

Edible and poisonous fungi of Azerbaijan

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Abstract: Mushroom diversity of Azerbaijan is not widely investigated. Mushroom specimens were collected during field surveys in Shaki-Zagatala region in 2013-2019 and identified by morphological features. Along with phenotypic features, the size, shape and color of spores, recent taxonomic and nomenclature updates were taken into account. The most common edible mushroom species in the district are *Boletus aereus*, *B. reticulatus*, *Leccinum pseudoscabrum*, while most widespread poisonous species are *Amanita pantherina*, *Coprinus picaceus* and *Hypholoma fasciculare*. Few of edible species, such as *Butyriboletus appendiculatus*, *Lepista nuda* and *Tuber aestivum* are rare on this territory, and *Galerina marginata* and *Rubroboletus satanas* are rare poisonous mushrooms. *Russula heterophylla* (Fr.) Fr. represents a new record for Azerbaijan.

Key Words: food quality, symbiotroph, xylotroph, species, herbarium

INTRODUCTION

There are approximately 100000 described fungal taxa at present of assumed 1.5 million, which represent less than 7% species of fungi on the Earth. About 6000 species of those can produce visible fruiting bodies [Ainsworth, 2008; Hawksworth, 1991; Tang et al., 2014]. All fungal species listed as rare, threatened and endangered are macrofungi [Mushroom Observer, 2020].

In ancient Greece, and in Roman culture mushrooms were valued and referred as the food of the Gods. Also in ancient China, mushroom dishes were named as the elixir of life. Mushrooms were popular since ancient time to the present day due to their low calories and nutritional content consisting of carbohydrates, low fat, high levels of Se, P, riboflavin, niacin (vitamin B3), vitamin D, high nutritional proteins and fiber. Approximately 2000 mushroom species exist in nature, but about 25 species are considered as food and just a few species are used for commercial cultivation [Valverde et al., 2015]. Besides,

several edible fungi possess medicinally important antibiotics and cholesterol-decreasing compounds.

Along with their nutritional value mushrooms have another ability that gives them functional value. They are accepted as nutraceutical food, because of their medicinal properties and economic significance. It is difficult to distinguish edible and medicinal mushrooms, because many edible mushrooms also own therapeutic properties. About 700 mushrooms of Basidiomycetes including edible species have been listed as pharmacological active [Valverde et al., 2015; Bernaś, 2006].

Large number of mushrooms are classified as poisonous and represent health risks, because they contain powerful toxins. Despite of this ability some poisonous mushroom species (such as *Amanita* Dill. ex Boehm., *Cortinarius* (Pers.) Gray, *Clitocybe* (Fr.) Staude, *Galerina* Early, *Lepiota* P. Browne, *Inocybe* (Fr.) Fr., *Gyromitra* Fr., *Psilocybe* (Fr.) P. Kumm.) are successfully used in medicine due to their pharmacological activities [Kaygusuz, 2013; Lima et al., 2012].

Historically, interest in mushrooms in Azerbaijan was rather insignificant due to the rich sources of plant and animal originated food. The first information about edible mushrooms (*Morchella esculenta*, *Polyporus officinalis*, *Tuber album*, *T. melanasporum*) along with few lichens (*Lecanora*, *Roccella*, *Usnea*) were mentioned in the medieval manuscripts written by physicians of those times [Alakbarli, 2006]. Numerous fungal samples were collected and reported by foreign botanists such as Y.N. Voronov in 1922-1923, F.A. Kolenati in 1858, N. Gelesnov in 1869, etc. [Aghayeva, 2018].

In recent years, interest to edible mushrooms is increased in the country, which also followed by mushroom poisonings and even mortality incidences in the northern regions, including Shaki district. Edible and poisonous fungi of Azerbaijan have been studied since 60s of the last century and more than 130 edible and 9 poisonous taxa were indicated across the country [Sadiqov, 2007]. Few edible species were also mentioned during the study of the macromycetes of the southern part of the Greater Caucasus [Aghayeva, Sadiqov, 2008; Mustafabayli, Aghayeva, 2019].

The aim of this study was to provide the list of edible and poisonous mushroom taxa recorded in Shaki-Zagatala region of Azerbaijan, including the data about their seasonal occurrence and ecological features.

MATERIAL AND METHODS

Field studies. This research was a part of mushroom diversity studies conducted in 2013-2019. For this reason 97 field trips were organised in different seasons. Mushroom specimens were collected, important phenological features and measurements related to collection locality, GPS coordinates were recorded in the field, photos of specimens were taken, after which all specimens were air dried.

