



## OCCURRENCE OF MUSHROOM SPECIES BELONGING TO THE GENUS *AGARICUS* (AGARICACEAE, BASIDIOMYCETES) IN SOME REGIONS OF UZBEKISTAN

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### Abstract

Data on occurrence of mushroom species of the genus *Agaricus* in regions of Uzbekistan received by other investigations as well as by the authors are analyzed and systematized. Forty three *Agaricus* species have been registered in total in the country. The most number of species (38) has been found in Jizzakh region, followed by Tashkent (10 spp.), Kashkadarya and Fergana regions (7 spp. in each). It is stated that 8 and 7 species of this genus have been identified in Tashkent and Kashkadarya regions, respectively. Till present purposeful investigations of *Agaricus* spp. have not been conducted in Kashkadarya region, and we have registered 7 species new for this region. Ecological and biological groups of these fungi are described here.

**Keywords** - fungi, edible mushrooms, genus *Agaricus*, species identification.

### I. INTRODUCTION

Species of the genus *Agaricus* L.:Fr. are best known among mushrooms and they are of great importance in nature and human's life. These fungi function as active participants in humus creation in soils, and by this, they play a significant role in increasing soil fertility. Besides, these mushroom fungi deserve a big attention because there are some edible species among them, that are produced commercially and in huge volumes. Noteworthy that only about 40 species are grown commercially of more than 14 000 species of mushrooms widely distributed in various natural habitats [6].

Till nowadays the value of agaric fungi as a source of nutrition have being determined by comparing content of protein in these mushrooms with that of a meat or vegetables. However, investigations carried out during last years have shown that it is necessary to consider not only amount of proteins available but also their accessibility by human organism, and, as well, by availability of essential amino-acids [7, 9, 16].

Genus *Agaricus* belongs to the family *Agaricaceae*, order *Agaricales*, class *Basidiomycetes* (*Agaricomycetes*). One of its most important from applied view representatives is *Agaricus bisporus*.

Some scientists estimated that there are not many representatives in this genus and their number are just over 200 species. These mushrooms are of big interest related to their morphology and anatomy, ontogeny, geographical distribution and ecology [10, 14, 20]. At the same time others have estimated that on a worldwide basis there are more than 300 species of this genus [2, 4, 22].

Genus *Agaricus* have been divided into several sections that were *Agaricus*, *Arvense*, *Chitonioides*, *Sanguinoletti*, *Xanthodermatei*, *Spissicaules*, and *Duploannulatae* [5, 12].

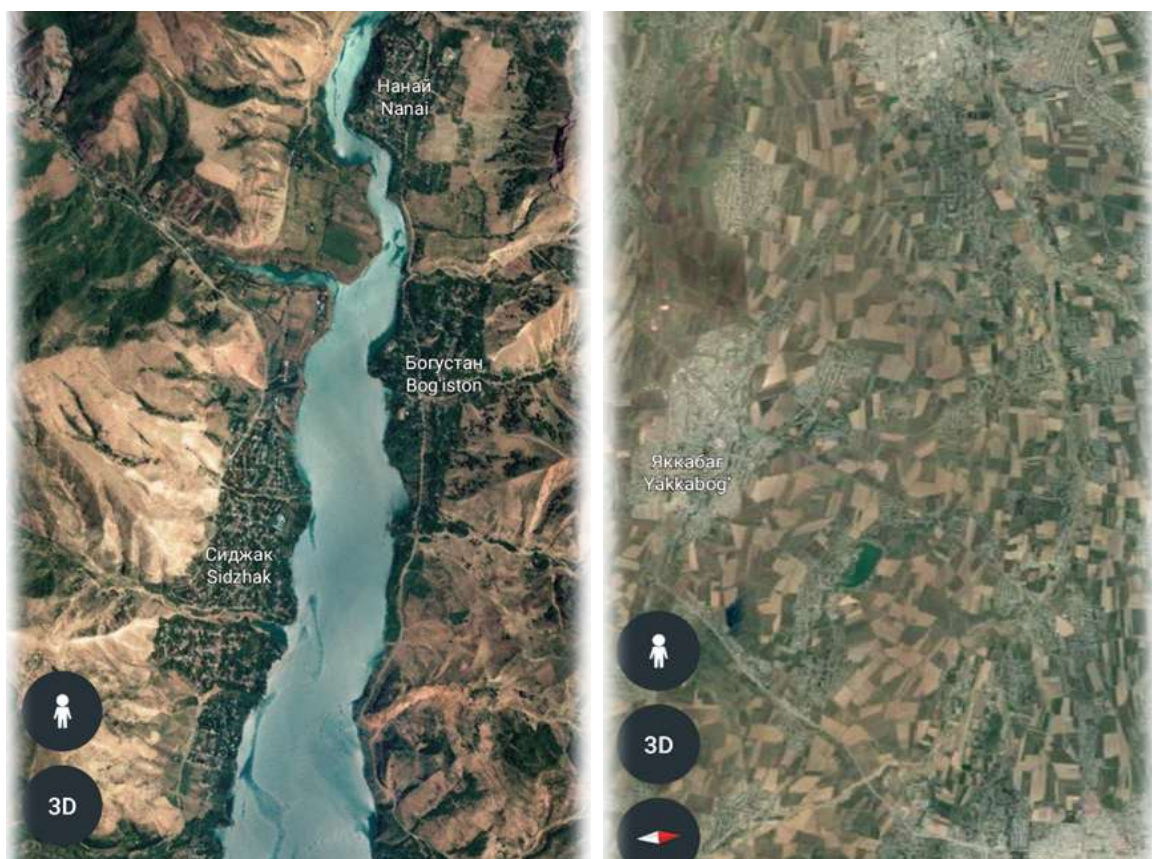
On the opinion of some other scientists genus *Agaricus* currently contains more than 90 species, among them *A. bitorquis*, *A. silvaticus*, *A. subperonatus*, *A. augustus*, *A. bernardii*, and *A. tabularis* can be considered as having the widest occurrence in the nature [15]. Still other mycologists consider that, in accordance with the modern taxonomic system, genus *Agaricus* contains 7 sections, and approximately 200 species [14].

