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Review: Pharmacognostic Studies, Phytochemical Screening and Pharmacological Activity of Bauhinia Variegate Linn

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ABSTRACT

In India, generally tribal people utilized the plant, *Bauhinia variegate* Linn., widely. It is alsoacknowledged in conventional medical practices including homeopathy, Ayurveda and Unani. Because of the numerous phytochemicals that are found in all of this tree's parts (flowers, stem,seed, root, bark and leaves) including flavonoids, tannins, kaempferol, terpenoids, saponins, cardiac glycosides and quercetin, it has long been used as a medicinal tree to treat a wide rangeof diseases. These phytochemicals are essential for maintaining and improving human health. The goal of the current study is to provide the pharmacological activity associated with animal models and to establish novel pharmacognostic and phytochemical analyses for the assessment of this plant's leaves, stems, bark, flowers and seeds. The pharmacology, biological activity, therapeutic qualities and phytochemistry of *Bauhinia variagata* are covered in this review. its application in many illnesses. Pharmacological investigations revealed that *Bauhinia variegate* had anti-inflammatory, nephroprotective, hepatoprotective, antioxidant, anticancer, molluscicidal, hypolipidemic, antibacterial and wound healing properties.

Keywords: *Bauhinia variegate* Linn, Pharmacognostic evaluation, Phytochemical constituents, Pharmacological activities, Animal models

Introduction

The plant known by many names as mountain ebony, orchid-tree, poor man's orchid, camel's foot and Napoleon's hat is *Bauhinia variegata* Linn (*BV*) (Synonyms: Phanera variegata Benth)(1). It is an associate of the Leguminosae family. It was planted as an ornamental plant in parks,gardens, and along highway sides in many warm temperate and subtropical climes. It grows intropical or subtropical areas and is endemic to Southeast Asia (2). Every component of the plant, including the leaves, flowers, stem, stem bark, seeds and roots was used in traditional medicine (3). It was originally used to treat bronchitis, leprosy and tumours. The stem bark hasbeen used as an astringent, tonic, anthelmintic and antidiabetic. The infusion of leaves was applied to piles and used as a laxative. Dried buds were used to cure worm infestations, piles, tumours and diarrhoea (4). The phytochemical screening results showed that *BV* included reducing sugars, steroids, flavonoids, tannins, saponins, terpenoids and cardiac glycosides. Pharmacological studies reveal that *BV* has anti-inflammatory, antibacterial, hypolipidemic, anticancer, nephroprotective, hepatoprotective, immunomodulating, molluscicidal and wound- healing qualities (5,6). The purpose of this review is to provide light on the pharmacological and therapeutic effects of *BV* in addition to its chemical components. *BV* Linn. is an important member of the Caesalpiniaceae family of medicinal plants. It goes by numerous other names as well such as the following: Raktakanchan (Marathi), Kachanara (Hindi), Mountain ebony or orchid tree (English) and Kanchana (Sanskrit meaning "A glowing beautiful lady") (7). Flavonoids, fixed oils, tannins, glycosides, triterpene saponins and polyphenols make up the majority of plant material. Flavonoids including apigenin, rutin, quercetin and apigenin 7-O- glucoside were isolated using *BV* Linn

(8). The bark possesses altering, anthelmintic, tonic andastringent qualities. The bark's juice is used to cure diarrhoea, amoebic dysentery and other gastrointestinal issues. Applying the bark paste externally can help heal cuts, wounds, scrofulaand ulcers. It can also be gargled for sore throats or administered internally to treat diarrhoea (9). In addition, it can be used to treat skin disorders, asthma, distention in the abdomen and

cough conditions. It helps with the discolouration of the skin (10). Its powdered bark has traditionally been used to treat ulcers as a strainer and as a tonic (11). Additionally, it helps with skin disorders. The following methods are traditionally used to prepare kachnar: The leaves of the kachnar plant are added to meat and fish as a seasoning eaten as a complement torice and used as a vegetable in curries. Pickles, flour, curries, raitas and vegetables are all madefrom the kachnar flower. It is also stuffed into pakoras and used to flavour meat and seafood (12). In central and northeastern India kachnar seeds are a high source of amino acids and are utilized as a pulse by many tribal communities. A multitude of mouthwatering broths are prepared from the flower's young buds. The buds are used to flavour a variety of foods and beverages including pickles, curries and flour (13).

