AN UPDATED REVIEW ON MULTIDIMENSIONAL USES OF BAUHINIA PURPUREA LINN

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Abstract

Despite the significant advancements that modern medicine has witnessed over the last century, optimum efficacy and safety are still a distant dream. Therefore, research for alternative approaches to diseases, such as the exploration of herbals and medicinal plants, is ongoing, with new evidence every day. Throughout the beginning of time, medicinal plants have been employed in healthcare. Bauhinia purpurea Linn (BP) is one such medicinal plant that has been used for the treatment of several medical conditions. It is used traditionally in diarrhoea, haemorrhoids, goitre, different type of ulcers, helminthic infections, piles, and blood dysentery. A large number of research have been conducted throughout the world to confirm its effectiveness. On scientific evaluation, it was found to be effective in pain, inflammation, fever, rheumatoid arthritis, different types of infections, ulcers, diabetes, obesity, hyperlipidaemia, epilepsy, depression, carcinoma, depression, thyroid disorder, immunological disorder, and hepatic disorder. BP was investigated at a wide dose range (50-500 mg/kg body weight) for various pharmacological activities. The dose that was found to be very effective and commonly used was 100-200mg/kg body. Several active principles have also been isolated from BP like bauhinia statins, glycosides, flavonoids, saponins, triterpenoids, phenolic compounds, oxepine, fatty acids, ergosterol, beta-tocopherol, stigmasterol and, phytosterols. The various pharmacological effect of BP is supposed to be due to the combined effect of all these phytoconstituents present in BP. This review summarises updated information regarding the research involving the pharmacological aspect of BP and its multidimensional use in various diseases. Considering the uses of BP for various medical conditions, the benefits obtained from its use, the absence of side effects, and its favourable toxicological profile, it can be concluded that BP can be used as a safer alternative for different medical conditions with additional clinical research.

Keywords: Medicinal Plants, Bauhinia Purpurea, Pharmacological activities, Diseases

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INTRODUCTION

Medicinal plants have been used for decades to treat various ailments. Bauhinia purpurea Linn is one such medicinal plant. The different parts of this plant have traditionally been used in medical conditions like dropsy, delirium, fever, anasarca, rheumatism, as an analgesic, anti-inflammatory, antiepileptic, anticonvulsant, and an antidote to a snake bite, animal bite, and scorpion sting. [1]

The various parts of this plant are rich in multiple chemicals like flavonoids, steroids, tannins, coumarins, carbohydrates, and reducing sugars. [2]

The pharmacological activity is thought to be because of the combined effect of various chemical substances in BP. Several studies have been carried out to demonstrate the underlying mechanism and validate its use. It has a significant immune modulatory effect and can be used for diseases where immune cells play a critical role. Several molecular events are found to be responsible for its effect. One such molecular event is the reduction in the level of cytokines like IL-1β, IL-6, and TNF-α and an increase in IL-10. Several studies have demonstrated the modulatory effect of flavonoids, steroids, tannins, and coumarins on cytokines like IL-1β, IL-6, and TNF α. [3-6] It can be used for COVID-19 and other disease conditions with severe cytokine-mediated damage in the present scenario.

Taxonomic hierarchy [7]

Kingdom: Plantae
Division: Angiosperms
Class: Dicotyledonae
Order: Fabales.
Family: Fabaceae or Leguminosae
Genus: Bauhinia
Species: Bauhinia purpurea

Geographical distribution

BP is found throughout India and is native to south China and Southeast Asia. In the United States, it is found in Florida, coastal California, and south Texas. [8]

Plant profile

It is a small to a medium-sized fast-growing tree with a height of about 17 m with dark brown bark. The leaf is 7.5 -15 cm long and bilobed, equally wide, the margin entire, and the surfaces smooth and glabrous. The flowers are conspicuous, pink, and fragrant, with five petals. The fruit is brown, strap-shaped, non-septate, dehiscent pods. It is 15-30 cm long, up to 1.5-2.5 cm wide, containing 10-15- shiny-brown rounded, flat seeds. [9].

