Structure
Flavonoids	Butein	
Flavonoids	Ampelopsin	
Steroids	β-sitosterol	
Carbohydrate	Galactitol	
Terpenoids	Echinocystic acid	
Aliphatic products	1-octacosanol	
Alkaloids	O-acetylethanolamine	
aminoacids peptides	γ-methyleneglutamine	
aromatic products	2,4-dihydroxybenzoic acid	

3. MEDICINAL AND OTHER USES

In India a decoction of AP young leaves is used against rheumatism and gout. It is also used for inflammations, blood disorders, arthritis, cholera, paralysis, epilepsy, convulsion, spasm and indigestion. Pulverized wood mixed with water is taken orally for migraines and headaches. Bark and leaf decoction are used to treat dysentery, diarrhoea and tonsillitis. Decoction of the seeds were used in pulmonary infection and externally applied in chronic opthalmia. The red, glossy seeds are used as toys and for necklaces, and in earlier days were used to weigh gold, silver and diamonds, because they have a narrow range in weight. The seeds are curiously similar in weight, four seeds making up about one gram. The malay name 'saga' is traced to the Arabic term for goldsmith. The bark contains saponin and has been used to wash hair and clothing.

4. PHARMACOLOGICAL STUDIES

The various in vivo, in vitro screening methods are used for the evaluation of pharmacological properties of *Adenanthera pavonina*. This plant is having the pharmacological activities like anti-diabetic activity, hypolipidemic activity, antihypertensive activity, antidiarrhoeal activity, anti-Cancer activity, Antioxidant activity, antiviral acitivity, anti-inflammatory activity and antimicrobial properties.[2]

4.1. *IN VIVO* STUDIES

4.1.1. Anticholesterolemia

The Anticholesterolemic effects of the methanol extract of the seeds of AP was evaluated by inducing atherogenic diet in wistar rat. Phytochemical screening showed that the extract contained cardiac glycosides, tannins, saponins, alkaloids and flavonoids. 200 mg/kg dose of the methanol extract showed significant decrease in the levels of serum cholesterol and triglyceride levels. The presence of cardiac glycoside in this plant known to slow and strengthen a failing heart may have accounted for its antihypercholesterolemia effect.[3]

4.1.2. Antinociceptive Activity

The antinociceptive activity of ethanol extract of leaves of AP (EEAP) was investigated using various nociceptive models like thermally or chemically induced models in mice. EEAP was administered orally 30min prior to the experiments at the doses of 50, 100, and 200mg/kg. The results showed extract produced a significant and dose-dependent increment in the hot plate latency and tail withdrawal time. It also reduced the number of abdominal constrictions and paw lickings induced by acetic acid and glutamate respectively. Extract inhibited the nociceptive responses in both phases of formalin test. These results prove the antinociceptive activity of the leaves of AP and support the traditional use of this plant[4]

4.1.3. Anti-Emetic Activity

Crude methanol extracts of the leaves of AP, were evaluated for anti-emetic activity. Extract administered at a dose of 150 mg/kg abdominally and volume of 10 ml / kg to the test animal. After 10 minutes emesis was induced by the oral administration of copper sulphate 50mg/kg body weight to male chicks of four days age. The results shows decrease in number of retching in contrast with those of control. All extracts showed anti-emetic activity when compared with standard drug Chlorpromazine at the same dose. The extracts showed 50.17% anti-emetic activity. This study justifies the traditional use of AP in G.I.T complaints.[5]

4.1.4. Antihypertensive

The effect of AP seed extract on the blood pressure of normotensive rats was evaluated. Wistar rats divided into 3 groups were treated orally with normal saline, propranolol and were given at 1mg/kg and 200mg/kg of AP seed extract over a 4- week period. The mean arterial blood pressure of the normal saline treated animal was 60mmHg, those of propranolol treated animals was 23mmHg while the 200mg/kg extract treated group was 30mmHg. The Na level for the 200mg/kg group was significantly lower than that of control group. Histopathological examination showed that the extract did not cause any significant lesion changes in the liver, kidney and even the testes. The study showed that AP seed extract have the potential to cause a blood pressure lowering effect.[6]

