Nature & Science
February 2026, Vol. 8, Issue 1, pp. 21–27
DOI: https://doi.org/10.36719/2707-1146/64/21-27

A Review of Research on *Prangos acaulis (D.C.)* Bornm.

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Abstract. *Medicinal plants occupy an important place in both traditional and modern medicine as rich sources of biologically active compounds. Among these plants, Prangos acaulis (D.C.) Bornm. has attracted the attention of researchers due to its diverse pharmacological effects. The plant has long been used in folk medicine for the treatment of various diseases, which has increased scientific interest in investigating its chemical composition and biological activity. The aim of this review article is to systematically summarize and analyze the existing scientific literature on the traditional uses, phytochemical composition, and pharmacological properties of Prangos acaulis (D.C.) Bornm. The article examines the findings of recent phytochemical, laboratory-based, animal model, and limited clinical studies. Overall, the available data indicate that Prangos acaulis (D.C.) Bornm. possesses significant therapeutic potential and may serve as a promising natural source for the future development of new pharmaceutical agents.*

Keywords: *Prangos acaulis (D.C.) Bornm., biologically active compounds, pharmacological activity, therapeutic potential, scientific review*

Introduction

Medicinal plants represent one of the oldest forms of medicine and have been used in traditional healthcare systems for thousands of years in many countries around the world. Empirical knowledge of their beneficial effects has been transmitted across generations within human communities (Marrelli, 2021). For many years, plant-based medicines have served—and continue to serve—as a primary source of medical treatment in developing countries. Owing to their natural antiseptic properties, plants have long been utilized for therapeutic purposes in medicine. Accordingly, research has expanded toward investigating the potential properties and applications of aerial plant extracts for the development of nanomaterial-based drugs, including those targeting diseases such as cancer (Greenwell, 2015). Medicinal plants are rich sources of numerous bioactive compounds, including alkaloids, flavonoids, terpenoids, phenolic compounds, and essential oils.

Plant-derived alkaloids constitute one of the largest and most diverse groups of natural compounds. This class comprises approximately 12,000 naturally occurring substances. The principal distinguishing feature of alkaloids is the presence of a basic nitrogen atom in some part of the molecule; however, nitrogen atoms involved in amide or peptide bonds are not included in this definition. Owing to this broad definition, alkaloids are characterized by considerable structural diversity and are often biologically unrelated in terms of their origin. A significant proportion of these compounds exhibit strong biological and pharmacological activities (Bribi, 2018).

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Received: 21 October 2025; Accepted: 6 January 2026; Published online: 25 February 2026

Flavonoids constitute a large subgroup of secondary metabolites and are classified as phenolic compounds. These substances are widely distributed in plants and prokaryotic organisms. To date, more than 6,500 flavonoids have been identified. Flavonoids protect plants against various biotic and abiotic stress factors, exhibit a wide range of biological functions, and play a crucial role in interactions between plants and their environment. They absorb harmful ultraviolet (UV) radiation, thereby preventing cellular damage. Although flavonoids are not considered essential for plant survival, they are biologically active and influence the transport of the plant hormone auxin. In addition, flavonoids play a key role in flower color formation and in protecting plants against microorganisms and insects (Samanta et al., 2011).

Terpenoids are considered one of the most important classes of natural compounds synthesized by various genera of plants, fungi, algae, and sponges. Due to their wide range of therapeutic applications, these substances have held great pharmaceutical significance since ancient times. For example, the aromatic leaves of eucalyptus trees are recognized as a rich source of terpenoids. Among the numerous pharmacologically valuable terpenoids, this article reviews both well-studied and relatively recently discovered examples and discusses their medical applications (Jaeger & Cuny, 2016).

Phenolic compounds are secondary metabolites present in plants and play an important role in plant stress tolerance. Their structure consists of an aromatic ring and hydroxyl groups, and they are mainly synthesized from phenylalanine. Phenolic substances regulate plant growth and development, seed germination, and also participate in defense mechanisms against infections, intense solar radiation, and other stress factors. A key characteristic of these compounds is their strong antioxidant activity, which is closely related to their chemical structure (Kulbat, 2016).