Vernacular Name

In India, it is known for its various vernacular names. The most commonly used names are Khairwal, Kaniar (Hindi), Vanaraja (Sanskrit Kaanchana (Ayurveda): and Sivappumanchori (Siddha) Orchid tree (English).[10]

Phytochemical constituents:

BP contains various types of bioactive compounds. Several researchers have demonstrated the presence of several phytoconstituents present in BP. BP's secondary metabolites are glycosides, flavonoids, saponins, triterpenoids, phenolic compounds, oxepine, fatty acids and phytosterols. Negi et al.,2012 demonstrated the presence of not only ergosterol, beta-tocopherol, stigmasterol, and lanosterol but also several other bioactive compounds like lupeol, phytol, hexadecanoic acids, methyl esters of hexadecanoic acids, octadecadienoic acids and octadecatrienoic acid, in the leaves extract.[11] The presence of flavonoids, saponins, condensed tannins and steroids was demonstrated by Zakaira et al.,2012.[12] The presence of bauhinia statins 1 and 2 was demonstrated by Pettit et al.,2006.[13]The presence of several other bioactive compounds has been demonstrated by many other investigators, like flavonoids (Yadav et al.,2005)[14]; xylopyranoside (Yadav et al.,2000) [15]; tripertine(Verma et al.,2009)[16]

Traditional Uses

BP is widely used in the traditional medicine system for treating different medical conditions. The leaves of BP are used for the treatment of diarrhoea and also wound healing. The root is used for the relief of flatulence and abdominal distension. The stem bark is used in treating diarrhea due to its astringent nature. Decoction prepared from the bark of BP is used in diarrhea. The flower buds are a laxative and anthelmintic agent [17].

The use of BP in several other medical conditions like hypothyroidism and malignancy has also been

reported [18-21]. The various medicinal uses of B. purpurea are shown in (Table 1).

Parts of B. purpurea	Ethnomedicinal uses
Flowers	Laxatives
Root bark	Haemorrhoids, goitre
Root	Carminative
Stem bark	Diarrhoea
Bark	Different type of ulcer
Flower buds	Laxative, anthelmintic, piles, and blood dysentery

Table 1: Ethnomedicinal uses of B. purpurea

PHARMACOLOGICAL ACTIVITIES

Anti-inflammatory, antinociceptive, and antipyretic activity:

Hydroalcoholic extract (stem bark) of B. purpurea was investigated scientifically by Kumar et al., 2019; for anti-inflammatory on adult albino Wistar rats using the carrageenan-induced paw edema model [22]. The pharmacological results of this study revealed that BP elicited a significant dose-dependent reduction in joint swelling throughout the observation period. Results reported a reduction in paw edema at different time scale intervals at 50 mg/kg, 100 and 200 mg per kg body weight. The anti-inflammatory action of B. purpurea was also supported by several studies. [22-24] Zakaira et al., 2007 found a significant anti-inflammatory, antinociceptive, and antipyretic activity of B. purpurea aqueous leaf extract in animal models at the dose of 6, 30, and 60mg per kg body weight. [23] Sreedhar et al., 2009 found a significant analgesic and anti-inflammatory activity of the ethanolic extract of B. purpurea stem at 50 and 100mg per kg body weight. [24] This shows a modulatory action of BP on the mediators of inflammation.

Anti-arthritic activity

Kumar et al., 2019. investigated the antarthritic activity BP on adult albino Wistar rats using Complete Freund's Adjuvant (CFA) induced arthritis model [22]. The inhibitory effect of BP extracts on increased joint diameter was evaluated on day 3, 7, 14, and day 21 using CFA induced arthritis model. Treatment with 50,100,200mg/kg produced a significant reduction in joint swelling on all observation days compared to the control.

