

RESEARCH

Open Access



Diversity of ethnomycological knowledge and mushroom foraging culture in a small nation: case of Lithuania

Jurga Motiejūnaitė^{1*}, Vita Džekčiorūtė^{1,2}, Ernestas Kutorga^{1,3}, Jonas Kasparavičius¹ and Reda Iršėnaitė¹

Abstract

Background Even in mycophilic nations, mushroom foraging and use traditions may vary from region to region, making it part of cultural diversity and a source of traditional knowledge even in modern and changing societies. The main objective of our study was to investigate mushroom foraging and use traditions in major ethno-regions of Lithuania, to record and analyse whether and how biogeographical and ethno-cultural features influence these traditions, what is their biocultural significance, and whether they persist in the face of societal and environmental change.

Methods The study conducted a survey among 106 respondents from eleven administrative units of Lithuania, representing four ethno-regions (Žemaitija, Suvalkija, Dzūkija and Aukštaitija, the latter divided into North and East). The age of the respondents ranged from 32 to 97 years (mean 70 years, median 68 years). Each respondent was asked six questions about mushroom species and mushroom foraging. The interviews were accompanied by 50 photographs of different mushroom species. The similarity between mushroom foragers' preferences in ethno-regions and the sets of mushroom species used for food and medicine was tested using cluster analysis. Clustering was carried out using Sørensen distances and the method of cluster mean linkage method.

Results The number of mushroom species recognised per respondent was quite similar, with the lowest number of mushroom species recognised in Žemaitija and the highest in Eastern Aukštaitija. Species of no economic or other importance were not well recognised in any of the regions. The number of names applied to mushroom species varied from region to region and did not coincide with the popularity of mushrooms among mushroom pickers. The number of mushroom species used for food was also similar between regions, except for Dzūkija, which had the lowest number of species collected. Nine mushroom species were identified by respondents as medicinal mushrooms, the most popular being *Amanita muscaria* and *Inonotus obliquus*. When analysing the similarity of mushroom species collected for food and medicine, it was found that ethno-regions clustered into three distinct groups. Two groups depended on the prevailing forest types, while Žemaitija formed a separate cluster defined only by local traditions.

Conclusions The work represents the largest study of ethnomycological tradition in Lithuania, covering major ethno-regions. We have found that ethnomycological knowledge and tradition are not influenced by any long-term historical events, ethnicity or religion, but rather by the prevailing forest types and regional ethno-culture. Knowledge of edible mushrooms is considered to be inherited from the older generation and is conservative regarding the changes in the set of species consumed and mushroom-related gastronomy. This is also reflected in the safety of mushroom consumption, as mushroom poisoning was very rare among the respondents. Economically insignificant mushrooms

*Correspondence:
Jurga Motiejūnaitė
jurga.motiejunaite@gamtc.lt
Full list of author information is available at the end of the article



© The Author(s) 2024. **Open Access** This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc-nd/4.0/>.

are not distinguished and overlooked by traditional mushroom pickers who are not a good source of information on rare or otherwise noteworthy species. However, from a biocultural point of view, mushrooms and mushroom-related traditions remain important for linguistic diversity, traditional knowledge systems and their transmission.

Keywords Biocultural diversity, Ethnobiology, Folk taxonomy, Macromycetes, Edible mushrooms, Medicinal mushrooms

Introduction

Fungi play a major role in ecosystem processes such as nutrient cycling, bioconversion and energy flows [1], and have long been used by humans influencing human livelihoods and culture [2]. However, the place of macromycetes (mushrooms) in human life does not always reflect their importance in nature. Various societies either reject them with fear and dislike (mycophobic attitudes) or willingly collect and consume them (mycophilic attitudes), elevating mushroom hunting to the level of patrimonial value [3–5]. Wild mushroom foraging used to be an important part of rural culture in Eastern Europe, and in poorer rural communities wild mushrooms remain an important source of food and income. Although mushrooms represent only a small proportion of calorie intake, they are an important dietary diversification [6, 7]. Other traditional uses of wild mushrooms, such as medicinal, also seem to be limited to mycophilic countries [8], as does the diversity of folk names for mushrooms [5].

However, even in mycophilic areas the selection of species utilised can differ quite significantly, sometimes depending on biogeographical situation and sometimes on cultural preferences, as is shown by analysis of the diversity of fungi sold in food markets [6, 9, 10] or the preferences of consumed mushrooms [11]. For example, Yamin Pasternak [7] noted the change of mushroom species used for the same dish when cooked in different geographical regions of Russia. Nevertheless, most of the papers dealing with ethnomycology concentrate either on the differences of attitude towards edible mushrooms between mycophobic or mycophilic nations or areas [3, 4], or the changes of these attitudes in both mycophobic and mycophilic areas [7, 12], or different sets of species utilised by mycophilic regions [13], or social differences in the mushroom picking tradition [14, 15]. Only a few studies provide some comparison in differences of consumed sets of fungi in mycophilic areas [11, 16, 17]. There is no comprehensive study showing whether there are differences in attitudes towards consumed fungi in ethno-culturally different regions of the same mycophilic country.

