

SOME WILD EDIBLE AND COMMERCIAL MUSHROOMS IN THE KICHEVO VALLEY (REPUBLIC OF NORTH MACEDONIA)

Emri Murati¹, Mitko Karadelev², Adelina Murati¹, Hirijete Idrizi¹, Dashmir Mamuti¹

¹ Faculty of Agriculture and biotechnology, University of Tetova

² Macedonian Mycological Society, Institute of Biology, Faculty of Natural Sciences and Mathematics, Ss. Cyril and Methodius University, Skopje

Corresponding author e-mail: emri.murati@unite.edu.mk

Abstract

This is the first paper on higher edible fungi (macromycetes) and their spread in the region of Kichevo Valley. In the territory of the Republic of North Macedonia so far have been researched, identified and described about 2000 species of macromycetes, of which about 1735 belong to the cap fungi (Basidiomycota type) and about 255 belong to the sac fungi (Ascomycota type). Out of the total number of fungi in the territory of the Kichevo Valley, over 450 species of macromycetes are encountered and registered. A number of them are edible and commercial. Some of them in addition to nutritional and commercial value have medical significance. This paper presents edible and commercial mushrooms that have been found and encountered in the territory of the Kichevo Valley. In this paper are presented a total of 42 species of wild edible fungi of macromycetes, of which 38 of the type Basidiomycota and only 4 species of the type Ascomycota. Some of them grow in the ground (terricola) while a smaller number grow on different trees (lignicola). The most common are: *Amanita caesarea*, *Boletus edulis*, *B. aereus*, *B. aestivalis*, *Cantharellus cibarius*, *Coprinus comatus*, *Macrolepiota procera*, *Pleurotus ostreatus*, *Morchella esculenta*, *M. conica* etc.

Keywords: Edible fungi, species, nutritive value

1. Introduction

The Republic of North Macedonia is relatively well researched from a mycological point of view, although in some regions it is poorly researched. Systematic mushroom research has so far been developed in the mountains such as: Pelister, Jakupica, Galicica, Kozhuf, Dobra Voda, Bistra, Korab, Osogovo etc. Sharr Mountain is relatively poorly researched although recent times in different regions are conducted more intensive research [1], publishes the first mycoflora in Macedonia where 585 macromycetes are described. In the latest research excel: Karadelev [2-10], Karadelev & Rusevska [11], Karadelev & Murati [12], Karadelev et al., [13] Murati & Karadelev [14], etc. In the research of Sharri Mountains according to Karadelev et al. [15]

From 2002 to 2018, in the region of the Kichevo Valley, intensive research has been done in the mountain massif of Dobra Voda, the massif of Chelojca Mountain, the Mountain Krushino, part of the mountain Bistra, etc [12-14]. The nutritional value may include those of the genera *Boletus*, *Agaricus*, *Suillus*, *Cantharellus*, *Tricholoma*, *Lactarius*, *Pleurotus*, *Morchella* etc.

Some species of edible mushrooms have a nearly complete complement of all necessary nutrient-vitamins, minerals, fiber, protein, carbohydrates and fatty acids. To absorb these nutrients, mushrooms should be well cooked to break down the tough fibers [16].

For the mineral composition of wild edible mushrooms in Macedonia analyzed by micro, macro and trace elements calculated in dry mass has been given by [17], and their nutritional value has been written by [18]. Before assuming that any wild mushroom is edible, it should be identified.

Accurate determination and proper identification of a species is the only safe way to ensure edibility, and the only safeguard against possible accident. Some mushrooms that are edible for most people can cause allergic reactions in some individuals, and old or improperly stored specimens can cause food poisoning. Great care should therefore be taken when eating any fungus for the first time, and only small quantities should be consumed in case of individual allergies. Deadly poisonous mushrooms that are frequently confused with edible mushrooms and responsible for many fatal poisonings include several species of the *Amanita* genus, in particular, *Amanita phalloides*, the *death cap*. It is therefore better to eat only a few, easily recognizable species, than to experiment indiscriminately. Moreover, even species of mushrooms that are edible, may be dangerous, as mushrooms growing in polluted locations can accumulate pollutants such as heavy metals: Cd, Pb etc.[19,20]. Therefore when collecting wild mushrooms for food or for sale in the market (commercial), it is important that they are collected in ecologically clean places. Locations where they are collected should be unpolluted and uncontaminated, away from urbanized places, factories, roads where the circulation of vehicles is high, etc.

2. Importance of edible mushrooms and their use

About the nutritional value of mushrooms in our country have written Bauer – Petrovska [21]. They are a rich source of mineral substances, aromatic compounds, B complex vitamins and protein rich in essential amino acids [22].