Immunomodulatory

The Immunomodulatory action of BP was studied extensively by Kumar et al., 2019. The hydro-alcoholic extract of BP was found to reduce the levels of pro-inflammatory cytokines like IL-1β and, IL-6, TNF-α and increase the level of anti-inflammatory cytokines like IL-10 in the serum of CFA-immunized rats. This shows that there is a modulatory action of BP on cytokines. [22]

Anti-oxidant activity

Kumar et al., 2019. investigated the antioxidant activity of BP on adult albinos' rats in CFA induced arthritis model. It was found that the administration of BP returns oxidants and anti-oxidants to their normal levels after oxidative stress caused by the administration of CFA. This was brought about by decreasing pro-oxidant Malondialdehyde (MDA) and increasing antioxidant superoxide dismutase (SOD), catalase (CAT), Superoxide dismutase (SOD), and Glutathione (GSH) parameters as compared to control. [22] The antioxidant activity of BP (ethanolic extract of leaves) was also demonstrated by Joshi et al., 2009.[25] and it was found to be significantly higher in comparison to ascorbic acid. The in vitro evaluation of the antioxidant activity of BP was performed by Zakaira et al., 2015. He evaluated the various partition of methanolic extracts of BP like ethyl acetate (EABP), petroleum ether, and aqueous. He observed a significant anti-oxidant activity of the EABP partition of BP's methanolic extract, which was rich in polyphenolic compounds. [26] The antioxidant activity of BP was also supported by Nafees et al., 2013 who found that the methanolic extract of BP in the dose of 100mg per kg body weight significantly decreased malondialdehyde formation.[27] The antioxidant activity of BP was further supported by the study done by Vijayan et al., 2009. Using Bauhinia purpurea leaf extract, he discovered the substantial antioxidant activity of green-synthesized metal nanoparticles. [28]

Anti-diabetic activity

Many researchers have investigated BP's antidiabetic potential, including Muralikrishna et al., 2008. He studied the antidiabetic potential of the ethanolic extract of BP stem at a dose of 100mg/kg body weight in an alloxan-induced diabetes model in rats. He found a significant reduction in the glucose level of BP-treated Wistar rats compared to control. This may be because of the inhibition of cyclogeneses and the promotion of β cell regeneration.[29]

Anti-microbial activity

Many authors have demonstrated the antimicrobial activity of BP. Boonphong et al., 2007 found that several bioactive compounds from Bauhinia purpurea possess antimalarial, antimycobacterial, and antifungal activity.[30] The antimicrobial activity of BP was studied by Negi et al.,2012 under in vitro conditions. He found a significant

antimicrobial activity of the methanolic extract of BP leaves in comparison to hexane, acetone, and aqueous extracts. [11] Vijayan et al., 2018 used the invitro agar well diffusion method to show that green-synthesized metal nanoparticles had considerable antibacterial activity when prepared using Bauhinia purpurea leaf extract.[28] Jyothi et al .,2012 also demonstrated in vitro antimicrobial activity of saponin extracted from BP using the well diffusion method.[31] Chinnapan et al.,2017 demonstrated the invitro antimicrobial activity of silver nanoparticles using flower extract of Bauhinia purpurea.[32] The antimicrobial activity of BP was also shown by Ahmed et al.,2012. He found a significant antimicrobial activity of the methanolic extract of BP. [33] Das et al., 2018 demonstrated the invitro antimicrobial activity of metal nanoflakes. These nanoflakes prepared using leaf extract of BP were found to have significant antimicrobial action.[34]

Wound healing activity

Numerous researchers have demonstrated the wound-healing potential of BP. Ananth et al.,2010 found it to be very effective in wound healing when the chloroform and methanol extract was used topically in the different types of wound models in Sprague Dawley rats. A significant increase in breaking strength was found in the incision wound model with BP. Also, there was a considerable increase in the breaking strength, dry tissue weight and hydroxyproline content of the granulation tissue in dead space wound models. [35]

Antiulcer activity

The antiulcer activity of BP was extensively studied by Hisam et al., 2012. He studied the effect of chloroform extract of BP in the 100-1000 mg/kg doses on ethanol and indomethacin-induced gastric ulcer animal model. He found a significant antiulcer activity of BP along with a significant increase in gastric mucus production.[36] The antiulcer activity was also studied by Zakaira et al.,2011 who found a significant anti-ulcer activity of the aqueous extract of BP at a varying dose (100, 500 and, 1000 mg/kg). The antiulcer activity was further supported by the histopathological examination and also the increased gastric mucus production.

