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STUDY OF THE BIOECOLOGICAL AND THERAPEUTIC CHARACTERISTICS OF MEDICINALLY IMPORTANT SPECIES BELONGING TO THE FAMILY Brassicaceae Burnett IN THE FLORA OF THE NAKHCHIVAN AUTONOMOUS REPUBLIC

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ИЗУЧЕНИЕ БИОЭКОЛОГИЧЕСКИХ И ЛЕЧЕБНЫХ СВОЙСТВ ЛЕКАРСТВЕННО ЦЕННЫХ ВИДОВ СЕМЕЙСТВА Brassicaceae Burnett. ВО ФЛОРЕ НАХЧЫВАНСКОЙ АВТОНОМНОЙ РЕСПУБЛИКИ

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Abstract. The bioecological and medicinal properties of medicinally important species belonging to the family Brassicaceae, distributed in the flora of the Nakhchivan Autonomous Republic, have been investigated. During the study, the altitudinal belts, life forms, ecological habitats, and ecological groups of the medicinally valuable species within the family were examined. It was determined that several medicinally important representatives of the family are widely distributed in various phytocenoses of the Nakhchivan Autonomous Republic and are characterized by a rich complex of biologically active compounds. The research has shown that these species are rich in vitamins, flavonoids, glucosinolates, phenolic compounds, essential oils, and other phytochemical substances. These compounds possess antioxidant, anti-inflammatory, antimicrobial, anticancer, and immunomodulatory properties and are widely used in both traditional and scientific medicine.

Аннотация. Исследованы биоэкологические и лечебные свойства лекарственно значимых видов семейства *Brassicaceae*, распространённых во флоре Нахчыванской Автономной Республики. В ходе исследования были изучены высотные пояса распространения, жизненные формы, экологические условия произрастания и экологические группы лекарственных видов, относящихся к данному семейству. Установлено, что ряд лекарственно ценных представителей семейства широко распространён в различных фитоценозах Нахчыванской Автономной Республики и характеризуется богатым комплексом биологически активных веществ. Результаты исследований показали, что эти виды содержат значительное количество витаминов, флавоноидов, глюкозинолатов, фенольных соединений, эфирных масел и других фитохимических веществ. Данные соединения обладают антиоксидантным, противовоспалительным, антимикробным, антиканцерогенным и иммуномодулирующим действием, благодаря чему широко используются как в народной, так и в научной медицине.

Ключевые слова: *Brassicaceae*, лекарственные растения, биоэкологические особенности, семейство, вид.

Keywords: *Brassicaceae* Burnett., medicinal plants, bioecological characteristics, family, species.

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Plants have been among the natural resources used by humans for food, economic, and medicinal purposes since ancient times. In the modern era as well, medicinal plants remain a primary source of raw materials for traditional medicine and the pharmaceutical industry, and they continue to maintain their importance. The majority of the world's population uses plant-derived preparations for the prevention and treatment of various diseases. From this perspective, the study of the bioecological characteristics and medicinal significance of medicinal plants is considered one of the most relevant directions in modern botany and pharmacology. The family *Brassicaceae* Burnett. (cabbage family) is one of the widely distributed and economically important families of flowering plants. Medicinal plants belonging to this family are rich in biologically active compounds such as glucosinolates, flavonoids, alkaloids, vitamins, phenolic compounds, and essential oils. These substances are responsible for their antibacterial, antioxidant, anti-inflammatory, diuretic, and immunomodulatory effects. Therefore, many species of this family are widely used in both traditional and scientific medicine.

