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## ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК  
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## FEATURES OF THE STRUCTURE OF NATURAL POPULATIONS *HUMULUS LUPULUS* L. (REVIEW)

**Abstract.** The article provides an overview of the structural features of the natural populations of *Humulus lupulus* L. in the world and in Kazakhstan. Currently, the use in medicine of natural products, medicines and biologically active substances of plant origin is increasing. Significant parts of the medicinal raw materials are wild plants. The need for medicinal plant raw materials (medicinal plants) is not decreasing; the technology of its procurement and reproduction in natural conditions wants significant perfection. It is known that they have a milder, more complex effect on the human body and are used in the treatment of many chronic diseases. The growing anthropogenic impact on populations of valuable medicinal plants is decreasing their stocks of raw materials. In this regard, the study of biological characteristics and the development of scientifically based agricultural techniques for the cultivation of many medicinal plants are becoming relevant. *Humulus lupulus* L. (common hop) is a valuable medicinal plant. They are used as painkillers, sedatives, hypnotics for increased nervous irritability, sleep disturbances, neuralgia, vegetovascular dystonia, mild coronary spasms, tachycardia, and in the early stages of hypertension. According to the classification of medicinal plant resources, *Humulus lupulus* L. is a plant with a wide range, but with a limited supply of raw materials. In places of growth of *Humulus lupulus* L. does not form large thickets [1].

Recently, a comprehensive approach has been applied in the study of natural plant populations, including ontomorphological and population-ecological studies. This makes it possible to objectively assess the state of the species in the cenosis and predict its future behavior. In this regard, a comprehensive study of the natural populations of *Humulus lupulus* L. is of great relevance.

Hops (*Humulus lupulus* L.) is an important crop worldwide, known as the main flavor ingredient in beer. A diversified brewing industry requires a variety of flavors, superior technological properties and sustainable agronomy, which are the center of advanced molecular breeding efforts in hops. Hop breeders have been limited in their ability to create strains with desirable traits, however, due to unusual and unpredictable inheritance patterns and the associated non-Mendelian segregation of genetic markers [2].

The use of hops has recently been undergoing a new change, driven by a growing international preference for more intensely flavored beer, supported by the craft-brewing sector. This movement led to the introduction of much more hops at various stages of beer production and to an ever-growing search for new flavors. Some hop varieties have thus received particular attention, including several older typical hops mostly used to date, although an intensive search for new varieties dubbed "Green Gold" has also taken place. A large number of new exquisite varieties have been described and are increasingly appreciated in the market. Global hop growing areas have increased over the past 5 years, although total world beer production has declined over the same period, confirming the trend of using more hops per liter of beer. In addition, a wide range of pharmacological properties have been described for hops and its derivatives, namely antioxidant, anti-inflammatory and antitumor properties, which are of great importance for the pharmaceutical industry. The bioactivity of beer can depend on the use of hops, which can become an important tool for brewers aiming to develop functional products.

Taken together, the compounds isolated from *Humulus lupulus* L. have a wide range of biological activity, such as anti-inflammatory action, antimicrobial action, antioxidant action, antiproliferative effects, cytochrome P450 effects, glucose metabolism effects, hormonal effects, lipid effects and sedative / hypnotic effects.

Therefore, the purpose of this Chapter is to describe the importance of hops in this new direction of beer production, market overview of hops, varieties, forms and methods of use, composition, value in bioactivity of beer and new discoveries in research hops [3].

**Key words:** *Humulus lupulus* L., essential oils, phenolic compounds, lupulin.

**Introduction.** The generic name of hops "humulus" comes from the Latin word "humus" – land, soil and indicates that it creeps on the ground. The species name "lupulus" translates as "wolf", indicating that the plant wraps around the tree like a predator. In ancient times, it was believed that hops is a parasite of trees and sucks juices from them, from which the trees dry up. However, in fact, the plant uses the trunk and crown of trees only for support.

