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EDIBLE SPECIES OF XYLOTROPHIC MACROMYCETES DISTRIBUTED IN AZERBAIJAN AND THEIR RESOURCE POTENTIAL

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Edible species of xylotrophic mushrooms distributed in forests located in different areas of Azerbaijan were comprehensively studied in the conducted researches. It was determined that 13 species corresponding to this characteristic are distributed in the studied forests.They also differed from each other in terms of their frequency of occurrence, relationship to the substrate, the approximate amount of fruiting body (FB) they formed under natural conditions, the amount of biomass (VM) they formed in the vegetative growth phase, as well as the toxicity and biochemical composition of BF and VM. Nevertheless, among them, it was determined that there are species that can be used successfully for both food, and was obtained information containing the scientific and practical basis of their effective use.

Keywords: *Azerbaijani forests, xylotrophic macromycetes, edible species, occurrence frequency, biochemical composition*

Currently, in order to obtain biomass (fruiting body and vegetative mycelium) from mushrooms, cultivated by various methods (intensive, extensive, deep, superficial) and contains various spectrum effects (anti-tumor, antibacterial, antiviral, antioxidant, immune-enhancing, weakening, stimulating, inhibitory, etc.) is considered one of the convenient and safe methods in different regions of the world[4, 7, 13-14]. Thus, this approach draws attention from the point of view of disposal of waste generated in various fields, primarily in the agricultural field [4]. The fact that fungi, which are characterized by great diversity, are active producers of metabolites useful for various (food, feed, medical and technical) purposes, also necessitates efforts aimed at expanding their use for product production Currently, the number of mushroom species used for one or another purpose exceeds the number of mushroom species known to science. It would be appropriate to mention one fact in this regard. Currently, the number of edible mushrooms intensively cultivated for food purposes is slightly more than 30[10], although the number of mushrooms belonging to this category is 10 times higher. For this reason, expansion of both the number of species of mushrooms used as a source of products suitable for food purposes and the assortment of products obtained from them is one of the modern research directions. The relevance of this issue attracts attention for another reason. The relevance of this issue attracts attention for another reason. So, the natural soil-climate and flora of this or that region are different and due to their effect, the biological activity of the fungi spread in those areas and the amount of biomass produced in natural conditions are characterized by different quantitative indicators. This allows us to note that there is a high probability of spreading of those with higher productivity compared to known mushroom strains from different regions. As a reason for this high probability, it is worth noting that even today the study of fungi is not comprehensive enough and mycological researches are not conducted or the coenoses conducted in the distant past are not enough. If we evaluate the si-

tuation in the Republic of Azerbaijan, which has a rich and colorful nature and a wide variety of soil and climate conditions, against the background of what has been mentioned, it becomes clear that the situation here is not at a level that can be evaluated positively. This can be explained by only one fact. The fact is that 11.8% of the territory of the Republic of Azerbaijan is covered with forest[8] and many studies have been conducted to study the mushroom that spread there, and if the results of our research are not taken into account, the number of species of xylotrophic macromycetes distributed in Azerbaijan was determined to be equal to 212 [1], and among them there are promising ones as producers of BAS[3]. Despite this, the number of mushroom species involved in comprehensive studies on the assessment of the potential of these mushrooms as food products and as BAS producers does not even reach 5%. On the other side, in the studies conducted so far, almost all of the mushrooms belonging to the category of edible mushrooms (except for *Pleurotus ostreatus*) have not been the object of specific research. All these are among the most relevant issues of comprehensive, primarily species composition and ecological-biotechnological research of xylotrophic macromycetes distributed in the nature of Azerbaijan and their use in order to obtain food products. Therefore, the presented work is aimed at solving these issues.

Material and methods

Researches were mainly conducted in the southern forests of the Republic of Azerbaijan. At the same time, in order to compare a number of indicators, samples were taken from plain and mountain forests located in large geomorphological units such as the Greater and Lesser Caucasus.

In taking samples(more than 700 samples in total) of xylotrophic macromycetes, that is FB produced in the natural environment was used traditional route (width 5-6 m, length 500 m to 5000 m) and permanent area (50mx50m size) selection method . The species composition of the mushroom was determined based on the morphological description of the MC and the known determinant [5] based on the data obtained from the microscopic examination.

