

Review

Biological advances in *Bergenia* genus plant

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***Bergenia*, a genus belonging to *Saxifragaceae* family, is one of the most important medicinal plants, has high application values for human. Currently, wild *Bergenia* is becoming lacking, due to destruction of ecological environment and excessive excavation; furthermore, the study on it is not deep enough, many related important problems have not been resolved. To protect and utilize more effectively the elite germplasm resource, this study introduced its germplasm situation and reviewed its application values in medicine, horticulture, food and cosmetic and summarized its research advances in biochemistry, cytology and molecular biology. This review can provide an important reference for further study in *Bergenia*.**

Key words: *Bergenia*, species, application, biological advance.

INTRODUCTION

Bergenia, a genus included in the family *Saxifragaceae* (Zhou et al., 2007; Dhalwal et al., 2008), is a kind of perennial herbaceous plant. At present, over 30 species were found in the world (www.ipni.org) and all of them have high pharmaceutical values, in addition, it can also be used in horticulture, food and cosmetic. But now, wild species of *Bergenia* possessing high application values have gradually been becoming lacking, nearly to the brink of extinction, because of destruction of ecological environment and excessive excavation. To protect and develop more effectively this kind of elite germplasm resource, this study introduced its germplasm situation, reviewed its application values and summarized its research advances in biochemistry, cytology and molecular biology.

Germplasm situation of *Bergenia*

Bergenia is mainly distributed in Asia, involved in East Asia, the southeastern regions of Central Asia and northern regions of South Asia (Chandrareddy et al., 1998; Zhou et al., 2007). According to The International

Plant Names Index (www.ipni.org), there are 32 species in the world (Table 1). In China, a total of seven species was found in five provinces, including Sichuan, Tibet, Shanxi, Yunnan and Xinjiang. To be mentioned, the four including *Bergenia emeiensis*, *Bergenia scopulosa*, *Bergenia tianquanensis* and *Bergenia yunnanensis* are unique, only found in China. Generally, wild *Bergenia* grows in high-altitude cold location, on the earth surface covered by forest and shrub, alpine meadow or the crevice of stone (Lu and Wang, 2003a).

APPLICATIONS OF *BERGENIA*

Medicinal fields

Bergenia is one of the most important folk medicinal herbs, in China, it is often used for treating cough, stop bleeding, increasing immunity and so on (Lu and Wang, 2003a); in India, the rhizomes of *Bergenia* have been used for centuries in the Ayurvedic formulations to dissolve kidney and bladder stones, abnormal leucorrhea, piles, and pulmonary affections (Gehlot et al., 1976; Srivastava and Rawat, 2008). *Bergenia* has many bioactive compounds in its rhizomes, including paashaanolactone (Chandrareddy et al., 1998), arbutin (Pop et al., 2009), bergenin, catechin and gallic acid

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Table 1. Species included in *Bergenia* genus*.

