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TWO ANTIOXIDANT PLANTS BEING USED IN TRADITIONAL MEDICINE OF SIKKIM (INDIA)

Tanaya Ghosh and Prasanta Kumar Mitra*

Department of Medical Biotechnology, Sikkim Manipal University, Sikkim Manipal Institute of Medical Sciences, Gangtok, Sikkim, India.

***Corresponding Author: Prasanta Kumar Mitra**
Department of Medical Biotechnology, Sikkim Manipal University, Sikkim Manipal Institute of Medical Sciences, Gangtok, Sikkim, India.

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ABSTRACT
Many antioxidant plants like A*ageratum conyzoides*, A*astilbe rivularis* buch. – Ham. Ex D. Don., *Abutilon indicum, Amorphophallus paeoniifolius, Asparagus racemosus, Bacopa monnieri, Bergenia ciliate, Costus speciocus, Mentha spicata, Murrya koenigii, Syzygium cumini etc.* are being used in traditional medicine of Sikkim. But *Bacopa monnieri* and *Bergenia ciliate* are found widely used. People of Sikkim specially villagers believe that these two plants help them to fight against diseases, thereby keep them well. Further, they use these plants due to easy access, less cost, least side effects and above all natural. In the present article antioxidant activity of *Bacopa monnieri* and *Bergenia ciliate* is discussed in detail in addition to their botanical description, vernacular names, classification, traditional use, content of bioactive compounds as well as other pharmacological properties.

KEYWORDS: Traditional medicine of Sikkim, use of antioxidant plants, *Bacopa monnieri, Bergenia ciliate*.

INTRODUCTION
Oxygen is indispensable for life but under certain situations could exert deleterious effects on the human body. Oxygen can form number of chemical compounds, known as reactive oxygen species (ROS). hydrogen peroxide, ozone, hypochlorous acid etc. are in the list of ROS.

Reactive species are free radicals. Due to presence of surplus free floating electrons free radicals can easily donate or accept electrons from other sources. They are, therefore, unstable and highly reactive. Hydroperoxyl radical, active oxygen, superoxide radical and triplet oxygen are the types of free radicals. Internal source (enzymatic reactions), external source (non enzymatic reactions, ozone, radiations, ultraviolet light, drugs, pesticides, cigarette smoke, environmental pollutant etc.) and physiological factors (stress, emotion and disease) are responsible for formation of free radicals. Free radicals cause oxidative stress which could develop many chronic and degenerative diseases including diabetes, cancer, atherosclerosis, ischemic heart disease, neurodegenerative diseases etc.[1]

Antioxidants, on the other hand, are the synthetic chemicals or substances present in different dietary sources like fruits, vegetables, tea, etc. which in low concentration could delay or inhibit oxidation of the substance. They can also break free radical chain reaction properties thereby save the living system from deleterious effects of free radicals.[2]

Human body has antioxidant defense mechanism. Still there is demand for exogenous antioxidant compounds.[3] This demand is being fulfilled by synthetic antioxidants such as butylated hydroxyl anisole and butylated hydroxyl toluene. But report says that the uses of theses synthetic antioxidants are not good for humans, they can cause carcinoma in human body.[4]

Hence search for antioxidants was going on from different sources and even extended to the field of medicinal plants. Chemicals like anthocyanins, lignans, phenolic acids, flavonoids, stilbenes as well as xanthophylls, carotenes etc. are the antioxidant compounds and found in extracts of many medicinal plants.[5] It is now known that many medicinal plants such as, *Amaranthus gangeticus, Artemisia absinthium, Berberis vulgaris Bacopa monnieri, Coffea Arabica, Curcuma longa, Ficus bengalensis, Hemidesmus indica, Ixora coccenia, Moringa oleifera, Melissa officinalis, Piper betle, Salvia officinalis, Terminalia chebula, Vitex negundo* etc. could exert antioxidant activities.[6] These medicinal plants are called ‘antioxidant plant’.