Geographical, origin and distribution

BV which originated in the East Indies was initially permitted to reside in Jamaica before extending to many other countries such as Texas and Louisiana (14). *BV* usually grows at an altitude of 1300 meters, though it can be found in deciduous forests and the driest mixed forests. Tropical and subtropical regions make up the majority of the trees' range (15). They are indigenous to several countries including the People's Democratic Republic of Lao, China, Burma, North Thailand, North Vietnam, Cambodia, Laos and Pakistan (16). it is present in many Indian states, including Bihar, Delhi, Jammu and Kashmir, Madhya Pradesh, Karnataka, Manipur, Nagaland, Meghalaya, Orissa, Mizoram, Punjab, Pondicherry, Rajasthan, UttarPradesh, Tamil Nadu, Tripura, West Bengal, Sikkim and many more (17). *BV* is grown as an avenue plant beside roadsides, yards and natural thickets and is valued for its fragrant flowers. Although it can grow in well-drained soils *BV* prefers soil that is slightly acidic or acidic. In general, rocky, loamy or sandy loam soil is found in hilly or sloping places where plants thrive. Its ideal growth conditions are 32–42 °C (mean maximum range) and 7–14 °C (mean minimumrange), with 760–1900 mm of rainfall. After the tree reaches the age of two or three it begins to flower when the dry summer approaches, usually in January through April. Fruiting takes place in the months of March through July (18). In the case of *BV* entomophily facilitates pollination (19). In India seeds are dispersed before the commencement of the monsoon seasonoften with the help of the wind and germination begins in time for the rainy season (20).

Cultivation aspects

The seeds are the natural process for *BV* propagation. In contrast to artificial propagation which involves direct seeding and stump planting the seeds are spread upon the dehiscence of the pods on the trees and rapidly sprout when given favourable conditions. Both of these techniques have been proven to be just as effective as planting whole plants that are only one season old. When auxins are applied in August, November and February branch cuttings often take longerto root; nonetheless, this root is readily (21). In direct sowing, lines are sown separated by roughly 3 meters. Following the commencement of the monsoon rains, germination occurs around one week later providing adequate soil saturation. The soil ball needs to be moved with the entire plant. When transplanting whole plants, it may be preferable to use stumps or container-grown plants. Seeds from the previous year are sown in March or April in preparationfor planting

out in July or August (22).

Pharmacognostic Estimation

Macroscopical Evaluation

BV is a deciduous tree with a small to moderate height of 10-15 m and a depth of 0.5 m. The bole has a thin, elongated, spreading crown and is straight, erect and single-stemmed. When the bark is old, it becomes brown to dark grey, has longitudinal fissures is fibrous and the inneris pale pink. Its main root is terete, tapering, whitish or light brown and it is moderately long and thick (23). The leaves of *BV* are bluish-green, simple, alternate, usually 7.5–15 cm long with a cleft located approximately one-quarter to one-third down. the leaves are wider than or equal to their length. Deeply cordate is the base of the leaf. A straight midrib runs between the lobes and the leaves are mucronate with apices of the lobes that are frequently sharp, whole, subcoriaceous, glabrous above and slightly pubescent below (24) The petioles are pubescent and 0.8–2.5 cm long with tiny stipules. The huge, colourful flowers that develop while the treeis leafless—purplish, pink or white—make it easy to identify the tree. Short axillary racemes of fragrant, hermaphrodite grey-pubescent flowers surround them. The species self-pollinates seldom in the wild and is primarily cross-pollinated (10–21.6%) (25).15–30 x 1.7–2.5 cm, the pods are papillose when young and firm and flat when old. They are green but as they ripen they turn a buff or pale brown. There are 2500–3500 seeds per kilogram, measuring 1.3–1.8 ×1.3–1.7 cm, almost round, flat and brown with a slightly coriaceous testa (26).

