*Plant Archives* Vol. 21, No. 2, 2021 pp. 401–410 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2021.v21.no2.063

# REVIEW ON COMPILATION OF ETHNOPHARMACOLOGICAL PROPERTIES OF *BERGENIA CILIATA*: THE MEDICINAL HERB OF HIMALAYAS

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(Date of Receiving : 27-04-2021; Date of Acceptance : 02-07-2021)

**ABSTRACT**

As mentioned in the texts such as Vedas, Charaka Samhita and Sushruta Samhita, *Bergenia ciliata* is a known to be the ancient and medicinal plant belonging to the family Saxifragaceae. It can be found as a shrub or an herb, while some are trees or vines. The family includes about 80 genera, 1250 species and has biological properties that are possessed by the different plant parts including antibacterial, antiviral, antioxidant, anti-ulcer, anti-diabetic, analgesic, anti-plasmodial, antitumor, antitussive activity, antineoplastic, diuretic and anti-inflammatory properties. Many of its members grow in rocky places. *Bergenia ciliata* itself shows that the plant originate between rocks and appears to break them or that it possesses lithotroptic property. It's different plant parts are reported to have different medicinal properties. There are three species of Bergenia found in India *Bergenia ligulata, Bergenia ciliata, Bergenia stracheyi*. The rhizomes of these plants are used in the indigenous system of medicines.

***Keywords*:** *Bergenia ciliata*, phytochemicals, rhizome, extract, herb**.**

## INTRODUCTION

A medicine or a pill that was being taken for every infectious disease has now been replaced by the increasing occurrence of antimicrobial resistance representing a worldwide major concern for both human and veterinary medicine (Lorian, 1996). Since then, there has been a growing interest in the antimicrobial screening of extract from plants as roots, bark, seeds, leaves, and flowers contain a variety of naturally occurring biochemicals, which contribute to the plant's medicinal benefits mostly against microorganisms (Folashade *et al*., 2014). The decoction, tincture, infusion, or herbal extract of many herbal plants are traditionally used for the treatment of many diseases (Wendakoon *et al*., 2012). According to data *Bergenia ciliata* is known to have major therapeutic potential to cure gastrointestinal problems, malaria, and kidney stone, etc (Hussain *et al*., 2019). The localities of Himalayan region use dried rhizomes of *B. Ciliata* for tea and tonic helpful in, and muscular pain (Khan *et al*., 2012). The medicinal activity of plant is due to the presence of secondary metabolites like glycosides, alkaloids, terpenoids, steroids, flavonoids, reducing sugars, tannins, fatty acids, and saponins (Khan *et al*., 2016). The species biological and pharmaceutical investigation exhibited its possible antifungal, antiviral, antibacterial, antioxidant, antitussive, anti-inflammatory, anti-neoplastic and anti-ulcer activities in many cases.

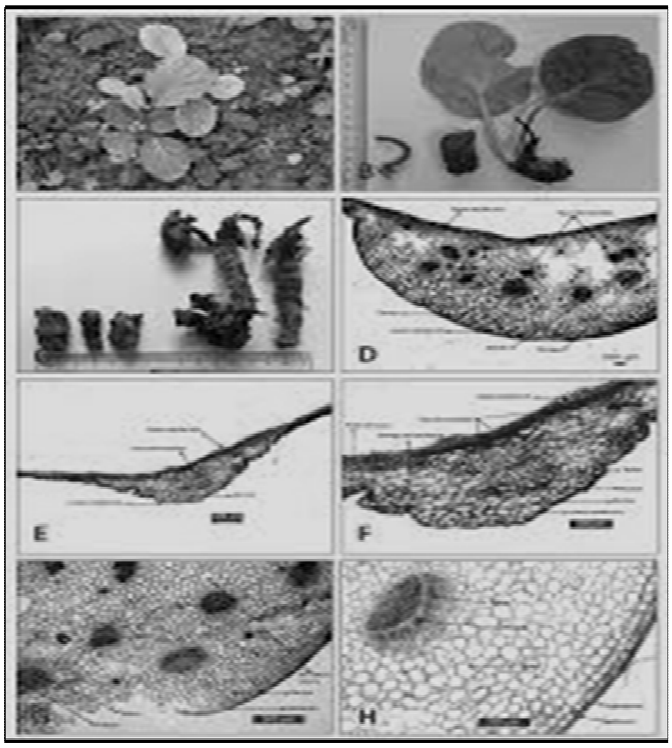


**Fig. 1 :** Bergenia ciliata, A). Habit, B). The fresh plant, C). Dry rhizomes and whole plant, D). T.S. of the lower portion of the leaf, E). T.S. of the upper portion of the leaf, F). T.S. of the upper portion of the leaf enlarged view, G). T.S. of the petiole, H). T.S. of the petiole showing vascular bundles. (Pankaj Kumar *et al.*, 2020)

**Botanical description**

Winter begonia and hairy bergenia is another name of this perennial herb *Bergenia ciliata* that belongs to the family Saxifragaceae. It consists of about 30 genera and 580 species worldwide. It mainly has herbs in its family which usually have a flower cluster held well above the basal whirl of leaves *Bergenia ciliata* height is estimated to be 30-60 cm in height and are evergreen, leathery, with pink to purple flowers (Żbikowska *et al*., 2017).