In the present article two antioxidant plants viz. *Bacopa monnieri* and *Bergenia ciliate*, being used in traditional medicine of Sikkim, are discussed. *Bacopa monnieri*

Botanical description

Bacopa monnieri (B. monnieri), commonly known as brahmi, is native to the wetlands of southern and Eastern India, Australia, Europe, Africa, Asia, and North and South America. It grows in warmer parts of India, China, Taiwan, Australia, Vietnam, and USA. *B. monnieri* is a perennial, creeping herb with numerous branches and small, oblong. The root is irregularly circular to angular in shape. Stem is cylindrical, glabrous, nodes prominent. Leaves are relatively thick which are arranged opposite to each other on the stem. Flowers are small and light purple or white with four to five petals. Fruit is lobose to ovoid, seeds are oblong or irregular. *B. monnieri* grows naturally in wetland, shallow water, damp and muddy shores. It needs warm and humid climate with plenty of sunshine and abundant rainfall for optimum growth.[7]

Bacopa monnieri

Vernacular names

B. monnieri has different vernacular names such as, *Mandookaparni, brahmi, gotu kola, water hyssop, waterhyssop, brahmi, thyme-leafed gratiola, herb of grace, Indian pennywort etc*.[8]

Classification[9]

Kingdom: *Plantae*, Clade: *Tracheophytes*
Division: *Tracheophyta*, Class: *Magnoliopsida*,
Order: *Lamiales*, Genus: *Bacopa*, Species: *monnieri*
Family: *Schrophulariaceae (Plantaginaceae)*

Traditional use

In Ayurveda, Unani systems of medicine *B. monnieri* has been utilized extensively as a nootropic, digestive aid and to improve learning, memory and respiratory function. It is used for the management of a range of mental conditions including anxiety, poor cognition and lack of concentration. The plant is also recommended as a diuretic and as an energizer for the nervous system and the heart as well as for treatment of asthma, insanity and epilepsy.[10]

Bioactive compounds

B. monnieri contains several compounds like, Pseudojujubogenin, luteolin, luteolin-7-glucoside, luteolin-7-glucuronide, apigenin- 7-glucuronide; β-sitosterol, D-mannitol, 3-O-β-D-glucopyranosyl-(l—»3)-[β-Dglucopyranosyl] jujubogenin, 3-O-[β-D--glucopyranosyl-(l—»3)-[β-Dglucopyranosyl] pseudoju- jubogenin, 3-*O*-α-l-arabinofuranosyl-(1→2)-[6-*O*-sulfonyl-β-d-glucopyranosyl-(1→3)]-α-l arabinopyranoside betulinic acid, wogonin, oroxidin, nicotine, 3-formyl-4-hydroxy-2H-pyran, bacosine, bacostcrol, bacosterol-3-O-β-D-glucopyranoside, stigmasterol, stigmastanol, monnieri, plantioside B, bacoside A1, bacoside A3, bacoside B, bacogenin A1, bacogenin A2, bacogenin A3, bacogenin A4, bacopa saponin-C, bacopasides I and II, bacopasides III-V, bacopasides VI-VIII, bacobitacins A-D, monnieraside I, monnieraside III, jujubogenin etc.[11]

Pharmacological activity

B. monniera possessed many pharmacological effects such as, Anti- oxidant, anti-depressant, anti-epileptic, anti-diabetic, anti-inflammatory, anti-ulcer, anti-cancer, anti-microbial, anxiolytic, analgesic, anticonvulsant and antiparkinsonia, neuro pharmacological, hepatoprotective, cardioprotective, smooth muscle relaxant and memory enhancer.[12]

Antioxidant activity of *Bacopa monnieri*

In vitro antioxidant property of the whole plant of *B. monnieri* was studied by Volluri *et al.* Methanolic extract was prepared and investigated for in vitro antioxidant property by nitric oxide scavenging activity, DPPH free radical scavenging assay and reducing power activity assay methods. Results were concentration dependant with IC50 values being 455.78±1.03µg/ml, 104.82±1.96µg/ml and 96.13±0.86µg/ml respectively. Total phenolic content of *B. monnieri* was measured. It revealed that *in vitro* antioxidant property of the plant had relation with total phenolic content of the plant.[13]

Ramadas isolated proteins from aqueous extract of *B. monnieri* plant leaves and studied its antioxidant activity by *in vitro* methods. Free radical scavenging activity was evaluated using 1, 1-Diphenyl-2-picrylhydrazyl (DPPH) radical scavenging assay and nitric oxide scavenging assay. Standard antioxidants like ascorbic acid and BHA were used for comparison.The study revealed that, *B. monnieri* plant leaves proteins showed potent antioxidant activity in comparison with standard antioxidants used. Result showed that, the proteins from *Bacopa monnieri* plant leaves had significant antioxidant activity.[14]

Bhattacharya and colleagues studied antioxidant activity of *B. monniera* in rat frontal cortex, striatum and hippocampus.[15] They found a dose related increase in enzyme activity responsible for scavenging reactive oxygen species, namely, superoxide dismutase, catalase, and glutathione peroxidase in these brain regions of rats after 14 and 21 days of chronic administration of *B.*

monnieri. They further showed that antioxidant effect of *B. monnieri* was comparable to that of deprenyl, a known antioxidant drug. Authors concluded that *B. monnieri* had antioxidant activity.