Lithuania belongs to mycophilic nations (following the definition by Wasson and Wasson [3]), together with other Baltic countries and Slavic nations [14]. The earliest records of wild mushroom collection and consumption

in Lithuania date back to the fourteenth century [18], and legal regulation of mushroom picking dates back to the sixteenth century [19]. The earliest Lithuanian fiction depicts mushroom picking in the eighteenth century [20]. However, there is no doubt that this tradition is much older, as evidenced by early eleventh-century documents from the territory of present-day Poland [21] and the frequent presence of mushroom picking motifs in Lithuanian folklore [22]. Even today, collecting mushrooms for one's own use and for sale is a culturally and sometimes economically significant activity [23, 24]. The first scientific studies of wild mushrooms used for food and sold in Lithuanian markets date back to the 1930s–1940s, when mushrooms sold in the markets of major Lithuanian cities and towns were investigated [25–28].

Although Lithuania is a small country (over 65,000 km²), with a population of less than 2.9 million people, and is relatively homogeneous (84.6% are Lithuanians) [29, 30], it is divided into five culturally distinct ethno-regions (Aukštaitija, Dzūkija, Suvalkija, Žemaitija (Samogitia) and Lithuania Minor) [31]. So far, research on mushroom foraging traditions in Lithuania and ethnomycology in general has been rather fragmentary, focussing mainly on folk names for mushrooms and mythology related to mushrooms and mushroom picking [25, 32–35].

Our aim was to investigate mushroom foraging and use traditions in major ethno-regions of Lithuania. The main questions we sought to answer were (1) whether and how biogeographical and ethno-cultural features of a region affect the species sets of picked mushrooms and their uses; (2) whether mushroom gathering traditions and use persist in the face of societal and environmental change; (3) what is present biocultural significance of mushroom-related tradition in Lithuania.

Materials and methods

The research was conducted in accordance with the International Society of Ethnobiology Code of Ethics [36]. Verbal informed consent was obtained. Interviews were conducted between 2022 and 2023 with people who were recommended as avid mushroom foragers by local residents. On several occasions, interviews were obtained by snowball sampling and by searching for people selling wild mushrooms in local markets. The interviews were

conducted in Lithuanian and the informants' answers were audio-recorded. All interviews are stored at the Lithuanian Folklore Archives at the Institute of Lithuanian Literature and Folklore, under the numbers LTRF cd 1784-LTRF cd 1884. Respondents were asked their name, surname, age, origin and the following questions:

1. Do you recognize the mushroom?
2. What name/s do you use for it?
3. Do you collect (or have you collected) it for food?
4. Who taught you mushroom foraging?
5. Do you use (or have you used) it for other purposes?
6. Are you aware of any cases of mushroom poisoning in your area?

In addition to the set of questions, the respondents were shown photographs of different fungal species (or groups of species that are difficult to distinguish from the photograph, e.g. *Armillaria* spp., *Lactarius* sect. *Deliciosi*, coloured *Russula* species, etc.), to check whether the respondents could identify and name the fungi in the pictures. We did not use actual specimens because the appearance of fungi is unpredictable, the fruiting bodies are perishable and, as Turner & Cuerrier [37] noted, it is difficult to have a sufficient set of specimens to show to all respondents. The set of pictures included edible, inedible and poisonous mushrooms, mushrooms known as medicinal and several rare and protected mushrooms (50 species in total). All shown species have vouchers in the herbaria of Nature Research Centre (BILAS) or Vilnius University (WI). Herbarium voucher and sequence numbers (for two species) are provided in Additional materials (Table 1), excluding species groups. As the Žemaitija ethno-region was part of the pilot project, photographs of four species, i.e. *Flammulina velutipes*, *Suillus granulatus*, *Sarcodon* spp. and *Tricholoma joachimii*, were not shown there. Respondents' data on these species were not used in the overall calculations and were only discussed under the species identification questions. The scientific names of the fungi included in the surveys follow Index Fungorum database [38]. For the following analysis and calculations, groups of species mentioned above were treated as single species.