Essential oils are volatile, complex natural compounds with strong aromas that are synthesized by aromatic plants as secondary metabolites. These oils are typically obtained through steam or hydrodistillation, a method that was first developed by Arab scholars during the Middle Ages. Essential oils are well known for their antiseptic properties (against bacteria, viruses, and fungi) as well as their therapeutic effects. Historically, they have been used in embalming, food preservation, and as antimicrobial, analgesic, sedative, anti-inflammatory, antispasmodic, and local anesthetic agents. Although these properties have remained largely unchanged to the present day, their mechanisms of action—particularly antimicrobial effects—are now better understood. In nature, essential oils play a crucial role in plant defense systems by providing protection against bacteria, viruses, fungi, insects, and herbivores. At the same time, they attract certain insects for pollination and seed dispersal, while repelling others (Bakali et al., 2008).

The pharmacological properties of these compounds—including antibacterial, antioxidant, anti-inflammatory, anticancer, and immunomodulatory effects—are being comprehensively investigated in modern scientific research (Ahmad et al., 2023).

Prangos acaulis is a perennial plant species belonging to the Apiaceae family and is mainly distributed in mountainous regions. This species is widely found in Central Asian territories, including Iran, and possesses valuable medicinal properties that are utilized in the preparation of various pharmaceutical products (Latif et al., 2025). In the Azerbaijani language, the plant is known as *Chashir*. In traditional medicine, it has been used for its antifungal, antioxidant, and antibacterial effects, as well as for the inhibition of cytokine release, anti-HIV activity, and for tonic, carminative (anti-flatulent), and anthelmintic purposes (Meshkatalsadat & Hadavand, 2007).

Studies indicate that the chitosan-based nanoformulation of the methanolic extract of *Prangos acaulis* significantly enhances cytotoxic activity against HT-29 and MCF-7 cell lines, with these effects observed at lower concentrations compared to the free extract (Latif et al., 2025). In addition, in other

studies, the antibacterial and antibiofilm activities of methanolic extracts of *P. acaulis* have been evaluated, and their potential mutagenic effects have also been investigated. The results obtained demonstrated that the extracts—particularly the root extract—exhibited significant antibacterial activity against the planktonic (single-cell) form of *S. mutans*. Furthermore, it was determined that all extracts inhibited biofilm formation in a dose-dependent manner and exhibited no mutagenic effects. Based on the results of *in silico* analyses, the compounds ar-curcumene, *d*-limonene, and α-pinene were identified as promising candidates for preventing the formation and development of *S. mutans* biofilms. In this regard, *P. acaulis* and its derived products may be considered potential candidates for the development of new pharmaceutical agents (Nosrati et al., 2018). At the same time, GC/MS analyses have revealed that the plant possesses a chemically rich composition in terms of essential oils (Meshkatalsadat et al., 2010). It is worth noting that methanolic extracts obtained from different parts of *Chashir* (*P. acaulis*) have a positive effect on lymphocyte proliferation, and considering the absence of mutagenic (genetic alteration–inducing) effects, this plant may be used as a safe medicinal herb in patients with immunodeficiency (Nosrati & Behbahani, 2015).

Although plants belonging to the genus *Prangos* attract considerable attention due to their rich phytochemical composition and diverse biological activities, systematic review studies summarizing the available scientific data on this genus remain limited. Existing research indicates that the principal secondary metabolites of *Prangos* species are coumarin derivatives, particularly furocoumarins. The potential phototoxic and carcinogenic effects of these compounds highlight the importance of their qualitative and quantitative evaluation. In this context, summarizing the available scientific data on the phytochemical profile, bioactive properties, and traditional uses of the genus may contribute both to a better understanding of the observed biological effects and to the identification of future research directions (Mottaghipisheh et al., 2020).

In this review article, the phytochemical and pharmacological properties of *Prangos acaulis* are summarized within the context of studies conducted on plants belonging to the genus *Prangos*. The main objective of the article is to comprehensively evaluate the therapeutic potential of this species by integrating the available scientific data.

Methods

This review article is based on a comprehensive analysis of the relevant scientific literature. The primary source for the literature search was the Google Scholar database. During the search process, keywords such as *Prangos acaulis* (D.C.) Bornm., biologically active compounds, pharmacological activity, therapeutic potential, and other related terms were used. Primarily peer-reviewed scientific articles published in English were included in the analysis. Data were collected from reliable sources addressing the chemical composition, biological activity, and potential therapeutic effects of the plant.