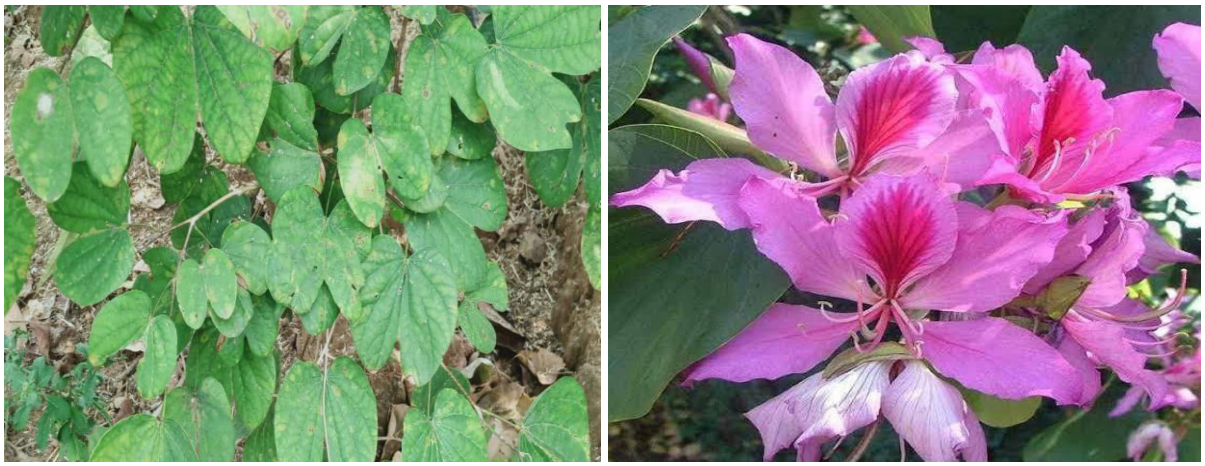

Fig.1: Flower and leave of *BV* (26).

Microscopical Characteristics

The mesophyllic stratum in the laminar region of the *BV* leaf revealed the existence of spongyparenchyma above the lower epidermis and palisade cells in two to three layers under the upper epidermis in the transverse slice of the leaf. Crystals of calcium oxalate are distributed prismatically across the mesophyllic membrane (27). The midrib has a somewhat concave form. The midrib is bordered by sclerenchymatic

cells and has a well-developed vascular bundle in the centre. One could observe the xylem on the upper side and the phloem on the lower side of the vascular bundle. Collenchymatous cells and calcium oxalate crystals are distinguished by their dispersion between the top and lower epidermis (28). Furthermore, covering trichomes are unique in that they are both unicellular and multicellular uniseriate, as well as unicellular sessile. More often than not, the lower epidermis is where they are seen (29).

Fig.2: Plant of *BV* (29).

Physiochemical parameters (30,31). Table.1: Evaluation of *BV* physiochemistry.

S.No.	Parameters	Values (%)
1.	Acid insoluble ash value	5.50
2.	Total Ash value	8.15
3.	Water soluble ash value	2.25

4.	Water insoluble ash value	6.50
5.	Loss on drying	6.6
6.	alcohol-soluble extractive	1.63

Phytochemical Estimation

Table No. 2: Chemical constituents and uses of different parts of *BV*.

S. No	Parts	Chemical Constituents	Therapeutic effect	Reference
1	Leave	Heptatriacontan-12,13-diol and dotetracont-15-en-9-ol. The phytoconstituents of leaves of Bauhinia variegata leaves are tannins, alkaloids, cardiac glycosides, flavonoids i.e. quercetin, rutin, quercetin, apigenin and apigenin 7-O-glucoside.	Antifungal, Antimicrobial, Antidiabetic, Hypoglycemic, Molluscicidal effect, Anti-cancerousactivity	32
2	Flower	Ascorbic, aspartic, glutamic, octadecanoic acid, keto acids, amino acids, tannins, rutoside, taxifoline rhamnoside, kaempferol-3-glucoside, myricetol glycoside, apigenin.	Anti-diarrhoeal, Antidiabetic, antioxidant, anti-hyperlipidemic activity	33
3	Seed	Amino acids, proteins, carbohydrates, leucoanthocyanines, alkaloids, aspartic acid, glutamic acid, arginine, glycine, alanine, histidine, isoleucine, lysine, methionine, phenylalanine, proline, serine, threonine, tyrosine, and valine 5-hydroxy-7-hydroxy7,3',4',5'-tetra-methoxyflavone-5-Obeta-D-xylopyranosyl-(l~->2) -alpha-L-rhamnopyranoside. The seeds yield fatty oil containing linolinic acid, oleic, steric, palmitic and myristic acid.	Haemagglutinating	34

