Plant & Fungal Research (2021) 4(1): 41-48

June 2021

New records on edible mushrooms collected from Guba district

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Abstract: The study presents first information on edible mushrooms of Guba district. Specimens were collected in 2017-19 in forest ecosystem. As a result of the study, 17 species (*Amanita rubescens*, *Boletus edulis*, *B. reticulatus*, *Cerioporus squamosus*, *Clitocybe odora*, *Clitopilus prunulus*, *Coprinellus micaceus*, *Hortiboletus rubellus, Laetiporus sulphureus*, *Leccinellum pseudoscabrum*, *Legaliana badia, Lycoperdon perlatum*, *Macrolepiota mastoidea*, *M. procera*, *Russula risigallina*, *R. turci, Xerocomellus chrysenteron*) of edible mushrooms belonging to 14 genera were identified. *Legaliana badia* is a new record for Azerbaijan mycobiota. All other mushroom species are new records for the study area. GPS coordinates and ecological groups of mushrooms were identified.

Keywords: *Ascomycetes, Basidiomycetes, diversity, ecological groups, food quality, species*

INTRODUCTION

Mushrooms have been consumed since the earliest human history. They were considered as providers of strength and named as "elixir of life" in ancient times [Valverde et al., 2015]. Since the 5th century, some medicinal mushrooms such as *Ganoderma lucidum* (Curtis) P. Karst and *Polyporus umbellatus* (Pers.) Fr. were noted by the alchemist Tao Hongjing [Stamets, Zwickey, 2014]. Since that time interest to mushrooms is increasingly growing [Kumar et al., 2021; Qwarse et al., 2021; Roupas et al., 2012]. Currently edible mushrooms are used in more than 80 countries of the world, especially for their unique flavour and culinary wonders [Barros et al., 2007; Novakovic et al., 2019].

Also, medicinal importance of some mushrooms has been comprehensively studied in recent years and is already used in the treatment of a number of diseases, such as cancer, diabet and neurodegenerative diseases [Wasser, 2016]. However, no special distinction is made between medicinal and edible mushrooms because many common edible species have therapeutic properties and some of those used for medicinal purposes are also edible, such as *Cantharellus cibarius, Cerioporus squamosus*, *Laetiporus sulphureus* and etc [Elkhateeb et al., 2020; Khatua et al., 2017; Novakovic et al., 2019].

Mushrooms play an important ecological role in the world [Hyde et al., 2019; Olah et al., 2020; Teke et al., 2019]. Many of the leading species live symbiotically with plant and some of them have a mycorrhizal association. Saprobic wild edible mushrooms are important in nutrient recycling [Boa, 2004; McGonigle, 2011].

Since 1950s, the mushroom diversity in the Guba district has been studied by local mycologists. Few herbarium specimens have been collected and are kept at the mycological herbaium of the Institute of Botany of ANAS (BAK). However, there have been no specific studies of macromycetes in this district. Taking all this into account, the aim of this study is to discover macromycete diversity of the research area and determine wild edible mushrooms growing in the territory.

MATERIAL AND METHODS

Distribution of study area. The relief of the district is mostly mountainous with predominance of broad-leaved mountain forests consisting of by *Carpinus orientalis* Mill., *Fagus orientalis* Lipsky, *Quercus robur* L. trees. The climate of the district is dry in summer, moderately hot in the foothills, but cold and humid in winter [Aghayeva et al., 2021].

Field studies. The research was carried out in 2017-19 on mushrooms collected from Armaki, Ispik, Gultepe, Gechresh, Gryzdahna, Kupchal, Kusnetgazma, Uchgun, II Nugadi villages of Guba district in spring, summer and autumn (May, July, October). The initial morphological features for each mushroom specimens (size, color, shape, surface texture, structure of hymenium and reticulum, whether or not volva and annulus, mushroom odour and taste, color change when cut, etc.) were recorded, photos were taken at the point of collection.