Previously, scientists attributed ordinary hops to the family of mulberry (Moraceae). Since 1972, most systematic botanists, based on embryonic and chemotaxonomic studies, have come to the conclusion that creeping hop's and other plants of the hops genus (*Humulus*) belong to the Cannabaceae family, which is part of the Urticales order, and consider that hops has more typical features characteristic of the hemp family.

However, even now, in some publications on botany and pharmacognosy, as well as in popular scientific literature, hops belong a statement to the mulberry family.

In addition, some botanists believe that four species belong to the genus hops: common hops, heart-shaped hops-*Humulus sordifolius*, American hops-*Humulus americanus* R., climbing hops-*Humulus scandens* (Lour.) Merr., which is known as the Japanese hop-*Humulus japonicus* Sieb. et Zucc. Since the first three species are very similar to each other and do not have significant distinguishing features from the climbing hops, most botanists do not consider them separate species, but refer to varieties or races of this species. Therefore, because of modern Botanical research to the genus hops include two species: common hops-*Humulus lupulus* L. and climbing hops-*Humulus scandens* (Lour.) Merr.

**History of hops.** Hops were known as a wild plant already during ancient times. Historical findings allow us to conclude that their origin was in Asia, more precisely in fertile Mesopotamia, the lowlands of the Caucasus and southern Siberia [4]. Botanically, however, the hop plant is believed to have originated in China because China is the only country in the world where all three-hop species (*H. Lupulus*, *H. Japonicus*, and *H. Yunnanensis*) occur naturally [5-7]. Hops have been cultivated since the beginning of our era. Records showing that hops were used for seasoning and canning beer by Slavic tribes date back to at least 1500-1000 BC. Other people began using hops for brewing from the 13th century (ad). Until the 12th century (ad), however, hops were probably obtained only by harvesting wild plants [8].

Over time, people discovered the healing effects of hops, which then found its place in folk medicine. Hops were used, according to the ancient herbarium, to treat various diseases, such as unpleasant foot odor, liver disease of bitter and aromatic properties. In addition, hops are used in the cosmetic and pharmaceutical industries, especially for their antimicrobial and antiviral effects. The fact that hops were originally used and added to beer for its antimicrobial activity as a preservative classifies this plant as a natural source of compounds with biological action.

An increasing number of pathogenic strains of bacteria (and viruses) resistant to various types of antimicrobials pose a serious medical problem. Secondary metabolites of hops have been described for constipation, sleep disorders and for blood purification [9,10]. Records from the 7th and 9th centuries' ad show that the earliest predecessors of hop gardens were founded under the monastic administration, where hops were grown for their medicinal properties along with other herbs [11]. Even at that time, hops extracts were recognized for their anti-inflammatory and antiseptic effects, as decoctions made from hops were used to treat poorly healing wounds.

Another example of this treatment is the use of heated hops as a poultice [12] for pneumonia or the treatment of fever using hops decoctions [13]. Alcohol extracts of hops have also been used in Chinese medicine to treat pulmonary tuberculosis or acute bacterial dysentery, and have been part of Ayurvedic procedures [14]. Some recent studies have shown that alcohol extracts from hops have a strong antispasmodic effect on smooth muscles and are therefore effective in conditions characterized by tension of visceral smooth muscles, including nervous colitis, nervous dyspepsia, palpitations, nervous or irritable cough and asthma [15,16].

**Phytogeography and botany of hops.** Wild hops, which grows in humid areas near rivers, are widespread in vast areas of Europe, Asia and North America [17].

Today, cultivated hop production is concentrated in areas with a humid, temperate climate, with most of the global production coming from the Middle East.

Hop yards are an integral part of the countryside around Europe, North and South America, South Africa, Australia and New Zealand. Varietal plants are grown, as a rule, on large flat areas with acidic soil. Currently, the largest hop producers are Germany, the USA, China and the Czech Republic (production in 2014 amounted to 25 338, 38 499, 6 887 and 6 202 tons, respectively) [18].

