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BOTANICAL, PHYTOCHEMICAL, PHARMACOLOGICAL OVERVIEW OF WILD GARLIC (*ALLIUM URSINUM*)

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Allium ursinum L. (ramson, wild garlic), is a perennial herb of Allium genus, known for its medicinal uses and recent growing significance in contemporary phytotherapy. Wild garlic (*Allium Ursinum* L.) has long been considered a spring vitamin. Past application of *A. ursinum* exists in the treatment of cardiovascular, gastrointestinal, and respiratory diseases. Current research focuses on its vast phytochemical content - in particular, sulfurous compounds, phenolic acids, and flavonoids - and pharmacological actions, including antimicrobial, antioxidant, and cardiovascular properties. This review summarizes recent data on the botanical, phytochemical, and pharmacological characteristics of *A. ursinum*, with particular attention to its potential in nutraceuticals and therapy.

Keywords: *Allium ursinum L., flavonoids, perennial herb, phenolic acids, sulfurous compounds.*

DESCRIEREA BOTANICĂ, FITOCHIMICĂ ŞI FARMACOLOGICĂ A RAMSONULUI (*ALLIUM URSINUM*)

Allium ursinum L. (ramson, usturoi salbatic), este o plantă perenă din genul Allium, cunoscut pentru utilizările sale medicinale și pentru importanța sa în fitoterapia contemporană. Usturoiul sălbatic (*Allium Ursinum* L.) a fost considerat mult timp o vitamină de primăvară. Aplicațiile anterioare ale *A. ursinum* există în tratamentul bolilor cardiovasculare, gastrointestinale și respiratorii. Cercetările actuale se concentrează pe conținutul său fitochimic extins - în special, compuși sulfuroși, acizi fenolici și flavonoide - și pe acțiunile sale farmacologice, inclusiv proprietățile antimicrobiene, antioxidante și cardiovasculare. Prezentul articol sintetizează datele recente privind caracteristicile botanice, fitochimice și farmacologice ale *A. ursinum*, acordând o atenție deosebită potențialului său în nutraceutice și terapie.

Cuvinte-cheie: *Allium ursinum L.*, *flavonoide, plantă perenă, acizi fenolici, compuşi cu sulf.*

Introduction

Vegetable crops are of great importance in human life. They contain useful biologically active substances, including vitamins. Important vegetable crops also include wild onions.

Wild garlic (*Allium Ursinum* L.*)* has long been considered a spring vitamin and has been used in traditional medicine. However, studies on its chemical compositions and pharmacological activity are fairly recent. The medicinal properties of *Allium ursinum* have been traditionally used in European medicine for a long time, especially for cardiovascular and digestive properties. The plant is receiving a scientific attention and studies have shown the presence of sulfur compounds (allicin, alliin), phenolic acids, and flavonoids, which have been shown with medicinal activity. The growing interest on plant-based therapies has driven studies of bioactive constituents and pharmacological actions of *A. ursinum*. The fresh extracts of Allium species as potential in vitro agents against planktonic and adherent cells of Candida spp. [1].

This review aims to provide a comprehensive analysis of *A. ursinum,* evaluating its botanical properties, phytochemical profile, and pharmacological effects, and exploring its potential applications in modern therapeutic practices. And to summarize the most important aspects related to *A. ursinum* and provide an outline of phytochemical and pharmacological properties of this plant. The plant contains four times more sulphur compounds than garlic [2].

Allium ursinum L., known us ramsons, bears garlic, cowleekes, broad-leaved garlic, wood garlic is a herbaceous perennial flowering plant belonging to a species of the genus Onion, subfamily Onionaceae, the Alliaceae family. The Latin specific name «*ursinum»* translates to ‘bear’ and refers to the supposed fondness of the brown bear for the bulbs; folk tales describe the bears consuming them after awakening from

hibernation [3].ᵮ One hypothesis is discussed that *Allium ursinum* may have been one of the best-known northern species of this genus to the ancient Greeks. The species was determined by the famous Swedish scientist Carl von Linné in volume I of his great work Species Plantarum in 1753 [4].

This perennial plant growing on fertile soil in shady, humid places and preferably under leafy trees in some regions of Europe and in the northern hemisphere of Asia.