**Geographical distribution**

This plant is found in Northern areas between altitudes of 800–3000 m in Pakistan, Afghanistan, South Tibet, India, Bhutan, Meghalaya, Bhutan, and Nepal (Phull A-R *et al*., 2016). This plant is generally found in the cold and temperate regions of Himalayas from Kashmir to Bhutan at an altitude of 900-3000m (Handa SS., 1997)**.** In India it is found in the Himalayas (Kumaon), Meghalaya, Lushai hills West Bengal (Darjeeling, Labha, Takdah, Rimbick (Kalimpong), Arunachal Pradesh (Nyam Jang Chu), Kyongnosla, Changu, Karponanag, Lachen to Thong, Nathang, Prekchu-Tsokha, Pangolakha-Subaney Dara, Gangtok (domesticated) in Sikkim (Hafidh *et al*. 2009)

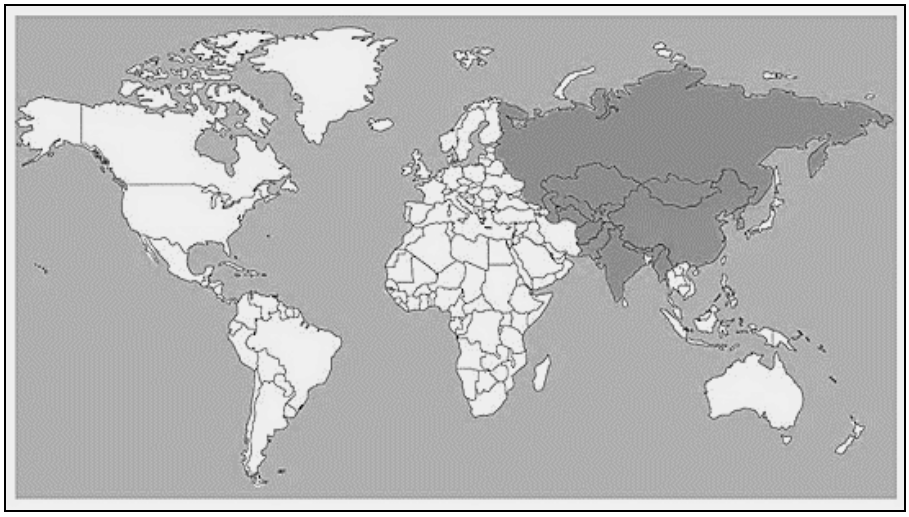

**Fig. 2 :** A world map showing the geographical distribution of Bergenia species (in shaded) (Bhupendra Koul *et al*., 2020)

**Vernacular Names**

| | | | |
|---|---|---|---|
| English | Rock-foil | Malayalam | Kallurvanchi |
| Sanskrit | Paashaanabheda | Oriya | Pasanbhedi |
| Hindi | Pashanbhed, Dakachru | Tamil | Sirupilai |
| Gujarati | Pashanbheda, Pakhanbheda | Telugu | Kondapindi |
| Bengali | Patharchuri Marathi Pasanbheda | Urdu | Pakhanabeda, Zakham-e-hayat |
| | | Arabic | Barghienia-mehdiyata |

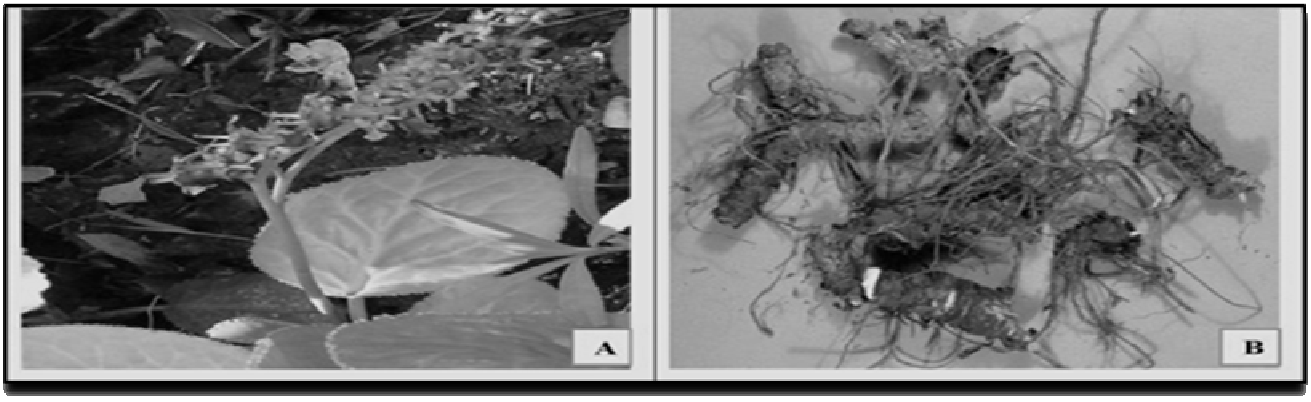


**Fig. 3 :** Bergenia ciliata A. Floral branch with flowers & B. Roots. (Ahmad *et al*., 2018)

**Taxonomic hierarchy** (Kritikar *et al*., 1935)

- Classification - Bergenia Moench.
- Kingdom - Plantae-plants
- Subkingdom - Tracheobionta-vascular plants
- Super division - Spermatophyta-seed plants
- Division - Magnoliophyta
- Class - Manoliopsida-dicotyledons
- Subclass - Rosidae
- Order - Saxifragales
- Family - Saxifragaceae
- Genera - *Bergenia*
- Species - *ciliata* f. ciliata.