Botanical and ethnobotanical information

Prangos acaulis is a perennial herbaceous plant covered with dense, short, grayish hairs. The petals are bearded on the outer surface. The stem leaves are small, while the leaves are glabrous or slightly elongated, measuring 8–13 mm in length. The umbels have 5–6 rays. The fruits are elongated and broad, measuring 12–18 mm in length. The flowers of the central umbel sometimes do not produce fruits. The plant reaches a height of 15–40 cm. Flowering occurs in April–May, while fruiting takes place in May–June. It is a xerophytic plant. It is distributed in plains and low mountainous areas, occurring on gypsum- and clay-rich soils as well as in dry ravines (Alikhanova, 2022). The young shoots and leaves have been found to contain 60 mg/% ascorbic acid, 15.03–16.95 mg/% monosaccharides, 2.94–4.01 mg/% sucrose, 14–22.02 mg/% cellulose, various protein compounds, and 0.7–5.02 mg/% lipids. The plant is included in the Red Book (Red Data Book). In Azerbaijan, the species is mainly found in the Nakhchivan Plain and the mountainous regions of Nakhchivan, and is most frequently observed in the Unuschay Valley, the Yeddibulag area, and the foothills of the

Soyutdag and Horkhart ranges (Gasimov et al., 2018). Globally, it is widely distributed from Iran to India and is also found in Turkey. In traditional medicine, it has been used as an emollient, carminative, and anti-flatulent agent (Meshkatalsadat et al., 2010).

Phytochemical composition

Phytochemical investigations have shown that *Prangos acaulis* (D.C.) Bornm. is rich in a variety of biologically active compounds. Studies have demonstrated that the essential oils obtained from the stems, leaves, and flowers of the plant possess a rich and diverse chemical composition. Specifically, in the essential oil obtained from the stem, 3-ethylidene-2-methyl-1-hexen-4-yne was the predominant component, accounting for 56.8% of the total composition. In the essential oil extracted from the leaves, the major constituents were α-pinene (39.54%), 3-ethylidene-2-methyl-1-hexen-4-yne (37.94%), and α-terpinene (10.9%). In the essential oil obtained from the flowers, the principal components were identified as α-pinene (35.4%), 3-ethylidene-2-methyl-1-hexen-4-yne (23.51%), α-terpinene (17.26%), and limonene (13.64%). GC–FID analysis of the essential oil was performed using a gas chromatograph manufactured by Thermoquest-Finnigan. These results indicate that the essential oils obtained from different organs of *Prangos acaulis* differ in their chemical composition and are rich in compounds with high biological activity (Meshkatalsadat et al., 2007).

Although the available information on *Prangos acaulis* is not limited, it remains incomplete. For example, data on the essential oil composition of the plant have been reported, and information on several other characteristics has also been provided. However, similar to other medicinal plants, *P. acaulis* may be rich in certain microelements, the types and quantities of which have not yet been sufficiently clarified. Likewise, the main groups of bioactive compounds—particularly flavonoids—still require further investigation. Therefore, an accurate evaluation of the biological and pharmacological effects of the plant, as well as a more in-depth characterization of its phytochemical profile, remains an important and necessary area of research.

Biological activity and pharmacological properties

Available scientific studies conducted on *Prangos acaulis* indicate that the plant may exhibit various biological activities, which have been primarily evaluated based on *in vitro* analyses carried out under laboratory conditions. The therapeutic effects of many medicinal plants and vegetables widely used in traditional medicine are largely associated with their phenolic composition and antioxidant compounds. Polyphenolic compounds are defined as substances possessing one or more aromatic rings with hydroxyl groups and are reported to neutralize oxygen-derived free radicals by donating hydrogen atoms or electrons. Studies have identified the antioxidant activity of *Prangos ferulacea*, a species within the genus *Prangos* (Goruh et al., 2007). The rich chemical composition of *Prangos acaulis* suggests that this species may also possess potential antioxidant activity. However, due to the limited number of available scientific studies, drawing a definitive conclusion regarding this property is not considered appropriate at the present stage.