Both level and depth of investigations that are being conducted differ in various countries and regions of the Globe. Analysis of literature sources on *Agaricus* mushrooms has shown that there were lots of research with these fungi carried out in many countries but purposeful trials have not been done in the Republic of Uzbekistan. There is only some information about *Agaricus* spp. collected in route observations on studying of fungi in the definite regions of Uzbekistan (Table 1).

As there were no research conducted with the express purpose to study *Agaricus* spp. in conditions of our country, this situation has been a trigger for realization of investigations aimed to determine occurrence of these fungi in Uzbekistan, and to isolate their strains, promising for commercial production of their fruiting bodies locally.

## II. MATERIALS AND METHODS

Research has been fulfilled in 2008-2012 in mountainous, foothill and plain areas of Tashkent and Kashkadarya regions (Photo 1). Objects of investigation were all species of *Agaricus* mushrooms registered by other scientists and in our own investigations. Field works were realized mainly in the route observations.



**Figure 1. Observation area**

Identification of collected samples of the *Agaricus* mushrooms to the species level has been done at the Department of Plant Pathology and Agricultural Biotechnology of the Tashkent State Agrarian University, using Mikmed-5-2M microscope. Common identification books have been used for this work [20, 21].

## III. RESULTS AND DISCUSSION

First data regarding species of *Agaricus* mushrooms found at the territory of the Republic Uzbekistan have been published by N.I. Gaponenko (1959, 1965) and G.T. Baymuratova (1963); some other works contained descriptions only of two (Panfilova, Gaponenko, 1963; Akhmedova, 1966), or 7 to 10 species (Khalikova, 1989; Iminova, 2009). A.A. Petrova (1985) has registered 38 species or varieties of the genus *Agaricus* in total during her observations. We have registered 11

species of this genus in Tashkent and Kashkadarya regions, including 5 species belonging to the subgenus *Agaricus*, and 6 species of the subgenus *Flavoagaricus* (Table 1).

