POLYPHARMACOLOGICAL ACTIVITIES OF BERGENIA SPECIES

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ABSTRACT

Bergenia species are evergreen herb belonging to the family saxifragaceae. The rhizomes of these plants are used in the indigenous system of medicines. There are three species of Bergenia, namely B. ligulata, B. ciliata and B. stracheyi. The rhizome and other parts of B. ligulata is used in urinary bladder stone, antilithic activity diuretic activity, anti-bradykinin activity, antiviral activity, antipyretic activity, antibacterial, anti-inflammatory, hepatoprotective activity, insecticidal activity, α-glucosidase activity and all these activities of the plant is due to presence of its constituents like; β-Sitosterol, Tannic acid, Stigmasterol, Gallic acid, Bergenin, (+)-Azelechin, (+)-Azelechin tetracetate, (+)-5,7,4′-trimethoxyazelechin, (+)-tetramethoxyazelechin, (+)-3-acetyl-5,7,4′-trimethoxyazelechin. The second species is B. ciliata, have antitussive, antilucer, antioxidant, antibacterial, hypoglycemic, toxicological activity. The plant contains Tannic acid, Gallic acid, Glucose, Metarbin, Albumen, Bergenin, (+)-Catechin, Gallicin and Gallic acid B. stracheyi is third species shows DPPH radical scavenging activity, antimicrobial and xanthine oxidase inhibitory activities. It also used in arthritis. The main chemical constituent of the species is Bergenin.

Keywords: Bergenia species, B. ligulata, B. ciliata, B. stracheyi, Pharmacological activity.

INTRODUCTION

Nature is an extremely rich source of highly diverse and innovative chemical structures. The relationship existing between plants and humans is as old as mankind, dating back to the origin of human civilization. Humans have relied on plants for food, clothing, shelter, fuel and medicine. Therapeutic plant use can be a herbal tea, a crude extract, a phytopharmaceutical or herbal mixture or isolated compounds. Harbalism is a traditional medicinal or folk practice based on the use of plants and plant extracts. The World Health Organization has recently defined traditional medicine (including herbal drugs) as comprising therapeutic practices that have been existence, often for hundreds of years, before the development and spread of modern medicine and still use in today. Herbal drug constitute only those traditional medicines which primarily use medicinal plant preparation for therapy. The earliest recorded evidence of their use in Indian, Chinese, Egyptian, Greek, Roman and Syrian text dates back to about 5000 years. The classical Indian texts dates include Rigveda, Athurveda, Charak Samhita and Sushruta Samhita. The herbal medicines/traditional medicaments have, therefore, been derived from rich traditions of ancient civilization and scientific heritage.

Saxifragaceae is a family of herbs or shrubs, rarely trees or vines. The family includes about 80 genera and 1250 species worldwide. Most members of the saxifragaceae family are herbs, and usually have a flower cluster held well above the basal whorl of leaves. Many of its members grow in rocky places. The fruit is a capsule with a lot of seeds. In term of economically importance, the family has Saxifrage, Heuchera, and Bergenia.
An attempt has been made during the last decade to study the identity, chemistry, pharmacology and clinical investigations of Pashanbheda plants. The whole plant, rhizome and root of Bergenia ligulata is used for kidney and bladder stones, urinary problems. Rhizome is the official part, is light, cool, bitter, used in cough and cold flowers are boiled and pickled. With honey Bergenia ligulata is applied to gums in teething of children to allay irritation. Bergenia ligulata has been reported to exhibit various biological activities and thus has several traditional uses. It is used as an antidiabetic (alpha-glucosidase inhibitor), antipyretic, and as a tonic.