4.1.5. Diabetic nephropathy

The renal protective effect of AP seed aqueous extract (APSAE) was studied in STZ-induced diabetic rats. APSAE (50, 100 and 200 mg/kg per day) was given daily to diabetic rats for 13 weeks. Kidney histopathology was also done. APSAE treatment significantly reduced proteinuria, albuminuria, lipid levels, and HbA1c deposition in diabetic rats. APSAE has therapeutic or preventive effects. These results suggested that APSAE has reduced development of diabetic nephropathy in streptozotocin-induced diabetic rats and could have beneficial effect in reducing the progression of diabetic nephropathy.[7]

4.1.6. Antidiarrheal

The earlier study reported as antidiarrheal activity of AP seed aqueous extract and bark methanolic extract. They studied the antidiarrheal activity in wistar albino rats using the castor oil and magnesium sulphate-induced diarrhoea models. On assessing the effect of extract on gastrointestinal transit using charcoal and castor oil induced enteropooling. Oral administration of plant extracts exhibited dose-dependent antidiarrheal potential. The plant extracts produced significant reduction in propulsive movement in castor oil-induced gastrointestinal transit using charcoal meal in rats when compared with reference standard Loperamide. These findings demonstrate that AP seed aqueous extract and methanolic bark extract shows significant antidiarrhoeal potential.[8,9]

4.1.7. Antidiabetic sactivity

To study diabetic activity, hyperglycemia was induced by intraperitoneal injection of freshly prepared alloxan monohydrate and streptozotocin (STZ) in rats and mice. The animals were treated with extract of seeds of AP and isolated Galactomannans. Body weight, water and food intake, fasting blood glucose, total cholesterol and triglycerides were measured. Results produced significant reversal in hyperglycemic status. The extract showed antidiabetic activity by regulating glycaemic level. The study scientifically justified the Sri Lankan folk claim that extract of AP has blood glucose lowering activity.[10,11,12]

4.1.8. Antiarthritis

The pharmacological evaluation of the aqueous (AET) and ethanolic extracts (EET) of AP leaf was carried out for its anti-arthritic and antioxidant potential in adjuvant-induced arthritic rats. The study revealed the predominant anti-arthritic activity of ethanolic extract and it was concluded based upon the histopathological study and paw volume examination. The biological defence system constituting superoxide dismutase (SOD), catalase (CAT), glutathione peroxides (GPX), ascorbic acid and Vitamin E showed significant increase while the lipid peroxide content was found decreased to a large extent on both AET and EET treatment there by indicating the antioxidant property and indirectly to support anti- arthritic potential of the plant. Further it was concluded that the antioxidant property of the plant might be due to the presence of phytoconstituents like flavonoids, stigmasterol and triterpenoids in the ethanolic extract.[13]

4.1.9. Anti-inflammatory Activity

Study determines the anti-inflammatory potential of seeds, leaves, and barks. Inflammatory was induced by carrageenan-induced hind paw edema, cotton pellet-induced granuloma formation, and formalin induced rat paw oedema model. The extract of AP fraction were screened for its anti inflammatory activity at the different dose levels AP can act as a preventive food for inflammation and other diseases without damaging the DNA integrity in the kidney, liver and the heart. Extract significantly inhibit the paw oedema in acute model and granuloma formation in chronic model with respect to the extract. The result indicates that the antiinfammatory activity of AP extract could be through a inhibition of elevated prostaglandin biosynthesis and reduction of proliferative mass inflammed cells.[14,15,16,17]

4.1.10. Analgesic Activities

The study presents the phytochemical evaluation, and analgesic studies of AP. The bark was extracted in pet-ether (PE), dichloromethane (DCM), ethyl acetate (EA), methanol (ME) and butanol successively. In the analgesic activity is tested by using acetic acid-induced writhing test in mice, the extracts were given interperitonially. The results showed that DCM extract (200 mg/kg) showed the highest (72.081%) analgesic activity while PE extracts (100mg/kg) showed the lowest (23.35%) activity in comparison to those of standard drug. It can be concluded from this study that bark extract of AP. possess significant anthelmintic and analgesic activity. [18,19]

Table 2: *In-vivo* models used for study of various pharmacological activities of AP.