The flora of Azerbaijan, particularly the vegetation cover of the Nakhchivan Autonomous Republic, is distinguished by a high level of biodiversity. The complex relief of the territory, diverse altitudinal zones, continental climatic conditions, and soil variability have contributed to the formation of a rich flora. Numerous genera and species of the family *Brassicaceae* Burnett. are distributed in the flora of Nakhchivan, a considerable proportion of which possess medicinal properties. The geographical distribution, ecological adaptations, phenological development characteristics, and therapeutic potential of these species are of particular interest in terms of the efficient use of plant resources in the region. In recent years, the increasing demand for natural medicinal raw materials, as well as issues related to biodiversity conservation, have made the comprehensive study of medicinal plants necessary. The investigation of the bioecological characteristics of medicinally important species of the family *Brassicaceae* Burnett., distributed in the flora of the Nakhchivan Autonomous Republic, is of significant scientific and practical importance for determining their distribution patterns, ecological requirements, and resource potential.At the same time, the study of the medicinal properties of these species expands the possibilities for obtaining new phytopreparations and for the rational use of existing plant resources. The main aim of the research is to investigate the bioecological characteristics, distribution ranges, ecological groups, and medicinal properties of medicinally important species belonging to the family *Brassicaceae* Burnett., distributed in the flora of the Nakhchivan Autonomous Republic, and to obtain scientifically substantiated data regarding their practical use and conservation.

The family *Brassicaceae* (cabbage family) includes more than 3,000 species belonging to 350 genera worldwide. In Azerbaijan, it is represented by 248 species distributed across 74 genera, while in the flora of the Nakhchivan Autonomous Republic it is represented by 165 species grouped into 67 genera [2, 10].

The family is represented by medicinally important species belonging to the following genera: *Aethionema* R.Br., *Alliaria* Heist. ex Fabr., *Alyssum* L., *Armoracia* (Gaertn.) C.A. Mey. & Scherb., *Barbarea* R.Br. (Campe Dulac), *Brassica* L., *Bunias* L., *Camelina* Crantz, *Capsella* Medik., *Cardamine* L., *Cardaria* Desv., *Clypeola* L., *Conringia* Adans., *Crambe* L., *Descurainia* Webb & Berth., *Draba* L., *Drabopsis* C.Koch, *Erophila* DC., *Erucastrum* C.Presl, *Erysimum* L., *Euclidium* R.Br., *Fibigia* Medik., *Goldbachia* DC., *Isatis* L., *Lepidium* L., *Matthiola* R.Br., *Murbeckiella* Rothm.(Phrine Bub.), *Microthlaspi* F.K.Mey., *Myagrum* L., *Nasturtium* R.Br., *Neslia* Desv., *Physoptychis* Boiss., *Raphanus* L., *Rapistrum* Crantz , *Rorippa* Scop., *Sameraria* Desv., *Sinapis* L., *Sisymbrium* L., *Strigosella* Boiss. (Malcolmia aict. p.p.) və *Thlaspi* L., all of which include species of medicinal importance all of which include species of medicinal importance [1, 6].

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In the flora of the Nakhchivan Autonomous Republic, the bioecological characteristics of medicinally important species belonging to the family *Brassicaceae* are presented in the Table below.

Table

BIOECOLOGICAL CHARACTERISTICS *Brassicaceae* Burnett.