Figure 1: Bergenia ligulata whole plant

The ethanolic extract of the roots of Bergenia ligulata showed anticancer, antiprotozoal, diuretic, cardiovascular, antiscorbutic, antilithiatic, litholytic property, anti-inflammatory, activity in dose dependent manner in rats. A novel herbal composition is being formulated using Saxifraga ligulata (Bergenia ligulata) extract for maintaining/caring the skin around the eyes. The efforts done by asian scientists in the period 2000-2008 to isolate natural antiviral agents from asian plants Bergenia ligulata for influenza virus. Bergenia ligulata is main ingredient of Pashanbhed churna manufacturer by dave Ayurved Bhavan, panvel, Mumbai, is used for diuretic, diarrhea, cough, pulmonary infection and fever.

The plant Bergenia ligulata showed in vitro, in vivo animals study that the crystal (calcium oxalate monohydrate) growth inhibition, decreases calcium phosphate nucleation, calcium oxalate, crystalization inhibition, diuretic, hypermagnesuric and antioxidant effect.

Antilithic activity

The antilithic property of the crude extract has been investigated that the alcoholic extract had no effect in preventing stone formation in rats (after the method of Lyon) but was of significant help in dissolving preformed stones. Low doses of Pashanabheda extract (0.5 mg/kg of alcoholic extract) promote diuresis in rats, but higher dose 100 mg/kg reduce the urine output and also reduce the diuresis produced by urea.

The crude aqueous-methanolic extract of Bergenia ligulata rhizome (BLR) was studied using in-vitro and in-vivo methods. The result was that BLR inhibited calcium oxalate (CaC₂O₄) crystal aggregation as well as crystal formation in the metastable solutions and exhibited antioxidant effect against 1,1-diphenyl-2-picrylhydrazyl free radical and lipid peroxidation in the in vitro. BLR caused diuresis in rats accompanied by a saluretic effect. In an animal model of urolithiasis, developed in male wistar rats by adding 0.75% ethylene glycol (EG) in drinking water, BLR (5-10 mg/kg) prevented CaC₂O₄ crystal deposition in the renal tubules. The lithogenic treatment caused polyuria, weight loss, impairment of renal function and oxidative stress, manifested as increased malondialdehyde and protein carbonyl contents, depleted reduced glutathione and decreased antioxidant enzyme activities of the kidneys, which were prevented by BLR. Unlike the untreated animals, EG intake did not cause excessive hyperoxaluria and hypocalciuria in BLR treated groups and there was a significant increase in the urinary Mg²⁺, instead of a slight decrease. These data indicate the antiurolithic activity in Bergenia ligulata mediated possibly through CaC₂O₄ crystal inhibition, diuretic, hypermagnesuric and antioxidant effects and this study rationalizes its medicinal use in urolithiasis.

Diuretic activity

The ethanolic extracts of root of Bergenia ligulata were assessed for diuretic activity in albino rats that was compared with standard drugs. For evaluation of the diuretic activity Lipschits method, was used. It was done by measuring the volume of urine collected at the end of 5 hrs and Na⁺, K⁺ and Cl⁻ concentration in urine. The ethanolic extract of the roots of Bergenia ligulata was found to produce significant activity.

The extracts of Bergenia ligulata root were studied in the presence of artificial reference urine (ARU) and human urine (HU) the growth behaviors of CHPD crystals grew within the rings. The addition of aqueous extract of B.ligulata to the calcium chloride in the supernatant solution modified the diffusion process and hence the periodic precipitation and the number of liesegang rings. The maximum length of the crystals was reduced due to inhibition produced by the addition of aqueous extract of B.ligulata the HU aqueous extract (AE) of B.ligulata contained a large number of salts and organic molecule. And their complex formation may have promoted the effect on growth of CHPD crystals. But when they are added separately to CaCl₂ they inhibit the growth of crystals. This suggests that these solutions separately inhibit the growth of crystals in in-vitro condition. But mixing with HU (humane urine) changes their behaviour.
markedly. The diuretic nature of AE/B. ligulata seems to be important in the remedy rather than their inhibitive nature. 

