

UDC 582.736.3: 502.753
AGRIS F70

https://doi.org/10.33619/2414-2948/105/05

SPECIES OF THE *Onobrychis* GENUS AS PROMISING SPECIES OF AZERBAIJAN FLORA

©*Jafarova Sh.*, ORCID: 0000-0002-8379-9529, Azerbaijan State Agricultural University,
Ganja, Azerbaijan, lala2002@list.ru

ВИДЫ РОДА *Onobrychis* КАК ПЕРСПЕКТИВНЫЕ ВИДЫ ФЛОРЫ АЗЕРБАЙДЖАНА

©*Джафарова Ш. Б.*, ORCID: 0000-0002-8379-9529, Азербайджанский государственный
аграрный университет, г. Гянджа, Азербайджан, lala2002@list.ru

Abstract. One of the tasks of pharmacy is to find affordable raw materials for herbal medicines. The studies were conducted in Azerbaijan. The results of the studies indicate that *Onobrychis* species are a rich source of β -arbutin. Arbutin (4-hydroxyphenyl- β -D-glucopyranoside), a monoglycoside form of hydroxyquinone, has been used in the field of cosmetology for several decades due to its effectiveness in the treatment of hyperpigmentation and removal of freckles. *Onobrychis* species are of significant ecological and economic importance, and also demonstrate intriguing therapeutic properties that have attracted attention in the field of medicine. The presence of bioactive compounds such as flavonoids and phenols, which are known for their antioxidant properties, is another noteworthy aspect. Antioxidants play a crucial role in neutralizing harmful free radicals in the body, which are involved in a wide range of diseases and the aging process. *Onobrychis* has anti-inflammatory properties. It is well known that inflammation is a common factor in many chronic diseases. Plants have antimicrobial, immunostimulating, hypoglycemic, hypocholesterolemic, gastrointestinal tract normalizing and vascular wall strengthening properties. The study of *Onobrychis* opens up potential prospects in the field of creating natural products.

Аннотация. Одной из задач фармации является поиск доступного сырья для фитопрепаратов. Исследования проводились на территории Азербайджана. Результаты проведенных исследований свидетельствуют о том, что виды *Onobrychis* являются богатым источником β -арбутина. Арбутин (4-гидроксифенил- β -D-глюкопиранозид), моногликозидная форма гидроксихинона, используется в области косметологии уже несколько десятилетий благодаря своей эффективности в лечении гиперпигментации и удалении веснушек. Виды *Onobrychis* имеют важное экологическое и экономическое значение, а также демонстрируют интригующие терапевтические свойства, которые привлекают внимание в области медицины. Наличие биоактивных соединений, таких как флавоноиды и фенолы, которые известны своими антиоксидантными свойствами, является еще одним примечательным аспектом. Антиоксиданты играют решающую роль в нейтрализации вредных свободных радикалов в организме, которые участвуют в широком спектре заболеваний и процессах старения. *Onobrychis* обладает противовоспалительными свойствами. Хорошо известно, что воспаление является общим фактором при многих хронических заболеваниях. Растения обладают противомикробными, иммуностимулирующими, гипогликемическими, гипохолестеринемическими, нормализующими желудочно-кишечный тракт и укрепляющими стенки сосудов свойствами. Изучение *Onobrychis* открывает потенциальные перспективы в области создания препаратов природного происхождения.

Keywords: *Onobrychis*, plant resources, antioxidants, plant raw materials, Azerbaijan.

Ключевые слова: *Onobrychis*, растительные ресурсы, антиоксиданты, растительное сырье, Азербайджан.

The protection of natural ecosystems on Earth not only increases biodiversity in nature, but also provides important plant varieties for such fields as medicine and agriculture. One of the current and promising issues in the field of the effective use of wild plants of Azerbaijani flora is the utilization of these resources in the aforementioned areas. It is noteworthy that the flora of our republic includes plant species that possess a substantial quantity of raw material. The research of such plant species, the identification of various groups of biologically active compounds in their composition, and the creation of effective medicines on the basis of these compounds represents an urgent problem in modern pharmacy. In this context, species belonging to the genus sainfoin (*Onobrychis* Mill. (1754)) play an important role in maintaining soil fertility, healthy animal nutrition and also in meeting human needs for medicinal raw materials of natural origin.