Number	Species	Full name	ID code
1	<i>Bergenia</i>	<i>Bergenia</i> Moench	331394-2
		<i>Bergenia</i> Moench	36961-1
		<i>Bergenia</i> sect. <i>Ciliatae</i> (Boriss.) J.T.Pan	926908-1
		<i>Bergenia</i> sect. <i>Scopulosae</i> J.T.Pan	926010-1
2	<i>Bergenia beesiana</i>	<i>Bergenia beesiana</i> Hort. ex C.Schneider	790352-1
3	<i>Bergenia biflora</i>	<i>Bergenia biflora</i> Moench	790353-1
		<i>Bergenia bifolia</i> Moench	790354-1
4	<i>Bergenia ciliata</i>	<i>Bergenia ciliata</i> A.Braun ex Engl.	790357-1
		<i>Bergenia ciliata</i> Stein	790355-1
		<i>Bergenia ciliata</i> (Haw.) Sternb.	790356-1
5	<i>Bergenia cordifolia</i>	<i>Bergenia cordifolia</i> Sternb.	790358-1
6	<i>Bergenia coreana</i>	<i>Bergenia coreana</i> Nakai	790359-1
		<i>Bergenia coreana</i> Nakai	790360-1
7	<i>Bergenia crassifolia</i>	<i>Bergenia crassifolia</i> (L.) Fritsch var. <i>sajanensis</i> Stepanov	77099297-1
		<i>Bergenia crassifolia</i> (L.) Fritsch	790361-1
8	<i>Bergenia delavayi</i>	<i>Bergenia delavayi</i> Engl.	790362-1
9	<i>Bergenia emeiensis</i>	<i>Bergenia emeiensis</i> C.Y.Wu ex J.T.Pan	934834-1
		<i>Bergenia emeiensis</i> C.Y.Wu ex J.T.Pan var. <i>rubellina</i> J.T.Pan	981392-1
10	<i>Bergenia fortunei</i>	<i>Bergenia fortunei</i> Stein	790363-1
11	<i>Bergenia gorbunovii</i>	<i>Bergenia gorbunovii</i> B.Fedtsch. & Boriss.	790365-1
		<i>Bergenia gorbunovii</i> B.Fedtsch.	790364-1
12	<i>Bergenia himalaica</i>	<i>Bergenia himalaica</i> Boriss.	790366-1
13	<i>Bergenia hissarica</i>	<i>Bergenia hissarica</i> Boriss.	790367-1
14	<i>Bergenia ligulata</i>	<i>Bergenia ligulata</i> (Wall.) Engl.	790368-1
		<i>Bergenia ligulata</i> (Wall.) Engl.	790369-1
15	<i>Bergenia media</i>	<i>Bergenia media</i> Engl.	790370-1
16	<i>Bergenia milesii</i>	<i>Bergenia milesii</i> Stein	790371-1
17	<i>Bergenia</i> × <i>newryensis</i>	<i>Bergenia</i> × <i>newryensis</i> Yeo	790372-1
18	<i>Bergenia orbicularis</i>	<i>Bergenia orbicularis</i> Stein	790373-1
19	<i>Bergenia ornata</i>	<i>Bergenia ornata</i> Stein & Guillaumin	790375-1
		<i>Bergenia ornata</i> Stein	790374-1
20	<i>Bergenia pacifica</i>	<i>Bergenia pacifica</i> Komarov	790376-1
21	<i>Bergenia pacumbis</i>	<i>Bergenia pacumbis</i> (Buch.-Ham. ex D.Don) C.Y.Wu & J.T.Pan	945348-1
22	<i>Bergenia purpurascens</i>	<i>Bergenia purpurascens</i> Engl.	790377-1
		<i>Bergenia purpurascens</i> (Hook.f. & Thomson) Engl.	790378-1
		<i>Bergenia purpurascens</i> (Hook.f. & Thomson) Engl. var. <i>sessilis</i> H.Chuang	1020959-1
23	<i>Bergenia schmidtii</i>	<i>Bergenia schmidtii</i> (Regel) Silva Tarouca	790379-1
24	<i>Bergenia</i> × <i>schmidtii</i>	<i>Bergenia</i> × <i>schmidtii</i> (Regel) Silva Tarouca , prospec. & Yeo	790380-1
25	<i>Bergenia scopulosa</i>	<i>Bergenia scopulosa</i> T.P.Wang	790381-1
26	<i>Bergenia smithii</i>	<i>Bergenia smithii</i> Engl.	790382-1
27	<i>Bergenia spathulata</i>	<i>Bergenia spathulata</i> Nagels ex Guillaumin	790383-1
28	<i>Bergenia stracheyi</i>	<i>Bergenia stracheyi</i> Stein	790384-1
		<i>Bergenia stracheyi</i> (Hook.f. & Thomson) Engl.	790385-1
29	<i>Bergenia thysanodes</i>	<i>Bergenia thysanodes</i> (Lindl.) C.Schneider	790386-1
30	<i>Bergenia tianquanensis</i>	<i>Bergenia tianquanensis</i> J.T.Pan	981391-1
31	<i>Bergenia ugamica</i>	<i>Bergenia ugamica</i> V.N.Pavlov	790387-1
32	<i>Bergenia yunnanensis</i>	<i>Bergenia yunnanensis</i> Hort.	790388-1

*Same species could probably be found by different researchers in different regions, so some species have several full names, but one full name only has unique ID code.