The frequency of occurrence of fungi in natural conditions (P) was determined according to the following formula:

$$P(un/ha)= N/S \quad (1)$$

Here, N is the number of fruit bodies of a specific species recorded along the chosen route (un.),S – the area of the selected route (ha). To find the area of the route, were used its width (a) and length (b) measured in m, thai is S=ab.

The amount of fruit bodies produced by mushrooms in natural conditions was calculated according to the following formula:

$$M = [(X_1+X_2+.....+Xn)/n]x(SP) \quad (2)$$

Here, M – is the weight (t) of the fruit body formed by the fungus under natural conditions, X1, X2, ..., Xn -is the weight (kg) of the MC produced by the fungus under natural conditions 24 hours after its removal, n – the number of MC (n), S – the total area of the studied forest (ha), P – is the occurrence frequency of MC determined according to formula 1.

The obtained of the pure culture of the fungus was carried out according to the known method in agarized malt juice (AMJ) [9]. Cultivation of pure cultures in liquid glucose-peptone medium (LGPM) was also carried out under deep cultivation conditions at a temperature of 26-28^{0}C for 5 days according to analogous methods. At the end of the period, the formed biomass is crushed in a magnetic stirrer and used as planting material. During the evaluation of edible mushrooms for biomass production in the vegetative phase, cultivation was carried out for 3-10 days under deep cultivation conditions (DC, 160-180 cycles/min, 26-28^{0}C). The formed biomass is separated from the nutrient medium with the help of a centrifuge (10 min, 5000 revolutions/min) and evaluated according to the dry weight method at 105^{0}C , and biomass yield expressed in g/l or mg/ml.

Determination of toxicity of mushroom cultures to infusora (Tetrahymena pyriformis), as well as the relationship of seed germination was carried

out according to the methods used in the work of K.F. Bakhshaliyeva and others[3].

During the determination of the biochemical composition of mushroom-specific MC and VM, the amount of proteins was determined by the Keldal method (N×6.25; N×4.38), the total amount of carbohydrates by the Bertrand method, the amount of water-soluble carbohydrates by the Shomodi-Nelson method, the amount of nucleic acids (the sum of RNA and DNA) was determined by the spectrophotometric method in the SF-2000 device, and the amount of fats was determined based on the Soxhlet apparatus [15]. Cultivation of *P. ostreatus* mushroom for receiving feed supplement was carried out under solid-phase fermentation conditi according to the methods used in the work of P.Z. Muradov [12].

Results and their discussion

During the identification of edible species of xylotrophic macromycetes in the studied areas during 2014-2022, according to the set goal, it became clear that the number of species corresponding to this characteristic is equal to 13[*Armillaria mellea* (Vahl)P.Kumm, *Fistulina hepatica* (Schaeff.) With., *Flammulina velutipes* (Curtis) Singer, *Ganoderma lusidum* (Curtis) P. Karst, *Kuehnerómyces mutábilis* (Schaeff.) Singer & A.H. Sm., *Laetiporus sulphureus* (Bull.) Lázaro İbiza, *Lentinis tigrinus* (Fr.) Fr., *Piptoporus betulinus* (Bull.: Fr.) P.Karst., *Pleurotus ostreatus* (Jacq.)P.Kumm, *P. pulmonarius* (Fr.) Quel., *Pluteus atricapillus* (Secr.) Sing., *Polyporus squamosus* (Huds.) Fr., *Polýporus umbellátus* (Pers.) Fr.)].

It should be noted that identification of edible types of mushrooms distributed in Azerbaijan, as well as in the world, is not at the desired level. Today, the mentioned figure does not fully reflect the reality, as there are quite a number of species whose status is not fully clarified, as well as those unknown to science, but actually in nature. More precisely, it is an indicator that includes only a certain part of edible mushrooms, not all of them. In the future, it is necessary to clarify this issue, to carry out studies aimed at clarifying the species whose status is not known according to whether they are edible or not.