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Received 08 April 2021; Received in revised form 30 April 2021; Accepted 26 May 2021

Microscopic studies. All newly collected samples were carefully dried and herbarium specimens were deposited in the BAK. Observation of the samples is based on classical approaches using distilled water, sometimes Congo Red solution. Main diagnostic features were examinated under the microscope (Axio Imager Vert. A1 Carl Zeiss, Germany). For each specimen, 30 spores were measured and their average mean value was calculated. Photos of microscopic structures were obtained using the Axiocam (Zeiss, 105 color).

Identification of mushrooms were carried out according to available literature: [Arora, 1986; Breitenbach, Kränzlin, 1984; Dermek, 1979; Erdem, 2018; Grunert, Grunert, 2002; Mustafabayli et al., 2021; Sadiqov, 2001, 2007; Van Vooren, 2020].

Nomenclature and taxonomy correspond to Index Fungorum [http://indexfungorum.org/] and MycoBank [http://www.mycobank.org/] databases.

RESULTS AND DISCUSSION

As a result of the sample analysis collected from the forest and meadows of the study area, 17 species of edible mushrooms belonging to five orders (Agaricales, Boletales, Pezizales, Polyporales, Russulales), 11 families (Agaricaceae, Amanitaceae, Boletaceae, Entolomataceae, Fomitopsidaceae, Lycoperdaceae, Pezizaceae, Polyporaceae, Psathyrellaceae, Russulaceae, Tricholomataceae) and 14 genera were identified. *Legaliana badia* represents a new record for Azerbaijan and all other species are new records for the study area.

These mushrooms differ according to their ecological groups. Thus, two of them are xylotropic, six of them - saprotrophic and nine of them - mycorrhizal. Information on the recorded species is provided below.

Ascomycota
Pezizales
Pezizaceae Dumort

Legaliana badia (Pers.) Van Vooren (Fig. 1)
Ispik village, N 41°18′32″ E0 48°25′05″, 25 May 2019, (BAK1720).

Macroscopic features: fruiting body about 6 cm, cup-shaped, irregular undulating, stalkless. Hymenium or inner surface (fertile) is smooth, dark olive-brown color, outer surface (infertile) dust reddish-brown, finely scurfy-furfuraceous. Flesh is fragile, thin, reddish-brown.

Microscopic features: spores hyaline, ellipsoidial, 17-19 × 8-10.2 µm in size, coarsely warty, colorless, with one