Microscopic studies. Cap, gills, stalk if have any volva and annulus, changing colour when cut and other general phenotypic appearance, fruit body were examined by magnifying lens first. Hyphal and basidial (cystidia, basidia, spores) structures and other micromorphological features were examined under light microscope (Vert. A1, Carl Zeiss, Axion Imager, Göttingen, Germany). Microscopy preparations of the diagnostic features of mushrooms were mounted mainly in the sterile water (sometimes with addition some chemicals), statistics included of minimum 20 measurements for any microstructures. Different basic identification techniques were used in order to determine taxonomical groups. All identified mushroom specimens were deposited to the mycological herbarium of the Institute of Botany, ANAS (BAK).

Mushroom taxa were identified on the appropriate literature [Dudka, Wasser, 1987; Hills, 2009; Horak, 2005; Klofac, 2013; Knudsen, 2012; Moser, 1967, 1986; Muñoz, 2005; Nakhushvili, 1985; Sadiqov, 2007; Šutara, 2008; Wasser, 1980]. Names of fungi were checked by using Index Fungorum.

RESULTS AND DISCUSSION

On the whole 97 species were found and they were attributed to the following groups: edible, conditionally edible, inedible and poisonous (Fig. 1, 2). The group of edible mushrooms includes 45 species and three infraspecies taxa which are *Agaricus bisporus* (J.E. Lange) Imbach, *Amanita rubescens* Pers., *A. vaginata* (Bull.) Lam., *Armillaria mellea* (Vahl) P. Kumm., *Boletus aereus* Bull., *B. edulis* Bull., *B. edulis* f. *betulicola* Vassilkov, *B. edulis* f. *quercicola* Vassilkov, *B. edulis* var. *arenarius* H. Engel, Krieglst. & Dermek, *B. reticulatus* Schaeff., *B. subtomentosus* L., *B. variipes* Peck, *Butyriboletus appendiculatus* (Schaeff.) D. Arora

& J.L. Frank, *B. pseudoregius* (Heinr. Huber) D. Arora & J.L. Frank, *Calocybe gambosa* (Fr.) Donk, *Cantharellus cibarius* Fr., *C. subalbidus* A.H. Sm. & Morse, *Chlorophyllum rhacodes* (Vittad.) Vellinga, *Clitocybe odora* (Bull.) P. Kumm., *Connopus acervatus* (Fr.) K.W. Hughes. Mather & R.H. Petersen., *Coprinus comatus* (O.F. Müll.) Pers., *Fistulina hepatica* (Schaeff.) With., *Flammulinavelutipes* (Curtis) Singer, *Gomphidius roseus* (Fr.) Fr., *Hymenopellis radicata* (Relhan) R.H. Petersen, *Imleria badia* (Fr.) Vizzini, *Lactarius deliciosus* (L.) Gray, *L. volemus* (Fr.) Fr., *Leccinellum pseudoscabrum* (Kallenb.) Mikšik, *L. griseum* (Quél.) Bresinsky & Manfr. Binder, *Leccinum crocipodium* (Letell.) Watling, *Lepista nuda* (Bull) Cooke., *Macrolepiota mastoidea* (Fr.) Singer, *M. fuliginosa* (Barla) Bon, *M. procera* (Scop.) Singer, *Mycetinis scorodonius* (Fr.) A.W. Wilson & Desjardin, *Otidea onotica* (Pers.) Fuckel, *Pleurotus ostreatus* (Jacq.) P. Kumm., *Pluteus pellitus* (Pers.) P. Kumm., *Russula delica* Fr., *R. olivacea* Pers., *R. turci* Bres., *R. heterophylla* (Fr.) Fr., *R. virescens* (Schaeff.) Fr., *Suillus collinitus* (Fr.) Kuntze, *S. granulatus* (L.) Roussel, *Tuber aestivum* (Wulfen) Spreng. and *Xerocomus chrysenteron* (Bull.) Quél.

There are also several taxa that could be considered edible only in juvenile period. Young fruit bodies are used by mushroom hunters due to their nutritional benefits, but old ones as a rule lose their nutritional value. These include *Apioperdon pyriforme* (Schaeff.) Vizzini, *Bovista plumbea* Pers., *Cerioporus squamosus* (Huds.) Quél., *Lycoperdon perlatum* Pers., *L. umbrinum* Pers., *Mycena haematopus* (Pers.) P. Kumm., *Polyporus septosporus* P.K. Buchanan & Ryvarden, *P. tuberaster* (Jacq. ex Pers.) Fr., *Russula albonigra* (Krombh) Fr., *Sarcoscypha coccinea* (Gray) Boud. and *Tremella mesenterica* Retz.