Based on the obtained results, it was determined that edible mushrooms are characterized by a wide variety of both their main indicators in natural conditions(frequency of occurrence, eco-trophic relations, distribution in different substrates, amount of fruit body formed during the year) and their indicators in the vegetative growth phase(amount of VM, biochemical composition, toxicity, etc.). Despite this diversity, the inclusion of promising species among edible mushrooms due to their main indicators in natural conditions, the fact that some of them are even dominant in terms of frequency of occurrence, most of them do not have true biotrophy or saprotrophy (i.e. polytrophy), some produce fruiting body (FB) twice a year is one of the data determined in the research conducted. This information is necessary when using mushrooms for various purposes, especially for food purposes. It should be noted that although the preparation of medicinal preparations, various food and nutritional supplements by synthetic means has led to great success, in recent times, the expansion of both fundamental and practical researches aimed at obtaining the mentioned products from natural sources is of particular importance. In this regard, in order to use natural resources more efficiently, it is important to calculate and at least predict their available natural resources. Therefore, a formula was developed for calculating the annual amount of FB that can be produced by common types of edible mushrooms in the conditions of Azerbaijan, and a target indicator was determined for the mushrooms recorded in the research (Table 1).

As it can be seen, the estimated amount of FB predicted to be produced by the mushrooms recorded in the conditions of Azerbaijan during the year is 216.9 t.

Table1

Estimated amount of FB naturally produced by xylotrophic macromycetes

Mushroom species	Number of FB generation waves (times)	Frequency of occurrence (un/ha)	Weight (t) of FB produced by year
Armillaria mellea	*2*	0,25	14,3
Fistulina hepatica	*1*	0,000021	0,003
Flammulina velutipes	*2*	0,11	0,090
Ganoderma lusidum	*1*	0,12	0,090
Kuehnerómyces mutábilis	*1*	0,0012	0,190
Laetiporus sulphureus	*2*	0,78	90,00
Lentinis tigrinus	*2*	0.12	5,00
Piptoporus betulinus	*1*	0,0005	0,007
Pleurotus ostreatus	*2*	0,76	98,80
P. pulmonarius	*2*	0,07	0,20
Pluteus atricapillus	*1*	0,0002	0,12
Polyporus squamosus	*2*	0,12	8,20
P.umbellátus	*1*	0,0017	0,090
Total			216,9

There is no doubt that this result is valuable information for the development of methods and approaches aimed at efficient use of resources.

Despite the determination of the annual approximate amount of FB produced by fungi under natural conditions, considering its limitation, the possibility of eliminating this limitation due to the biomass produced by these fungi during the vegetative growth phase was also investigated. It became clear that the fungi differ from each other in terms of the yield of biomass they produce in the vegetative growth phase (Table 2) and the difference between the minimum (P. umbelatus) and maximum (Pleurotus ostreatus) indicators of biomass yield is 3.16 times. Nevertheless, it was considered appropriate to select the most active strain of each of *G. lucidum, L. sulphureus* and *P. ostreatus* mushrooms as the most active producer in terms of biomass yield: *G. lucidum* BS-11(6.7 g/l), *L. sulphureus* BS- 21(6.6 g/l) and *P. ostreatus* BS-32 (7.9 g/l).

Table 2

Evaluation of the edible species of xylotrophic macromycetes recorded in the studies according to the biomass yield during the vegetative phase

Mushrooms species	Number of strains used (un)	Cultivation period (days)	Amount of processed biomass (g/l)
Armillaria mellea	5	5	3,2-4,1
Fistulina hepatica	1		2,9
Flammulina velutipes	3		3,1-4,0
Ganoderma lusidum	7		4,0-6,7
Kuehnerómyces mutábilis	3		2,7-3,9
Laetiporus sulphureus	6		3,7-6,6
Lentinis tigrinus	4		3,0-5,0
Piptoporus betulinus	2		3,1-4,3
Pleurotus ostreatus	7		5,3-7,9
P. pulmonarius	2		3,5-4,2
Pluteus atricapillus	1		3,1
Polyporus squamosus	3		2,7-4,0
P.umbellátus	1		2,5

The selection of strains belonging to different species is related to the fact that the mentioned mushroom species are currently in the center of attention as active producers of various biologically active substances [2, 6, 11], which are widely studied in the world.