4	Stembark	The stem bark constitutes hentriacontane, octacosanol and stigmasterol; 5, 7-dihydroxyflavanone-4'-O--L-rhamnopyranosyl--D-glucopyranoside; -sitosterol, lupeol and kaempferol-3-glucoside; 2, 7-dimethoxy-3-Beta-sitosterol, naringenin5, 7dimethylether 4- rhmnoglucosides, lupeo, methyl-9, 10-dihydro phenanthrene-1, 4-dione, f glycosides, reducing sugars, nitrogenous substances.	Antitumour, Antiulcer, Immunomodulatory effect, Haematinic, Anti-microbial, Hepatoprotective, Anti-oxidant, Anti-bacterial, Anti-carcinogenic	35
5	Root bark	Flavone, dihydrodibenzoxepin, flavanol, glycoside-5, 7, 3', 4- tetrahydroxy-3-methoxy-7-O-alpha-L- rhamnopyranosyl	Anti-oxidant, Anti-obesity effect	36
6	Root	flavanol glycosides 5,7,3,4 tetrahy-droxy-3- methoxy-7-o-α-L rhamno-pyranosyl (1-3)-o-β-D- galactopyra-noside.	Anti-inflammatory, Wound healing and nephroprotective effect, anti-oxidant activity	37
7	Stem	Beta sitosterol, naringenin5, 7dimethylether 4- rhmnoglucosides, lupeol.	Anti-ulcer	38
8	Non-woody aerial parts:	6 flavonoids were identified by phytochemical analysis of non-woodyaerial parts: kaempferol, ombuin, kaempferol 7,4'-dimethylether-3-o-β-D-glucopyranoside, kaempferol-3-o-β-D-glucopyranoside, isorhamnetin-3-o-β-D-glucopyranoside, and hesperidin, along with one triterpene caffeate, 3β trans-(3,4 dihydroxycinnamoyloxy) olean-12-en-28-oic acid.		39

1. Materials and methods

1.1 Extraction of *BV* leaves

Following being first cleaned with tap water the *BV* leaves were then dried in the shade and ground into a powder. The powder was then kept put into a Soxhlet column and extracted using petroleum ether at 60–80°C for a whole day. After obtaining the marc it was extracted successively for 24 hours using ethanol

extraction (68–78°C) and chloroform (50–60°C). An extract was obtained and concentrated in a water bath at 50°C. The extracted dry powder was kept at room temperature. It was discovered that the harvest of the petroleum, chloroform, methanol, ethanol and water extracts was 9.50 percentile (w/w), 7.65 percentile (w/w), 8.95 percentile (w/w), 8.50 percentile (w/w) and 0.30 percentile as well. The ethanolic leaf extract was used in the experimental analysis (40,41).

1.2 Extraction of *BV* Flower

A desiccator was used to store the 1.2 kg of flowers that were extracted which were first extracted with petroleum ether to remove fatty substances and then extracted with 95% ethanolby hot percolation method. The flowers were identified by the healers in the area and verified by the pharmacognosy department of the institute. The flowers were collected and were then dried, powdered and washed using a mixer. It was found that the ethanolic extract (BVE) percentage yield was 20.8% w/w. This raw extract was mixed with ethanol and purified with water to provide several fractions: F1 (12.5 grams) containing n-hexane, F2 (17.1 grams) containing CH_2Cl_2, F3 (21.2 grams) containing EtOAc and F4 (13.4 grams) containing EtOH (42).

1.2.1 Isolation of Compound from Extract of *BV* flower

Elution was carried out by introducing an increasing order of polarity into the n-hexane-DCMmixture after the transfer of the CH_2Cl_2 fraction F2 (17.1 grams) to the silica gel (70–230 mesh)column. By employing TLC analysis to further purify the unknown compound and conductingcolumn chromatographic studies at the n-hexane-DCM (2:8) eluting system we were able to identify it as a yellow amorphous solid. Compound A, a novel substance was discovered through the use of several spectroscopic techniques, such as mass spectrometry and infrared spectroscopy. Additionally, the TLC card displayed one prominent spot and a few minor spotsby 100% DCM. Compound B was obtained by further purifying this fraction using a silica gel column eluting EtOAc-DCM (1:9) after structural elucidation and the use of multiple spectroscopy methods (43).

1.3 Extraction of *BV* stem bark

The 4.5 kg of *BV* stem bark was powdered after being washed and dried in an oven at ±40 ◦C. After being percolated with 80% methanol, it was dried in a vacuum-assisted rotary evaporator. The extract was lyophilized once more to produce the methanol extract (MEB). The *BV* bark MEB extraction was analyzed using column chromatography. The mixture was mixed with silica gel to form a slurry while the MEB extract (20 g) was dissolved in 50 mL of methanol. A packed silica gel column with a mesh size of 60–120 was positioned above the slurry. Non- absorbent cotton was placed on top of the slurry to prevent any disruption during column elution, which was done with a gradient of hexane/ethyl acetate (hex/EtOAc) (100:0), (90:10), (80:20), (75:35), (70:30), (65:35), (60:40), (55:45), (50:50), (40:60), (20:80), (10:90), (0:100).