Protein concentrations in the fruiting bodies of mushrooms range from 1-4% of the fresh weight, or approximately 10-45% of the weight in the dry state. It is known that up to 40% of the amino acids in the mushrooms are essential amino acids. Carbohydrates range from 3-28%, and the fibers of 3-32% of the fresh fungus weight and usually consist of pentose such as xylose and ribose, hexoses such as glucose, galactose and mannose, sugar alcohols such as mannitol (in abundance) and inositol. The large polysaccharides commonly found in mushrooms include glycogen, animal polysaccharide and chitin, the main compound of non-soluble fiber from mushrooms. The fats normally range from 0.2-0.8% of the fresh mass, or between 2-8% dry mass, where linoleic acid is most common. On the Macedonian mushrooms content of protein, fat, ash and energy value are: for *Agaricaceae* (protein-39.66%, fat-2.99%, ash-17.99% and energy value has 1,463,99 kJ/100g), for *Boletaceae*: protein -26.07%, fat-4,72%, ash-8.61%, and energy value has 1,662,72 kJ/100g) [18,22].

Aims and purpose of this paper

- To recognize the population with the most popular species of edible wild mushrooms;
- To know and distinguish fungi from poisonous ones;
- To know more about how to collect commercial fungi;
- To know how to store the mushrooms;
- To recognize the population with their nutritional, medical and commercial value etc.

3. Materials and methods

The material is collected in forest communities and substrates such as: on logs, stems or branches of trees, stalks and rotten, semi-rotten trees, lush trees and fallen trees, mainly in beech, oak, willow, pine, fir, etc., as well as in high mountain pastures.

A certain specified number of species is identified and determined in the place where they are found in fresh state immediately after it has been collected while in the other part there are made different detailed analysis for identification and determination with the help of the microscope where the fungal spores are identified, cistidies, than its made their measurement chemical reagents (melzer, sulfovanilin, guaiacol, KOH, K₂SO₄, etc.) at the Mycological laboratory, of the institute of Biology in Faculty of Natural Science and Mathematics in Skopje. For determination of these fungi there were using the newest keys and monographs such as: Ahti (2000) [23], Alessio (1985) [37] Breitenbach&Kranzlin [24-28], Eriksson & Ryvarden[29]; Eriksson, Hjortstam&Ryvarden [30,31], Moser [32],Corfixen et al.[33], Däncke[34], etc.

4. Results and discussion

In the region of the Kichevo Valley, the northern parts are most intensively researched, such as the Dobra Voda Mountain Massif [12-14,36], the Chelolja Massif [35], and some parts from Bistra Mountain [19,20], In the region of Kichevo Valley are identified about 450 species, of which in the Dobra Voda Mountain Massif, 335 species (of which 301 species belong to the type *Basidiomycota*, 32 species to the type and only 2 species are *Myxomycota*), in Mountain Chelolja 59 species (of which 40 species *Basidiomycota* and 19 *Ascomycota*).

Of their total number, edibles can be counted close to 75 species but of these only 15 species are used for commercial purposes, ie the local population collectsthem for sale in the market to increase the family budget. Here we have presented 42 species of edible fungi, of which 38 of the type *Basidiomycota* and 4 species of *Ascomycota*. In the collection points in the Kichevo region in different seasons the number of species collected and sold by sellers for commercial purposes varies because their appearance is seasonal as for example a number of species we encounter only in the spring months (march-april- maj). The largest number belong to the type *Ascomycota*, order *Pezizales*, family *Morchelaceae* where we can mention: those of the genus *Morchella* (*Morchella esculenta*, *M.conica*), genus *Verpa* (*Verpabohemica*, and genus *Mitrophora* (*M. semilibera*)[9]. Some can be found in forests of *Quercetum* oak, pine (*Pinetum*), beech (*Fagetum*), near poplars (*Populus*), some of them in riverine vegetation in mycorrhiza with willow (*Salix sp.*), alder(*Alnus sp.*).