| *Bergenia* Species | Distribution | Medicinal Property | Part Used | Chemical Constituents (Structure Number) |
|---|---|---|---|---|
| *Bergenia ciliata* (Haw.) Sternb.  | Central Asia, Afghanistan to China, Himalayan region. Altitude range (1800–3000 m) | Analgesic, Antiarrhythmic, Antiwrinkle, Antiasthma, Antibacterial, Anticancer, Antidiabetic, Antidiarrheal, Antidotary, Antiepileptic, Antiflatulent, Antifungal, Anti-haemorrhoidal, Antiviral, Anti-inflammatory, Antilithiatic, Antimalaria; Antimenorrhagic, Antiobesity, Antiophthalmia, Antioxidant, Antipyretic, Antispasmodic, Antiulcer, Burn wound healing, Deobstruent, Cerebroprotective, Diuretic, Ecbolic, Emmenagogue, Expectorant, Hepatoprotective, Immunomodulatory, Pulmonary affection | Whole plant | Bergenin (1) [a]<br>Catechin (2) [a]<br>Gallic acid (3) [a]<br>β-Sitosterol (4) [d]<br>Catechin-7-*O*-glucoside (5) [a]<br>Afzelechin (6) [a]<br>Quercetin-3-*O*-β-D-xylopyranoside (7) [a]<br>Quercetin-3-*O*-α-L-arbinofuranoxide (8) [a]<br>Eryodictiol-7-*O*-β-D-glucopyranoside (9) [a]<br>Arbutin (10) [c]<br>6-*O*-*p*-Hydroxybenzoyl arbutin (11) [a]<br>4-*O*-Galloylbergenin (12) [a]<br>11-*O*-Galloylbergenin (13) [a]<br>*p*-Hydroxybenzoic acid (14) [f]<br>Protocatechuic acid (15) [a]<br>6-*O*-Protocatechuoyl arbutin (16) [a]<br>11-*O*-*p*-Hydroxybenzoyl bergenin (17) [a]<br>11-*O*-Protocatechuoyl bergenin (18) [a]<br>6-*O*-*p*-Hydroxybenzoyl parasorboside (19) [a] |

**Fig. 4 :** Bioactive compounds and medicinal properties of different Bergenia species. (Bhupendra Koul *et al*., 2020)

## PHARMACOLOGICAL PROFILE OF BERGENIA CILIATA RHIZOME

Researchers have been always attracted to *Bergenia ciliate* due to its traditional medicinal values for the treatment of many diseases i.e., skin diseases, muscular/skeletal disorders, pulmonary infections, gastrointestinal infections, fever, eye diseases, worm infection, diarrhoea, respiratory diseases, renal disorders, fever, oral infections, cancer, and gynaecological disorders (Ahmad *et al*., 2018)


**Fig. 5 :** Pharmacological significance of Bergenia species. (Bhupendra Koul *et al*., 2020)

### Toxicology

*Bergenia ciliata* has an acute, systematic and intracutaneous toxic behaviour towards animals when applied. It showed symptoms of various diseases such as erythema, oedema, breathing problem, starting of bloody diarrhoea, blood in stool and gasterointestinal problems in acute systematic case. In case of higher dose, itexhibited cardio-toxic, anti-diuretic and depressant action on the Central Nervous System (Islam *et al*., 2002).

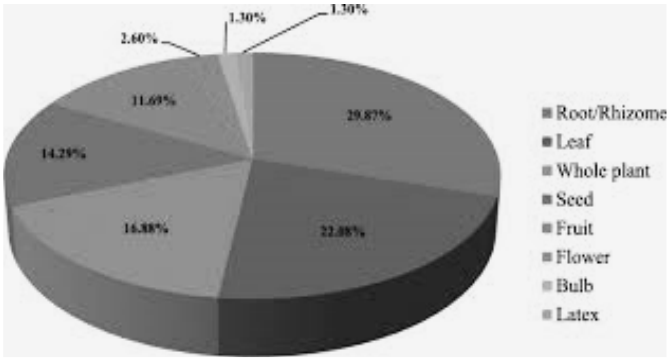


**Fig. 6 :** Concentration of antimicrobial activity in different parts of Bergenia ciliata (www.google.com.)

### Anti-inflammatory activity

According to Kumar *et al*., 2002 aqueous extract of rhizome of *Bergenia ciliata* showed a potent and dose dependent anti-inflammatory effect comparable to Diclofenac sodium on induce paw edma in rats. For that he screened *Bergenia ciliata* rhizome and found that the methanolic extracts of rhizome were found to be highly active against antiviral activity against HSV-1 ($IC_{50}$ value 6.25µg $ml^{-1}$) and influenza virus A ($IC_{50}$ values from 8to 10µg $ml^{-1}$) (Ruby *et al*.2012)


**Fig. 7 :** Some important traditional uses of Bergenia ciliata. (Shah *et al*., 2020)

**Anti-cancer activity**

Methanolic and aqueous extract of *Bergenia ciliata* rhizome showed concentration-dependent cytotoxicity in each of the three cell lines. According to Islam *et al*., 2002 the $IC_{50}$ value to consider a crude extract promising for the development of anticancer drugs is lower than a limit threshold (30µg/ml). *Bergenia ciliata* bear potent anti-neoplastic activities that may have prospective clinical use as precursor for preventive medicine (Bhandari *et al*., 2008). For chemoprevention/chemotherapy both methanolic and aqueous extract of *Bergenia ciliata* rhizome shown potential therapeutic activity towards neoplastic growth and malignancy target tumours (Venkatadri *et al*., 2011). *Bergenia ciliata* bear potent anti-neoplastic activities that may have prospective clinical use as precursor for preventive medicine (Islam *et al*., 2002).

