

Health Benefits of Crassulaceae Species Frequent in Romania

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Abstract: A family of succulent plants with a nearly global range and adaptation to xeric ecological conditions is the Crassulaceae. There are roughly 1500 species in this family, most of which are used as decorative plants or as part of the design of green roofs. Their pharmacological and therapeutic effects, which we list here, include analgesic, antioxidant, hypoglycemic, antibacterial, and anticancer, were recently emphasized by biochemical analyses. Several researches have demonstrated the presence of the following chemical substances with biological and pharmacological action: flavonoids, sterols, ascorbic acid, trace elements, hydrocarbons, bufadienolides, etc. This paper aims to provide a short overview of the known therapeutic effects of the species from the Crassulaceae family which are frequently met in Romania. The studies can serve as a prelude to the application of these properties in the context of alternative medicine, while also opening up new research avenues for the advances of phytotherapy.

Keywords: flavonoids, spontaneous, succulent plants, therapeutic effects.

Introduction

“Science is the great antidote to unfounded enthusiasm and superstition” (Adam Smith)

The Crassulaceae family of plants, which consists of 35 genera and over 1500 species, is morphologically and systemically diverse (Berger, 1930; Eggli, 2002). With such a variety of biological applications, these plants are primarily used for ornamental purposes (López-Angulo et al., 2016). However, they also have ecological uses, such as in the form of green roofs that regulate urban microclimates. The presence of bioactive chemical components that dictate the pharmacological capabilities of the plants from the Crassulaceae family can be emphasized, though, if we concentrate on the scientific field of phytotherapy. We list a few of them here: bufadienolides, sterols, ascorbic acid, trace elements, and flavonoids (Oufir et al., 2015). Phytochemical research led to the isolation of 55 distinct types of phenolic compounds, 8 steroid compounds, and 8 bufadienolides from the plant tissues (Szewczyk et al., 2014). *Sedum*, *Aeonium*, *Crassula*, *Echeveria*, *Kalanchoe*, *Rhodiola* and *Sempervivum* are among the Crassulaceae family's botanical genera that are interesting in the context of complementary medicine (López-Angulo et al., 2016). Pharmacological studies have highlighted the therapeutic effects of these predominantly succulent plants, based on the identified biological activities. Antioxidants, hypoglycaemic, antibacterial, anticancer, hepatoprotective, analgesic impact, are a few of the studied effects (Milad et al., 2014). The current manuscript reviews the therapeutic properties of the plants from the Crassulaceae family that are frequently spread in Romania.

Family description

Urs Eggli presents a detailed description of the Crassulaceae family in the Illustrated Handbook of Succulent Plants: Dicotyledons (2002). It is the largest botanical family as number of species, belonging to the Order Saxifragales. Most of the species are represented by succulent plants. Regarding the ecology, they live in semi-arid areas and have an almost cosmopolitan distribution, with centres of diversity in Mexico, South Africa, and the Himalayas. The species of the Crassulaceae are perennial plants, rarely annual, with succulent, sessile, or rarely petiolate leaves, usually alternate and spiral or opposite and decussate, often aggregated into simple or crenate to lobed rosettes. Inflorescences are most often terminal with numerous flowers panicles or spikes. The flowers are usually bisexual, rarely unisexual, having actinomorphic symmetry, mostly

protandrous, 5-merous, with free sepals or united at the base, often unequal in size; petals are free or fused with the corolla tube, and stamens equals the number of petals or double them, with free or united filaments; gynoecium has a superior or semi-inferior position with numerous ovules. The fruits are most of the time polyfollicles more or less completely dehiscent, with numerous small seeds, elongated or fusiform, ribbed or papillate, rarely smooth, usually brownish; the embryo is small and the secondary endosperm poorly developed (Eggl, 2002).

Brief history of therapeutic use

The Crassulaceae is a botanical family with an impressive morphological diversity, having representative plants with an important decorative value. Throughout history, however, the medicinal uses of these plants are also known, some even with tradition in the treatment of gastric ulcers, epilepsy, dermatological conditions, or hemorrhages (Gerelt-Od et al., 2015). Starting from these past uses, the present ones are focusing on the biological activities discovered following the phytochemical analyses performed by different researchers on the multiple genera belonging to the Crassulaceae family. For example, the biologically active activity of flavonoids, tannins, and phenolic acids as antioxidant agents has been analysed by a big number of researchers (Fernandez-Panchon et al., 2008).