**Anti-bradykinin activity**

The alcoholic extract of *Bergenia ligulata* rhizome displays marked anti-bradykinin activity. Although it does not affect the action of 5-HT and acetylcholine on isolated guinea pig ileum. It has been shown to potentiate the action of adrenaline on guinea-pig trachea and ileum muscle. Its cardiotoxic, antidiuretic and CNS depressant action on experimental models have been reported with large doses. It is unlikely that these effects will be encountered with the doses in clinical use. In rats, the LD₅₀ of the aqueous extract was 650 mg/kg intraperitoneally. It is widely used in the treatment of dysuria and renal failure, cystitis and crystalluria. Its anti-inflammatory property finds a use in the treatment of abscesses and cutaneous infections. It is also used in the treatment of dysentery and diarrhoea.

**Antiviral activity**

Methanol-water extract from rhizomes of *Bergenia ligulata* inhibited in vitro the replication of influenza virus in a dose dependent manner and did not show virucidal activity at effective concentration. Pretreatment of cells with *B. ligulata* extract was shown to be most effective to prevent cell destruction. The extract inhibited viral RNA synthesis and reduced viral peptide synthesis at 10 µg/ml. The principal chemical compound was condensed tannins in the extract.

**Antipyretic activity**

The ethanolic (95%) extracted of roots, rhizomes and leaves and aqueous extract of whole plant of *Bergenia ligulata* Wall in yeast induced fever in albino rats of wistar strain were assessed for antipyretic activity. The yield of semisolid mass (w/w) was obtained as ethanol extract of roots (13.36%), ethanol extract of rhizomes (15.12%), ethanols extract of leaves (11.02%) and aqueous extract of whole plant (09.21%). Acute toxicity studies were carried out for all the extracts of *Bergenia ligulata* Wall on healthy swiss albino mice of body weight 25-35g by using Up and Down or Stair case method. The suspension of all the extracts of *Bergenia ligulata* Wall was prepared in 5% gum acacia and employed for assessment of antipyretic activity at the dose of (300 and 500mg/kg body weight). The standard drug used was paracetamol (200mg/kg p.o). Rectal temperature of experimental animals was recorded at a time interval of 1hr, 2hr, 3hr, 4hr and 5 hr after drug administration for evaluation of antipyretic activity. The ethanolic extract of roots and rhizomes of *Bergenia ligulata* Wall at a dose of 500mg/kg p.o decreased the yeast induced fever in experimental animals.

The ethanolic extracts of root of *Bergenia ligulata* were assessed for antipyretic activities in albino rats that were compared with standard drug. The assessment of Antipyretic activity was carried out using Brewer's Yeast induced pyrexia method in wistar rats. Rectal temperature was recorded at a time interval of 0, 30 min, 1 hr, 2 hr, 3 hr after drug administration for evaluation of antipyretic activity the ethanolic extract of the roots of *Bergenia ligulata* was found to produce significant antipyretic activity.

**Antibacterial activity**

The antibacterial activity was tested using the diffusion method. The activity measured by fixed volume of plant extract (10 mg/ml, 25mg/ml or 50 mg/ml). The zone of inhibition was calculated by measuring the minimum dimension of the zone of no microbial growth around the well. Aqueous, 50% ethanolic and methanolic extracts of *B. ligulata* rhizomes were tested for their ability to inhibit the growth of *E. coli*, *B. subtilis*, and *S. aureus* at the dose levels of 10, 25 or 50 mg/ml for each extract. At a dose level of 50 mg/ml, the antibacterial effect was most significant. Incidentally, the antibacterial effect of the extracts at this level was comparable to ciprofloxacin (25 mg/ml). The results clearly suggest that *B. ligulata* possesses a strong antibacterial activity.