**Antibacterial activity**

Globally the prevalence of bacterial infectious diseases become the major health problem. Lately to fight this some medicinally important plants extracts have been developed which are used as antimicrobials (Shan *et al*., 2007). The roots and leaves extract viz ethanol, hexane, ethyl acetate, chloroform, butanol, and aqueous (5mg/ml) aliquots of *Bergenia ciliata* were screened and used to test antibacterial activity. *Bergenia ciliata* root extract was found to inhibit the growth of gram-positive bacteria as compared to the gram-negative strain (Rajbhandari *et al*., 2009).

| Extract | Susceptible bacteria |
|---|---|
| Acetone extract | *Escherichia coli, Bacillus subtilis and Pseudomonas aeruginosa* |
| Methanol, ethanol, water and n-hexane extracts | *Klebsiella pneumonia, Staphylococcus auereus, Bacillus subtilis and Escherichia coli* |
| Ethanol extract | *Salmonella typhimurium* and *Escherichia coli* |
| Ethanol, chloroform, butanol, hexane, ethyl acetate and aqueous extracts | *Staphylococcus auereus, Bacillus subtilis, micrococcus* and *Bacillus megalerium* |
| Callus extract | *Pseudomonas aeruginosa, Staphylococcus aureus, Pseudomonas aeruginosa, Pseudomonas aeruginosa, Staphylococcus aureus* and *Pseudomonas aeruginosa* |
| Methanol, ethyl acetate and hexane extracts | *Nocardia tenerifensis, Bacillus megaterium* and *Bacillus subtilis* |
| Crude extract | *Bordetella bronchiseptica, Salmonella Setubal, Escherichia coli, Micrococcus luteus, Staphylococcus aureus* and *Salmonella typhimurium* |
| Ethanol, hexane, distilled water and butane extracts | *Escherichia coli, Staphylococcus aureus, Pseudomonas aeruginosa* and *Streptococcus faecalis* |
| Leaves extracts | *Staphylococcus aureus* and *Bacillus megaterium* |
| Ethanol extract | *Bacillus subtilis, Klebsiella pneumonia, Staphylococcus aureus, Escherichia coli, Salmonella typhi, Shigella dysentriae* and *Sacchromyces cerevisiae* |

Fig. 8 : Antibacterial activities of *Bergenia ciliata*. (Shah *et al*., 2020)

**Antidiabetic activity**

During working on some selected medicinal plant some researchers observed anti diabetic mode of action of *Bergenia ciliata*. The study suggested that due to the inhibition of digestive enzymes, α-glucosidase and α-mylase there is an effective fall in glucose level. Active compounds ([10]-3-O-galloylepicatechin and [10]-3-O-galloylcatechin) isolated from 50% aqueous-methanol extract of *Bergenia ciliata* rhizome showed strong dose dependent enzyme inhibitory activity against rat intestinal α-glucosidase and porcine pancreatic α-amylase. Their results supported the use of *Bergenia ciliata* in traditional medicines for treating diabetes (Chauhan *et al*., 2012). According to Yadav *et al*. (2011) *Bergenia ciliate* can be classified as hypoglycaemic activity in experimental diabetes ranging from 40-70% of its onset to reduce blood glucose level except chloroform extract of root and leaves out of ethanol, hexane, ethyl acetate, chloroform, butanol and aqueous of *Bergenia ciliata.*

**Antifungal activity**

Kumar and Tyagi (2013) suggested that different extracts of (*Bergenia stracheyi*) exhibit different extent of antifungal activity against all test fungi viz. *Alternaria alternate, Aspergillus niger, Colletotrichum gloeosporioides, Fusarium oxysporium, Ganoderma lucidum and Rhizoctonia solani.*

**Antimalarial activity**

Due to the growing resistance towards the drugs which has been used to treat malaria had triggered the disease load in endemic regions. Many plant species were being used for the cure of malaria in traditional health systems. For the treatment of fever, local communities of Himalayan Region conventionally use *Bergenia ciliata* which was evaluated for its possible role as antimalarial drug (Rajput and Mandal, 2012). The leaf extract of the plant showed good in vitro ant plasmodial activity with mean survival time of 8.6 ± 1.5 days (Walter *et al*., 2013).

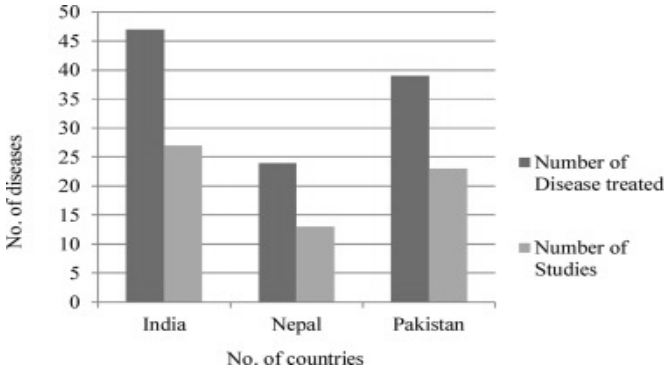


**Fig. 9 :** Number of disease and country wise research work on *Bergenia ciliata*. (Ahmad *et al*., 2018)

**Anti- urolithic activity**

Administrating dose of hydro-alcoholic extract of *Bergenia ciliata*/standard drug cystone along with ethylene glycol showed significant changes in body weight and organ weight of ethylene glycol treated animals. Furthermore, *Bergenia ciliata* extract expressed higher reno protective index than cystone at the same dose level (Saha *et al*., 2011). Crude extract of *Bergenia ligulate* rhizome also showed ant urolithic activity (Bashir *et al*., 2009).