2mm thick precoated Kieselgel F254 plates were used for thin layer chromatography (TLC) following the collection of 160 fractions (50 mL each). *BV*1 fraction (31 mg), a yellow-colouredcompound with a single spot in TLC was formed by the hexane/ethyl acetate (10:90) fractionsthat eluted from column (44).

1.3.1 Isolation of pure Compound from Extract of *BV*

The fractions that eluted in a hexane/ethyl acetate ratio of 65:35 to 60:40 was combined basedon TLC spots that were identical. The combined fractions were dehydrated and the solid fraction MEBI (310 mg) was dissolved in 5 mL of ethanol, combined and desiccated to form aslurry which was then placed on a silica gel-filled column (230–400 mesh). Following an overnight stay, precipitates were recovered from the gradient of hexane/ethyl acetate (98:2), (95:5) and (92:8) that was used to elute the column. Fifteen fractions (15 mL each) were collected and the fractions from the 95:5 gradient were pooled based on TLC. After being cleaned and eluted in a column using hexane/ethyl acetate (94:4) these precipitates known as MEBI a fraction (42 mg) produced a white-coloured molecule known as *BV*2 fraction (26 mg). After pooling and drying the fractions obtained from the hexane/ethyl acetate gradient (92:8) in MEBI column chromatography a dark yellow substance known as the *BV*3 fraction (32 mg)was produced (45,46).

2. Analysis of *BV*

Mass spectroscopy, Fourier transform infrared (FTIR) and nuclear magnetic resonance (NMR)were used to evaluate the structure and perform chemical characterization of the pure isolatedsubstances.

2.1 Nuclear Magnetic Resonance (NMR)Spectroscopy

NMR spectroscopy uses the identification of the carbon-hydrogen framework to assist discoverthe specific structure of a molecule. NMR quartz tubes with a standard size of 15 cm by 5 mm were filled with deuterated methanol (CD3OD) to prepare samples for analysis. Techniques from ^{1}H and ^{13}C NMR were applied. The Brucker Avance-300 was used to record the NMR spectra (47).

2.2 Fourier Transform Infra-Red (FTIR) Spectroscopy

The functional groups are detected by FTIR spectroscopy because these produce distinctive bands that show intensity and location (frequency). Reciprocal cm, or cm−1, are the units of frequency that are utilized (48, 49).

2.3 Mass Spectroscopy

The molecular weight of a chemical is determined using mass spectroscopy. To record the massspectrum the chemical (2 mg) was sonicated with a 1:1 mixture of water and HPLC-grade acetonitrile for 15 minutes at room temperature. The resultant solution was then injected (20 µL) into a Bruker mass spectrophotometer (50).

3. Models perspectives on therapeutic action

Table No.3: Pharmacological activities of different parts of *BV* Linn. It is related to models.

S.NO	Activity	Part to be used	Extract used	Model used	Ref.

1	Anti-arthritic	Stem	Ethanolic	Rat arthritis caused by Freund's adjuvant (CFA)	51
2	Immuno-modulatory	Stem bark	Ethanolic	humoral antibody responses to primary and secondary antibodies for a	52
				particular immune response	
3	Anti-tumour	Stem	Ethanol	Produced Dalton's ascetic lymphoma	53
4	Hepatoprotective	Stem bark	Alcohol	CCl4 induced Hepatotoxicity	54
5	Haematinic	Stem bark	Ethanolic	Phenylhydrazine administration	55
6	Anti-ulcer	Stem	Alcohol	Gastric ulcer induced by pyloric ligation & Aspirin-induced ulcer model	56
7	Anti-carcinogenic	Stem bark	Methanolic extract	DMBA & croton oil induced skin carcinogenesis in mice	57
8	Anti-bacterial	Stem bark	Methanolic and aqueous extract	Against bacterial strains	58
9	Anti-diabetic	Leaves	ethanolic, hydro-alcoholic	Glucose - induceddiabetic	59
10	Anti-microbial	Stem bark	Aqueous, methanol	Against bacterial strains	60
11	Chemoprevention & Cytotoxic effects	Stem		Rats were given N-nitrosodiethylamine to create an experimental liver tumour.	61
12	Haemagglutinating	Crude seed	Saline extract	Against erythrocytes in rat	62
13	Anti-helminthic activity	Bark	Chloroform	helminthic action against Pheretima posthuma and Ascardia galli	63