A. ursinum L. is very common in deciduous forests at an altitude of one thousand meters above sea level, especially in beech forests all over the world. In addition to its growth in the forests of the Republic of Moldova, currently, this culture is grown farmers and private individuals on plots near their homes or in the field [5]. In Republic of Moldova, the ramson is much appreciated, as well as in Canada and all over Europe [6]. Turmeric is very nutritious and deserves a separate story about itself.

It is worth noting that wild garlic is listed in the Red Book of the Republic of Belarus due to unlimited collection and trampling [7].

Description

Vegetative characteristics

Ramson is a perennial plant and can stay in one place for several years. It forms large colonies in cool undergrowth or along streams. The stem is triangular, leafless, 20-50 cm high.

Seeds need cold stratification (about 100 days) and must pass a period of frost (0-(-3) °C) before germinating [8]. Seed germination is subterranean in the year of formation in the fall or spring and do not survive long in the soil. The seeds germinate in the year of formation in autumn or spring and do not survive in the soil for long. Seed germination is underground.

The very slender, elongated onion, with a diameter of about 1 cm, is formed from near the two leaves, having 2 to 4, rarely up to 6 cm long. It is covered by transparent, whitish or yellowish scales which are later reduced to a few bristles. Lateral bulbs are formed only sporadically or are completely absent. The erect, compact inflorescence peduncle is triangular to almost round and leafy only at the base. Mostly two, rarely one or three basal leaves have a 5-20 mm long stem that suddenly widens into flat, elliptic-lanceolate and long-petiolate limbs, 2-5 cm wide. The upper part of the leaf is shiny and darker green, the lower part is dull. When its foliage is slightly crumpled, it emits a strong, characteristic garlic smell [8].

In spring, the first green leaf of the sprout appears above the soil, covered with a membranous sheath. By the end of the first year of vegetation, the cotyledon connective dries up and the seed covers fall off; the cotyledon sheath forms the shell of the young bulb, and the base of the green leaf forms its storage scale; later, new thin roots appear [9].ᵮ

Juvenile plants in the second year of life still retain the main root, the leaves reach 8-10 cm in length; the bulb is short, almost spherical, round in cross section. Most of the roots that appear in the spring are thickened, growing downwards, deep into the soil. In the second year of the plant›s life, the main root dies. In adult vegetative specimens, the length of the leaf is 30-40 cm, their bottoms lie at a depth of 5-8 cm. The transition to the generative age state in bear›s onion is associated with a significant restructuring of the structure. The bulb becomes sympodial, biaxial, in the above-ground part the plant bears two, and later often three green leaves. In this age state, vegetative reproduction becomes possible. The plant is ready to reproduce (by seeds and vegetative) in the fourth year of life.

Generative characteristics

The leaves: are basilar, convex, with a single main vein, long petiolate, 20 cm long, elliptic lanceolate, 5-7 cm wide, dark green on the upper side and light green on the lower side. The top is shiny, the bottom is matte. The venation is parallel, more prominent beneath. It gives off a strong smell of garlic. Harvest the tender, young leaves in March and April in condition Republic of Moldova, before flowering, as their aroma begins to decline, and later develop a bitter taste as the plant begins to flower [10].

The flowers: small, whitish, hexapartite with a short pedicel are grouped in umbels of 15-20 flowers, small, white, bloom in the months of April-May which are edible being eaten raw like the leaves, being hermaphrodite - they have both male and female organs. They are pollinated by bees and other insects.

Bulbs: ensure the survival of the plant from one year to the next. Each bulb develops a single basal leaf which is narrow, elongated, edible, collected in September and October, eaten raw or cooked, often used as a substitute for capers (*Capparis spinosa*). The coloring is green [11].

Fruit: It is a small capsule with black seeds (3 seeds).

The total life cycle of the bear's onion, a vegetative perennial, is difficult to establish.

Life Cycle and Reproductive Strategy

Allium ursinum is a geophyte, i.e., it finishes most of the life cycle in the ground. In Winter the plant is in dormancy in bulbous state from where it accumulates reserves to ensure fast growth in early spring before the canopy forest is dense enough. The current period of intense growth enables *A. ursinum* to capture as much light and accumulate as much of the available resources as possible before shading becomes a factor due to the growing tree canopy [12].