**Antiinflammatory activity**

Antinflammatory activity of *B. ligulata* rhizome was determined according to the method described by Winter and colleagues. Evaluation of the anti-inflammatory activity of aqueous and 50% ethanolic extracts of the rhizomes of *Bergenia ligulata* are reported to attenuate the inflammatory response as determined by pharmacological and biochemical measurements. The treatment significantly decreased the inflammation as can be seen in figure 1. The activity level of succinate dehydrogenase (SDH), which has been reported to rise in inflammation decreased in rats receiving the extract treatment (Figure 2). In conclusion, this study reports the antinflammatory and antibacterial activity of *B. ligulata* extracts. Besides these activities, the study reports the radical scavenging activity of the rhizomes of *B. ligulata*, and establishes the therapeutic rationale of using *B. ligulata* in India System of Medicine.
volume was less in comparison to the carrageenan alone treated group.

Figure 3: Succinate dehydrogenase in rats treated with *Bergenia ligulata* for treating inflammation. NC: normal control receiving the vehicle alone, C: animal group receiving carrageenan injection, C+Aq: treated with aqueous extract, C+E-A: treated with 50% ethanolic extract, and C+D: treated with diclofenac. Succinate dehydrogenase has been reported to increase in animal model of inflammation. Extract treatment could significantly bring down the increased value.

**Hepatoprotective activity**

The ethanolic extracts of root of *Bergenia ligulata* were assessed for hepatoprotective activity in albino rats that was compared with standard drugs. Acute toxicity studies were carried out for ethanolic extract of *Bergenia ligulata* root on healthy Swiss albino mice of body weight 25-35g by using Up and Down or Stair case method. Evaluation of the hepatoprotective activity was done by measuring the levels of serum glutamate pyruvate transaminase (SGPT), serum glutamate oxaloacetate transaminase (SGOT) serum alkaline phosphatase and total bilirubin levels. The ethanolic extract of the roots of *Bergenia ligulata* was found to produce significant activity.

**Chemical constituents**

*Bergenia* has many bioactive compound in its rhizomes, including paashaanolactone, arbutin, bergenin, catechin and gallic acid etc. Starch (19%), minerals, vitamins, albumin (7.75%), glucose (5.5%), mucilage, ash (mostly calcium oxalate). Seeds of *Bergenia ligulata* contain coumarin (bergenin), tannic acid, gallic acid, minerals and wax. The root of *Bergenia ligulata* was extracted with different organic solvent in increasing order of polarity (petroleum ether, diethyl ether, chloroform, acetone and ethanol). The result of the preliminary investigation revealed the presence of alkaloids, steroids, flavonoids, terpenoids, tannins, glycosides, carbohydrates and saponins the diethylether and acetone extract were studied. β-Sitosterol, stigmasterol, tannic acid and gallic acid were isolated by using thin layer and column chromatography. The chemical structures of the isolated compounds were established by spectroscopic techniques such as UV, IR and NMR spectroscopy. This was again confirmed by TLC with standard sample. In fact, the whole plant of *Bergenia* can be used in medicine, but its active ingredients were mainly focused on polyphenols, among which bergenin is studied and applied most frequently.

According to the records of official Chinese Pharmacopoeia version 2005, bergenin can be used for relieving coughs and reducing sputum caused from the disease named chronic bronchitis. Recently, many studies demonstrated that bergenin have good effects in antiviruses, diminishing inflammation caused from bacteria, enhancing immunity and so on.

Rhizome, petiole and leaf (1gm each) were extracted with methanol and analysed by HPLC for the estimation of Bergenin and (+)-Afzelechin. Extraction of the rhizome material using three reflux periods (60, 90, 120 min.) showed that a 90 min reflux periods time gave the highest yield of the two active constituents, Bergenin and (+)-Afzelechin. Thus a procedure involving two cycle of refluxes (90 min each) with methanol (50 ml) was found to be suitable for the complete quantification of Bergenin and (+)-Afzelechin in all the test samples. Bergenin was found to be the major component of *B. ligulata* yeo. rhizomes with the concentration being about 7 times greater than that of (+)-Afzelechin while the latter was not detected in the aerial parts (petiole, leaf). The content of Bergenin in the petiole and leaf was found to be less than 8 times of that found in the rhizomes. Therefore rhizomes from the major source of bergenin and (+)-afzelechin.