A total of 106 people were interviewed, 35 men and 71 women, mostly middle-aged and older (age range 32–97 years, mean 70 years, median 68 years). The interviews were conducted in 40 localities belonging to eleven administrative units of Lithuania, representing all ethno-regions (exact locality data are listed in Additional materials, Table 2), except for Lithuania Minor, where local traditions have been largely lost due to major population changes and immigration from other parts of Lithuania after World War II [39]. The Aukštaitija ethno-region is

the largest and has the highest forest diversity, so it was divided into two parts (Northern Aukštaitija and Eastern Aukštaitija) and the majority of respondents were from this ethno-region.

To obtain additional information, we reviewed unpublished data from the records of Lithuanian Folklore Archives at the Institute of Lithuanian Literature and Folklore (LTR 605/217, 256; LTR 1483/197; LTR 3463/76; LTR 3937/59; LTR 4111/265, 654). These sources were consulted for the following information related to mushrooms: species collected, local species names, uses and mushroom foraging traditions.

For calculations, only the cases when respondents clearly recognised the shown mushroom species were used. The cases when mushrooms were mis-recognised or not distinguished from other species are stated in Additional materials (Table 1). Percentages and medians were calculated with Excel programme (MS Office 16). The similarity between the mushroom foragers preferences in the ethno-regions and the sets of mushroom species used for food and medicine was verified using cluster analysis. A matrix of 35 species and five regions was used, indicating the percentage of respondents who reported collecting mushroom species for food or medicine. Clustering was performed using Sørensen's distances and the cluster mean linkage method. The analysis was performed using software PC-ORD ver. 6.0 [40].

The study site

Lithuania covers an area of 65,300 km², with a resident population of 2.89 million in 2024 [41]. The country is located in the eastern part of the Baltic Sea region, between latitudes 56.27° and 53.53° N, and longitudes 20.56° and 26.51° E. The average altitude from sea level is 99.8 m and the highest point is 293.8 m. The climate is moderately cold, with an average annual air temperature of 7.4 °C, with the warmest month being July (18.3 °C) and the coldest January (−2.9 °C), and an average annual rainfall of 695 mm [42]. Forest land covers about 33.8% of the territory of Lithuania, dominated by Scots pine (*Pinus sylvestris*), Norway spruce (*Picea abies*) and birch (*Betula pendula*, *B. pubescens*) [43].

Ethno-regions studied

The following brief description of the landscape and forest types of the studied ethno-regions (Fig. 1) was taken from [45–47]. Data on ethnicity and religion of the studied localities (by administrative units, data for 2021) were taken from [41]. Almost all administrative units are rather homogeneous in terms of ethnicity and religion with dominant ethnic group Lithuanians and dominant religion Roman Catholic.