The plant propagates primarily through vegetative reproduction, forming daughter bulbs from the parent plant, a strategy that enables it to quickly colonize suitable environments [13]. These daughter bulbs are attached to elastic roots which can be contracted to drag the bulbs in the soil deeper where they enjoy stability and protection from stress factors. This vegetative strategy is complemented by sexual reproduction; *A. ursinum* produces black, rounded seeds encased in trichotomic capsules, which disperse by gravity and can be transported by water or animals, facilitating genetic diversity and distribution across forested areas.

Seasonal rhythm of development

The bear's onion is an ephemeroid; its above-ground organs die off soon after flowering and fruit ripening. There is a distinct period of summer dormancy, when there is no visible growth and there are no assimilating organs. The shoot of the next year is fully formed in the renewal bud in the fall; the growth of leaves and flower stalks in the spring occurs simultaneously [14].

In the conditions of the Republic of Moldova, green shoots of the bear›s onion appear above the soil surface in February-March. During this period, the roots, leaves grow and flower stalks stretch out simultaneously; by the end of March, growth ends. Flowering occurs in May-June; its duration varies greatly depending on weather conditions. Fruit ripening occurs in August [10].

Geographical distribution and ecological importance

Wild garlic is distributed in almost all of Europe, except the Mediterranean sempervire-scent region and (Great Hungarian Plain) to Western Asia (Asia Minor, Caucasus). It grows at altitudes from sea level up to 1900 meters, so also in especially in the forests of Muntenian, Transylvania (Romania), also in the Republic of Moldova, preferring bushes and moist forests and shady deciduous (hornbeam, beech, ash, oak), with rotten foliage, littered on loose, humus-rich and weakly acidic soils [15]. Ecologically, *A. ursinum* plays a significant role in woodland biodiversity. The plant produces tight carpets, which frequently go on to become the dominant ground cover of its ecosystem. This dominance enables it to effectively obtain resources and hence play a key role in the distribution of the remaining species in the ecosystem [10].

Wild garlic is commonly located in the shady, more humid areas of deciduous forests in the Republic of Moldova, where it grows on nutrient-rich well-drained soils. As in the other regions of its native range, *A. ursinum* is a dense ground cover plant in Moldovan woodlands, creating a green sward in early spring. This dense growth pattern is facilitated by the plant's capacity for vegetative propagation through contractile roots, which enable the formation of daughter bulbs, allowing it to spread rapidly under favorable conditions [16]. Across the forested regions of Republic of Moldova, *A. ursinum* is adapted to the low levels of light and high levels of humidity that prevail in the canopy of mature multi-layered forests which are principally composed of oaks, beech and hornbeam trees.

From an ecologically, there is a dense stand of ramson that stabilizes the soil, and it also serves as a regulator of understory community composition, which at times overshadows any other ground flora by light and nutrient competition because of its early spring growth. In Republic of Moldova, as in other areas of Eastern Europe, *A. ursinum* is valued for its role in maintaining woodland biodiversity, where it sup-

ports the ecological balance by providing a habitat for various insect species and contributing to the forest's overall health [10].

Conservation of *A. ursinum* in Republic of Moldova is a focus for biodiversity preservation, as its habitats are sensitive to deforestation and changes in land use. Sustainable harvesting methods are also promoted to avoid overexploitation because the plant is in demand for both culinary and medicinal purposes [17]. This ecological importance highlights *A. ursinum's* role in Moldova's forest ecosystems, where it not only supports biodiversity but also contributes to the resilience of these natural landscapes.

Phytochemical composition

The medicinal properties of *A. ursinum* are mainly due to a rich phytochemical profile containing sulfur compounds, phenolic acids, flavonoids and essential oils [18]. These compounds present a wide range of bioactive activity, and therefore, the plant is potential for use as a medicine. Wild garlic has a characteristic bright aroma, due to the content of essential oils. The smell of garlic is given by the organic compound allicin, which is formed during the mechanical destruction of plant cells. Allicin is an organic compound, a sulfoxide.