Second group encompasses conditionally edible taxa: *Helvella lacunosa* Afzel., *Lactarius piperatus* L. Pers., *Russula foetens* Pers. and *Suillellus luridus* (Schaeff.) Murrill.

Mushrooms that belong to the third group do not represent nutritional importance and include 13 taxa, five of them have either sour and bitter taste (*Boletus purpureus* Pers., *Caloboletus radicans* (Pers.) Vizzini, *Lactarius zonarius* (Bull.) Fr., *Russula sanguinaria* (Schumach.) Rauschert., *Tricholoma batschii* Gulden ex mort. Chr. & Noordel.), or hard texture (*Clavariadelphus pistillaris* (L. Donk, *Cerioporus varius* Fr, *Ganoderma lucidum* (Curtis) P. Karst., *Geastrum saccatum* Fr., *Helvella acetabulum* (L.) Quél., *Hydnellum concrescens*



Figure 1. Photos of some poisonous mushroom species: A. *Amanita pantherina*, B. *A. phalloides*; C. *Pseudosperma rimosum*; D. *Coprinus picaceus*; E. *Galerina marginata*; F. *Hebeloma sinapizans*; G. *Mycopholoma fasciculare*; H. *Mycena pura*; I. *Rubroboletus satanas*.



Figure 2. Photos of some high quality edible mushrooms: A. *Agaricus bisporus*; B. *Armillaria mellea*; C. *Boletus aereus*; D. *Boletus edulis*; E. *Boletus edulis* var. *arenarius*; F. *Boletus reticulatus*; G. *Boletus variipes*; H. *Butyriboletus appendiculatus*; I. *Cantharellus cibarius*; J. *Lactarius deliciosus*; K. *L. volemus*; L. *Leccinellum pseudoscabrum*; M. *Lepista nuda*; N. *Pleurotus ostreatus*; O. *Russula virescens*.

(Pers.) Banker, *Mycena crocata* (Schrad.) P. Kumm.) or small fruiting bodies (*Auriscalpium vulgare* Gray).

Poisonous fungi are also classified into a number of groups depending on the type of damage which they cause, such as arcinogenic, cardiac and lung function disorders (neurotoxic) and renal insufficiency. The following 11 species recorded in the study region are poisonous – *A. pantherina* (DC.) Krombh., *A. phalloides* (Vaill. ex Fr.) Link, *Coprinopsis atramentaria* (Bull.) Redhead Vilgalys & Moncalvo, *Coprinus picaceus* (Bull.) Gray, *Galerina marginata* (Batsch) Kühner, *Hebeloma sinapizans* (Paulet) Gillet., *Hypholoma fasciculare* (Huds.) P. Kumm., *Inosperma maculatum* (Boud) Matheny & Esteve-Rav., *Mycena pura* (Pers.) P. Kumm., *Pseudosperma rimosum* (Bull.) Matheny & Asteve-Rav. and *Rubroboletus satanas* (Lenz) Kuan Zhao & Zhu L. Yang. (Fig. 1).

In the last 4-5 years some poisoning accidents were repeatedly reported from Shaki-Zagatala region. Poisonings occur in the spring, mainly in March and April. They supposedly arise due erroneous gathering of poisonous *Gyromitra esculenta* (Pers.) Fr. instead of very similar edible *Morchella esculenta* (L.) Pers. Symptoms of *G. esculenta* intoxication include acute abdominal pain and diarrhea, that later can be followed by hypotension, anuria, jaundice, hemiplegia and coma. According to J. Patocka et al. [2012] death occurs on the third day and may include causes such as necrosis, renal failure, nephrosis (nephron deficiency) and internal bleeding.

Among the species collected and assigned from the region, some edible fungi are considered delicacies in several European countries due to their pleasant taste, as well as high content of proteins, B group vitamins and glycogen. *Agaricus bisporus*, *Armillaria mellea*, *Boletus aereus*, *B. edulis*, *B. edulis* f. *betulicola*, *B. edulis* f. *quercicola*, *B. variipes*, *B. reticulatus*, *Butyriboletus appendiculatus*, *Cantharellus cibarius*, *Lactarius deliciosus*, *Pleurotus ostreatus*, *Russula virescens*, *Suillus granulatus* and *Tuber aestivum* are the main edible mushrooms of the investigated region (Fig. 2).