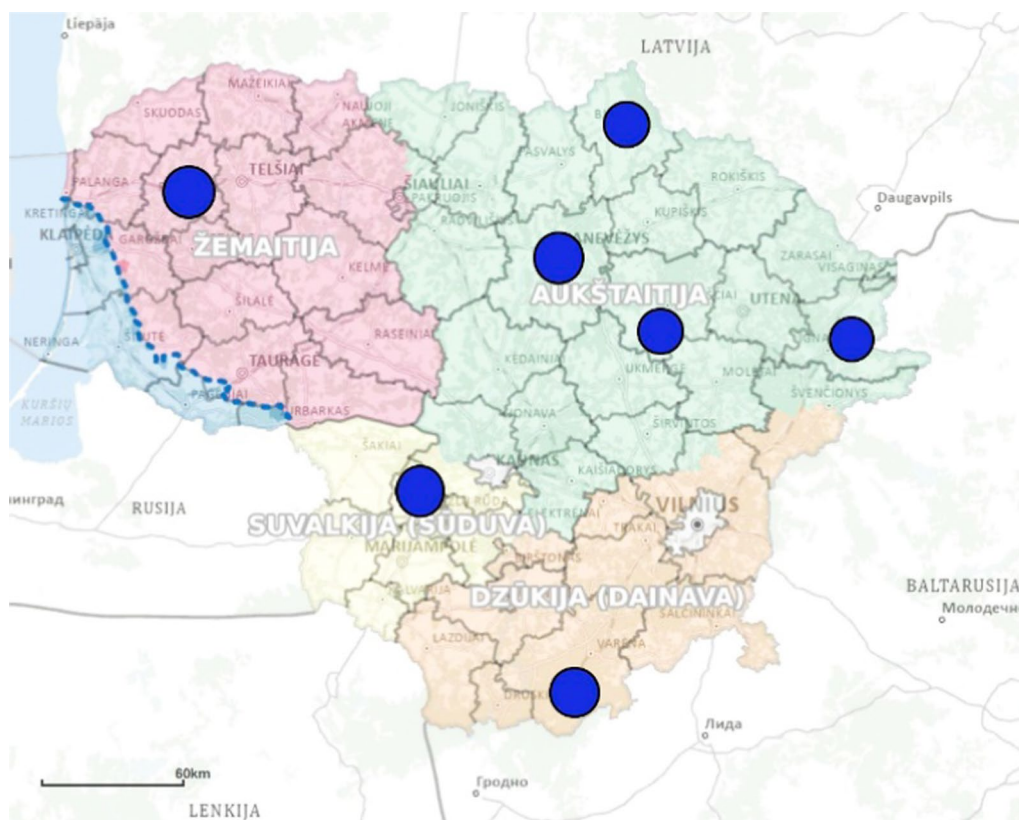


Fig. 1 Map of ethno-regions in Lithuania and locations of data collection. The blue dot line marks the boundaries of Lithuania Minor (not studied, see Materials and Methods). The map base is from [44]. Exact geographical data of the localities are presented in Additional materials (Table 2)

Aukštaitija is the largest ethno-region in north-eastern Lithuania. Northern Aukštaitija is an intensively farmed area, with larger forested areas in the Biržai and Panevėžys districts. The dominant forests are broad-leaved, mixed broadleaved and coniferous, and spruce stands *Piceion abietis*, growing on clay loam soils. In Eastern Aukštaitija, the agrarian landscape is mixed with forests, and the naturalness of the landscape is greater than in the northern part. Coniferous stands, especially pine stands *Dicrano-Pinion sylvestris*, are predominant on loamy soils. Lithuanians make 97.83% of population in Biržai district 97.44% and 84.4% in Panevėžys district (Northern Aukštaitija), 96.5% in Anykščiai district, 80.83% in Ignalina district, 96.01% in Utena district and 52.63% in Švenčionys district (Eastern Aukštaitija). Roman Catholics make 75.4% of population in Biržai district, 84.4% in Panevėžys district (Northern Aukštaitija), 85.5% in Anykščiai district, 81.7% in Ignalina district, 85.5% in Utena district and 77.6% in Švenčionys district (Eastern Aukštaitija).

Dzūkija is located in south-eastern Lithuania. It is the country's most forested region, with a high degree of naturalness, especially in the southern part of the region,

which is the most forested area of the country. Pine forests predominate, especially thermophilic pine stands *Cladonio-Pinetum sylvestris*, growing on the sandy deposits of the former glacier margins. The southern part of Dzūkija is most famous for its mushroom picking traditions [23]. Population of Lithuanians in the studied Varėna district makes 90.44%, Roman Catholics make 87.6%.

Žemaitija (Samogitia) is located in the western part of the country. The landscape is mixed, with agricultural and forested areas which are dominated by spruce stands *Piceion abietis*, hardwoods and mixed stands of spruce and hardwoods or pine and hardwoods. Lithuanians make 98.36% of population in Kretinga district and 98.54% in Plungė district, Roman Catholics make 89.5% in Kretinga district and 87.1% in Plungė district.

Suvalkija is located in south-western Lithuania. It is a land of intensive agriculture and the least forested area of Lithuania. Forests are dominated by hardwood stands *Carpinion betuli* and temperate mixed stands of hardwoods and spruce *Querco roboris-Picceetum*. Lithuanians make 97.89% of population in Kazlų Rūda municipality and 97.77% in Marijampolė municipality,

Roman Catholics make 89.5% in Kazlų Rūda municipality and 85.2% in Marijampolė municipality.

Results

Respondents showed interest in naming mushrooms and describing their uses (gathered or not gathered for food, gathered for non-food uses, poisonous, recognisable or not). On average, 30.76 species were named or recognised per respondent (minimum 8, maximum 43, median 31). Regionally, the average number of named or recognised species per respondent in Žemaitija was 23 (min. 8, max. 35, median 23), in Suvalkija 31.25 (min. 9, max. 41, median 33), in Dzūkija 33.61 species (min. 21, max. 43, median 34), in Northern Aukštaitija 31.83 species (min. 21, max. 41, median 33) and 31.74 species (min. 20, max. 41, median 33) in Eastern Aukštaitija.

Based on the characteristics of the mushrooms and the results of the interviews, we have divided the species shown into six groups: (1) universally popular edible species (collected by $\geq 30\%$ of respondents in every region), (2) regionally or temporarily popular edible species (collected by $\geq 30\%$ of respondents in at least one region, or popularity of which has declined over time), (3) edible species that are not popular in any region (collected by less than 30% of respondents in any region), (4) non-edible species (strongly acrid-tasting, or mildly poisonous, or only used for non-food purposes, or not used at all), (5) poisonous species and (6) species that are rare, protected or newly discovered (Additional materials, Table 1).