14	Anti-inflammatory	Non-woodyarial part	Isolated flavanol glycoside	Carrageenan-inducedhind paw edema	64, 65
15	Nephroprotective	Entire stem	Ethanolic	against cisplatin-prompted nephropathy	66

4. Pharmacological activity

4.1 Antioxidant effects

The crude extracts and *BV* fractions' antioxidant qualities were evaluated. The antioxidant activity was assessed using the DPPH radical scavenging test. The chloroform fraction had thelowest overall antioxidant activity (67). The scavenging efficiency of the ethyl acetate, methanol, and n-hexane fractions was moderate when compared to normal quercetin (68). Several techniques were used to assess the in vitro antioxidant activity of aqueous and ethanolic extracts of the stem bark and root of *BV*. These techniques included total reducing power and scavenging of several free radicals, including superoxide, nitric oxide, hydrogen peroxide, and 1,2-diphenyl-2-picrylhydrazyl (DPPH). When it came to power reduction and scavenging radicals such as nitric oxide, superoxide, hydrogen peroxide and DPPH, all of the approaches demonstrated considerable antioxidant activity ($P > 0.01$) and ($P < 0.001$)(69).

4.2 Anti-microbial Activity

A study was conducted in vitro to examine the antibacterial activity of ethanolic extracts of *BV* against *Salmonella typhi*, *Bacillus subtilis* MTCC (Microbial type culture collection) 121, *Escherichia coli* MTCC 64, *Enterobacter aerogenes* MTCC 111, *Klebsiella pneumoniae* MTCC 39, *Pseudomonas aeruginosa* MTCC 424, and *Escherichia coli* MTCC 64. Regarding gram-positive bacteria versus gram-negative bacteria the extracts appeared to be more effective (70). *Bacillus subtilis*, *Klebsiella pneumonia* and *Staphylococcus aureus* were among the bacterial species used to evaluate the antibacterial activity of *BV* extracts and fractions. *Bacillussubtilis, Klebsiella pneumonia* and *Staphylococcus aureus* were shown to be susceptible to thehigh inhibitory zone of 14 nm of the *BV* chloroform and methanolic fractions at a dosage of 22 mg/ml (71). *Laurus nobilis's* antimicrobial qualities. Leaf and bark extract was evaluated against Gram-positive and Gram-negative bacteria including *Escherichia coli* and *Pseudomonas aeruginosa* and *Staphylococcus aureus* and *Bacillus subtilis*. The alcoholic *BV* leaf extract had the highest amount of antibacterial activity when compared to petroleum ether and chloroform extracts (72). *B. subtilis, P. aeruginosa, S. typhi, S. dysenteriae, S.* aureus and *Vibrio cholerae* were all susceptible to the antibacterial action of an ethanolic extract of *BV*'s stem bark. It proved more effective against gram-positive bacteria than gram-negative ones (73). Furthermore, *BV* leaf methanolic extracts demonstrated their ability to inhibit *Aspergillusfumigates* and *Aspergillus Niger* (74).

4.3 Anti-inflammatory activity

A phytochemical investigation found that the non-woody aerial parts of *BV* generated one triterpene, caffeate and six flavonoids. These seven substances exhibited anti-inflammatory properties; they also suppressed the production of cytokines and lipopolysaccharides that weregenerated by interferon-γ (75).

4.4 Immunomodulatory activity

BV's stem bark ethanolic extract influenced the primary and secondary antibody responses. Italso increased the phagocytic index and the proportion of neutrophil adhesion (76).

4.5 Nephroprotective activity

The effects of ethanolic and aqueous extracts of the root of *BV* (200 and 400 mg/kg bw, orally) on antioxidant and nephroprotective response to gentamicin-induced nephrotoxicity were investigated in rats. Generated considerable free radical scavenging activity from both ethanolic and aqueous root extracts of *BV* (77). Reduced levels of increased serum creatinine, serum urea, urine creatinine and BUN (Blood urea nitrogen) were indicative of both extracts' strong nephroprotective effect in the gentamicin-induced nephrotoxicity model. Histopathological analysis supported these findings. Rats6T treated with gentamicin and cisplatin-induced nephrotoxicity were used to test the nephroprotective effects of the ethanolic and aqueous extracts of the *BV* root at a concentration of 400 mg/kg bw (78). Both extract-treated groups had lower serum creatinine, urine creatinine, serum urea and BUN levels than the gentamicin and cisplatin-induced nephrotoxicity models which was further supported by a histopathological analysis. These findings demonstrate the nephroprotective activity of 6T Bothextracts in these models (79).