Part	Extract/ formulation	Activity	Model	Dose	Parameter	Mechanism	Author
Seeds	Powder	Anti Inflammatory	Carrageenan induced hind paw edema	10 – 30g	Paws size COX-2, TNF-α, Soluble intracellular adhesion molecule (sICAM) levels in the serum	*A.pavonina* influenced repairs of the damaged DNA	Israel Sunmola A, *et al* 2018
Seeds	Aqueous, Ethanol	Antidiabetic hypolipidemic	Alloxan induced diabetic rats	500mg/kg	Glucose TG HDL LDL	Promote insulin secretion	A.Krishnaveni *et al* 2011
Seeds	Aqueous	Antidiarrheal	Castor oil and Magnesium sulphate induced diarrhoea	50,100& 200mg/kg	GI transit time	inhibits GI motility through anticholinergic effect	Ramdas Pandhare *et al* 2017
Seeds	Methanol	Anticholeste-rolemic	Antherogenic diet induced hyperlipidemia	200mg/kg	TC, TG, LDL, HDL, VLDL	Reduce inhibition on LPL & LCAT activity	Vetta Gounderr Maruthappan *et al*, 2010
Seeds	Aqueous	Diabetic nephropathy	streptozotocin-induced diabetic	50, 100 and 200 mg/kg	Blood glucose, albumin, creatinine, total protein, urea, lipid profile, HbA1c	-	Ramdas Pandhare *et al*., 2012

					urine protein, Kidney histopathology		
Seeds	Methanol	Blood Pressure Lowering Effect	Normotensive Rats	200mg/kg	arterial blood pressure	Relax smooth muscles of arterioles thereby decreasing systemic vascular resistance	Aduragbenro D. A. Adedapo 2009
Leaves	Ethanol	Anti-inflammatory	Carrageenan induced hind paw edema Cotton pellet granuloma Castor oil-induced diarrhea	250 and 500 mg/kg	Paw edema Cotton pellet granuloma weight Weight of faeces	inhibition of prostaglandin synthesis	C. Mayuren 2009
Leaves	Aqueous and ethanol	Antiarthritis Antioxidant	Adjuvant induced arthritis	-	SOD CAT GPx	Antioxidant property	P. Muthu Kumran *et al* 2013
Leaves	Aqueous	Hypoglycae-mic and Antihypergl-ycaemic	OGTT	500, 750 and 1000 mg/kg	FSG RSG	Extract may have insulin releasing potentiation activity by acting on beta cell of the pancreas	D.M.R.K. Dissanayake *et al* 2016
Leaves	Methanol Aqueous	Antiinflamm-atory	Formalin induced rat paw oedema	200 & 400mg/kg	Paw edema	Inhibits monocyte infiltration & fifibroblast prolifertaion	S.Jayakumari *et al* 2012
Leaves	Ethanol	Antinocicept-ive	Hot plate Tail immersion test Acetic acid induced writhing model Glutamide induced nociception Formalin induced nociception	50, 100, & 200mg/kg	Paw licking Tail immersion latencies Abdominal constriction	NO- cGMP pathway	Moniruzzaman, *et al* 2015
Leaves	Methanol	Antiemetic	Orally administered copper sulphate	150mg/kg	No. of retching	-	Muhammad Mohtasheen *et al* 20112
Bark	petroleum ether, ethyl acetate, chloroform and ethanol	Analgesic	acetic acid induced writhing model	200 mg/kg,	No. of writhing Percentage of inhibition	inhibit or modify responses to pain mediated by nociceptors peripherally.	Sujit Dash, *et al* 2017
Bark	Methanol	Anti diarrheal Acute toxicity	Castor oil induced diarrhea	500 & 1000 mg/kg	Diarrhoeal episode	Inhibit motility & secretion induced by castor oil	Arzumand Ara *et al* 2013
Bark	petroleum ether, dichloromethane ethyl acetate and methanol	Analgesic	acetic acid-induced writhing test	100 and 200 mg/kg	No. of writhing	inhibited prostaglandins synthesis.	Arzumand Ara, *et al* 2010
Bark	PE, DCM, EtOAc and MeOH	Antiinflamm-atory	carrageenan-induced oedema model	200 and 400 mg/kg	Rat paw oedema	inhibition of histamine or serotonin, and inhibition of the enzyme	Arzumand Ara, *et al* 2010