Ethnotaxonomy and ethnonomenclature

Only two of the mushroom species shown—*Cortinarius sanguineus* and *Flammulina velutipes*—were not named in any of the regions. The latter was not even mentioned by the respondents as a mushroom they had ever seen, even though it is a very common wood-inhabiting species in the country. In both Žemaitija and Suvalkija, respondents named 37 species, in Dzūkija—39, in Northern Aukštaitija—41 and in Eastern Aukštaitija—45 species. It should be noted that even some mushrooms that were not used for food or other purposes were traditionally known and named. The number of names per species in the region varied from zero to ten, and the number of names applied did not usually correspond with the popularity of the species or even with the use for food. For example, the most prized edible mushroom *Boletus edulis* was given between one and seven names in the different regions, the very popular *Cantharellus cibarius* was given between two and three names; meanwhile, the less valued *Imleria badia* was given between four and ten names, the not consumed *Lycoperdon* spp. were given between two and eight names, and the inedible *Tylopilus felleus* was given between two and 10 names (Additional

materials, Table 1). However, mushrooms that had no economic, medicinal or recreational and aesthetic value were generally not named, even if they were recognised.

Respondents generally did not distinguish between similar species in the genera, for example, *Boletus edulis* from *B. pinophilus* and *Suillus luteus* from *S. granulatus*. The latter were best distinguished in Eastern Aukštaitija (6 respondents), the former in Dzūkija and Eastern Aukštaitija (16 and 11 respondents, respectively), which is explained by the distribution of pine forests and the higher frequency of *B. pinophilus* in these ethno-regions. It should be noted that only in these two regions did all respondents clearly distinguish *Imleria* from *Boletus*, whereas in the other ethno-regions there were between one to three respondents who identified *Imleria badia* as one of the *Boletus*. *Leccinum* was almost universally distinguished as 'brown-capped' and 'red-capped,' and the names of the two groups were different. Only three respondents (all in Suvalkija) did not distinguish between the two *Leccinum* species. The species of coloured *Russula* all had the same names and were not distinguished in most regions, with the exception of the acrid-tasting carmine capped species, such as *R. emetica*, which were reported as inedible, even though they had the same name as the mild-tasting species. However, in Suvalkija, some respondents differentiated *Russula* by cap colour and to some extent by habitat. Only a small proportion of respondents distinguished *Xerocomus subtomentosus* from other boletoids, even if they collected them. In Northern Aukštaitija and Suvalkija, some respondents did not distinguish between *Tricholoma equestre* and *T. portentosum*, in contrast to Eastern Aukštaitija and especially Dzūkija, where the two species were clearly separated. Some respondents did not distinguish *Morchella* spp. from *Gyromitra esculenta*. In all regions, a proportion of respondents did not distinguish *Russula delicata* from *Lactifluus piperatus* and *Armillaria* spp. from *Kuehneromyces mutabilis*, with a higher percentage of distinguishing the latter in regions where *Armillaria* spp. were popular among mushroom pickers. *Gyroporus cyanescens* was mostly confused with other boletoids (e.g. *Boletus radicans* and *Tylopilus felleus*), except in Dzūkija, though it was not collected there. *Suillus bovinus* was confused with other *Suillus* species by some respondents, but it was also best recognised in Dzūkija, although it was not collected there. *Agaricus* spp. and *Macrolepiota procera* were attributed to *Amanita* by some respondents. Only a few respondents clearly distinguished *Calvatia* from *Lycoperdon*, their names and recognition stemming mainly from characteristic release of dry spore masses in both genera. *Amanita muscaria* and *A. phalloides* were both referred to as *musmirės* (*Amanita*) by the majority of respondents, although it was clear from the descriptions that the two species were seen as distinct.

Uses of mushrooms

Food

A total of 36 species were consumed for food. Regionally, a total of 27 species were collected for food in Žemaitija, 31 in Suvalkija, 22 in Dzūkija, 29 in Northern Aukštaitija and 32 in Eastern Aukštaitija (regardless of the number of respondents collecting the individual species).



Fig. 2 **a** Traditionally dried *Gyromitra esculenta* (Dzūkija). **b** Fermented mushrooms with prevailing *Cantharellus cibarius* and *Russula* spp. (Eastern Aukštaitija). **c** Harvested *Tricholoma equestre* (Dzūkija). Photographs: **a** and **b**: Vita Džekčiorūtė; **c**: Žydrūnas Sinkevičius (see acknowledgements)

Among the universally popular mushrooms, Boletales dominated, as well as *Cantharellus cibarius*, *Lactarius* sect. *Deliciosi* and coloured *Russula* species (Fig. 2b).