Some botanists believe that climbing hops come from the Mediterranean region. However, reliable data that would confirm such an origin are absent in the literature on botany. M. I. Vavilov attributed hops to the Mediterranean focus of the origin of cultivated plants, the range of which extends far to the north, where, obviously, it was first introduced into the culture. V. Linke considers the homeland of hops Northern and Central Europe. According to L. Venta, the primary geobotanical region of hop distribution is the fertile valleys and foothills of the Caucasus, as well as the Black Sea coast. Hence, during the resettlement of the Slavs in the II-V century AD hops spread throughout Europe. As a wild plant, climbing hops are widely distributed in the forest zone of the temperate climate of Eurasia: it grows throughout Europe (reaching the Arctic belt), the Caucasus, Western Siberia, Altai, the Far East, and Central Asia. Wild hops are distributed throughout the forest and forest-steppe zones of Ukraine, where they grow in humid broad-leaved forests, along the banks of rivers and marshes, in ravines, on the edges, among shrubs, near roads and fences.

Hops have long been widely cultivated for the needs of the food industry as a technical culture in many countries, in particular in France, England, the Czech Republic, southern Germany, North-east China, South Africa, the USA, Argentina, Chile, Brazil, Australia and New Zealand. In Ukraine, specialized hop cultivation farms are located mainly in the northern regions (more than 60% of all Ukrainian hoppers).

It grows in river valleys, ravines, shrubbery, forest edges, and is bred in gardens and kitchen gardens. Found in Tobyl-Esil, Irtysh, Semey, Kokshetau, Aktobe, Western and Eastern small hills, Altai, Tarbagatai, Dzhungarsky Alatau, ZailiyskyKungei Alatau, Karatal. The general distribution is South Europe, the Caucasus, Western Siberia, Western Europe, the Mediterranean, Asia Minor, and North America [19].

In the Russian Far East, common hops used to be known only in culture. However, later botanists in some areas of revealed insignificant thickets of feral and introduced hops. Since ordinary hops are widely cultivated in many regions of the world, in some places, it becomes an alien and feral species; it is sometimes quite difficult to establish clear boundaries of its natural range.

When discussing the technological aspects or medical effects of products derived from hops, it should be noted that these products are obtained only from cones from female plants. *Humulus lupulus* L. is a dioecious climbing perennial creeper from the Cannabis family [20], which also includes the genera Cannabis (hemp) and Celtis (blackberry). The leaves are located on the stem in the opposite way on stems from seven to 12 cm long and have roughly jagged edges in the shape of a heart. Female flowers (often bumps) are made up of short green spikelets (called hop cones, seed cones or strobiles) and secrete a fine yellow resinous powder from structures called lupulin glands. Lupulin glands synthesize resins and essential oils [21,22], which characterize the bitter taste and aroma of beer, but also stabilize the foam and the final product [23]. Special vacuoles of the external system of lupulin glands are rich brewing tanks and pharmacologically important substances, which are often called secondary metabolic products.

Male plants are characterized by small yellow flowers and are important for breeding new varieties! Otherwise, male plants are removed from hop fields to prevent fertilization of female plants and seed production [24].

*Medicinal raw material.* For medical needs use inflorescences hops ordinary, which mistakenly call soplodiyami-women's "cones" (StrobuliHumulilupuli, or StrobuliLupuli), and glands hops (Glandulae Lupuli), or lupulin (Lupulinum). Lupulin-glands in the form of a bright yellow coarse-grained powder called hop flour. Lupulin is derived from the dried cones of the knocking in the city. The finished product has the form of a heterogeneous coarse-grained adhesive substance of a greenish-yellow color, which gradually acquires a reddish hue in the air. For the needs of the pharmaceutical industry, the inflorescences of hops are harvested in mid-August, when they acquire a greenish-yellow color (later they become brownish, dry and after drying, they easily crumble), tear them off with their hands together with the pedicels. The collected raw materials are quickly dried in the shade in the fresh air, spreading a thin layer on paper or fabric. It is better to store cones in non-ground form, since they lose activity when crushed [25].