**Specific compound activity**

**Natural insectidal activity**

The volatile oil from roots of *Bergenia ligulata* was analyzed by GC-MS. A total of 97 compounds were identified. (+)-(6S)-parasorbic acid (5) 47.45%, isovalaric acid(6) 6.25%, 1,8-cineole(7) 4.24%,(Z)-asarone (9) 3.50%, and terpinen-4-ol (8) 2.96% were the most prominent constituents. The former one compound was isolated and characterized by spectroscopic data as (+)-(6S)-parasorbic acid (5). The volatile oil and the isolated compound were...
tested against Drosophila melanogaster. The results obtained showed that the volatile oil from roots could be considered as natural insecticidal effect agents. From the rhizomes of B. ligulata only bergenin and β-sitosterol have been isolated. This review presents a comprehensive literature search of different studies carried out on phytoconstituents like β-sitosterol, β-sitosterol-D-glucoside, afzelechin and Catechin. Further investigations may help in exploiting its properties.

The dried and powdered raw material of Bergenia ligulata rhizomes (5kg) was sequentially extracted by cold percolation with petroleum ether, (60-80°C) chloroform and methanol and then phytochemical analysis was done respectively and characterised as (+)-afzelechin (11) and bergenin (10) respectively.

α-glucosidase activity

The 80% ethanolic extract of B. ligulata rhizome was fractionated to investigate for α-glucosidase. Sample solution were evaluated at dose levels of 5.0, 0.5, 0.05 mg/ml to obtain dose–response. The ethyl acetate extract exhibited an inhibitory effect of α-glucosidase activity. The α-glucosidase inhibitor was isolated by silica gel column chromatography with chloroform and methanol as eluents and identified as (+)-afzelechin (12) by El-MS, IR, H1 and C13 NMR spectroscopy. The inhibitory compound 12 was investigated in the inhibition of α-glucosidase activity at a concentration of 0.25 mm and the ID50 (50% inhibition dose) value was 0.13 mm. For confirming the structure-activity relationship, compounds 13-16 were investigated in the inhibition of α-glucosidase activity test. Compound 13-16 inhibited 2.8%, 41.8%, 59.4% and 90.4% of α-glucosidase activity at a concentration of 0.25mm. The ID50 values of compound 15 and 16 were 0.14 and 0.05 mm respectively. Compound 16 had strongest inhibitory activity in these compounds and IC50 value of 16 was 2-fold higher than those of 12 and 15. Previously, α-glucosidase inhibitory activity of natural occurring flavan-3-ols has been reported. IC50 value of (+)-catechin, and (-)-epicatechin were 12.8 and 0.18 mm respectively. Compound 12, 15 and 16 showed more potent inhibitory activity than those of catechins. This research suggests that the α-glucosidase inhibitor in B. ligulata was primarily (+)-afzelechin.

Bergenia ciliata

Bergenia ciliata (haw.) sternb. is found throughout the temperate himalayas between elevations of 800-3000m.

Figure 4: Bergenia ciliata whole plant

The efforts done by asian scientists in the period 2000 to 2008 to isolate natural antiviral agents from asian plants Bergenia ciliata for Herpes simplex virus. Bergenia ciliata rhizome extracts is proved to have anti-bacterial and anti-tussive properties. It is reported to be helpful in dissolving kidney-stones. They are also reports on the anti-oxidant and the DNA protection abilities of the extracts.