Sulfur compounds

Most important ramson's constituents are sulfur componts, polyunsaturated fatty acids are antioxidant. These include antimicrobial, antithrombotic, antitumor, hypolipidaemic, antiarthritic and hypoglycemic activities. Sulfur compounds (allicin, alliin, methiin) play a crucial role in *A. ursinum's* therapeutic activity. Plant tissues rupture and allicin is synthesized by enzymatic breakdown of alliin, with pronounced antimicrobial and antioxidant properties. Seasonal fluctuation influences the levels of these compounds, higher levels being identified in spring. The sulfur-profile of *A. ursinum* is in agreement with that of cultivated garlic and it plays a main role in the characteristic smell and bioactivity [19].

Phenolic Compounds and Antioxidants

Apart from sulfur-containing substances in fresh leaves and bulbs of wild garlic has been also reported to be a good source of phenolic compounds, sulfhydryl, methylthiosulfate, methylcysteine, sulfoxide,meth ylallylthiosulfat, methanethiol [20].

The phenolic compounds present in *A. ursinum*, including p-coumaric and ferulic acids, are potent antioxidants that play a role in reducing oxidative stress. Research indicates that these molecules show considerable free radical scavenge activity when extracted with methanol or ethanol, which would be of interest for nutraceutical applications. Both antioxidants are represented in significant amounts and their activities are necessary to neutralize oxidative stress.

Essential oil

A. ursinum L. contain a significant amount of essential oil, and phytoncides in the leaves.

Ramson is a species from which essential oils with sulfur-containing volatile substances (e.g., diallyl disulfide and methyl-allyl thiosulfinate) are present, and which therefore exert that antimicrobial effect. These oils have also demonstrated potential as natural food preservatives (their ability to suppress microbial growth has been reported in as antimicrobials) [21].

The basis of the action is attributed to the sulfur containing essential oil, the antibacterial action is due to mustard oils (glycosides). Also, bulbs, roots and leaves contain lectins. The bulbs are also rich in polysaccharides, a number of fatty acids (palmitic, linoleic oleic, palmitoleic, stearic, a-linolenic, and myristic acid). Ramson leaves seem to be relatively abundant in pigments - 2.87 ± 0.03 mg/g of chlorophyll [22].

The plant is rich in essential nutrients such as vitamins A, C (three times more than in oranges) and E, K, H (biotin), calcium, iron, phosphorus, sodium, copper, zinc, selenium and magnesium.

French scientist Bernard Bertrand conducted an interesting study comparing some minerals of wild and cultivated garlic. Comparative analysis showed that wild garlic contained higher levels (Table 1) [23]. He same applies to other microelements and vitamins.

Table 1. Comparative analysis of minerals content of wild and cultivated garlic

Minerals	Cultivated garlic mg/100 g	Raspberry leaf mg/100 g	Raspberry bulb mg/100 g
Sulfur (S)	200	83.2	1000-2835
Nitrogen (N)	-	4016	405
Phosphorus (P)	153	333	127

Per 100 g of fresh wild garlic contains:
- ✓ Proteins – 2.5 g
- ✓ Fats – 0.5 g
- ✓ Carbohydrates – 7 g
- ✓ Water – 92 g
- ✓ Dietary fiber – 2 g

Pharmacological properties

Pharmacological properties of wild garlic have been well characterized, showing diverse bioactive activity, most notably its antimicrobial, antioxidant and cardio protective activity. Its therapeutic applications have given it value in both "traditional" and "modern" medicine. Following is a review of the major pharmacological effects of *A. ursinum.*

Antioxidant Effects

Antioxidant activity of the constituent of *A. ursinum,* such as flavonoids, phenolic acids, and sulfur compounds, with special attention on allicin, is important. These bioactive molecules play a key role in neutralizing free radicals and reducing oxidative stress, which is a major contributing factor to chronic diseases such as cardiovascular disorders, diabetes, neurodegenerative conditions, and cancer [24].

The strong antioxidant activity of *A. ursinum* has been exploited in the formulation of nutraceuticals, functional foods, and dietary supplements with the objective of reducing oxidative stress and preventing age-related disorders. In particular, the oxidative stress-reducing properties of wild garlic have been recognized for their role in supporting cardiovascular health and preventing the progression of atherosclerosis and other vascular diseases [25].

Further, the plant's antioxidant nature points to its potential as an adjunctive therapy in inflammatory diseases, when oxidative stress promotes the disease pathophysiology. Therefore, *A. ursinum* may have a significant contribution in the advance of natural products for the purpose of health maintenance and longevity.