In an *in vitro* study Russo and coworkers[16] investigated effect of ethanol extract of *B. monnieri* on hydrogen peroxide induced cytotoxicity and DNA damage in human nonimmortalized fibroblast cells. They also investigated the free radical scavenging capacity and the effect on DNA cleavage induced by hydrogen peroxide. Result showed that *B. monnieri* was able to inhibit superoxide anion formation in a dose dependent manner which is the indication of free radical scavenging ability. Further, protective effect of *B. monnieri* was observed against hydrogen peroxide cytotoxicity and DNA damage.

B. monnieri can combat stress. This is due to its antioxidant properties which is expressed by its capacity to scavenge superoxide anion and hydroxyl radical, and to reduce hydrogen peroxide induced cytotoxicity and DNA damage in human fibroblast cells.[17]

One of the important bioactive compounds present in *B. monnieri* is Bacoside A. Anbarasi *et al*. showed that Bacoside A can protect rat brain against chronic cigarette smoking-induced oxidative damage demonstrating thereby the antioxidant activity of the plant.[18]

B. monnieri, traditionally used for various ailments, is best known as a neural tonic and memory enhancer. The plant has also a great role in attenuation of dementia, Parkinson's disease, and epilepsy. Numerous experiments with animals and humans have proved this. Based on current evidence Aguiar and Borowski suggested that *B. monnieri* acts through many mechanisms—most important is anti-oxidant neuroprotection via redox and enzyme induction.[19]

In conclusion, Indian herb *B. monnieri* is a dietary antioxidant. It protects oxidative damage in many organs including brain. It improves cognitive function in humans suggesting thereby its therapeutic applications in many diseases including neurodegenerative disorders such as Alzheimer's disease.

Bergenia ciliata

Botanical description

Bergenia ciliata (*B. ciliata*), popularly known as 'Paashanbheda' (meaning 'to dissolve the stone'), is one of the important medicinal plants of Sikkim Himalaya. The Plant, grows between rocks, is distributed in the temperate Himalaya (from Kashmir to Nepal) from 2000 to 2700 m and is very common in Pakistan and Central and East Asia. The plant has spirally arranged of rosette of leaves. Leaves are glabrous or hirsute, suborbicular to orbicular broadly obovate, base cordate or sometimes rounded and apex round in shape. Flowers, produced in cyme, are pink to purplish. Sepals are pink to red. Carpels and styles are green or pinkish. Seeds are elongated about 1 mm long, minutely tuberculate, usually numerous, albuminous. Stamens are inserted with the petals, equaling or double their number. Rhizomes are compact solid, somewhat cylindrical barrel shaped, longitudinally wrinkled, covered with root scars, possess a characteristic, slightly camphoraceous odour and pungent taste. The plant is drought resistance.[20]

Bergenia ciliate

Vernacular Names[20]

B. ciliata has different vernacular names such as, Arabic: *Barghienia-mehdiyata* Assamese: *Patharkuchi* Bengali: *Patharchuri* English: *Rock-foil* German: *Steinbrech* Gujarati: *Pashanbheda, Pakhanbheda* Hindi: *Pashanbhed, Dakachru* Japanese: *Yukinoshita* Kannada: *Alepgaya* Kashmir: *Pashanbhed* Malayalam: *Kallurvanchi* Marathi: *Pasanbheda* Oriya: *Pasanbhedi* Sanskrit: *Paashaanabheda* Tamil: *Sirupilai* Telugu: *Kondapindi* Urdu: *Pakhanabeda, Zakham-e-hayat.*

Classification[20]

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

Traditional use

B. ciliata has many traditional uses. Plant is reported to be used in fever, cough, diarrhea, lungs diseases, asthmatic disorders, vomiting, bruises and boils, digestive disorders, malaria, chronic dysentery, pulmonary disorders, ulcers, dysuria, spleen enlargement, eye diseases, boils, cuts and burn, dissolving kidney stones etc. The plant is also used as tonic and anthelimintic. Local people of Sikkim use this plant as an anti-tussive for cold and cough.[21]