Species	*Height, phenophase*	*Life form*	*Ecological group*	*Altitudinal belt*	*Ecological habitat*
Aethionema cardiophyllum Boiss. & Heldr.	15-25 cm V-VI, VI-VII	S	X	Mid-mountain belt	Dry, gravelly and rocky slopes
Aethionema pulchellum Boiss. & Huet.	15-30 cm V-VI	S	X	Mid-mountain belt	Rocky and gravelly slopes
Alliaria petiolata (Bieb.) Cavara & Grande (*A. officinalis* Andrz. ex Bieb.)	20-100 cm IV-V,VI-VIII	B	M	Up to the mid-mountain belt	Forests, edges of shrublands, as a weed in parks
Alyssum hirsutum Bieb.	8-25 cm IV-VI	A	X	From lowland to the mid-mountain belt	Dry, clayey slopes, steppes, shrublands
Alyssum persicum Boiss. (*A. muelleri* Boiss. & Buhse)	5-15(25) cm (IV)V-VI, (V)VI-VIII	P	X	Mid-mountain belt (rarely reaching subalpine elevations)	Dry, rocky and clayey slopes, calcareous areas
Alyssum Stapfii Vierh.(*A. Buschianum* Grossh.)	5-20 cm V, VI	A	X	Lower and mid-mountain belts	Dry, rocky and gravelly areas
Alyssum tortuosum Waldst. & Kit. ex Willd. (*A. bracteatum* auct.)	8-25 cm V-VIII, VI-IX	P	X	From lower to upper mountain belts	Gravelly and rocky areas, grassy slopes
Alyssum turkestanicum Regel & Schmalh. (*A. desertorum* Stapf)	6-15(20) cm (III) IV-V, IV-VI	A	X	Lowland, lower mountain belt (mostly mid-mountain belt)	Semi-desert, clayey and rocky areas, field margins, sandy areas, riverbanks
Armoracia rusticana (Gaertn.) C.A. Mey. & Scherb.	50-150 cm VI-VII	P	M	Lowland, mid-mountain belt	Gardens, weedy areas, shrublands
Barbarea minor C.Koch	5-25(35) cm V-VI (VII), VI-VIII (IX)	P	M	From the mid-mountain belt to alpine elevations	Moist meadows, riverbanks
Brassica campestris L.	Up to1 m IV-VII, V-VIII	A	M	From lowland to subalpine elevations	Weedy areas, vegetable gardens, vineyards
Bunias orientalis L.	25-80(100) cm IV-V (VI), VI-VII	A	M	From lower mountain belt to subalpine elevations	Meadows, weedy areas, cultivated fields
Camelina laxa C.A. Mey.	20-80 cm IV-V, VI-VII	A	X	Lower and mid-mountain belts	Dry slopes, rocky areas, cultivated fields, roadsides
Capsella bursa - pastoris (L.) Medik.	5-60 cm IV-V(IX), V-VII (IX)	A	Mx	From lowland to alpine elevations	Roadsides and weedy areas
Cardamine uliginosa Bieb. (*C. amara* L. x *C. dentata* Schult.)	20-40(50) cm V-VI(VIII), VI-VIII(IX)	P	M	Mid and upper mountain belts	Rocky slopes and oases (sometimes)
Cardaria Boissieri (N. Busch) Soo (*Lepidium*	40-60 cm VI	P	Xh	Lower and mid-mountain belts	Dry slopes, weedy areas, cultivated fields,

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Species	*Height, phenophase*	*Life form*	*Ecological group*	*Altitudinal belt*	*Ecological habitat*
Boisseri N. Busch)					gardens
Cardaria draba (L.) Desv. (*Lepidium draba* L.)	20-50 cm IV-V, V-VI(VII)	P	Xh	Lowland, foothill, occasionally mid-mountain belt	Dry slopes, weedy areas, cultivated fields
Clypeola jonthlaspi L.	3-25 cm III-IV, IV-V(VI)	A	X	From lowland to the mid-mountain belt	Dry, clayey and rocky areas, shrublands, semi-desert
Conringia planisiliqua Fisch. & C.A. Mey.	20-40 (70) cm V, VI	A	X	Mid-mountain belt	Dry, rocky and gravelly slopes, as a weed in shrublands and cultivated fields
Crambe juncea Bieb.	30-70 cm V, VI	P	X	Up to the mid-mountain belt	Dry, rocky and gravelly slopes
Crambe orientalis L. (*C. amabilis* Butk. & Majlun)	30-80 cm V (VII), VI-VII	P	X	From the lower to the upper mountain belt	Dry, rocky and gravelly areas, as a weed in cultivated fields
Descurainia Sophia (L.) Webb. ex Prantl	15-70 cm V-VI, VI-VIII	A	Xh	Up to the mid-mountain belt	As a weed in fertile soils, vegetable gardens
Draba nemorosa L.	8-30 (60) cm (IV)V-VII (IX), VI-VIII (IX)	A	M	From the lower to the upper mountain belt	Subalpine and alpine meadows, grassy, rocky and stony slopes, between shrublands, cultivated fields
Drabopsis nuda (Belanger) Stapf (*D. verna* C. Koch)	1-10 cm V, V-VI	A	X	Mid-mountain belt	Dry, rocky slopes
Erophila verna (L.) Bess.	2-15 (30) cm III-IV, IV-V	A	M	From lowland to the mid-mountain belt	Steppes, grassy slopes, among rocks, semi-desert and weedy areas
Erucastrum armorasioides (Czern. ex Turez.) Cruchet (*Brassica elongata*.) Ehrn	15-50 cm V-IX	B	X	Lower and mid-mountain belts	Steppes, roadsides, cultivated fields, stony soils, dry, gravelly, clayey, and rocky slopes
Erysimum lilacinum Steinb.	50 cm V-VI	B	Mx	Mid-mountain belt	Open woodlands, rocky slopes
Erysimum leucanthemum (Steph.) B.Fedtsch.(*E. passgalense* Boiss.)	50-70 cm (IV)V, VI	B	X	Up to the lower mountain belt	Edges of shrublands, steppe areas
Erysimum pulchellum (Willd.) J.Gay	15-30 cm VI, VII-VIII	P	X	Mid and upper mountain belts	Rocky and stony areas
Euclidium syriacum (L.) R. Br.	5-25 cm IV, V	A	X	Up to the mid-mountain belt	Semi-desert, as a roadside weed, fields
Fibigia macrocarpa (Boiss.) Boiss.	15-35 (40) cm V-VI, VI-VII	P	X	Mid-mountain belt	Dry, rocky slopes
Goldbachia torulosa DC.	8-45 cm V (VI), V-VI(VII)	A	X	Lowland, rarely up to the mid-mountain belt	Dry, stony areas, cultivated fields, weedy areas
Isatis Steveniana Trautv. (*İ. anceps* N. Busch)	30-40 cm V,VI	Pl	X	Mid-mountain belt	Rocky slopes, screes