Ordinary hops and its medicinal raw materials - "hop cones" - are official in Ukraine and Russia, as well as in Germany, France, Spain, Portugal, Greece, Romania, Mexico, and the United States. Lupulin entered the Pharmacopoeia of Germany, Portugal, Switzerland, Italy, Austria, Holland, Brazil, and USA.

The inflorescence of the hop plant, *Humulus lupulus* L., contains unique compounds used primarily for beer production, but also contain compounds with bioactive properties, with the potential to improve human health. Hops are bitter soft resins and aromatic oils derived from their lupulin glands are essential for beer. The third component in lupulin is solid resins, which are undesirable in beer but contain biologically active polyphenols that have been shown to reduce the risk of disease in humans and animals. Extracts of hard hop resins are rich in antioxidants and estrogenic prenyl flavonoids and are used today as food additives, especially to relieve menopausal discomfort. However, the bioavailability of prenylflavonoids depends on their metabolism by the intestinal microbiota. This review focuses on women's use of prenyl flavonoid-rich hop extracts to alleviate complaints during menopause with the added benefit of reducing the risk of diseases including metabolic syndrome and cancer. The role of the gut microbiota and bioavailability of prenyl flavonoids will also be discussed [26].

*Biologically active substance.* The main biologically active substances that determine the pharmacological activity of hop cones are bitterness and polyphenolic compounds, as well as essential oil. These are the most important compounds of hops; they are of particular importance in pharmaceutical production and in scientific and practical medicine. Hop cones contain 0.2-1.8% essential oil, 2-5% polyphenolic compounds and 5 to 26% water.

Lupulin contains 1-3% essential oil, about 5% bitterness, 50-70% resinous substances, as well as waxes, yellow pigment, choline, hypoxanthin, adenine, ceratinic and isopropylacrylic acids, as well as Humulin (hopein) - alkaloid-like substance with narcotic effect [27].

Bitterness of hops, related to polyketide allforgiving type, are a mixture of acidic and resinous substances. According to J. Kuroiwe and E. Kukubo (1973), more than 90 chemical compounds were isolated in the analysis of hop bitterness. According to the international nomenclature, they are called "common resins". They are soluble in cold methanol and diethyl ether. According to the classification, there are hard and soft resins. Solid resins are a fraction of common resins insoluble in paraffin hydrocarbons, hexane, and petroleum ether with a low boiling point. Soft resins-fraction of General resins, soluble in paraffin hydrocarbons with low boiling point, consisting of  $\alpha$ - and  $\beta$ -acids,  $\alpha$  - and  $\beta$ -soft resins. Uncoated soft resins are a mixture of  $\alpha$ - and  $\beta$ -soft resins-oxidation products of  $\alpha$ - and  $\beta$ -acids, respectively. The composition of hop resins is shown in the diagram.

Phenolic compounds contained in plant raw materials are of interest to science and industry, because their chemical structure causes the manifestation of different physiological activity.

One of the sources of phenolic compounds is common hops-an important technical crop, which is widely used both in medicine and in the brewing industry. The importance of phenolic compounds of hops for brewing is their participation in slowing down oxidative processes, thereby increasing the shelf life of beer. Nevertheless, on the other hand, it is believed that the interaction of some polyphenols with proteins leads to colloidal turbidity of the drink [28].

Currently, the industry uses mainly hop products (up to 80% of hop raw materials). They are extremely complex mixtures of chemical compounds, and the technology of production, and, consequently, the composition of individual species is dramatically different. Despite the fact that hops have been subjected to quite a thorough study, phenolic compounds of hop products from a chemical point of view have not been studied enough.