Bioactive compounds

B. ciliata contains many bioactive compounds. Few are, Gallic acid, methyl gallate, quercetin-3-O-β-D-

xylopyranoside, quercetin-3-O-α-L-arabinofuranoside, sitoindoside, eryodictiol-7-O-β-D-glucopyranoside, arbutin, 6′-O-p-hydroxybenzoylarbutin, β-sitosterol bergenin, 4-O-galloylbergenin, 11-O-galloylbergenin, p-hydroxybenzoic acid, gallicin, (-)-3-0-galloylcatechin, β-Sitosterol, protocatechuic acid, 6′-O-protocatechuoylarbutin, 11-O-p-hydroxybenzoylbergenin, hexanal, leucocyanidin, bergenin 11-O-protocatechuoylbergenin, 6′-O-p-hydroxybenzoylparasorboside, (-)-3-O-galloylepicatechin,(-)-3-O-galloylcatechinbergenin, arbutin, catechin, polymeric tannin, 4-methoxy-2-[(1S,2R,3S,4S,5R)-3,4,5,6-tetrahydro-3,4,5-trihydroxy-6 hydroxymethyl)-2H-pyran-2-yl]-α-resorcylic acid δ-lactone monohydrate., C-glucoside of 4-O-methylgallic acid, β-sitosterol-d- glucoside etc.[22]

Pharmacological activity

B. ciliata has several pharmacological activities like**,** Anti-cancer, antipyretic, anti-diabetic, anti-inflammatory, anti-tussive, antibacterial, antiulcer, antioxidant, anti-malarial, anti-antiurolithic, diuretic, hepatoprotective, antiscorbutic etc.[23,24]

Antioxidant activity of *Bergenia ciliate*

Methanolic and aqueous *B. ciliata* rhizome extracts were evaluated for antioxidant activity. *In vitro* antioxidant activity was measured by various ways including reducing power, free radical scavenging activity and lipid peroxidation inhibition potential. The methanolic extract showed greater potential in all antioxidant assays. Authors concluded, due to antioxidant activity *B. ciliata* rhizome extracts might find use in pharmaceutical industry as precursors of therapeutic drugs that can be implemented as antithesis against oxidative stress and consequent toxicity to cellular biomolecules.[25]

Khan *et al.* evaluated antioxidant activity of *B. ciliata* Sternb (Rhizome) crude extract as well as chloroform, ethyl acetate and n-hexane fractions. Antioxidant activity was checked on the basis of scavenging 1-diphenyl-2-picrylhydrazyl (DPPH) radical. Chloroform fraction was found to be highly anti-oxidative value as compare to other fractions. Author further studied antimicrobial activity of *B. ciliata* Sternb (Rhizome) crude extract against *Bacillus atrophoeus, Bacillus subtilis, Kleibsiella pneumonia* and *Pseudomonas aeruginosa* strains. Result showed that *B. ciliata* Sternb (Rhizome) crude extract exerted antimicrobial property through its antioxidant activity.[26]

Antioxidant activity and phenolic content of *B. ciliate* leaves was studied by Hendrychováa *et al. In vitro* antioxidant activity was checked through free radical scavenging potential in DPPH and ABTS assays. Results showed that water extracts of *B. ciliate* leaves showed antioxidant activity which correlated well with the content of total phenol in the leaves.[27]

Ruby *et al.* studied *in vitro* antioxidant activity of hydroethanolic extract of B. ciliate using ferric thiocyanate assay, thiobarbituric acid (TBA) assay, phosphomolybdenum assay, nitric oxide radical inhibition assay, ABTS radical scavenging assay, hydroxyl radical scavenging activity and peroxynitrite scavenging assay. Results showed that hydroethanolic extract of *B. ciliate* exerted antioxidant activity in all assays. Antioxidant activity had relation with total phenolics content and total flavonols content of the extract.[28]