Cardiovascular Benefits

Allium ursinum has a well-documented history of use in traditional medicine for its cardiovascular benefits, including its ability to lower blood pressure and reduce cholesterol levels. Modern pharmacological studies have confirmed these benefits, with ramson demonstrating significant effects in improving vascular health. Compounds present in the plant, for example allicin, play a role in the plant's ability to increase plasma levels of nitric oxide (NO), which in turn promotes vessel dilation and enhance endothelial function.

All of this due to the promotion of Nitric Oxide (NO) production by *A. ursinum*, which contributes to maintaining the integrity of blood vessels and to the prevention of hypertension and atherosclerosis [26].

Studies have shown that consumption of wild garlic extracts leads to reductions in systolic and diastolic blood pressure in animal models, while human studies indicate its potential to lower blood pressure and improve lipid profiles. These influences have potential in making *A. ursinum* a natural therapeutic for the control of hypertension and prevention of cardiovascular diseases, in line with traditional therapeutic use in treatment of circulatory disorders.

The cholesterol-lowering effects of *A. ursinum* are thought to be related to its ability to regulate lipid metabolism, possibly through the inhibition of cholesterol synthesis and the enhancement of its excretion [27].

Cytotoxic and Anticancer Potential

Recent studies have underscored the cytotoxic and anticancer actions of *A. ursinum*, and preliminary evidence indicates that its extracts can also cause apoptosis in human cancer cells and exert inhibitory effects on tumour growth. Allicin, along with other flavonoids and sulfur compounds, has shown promise in reducing the viability of cancer cells in vitro, with potential effects on various cancer types, including breast, colon, and liver cancer cells.

The anticancer activity of *A. ursinum* may be explained by its multifaceted phytochemical mixture, which acts in synergy targeting various levels of cancer cell biology. Nevertheless, deeper clinical trials are still required to prove its effectiveness and to clarify the molecular mechanisms of action. This may result in the creation of wild garlic-based therapeutics as an adjunctive treatment strategy [28].

Traditional and Modern Applications

The traditional uses of *A. ursinum* include treatments for digestive issues, respiratory ailments, and cardiovascular disorders. In modern applications, the plant's extracts have been incorporated into a variety of products, including nutraceuticals, functional foods, and natural preservatives, thanks to its antimicrobial and antioxidant properties [29].

With the growing consumer demand for natural health products, *A. ursinum* has gained recognition as a promising ingredient for dietary supplements that target cardiovascular health, immune support, and overall well-being. The growing body of scientific evidence supporting its medicinal effects continues to drive its popularity, and it is increasingly being used in natural remedies for conditions such as high blood pressure, high cholesterol, and chronic inflammation.

As research into the pharmacological properties of *A. ursinum* expands, it is likely to find even broader applications in the field of holistic health, offering a safe and effective natural option for promoting wellness and preventing disease [30].

Traditional and ecological background of *Allium ursinum* in Republic of Moldova

Historically, *A. ursinum* has been part of Moldova's rich botanical heritage, utilized both for culinary and medicinal purposes. The plant's presence in the wild, particularly in temperate forest ecosystems, aligns with Moldova's biodiversity-rich landscapes, where it has been traditionally foraged. It has also been integrated into ancient medicine, prized for antimicrobial, antioxidant and cardioprotective activities [31]**.** These applications highlight ramson`s possible value in the current state of affairs, not only for the human health, but also as an ecological product in agricultural contexts. In the context of the transition towards more sustainable agricultural practices in Republic of Moldova*, A. ursinum* has potential to contribute greatly in improving agro ecosystem health and resilience.

Agroecological Role of *Allium ursinum* in Republic of Moldova

Soil Fertility and Conservation

One of the main ecological benefits that is offered by the production of *A. ursinum* in Republic of Moldova is its capacity to promote soil health and soil protection. *A. ursinum's* fibrous root system and the organic matter contributed by its decaying biomass can improve soil structure, enhance water retention, and reduce erosion. Since Republic of Moldova is a country with a significant risk for soil degradation and erosion in some parts of the country, especially around intensive agricultural activities, the growing of *A. ursinum* may offer a natural way to ameliorate soil health [31]. Shady-environment plant growth suits the plant well for use in agro forestry systems, which can be introduced into the agricultural practices of Republic of Moldova to sustain land productiveness and ecological balance in the long-term [10].