Anti-tussive activity

The methanol extract of the rhizome of Bergenia ciliata Sternb. (Saxifragaceae) has been evaluated for its...
potential in a cough model induced by sulphur dioxide gas in mice. The extract exhibited significant anti-tussive activity in a dose-dependent manner, as compared with control. The antitussive activity of the extract was comparable to that of codeine phosphate (10 mg/kg body wt.), a standard anti-tussive agent. The extract at doses of 100, 200 and 300 mg/kg body wt. showed significant inhibition of cough reflex by 28.7, 33.9 and 44.2%, respectively, within 90 min of the experiment. The methanolic extract of Bergenia ciliata rhizome was screened for their antiviral activity against herpes simplex virus and influenza virus A by dye uptake assay. The methanolic extracts of Bergenia ciliata rhizome were found to be highly active against antiviral activity against HSV-1 (IC\textsubscript{50} value 6.25µg/ml) and influenza virus A (IC\textsubscript{50} values from 8to 10µg/ml). \textsuperscript{79}

**Antilulcer activity**

*Bergenia ciliata* is used for the treatment of stomach disorders in the folk medicine of some areas of South East Asia. This study was designed to evaluate its gastroprotective effects on ethanol/HCl, indomethacin and pylorus ligation-induced gastric ulcers in rats. Doses of 15, 30 and 60 mg/kg between of the aqueous and methanol extracts of the rhizome were administered 1 h after ulcerogenic treatment. The animals were killed 3 h later, their stomachs removed and the mean area of ulcer lesion was determined. The weight of mucus and gastric acidity were also measured. The aqueous extract decreased the ulcer lesion (p < 0.05) in all models to a greater extent than the methanol extract, but at the higher doses the effect was reduced. In addition, the antilulcer activity appears to be mediated via cytoprotective effects conferred by enhancement of the mucosal barrier, rather than by prevention of gastric acid secretion or the lowering of pH and acidity. \textsuperscript{80}

**Anti-neoplastic activity**

Methanolic and aqueous extract of *Bergenia ciliata* rhizome were found to have promising potential towards the development of drug that might be used to target tumours for chemoprevention/chemotherapy to check neoplastic growth and malignancy. Both extracts showed concentration-dependent cytotoxicity in each of the three cell lines. According to the American national cancer institute, the IC\textsubscript{50} value to consider a crude extract promising for development of anticancer drugs is lower than a limit threshold (30µg/ml). \textsuperscript{81} IC\textsubscript{50} value of both the extracts falls well within this prescribed threshold in all cell lines (except the aqueous extract with higher IC\textsubscript{50} in help 38 cell lines) *B.ciliata* bear potent anti-neoplastic activities that may have prospective clinical use as precursor for preventive medicine. \textsuperscript{82}

**Antioxidant activity**

Methanolic and aqueous *B. ciliata* rhizome extracts were found to possess antioxidant activity, including reducing power, free radical scavenging activity and lipid peroxidation inhibition potential. The methanolic extract displayed greater potential in all antioxidant assays. It is, however, interesting to note that the aqueous extract demonstrated considerably higher DNA protection, albeit lagging behind its methanolic counterpart as an antioxidant. \textsuperscript{82}

**Antibacterial activity**

The roots and leaves extract viz ethanol, hexane, ethyl acetate, chloroform, butanol and aqueous (5mg/ml) aliquots of *Bergenia ciliata* were used to test of antibacterial activity. *Bergenia ciliata* root extract was found to inhibit the growth of gram positive bacteria as compared to gram negative strain. Therefore in a way it can be inferred that *Bergenia ciliata* extracts exhibit rather a narrow spectrum antibacterial activity. The screening result of various leaves extract of *Bergenia ciliata* exhibited activity against the gram positive *staphylococcus aureus* (zone of inhibition 8-12 mm) whereas chloroform butanol and aqueous extracts were found active against *Bacillus subtilis, Bacillus megalarium* and *micrococcus.*(zone of inhibition 10-20). Consequently it can be suggested that the activity of root extract is much higher as compared to the leaves extract of *Bergenia ciliata*. \textsuperscript{78}

**Hypoglycemic activity**

The roots and leaves extract viz., ethanol, hexane, ethyl acetate, chloroform, butanol and aqueous of *Bergenia ciliata* were used to test of hypoglycemic activity. All the extracts except chloroform extract of root and leaves of *Bergenia ciliata* were found to possess hypoglycemic activity in Streptozotocin (STZ) treated rats. Therefore the plant can be classified as hypoglycemic activity in experimental diabetes ranging from 40-70% of its onset to reduce blood glucose level. \textsuperscript{83}