**Antioxidant activity**

According to Rajkumar *et al.* 2010 the antioxidant activity of methanolic and aqueous extracts of *Bergenia ciliata* were observed and both extracts were found to have free radical scavenging effect that might prevent oxidative damages to biomolecules. The rhizome extracts also possess lipid peroxidation inhibition potential (Islam *et al*., 2002). Ruby *et al*. (2015) reported that the hydroethanolic leaf extracts of *B. ciliata, B. ligulata*, and *B. Strachey* have antioxidant and hemorrhoidal potential in vitro using 10 antioxidant assays.

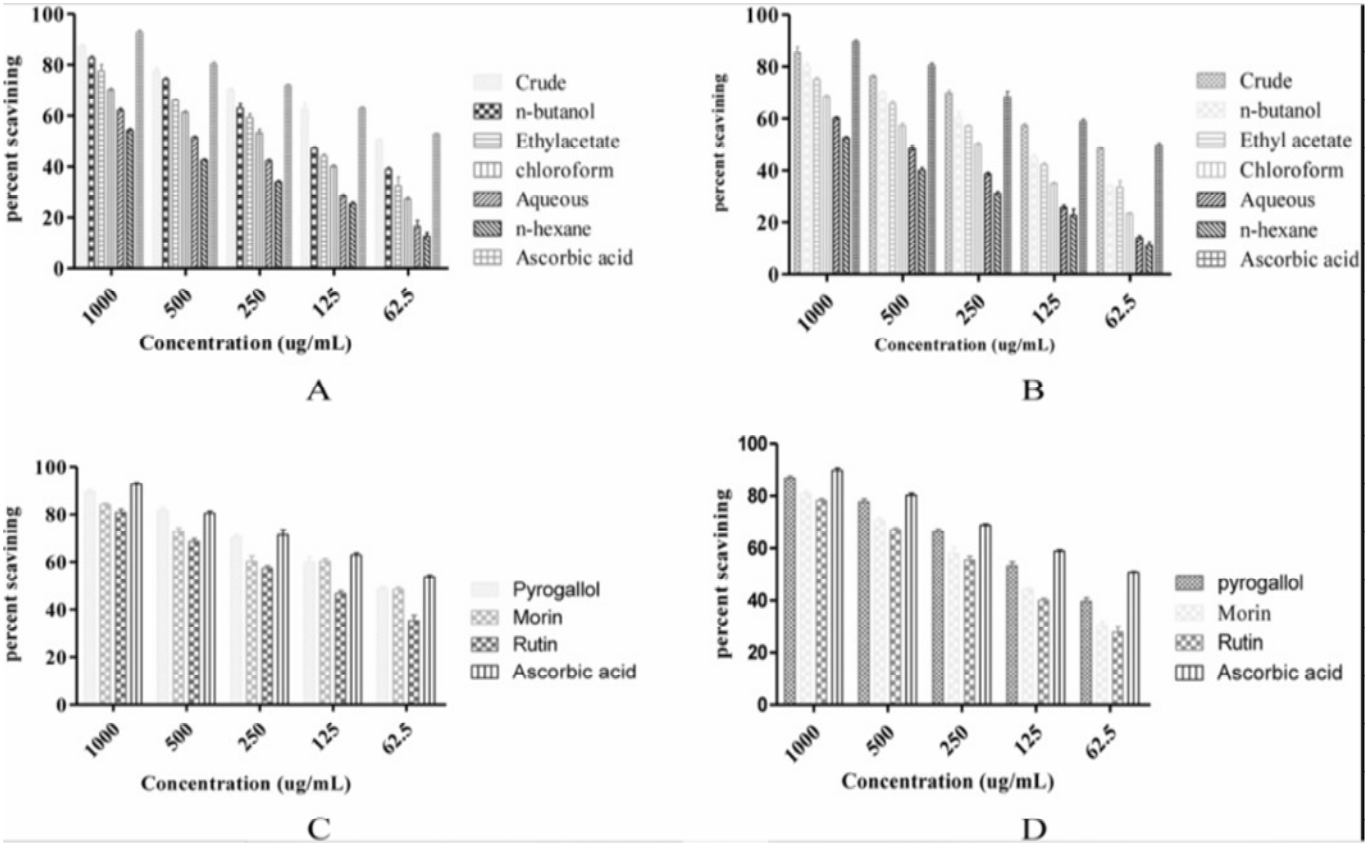


Fig. 10 : Antioxidant potential of *Bergenia ciliata* rhizome. (www.google.com.)

**PHYTOCHEMISTRY OF BERGENIA CILIATA**

Many observants have noticed that the pharmacological effects of plants are due to the presence of metabolites. These are organic compounds and classified into primary metabolites and secondary metabolites. Primary metabolite is common in human body which is essential for growth and development of the body (includes glucose, starch, polysaccharide, protein, lipids and nucleic acid). Plants usually produce secondary metabolites which include alkaloids, flavonoids, saponins, terpenoids, steroids, glycosides, tannins, volatile oils etc (Maurya *et al*., 2008). These secondary metabolites of plants are responsible for its therapeutic efficacy for curing many diseases and in plants these metabolites are termed as phytochemicals which are pharmacologically active compounds. Some of the pharmacological activities include alkaloids have an antispasmodic, antimalarial, analgesic, diuretic activities; Terpenoids are known for their antiviral, anthelmintic, antibacterial, anticancer, antimalarial, anti-inflammatory properties; Glycosides are reported for antifungal and antibacterial properties; Phenols and flavonoids have an antioxidant, anti-allergic, antibacterial properties etc. and Saponins are reported to have anti-inflammatory, antiviral, plant defence activities (Chopra *et al*., 2002). The literature search on *Bergenia ciliata* has revealed that very little chemical work has been carried out on this plant (Sticher *et al*., 1979). Some of the important classes of compounds along with their IUPAC names and general formula isolated from *Bergenia ciliata* are given:

| S. No. | Phytochemicals | IUPAC names | General formula |
|---|---|---|---|
| Phenolic contents | | | |
| 1 | Bergenin | (2R,3S,4S,4aR,10bS)-3,4,8,10-tetrahydroxy-2-(hydroxymethyl)-9-methoxy-3,4,4a,10b-tetrahydro-2H-pyrano[3,2-c]isochromen-6-one | $C_{14}H_{16}O_9$ |
| 2 | Gallic acid | 3,4,5-Trihydroxybenzoic acid | $C_6H_2(OH)_3COOH$ or $C_7H_6O_5$ |
| 3 | Tannic acid | [2,3-dihydroxy-5-[[(2R,3R,4S,5R,6S)-3,4,5,6-tetrakis[[3,4-dihydroxy-5-(3,4,5-trihydroxybenzoyl) oxybenzoyl]oxy] oxan-2-yl]methoxycarbonyl]phenyl] 3,4,5-trihydroxybenzoate | $C_{76}H_{52}O_{46}$ |
| Alcohols | | | |
| 4 | 3-Pentanol | 3-Pentanol | $C_5H_{12}O$ |
| 5 | Terpinen-4-ol | Terpinen-4-ol | $C_{10}H_{18}O$ |
| 6 | Pentanol | Pentan-1-ol | $C_8H_{18}O$ |
| Flavonoids | | | |
| 7 | (+)-Afzelechin | (2R,3S)-2-(4-hydroxyphenyl)-3,4-dihydro-2H-chromene-3,5,7-triol | $C_{15}H_{14}O_5$ |
| 8 | Quercetin 3-o-α-L-arbinofuranoxide | 3-[(2S,3R,4R,5S)-3,4-dihydroxy-5-(hydroxymethyl)oxolan-2-yl]oxy-2-(3,4-dihydroxyphenyl)-5,7-dihydroxychromen-4-one | $C_{20}H_{18}O_{11}$ |
| Fatty acids | | | |
| 9 | 2-Methyl butanoic acid | 2-Methyl butanoic acid | $C_5H_{10}O_2$ |
| 10 | Decanoic acid | Decanoic acid | $C_{10}H_{20}O_2$ |
| 11 | Nonanoic acid | Nonanoic acid | $C_9H_{18}O_2$ |
| Terpenoids | | | |
| 12 | Camphor | 1,7,7-Trimethylbicyclo[2.2.1]heptan-2-one | $C_{10}H_{16}O$ |
| 13 | Glucoside | 4,11,11-trimethyl-8-methylene-bicyclo[7.2.0]undec-4-ene | $C_{15}H_{24}$ |
| Terpenes | | | |
| 14 | Linalool | 3,7-dimethylocta-1,6-dien-3-ol | $C_{10}H_{18}O$ |
| 15 | Beta-phellandrene | 3-methylidene-6-propan-2-ylcyclohexene | $C_{10}H_{16}$ |

**Fig. 11 :** Some important phytochemicals isolated from *Bergenia ciliata*. (Shah *et al*., 2020)

*Bergenia ciliata* is a magical herb that has many therapeutic activities present in it which is because of the occurrence of many bioactive compounds. Many researchers have evaluated various phytochemicals from *Bergenia ciliata*. Approximate 58 phytochemicals are there in the plant out of which 48 volatile compounds are categorized into 11 classes; flavonoids, glycosides, nitro compounds, alcohols, fatty acids, phenols, carboxylic acids, terpenoids, cinnamic acid, sterol and volatile organic compounds (Hussain *et al*., 2009). The preliminary phytochemical investigation of rhizome of *Bergenia ciliata* showed presence of flavonoids, glycosides, sterols, terpenoids, saponinswhile alkaloids were found to be absent (Khan and Kumar, 2016). There is also the presence of few other compounds like bergenin, leucocyanidin, gallic acid, methyl gallate, catechin and polymeric tannin (Dixit and Srivastava, 1989). In some studies, the rhizomes also yielded a new lactone compound Paashanolactone (Chandrareddy *et al.*, 1998). Bergen in is major compound in the rhizome (0.6%). It is 4-methoxy-2-[(1S,2R,3S,4S,5R)-3,4,5,6-tetrahydro3,4,5-trihydroxy-6-hydroxymethyl)-2H-pyran-2- yl]-α- resorcylic acid δ-lactone monohydrate.

Bhandari *et al*. (2008) reported the isolation of many biochemical compounds by phytochemical analysis of aerial parts and of leaves of the plant and these are hydroquinone (benzenoids), (+) afzelechin, (+) catechin, quercetin-3-O-β-Dxylopyranoside,quercetin-3-O-α-L-arabinofuranoside, eryodictiol-7-O-β-D-glucopyranoside, arbutin,62 –O-p-hydroxybenzoylarbutin, bergenin, 4-Ogalloylbergenin, 11-O-galloylbergenin, p-hydroxybenzoic acid and protocatechuic acid. 62-O-protocatechuoylarbutin, 11-O-p-hydroxybenzoylbergenin, 11-O-protocatechuoylbergenin and 62-O-phydroxybenzoylparasorboside (-)-3-O-galloylepicatechin and (-)-3-O-galloylcatechin (Sticher *et al*, 1979). Some phytochemicals are mentioned below:

**Phenols**

The most important constituents of *Bergenia ciliata* are Phenols. Bergenin, tannic acid, gallic acid, catechin, [10]- 3-O-galloylcatechin and [10]-3-O-galloylepicatechin are few of them (Chauhan *et al*., 2012). Isolation of Bergenin, catechin, (−)-3-O-galloylcatechin and [10]- 3-O-galloylepicatechin has been observed from rhizome of the plant (Keri and Patil, 2014).