Onobrychis is a genus within the Fabaceae family, comprising approximately 170 species worldwide. Of these, 133 species are found in a wild state, while the remainder are cultivated. These species are prevalent in regions of Asia, Europe, and North Africa, with some considered endemic to specific areas. It is distributed across a broad geographical range, extending from the vicinity of the Baltic Sea in the north to the Mediterranean in the south and as far west as Asia and Siberia in the east. The diversity and abundance of these species is particularly high in the Anatolia-Iran-Caucasus region. The "Flora of Azerbaijan" (1954) lists 22 plant species on the territory of the Republic of Azerbaijan. One of these species is endemic to Azerbaijan [1, 2].

Botanical characteristics. *Onobrychis* species are annual or perennial herbs, and in some cases thorny shrubs. They exhibit a variety of growth characteristics, with some species having upright or climbing stems, while others may have a more spreading form. The leaves are usually alternate and compound, sometimes all or only the lower ones are single-leafed. They vary in shape, from lanceolate to ovate, and are often covered with fine hairs. The flowers are collected in a dense spike or cluster of flowers formed in the axils of the upper leaves, which are mostly pink, purple or white in color. The fruit is a pod containing several seeds. The size and shape of the pods varies between species. It has a root system that penetrates deep into the soil.

Onobrychis species thrive in arid or semi-arid areas, including meadows and pastures [1].

Chemical composition. The chemical composition of *Onobrychis* species can vary between different species within the genus, depending on factors such as environmental conditions and growth stage. Based on literature data, the plant was studied using various chromatography and spectroscopy methods, and it was found to have a rich composition.

The analysis of *Onobrychis carduchorum* C. C. Towns., *O. nitida* Boiss., *O. argyrea* Boiss., *O. sosnowskyi* Grossh., *O. viciifolia* Scop. and *O. melanotricha* Boiss. species revealed the presence of significant quantities of phenolic compounds and flavonoids, tannins, organic acids, proteins, fatty oils, and dietary fibers. It has been demonstrated that the plant stores carbohydrates, amino acids [3, 4].

The element composition of the plant was studied by inductively coupled plasma mass spectrometry, which revealed the presence of macro- and microelements (potassium, calcium, magnesium, phosphorus, zinc and iron) [5].

It was determined that the species *Onobrychis hypargyrea* Boiss., *O. viciifolia*, *O. caput-galli*, *O. fallax* and *O. oxyodonta* var. *armena* are rich in fat-soluble vitamins, including β -carotene, γ -

tocopherol, vitamin D3, vitamin A and vitamin K₁ [6].

The results of the conducted studies indicate that the *Onobrychis* species are a rich source of β -arbutin. Arbutin (4-hydroxyphenyl- β -D-glucopyranoside), a monoglycoside form of hydroxyquinone, has been employed in the field of cosmetology for several decades due to its efficacy in the treatment of hyperpigmentation and the removal of freckles [7].