						cyclooxygenase leading to the inhibition of PG synthesis.	

4.2. *IN VITRO* STUDIES

4.2.1. Anticancer

Evaluation of antiproliferative effect were reported for leaves and barks of AP. MTT, LDH and Sulforhodamine B (SRB) assays were carried out to study cytotoxicity. Anti-proliferative activity of different solvent extracts of AP were studied against cancer cell lines, HEp-2, HCT116, NCIH460, U251 and MCF7. Chloroform extract showed high growth inhibition of MCF7 cancer cell lines while ethanol extract showed low growth inhibition against all the cell lines. Induction of cell death was visualized by fluorescence microscopy stained with ethidium bromide/acridine orange dye mix. The toxicity of the extracts suggests the presence of bioactive compounds in the extracts.[20,21,22,23]

4.2.2. Antimicrobial

Evaluation of the antimicrobial activity of the different solvent extracts of leaves, stem, seeds and bark of AP by MIC, Disc diffusion method, and biosensor bioassay method. In this study, the plant was tested against different bacteria (*Salmonella enteritidis, Klebsiella pneumoniae, Bacillus subtilis, staphylococcus aureus, Escherichia coli* and *Pseudomonas aeruginosa...etc)* and fungi (such as *Saccharomyces cerevisiae and Candida albicans.*) The results revealed that these extracts have both antibacterial and antifungal activity. The zone of inhibition was compared with commercially available standard antibiotics. The inhibitory effects of extracts are higher or very close and comparable with the standard antibiotics used.[24,25,26,27]

4.2.3. Antioxidant

Study of AP leaves and barks, for Free radical scavenging capacity has been performed. Antioxidant activity of extract AP was investigated by DPPH, nitric oxide and reducing power assays. The free radicals such as singlet oxygen (O_2), superoxide anion (O_2^-), hydroxyl radical (OH) and hydrogen peroxide (H_2O_2) are highly reactive unstable molecules, which are generated naturally as unwanted products during oxidation‑reduction reaction in the human body. These had been counteracted by antioxidant properties of different solvent extracts and shows potential scavenging activity on measurement. The possible antioxidant activity is due to the reducing potential of the compound which plays an important role by acting as a marker. The results of the study indicated that anti-oxidant activities of phenolic and flavonoidal compounds are responsible for the anti-oxidant activities of extract of AP.[28,29,30,31]

Table 3: *In-vitro* models used for study of various pharmacological activities of AP.