**Bergenin**

Bergenin is the most abundant and important component which is found in Saxifragaceae family. It is also known as cuscutin (Chauhan *et al*., 2012). According to S. Gurav, N. Gurav., 2014. 0.75% bergenin is present in the rhizome of *Bergenia ciliata*, also has antioxidant property and activity against ascorbic acid. It has germicidal effect against many bacteria and can act on fungus too (Han, *et al*., 1998). It shows activity against Hepatitis C virus, mild activity against HIV, protects liver, blocks the secretion of inflammatory cytokines, stimulate anti-inflammatory messengers, break down fat, increase the activity of norepinephrine (Zuo *et al*., 2005). No adverse effects of bergenin have been reported even with very large dosages (Chauhan *et al*., 2012).

**Gallic acid**

Gallic acid is present in seed of *Bergenia ciliata*. It has antioxidant, antiviral and antifungal activities, used to treat psoriasis in ointments and is inhibitor of weak carbonic anhydrase (Chauhan *et al*., 2000).

**Tannic acid**

It is a polyphenol present in *Bergenia ciliat*a in tannin form. It is also known as tannimum, gallotannin, quercotannic acid, acidum, tannicum, digallic acid, oak bark tannin and quercitannic acid. It is used in food and beverage industries as an aromatic compound, taste enhancer, color stabilizer and also as clarifying agent. It can be used in the treatment of burns and injuries (Rajbhandari *et al*., 2003).

**Catechin**

It is present in rhizome of *Bergenia ciliata* (Pokhrel *et al*., 2014). Catechin is also known as Cyanidanol, Cianidol, Catechuic acid, Catechinic acid and D-Catechin. Catechin compounds are strong therapeutic candidates and can also be used to treat Alzheimer's and Parkinson's diseases (Kielhorn, Thorngate Iii., 1999).

**Sterol**

In *Bergenia ciliata* roots and leaves, phytosterol β-sitosterol is present. It is used in the treatment of hypercholesterolemia as it reduces blood cholesterol level. It hinders cholesterol absorption in intestine and also used to treat benign prostatic hyperplasia (Kauffman, Kirk-Othmer, 2002).

**Glycoside**

Glycoside, Arbutin also called as Arbutoside hydroquinone β-D-glucopyranoside present in rhizome of *Bergenia ciliata*. It reduces the formation of melanin hence it is used as a skin lightening agent (Yuldashev *et al*., 1993).

**Flavonoid**

(+) Afzelechin is a flavonoid present in rhizome of *Bergenia ciliata*. It is also found in B. ligulata rhizome. Afzelechin show α-glucosidase inhibitory activity (Roselli *et al*., 2012). Other flavonoids present in *B. ciliata* rhizome are quercetin 3- o-β-D xylopyranoside and quercetin 3-o-α-L-arbinofuranoxide. According to Rauf *et al*., 2014 quercetin show anti-oxidant, antiradical property and iron chelating effectiveness.

**Terpene**

Terpene present in *B. ciliata* rhizome is limonene (Gyawali, 2011).

**Other phytochemicals**

2-Pentanone, 2,4-Dimethyl-3-pentanone, Hexanal, 2-Methyl-1-propanol, Acetic acid, Heptanol, 2-Ethyl hexanol, 3-Pentanol, 2-Pentanol, Octanol, Pentanol, Heptanal, 3-Methyl-4-hexen-2-one, 2-Nitropropane, Hexanol, 2.4-Hexadienal, 2,4-nonadienal, Pentanoic acid, Hexanoic acid, Hexalactone, Isobutyrophenone, 5,6-Dihydro-2-pyranone, Methyl nonanoate, Methyl cinnamate, β-phellandrene, [E]-4-Hepten-2-one are present in the oil extracted fom B. *ciliata* plant (Gyawali, 2011).