**Table 1. Species of the genus *Agaricus* registered in Uzbekistan**

No	Species of the genus <i>Agaricus</i>	Source of information (authors)							
		Gaponenko, 1959, 1965	Panfilova, Gaponenko, 1963	Baymuratova, 1963	Akhmedova, 1966	Petrova, 1985	Khalikova, 1989	Iminova, 2009	Khakimov et al. (=current paper)
1	2	3	4	5	6	7	8	9	10
<b>Subgenus <i>Agaricus</i></b>									
1	<i>Agaricus campestris</i> L.: Fr.	+	+	+	+	+	+	+	+
2	<i>A. altipus</i> (Moell.) Pil.					+			
3	<i>A. benesii</i> (Pilát) Pilát					+			
4	<i>A. bernardii</i> Quel. apud Cke. et Quel.	+		+		+	+		+
5	<i>A. bisporus</i> (J. Lge.) Imbach					+	+	+	+
6	<i>A. bitorquis</i> (Quel.) Sacc.					+	+		+
7	<i>A. campestris</i> var. <i>floscupus</i> (Moell.) Pil.					+			
8	<i>A. deulii</i> Pil.					+			
9	<i>A. gennadii</i> (Chat. et Boud.) P.D.Orton						+		
10	<i>A. gennadii</i> var. <i>microsporus</i> (Bohus) Wasser								+
11	<i>A. porphyrocephalus</i> (F.H. Møller) F.H. Møller					+			
12	<i>A. romagnesii</i> S.Wasser					+			
13	<i>A. spissicaulis</i> (F.H. Møller) F.H. Møller					+			
14	<i>A. squamulliferus</i> (Moell.) Pil.					+			
15	<i>A. silvaticus</i> Schaeff. ex Secr.						+	+	
16	<i>Agaricus</i> spp.	+*		+*		+			
<b>Subgenus <i>Flavoagaricus</i></b>									
17	<i>A. aestivalis</i> var. <i>flavotacta</i> (Moell.) Pil.					+			+
18	<i>A. aestivalis</i> Secr.					+			
19	<i>A. aestivalis</i> var. <i>aestivalis</i> (Moell.) Moell.					+			
20	<i>A. amanitaeformis</i> Wasser					+			
21	<i>A. arvensis</i> Schaeff.					+	+	+	+
22	<i>A. augustus</i> Fr.								+
23	<i>A. decoratus</i> Lindgr.					+			
24	<i>A. essettei</i> Bon					+			
25	<i>A. fissuratus</i> (F.H. Møller) F.H. Møller					+			
26	<i>A. impudicus</i> (Rea) Pilát					+			
27	<i>A. leucotrichus</i> (F.H. Møller) F.H. Møller					+			
28	<i>A. luteomaculatus</i> (F.H. Møller) F.H. Møller					+			
29	<i>A. lutosus</i> (Moell.) Moell.					+			
30	<i>A. macrocarpus</i> (F.H. Møller) F.H. Møller					+			+

31	<i>A. maskae</i> Pilát					+			
32	<i>A. niveolutescens</i> Huijsman					+			
33	<i>A. nivescens</i> (Moell.) Moell.					+	+		
34	<i>A. perrarus</i> Schulz.					+			
35	<i>A. phaeolepidotus</i> (Moell.) Moell.					+			
36	<i>A. pseudopratis</i> var. <i>niveus</i> Bohus,					+			
37	<i>A. rusiophyllus</i> Lasch					+			
38	<i>A. semotus</i> Fr.					+			
39	<i>A. tabularis</i> Pk		+		+		+		+
40	<i>A. tenuivolvatus</i> (Moell.) Moell.					+			
41	<i>A. velenovskyi</i> Pil.					+			
42	<i>A. wassereri</i> Bon & Courtec.					+			
43	<i>A. xanthodermus</i> Genevier					+	+	+	+
	<b>Total</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>38</b>	<b>10</b>	<b>7</b>	<b>11</b>

Analysis of distribution of spp. in regions of Uzbekistan showed that the most number of species (38) has been found in Jizzakh region, followed by Tashkent (10 spp.), Kashkadarya and Fergana regions (7 spp. in each). These 7 species have been registered for the first time in Kashkadarya region (Table 2).

Natural substrates where species of the genus *Agaricus* grow and levels of adaptation for their growth on these substrates are considered as one of the most important taxonomic criteria. We have determined that these mushrooms belonged to the following ecological – biological groups: saprotrophs that prefer growing on humus, saprotrophs on grass covers, coprophilous species, bryotrophs, lignicolous species, and carbotrophs [21].

Among registered species of the genus *Agaricus* the followings preferred to grow on humus: *A. campestris*, *A. bisporus*, *A. bitorquis*, *A. bernardii*, *A. gennadii* var. *microsporus*, *A. tabularis*, *A. arvensis*. Three species, namely *A. bernardii*, *A. gennadii* var. *microsporus* and *A. tabularis*, were growing on open fields where no trees. *Agaricus augustus* and *A. xanthodermus* have been growing on grass covered sites.

**Table 2. Occurrence of *Agaricus* spp. in regions of Uzbekistan**

No.	Species of the genus <i>Agaricus</i>	Regions where <i>Agaricus</i> spp. have been registered				
		Tashkent	Fergana Valley	Jizzakh	Our observations	
					Tashkent	Kashkadarya
<b>Subgenus <i>Agaricus</i></b>						
1	<i>A. campestris</i> L.: Fr	+	+	+	+	+
2	<i>A. altipus</i> (Moell.) Pil.			+		
3	<i>A. benesii</i> (Pilát) Pilát			+		
4	<i>A. bernardii</i> Quel.apud Cke et Quel.	+		+	+	+
5	<i>A. bisporus</i> (J.Lge) Imbach	+	+	+	+	+
6	<i>A. bitorquis</i> (Quel.) Sacc.	+		+	+	+
7	<i>A. campestris</i> var. <i>floscupus</i> (Moell.) Pil.			+		
8	<i>A. deulii</i> Pil.			+		
9	<i>A. gennadii</i> (Chat. et Boud.) P.D. Orton	+				