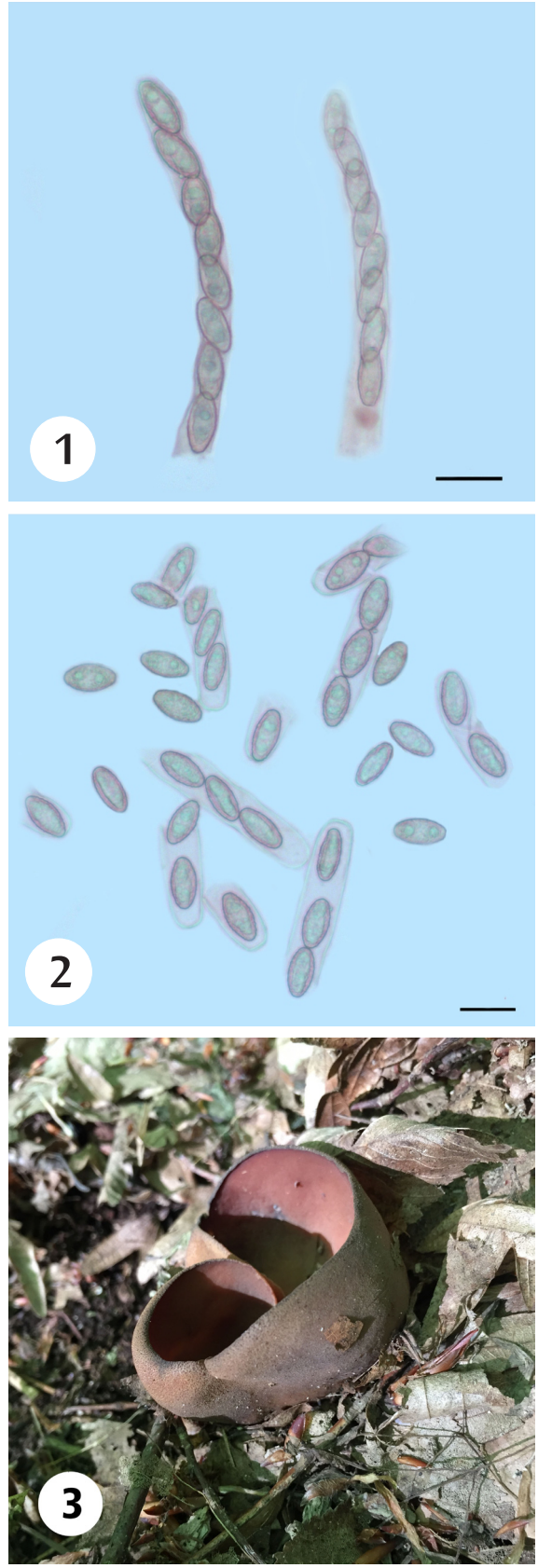

Figure 1. *Legaliana badia* - a new record for Azerbaijan: 1– ascospores in asci; 2 – ascospores; 3 – fruit body.

or two oil drops. Spore print is white. Asci eight-spored, 300 × 15 µm. Growing gregariosusly, in deciduous forests, saprotrophic and occurs on compacted heavy solis. Edible, but odor and taste are not distinctive [Dermek, 1979].
Note: The species was mentioned for the Caucasus without exact distinction place [Barseghyan, Wasser, 2011].

Basidiomycota
Agaricales
Agaricaceae Chevall
Macrolepiota mastoidea (Fr.) Singer (Fig. 2 A)
Kupchal village, N 41°21′24″ E0 48°27′45″, 30 Sep. 2018, (BAK1710), saprotrophic, found singly.
Note: *M. mastoidea* is edible mushroom, but only the cap is valuable for food and can be eaten raw. The stems are wooden [Arora, 1986].

Macrolepiota procera (Scop.) Singer (Fig. 2 B)
Gultepe village, N 41°17′38″ E0 48°28′30″, 01 Oct. 2018, (BAK1708), saprotrophic, found singly in chestnut plantation.
Note: *M. procera* is common edible mushroom. Only the cap of the adult individuals is edible, stems are wooden [Grunert, Grunert, 2002].

Amanitaceae R. Heim ex Pouzar
Amanita rubescens Pers. (Fig. 2 C)
Ispik village, N 41°18′32″ E0 48°25′05″, 15 July 2019, (BAK1704), mycorrhizal, found in groups, under the *C. orientalis*.
Note: *A. rubescens* tastes good, but after a long period of rains it tastes earthy. Edible if thoroughly cooked, otherwise it is indigestible and can cause serious illness. In raw form this mushroom is poisonous due to compound hemolysin. It is highly esteemed in Europe and edible in our locality [Arora, 1986; Sadiqov, 2007].

Entolomataceae Kotl. & Pouzar
Clitopilus prunulus (Scop.) P. Kumm. (Fig. 2 D)
Kupchal village, N 41°20′99″ E0 48°25′65″, 30 Sep. 2018, (BAK1721), saprotrophic, found in groups, under the *F. orientalis*.
Note: *C. prunulus* is edible but not highly rated mushroom in the world. Mushroom is strongly mealy. They are morphologically similiar to poisonus *Clitocybe dealbata* or *C. rivulosa* although, but these generally grow in rings in grassland [Grunert, Grunert, 2002; O' Reilly, 2016].

Lycoperdaceae F. Berchtold & J.S. Presl
Lycoperdon perlatum Pers. (Fig. 2 E)
Gultepe village, N 41°17′38″ E0 48°28′30″, 01 Oct. 2018, (BAK1722), saprotrophic, found in groups.
Note: *L. perlatum* is edible and delicious at young age when it firm and white, but yellowish specimens are not edible [Grunert, Grunert, 2002].