Antidiarrheal activity

The antidiarrheal activity of BP was scientifically investigated by Mukherjee et al., 1998. He found that the ethanolic extract of BP was very effective in the castor-induced diarrhoea model in rats.[37]

Anti-tumor / Cytotoxic activity

The anti-tumor activity of BP was scientifically evaluated by Agrawal et al., 2020. He found significant antiproliferative action of BP. The lectins obtained from BP seeds were very effective against MCF-7 Breast cancer cell lines.[38] The antitumor activity was also studied extensively by Nafees et al .,2013 who found a protective effect of B. purpurea against chemically induced liver cancer in experimental animals and postulated that it might act possibly by its antioxidant, antiproliferative, and apoptotic activities.[27] Ikemoto et al .,2015 successfully demonstrated suppression of prostate cancer growth by the treatment with BP agglutinin and postulated that BPA could be a potent active targeting probe of nanocarriers for delivering anti-cancer drugs to prostate cancer cells. BP may be used as a predictor of gastric cancer recurrence.[39] Futsukaich et al.,2015 observed a decrease in the expression of BP lecithin which can be utilised for determining gastric carcinoma recurrence.[40] Pettit et al.,2006 demonstrated that there was significant inhibition of invitro cancer cell growth by using BP extract prepared from the different parts of the plant.[41]

Anti-Obesity/Anti- lipidemic activity

Bauhinia purpurea bark extract was extensively studied by Mopuri et al., 2010 for its antilipidemic and anti-obesity potential. He found that the methanolic extract of BP was highly effective in decreasing total cholesterol, triglycerides, and LDL cholesterol. On the other hand, there was an increase in HDL cholesterol in rats fed with a high-fat diet.[42] Karunakaran et al.,2021 demonstrated lipid-lowering property of the active principle obtained from BP. He found Bauhiniastatin-1 to be very effective in both in vitro and in vivo models. He hence suggested that it could be a promising pharmacological molecule in treating obesity and dyslipidemia.[43]

Cardiotonic activity

The cardiac activity of BP was investigated scientifically by Muralikrishna et al.,2008 on a frog's heart. The ethanolic extract of BP was found to have cardiotonic activity. He observed that there was an ionotropic and chronotropic effect and the action could be blocked by propranolol.[17] The cardiotonic activity of BP was also investigated by Aziz et al.,2022. He found significant cardioprotective action of the methanolic extract of BP in adrenaline-induced cardiotoxicity in rats by improving cardiac function, reducing ECG and histopathological changes that could be partly mediated through its anti-oxidant, anti-

inflammatory effects, inhibition of ACE, MMP-9, and iNOS.[44]

Hormone regulation

Panda et al. (1999) studied the effect of BP on thyroid hormonal regulation. It was observed that there was a significant increase in T3 and T4 levels following the administration of an aqueous extract of BP for 20 days indicating stimulatory action of BP on the thyroid gland of mice. The antioxidant activity of BP may be one of the causes responsible for this action or it may be because of the decrease in enzyme metabolising thyroid hormone.[45]

Hepatoprotective action

The hepatoprotective activity of BP was investigated scientifically by Yahya et al., 2013. He found that there was a significant decrease in lipid AST, and ALT level along with antioxidant activity suggesting a hepatoprotective role of BP methanolic extract.[46]

Nephroprotective action

The nephroprotective action of BP was demonstrated scientifically several researchers. Lakshmi et al., 2009 investigated the nephroprotective role of BP in the gentamycin-induced nephrotoxicity model. Daily administration of BP leaves extracts at a dose of 300mg/kg body weight for eight days effectively reduced blood vessel congestion, epithelial desquamation, and kidney necrosis. The extract also normalised the raised uric acid, serum creatinine, and blood urea nitrogen induced by gentamycin.[47] Rana et al.,2016 investigated the nephroprotective action of BP in a cisplatin-induced nephrotoxicity model. He found that the ethanolic extract of BP in the dose of 200 and 400mg per kg body weight produced significant protection against the cisplatin-induced nephrotoxicity model.[48]