Study was undertaken to evaluate *in vitro* antioxidant activity of methanol, ethyl acetate and hexane extracts of *B. ciliata* leaves of Sikkim origin. Antioxidant activity was checked by 2,2- diphenyl-1-picrylhydrazyl (DPPH) and 2,20-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) (ABTS) assays. Methanol extract showed maximum antioxidant activity. Methanol extract also showed antimicrobial activity. High performance liquid chromatography (HPLC) analysis revealed that methanolic extract contained the highest amount of bioactive compounds viz. bergenin, catechin and gallic acid. Authors commented, methanol extract of *B. ciliata* may be a potential source of natural antioxidant and antimicrobial compounds that can be used in food and drug industries.[29]

Bagul *et al* studied free radical scavenging properties of rhizome of *Bergenia ciliata* (Haw.) Sternb and noted that its methanolic extract scavenged superoxide ions at standard dose.[30] Antioxidant activity of *B. ciliate* was also confirmed by Saha *et al.* through *in vitro* and *in silico* studies.[31]

CONCLUSION

Bacopa monnieri and *Bergenia ciliate*, are being widely used in traditional medicine of Sikkim as antioxidant plants. Village people of Sikkim believe that the traditional medicine where these two antioxidant plants are being used keep them well. Future researchers, therefore, have the following responsibilities.

1) They should validate scientific use of *Bacopa monnieri* and *Bergenia ciliate* in traditional medicine of Sikkim.

2) Researchers should proceed for isolation of antioxidant compound(s) from the plants.

3) They should undertake various spectroscopic experiments like infrared, ultraviolet, nuclear magnetic resonance, mass spectroscopy etc. to characterize the isolated compound(s).

As the characterized compounds are isolated from plants, these will be ‘Natural antioxidant’ which can overcome the deleterious effect of synthetic antioxidant.

REFERENCES

1. Halliwell B. Free radicals, antioxidants, and human disease: curiosity, cause, or consequence? Lancet, 1994; 344: 721-724.