List of edible wild mushrooms in the Kichevo Valley region:

A. Type: *Basidiomycota*

- | | |
|---|--|
| 1. <i>Agaricus arvensis</i> Schaeff. | 22. <i>Hydnum repandum</i> L. |
| 2. <i>Agaricus campestris</i> Scop. | 23. <i>Coprinus comatus</i> (O.F. Müll.) Pers |
| 3. <i>Agaricus macrosporus</i>
(F.H.Møller & Jul.Schff.) Pilát | 24. <i>Lactarius deliciosus</i> , (L. ex Fr.) S.F.Gray |
| 4. <i>Agaricus silvicola</i> (Vittad.) Peck | 25. <i>Leucoagaricu sleucothithes</i> (Vittad.) Wasser |
| 5. <i>Amanita caesarea</i> (Scop.) Pers. | 26. <i>Lepista nuda</i> (Bull.) H.E.Bigelow & A.H.Sm. |
| 6. <i>Amanita rubescens</i> Pers 1797 | 27. <i>Macrolepiota mastoidea</i> (Fr.) Singer, |
| 7. <i>Amanita vaginata</i> Bull.Lam. | 28. <i>Macrolepiota procera</i> (Scop.) Singer |
| 8. <i>Amanita fulva</i> (Schaeff.) Fr. | 29. <i>Marasmius oreades</i> (Bolton) Fr. |
| 9. <i>Armillariella mellea</i> (Vahl) P. Kumm. | 30. <i>Oudemansiella mucida</i> (Schrad.) Höhn |
| 10. <i>Auricularia auricula-judae</i> (Bull.) J.Schröt. | 31. <i>Pleurotus ostreatus</i> (Jacq.) P. Kumm. |
| 11. <i>Boletus aereus</i> Bull. | 32. <i>Pleurotis eryngii</i> (DC.) Quél. |
| 12. <i>Boletus edulis</i> Bull. | 33. <i>Pleurotus pulmonarius</i> (Fr.) Quél |
| 13. <i>Boletus reticulatus</i> (Paulet) Fr., | 34. <i>Suillus granulatus</i> (L.) Roussel, |
| | 35. <i>Suillus luteus</i> (L.) Roussel, |
| | 36. <i>Russula cyanoxantha</i> (Schaeff.) Fr |

- | | |
|--|---|
| 14. <i>Butyriboletus</i> (<i>Boletus</i>) <i>regius</i> D. Arora & J.L. Frank 2014 | 37. <i>Russula virescens</i> (Schaeff.) Fr. |
| 15. <i>Boletus betulicola</i> (Vassilkov) Pilát&Dermek | 38. <i>Tricholoma portentosum</i> (Fr.) Quél. |
| 16. <i>Boletus pinophylus</i> Pilát&Dermek | |
| 17. <i>Bovista plumbea</i> Pers. | B. Type: Ascomycota |
| 18. <i>Calocybe gambosa</i> (Fr) Donk | 1. <i>Morchelaesculenta</i> (L.) Pers |
| 19. <i>Cantharellus cibarius</i> Fr. | 2. <i>Morchellaconica</i> Pers. |
| 20. <i>Craterellus cornucopiae</i> (L.) Pers. | 3. <i>Mitrophorasemilibera</i> (DC.) Lev. |
| 21. <i>Handkea</i> (<i>Calvatia</i>) <i>utriformis</i> (Bull.) Kreisel | 4. <i>Verpabohemica</i> (Krombh.) J.Schröt. |

Some types of edible wild mushrooms due to their quality as well as high nutritional values can be put on the market for sale and thus can be labeled as commercial mushrooms. These types of mushrooms can last longer both fresh and dried and are therefore used to be exported abroad, especially to European countries such as Switzerland, Italy, the Netherlands, Germany, as well as other European Union countries. Here we can mention the species of the genus *Boletus* such as; *Boletus edulis*, *Boletus reticulatus (aestivalis)*, *Boletus aereus*, *Cantharellus cibarius*, *Craterellus cornucopiae*, *Amanita caesarea*, *Lactarius deliciosus*, *Tricholoma portentosum*, *Morchela esculenta*, *Morchela conica*, *Verpa bohemica* etc. Undoubtedly, the role and importance of fungi in the ecosystem and in the food of the population is great, but more and more important is their role and use for medicinal purposes. A certain number of mushrooms found in the territory of the Kichevo Valley, in addition to nutritional values, have medicinal values such as: *Agaricus campestris*, *Boletus edulis*, *Bovista plumbea*, *Flammulina velutipes*, *Ganoderma lucidum*, *Ganoderma applanatum*, *Coprinus comatus*, *Hericium erinaceus*, *Pleurotus ostreatus*, *Suillus luteus*, *Trametes versicolor*, *Auricularia- auricula-judae* and many others.[11]. A certain number of these wild mushrooms can be cultivated in artificial, industrial, semi-industrial and domestic conditions which greatly increases their commercial value due to their export to European Union countries. Such are several species of the genus: *Agaricussp*, *Pleurotussp*, *Lentinus edodes*, *Morchela sp.*, etc.