4.6 Anti-ulcer activity

In traditional medical systems, the plant is a useful therapy for mouth ulcers. Swiss albino ratswere used to test the alcoholic extract of *BV* stem against pyloric ligation-induced stomach ulcers and aspirin-induced ulcer models to objectively substantiate the claim. The stomach was cut and its greater curvature was checked for ulcers (80). It was determined what the ulcer index, total free acidity and gastric secretion volume were. The level of gastric output, total, free acidity, and ulcer index were all considerably ($P < 0.001$) lower in the rats treated orally with *BV*'s alcoholic extract than in the control group (81).

4.7 Anti-arthritic

The anti-arthritic effect of *BV* ethanolic extract was investigated in rats with complete Freund's adjuvant (CFA)-induced arthritis for 15 days. The rodents were given the ethanolic extract orally at a dosage level of 250 mg/kg. The rodents were slaughtered after 15 days their blood was drawn and the serum was then separated (82). Subsequently, a range of indicators were measured, including total cholesterol, triglycerides, alkaline phosphatase (ALP) and alanine aminotransferase (ALT). The levels of many antioxidant enzymes including catalase, glutathione peroxidase (GPx), lipid peroxidase (LPO) and superoxide dismutase (SOD) were also assessed in the kidney and liver of rats treated with extract, control and arthritic conditions(83). These research' findings demonstrate that giving rats this medicine considerably increased their Paw Edema volume and changed their biochemical parameters as well as the amount of different antioxidant enzymes that affected the rats' arthritic conditions. This study's findings indicated that this plant's ethanolic extracts significantly reduced rat inflammation (84,85).

4.8 Anti-tubercular activity

Clinical reviews indicate that when anti-tubercular medications are used to treat tubercular cervical lymphadenitis, the *BV* stem bark configuration increases their efficacy (86).

4.9 Anti-goitrogenic activity

In traditional medicine the herb is a helpful therapy for goitre. The finding was confirmed through an analysis of the effects of an alcoholic *BV* stem extract on a Swiss albino rat goitre model induced by neomercazole. The plant was found to be highly effective in bringing the goitrogenic thyroid back to normal at a dose of 200 mg per day (87,88).

4.10 Haemagglutination activity

The saline seed extract shown the ability to haemagglutinate human, monkey, rabbit, rat, goat,sheep, cow, buffalo, horse, mule and poultry erythrocytes (89).

4.11 Anticancer activity

When *BV* was extracted ethanolically it was demonstrated that ascitic lymphomas in Dalton were resistant to the lethal effects of diethyl nitrosamine (90). The ethanolic extract was also cytotoxic, according to mice cell lines from Ehrlich Ascites Carcinoma (EAC). The methanolic extract of *BV* stem bark administered at 500 and 1000 mg/kg bw, inhibited the development ofskin carcinogenesis caused by 7, 12-dimethylbenz[a] anthracene and croton oil, therebyavoiding skin cancer in mice with skin papilloma model (91). Its efficacy was demonstrated bya decrease in the incidence of tumours and the overall number of papillomas. Both the tumour burden and tumour production were reduced. The lowered glutathione level was restored in the groups treated with *BV* bark extract (92).

4.12 Hepatoprotective effect:

Chemoprevention against *BV* stem ethanolic concentration was demonstrated in rats with test liver tumour produced by N-nitroso diethylamine. The ethanolic extract buried the liver tumourthat was caused by it, as indicated by a drop in N-nitrosodiethylamine (93). The serum also included higher concentrations of glutathione-Transferees, glutathione peroxidase, glutamate pyruvate transaminase, gamma glutamate Trans peptidase, and basic phosphatase. The ethanolic stem bark concentration of *BV* (given orally at doses of 100 and 200 mg/kg) indicatedthat the hepatoprotective movement of rats lowered the levels of AST, ALT, ALP and GGTP,which in turn caused hepatotoxicity (94,95).