(Dhalwal et al., 2008), etc. Many extracts from *Bergenia* have high medicinal values, take methanol extract as an example, the results obtained by Sinha et al. (2001a) showed that it had a wide spectrum of concentration-dependent antibacterial activity, in addition, it was demonstrated anti-inflammatory potentiality as described by Sinha et al. (2001b).

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 (Reddy et al., 1999; Chauhan et al., 2000; Ji, 2005; Singh et al., 2007; Dhalwal et al., 2008). 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 anti-virus, diminishing inflammation caused from bacteria, enhancing immunity and so on (Asia and Liu, 1998; Li et al., 2006).

Horticultural fields

According to our outdoor investigations on the biological characters of *B. tianquanensis* and *B. emeiensis* and the report by Zhou et al. (2007) on *B. purpurascens*, *Bergenia* is a kind of perennial herbaceous plant with plant height ranging from 10 to 80 cm, with short internodes, its underground rhizomes grow creepingly with radial branches. The alternate leaves of *Bergenia* exhibit dense clusters, thick and soft, with 5 to 25 cm of leaf length and 3 to 17 cm of leaf width, usually, the leaves displays dark green, but winter comes, they will become red and spring comes, partial leaves will gradually turn green and send forth new leaves. Several beautiful flowers grow on scape with the height of 10 to 50 cm; its flowering period is 3 to 4 months. Thus, it has high visual value. If it is well-designedly planted in flower bed, among flower border, on hillside or under forest, a wonderful landscape will come into our view. In addition, it can also be used for landscaping of rock garden and pot-planting indoors.

Edible and cosmetic fields

As for food aspect, *Bergenia* has many kinds of amino acids and mineral elements which are helpful in health care (Yang et al., 2009), so it may be considered in cuisine. Additionally, arbutin contained in *Bergenia* are beneficial for diuresis and antibiotics and thus, it can be used as the disinfectant of urine. At same time, it can inhibit degradation of insulin (Li et al., 2006). For cosmetic application, the ingredient arbutin can make skin whiten and be manufactured into cosmetic brightening agent, because it can prevent tyrosinase within skin from taking effect (Guo et al., 2004).

BIOCHEMICAL, CYTOLOGICAL AND MOLECULAR ADVANCEMENTS

With respect to biochemical studies, as early as fifty years ago, the two ingredients tannin and arbutin were investigated. To this day, there are many reports on extraction and analysis of bioactive ingredients in *Bergenia* (Thieme et al., 1969; Chen et al., 1987; Hasan et al., 2005; Saijyo et al., 2008; Chen et al., 2008b; Dhalwal et al., 2008; Yang et al., 2009). In 1998, Chandrareddy et al. isolated four compounds from *Bergenia and ligulata*, subsequently, Lu and Wang (2003b), Wang and Lu (2005) and Chen et al. (2008a) extracted 5, 4 and 40 compounds from *B. scopulosa*, respectively. Recently, Rajkumar et al. (2010) extracted and evaluated the antioxidant activities from *Bergenia ciliata*. To be noticed, bergenin is one of the most researched organic compounds among the many bioactive ingredients (Reddy et al., 1999; Ji 2005; Singh et al. 2007; Chauhan et al., 2000; Dhalwal et al., 2008), due to quite high medicinal value.

For cytological and molecular studies on *Bergenia*, Liu et al. (2009) established a regeneration system of *B. crassifolia* using its leaves as explants, besides this; there are hardly any research reports according to published literature on *Bergenia* at cytological and molecular levels.

CONCLUSIONS

Bergenia has high application values in medicine, horticulture, food and cosmetic, this attracted many researchers' attention, but previous studies on *Bergenia* were focused on investigation and evaluation of germ-plasm resources, function identification of extracts and isolation of bioactive ingredients, while the experiments for *Bergenia* at cytological and molecular levels were hardly carried out. Additionally, wild *Bergenia* is becoming less and less, because of destruction of ecological environment and excessive excavation. Therefore, to develop and utilize effectively *Bergenia*, it is necessary and significant that more experiments are used to (1) realize specific active ingredients; (2) introduce and breed elite germplasm resources; (3) understand the functional genes coding active proteins by modern biochemical, cytological and molecular technologies.

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