Among the phenolic compounds contained in hop raw materials, the Central place is occupied by prenylated chalcones, which exhibit high antitumor, antioxidant, phytoestrogenic, anti-inflammatory and antiviral activity. Many laboratories around the world are developing methods for isolating these compounds. However, due to the multicomponency and complexity of the composition of hop products, the existing schemes do not allow obtaining compounds of a high degree of purity, and are quite complex in hardware design. Therefore, a promising direction is the development of schemes for the isolation of prenylated chalcones, devoid of these shortcomings, and the actual task is to study the chemical composition of phenolic compounds of hop products [29].

The cultivation of hops for this purpose has been traced back to Germany, 736 ad. for hops, despite its long successful history of domestication, modern breeding practice is fraught with a number of



problems. For example, although hops are usually cultivated vegetatively using rhizomes, sexual crosses are necessary to breed new disease-resistant and chemically desirable varieties. The long history of cultivation includes colchicine-induced polyploidization and introgression of genetically distinct wild populations. Recent genetic, genomic, and quantitative character analyses have shown that the hop genome is complex and structurally diverse. Violations in the genetics of hop transmission are reflected in the non-Mendelian distortion of segregation and displacement of the ratio [30].

Hops (*Humulus lupulus*, Cannabinaceae) - is a source of a number of biologically active compounds, such as essential oils, bitterness and flavonoids. One of the most interesting from a pharmacological point of view are the flavonoids of hops, represented by flavonol glycosides and prenylated flavonoids [31]. While flavonol glycosides are ubiquitous in green plants, the prevalence of prenylated flavonoids is limited to a small number of species, primarily the order urticaceae, the mulberry Mogaseae family, and the hemp Cannabinaceae (the latter family includes the hop plant). Hops are almost the only significant source of prenylated flavonoids such as xanthohumol and isoxanthohumol.

Interest in natural flavonoids is associated with their pronounced antioxidant properties, a number of types of flavonoids have anti-allergic, anti-inflammatory, antiviral, antibacterial properties and other types of biological activity. In addition, xanthohumol and isoxanthohumol of hops exhibit antiproliferative and anticancerogenic properties [32]. According to experimental data of many scientists, the presence of isoprenoid chains leads to various modifications of biological activity, which is mainly associated with a pronounced affinity with biological membranes and more pronounced interactions with proteins.

Hops are part of a number of well-known drugs and many registered dietary supplements (BAA) to food.

*Humulus lupulus* - it is a specialized crop with potential for new uses beyond its most common use in the brewing industry. As a medicinal plant already used in the food industry, hops are a compelling candidate for further scientific research, especially biochemical and molecular genetic studies. However, since hops are a niche crop, crop improvement studies should have superior cost-effectiveness [33].

In brewing practice, the use of appropriate hops is important for the production of stable and high-quality beer. However, batches of hops of the same variety cultivated in different geographical regions can exhibit significant biochemical differences, leading to specific taste and aroma characteristics of the beer. Genetic studies illustrate the complementarity of genetic and biochemical fingerprinting methods for the complete characterization of hop batches. Using genotyping by sequencing (GBS), a set of 1,830 polymorphic single nucleotide polymorphism markers (SNP) yields 48 unique genetic imprints for a collection of 56 commercial hop varieties. Three groups of varieties consisting of somaclonal variants could not be further differentiated using this set of markers. Biochemical marker information provides additional value for the characteristics of hop samples of this variety grown in different geographical locations [34].

*Humulus lupulus* L. (Cannabaceae), commonly called hops, is widely grown worldwide for its use in the brewing industry. Its female inflorescences (hops) are especially prized by brewers because they produce some secondary metabolites that give the beer bitterness, flavor and antiseptic properties. These metabolites exhibit numerous biological activities, including antimicrobial, sedative, and estrogenic properties. This review presents a list of chemical properties of hops with an emphasis on secondary metabolites and their biological activity. These compounds, of biological interest, are mainly formed in female inflorescences, while other parts of the plant synthesize them only in small quantities [35].