10	<i>A. gennadii</i> var. <i>microsporus</i> (Bohus) Wasser				+	
11	<i>A. porphyrocephalus</i> (F.H. Møller) F.H. Møller			+		
12	<i>A. romagnesii</i> S. Wasser			+		
13	<i>A. spissicaulis</i> (F.H. Møller) F.H. Møller			+		
14	<i>A. squamulliferus</i> (Moell.) Pil.			+		
15	<i>A. sylvaticus</i> Schaeff. ex Secr.	+	+			
16	<i>Agaricus</i> sp.			+		
<b>Subgenus <i>Flavoagaricus</i></b>						
17	<i>A. aestivalis</i> var. <i>flavotacta</i> (Moell.) Pil.			+		+
18	<i>A. aestivalis</i> Secr.			+		
19	<i>A. aestivalis</i> var. <i>aestivalis</i> (Moell.) Moell.			+		
20	<i>A. amanitaeformis</i> Wasser			+		
21	<i>A. arvensis</i> Schaeff.	+	+	+	+	
22	<i>A. augustus</i> Fr.					+
23	<i>A. decoratus</i> Lindgr.			+		
24	<i>A. essettei</i> Bon.			+		
25	<i>A. fissuratus</i> (F.H. Møller) F.H. Møller			+		
26	<i>A. impudicus</i> (Rea) Pilát			+		
27	<i>A. leucotrichus</i> (F.H. Møller) F.H. Møller			+		
28	<i>A. luteomaculatus</i> (F.H. Møller) F.H. Møller			+		
29	<i>A. lutosus</i> (Moell.) Moell			+		
30	<i>A. macrocarpus</i> (F.H. Møller) F.H. Møller			+	+	
31	<i>A. maskae</i> Pilát			+		
32	<i>A. niveolutescens</i> Huijsman			+		
33	<i>A. nivescens</i> (Moell.) Moell.	+		+		
34	<i>A. perrarus</i> Schulz.			+		
35	<i>A. phaeolepidotus</i> (Moell.) Moell.			+		
36	<i>A. pseudopratisensis</i> var. <i>niveus</i> Bohus,			+		
37	<i>A. rusiophyllus</i> Lasch			+		
38	<i>A. semotus</i> Fr.			+		
39	<i>A. tabularis</i> Pk.	+				+
40	<i>A. tenuivolvatus</i> (Moell.) Moell.			+		
41	<i>A. velenovskyi</i> Pil.			+		
42	<i>A. wasseri</i> Bon & Courtec.			+		
43	<i>A. xanthodermus</i> Genevier	+	+	+	+	
	<b>Total</b>	<b>10</b>	<b>7</b>	<b>38</b>	<b>8</b>	<b>7</b>

Species registered on lands under field crops have included *Agaricus campestris*, *A. bisporus*, *A. gennadii* var. *microsporus*, *A. arvensis* and *A. xanthodermus*. S.P. Wasser (1985) has noted in the past that one often can find *A. xanthodermus* on such crop fields.

It has been observed that development of fruiting bodies of these species has been registered during spring to early summer and fall. These structures usually appear at spring times; they could be met at early summer only when there were more rainy days. Scarcity of rains almost throughout in Uzbekistan, accompanied by high temperatures do not allow these mushrooms to develop their fruiting bodies at summer seasons. At summer times fruiting bodies have been found only in mountainous regions at altitudes higher than 1000 to 1500 m above the sea level.

Aforesaid allows to conclude that ecological analysis of representatives of the genus *Agaricus* and their trophic groups has showed that substrates used by these mushrooms for growth and development are highly important for their distribution. Thanking to activities of these trophic groups humic compounds are created in the fertile layers of soils and this enriches these layers with a nutrition, and creates grounds for increasing yields of agricultural crops.

So, the main goals of investigation of the occurrence of *Agaricus* spp. in Uzbekistan were to isolate pure cultures of representatives of these edible mushrooms, and to select strains among them well adapted to the local conditions, and to use them in further research.

#### IV. CONCLUSIONS

1. Literature sources in regard to occurrence of species of the genus *Agaricus* in the Republic Uzbekistan have been reviewed, and it has been found that 43 species in total were registered in the country, the most number of species (38) has being found in Jizzakh region, followed by Tashkent (10 spp.), Kashkadarya and Fergana regions (7 spp. in each).
2. 11 species of the genus *Agaricus* in total have been registered in Tashkent and Kashkadarya regions. Two and seven *Agaricus* species have been registered for the first time in Tashkent and Kashkadarya regions, respectively.
3. It has been determined that the registered *Agaricus* species belonged to the groups of saprotrophs growing on humus, saprotrophs on grass covers, and those species that grow on croplands and open areas with no trees.

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