Agroforestry Systems

The climate of Republic of Moldova in its temperate nature and good soil leads to the possibility of integrating *A. ursinum* in agroforestry systems (e.g., agroforestry, which combines the cultivation of trees with other crops, provides multiple ecological benefits, including enhanced biodiversity, improved carbon sequestration, and reduced soil erosion [31].

The ability of wild garlic to thrive under partial canopy conditions makes it an excellent candidate for cultivation in agroforestry systems alongside fruit trees, timber species, or in riparian zones. This practice not only supports the restoration of degraded lands but also aligns with the country›s goals of fostering more resilient and diverse farming systems.

Natural Pest Management Applications

Antimicrobial and Antifungal Properties

The antimicrobial and antifungal properties of *A. ursinum* are attributed to sulfur-containing compounds, particularly allicin, which have been shown to possess potent bactericidal, fungicidal, and insecticidal effects [32]. These features place ramson as a valuable candidate for natural pest control in moldavian agriculture.

The application of *A. ursinum* extracts as natural biopesticides may help to decrease the use of synthetic chemicals, many of which are toxic to both the environment and human health. Here, *A. ursinum* might be utilized in integrated pest management strategies, the goal of which is to suppress pest populations using ecological tools instead of merely chemical control.

Economic Viability and Market Potential

The growing consumer interest for natural, organic and functional foods makes an economic opportunity for Moldavian lands of cultivation of *A. ursinum*. As a high-value crop with both culinary and medicinal uses, ramson can be marketed for its fresh leaves, which are commonly used in salads, soups, and sauces, as well as its processed forms, such as dried herbs or extract products ⟦31⟧.

Sustainability and Ecosystem Services

The introduction of *A. ursinum* to Moldovan agricultural systems is in line with Moldovan’s focus on sustainable agriculture and enhancement of ecosystem services. When cultivating wild garlic in agro ecological systems, Moldovan farmers could help achieve soil regeneration, biodiversity increase, and adaptation to climate change. Agroforestry systems with ramson has potential for carbon sequestration, enhanced water use, and fewer need for synthetic fertilizer and pesticide [10].

Future Research and Policy Implications

For the complete exploitation of agricultural possibilities of *A. ursinum* in Republic of Moldova, there is still a need to further investigate in the optimization of cultivation such as the establishment of the most efficient procedures for mechanised planting, harvesting and processing. Research should also address the plant’s role in crop rotation systems, its contribution to soil health, and interaction with other plant species in agro forestry systems.

Conclusion

Allium ursinum is a plant with high medical and nutritional value based on its abundant phytochemical profile and respective bioactivities. Its sulfur, phenolic acid, and flavonoid content, which mediate its pharmacological activity, has strong antimicrobial, antioxidant and cardiovascular activities.

Botanical and Ecological Significance

Because of its dense ground covering, *A. ursinum* plays an important role in forest biodiversity and the vegetative reproduction of the plant allows for easy spread. Studies by Błażewicz-Woźniak et al. describe its extensive vegetative propagation, in which contractile roots allow resulting daughter bulbs to form large colonies [33]. This ecological resilience is a testament to the importance of the plant in forest ecosystems, but also points to the importance of conservation during a period of increasing demand.

Therapeutic Potential and Future Directions

The observed antimicrobial, antioxidant and cardiovascular activities of wild garlic strongly support its application in contemporary therapies. Cardiovascular effects (e.g., blood pressure, cholesterol decrease) fur-

ther support the ancient claims and highlight its cardioprotective effect. Initial cytotoxic assays indicate the possibility of *A. ursinum* as a supportive anticancer therapy, but clinical studies are needed to confirm this.

Allium ursinum possesses both potential therapeutic activities and complex bioactivities and adaptiveness. Its incorporation into nutraceuticals and functional foods is an exciting route towards natural health products.