Importance in medicine. The distinctive composition of sainfoin renders it suitable for a wide range of applications. It can be argued that species belonging to the genus are of great importance from a medicinal perspective. Given its rich biologically active substance content, the plant has been utilized in folk and practical medicine for a considerable period of time. In traditional medicine, the infusum of sainfoin grass and roots is employed as an immunostimulator, reducing the level of sugar and cholesterol in the blood, normalizing the activity of the gastrointestinal tract, increasing intestinal peristalsis, strengthening vessel walls, and exhibiting anti-inflammatory and soothing effects. It is employed in the treatment of a number of conditions, including adenoma, chronic prostatitis, atherosclerosis, insomnia, gastric and duodenal ulcers, and increases the synthesis of testosterone and androgens in men. It also shows positive results in ovarian dysfunction, algodysmenorrhea, juvenile bleeding, and gonadal function disorders during premenopause in women. Studies have demonstrated that different species exhibit robust antioxidant properties and also possess the capacity to bind iron ions. The ethanol extract of the *O. buhseana* species and its principal constituent, β -arbutin, demonstrated robust anticholinesterase activity against the AChE enzyme and exhibited only a modest inhibitory effect on the α -glucosidase enzyme. It was demonstrated that the aerial parts of *O. viciifolia* exhibited antibacterial activity, while *O. oxydonta* demonstrated moderate antitumor activity. Some studies have demonstrated that extracts derived from these plants can prevent the proliferation of cancer cells and cause their destruction under certain conditions. Such studies provide a foundation for future research and development of new anticancer drugs based on components of *Onobrychis* species [8, 9, 10, 11, 12].

The intragastric injection of *Thlaspi arvense* and *O. arenaria* layer extract has been demonstrated to exert a prooxidant effect (antioxidant balance restoration), as well as to normalize the hormonal background of male rats [13].

A study was conducted to investigate the activities of *O. argyrea* and *O. hypargyrea* extracts prepared in different solvents on a range of enzymes and proteins associated with diabetes, Alzheimer's disease, and skin hyperpigmentation. These included α -amylase, α -glucosidase, acetylcholinesterase, butyrylcholinesterase, tyrosinase, and the inhibitory activity of the extracts. The methanol extract of *O. argyrea* demonstrated a pronounced inhibitory effect against acetylcholinesterase, tyrosinase, and glucosidase. *O. hypargyrea* species has been identified as a promising source of inhibitors against cholinesterase, tyrosinase, and α -amylase enzymes, with a notable antioxidant capacity [14].

Onobrychis species are employed in the treatment of a range of dermatological conditions, including wounds, cuts, and burns. A study was conducted to investigate the effect of *O. nitida* on various bacteria. The results demonstrated that *O. nitida* exhibited activity against *B. subtilis* at a value of 1.25 mg/ml. Additionally, *O. Carduchorum* demonstrated sensitivity against *S. Aureus*, anti-inflammatory effects, and against breast cancer cells. However, a cytotoxic effect was also detected, with an IC₅₀ value between μ M [15].

The antidiabetic effects of four *Onobrychis* species were investigated using an alloxan-induced diabetic mouse test model. The results demonstrated that methanol-water extracts of *O. albiflora* Hub.-Mor., *O. argyrea* Boiss. subsp. *argyrea* Boiss., *O. galegifolia* Boiss. and *O.*

tournefortii species exhibited antidiabetic effects [16].

Importance for agriculture. Some species are used for fodder production in agriculture. It is valued for its sufficient protein content, richness in certain vitamins and minerals, tannins and carbohydrates. In addition to high taste, excellent nutritional properties, it is also very beneficial for animal health. Thus, the addition of sainfoin-derived feeds, rich in condensed tannins, to animal feed prevents flatulence, facilitates the fermentation process in the gastrointestinal tract, and also such feeds have the properties of keeping lower methane and nitrogen wastes. On the other hand, it stimulates height growth in ruminants and increases productivity. In studies, species belonging to the genus *Onobrychis* have shown anthelmintic bioactivity against nematode parasitism in cattle and herd animals such as sheep, lambs, and goats. Horses in the diet group fed with *O. viciifolia* bioactive feed showed a significant reduction in larval development rate, which confirms the anthelmintic effect of the plant [17, 18].

Additionally, the plant's contribution to the agricultural sector can be demonstrated. These include the natural fertilization of soil, an increase in crop productivity and ecological safety, the creation of meadows, pasture phytocenosis and landscape areas. The *Onobrychis* species facilitate the creation of ecologically clean agricultural areas by reducing the use of chemical pesticides. Rhizobium, which lives symbiotically in its roots, absorbs free nitrogen from the air at the expense of nitrogen-fixing bacteria and transforms it into a form that can be used by the plant, thus maintaining the fertility and vitality of the soil by ensuring its development without fertilizers. Conversely, the plant is capable of thriving in calcareous soils, which enhances soil stability and serves to create a barrier against erosion. Consequently, it is possible to transform polluted and eroded lands into productive agricultural areas [19].