Antiepileptic activity

The antiepileptic activity of Purpurea was investigated by Joshi et al., 2011 on Swiss Albino mice using PTZ (pentylenetetrazol-induced seizure) and MEZ (maximum electric shock) models at different doses. He found a significant decrease in the duration of different phases of epilepsy in the experimental animals.[49]

Anti-Depressant activity

B. purpurea ethanolic leaves extract was investigated for antidepressant potential in Swiss Albino mice using the forced swim test (FST) and tail suspension test (TST). The duration of immobility with Ethanol extract at the doses 100, 250, and 500 mg per kg was evaluated for 4 minutes. A dose of 500 mg per kg, when administered in mice produced a fall in immobility time in TST and FST models. The action was reported to be comparable with the standard antidepressant drug Imipramine.[50]

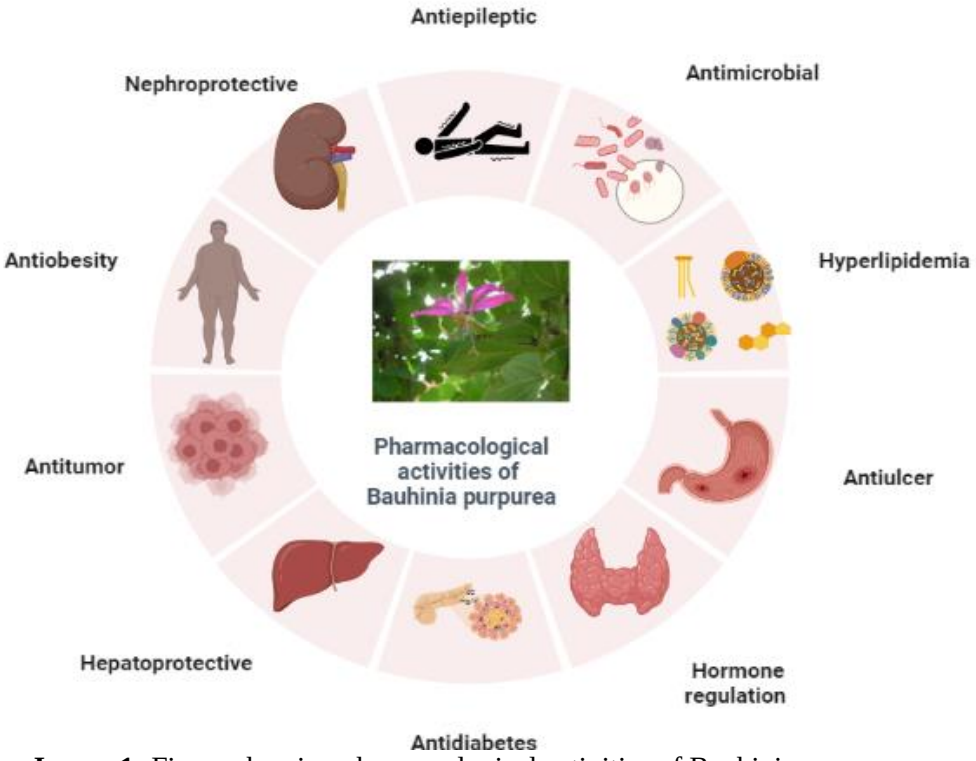

Image 1: Figure showing pharmacological activities of Bauhinia purpurea

Biological activity	Plant part	Extract /Formulation	Dose (mg/kg body weight)	Model/organism/Cell lines	References
Anti-arthritic activity	Stem bark	Hydro-alcoholic	50,100,200	CFA induced arthritis in rats	22
Anti-inflammatory	Stem bark	Hydro-alcoholic	50,100,200	Carrageenan induced oedema	22
Anti-oxidant activity:	Stem bark	Hydro-alcoholic	50,100,200	Biochemical estimation of glutathione, catalase, and superoxide dismutase level	22
Anti-diabetic activity:	Stem	Ethanol	100	Alloxan induced diabetes in rats	29
Anti-microbial activity:	Leaves	Methanol		Against microorganisms Bacillus subtilis, Staphylococcus aureus, Salmonella typhi, Escherichia coli, Pseudomonas aeruginosa and Candida albicans using the disk diffusion method	11
Wound healing activity:	Leaves	Methanol Chloroform	100,500	Incision wound model in rats	35
Antiulcer activity:	Leaves	Chloroform	100,1000	Absolute ethanol- and indomethacin-induced gastric ulcer, and pyloric ligation assays	36
Antidiarrheal activity:	Leaves	Ethanol	100,200,300	Castor induced diarrhoea	37
Anti-tumour / Cytotoxic activity:	Seeds	Lectins isolated from BP seeds	2.2 µM	Invitro study on Breast Cancer MCF-7 Cell Lines	38
	Whole plant	Methanol	100,200	2-AAF-induced hepatotoxicity in rats	27
Anti-Obesity/Anti-lipidemic activity	Bark	Methanol	100,200,400	High fat diet in rats	42
Cardiotonic activity:	Aerial part of plant	Methanol		Adrenaline induced cardiotoxicity in rats	44
Hormone regulation:	Bark	Methanol	2.5	Biochemical estimation in female mice	45
Hepatoprotective action:	Leaves	Methanol	50,250,500	Paracetamol induced hepatic toxicity in rats	46
Nephroprotective action:	Leaves	Ethanol	300	Gentamycin induced nephrotoxicity	47
Antiepileptic activity:	Leaves	Ethanol	100,250,500	MES, PTZ induced seizure in mice	49
Anti-Depressant activity:	Leaves	Ethanol	100,250,500	FST, TST model in mice	50