Present uses

The plants belonging to the botanical family Crassulaceae present by their constitutive chemical nature a series of therapeutic properties that can be used in alternative medicine and at the same time require increased attention from this perspective as they can constitute new horizons of research in the field of phytotherapy. The main therapeutic effects of the species from the Crassulaceae family are summarized in table 1.

Sedum acre L. (figure 1) is a spontaneous perennial herbaceous plant with succulent, smooth-edged leaves and yellow flowers. It is used in the treatment of epilepsy and some dermatological conditions, in the treatment of ulcers and hypertension (Gerelt-Od et al., 2015).

Table 1

The main therapeutic effects of plants from the Crassulaceae family

Biological activity	Name of the species	References
Antioxidant	<i>Jovibarba globifera</i> , <i>Sempervivum marmoreum</i>	Szewczyk et al., 2014 Karabegovic et al., 2018
Hypoglycemic	<i>Rhodiola rosea</i> , <i>Kalanchoe pinnata</i>	M.Déciga-Campos et al., 2016 S.B.Patil et al, 2013
Antimicrobial	<i>Sedum acre</i> , <i>Sedum spurium</i>	Stankovic et al., 2012 Yaylı et al., 2010
Anticarcinogenic	<i>Sedum aizoon</i> , <i>Sedum sarmentosum</i>	T.Xu et al, 2015, D.Huang et al., 2010
Hepatoprotectors	<i>Sedum sarmentosum</i>	L.-H. Lian, et al., 2010
Analgesic	<i>Kalanchoe pinnata</i> (<i>Bryophyllum pinnatum</i>)	M. Afzal et al., 2012

Biochemical analyses carried out on different extracts of *Sedum acre* demonstrated the significant uses of this species in the context of alternative medicine, in the food and pharmaceutical industry (Stankovic et al., 2012). Specific antimicrobial activity tests against 13 bacterial strains and 4 fungal species using the microdilution method showed considerable antimicrobial and moderate antifungal activities (Stankovic et al., 2012).

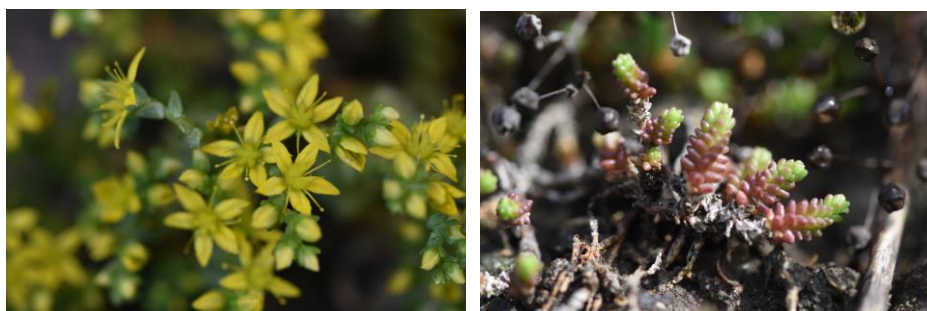


Figure 1. *Sedum acre* L. Wild in Hodoșa, Mureș County
(Photos by Mădălina BORCĂ, 2022)

Sempervivum marmoreum Griseb. (figure 2) is a spontaneous succulent plant with pink flowers that grows on slopes with southern exposure from the Romanian mountains. Phytochemical analysis of different extracts prepared from fresh leaves led to the isolation of 10 distinct types of flavonoids, which determine the antioxidant activity of these plants (Karabegovic et al., 2018).