Some of above listed mushrooms are rare on the studied territories, in particular *Butyriboletus appendiculatus*, *Lepista nuda* and *Tuber aestivum* (edible), as well as *Galerina marginata* and *Rubroboletus satanas* (poisonous). One new edible mushroom species – *Russula heterophylla* (Fr.) Fr. was recorded for Azerbaijan as a result of our study. The species is associated with *Quercus iberica* M. Bieb (Fig. 3).



Figure 3. *Russula heterophylla* (Fr.) Fr

CONCLUSIONS

It is important to define mushrooms by their nutritional value, but identifying them by poisonousness is extremely important as they may pose health hazard. Some edible and poisonous species are morphologically similar and difficult to distinguish visually. As it is well known 90% of deaths are caused by poisoning with *Amanita phalloides* (Vaill. Ex Fr.) Link. This mushroom is a reason more than 100 deaths each year worldwide. [Santi et al., 2012]. According to the survivors evidences the mushroom is very tasty despite of unpleasant smell [Arora, 1986]. The main reason of such large number of poisonings due *A. phalloides* is its similarity to some edible mushrooms, for example *Russula heterophylla*. In some cases, inexperienced mushroom pickers collect these mushrooms by mistakenly resembling each other. Both mushrooms are common in hardwood and mixed forest, in near *Fagus*, *Quercus*. Caps of both mushrooms are pale green, olive green in color and large enough, gills is white when young. These are the main distinguishing phenotypic features: in *A. phalloides* stem 40-150×15-20 mm with a free volva and annulus, white, pale green with a zig-zag pattern and fibrous. Universal veil forming a free volva, gills is white. But in *R. heterophylla* gills and stalk are white, in older mushrooms cream-yellow, brown. Stalk is 30-60×20-25 mm and fragile.

In this article we inform about edible and poisonous fungi, and provide the photos of the most occurring taxa. Our further studies will be conducted to reveal and analyze all recorded edible and poisonous taxa in the country.

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Azərbaycanın yeməli və zəhərli göbələkləri

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Azərbaycanın göbələk müxtəlifliyi ətraflı öyrənilməyib. Ümumilikdə, 2013-2019-cu illərdə Şəki-Zaqatala regionunda müxtəlif yerlərdə və fəsillərdə çöl tədqiqatları zamanı göbələk növləri toplanılıb və morfoloji əlamətlərə görə təyin edilib. Fenotipik xüsusiyyətlərlə yanaşı sporların ölçüsü, forması və rəngi, son taksonomik və nomenklatur yeniliklər nəzərdə alınır.

Bu regionda ən çox yayılan yeməli göbələklər *Boletus aereus*, *B. reticulatus*, *Leccinum pseudoscabrum*, zəhərli göbələklər isə *Amanita pantherina*, *Coprinus picaceus*, *Hypholoma flaviculare* növləridir. Onlardan bəziləri: *Butyriboletus appendiculatus*, *Lepista nuda* və *Tuber aestivum* yeməli göbələklər, *Galerina marginata* və *Rubroboletus satanas* isə zəhərli göbələklər arasında nadir növlərdir. *Russula heterophylla* Azərbaycan üçün yeni növdür.

Açar sözlər: qida dəyəri, simbioz, ksilotrof, növ, herbari, takson

Съедобные и ядовитые грибы Азербайджана

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Грибное разнообразие Азербайджана исследовано недостаточно. Образцы грибов были собраны во время полевых исследований в Шеки-Загатальском регионе в 2013-2019 гг и идентифицированы по морфологическим признакам. Наряду с фенотипическими особенностями, размером, формой и цветом спор, последние таксономические и номенклатурные обновления были приняты во внимание. Наиболее распространенными съедобными видами грибов в районе являются *Boletus aereus*, *B. reticulatus*, *Leccinum pseudoscabrum*, а ядовитыми видами являются *Amanita pantherina*, *Coprinus picaceus* и *Hypholoma flaviculare*. Немногие из них, такие как *Butyriboletus appendiculatus*, *Lepista nuda* и *Tuber aestivum* редки среди съедобных, а *Galerina marginata* and *Rubroboletus satanas* редки среди ядовитых видов. *Russula heterophylla* представляет новый вид для Азербайджана.

Ключевые слова: пищевое качество, симбиотроф, ксилотроф, виды, гербарий, таксон