Part	Extract	Activity	Method	Author
Leaves, seeds, & stem woods	Petroleum ether, acetone, chloroform, methanol	Antibacterial	MIC Zone of inhibition	Abdul Matin., *et al*, 2015
Seeds	Methanol	Antimicrobial	Zone of inhibition	Oluwatofunmilayo A. Adeyemi *et al* 2015
Leaves	Aqueous Extract Petroleum Ether, toluene, Chloroform, Methanol And Ethanol	Antibacterial and antioxidant	Disc diffusion method DPPH Linoleic Acid Bleaching Inhibition Assay Hydrogen Peroxide Reducing Power Assay	Sreerangegowda Thippeswamy., *et al* 2015
Bark	Aqueous Extracts	Anticancer	HEp-2 cell line MTT assay LDH activity Sulforhodamine B assay EB/AO staining	Indeewari K S., *et al*, 2016
Leaves	chloroform, ethyl acetate, acetone, methanol and ethanol	Cytotoxicity	HCT116, NCIH460, U251 and MCF7 Brine shrimp cytotoxicity assay	Renilda Sophy AJ *et al* 2015
Bark	Aqueous Extracts	Antioxidant	DPPH Nitrix oxide radical	Indeewari K. S., *et al*, 2011

			scavenging activity Deoxyribose assay	
Bark	Petroleum ether acetone and methanol	Antioxidant and cytotoxicity	DPPH Reducing Ability Assay NCI-H460, U251, and MCF7	Renilda Sophy A J *et al* 2015
Bark	petroleum ether,dichloromethane ethyl acetate and methanol	Antimicrobial and antioxidant	Disc diffusion method DPPH	Arzumand Ara, *et al* 2010
Bark	petroleum ether, ethyl acetate, chloroform and ethanol	Anthelmintic	Bioassay	Sujit Dash, *et al* 2017
Leaves	Ethanol	Cisplatin induced Genetic damage in cultured human peripheral lymphocytes	Chromosomal Aberration Assay Comet Assay	Pushpa C. Tomar *et al* 2018
Leaves	Methanol	Scavenging Activity	DPPH Assay for nitric oxide anion scavenging activity Assay for reducing power	Mohd. Mujahid, *et al* 2015
Leaves	Ethanol	Anti quorum	Biosensor bioassay	Halkare surayanarayana vasavi 2015

Table 4: Studies on The Isolated Compounds from AP.

Part	Isolation compound	Activity	Method	Drug dose	Author
Seeds	Trypsin inhibitor protein	tryptic activity.	stoichiometry,	0.16mg/mL	D.D. de Souza *et al* 2016
Seeds	α – amylase inhibitor	Antibacterial	Well diffusion	50µl	Chandrashekhraiah K.S 2017
Leaves	Quercetin Kaempferol	cytotoxic activity antioxidant activity	Hep G2 MCF7 HCT116 DPPH	2.50µg 100 mg/kg	R.S. Mohammed,*et al* 2014
Seeds	Sulfated polysaccharide	Antiviral Activity	MTT Assay Plaque Reduction Assay Time-of-Addition Assay. Virucidal Effect Inhibition of Adsorption Assay Immunofluorescence Assay	0.78 to 100 μg/mL 12.5 μg/mL, 25 μg/mL, 50 μg/mL, 100 μg/mL 12.5–100 μg/mL) 12.5 μg/mL, 25 μg/mL, 50 μg/mL, and 100 μg/Ml	Ananda Marques de Godoi, *et al* 2014
Seeds	Galactomannans	Antidiabetic	STZ induced diabetic	1% 2%	Caro Gusmao Pinto Vieira *et al* 2018
Seeds	Kunitz type inhibitor	Insecticide effect	*Callosobruchus maculatus* larvae	0.25% 0.5%	Maria Liägia Rodrigues Macedo *et al*l 2004
Seeds	Peptide - APDef1	Antifungal	Cell viability assay	80 µg/mL	Julia Ribeiro Soares *et al* 2012
seeds	APPI-1, APPI-2and APPI-3	Protease Inhibitors	well diffusion method, Trypsin and Chymotrypsin inhibitor activity	50µl	KS Chandrashekharaiah1, *et al* 2017

5. CONCLUSION

Adenanthera pavonina is one of the folk plants which had the various medicinal properties. In this review, an effort has been taken to cover updated pharmacological activity literature which could be useful for the quick search of pharmacological activities on different parts of *Adenanthera pavonina*.

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