Hops ordinary (*Humulus Lupulus* L.) - root herbaceous plant. The length of the stem of hops 3-5 m, sometimes more, has a faceted, sloping, on the hair with low-rounded spines. The bottom of the leaves is a heart-shaped opening, at the edges-toothed, mouth. Leaf satellites of Lancet. The flowers of the males are collected on the tips of the stem and branches as tassels. Females are located in the saddle, on the upper leaf scaffolds. The nut is round. In June – July bloom, fruits ripen in July-August. In medicine, the use melnichnye bottles. Vitamin C is found in the leaves. On the Kazakh land, it is found in the Northern part of the West Kazakhstan region, along Tobolsk, Irtysh, Ishim, Mugalzhar, Aktobe, Kokshetau [36].

Summing up, undoubtedly, due to the increased anthropogenic impact on the environment, as well as the weakening of the adaptation of nature, there is a need for actions to ensure the restoration of natural resources now.

In addition, the best knowledge can be used in the hope of breeding programs that allow the targeted enrichment of new varieties in the right compounds.

Given the key role of hops, there is great scientific interest in the use of hops extract to create for the taste of beer and study the molecular and biochemical basis of hops.

In world practice, the use of natural products, medicines and biologically active substances of plant origin in medicine is currently increasing. Significant parts of the medicinal raw materials are wild plants. The need for medicinal plant raw materials (medicinal plants) is not reduced; the technology of its preparation and reproduction in natural conditions requires significant perfection.

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### ТАБИҒИ ПОПУЛЯЦИЯЛАР ҚҰРЫЛЫМЫНЫҢ ЕРЕКШЕЛІКТЕРІ *HUMULUS LUPULUS* L. (ШОЛУ)

**Аннотация.** Мақалада әлемдегі және Қазақстандағы *Humulus lupulus* L. табиғи популяциялар құрылымының ерекшеліктері көрсетілген. Қазіргі уақытта медицинада табиғи өнімдерді, дәрі-дәрмектерді және өсімдік тектес биологиялық белсенді заттарды пайдалану ұлғайып келеді. Жабайы өсімдіктер дәрілік шикізаттың елеулі бөлігін құрайды. Дәрілік өсімдік шикізатына (дәрілік өсімдіктерге) қажеттілік азаймайды, оны дайындау және табиғи жағдайларда қайта өндіру технологиясы айтарлықтай жетілдіруді қажет етеді. Олар адам ағзасына кешенді әсер етеді және көптеген созылмалы ауруларды емдеуде қолданылады. Антропогендік әсердің артып отыруы салдарынан бағалы дәрілік өсімдіктер популяциясындағы шикізат қорларын азаяды. Осыған байланысты биологиялық ерекшеліктерді зерттеу және көптеген дәрілік өсімдіктерді өсірудің ғылыми негізделген агротехникасын әзірлеу өзекті болып отыр. *Humulus lupulus* L. (кәдімгі құлмақ) – бағалы дәрілік өсімдік. Олар жоғары жүйке қоздырғыштығы, ұйқының бұзылуы, невралгия, вегето-тамыр дистониясы, коронарлық тамырлардың айқын көрінбейтін спазмалары, тахикардия кезіндегі, гипертониялық аурудың ерте сағыларындағы ауырсыну кезінде, седативті, ұйықтататын дәрі ретінде қолданылады. *Humulus lupulus* L. дәрілік өсімдіктер ресурстарын жіктеу бойынша, *Humulus lupulus* L. өсетін жерлер қарастырылады [1].

Соңғы уақытта, өсімдіктердің табиғи популяцияларын зерттеуде, онтоморфологиялық және популяциялық-экологиялық зерттеулерді қамтитын кешенді тәсіл қолданылып келеді. Бұл ценоздағы түрдің жайкүйін объективті бағалауға және болашақта оның мінез-құлқын болжауға мүмкіндік береді. Осыған байланысты *Humulus lupulus* L. табиғи популяцияларын кешенді зерттеу үлкен маңызға ие.