Bibliography:

1. Chudzik, B., Malm, A., Rajtar, B. et al (2010). *The fresh extracts of Allium species as potential in vitro agents against planktonic and adherent cells of Candida spp. Ann Univ. Maria Curie-Sklodowska, DDD Pharm* 23(1):73–78.
2. Benkeblia, N., Lanzotti, V. (2007). *Allium thiosulfinates: chemistry, biological properties and their potential utilization in food preservation. Food* 1(2):193–201.
3. Abu-Lafi,S, Dembicki, J., Goldshlay, P, Hanus, L., Dembitsky, V. (2004). *The use of the "Cryogenic" GC/MS and on-column injection for study of organosulfur compounds of the Allium sativum. Journal of Food Composition and Analysis*, *17*, 235-245.
4. Copra-Janicijevic, A., Muradic, S., Huseinovic, S. et al (2008). *Isolation of essential oils of Allium ursinum L. from Bosnia. Planta Med* 74:PI42.
5. Gıˆtin, L., Dinica,˘ R., Parnavel, R. (2012). *The influence of extraction method on the apparent content of bioactive compounds in Romanian Allium spp. leaves. Not Bot Horti Agrobot Cluj Napoca* 40(1):93–97.
6. Leporatti, M., Ivancheva, S. (2003). *Preliminary comparative analysis of medicinal plants used in the traditional medicine of Bulgaria and Italy. J Ethnopharmacol* 87:123–142.
7. *Krasnaya kniga Rossijskoj Federacii. [Red Book of the Russian Federation]. (2008). Rasteniya i griby.* M.: KMK. 885 s.
8. Kujumgiev, A, (2013). *Maine Department of Agriculture, Conservation and Forestry. Maine rare plant list and rare plant fact sheets. Allium canadense*. http://Maine.gov.
9. Abbas, M., Anwar, J., Zafar-ul-Hye, M., Khan, R. I., Saleem, M., Rahi, A. A., Danish, S., & Datta, R. (2020). *Effect of seaweed extract on productivity and quality attributes of fouĸ onion cultivars*. *Horticulturae*, *6*(2), Article 28.
10. Ghendov, V. Izverscaia, T. Ciocarlan, N. (2017). *Rare vascular flora and medicinal plant resources of «Saharna» landscape reservation in Republic of Moldova. Journal of Botany*, 9(2), 15. CZU 58.006: 502.75:581.:6 15.32(478). https://ibn.idsi.md.
11. Govaerts, R. (2011). *World checklist of selected plant families. Royal Botanic Gardens*, Richmond, Surre.
12. Seregin A., Anackov G., Friesen N. (2015). *Molecular and morphological revision of the Allium saxatile group (Amaryllidaceae): geographical isolation as the driving force of underestimated speciation. Botanical Journal of the Linnean Society.* № 178(1). S. 67–101.
13. Błażewicz-Woźniak, M. et al. (2011). *Flowering of bear garlic (Allium ursinum L.) cultivated in the field at varied nitrogen nutrition and mulching. Acta Scientiarum Polonorum Hortorum Cultus*, 10(3), 133–144.
14. Golubkina, N. i dr. (2012). *Osobennosti formirovaniya urozhaya i akkumulyacii selena v luke pobednom (Allium victorialis L.) i luke medvezh'em (Allium ursinum L.). [Characteristics of yield formation and selenium accumulation in victorious onion (Allium victorialis L.) and bear onion (Allium ursinum L.). // Izvestiya Timiryazevskoj sel'sko-hozyajstvennoj akademii*. № 6. S. 80–86.
15. Chase, M., Reveal, J., Fay M. (2009). *A subfamilial classification for the expanded asparagalean families Amaryllidaceae, Asparagaceae and Xanthorrhoeaceae. Bot J Linn Soc* 161(2):132–136.
16. Leahu, A., Damian, C., Oroian, M., Juravle, L., & Ropciuc, S. (2015). *Physico-chemical and antioxidant properties of two medicinal wild plants grown in Moldova region. Scientific Papers: Animal Science and Biotechnologies,* 48(1). https://mail.spasb.ro/index.php/public_html/article/view/299.
17. Condrat, D., Mosoarca, C., Zamfir, A. et al (2010). *Qualitative and quantitative analysis of gallic acid in Alchemilla vulgaris, Allium ursinum, Acorus calamus and Solidago virga-aurea by chip-electrospray ionization mass spectrometry and high-performance liquid chromatography. Cent Eur J Chem* 8(3):530–53.5.
18. Luta, G.; Gherghina, E.; Balan, D.; Israel-Roming, F. *Bioactive Compounds and Antioxidant Properties of Some Wild Plants with Potential Culinary Uses. Rev. Chim.* 2020, 71, 179–184. [CrossRef].