Although studies on the antimicrobial activity of the plant are limited, the available scientific evidence demonstrates that it exhibits a certain degree of antimicrobial effect against microorganisms. In one study, an extract obtained from *P. acaulis* was combined with chitosan-based nanoparticles and was found to exhibit antimicrobial activity against several bacterial strains. Although the plant extract was the primary active component in this analysis, the enhancement of the antimicrobial effect was attributed to the contribution of the nanoparticle system. To confirm the properties of the nanoparticles, analytical techniques such as FTIR, FE-SEM, DLS, and zeta potential measurements were employed (Nostari & Ranjbar, 2022). In another study, the effects of methanolic extracts obtained from the roots and leaves of *Prangos acaulis* against *Streptococcus mutans* were investigated. It was reported that the root extract, in particular, exhibited strong antibacterial and antibiofilm activities and showed effective interactions with glucosyltransferase enzymes. These

findings suggest that the plant represents a promising natural candidate for the prevention of dental caries (Nosrati et al., 2018).

In cytotoxicity-related studies, the cytotoxic effects of a chitosan-based nanoformulation of the methanolic extract of *P. acaulis* against two cancer cell lines—HT-29 and MCF-7—were evaluated using the MTT assay. The results showed that loading the studied extract onto nanoparticles enhanced its efficacy and led to the manifestation of cytotoxic effects at lower concentrations compared to the free (non-nanoformulated) extract. Based on the obtained results, chitosan–extract nanoparticles (Chitosan-Extract-NPs) may be considered suitable candidates for more extensive *in vitro* and *in vivo* evaluation of their anticancer potential (Latif et al., 2025).

As noted above, the results of phytochemical and biological studies conducted on *Prangos acaulis* indicate that the plant is rich in essential oils. Moreover, its chemical composition is closely associated with the exhibition of certain biological activities. The plant possesses considerable biological potential, which is further supported by the results obtained from laboratory-based antioxidant, antimicrobial, and cytotoxicity studies. Nevertheless, the pharmacological properties of *Prangos acaulis*—namely, the mechanisms of action of these biological activities at the level of living organisms, as well as their efficacy and safety profiles—have not yet been sufficiently investigated. In particular, the need for systematic *in vivo* and pharmacological studies remains unresolved in order to determine dose–response relationships, assess potential toxicological risks, and therapeutically substantiate the obtained findings.

Discussion

As previously noted, earlier phytochemical and biological studies conducted on species belonging to the genus *Prangos* have confirmed that these plants possess significant potential in terms of essential oils and coumarin derivatives. The available scientific data on this genus are, undoubtedly, substantial. However, the species *Prangos acaulis* can be considered to have remained outside the scope of a large portion of these studies. Since its recognition has been largely limited to its essential oil composition, this alone is insufficient for a comprehensive understanding of the plant. Although flavonoids and various coumarin derivatives have been extensively identified in other *Prangos* species (Mottaghipisheh et al., 2020), this highlights even more clearly that these compounds have not yet been systematically investigated in *P. acaulis*. Moreover, the fact that most of the reported biological activities of *Prangos* species remain at the *in vitro* level and that their toxicological profiles have been scarcely studied clearly indicates that the use of plants from this genus in traditional medicine has not yet been scientifically substantiated. In other words, comprehensive phytochemical, pharmacological, and safety-oriented studies to be conducted on *Prangos acaulis* are considered essential both for clarifying the potential of this species and for accurately evaluating the overall biological and therapeutic significance of the genus *Prangos*.

Conclusion

In this review article, we have systematically summarized the available phytochemical, biological, and pharmacological studies on *Prangos acaulis*. It can be concluded that the chemical composition of the plant is predominantly rich in essential oils. It is also well established that essential oils obtained from different plant organs possess distinct chemical profiles. Although studies on biological activity indicate that *P. acaulis* exhibits certain biological effects, such as antioxidant, antimicrobial, and cytotoxic activities, it should be noted that these findings are largely based on a limited number of *in vitro* studies conducted under laboratory conditions.

It should be emphasized once again that the phytochemical profile of *Prangos acaulis*—particularly with respect to flavonoids, coumarins, phenolic compounds, and microelements—as well as its

pharmacological mechanisms of action, safety, and toxicological characteristics, has not yet been sufficiently investigated. Future studies should focus on a more detailed characterization of the plant's chemical composition, comprehensive *in vivo* pharmacological and toxicological evaluations, and the establishment of a solid scientific basis for its potential therapeutic applications. In the context of the growing interest in naturally derived bioactive compounds and the search for alternative sources to existing pharmaceuticals, the scientific evaluation of insufficiently studied plants such as *Prangos acaulis* is of considerable relevance. It can be concluded that *Prangos acaulis* represents a promising source of bioactive compounds; however, more in-depth and systematic scientific evidence is required to support its practical application.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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