2. Young IS, Woodside JV.Antioxidants in health and disease. J.Clin. Pathol, 2001; 54: 176-186.
3. Kunwar Amit, Priyadarsini KI. Free radicals, oxidative stress and importance of antioxidants in human health. J Med Allied Sci, 2011; *1*(2): 53-60.
4. Branen AL. Synthetic anti oxidants. Journal of American Oil Chemist Society, 1975; 52: 59-63.
5. Xu Dong-Ping, Li Ya, Meng Xiao, ZhouTong, ZhouYue, Zheng Jie, Zhang Jiao-Jiao, Li Hua-Bin. Natural Antioxidants in Foods and Medicinal Plants: Extraction, Assessment and Resources. Int. J. Mol. Sci, 2017; 18(96): 1-32.
6. Mathew Ansa, Madhu CD, Philip Subash. Antioxidant Activity of Some Common Medicinal Plants. International Journal of Pharmaceutical and Clinical Research, 2013; 5(2): 43-46.
7. Chopra RN. Indigenous Drugs of India. 2nd ed. Calcutta, India: U.N. Dhur and Sons, 1958; 341.
8. Aguiar S, Borowski T. Neuropharmacological review of the nootropic herb. Bacopa monnieri. Rejuvenation Res, 2013; 16: 313-326.
9. Russo A, Borrelli F. Bacopa monniera, a reputed nootropic plant: an overview. Phytomed, 2005; 12: 305-17.
10. Rai D, Bhatia G, Palit G, Pal R, Singh S, Singh H. Adaptogenic effect of Bacopa monniera (Brahmi). Pharmaco Biochem Behav, 2003; 75: 823-30.
11. Chatterji N, Rastogi RP, Dhar ML. Chemical examination of BacopamonnieraWettst: part II - isolation of chemical constituents. Ind J Chem, 1965; 3: 24-9.
12. Pushkar Gayatridevi, Pushkar Bhupendra, Sivabalan Rohini. A Review on Major Bioactivities of Bacopamonnieri. Annals of Applied Bio-Sciences, 2015; 2(2): 1-11.
13. Volluri SS, Srinivasa RB, Chippada SC,Meena V. In-vitro antioxidant activity and estimation of total phenolic content in methanolic extract of *Bacopa monniera*. RASAYAN J Chem, 2011; 4(2): 381-386.
14. Ramadas D, Ravishankar M, Shwetha S, Chikkanna D. Phytochemical studies and antioxidant activity of *Bacopa monnieri* plant leaves proteins. Indo American Journal of Pharmaceutical Research, 2016; 6(1): 4302-4307.
15. Bhattacharya SK, Bhattacharya A, Kumar A, Ghosal S. Antioxidant activity of *Bacopa monniera* in rat frontal cortex, striatum and hippocampus. Phytotherapy Research, 2000; 14(3): 174–179.
16. Russo A, Izzo AA, Borrelli F, Renis M. Free radical scavenging capacity and protective effect of *Bacopa monniera* L. on DNA damage. Phytotherapy Research, 2003; 17(8): 870–875.
17. Bhakuni DS, Dhar ML, Dhar MM, Dhawan BN, Mehrotra BN. Screening of Indian plants for biological activity: Part II. Ind J Exp Biol, 1969; 7: 250-62.
18. Anbarasi K, Vani G, Balakrishna K, Devi CS. Effect of bacoside A on brain antioxidant status in cigarette smoke exposed rats. Life Sci, 2006; 78: 1378-84.
19. Aguiar Sebastian, Borowski Thomas. Neuropharmacological Review of the Nootropic Herb *Bacopa monnieri.* Rejuvenation Res, 2013; 16(4): 313–326.
20. Khan Mohammad Yaseen, Kumar Vimal. Phytopharmacological and Chemical Profile of *Bergenia ciliate.* International Journal of Phytopharmacy, 2016; 6(5): 90-98.
21. Singh Lakhwinder, Kumar Antul, Paul Amandeep. *Bergenia ciliata*: The medicinal herb of cold desert. International Journal of Chemical Studies, 2018; 6(3): 3609-3613.
22. Fujii M, Miyaichi Y, Tomimori T. Studies on Nepalese Crude Drugs. XXII: On the Phenolic Constituents of the Rhizome of *Bergenia ciliata* (HAW.) STERNB. *Natural Medicines*, 1996; 50 (6): 404-407.
23. Sinha S, Murugesan T, Maiti K, Gayen JR, Pal B, Pal M, Saha BP. Antibacterial activity of *Bergenia ciliata* rhizome. *Fitoterapia*, 2001; 72(5): 550-552.
24. Bashir S, Gilani AH. Antiurolithic effect of *Bergenia ligulata* rhizome: an explanation of the underlying mechanisms. *Journal of Ethnopharmacology*, 2009; 122(1):106-16.
25. Rajkumar Venkatadri, Guha Gunjan, Kumar R. Ashok, Mathew Lazar. Evaluation of Antioxidant Activities of *Bergenia ciliata* Rhizome. Rec. Nat. Prod, 2010; 4(1): 38-48.
26. Aman Khan, Gul Jan, Afsar Khan, Farzana Gul Jan, Muhammad Danish. Evaluation of antioxidant and antimicrobial activities of *Bergenia ciliata* Sternb (Rhizome) crude extract and fractions. Pak. J. Pharm. Sci, 2018; 31(1): 031-035.
27. Hendrychováa Helena, Vildováa Anna, Kočevar-Glavačb Nina, Tůmováa Lenka, Abdykerimova Elnura, Bekovnac Kany, Tůmad Jiri. Antioxidant Activity and Phenolic Content of *Bergenia crassifolia*, *B.* x *ornata* and *B. ciliate*.Natural Product Communications, 2014; 9(4):519-522.
28. Km. Ruby, Sharma Suman, Chauhan Rajani, Dwivedi Jaya. *In-vitro* antioxidant and hemorrhoidal potential of hydroethanolic leaf extracts of *Bergenia ciliata*, *Bergenia ligulata* and *Bergenia stracheyi.* Asian J. Plant Sci. Res, 2015; 5(5): 34-46.
29. Singh Mithilesh, Pandey Neha, Agnihotri Vasudha, Singh KK, Pandey Anita. Antioxidant, antimicrobial activity and bioactive compounds of Bergenia ciliata Sternb.: A valuable medicinal herb of Sikkim Himalaya. Journal of Traditional and Complementary Medicine, 2017; 7: 152-157.
30. Bagul MS, Ravishankara MN, Padh H, Rajani M. Phytochemical evaluation and free radical scavenging properties of rhizome of *Bergenia ciliata* (Haw.) Sternb. *Forma ligulata* Yeo.
31. Journal of Natural Remedies, 2003; 3(1): 83-89.
32. Saha Sarmistha, Veerma Ramtej J. *In vitro* and *in silico* study of antioxidant effect of *Bergenia ciliata* and *Terminalia chebula* against sodium oxalate induced oxidative stress. Toxicology and Environmental Health Sciences, 2015; 7: 50-57.