**Toxicological investigation**

The toxicological investigations of *Bergenia ciliata* with particular reference to acute systematic toxicity and intracutaneous toxicity in experimental animals displayed that it elicit severe toxicity. The symptoms of toxicity in intracutaneous test showed erythema and edema whereas assessment of acute systemic toxicity frequently observed breathing problem and initiations of diarrhea with blood in stool of experimental model and caused gastro-intestinal syndrome. *Bergenia ciliata* can produce toxicity suggesting a role in certain diseases. It is therefore, premature to speculate about mechanism of effect until toxin is unequivocally identified. \textsuperscript{84} The hemolysis test on the extract of *Bergenia ciliata* was almost devoid of activity. \textsuperscript{84}

**Chemical constituents**

The plant contains tannic acid, gallic acid, glucose, mucilage, wax, metarbin, albumen and mineral Salts. \textsuperscript{99} Bergenin, (+)-Catechin, Gallicin and Gallic acid quantified by using solvent System of Toluene: Ethyl acetate: Formic acid (6: 6: 1, v/v/v) by HPTLC. Developed method permitted simultaneous quantification of Bergenin, (+)-
Catechin, Gallicin and Gallic acid, and showed good resolution and separation from other constituents of extract and was found to be simple, precise, specific, sensitive and accurate. It can be adopted for routine quality control of herbal material and formulations containing Bergenia ciliata.12

Tinctures were prepared by macerating the rhizomes of B. ciliata in different strengths of alcohol (30, 40, 50, 60, 70, 80, 90 and 100%, v/v) for 7, 14 and 21 days. After maceration, the pH, specific gravity and total solid matter, chemical contents were determined. The pH of the tinctures decreased with increase in alcohol strength, as well as with the number of days of maceration. Results showed that the tinctures prepared with 50% alcohol had the highest specific gravity of 0.9907 and yield (total solid content) of 9.11% (w/v) when macerated for 21 days. The chemical components of the tinctures irrespective of alcohol strengths were steroid, triterpenoid, flavonoid, tannins, carbohydrates and saponins.12 The rhizome of B. ciliata yield galloylated leucoanthocyanidin-4-(2-galloyl) glucoside as well.41

Figure 5: Bergenia stracheyi whole plant

Previous chemical and pharmacological studies on this species reported the occurrence of glycosides, gallic acid, tannic acid, mucilage, wax, albumens, starch etc. A K Goel et.al perform the antibacterial, antifungal, antiprotozoal, antiviral, antifertility cardiovascular, analgesia, and diuretic activity on plant excluding root of Bergenia stracheyi and the result was negative.82

Chemical constituents

Bergenia stracheyi have potential to act as broad spectrum antimicrobial agent because of the presence of phytochemicals showed positive result for free anthraquinone, ascorbic acid, carbohydrates, phenolics, saponins and steroids. The presence of phenolics, ascorbic acid, steroids in Bergenia stracheyi have potential to act as antioxidant, anticancer and antimicrobial agents.87

Specific compound activity

Anti-arthritic activity

Bergenin, a C-glycoside of 4-O-methylgallic acid, isolated from rhizomes of Bergenia stracheyi (Saxifragaceae) and its O-demethylated derivative norbergenin, prepared from bergenin, are reported to show anti-arthritic activity through possible modulation of Th1/Th2 cytokine balance. Flow cytometric study showed that the oral administration of bergenin and norbergenin at doses of 5, 10, 20, 40 and 80mg/kg per oral dose inhibit the production of proinflammatory Th1 cytokines (IL-2, IFN-gamma and TNF-alpha) while as potentiate anti-inflammatory Th2 cytokines (IL-4 and IL-5) in the peripheral blood of adjuvant-induced arthritic BALB/c mice. This shows the potential Th1/Th2 cytokine balancing activity of bergenin and norbergenin which is strongly correlated with their anti-arthritic activity. At similar dose levels, the effect of norbergenin was found to be more than that of bergenin. The oral LD (0) for
bergenin and norbergenin was more than 2000mg/kg body weight of the mice. 