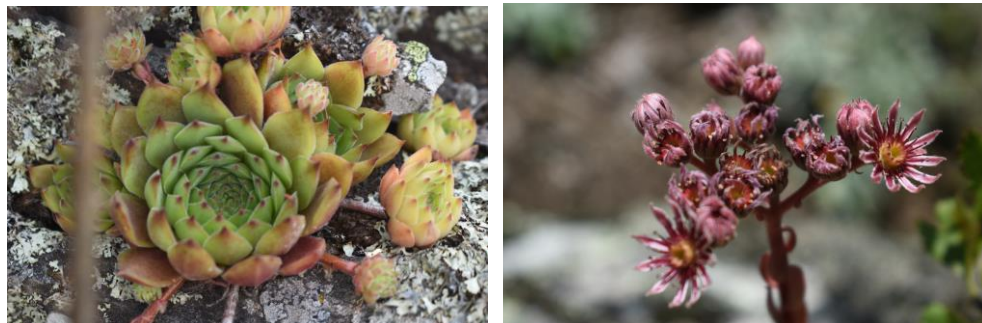


Figure 2. *Sempervivum marmoreum* Griseb. Wild in Tarnița Peak, Toplița, Harghita County
(Photos by Mădălina BORCĂ, 2022)

Jovibarba globifera (L.) J. Parn. (figure 3) is a spontaneous and perennial species in Romania, with yellow flowers. Phytochemical analysis of dry and fresh leaves led to the isolation of 7 flavonoids with biological activity, mainly of an antioxidant nature (Szewczyk et al., 2014).



Figure 3. *Jovibarba globifera* (L.) J.Parn. Wild in Botanical Reserve 'Piatra Roșie' from Tulgheș, Harghita County
(Photos by Mădălina BORCĂ, 2022)

Rhodiola rosea L. (figure 4) is a perennial, succulent, dioecious plant with yellow flowers, traditionally used as an adaptogenic compound (Pârvu, 2000). It grows sporadically in the mountains area of Romania. About 140 chemical compounds have been isolated from the root and rhizome, including glycosides, flavonoids, and gallic acids. *Rhodiola rosea* extracts can reduce stress levels and fatigue, symptoms of depression and can be used in the management of diabetes, having a hypoglycemic effect (Panossian et al., 2010).



Figure 4. *Rhodiola rosea* L.
(Draw by Mădălina BORCĂ, 2022)

Sedum spurium M. Bieb. (*Phedimus spurium*) (figure 5) is a succulent, perennial plant with simple alternate leaves and pink flowers that are appearing from spring to autumn. It is frequently cultivated, sometimes subsponaneous, in Romania. Phytochemical analysis of the essential oil extracted from *Sedum spurium* led to the identification of 35 chemical compounds with moderate antimicrobial activity (Yaylı et al., 2010).



Figure 5. *Phedimus spurius* M. Bieb. Wild in Hodoșa, Mureș County
(Photos by Mădălina BORCĂ, 2022)

Sedum sarmentosum Bunge (figure 6) is a perennial plant with thin, creeping, and rooted shoots, broadly oblanceolate or lanceolate to linear leaves, bracteate inflorescences, dense cymes or corymbs, 5-merous subsessile or sessile flowers, sepals basally united, broadly sessile often unequal, petals sometimes slightly connate at the base, lanceolate to elongated, yellow (ICN, 2003). Following the biochemical studies carried out on *Sedum sarmentosum* extracts containing sarmentosin, the hepatoprotective and anticancer effect of this plant was demonstrated, based on an experimental model, carried out on laboratory mice. At the same time, a significant reduction of apoptotic hepatocytes and even prevention of liver failure was noted (Huang et al., 2010). In Romania, this species has a wide ornamental distribution, being frequently cultivated.



Figure 6. *Sedum sarmentosum* Bunge
(Draw by Mădălina BORCĂ, 2022)

Conclusions

Beyond their overwhelming beauty, plants from the Crassulaceae family present a series of biological properties that can be used in alternative medicine, thus improving the daily life of humanity. Some botanical genera of interest in the field of phytotherapy are *Sedum*, *Aeonium*, *Crassula*, *Echeveria*, *Kalanchoe*, *Rhodiola*, and *Sempervivum*. Within them, phytochemical studies led to the isolation of several chemical compounds such as flavonoids, sterols, and bufadienolides, which determine important biological activities from a therapeutic point of view, among which we mention antioxidant, hepatoprotective, hypoglycemic, antimicrobial, anticancer, analgesic, antistress. Thus, viewed from a medicinal perspective, these succulent plants present an interesting curative potential in the prophylaxis and treatment of some pathologies, at the same time helping to develop specialized phytotherapeutic and biochemical studies.

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