The *Onobrychis* genus represents a valuable source of nectar for honey bees. A melissopalynological analysis was conducted in eight districts of the Kars region of the Republic of Turkey, and it was determined that 99% of the analyzed honey samples contained *O. radiata* [20].

A study was conducted on 13 *Onobrychis* taxa and genotypes to investigate the effects of soil salinity on plant growth and physiology. The species were subjected to NaCl concentrations of 5, 10, 15 and 20 dS/m, and it was observed that an increase in salinity level resulted in a significant reduction in seed germination and growth indicators, accompanied by an increase in the mean germination time. Additionally, *Onobrychis* species were found to be tolerant to salinity levels up to 10 dS/m, with the critical concentration varying depending on the species [21].

One of the advantages of the plant is its resilience to drought. This feature is attributable to the plant's robust root system, which is situated at a depth below the surface, and the presence of small hairs that are distributed along the majority of the plant's surface. These characteristics collectively serve to minimize water loss. To investigate the impact of drought stress, some species belonging to the genus *Onobrychis* were cultivated in a medium supplemented with PEG-6000. The results demonstrated a significant increase in antioxidant components in the calli. In a separate study, a transcriptome analysis utilizing RNA sequencing was conducted on *O. viciifolia* cultivated under natural extreme conditions. This analysis revealed the involvement of numerous flavonoids and phenylpropanoid biosynthesis pathways in the plant's adaptation to adverse conditions, including salinity, drought, heat, cold, flooding, UV radiation and the toxic effects of heavy metals. Genes associated with these pathways were identified [22, 23].

Conclusions. It is important to conclude that *Onobrychis* species represent a valuable natural resource that plays a significant role in both natural ecosystems and agricultural landscapes. The plant's capacity to adapt to diverse environmental conditions and its distinctive developmental patterns in various ecosystems serve to reinforce its sustainability and ecological significance.

Onobrychis species constitute a valuable source of fodder for livestock and are of significant importance for animal health. It enhances soil fertility by facilitating nitrogen fixation through the symbiotic relationship between the plant and the bacteria Rhizobium. Consequently, the plant plays a multifaceted role in maintaining the sustainability of agricultural practices.

The Onobrychis species are of significant ecological and economic importance, and also demonstrate intriguing therapeutic properties that are attracting attention in the field of medicine. It is worthy of note that the presence of bioactive compounds, such as flavonoids and phenols, which are known for their antioxidant properties, is a further noteworthy aspect. Antioxidants play a crucial role in the neutralization of harmful free radicals within the body, which are implicated in a wide range of diseases and the ageing process. Moreover, research indicates that Onobrychis possesses anti-inflammatory properties. It is well established that inflammation is a common factor in many chronic diseases. Consequently, the identification of natural sources with anti-inflammatory effects and the development of potential drugs are of interest to the medical community. The plant has been found to possess antimicrobial, immunostimulating, hypoglycaemic, hypocholesterolaemic, gastrointestinal tract normalizing, and vascular wall strengthening properties. In conclusion, the detailed study of Onobrychis provides potential perspectives in the field of the creation of preparations of natural origin.

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Работа поступила
в редакцию 19.07.2024 г.

Принята к публикации
29.07.2024 г.

Ссылка для цитирования:

Jafarova Sh. Species of the *Onobrychis* Genus as Promising Species of Azerbaijan Flora // Бюллетень науки и практики. 2024. Т. 10. №8. С. 43-50. <https://doi.org/10.33619/2414-2948/105/05>

Cite as (APA):

Jafarova, Sh. (2024). Species of the *Onobrychis* Genus as Promising Species of Azerbaijan Flora. *Bulletin of Science and Practice*, 10(8), 43-50. <https://doi.org/10.33619/2414-2948/105/05>