4.13 Effect on wound healing:

In pale-skinned Wistar rats, the injury-recovering movement of the ethanolic and fluid concentrates of the foundation of *BV* at concentrations of 200 and 400 mg/kg bw was assessed utilizing extraction and entry point twisted models (96). Extraction and cut damage models using both fluid and ethanolic concentrations of the *BV* foundation at both measurements resulted in significant injury recovery. This was similar to the extraction wound model treatedwith framycetin, the usual treatment (97,98).

4.14 Anti-diabetic action:

Oral treatment of an ethanolic, fluid, and hydro-alcoholic concentrate of BV leaves and stem bark at varying dosages (200 and 400 mg/kg) decreased the increased blood glucose level in diabetic rats initiated on alloxan and streptozotocin (STZ) by boosting glucose metabolism (99).

4.15 Anti-helminthic activity

The purpose of the study was to find out if *BV* stem bark possesses traditional anthelmintic properties. Test worms namely *Pheretima posthuma* (L. Vaill) and *Ascardia galli* (Nematode), were used to evaluate the anthelmintic effect of the plant's crude ethanolic extract. (100). Several doses (10–100 mg/ml) of ethanolic extract were investigated in the bioassay, which involved timing the worms' paralysis and death. Piperazine citrate (10 mg/ml) was used as the reference standard. When the study's findings were compared to the investigation's standard the latter showed promising anthelmintic effects at a higher level of 100 mg/ml (101).

5. Conclusion:

In conclusion, the *BV* plant is a species of Linn. The people of India commonly use it and It isrecognised in conventional medical systems such as homeopathy, Ayurveda, and Unani. It contains phytochemicals that show an important role in promoting human health, such as flavonoids, tannins, saponins, kaempferol, cardiac glycosides, terpenoids and quercetin. The plant has been found to have medicinal properties, including anti-inflammatory, nephroprotective, hepatoprotective, antioxidant, anticarcinogenic, molluscicidal, lipid- lowering, antibacterial and healing properties. In ancient times it was used to treat many diseases, including tumours, leprosy, bronchitis, diarrhoea and insect infections. This plant is natural to Southeast Asia and is distributed in tropical and subtropical regions and many Indian states. It is propagated by simple technology of scattering and propagation of seeds. Different parts of the plant, including leaves, flowers, stems, bark, seeds and roots have different chemical compositions and therapeutic effects. In addition, many compounds were isolated from plants, and their chemical characterization and structural elucidation were performed using nuclear magnetic resonance (NMR), Fourier transform infrared (FTIR) and mass spectroscopy. This plant shows antioxidant and antibacterial properties, making it an importantmedicinal plant with the ability to treat many diseases. The extract showed antibacterial activity against Gram-positive bacteria and showed antifungal activity. It also showed anti-inflammatory properties and immunomodulatory activity, increasing neutrophil adhesion and phagocytic signalling. The extract showed nephroprotective effects reducing serum and urinary levels and histopathological damage in the nephrotoxicity model. In addition, the extract showed anti-inflammatory activity by reducing gastric emptying, free acid and ulcer symptoms. It also showed anti-inflammatory effects and increased the amount of leg swelling in allergic mice. An extract from the bark of the trunk increases the effectiveness of anti-tuberculosis drugs and exhibits anti-goitrogenic activity. Haemostatic activity has been observed in several types of red blood cells. The extract also showed anticancer activity preventing skin cancer and reducing cancer risk and stress. Hepatoprotective effects and wound healing properties were

also observed. Finally, the extract showed anti-diabetic activity by lowering blood sugar levels and also showed anthelmintic activity through bioassays.

6. Future aspects:

Drug development:

Isolation and purification: using this research we can focus on isolating and purifying the specific active compounds responsible for the various medicinal properties. This could lead tothe development of new and more potent drugs.

Exploring New Applications:

- **Combination Therapies:** Studying the potential benefits of combining Bauhinia extracts withother natural products or conventional drugs for a broader therapeutic effect.
- **Targeted Drug Delivery Systems:** Developing targeted drug delivery systems using Bauhiniaextracts could improve their bioavailability and effectiveness in specific tissues or organs.

Further Pharmacological Investigations:

- **Mechanism of Action:** In-depth studies are needed to understand the precise mechanisms bywhich Bauhinia extracts exert their various medicinal properties.
- **Toxicity Testing:** Thorough toxicological evaluations are crucial to ensure the safety ofBauhinia extracts for human consumption. By addressing these future aspects, *BV* research hasthe potential to unlock a treasure trove of natural medicines for various human ailments. **Acknowledgments**

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