Psathyrellaceae Vilgalys, Moncalvo & Redhead
Coprinellus micaceus (Bull.) Vilgalys, Hopple & Jacq. Johnson (Fig. 2 F)
Uchgun village, N 41°19′47″ E0 48°22′57″, 02 Oct. 2018, (BAK1707), saprotrophic, on meadow, often occurs in large numbers.
Note: *C. micaceus* is edible, but thin-fleshed and watery with pleasant flavour. It is edible within 1 to 3 hours. It is rich in potassium. *Coprinus* species produce the compound coprine. In combination with the alcohol, it causes "Coprinus syndrome" [Michelot, 1992].

Tricholomataceae R. Heim ex Pouzar
Clitocybe odora (Bull.) P. Kumm. (Fig. 2 G)
Ispik village, N 41°18′32″ E0 48°25′05″, 04 Oct. 2019, (BAK1730), mycorrhizal, found in groups, under the *F. orientalis*.
Note: *C. odora* is edible, most often used as food additive to flavor [Grunert, Grunert, 2002].

Boletales
Boletaceae Chevall.
Boletus edulis Bull. (Fig. 2 H)
Ispik village, N 41°18′32″ E0 48°25′05″, 15 July 2019, (BAK1729), mycorrhizal, found singly, under the *C. orientalis*.
Note: *B. edulis* is a well-known edible mushroom. According to D. Arora odor and taste of dried *B. edulis* are marvelous-nutty, earthy and meaty [1986].

B. reticulatus Schaeff. (Fig. 2 I)
Ispik village, N 41°18′32″ E0 48°25′05″, 15 July 2019, (BAK1723), mycorrhizal, found singly, under the *C. orientalis*.
Note: The texture and taste are almost identical to *B. edulis* [Arora, 1986].

Leccinellum pseudoscabrum (Kallenb.) Mikšík (Fig. 2 J)
Ispik village, N 41°18′32″ E0 48°25′05″, 15 July 2019, (BAK1728), mycorrhizal, found in groups.

Figure 2. New records for Guba district: A. *Macrolepiota mastoidea;* B. *M. procera;* C. *Amanita rubescens*; D. *Clitopilus prunulus*; E. *Lycoperdon perlatum*; F. *Coprinellus micaceus*; G. *Clitocybe odora*; H. *Boletus edulis*; I. *B. reticulatus*; J. *Leccinellum pseudoscabrum*; K. *Hortiboletus rubellus*; L. *Xerocomellus chrysenteron*; M. *Laetiporus sulphureus*; N. *Cerioporus squamosus*; O. *Russula risigallina*; P. *R. turci.*

Note: *L. pseudoscabrum* is moderately edible. Their odor is pleasant, but not distinctive [Arora, 1986; Mustafabayli, 2020].

Hortiboletus rubellus (Krombh.) Simonini, Vizzini & Gelardi (Fig. 2 K)
Ispik village, N 41°18′32″ E0 48°25′05″, 15 July 2019, (BAK1705), mycorrhizal, found singly.
Note: Mushroom has soapy flavour and no significant taste [Watling, Hills, 2005].

Xerocomellus chrysenteron (Bull.) Šutara (Fig. 2 L)
Ispik village, N 41°18′32″ E0 48°25′05″, 04 Oct. 2019, (BAK1726), mycorrhizal, found singly.
Note: *X. chrysenteron* is generally considered edible if it is cooked thoroughly [Hills, 2008].

Polyporales
Fomitopsidaceae Jülich
Laetiporus sulphureus (Bull.) Murrill (Fig. 2 M)
Kusnetgazma village, N 41°16′32″ E0 48°20′15″, 19 May 2019, (BAK1731), xylotrophic, found in groups, on the *C. orientalis*.
Note: *L. sulphureus*, with its sulfur yellow color also known as the "Chicken of the woods". The mushroom is edible [Katarzyna et al., 2018; Khatua et al., 2017].

Polyporaceae Corda
Cerioporus squamosus (Huds.) Quél. (Fig. 2 N)
Ispik village, N 41°18′32″ E0 48°25′05″, 15 July 2019, (BAK1727), xylotrophic, found singly, on the *C. orientalis*.
Note: *C. squamosus* is edible. Young fruiting bodies are soft. This mushroom has nutritional value as they are rich in proteins and considered vital sources of many vitamins – B1, B2, B12, C, D and E [Elkhateeb et al., 2020].