5. Conclusions

- In Macedonia, out of a total of 1990 types of mushrooms, about 500 species are used for food.
- In the region of the Kichevo Valley we have presented 42 species of edible fungi, of which 38 of the type *Basidiomycota* (cap fungi) and 4 species of *Ascomycota* (sac fungi).
- Of the type *Basidiomycota*, edible wild mushrooms as the most popular can be mentioned: *Agaricus arvensis*, *A. campestris*, *Boletus edulis*, *B. aestivalis*, *B. aereus*, *Butyriboletus regius*, *Cantharellus cibarius*, *Amanita caesarea*, *Coprinus comatus*, *Lactarius deliciosus*, etc:
- Of the *Ascomycota* type of nutrition are those of the genus *Morchela* and *Verpa* such as: *Morchella esculenta*, *M. conica* and *Verpa bohemica*.
- The second group includes the least important types, such as: *Amanita rubescens*, *Craterellus cornucopioides*, *Armillariella mellea*, *Hydnum repandum*, *Marasmius oreades*, *Russula cyanoxantha* *Suillus luteus*, *S. granulatus*, *Tricholoma portentosum* etc.
- The mushrooms that are found in the territory of the Kichevo Valley, in addition to nutritional values, have medicinal values also are: *Agaricus campestris*, *Boletus edulis*, *Bovista plumbea*, *Flammulina velutipes*, *Ganoderma lucidum*, *Ganoderma applanatum*, *Coprinus comatus*, *Hericium erinaceus*, *Pleurotus ostreatus*, *Trametes versicolor*, *Auricularia-auricula-judae* and many others.

- Fungus is mentioned for their nutritional value rich in minerals and vitamins.

References

- [1] Tortich, M., (1988): Materials for the mycoflora of Macedonia. Maked. Akad. na Naukite i Umetnostite. Skopje.
- [2] Karadelev, M., (1989): LignicolusAphylllophorales (BASIDIOMYCETES) On Macedonian Oak (QuercustrojanaWebb.). Biosistematika, 15 (2):119-125.
- [3] Karadelev, M.,(1993): Contribution to the knowledge of wood- Destroying fungi in the Republic of Macedonia. Young Explorer of Macedonia, Fungi Macedonici I, 78 pp.
- [4] Karadelev, M., (1994): Qualitative and quantitative analysis of lignicolusmacromycetes in different forest associations on Galicica Mountain. Ekol. Zast. Ziv. Sred, 3: 3-12.
- [5] Karadelev M., (1995): Lignicolous Basidiomycetes as producers of antibiotic and citostatics, Fungi Macedonici-MIM, 1-19.
- [6] Karadelev, M., (1998): Fungal Biodiversity in Macedonia I with a special regard to substrates with a disjunct range and relict origin. MicologiaMontenegrina, I-n, 49-55.
- [7] Karadelev, M., (1999). PreliminarnaCrvena Lista na Gabi naRepublika Makedonija, ZborniknaTrudovi od I- KongresnaEkolozitena Makedonija 5: 289-295.
- [8] Karadelev, M., (2000). Preliminary red list of Macrofungi in the Republic of Macedonian, European Council of Conservation of Fungi, Newsletter 10, 7-11.
- [9] Karadelev. M., (2001): Fungi Macedonici-Makedonsko Mikoloshko Drushtvo. Skopje. Str. 1-299.
- [10] Karadelev, M., (2002a) Fungi Macedonici-Gabitenae Makedonija. Makedonskomikoloshkodrushtvo, Skopje:42-48.
- [11] Karadelev, M., Rusevska K. (2004): Eco-taxonomic research of Fungi on Bistra Mountain. Proceedings of II Congress of Ecologists of the Republic of Macedonia with International Participation. Skopje, Vol. 6, pp. 393-397.
- [12] Karadelev, M., Murati, E. (2008). Ecology and distribution of macromycetes (Basidiomycota and Ascomycota) on Dobra Voda Mountain in the Republic of Macedonia. Internacional Conference on Biological and Environmental Sciences. Tirana. 459-466 pp
- [13] Karadelev, M., Sylejmani, S., E. Murati. (2009). Ecology and distribution of Macromycetes (Basidiomycota and Ascomycota) in Quercetumfrainetto-cerris macedonicum association on Dobra Voda mountain. Proceedings of III Congress of Ecologists of the Republic of Macedonia with International Participation. Struga, 06-09.10.2007. Macedonian Ecological Society, Skopje, Macedonia. pp. 217–223
- [14] Murati, E., &Karadelev, M., (2012)., Ecology and distribution of the ascomycota fungi on the Mountain Massive Dobra Voda. 4th –Congress of ecologists of the Republic of Macedonia with International participation. Ohrid.Macedonia. Proceediings book.
- [15] Karadelev, M., Nastov, Z., &Rusevska K., (2002): Qualitative and quantitative investigation of Macromycetes on Shar Planina Mountain Bull. Biol. Stud. Res. Soc, Skopje, 2, 71-78.
- [16] Hobbs, Ch., 1995. Medicinal Mushrooms: An Exploration of Tradition, Healing, and Culture, 2nd Ed., Botanica Press, Inc.: Santa Cruz, CA, USA
- [17] Bauer-Petrovska, B., (1999). Mineral composition of some edible mushrooms. Acta Pharmaceutica 1/9, vol 49, 59-64. Zagreb.
- [18] Bauer-Petrovska, B., Sulejmani, S., Karadelev M. (2008). Nutritive value of some edible wild mushrooms from Macedona. BSHN (UT) 5/2008.199-205 pp
- [19] Murati, E., Hristovski, H., Melovski, Lj., Karadelev, M., (2014). Heavy metals content in some wild edible mushrooms in Kichevo area, Republic of Macedonia 4th International Conference of Ecosystems, Tirana, Albania, May 23 - 26, 2014, Tirana, Albania; 05/2014