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Species	Height, phenophase	Life form	Ecological group	Altitudinal belt	Ecological habitat
Lepidium draba L.	16-40(52) cm IV-V, V-VI(VII).	P	Mx	Lowland and lower mountain belt, mostly mid-mountain belt	As a weed in fields, cultivated lands, gardens, roadsides, mostly in meadows
Lepidium perfoliatum L.	10-35 cm IV-V, V-VI	A	Xh	Lowland, lower mountain belt, rarely mid-mountain belt	Dry, clayey and rocky slopes, along rivers as a weed in cultivated fields, gardens, and steppe areas
Lepidium ruderale L.	10-30 cm IV-VI, V-VII	A	X	Lowland, rarely up to the mid-mountain belt	Clayey and saline areas, roadside weed habitats
Matthiola Boisseri Grossh.	15-35 cm IV-V, V-VII	P	X	Mid-mountain belt	Clayey and rocky slopes
Murbeckiella Huetii (Boiss.) Rothm.	10-30 cm VI-VII, VIII	P	X	Upper mountain belt	Rocky outcrops, stony soils, rocky areas
Microthlaspi perfoliatum (L.) F.K. Mey. (*Thlaspi perfoliatum* L.)	5-30 cm IV-V, V-VI	A	Mx	From lowland to the mid-mountain belt	Meadows, shrublands, and waste areas
Myagrum perfoliatum L.	(10)20-50 cm IV-V, VI(VIII)	A	Mx	From lowland to the mid-mountain belt	Cultivated fields, mostly weedy areas
Nasturtium officinale R. Br.	10-60 cm V-VII, VII-VIII	P	Hd	Up to the mid-mountain belt	Marshes, shores of water bodies
Neslia paniculata (L.) Desv.	15-80 cm IV-V, V-VI	A	X	From lowland to the mid-mountain belt	Cultivated fields
Physoptychis caspica (Habl.) V. Boczantzeva [*Ph. gnaphalodes* (DC.) Boiss.]	5-15 sm VI-VII, VII-VIII	P	X	Alpine elevation	Rocky slopes
Raphanus raphanistrum L.	25-70 cm V-IX, VI-IX	A	Mx	Lowland	Weedy areas
Rapistrum rugosum (L.) All.	30-100 cm IV-V, V-VI(VII)	A	X	Up to the mid-mountain belt	Dry slopes and weedy areas
Rorippa amphibia (L.) Bess.	40-100 cm (IV) V-VII, VI-VIII	P	Hd	Mid-mountain and subalpine belts	Slow-flowing rivers, marshes, and stagnant waters
Rorippa austriaca (Crantz) Bess.	30-90 cm V-VI, VI-VII	P	M	Up to the mid-mountain belt	Moist areas along riverbanks
Sameraria glastifolia (Fisch. & C.A. Mey.) Boiss.	15-40 cm IV-V, V-VI	A	X	Lower and mid-mountain belts	Dry, rocky, and clayey slopes
Sinapis arvensis L.	40-100 cm V-VI, VI-VII (VIII)	A	Mx	Mid-mountain belt	Cultivated fields (mainly cereal crops) and weedy
Sisymbrium altissimum L.	20-60 cm IV-V,V-VII	A	Hm	Lower mountain belt (rarely in the mid-mountain belt)	Slightly saline and weedy areas