Russulales
Russulaceae Lotsy, Truffe
Russula risigallina (Batsch) Sacc. (Fig. 2 O)
Kupchal village, N 41°21′24″ E0 48°27′45″, 30 Sep. 2018, (BAK1724), mycorrhizal, around the tree *Quercus r.* area, found singly.
Note: *R. risigallina* is edible. Taste is mild, odor is fruity when matured. Edible only in the cooked form [Sadiqov, 2007].
Russula turci Bres. (Fig. 2 P)
Gultepe village, N 41°17′38″ E0 48°28′30″, 01 Oct. 2018, (BAK1725), mycorrhizal, found singly, under the *Castanea* sp.
Note: *R. turci* is a common edible with a pleasant, non-bitter taste [Mustafabayli, Aghayeva, 2019].

CONCLUSION
Mushrooms were not favourite food for people living in Azerbaijan until last few decades [Mustafabayli, 2020]. Most of local population are not familiar with edible mushrooms and avoid them due to a number of cases of poisoning. In this article we report about 17 species that are well distributed in the Guba district.

It is well-known today edible mushrooms are valuable, not only due to their unique flavor and texture, but because of their important nutritional and medicinal properties. Mushrooms are rich in minerals, proteins, dietary fiber, essential oils and vitamins. In addition, they are low in calories, fat and cholesterol [Boonsong et al., 2016; Friedman, 2016]. Also species such as *M. procera* and *B. edulis* have been suggested to have strong antioxidant, antimicrobial, and anti-cancer potentials. In the future, we plan to study the biological characteristics of edible and medicinal fungi found in the study territory [Kosanić et al., 2016, 2017].

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Quba rayonundan toplanılmış yeməli göbələklərə dair yeni qeydlər

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Tədqiqat Quba rayonunun yeməli göbələkləri haqqında ilkin məlumatları əks etdirir. Nümunələr 2017-19-cu illərdə meşə ekosistemindən toplanmışdır. Tədqiqat nəticəsində 14 cinsə aid 17 yeməli göbələk növü (*Amanita rubescens*, *Boletus edulis*, *B. reticulatus*, *Cerioporus squamosus*, *Clitocybe odora*, *Clitopilus prunulus*, *Coprinellus micaceus*, *Hortiboletus rubellus, Laetiporus sulphureus*, *Leccinellum pseudoscabrum*, *Legaliana badia, Lycoperdon perlatum*, *Macrolepiota mastoidea*, *M. procera*, *Russula risigallina*, *R. turci, Xerocomellus chrysenteron*) ayırd edilmişdir. Bunlarr dan *Legaliana badia* Azərbaycan mikobiotası üçün yenidir. Digər bütün növlər tədqiqat ərazisi üçün yenidir. Göbələklərin GPS koordinatları və ekoloji qrupları qeyd edilmişdir.

Açar sözlər: *Askomikota, Bazidiomikota, müxtəliflik, ekoloji qruplar, qida keyfiyyəti, növ*

Новые находки съедобных грибов, собранных в Кубинском районе

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Исследование представляет собой первую информацию о съедобных грибах, Кубинского района. Экземпляры собраны в 2017-19 гг. в лесной экосистеме. В результате выявлено 17 видов (*Amanita*

rubescens, *Boletus edulis*, *B. reticulatus*, *Cerioporus squamosus*, *Clitocybe odora*, *Clitopilus prunulus*, *Coprinellus micaceus*, *Hortiboletus rubellus, Laetiporus sulphureus*, *Leccinellum pseudoscabrum*, *Legaliana badia, Lycoperdon perlatum*, *Macrolepiota mastoidea*, *M. procera*, *Russula risigallina*, *R. turci, Xerocomellus chrysenteron*) съедобных грибов, относящиеся к 14 родам. Из них *Legaliana badia* является впервым для микобиоты Азербайджана. Все другие виды явб ляются новым для исследуемого района. Отмечены GPS координаты и экологические группы грибов.

Ключевые слова: *Аскомицеты, Базидиомицеты, разнообразие, экологические группы, пищевое качество, виды*