Құлмақ (*Humulus lupulus* L.) сырадағы негізгі дәм – ингредиент ретінде белгілі, бүкіл әлемдегі маңызды мәдениет. Өртараптандырылған сыра қайнату өнеркәсібі құлмақ алдыңғы қатарлы молекулалық селекциялық күш-жігердің орталығы болып табылатын дәмдердің, тамаша технологиялық қасиеттердің және тұрақты агрономияның әртүрлілігін талап етеді. Құлмақ селекционерлері қалаған белгілері бар штаммдар жасау қабілетіне шектеулі болды, алайда тұқым қуалаудың ерекше және болжанбаған модельдеріне және генетикалық маркерлердің Менделевтік сегрегациясына байланысты [2].

Соңғы уақытта құлмақ пайдалану қолөнер сыра қайнату секторы қолдайтын неғұрлым қарқынды хош иістендірілген сыраны халықаралық деңгейде өсіп келе жатқан артықшылық тудыратын жаңа өзгерісті бастан кешуде. Бұл қозғалыс сыра өндірісінің әртүрлі кезеңдерінде құлмақтың көп мөлшерін енгізуге және ұдайы өсіп отыратын жаңа талғамды іздеуге алып келді. Осылайша, құлмақтың кейбір сорттары – негізінен қазіргі уақытқа дейін пайдаланылып келген ескі типтегі сорттар, бірақ, соның ішінде "жасыл алтын" деп аталатын жаңа сорттарды қарқынды түрде іздеу жұмыстары ерекше назар аудартады. Таңдаулы жаңа сорттардың көптеген саны анықталып, сипатталған және нарықта көбірек бағаланады. Құлмақ өсірудің жаһандық алаңдары соңғы 5 жылда ұлғайды, бірақ сыраның жалпы әлемдік өндірісі сол кезеңде қысқарды. Бұл жайт сыраның бір литріне құлмақтың көп мөлшерін пайдалану үрдісін растайды. Бұдан басқа, құлмақ және оның туындылары үшін фармакологиялық қасиеттердің кең спектрі, атап айтқанда, фармацевтикалық өнеркәсіп үшін үлкен маңызы бар антиоксиданттық, қабынуға қарсы және ісікке қарсы қасиеттері сипатталған. Сыраның биоактивтілігі құлмақ пайдалануға байланысты болуы мүмкін, сондай-ақ ол функционалдық өнімдерді әзірлеуге бағытталған сыра қайнатқыштары үшін маңызды құрал болуы мүмкін.

Қабынуға қарсы әрекет, микробқа қарсы әрекет, антиоксидантты әрекет, антипролиферативті әсерлер, P450 цитохромының әсерлері, глюкоза метаболизмінің әсерлері, гормональды әсерлер, липидті әсерлер және седативті / гипнотикалық әсерлер сияқты биологиялық белсенділіктің кең спектріне ие.

Сондықтан осы тараудың мақсаты сыраны өндірудің осы жаңа бағытындағы құлмақ мәнін сипаттау, құлмақ нарығына, сорттарға, формаларға және пайдалану әдістеріне, құрамына, сыраның биобелсенділігіне және құлмақ зерттеулеріндегі жаңа жаңалықтарға шолу жасау болып табылады [3].