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Species	*Height, phenophase*	*Life form*	*Ecological group*	*Altitudinal belt*	*Ecological habitat*
Sisymbrium Irio L.	10-60 cm IV-V,V-VII	B	Mx	Lower mountain belt (rarely in the mid-mountain belt)	Weedy areas, residential areas, ditches, and roadsides
Sisymbrium Loeselii L.	20-60 cm IV-VIII (IX),V-IX (X)	B	M	Mid-mountain and subalpine belts	Meadows, forest clearings, and waste areas
Strigosella intermedia (C.A.Mey.) Botsch. (*Malcolmia taraxafolia* Balb.)	3-25 cm IV-V, V-VI	A	Xh	Lowland and lower mountain belt	Semi-desert, dry, clayey and rocky slopes, saline areas, and cultivated fields
Thlaspi arvense L.	20-50 cm VI-IX, VII-IX	A	Mx	Mid-mountain and subalpine belts	Grassy slopes, edges of shrublands, mostly in weedy areas

Note: A – Annual, B – Biennial, P – Perennial, S – Subshrub, Hm - Halomesophyte, Hd - Hydrophyte, M - Mesophyte, Mx - Mesoxerophyte, Xh - Xerohalophyte, Xerophyte

Based on the data presented in the table, among the medicinally important species of the family, 27 species (50%) belong to the xerophytic ecological group, 10 species (18.51%) to the mesophytic, 9 species (16.66%) to the mesoxerophytic, 4 species (7.40%) to the xeromesophytic, 2 species (3.70%) to the hydrophytic, one species (1.85%) to the xerohalophytic, and one species (1.85%) to the halomesophytic ecological groups. In terms of life forms, 24 species (44.44%) are annuals, 19 species (35.18%) are perennials, 5 species (9.25%) are biennials, 3 species (5.55%) are annual or biennial, 2 species (3.70%) are subshrubs, and one species (1.85%) is biennial or perennial. Among the medicinally important species of the family Brassicaceae Burnett, xerophytic ecological groups and annual life forms are predominant.

Figure 1. *Bunias orientalis* L.

Figure 2. *Lepidium perfoliatum* L.

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Figure 3. *Armoracia rusticana* (Gaertn.) C.A. Mey. & Scherb.

Figure 4. *Rapistrum rugosum* (L.) All.

As vegetables in the Brassicaceae family contain vitamins, catalase, superoxide dismutase, and peroxidase, they are a prominent source of antioxidant activity. Phytochemicals present in Brassica vegetables help prevent oxidative stress, cancer risk, carcinogenic mutations, and the proliferation of cancer cells. Brassicas are also used as biocontrol agents in the biofumigation process [4, 5, 8].

The beneficial role of the Mediterranean diet in the prevention of chronic diseases, including cardiovascular disease, diabetes, and obesity, is well-recognized. In this context, Brassicaceae are considered important vegetables due to evidence of their health-promoting effects, which are associated with bioactive compounds present in the edible parts of the plants [7].

Nutritious foods are integral to supporting physiological and cognitive functions, facilitating growth and development, and mitigating the risk of chronic conditions [3, 9, 11].

Studies have shown that members of the Brassicaceae family contain compounds that reduce inflammation, regulate estrogen levels and blood sugar, promote weight loss, improve cardiovascular health, and exhibit anti-cancer properties (https://707.su/IQ8f).

Scientists have suggested that cabbage may aid in cancer prevention and provide protection against radiation. Furthermore, a compound called diindolylmethane (DIM) has been shown to be safe for humans and is being investigated as part of cancer treatment protocols. Dr. Eliot Rosen, from the Georgetown Lombardi Comprehensive Cancer Center, has conducted research on the effects of this compound on the human body when exposed to radiation (https://clck.ru/3VYbXN).

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