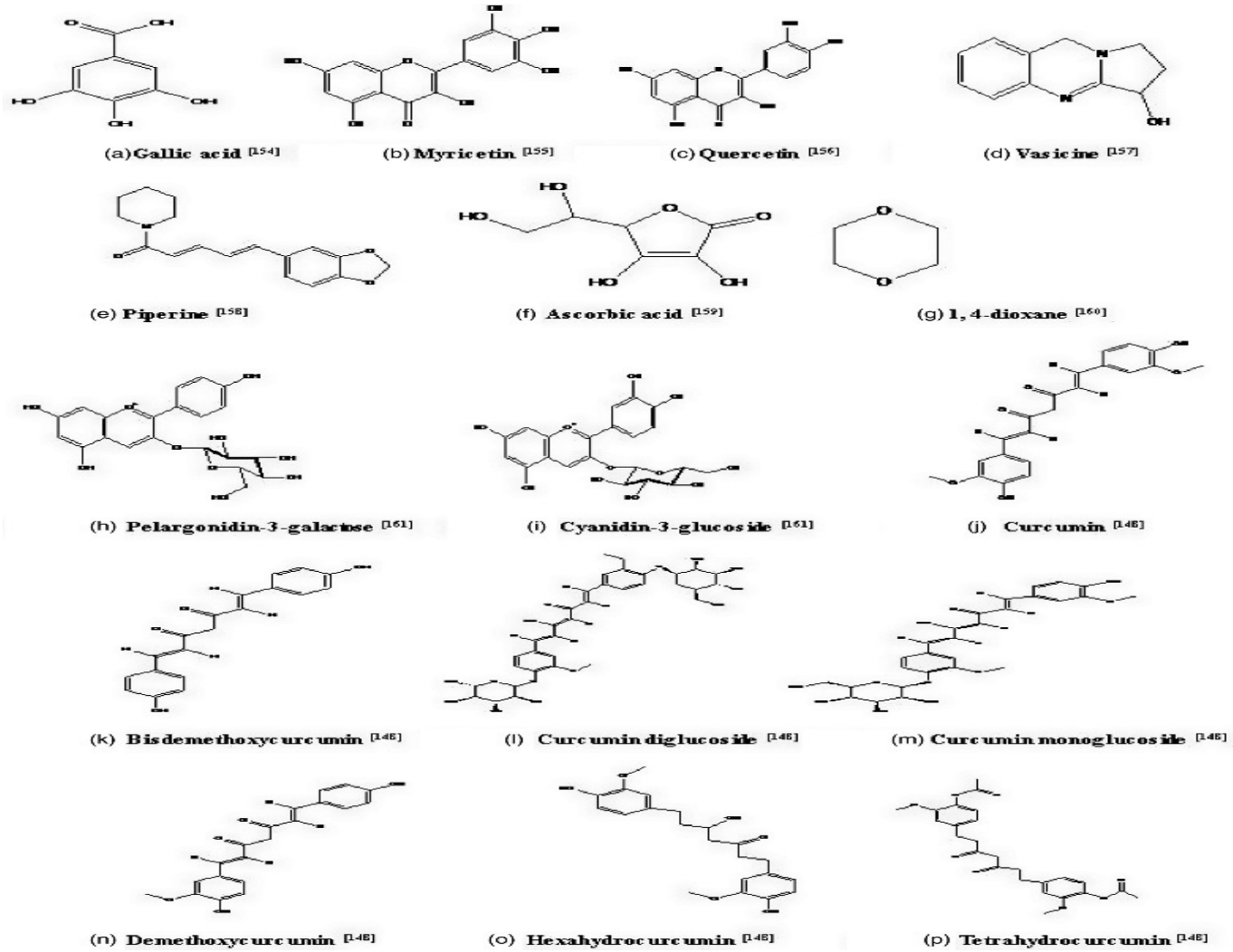


**Fig. 12 :** Some important chemical constituents of *Bergenia ciliata*. (www.google.com.)

## CONCLUSION

The present study explores that *Bergenia* species is a very effective herb which has been used for medicinal purposes. It contains a wide range of bioactive compounds of therapeutic value. The versatility of *Bergenia ciliata* can be explained by its phytochemical, pharmaceutical and biological investigation. The raising concern of antimicrobial resistance towards allopathic medicine can also be solved to some extent by using the pharmacological properties of whole plant of *Bergenia ciliata*. During the long-period of traditional use it has been noticed the plant can be used to treat many ailments without causing any side effects that leads to its great safety and efficiency that also has been tested and documented every time. It is easily available and cost effective so everyone can use it for the treatment. It has been observed that only 9 species out of 32 possess the pharmacological properties, hence there is a scope for phytochemical analysis and clinical efficacy trials with the rest of the 23 species.

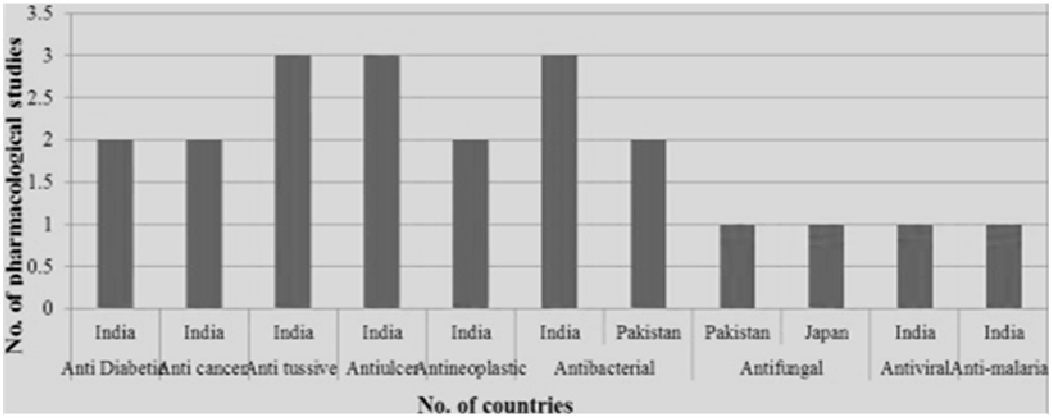


**Fig. 13 :** The graph showed the pharmacological research work of different countries on *B. ciliata*. (Ahmad *et al*., 2018)

The conservation of the Bergenia species is of immense concern from a biodiversity, ethnobotanical, and pharmacological perspective. In present situation where old traditional practices are declining and at risk due to rapid modernization there is an urgent need to take actions towards saving these tribal species and help to find ground-breaking ways to untap its efficiency so that it can be used for human welfare in future. It also has been observed that there is deficiency in clinical trials therefore additional clinical attempts on this plant should be conducted so that discovery of new drugs can be made possible, detailed toxicological research work should be carried out. These studies will provide valuable knowledge to the researchers about different disorders which can be treated by the prepared new drugs. However, there is still a scope of research on several other aforementioned therapeutic activities.

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