Fifteen of the mushroom species were only regionally (Fig. 3) or temporarily (and sometimes only temporarily) popular mushrooms. *Suilellus luridus* was a recognised and popular edible mushroom in Suvalkija and especially in Žemaitija, while in other ethno-regions it was mostly treated as inedible, or was not distinguished from other boletoids by those who collected it.

In Dzūkija, by contrast, *S. luridus* was not named by any respondent and was recognised by less than 30% of respondents, which can be explained by the lack of forests suitable for *S. luridus* in this region. *Gyromitra esculenta*, a toxic mushroom that requires special preparation before consumption, is still widely collected in Europe. In Lithuania, between 44 and 100% of respondents in different regions admitted to collecting *G. esculenta* for food (Fig. 2a), except in Žemaitija, where less than 30% of respondents consumed it. Žemaitija was also the region where fewer people recognised the mushroom. *Gyromitra esculenta* was also among the mushrooms whose popularity was declining, except in Suvalkija and Dzūkija, where nobody admitted to having stopped collecting it. *Suillus variegatus* was also unpopular and unfamiliar in Žemaitija, where it was recognised by less than 30% of respondents and collected by even less percentage. In Northern Aukštaitija, *S. variegatus* was recognised and

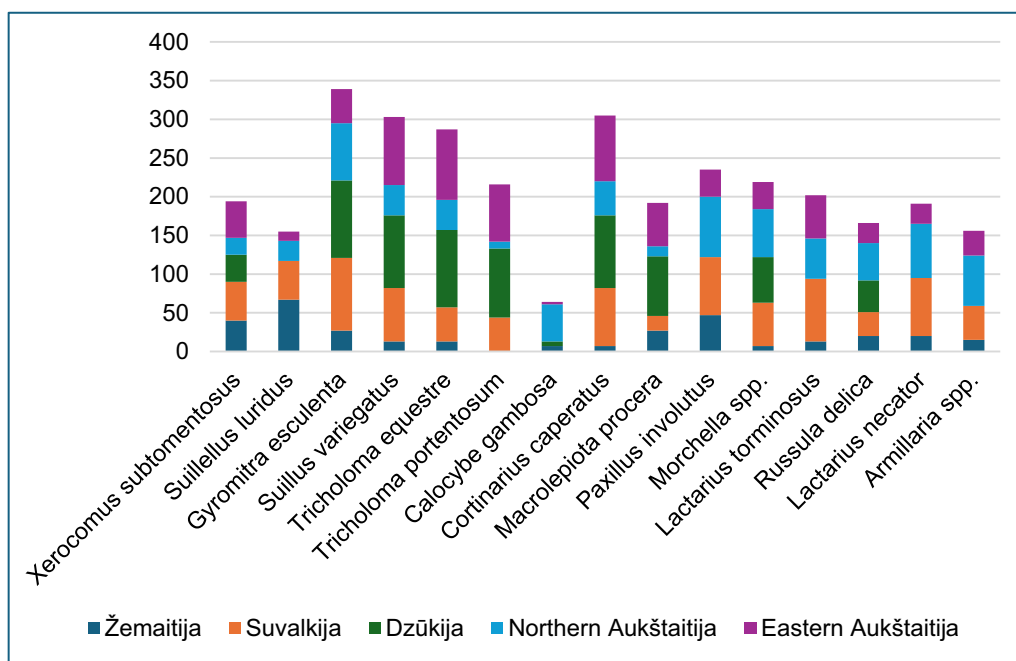


Fig. 3 Percentage of mushroom foragers collecting regionally popular mushroom species in different ethno-regions. Colour scheme refers to individual ethno-regions

collected by slightly less than half of the respondents, whereas in other regions, it was known and popular. *Tricholoma equestre* was popular in the pine forest-dominated regions of Dzūkija and Aukštaitija, where it was recognised and admitted to be collected by 94–100% of respondents (Fig. 2c). Žemaitija was an exception—only 13% of the respondents recognised and collected this species.