- [20] Murati, E., Hristovski, H., Melovski, Lj., and Karadelev, M. (2015) Heavy Metals Contents in *Amanita pantherina* in a Vicinity of the Thermo Electric Power Plant Oslomej, Republic of Macedonia. *Fresenius Environmental Bulletin* (FEB).
- [21] Bauer-Petrovska, B., Kulevanova, S. Stefov V. - Analysis of Dietary Fiber Composition in Macedonian Mushrooms, -January 2001 *International Journal of Medicinal Mushrooms* 3(2-3):1
- [22] Bauer-Petrovska, Karadelev, M., Kulevanova S. (2006). Medicinal species of macromycetes recorded in the Republic of Macedonia
- [23] Ahti et al., (2000): *Nordic Macromycetes Volume1*. Nordsvamp, Copenhagen. 309 pp
- [24] Breitenbach, J.& Kranzlin, F. (1981): *Fungi of Switzerland Volume 1*, Edition Mycologia, Switzerland, 313pp.
- [25] Breitenbach, J.&Kranzlin, F., (1986): *Fungi of Switzerland, Volume 2*. Edition Mycologia, Switzerland, 412pp.
- [26] Breitenbach, J.&Kranzlin, F., (1991): *Fungi of Switzerland Volume 3*. Edition Mycologia, Switzerland, 361pp.
- [27] Breitenbach, J.&Kranzlin, F., (1995): *Fungi of Switzerland Volume 4*. Edition Mycologia, Switzerland, 368pp.
- [28] Breitenbach, J.&Kranzlin, F., (2000) *Fungi of Switzerland Volume 5*. Edition Mycologia, Switzerland. 368pp.
- [29] Eriksson, J. & Ryvarden, L (1975): *The Corticiaceae of North Europe 3 Fungi flora*, Oslo
- [30] Eriksson, J. & Hjortstam, K.. & Ryvarden, L. (1978): *The Corticiaceae of North Europe 5, Fungiflora*, Oslo. 1047 pp
- [31] Eriksson, J. & Hjortstam, K.. & Ryvarden, L. (1981): *The Corticiaceae of North Europe 6. Fungiflora*, Oslo 1276 pp.
- [32] Moser, M. (1983): *Die Rorhrnge und Blatterpilze*. Gystav Fischer Verlag, Stuttgart, 533 pp
- [33] Corfixen, P. et al., (1997): *Nordic Macromycetes Volume 3*. Nordsvamp, Copenhagen. 444 pp.
- [34] DÄhncke, R. M., (2004): *1200 Pilze*. Verlag GmbH, Augsburg, 1178 pp.
- [35] Murati E., Karadelev M., Ecology and biodiversity of macromycetes on Chelolja Mountain (Kichevo, Macedonia) *UNIVERSI - International Journal of Education, Science, Technology, Innovation, Health and Environment* (ISSN: 1857- 9450) Volume 05– Issue 01, November 2018
- [36] Мурати, Е., (2009). Квалитативни и еколошки карактеристики на макромицетите на Планинскиот масив Добра Вода. ПМФ-УКИМ-Скопје. Магистерска работа. 1-167
- [37] Alessio, C, L. (1985): *Boletus. Italia. Fungi Europaei*, 712 pp.