19. Lyantagaye, S. L. (2011). *Ethnopharmacological and phytochemical review of Allium species (sweet garlic) and Tulbaghia species (wild garlic) from Southern Africa. Tanzania Journal of Science*. 37: 58-72.
20. Rose, P., Whiteman M., Moore P., Zhu Y. (2005). *Bioactive S-alk(en)yl cysteine sulfoxide metabolites in the genus Allium: the chemistry of potential therapeutic agents. Natural Product Reports*, 22, 351-368.
21. Leuschner, C., Lendzion, J. (2009). *Air humidity, soil moisture and soil chemistry as determinants of the herb layer composition in European beech forests. J Veg Sci* 20:288–298.
22. Schmitt, B., Glodek, J., Keusgen, M. (2002). *Ontogenic changes of cysteine sulphoxides in Allium ursinum L. Revista de Fitoterapia 2* (Suppl.1) 224, B020.
23. Colombo, M., Assisi, F., Puppa, T. et al (2010). *Exposures and intoxications after herb-induced poisoning: a retrospective hospital-based study. J Pharm Sci Res* 2(2):123–136.
24. Sengupta, A., Chosh, S., Bhattacharjee, S. (2004) *Allium vegetables in cancer prevention: an overview. Asian Pacific Journal of Cancer Prevention,* 5, 229-230.
25. Kalayarasan, S., Prabhu, P., Sriram, N. et al (2009) *Diallyl sulfide enhances antioxidants and inhibits inflammation through the activation of Nrf2 against gentamicin-induced nephrotoxicity in Wistar rats. Eur J Pharmacol* 606(1–3):162–171
26. Manukyan, K. i dr. (2015). *Farmakognosticheskaya harakteristika list'ev luka medvezh'ego (Allium ursinum L.). [Pharmacological characterisation of leaves of bear onion (Allium ursinum L.)]. Sovremennye problemy nauki i obrazovaniya.* № 3. 255 s.
27. Kao, S-H, Hsu, C-H, Su, S-N et al (2004) *Identification and immunologic characterization of an allergen, alliin lyase, from garlic (Allium sativum). J Allergy Clin Immunol* 113(1):161–168.
28. Wu, C., Sheen, L., Chen, H. et al (2001). *Effects of organosulfur compounds from garlic oil on the antioxidation system in rat liver and red blood cells. Food Chem Toxicol* 39(6):563–569.
29. Parvu, M., Parvu, A., Vlase, L. et al (2011). *Antifungal properties of Allium ursinum L. ethanol extract. J Med Plants Res* 5(10):2041–2046.
30. Ivanova, M. i dr. (2019). *Biohimicheskij sostav list'ev vidov Allium L. v usloviyah Moskovskoj oblasti. [Biochemical composition of leaves of Allium L. species under conditions of Moscow region]. Dos-tizheniya nauki i tekhniki APK.*. T. 33. № 5. S. 47–50.
31. Leahu, A., Damian, C., Oroian, M., Juravle, L., & Ropciuc, S. (2015). P*hysico-chemical and antioxidant properties of two medicinal wild plants grown in Moldova region. Scientific Papers: Animal Science and Biotechnologies,* 48(1). https://mail.spasb.ro/index.php/public_html/article/view/299.
32. Sobolewska, D., Janeczko, Z., Galanty, A., Trojanowska, D. (2003). *Cytotoxic, antifungal and antibacterial activity of spirostanol saponin from ramson Allium ursinum L. Proceedings of the 3rd international symposium on natural drugs.* Naples. 2–4 Oct 2003.
33. Golubkina, N. i dr. (2010). *Soderzhanie biologicheski aktivnyh veshchestv selena, flavonoidov, askorbino-voj kisloty i hlorofilla – v razlichnyh vidah cheremshi. [The content of biologically active substances selenium, flavonoids, ascorbic acid in different types of ramsons]. Voprosy pitaniya.* T. 79. № 1. S. 78–81.

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