The situation was similar for *Tricholoma portentosum*: none of the respondents recognised and collected it in Žemaitija. In Northern Aukštaitija, it was also mostly not recognised and not collected. It was best recognised and collected in Dzūkija; meanwhile in Eastern Aukštaitija, it was less recognised and collected than *T. equestre*. *Calocybe gambosa* was popular only in Northern Aukštaitija, where it was recognised and collected by almost half of the respondents. In the other regions, it was identified by very few respondents, with only one respondent in each region collecting it, with the exception of Suvalkija, where no one admitted collecting it. *Cortinarius caperatus* was well recognised and collected in all regions except Žemaitija. *Macrolepiota procera* was popular only in Dzūkija and Eastern Aukštaitija. Only one respondent in Dzūkija admitted to having collected *Paxillus involutus* before. In the other regions, between 35 and 78% of respondents admitted to having collected it. In all regions except Suvalkija, some respondents admitted to have stopped collecting *P. involutus*. *Lactarius torminosus* was not collected at all in Dzūkija, and only by two respondents in Žemaitija. In other regions, except Suvalkija, some respondents stopped collecting it. *Russula delica* was collected in all regions and the number of collecting respondents varied from 20% (Žemaitija) to 48% (Northern Aukštaitija). *Lactarius turpis* was the most popular in Northern Aukštaitija (collected by 70% of respondents), while in Dzūkija it was not collected at all, although it is very well recognised in all regions, but its popularity has decreased. *Armillaria* spp. was not collected in Dzūkija, in other regions its popularity ranged from 32% (Eastern Aukštaitija) to 65% (Northern Aukštaitija) of respondents. The popularity and use of *Xerocomus subtomentosus* and *Morchella* spp. were difficult to assess, as a large proportion of respondents did not seem to distinguish them from other Boletales and *Gyromitra eculeuta*, respectively.

Gyroporus cyanescens, edible but unpopular with mushroom pickers, was least recognised and not named in Northern Aukštaitija, quite well recognised and distinguished in Dzūkija, but collected by only a few respondents in all regions (Fig. 4), and not collected at all in Dzūkija. *Suillus bovinus* was also best recognised in Dzūkija, although not collected and worst recognised

and not even named in Žemaitija. In other regions it was collected by few people. *Agaricus* spp. were neither well recognised nor popular, and was not collected at all in Dzūkija. *Lactarius piperatus* was neither recognised nor collected in Žemaitija, not collected in Suvalkija. In other regions, it was difficult to assess its use due to confusion with *Russula delica*. *Sarcodon* spp. were not named (although recognised) in Suvalkija and Northern Aukštaitija, collected by one respondent (in Suvalkija). *Hydnum* spp. were best identified and collected in Žemaitija (47% identified, 27% collected), in most other regions they were neither named nor collected. Only one respondent admitted collecting *Kuehneromyces mutabilis*, even that one possibly confused it with *Armillaria* spp. *Lycoperdon* spp. were identified and named by the majority of respondents in all regions but were not consumed in any of them. *Calvatia gigantea* was collected by one respondent, although it was also well recognised everywhere.

Mushrooms are mostly consumed in mixtures (different types of mushrooms), and the most popular dish mentioned by all respondents was pre-boiled mushrooms fried with bacon and onions, with the addition of sour cream (Additional materials, Table 3). Mushroom soup and mushroom salad with sour cream were also mentioned. Boletoid mushrooms, in particular *Boletus* spp., are commonly dried and then used in soups, stews, pies, dumplings and herring dishes, especially for Christmas Eve dinner. *Boletus* spp., *Leccinum* spp., *Lactarius* sect. *Deliciosi*, *Cantharellus cibarius* are sometimes eaten separately, either fried or in soups, or pickled when there are enough fruit bodies for a separate dish. Exceptions are the mushrooms of the spring season, which are eaten separately, pre-boiled and fried, and *Macrolepiota procera*, which is always fried without pre-boiling, either in batter or without it. Mushrooms are also preserved for the winter, although the traditional methods of salting or fermenting have been largely replaced by pickling and freezing. However, the mushroom dishes mentioned by the majority of respondents did not differ much from those described in various books on traditional Lithuanian cuisine and food traditions [18, 48], as well as on regional cuisines [23, 49].

Medicinal

A total of nine medicinal mushroom species were named (Fig. 5). Of these, only *Amanita muscaria* and *Inonotus obliquus* (Fig. 6a) were recognised as medicinal mushrooms in all regions, with consumption ranging from 77% of respondents (Dzūkija) to 21% (Northern Aukštaitija) and from 23% (Northern Aukštaitija) to 13% (Žemaitija), respectively.