Table 2: Summary of known biological activities of Bauhinia purpurea

Safety profile of B. Purpurea

The harmful effect of BP was investigated by many authors. BP was found to be safer in several acute as well as subacute toxicity studies in animals. Hisam et al.,2012 performed an acute toxicity study at a dose of 5000 mg/kg body weight and found that there was no sign of toxicity at this dose.[36] BP was also found to be safer in acute as well as subacute toxicity studies carried out by Kumar et al.,2019.[22]

CONCLUSION

BP has long been used in the traditional system of medicine since ancient times for pain, fever, inflammation and several other several medical conditions. There was dearth of knowledge regarding the various pharmacological aspect of this medical plant. In order to overcome this problem, it was scientifically investigated by many investigators to validate its use in several medical conditions. In this article, we have discussed the relevant phytochemical, pharmacognostic, and pharmacological properties of BP along with the various scientific work done by various investigators. The various phytochemical investigations have revealed that several active principles are present in BP like bauhiniastatins, glycosides, flavonoids, saponins, triterpenoids, phenolic compounds, oxepine, fatty acids, ergosterol, beta-tocopherol, stigmasterol and, phytosterols and these biological constituents are responsible for different pharmacological actions of BP. The present review revealed that BP contains various bioactive constituents and acts as an antibacterial, antioxidant, anti-inflammatory, nephron protective, proteinase inhibitor, insulin release enhancer, hepato protective, hemagglu tinator, antihyperlipidemic, anticarcinogenic & antimutagenic agent. The recent work on BP has revealed that it can modulate the immune system and restores the normal level of antioxidants and prooxidants. At the present scenario there is no available safe treatment for several infectious and non-infectious disease conditions. Even the existing therapy is associated with a very large number of unavoidable side effects. So, there is a need of therapy that is effective and devoid of all side effects. Medicinal plants have been used since time immortal for various medical conditions and there is tremendous increase in the use of herbal medicinal products and supplements in few decades. BP has shown promising results in a large number of infectious and non-infectious conditions and the result of scientific studies have also shown that BP is safe. It can be concluded that BP has huge potential to treat several medical conditions and it is also free from side effects and it may be further explored for the several immunogenic and non-immunogenic medical conditions

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