**Түйін сөздер:** *Humulus lupulus* L., эфир майлары, фенолды қосылыстар, лупулин.

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### ОСОБЕННОСТИ СТРУКТУРЫ ПРИРОДНЫХ ПОПУЛЯЦИЙ *Humulus lupulus* L. (ОБЗОР)

**Аннотация.** В статье представлен обзор особенностей структуры природных популяций *Humulus lupulus* L. в мире и в Казахстане. В настоящее время увеличивается использование в медицине натуральной продукции, лекарств и биологически активных веществ растительного происхождения. Существенную часть лекарственного сырья составляют дикорастущие растения. Потребность в лекарственном растительном сырье (лекарственных растениях) не уменьшается, технология его заготовки и воспроизводства в природных условиях желает значительного совершенства. Известно, что они оказывают более мягкое, комплексное действие на организм человека и используются при лечении многих хронических заболеваний. Растущее антропогенное воздействие на популяции ценных лекарственных растений сокращает запасы их сырья. В связи с этим актуальными становятся изучение биологических особенностей и разработка научно обоснованной агротехники возделывания многих лекарственных растений. *Humulus lupulus* L. (хмель обыкновенный) – ценное лекарственное растение. Их используют как болеутоляющее, седативное, снотворное средство при повышенной нервной возбудимости, нарушениях сна, невралгии, вегетососудистой дистонии, нерезко выраженных спазмах коронарных сосудов, тахикардии, при ранних стадиях гипертонической болезни. По классификации ресурсов лекарственных растений *Humulus lupulus* L. – растение с широким ареалом, но с ограниченным запасом сырья. В местах произрастания *Humulus lupulus* L. не образует крупных зарослей [1].

В последнее время в изучении природных популяций растений применяется комплексный подход, включающий онтоморфологические и популяционно-экологические исследования. Это дает возможность объективно оценить состояние вида в ценозе и прогнозировать его поведение в будущем. В связи с этим, комплексное изучение природных популяций *Humulus lupulus* L. имеет большую актуальность.

Хмель (*Humulus lupulus* L.) является важной культурой во всем мире, известной как основной вкусовой ингредиент в пиве. Диверсифицированная пивоваренная промышленность требует разнообразия вкусов, превосходных технологических свойств и устойчивой агрономии, которые являются центром передовых молекулярных селекционных усилий в хмеле. Селекционеры хмеля были ограничены в своей способности создавать штаммы с желательными признаками, однако из-за необычных и непредсказуемых моделей наследования и связанной с ними неменделевской сегрегации генетических маркеров [2].

В последнее время использование хмеля переживает новое изменение, вызванное растущим на международном уровне предпочтением более интенсивно ароматизированного пива, поддерживаемого сектором ремесленного пивоварения. Это движение привело к введению гораздо большего количества хмеля на различных этапах производства пива и к постоянно растущему поиску новых вкусов. Некоторые сорта хмеля, таким образом, получили особое внимание, в том числе несколько старых типичных хмелей, в основном используемых до настоящего времени, хотя интенсивный поиск новых сортов, получивших название “Зеленое золото”, также имел место. Большое количество новых изысканных сортов было описано и все больше ценится на рынке. Глобальные площади выращивания хмеля увеличились за последние 5 лет, хотя общее мировое производство пива сократилось за тот же период, что подтверждает тенденцию использования большего количества хмеля на литр пива. Кроме того, для хмеля и его производных описан широкий спектр фармакологических свойств, а именно антиоксидантные, противовоспалительные и противоопухолевые свойства, которые имеют большое значение для фармацевтической промышленности. Биоактивность пива может зависеть от использования хмеля, который может стать важным инструментом для пивоваров, нацеленных на разработку функциональных продуктов.

Взятые вместе, соединения, выделенные из *Humulus lupulus* L., обладают широким спектром биологической активности, таким как: противовоспалительное действие, противомикробное действие, антиоксидантное действие, антипролиферативное действие, эффекты цитохрома P450, глюкоза эффекты метаболизма, гормональные эффекты, липидные эффекты и седативные / гипнотические эффекты.

Поэтому целью настоящей статьи является описание значения хмеля в этом новом направлении производства пива, обзор рынка хмеля, сортов, форм и методов использования, состава, значения в биоактивности пива и новых открытий в исследованиях хмеля [3].

**Ключевые слова:** *Humulus lupulus* L., эфирные масла, фенольные соединения, лупулуин.

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