DPPH (diphenyl picrylhydrazyl) radical scavenging, antimicrobial and xanthine oxidase inhibitory activities

Bergenin pentacetate (22), a peracetate derivative of biologically active lead compound Bergenin isolated from methanol extract of Bergenia stracheyi rhizomes was subjected to lipase catalyzed regioselective alcoholysis to obtain 3,4,10,11-tetraacetate of Bergenin. The free hydroxyl group of Bergenin-3, 4, 10, 11-tetraacetate was derivatised using higher carboxylic acids to obtain acyl derivatives (Hexanoate, Benzoate, Decanoate, Myristate). These compounds synthesized via chemoenzymatic route were characterized using H\textsuperscript{1}NMR, C\textsuperscript{13}NMR and mass spectral data and evaluated for DPPH radical scavenging, antimicrobial and xanthine oxidase inhibitory activities. The studies revealed that biological activity of Bergenin can be optimized by selective modification of its structure.  

A simple TLC method has been developed for the simultaneous quantification of bergenin, catechin and gallic acid from different parts of Bergenia ligulata and Bergenia ciliata using HPTLC plate precoated with silica gel 60 F250. The method was developed in toluene: ethyl acetate: formic acid (4:6:1,v/v). The linearity range for bergenin, catechin and gallic acid were found to be 160-800, 160-480 and 160-56 ng/spot respectively. The rhizomes were found to contain higher concentration of bergenin, catechin and gallic acid than other parts of the plants. The rhizome of Bergenia ciliata and Bergenia stracheyi contain gallic acid, tannic acid, mucilage, wax, glycosides, albumens, starch, etc. The rhizome used, wounds cure septic, act as astringent etc. The seeds of Dolichos biflorus and rhizomes of Bergenia ligulata were tested for their in vitro antilithiatic and anticalcification activity by the homogenous precipitation method. The extracts were compared with an aqueous extract of cystone (a marketed preparation) for their activities. Also a combination of the extracts of the two plants was tested. Extracts of Dolichos biflorus showed activity almost equivalent to cystone while Bergenia ligulata showed less activity and the combination was not as active as the individual extracts.  

Effectiveness of Bergenia ligulata, Nigella sativa and their combination on rats rendered nephrolithiasis by administration EG. volatiles were distilled from leaves of three Bergenia species collected from Yunnan, Xinjiang and Tibet in western China and analyzed using GC/MS instrumentation. The contents of extractable volatiles varied substantially among the three species with B. crassifolia having approximately 0.05% dry wt (v/w), B. purpurascens 0.01% (v/w) and B. stracheyi 0.13% (v/w), respectively. In B. stracheyi, 3-methyl-2-buten-1-ol was the dominant sort of volatile (52.71%), whereas detected major constituents included β-eudesmol (7.44%), damascenone (3.22%), caryophyllene (2.75%) and phytol (2.57%).

Combined plant extract

The fine powder of roots is made into paste mixed with the resin of pine tree and applied on fresh boils, enables them to ripen and burst. Many extracts from Bergenia have high medicinal values, take methanol extract as an example, the results obtained showed that it had a wide spectrum of concentration dependent antibacterial activity, in addition, it was demonstrated anti-inflammatory potentiality.
Flavonoids are also found in other species of *Bergenia* as glycosides. Flavonoids has widely been associated with various biological activities such as antimicrobial, antioxidant, anti-inflammation and anticancerogenic. Antioxidant play a role in maintenance of the pro/antioxidant balance by neutralizing the radical oxygen and nitrogen species which are responsible for deleterious processes in biological system.

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