In the studies conducted on finding the optimal environment for the formation of maximum biomass for the fungi selected as active producers, more precisely, the optimal ones according to a number of parameters, the initial biomass yield was increased to 14-19%. As it is known, these or other biologically active substances are found in both FB and VM of mushrooms, and therefore both substances are used. Considering this, the biochemical composition and toxic activity of the materials obtained from both substances of the producers selected as active producers were also studied. The results made it possible to note that they do not have a toxic effect and have indicators that can be characterized in a positive direction according to their biochemical composition. This can also be realized by obtaining pure cultures of mushroom whose distribution has been recorded in research, selecting active strains according to biomass yield, and finding the optimal environment for the selected strains. The biomass obtained in this way has characteristics that can overcome the limitations of the biomass (FB) produced by fungi in natural conditions due to ecological, technological, and economic considerations and it finds its highest expression in the example of mushroom such as *G.lucidum* BS-11, *L.sulphureus* BS- 21 and *P.ostreatus* BS-32 .

Thus, in the conducted research were comprehensively(according to species composition, frequency of occurrence, approximate amount of FB they form in natural conditions, physiological-biochemical characteristics of both FB and VM) studied the edible species of xylotrophic mushrooms distributed in the forests located in different areas of Azerbaijan , and determined that among them are species that can be use successfully for both food and fodder purposes, also was obtained information containing the scientific and practical basis of their effective use.

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AZƏRBAYCANDA YAYILAN KSİLOTROF MAKROMİSETLƏRİN YEMƏLİ NÖVLƏRİ VƏ ONLARIN RESURS POTENSİALI

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Aparılan tədqiqatlarda Azərbaycanın müxtəlif ərazilərində yerləşən meşələrdə yayılan ksilotrof göbələklərin yeməli növləri kompleks şəkildə tədqiq edilmişdir. Tədqiq edilən meşələrdə bu xarakteriskaya uyğun gələn 13 növün yayılması müəyyən edilmişdir ki, onlar da bir-birlərindən rastgəlmə tezliyinə, substrata münasibətinə, təbii şəraitdə əmələ gətirdikləri meyvə cisminin (MC) təxmini miqdarına, vegetativ böyümə fazasında əmələ gətirdiyi biokütlənin miqdarına(VM), eləcə də MC və VM-nin toksikliyinə və biokimyəvi tərkibinə görə fərqlənmişlər. Buna baxmayaraq, onların arasında həm qida, həm də yem məqsədlərində uğurla istifadə etməyə imkan verən növlərin olması müəyyən edilmiş, onlardan səmərəli istifadənin elmi və praktiki əsaslarını özündə əks etdirən məlumatlar əldə edilmişdir.

Açar sözlər: *Azərbaycan meşələri, ksilotrof makromisetlər, yeməli növlər, rastgəlmə tezliyi, biokimyəvi tərkib*

РАСПРОСТРАНЕННЫЕ В АЗЕРБАЙДЖАНЕ СЪЕДОБНЫЕ ВИДЫ КСИЛОТРОФНЫХ МАКРОМИЦЕТОВ И ИХ РЕСУРСНЫЙ ПОТЕНЦИАЛ

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В проведенных исследованиях были всесторонне изучены съедобные виды ксилотрофных грибов, распространенных в лесах различных территорий Азербайджана. В соответствии с данной характеристикой в исследованных лесах определено распространение 13 видов , которые отличаются друг от друга по частоте встречаемости, отношению к субстрату, приблизительному количеству образуемых ими в естественных условиях плодовых тел (ПТ) , по продуцируемой ими в фазу вегетативного роста количеству биомассы (БМ), а также по токсичности и биохимическому составу ПТ и ВМ. Кроме того выявлено, что среди них имеются виды, которые можно успешно использовать как в пищевых, так и в кормовых целях, и получены сведения, включающие научно-практические основы их эффективного использования.

Ключевые слова: *леса Азербайджана, ксилотрофные макромицеты, съедобные виды, частота встречаемости, биохимический состав*