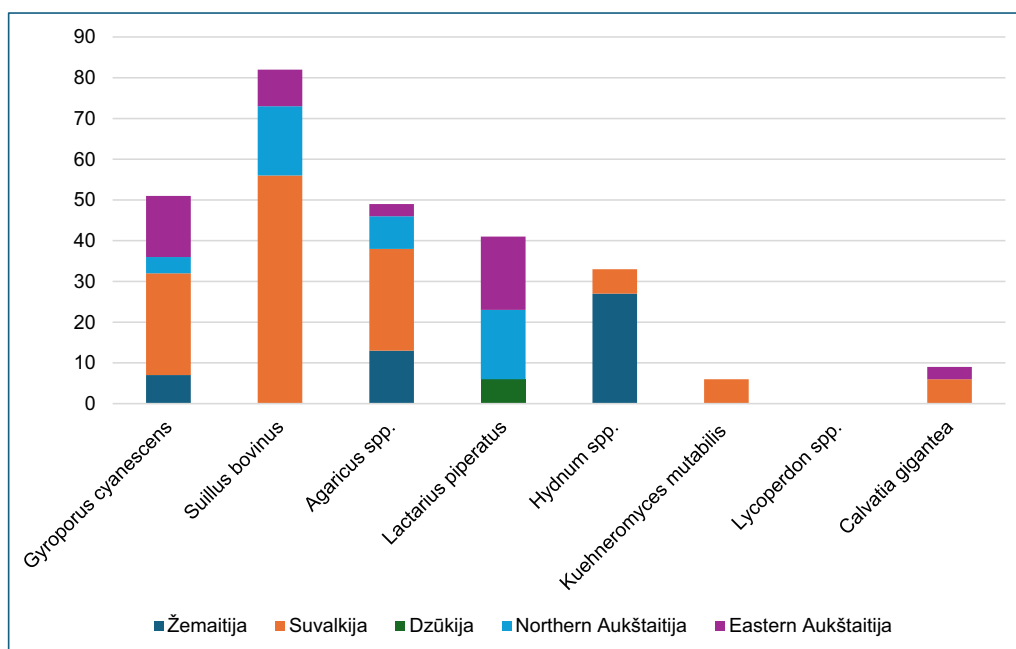


Fig. 4 Percentage of mushroom foragers collecting unpopular mushroom species in different ethno-regions. Colour scheme refers to individual ethno-regions. Note: *Sarcodon* spp. and *Flammulina velutipes* were not included in the graph as they were not shown in one of ethno-regions (see Material and methods)

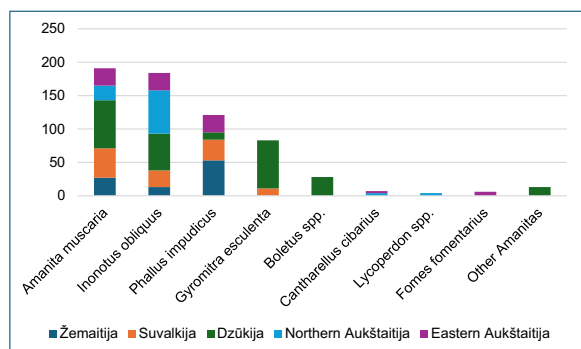


Fig. 5 Mushrooms used as medicinal by the per cent of respondents in the individual ethno-regions. Colour scheme refers to individual ethno-regions. Other Amanitas include *A. phalloides* and *A. virosa*

Even if not used personally, *A. muscaria* was recognised and named by the absolute majority of respondents. *Inonotus obliquus* was also well recognised and named in all regions (53% to 93% of respondents). *Phallus impudicus* was recognised as medicinal in all regions except Northern Aukštaitija, its use ranged from 53% of respondents (Žemaitija) to 12% (Dzūkija) (Fig. 6b).

Phallus impudicus was most accepted in Žemaitija (100% of respondents). In Dzūkija, however, only two people recognised it and did not have a name for it. Other



Fig. 6 a Alcohol-based extract of *Inonotus obliquus* and fruit bodies of the fungus used to prepare the extract (Dzūkija). b Alcohol-based extract of *Phallus impudicus* (Eastern Aukštaitija). Photographs: a: Ernestas Kutorga; b: Vita Džekčiorūtė

species were only occasionally mentioned as medicinal mushrooms, except for *Gyromitra esculenta* in Dzūkija.

Other uses

Among the other uses of mushrooms, the absolute majority of respondents mentioned *Lycoperdon* and *Calvatia* as children’s play objects. Respondents over 70 years of age indicated that *Fomes fomentarius* had been used in

the past to bring fire from the church at Easter and for the fire ignition. The mushroom was well recognised and named (between 87 and 100% of respondents in different regions), although the vast majority of respondents used the name which refers to any larger bracket. Two respondents in different regions mentioned the use of *F. fomentarius* as a fogging agent to calm the bees during honey collection. One respondent mentioned *Sarcodon* spp. as a fodder additive for cattle, another respondent mentioned *Lycoperdon* spp. as a fodder additive for pigs. A few respondents in Dzūkija, Northern and Eastern Aukštaitija mentioned that cows and pigs were fed with mushroom cleaning residues and old fruit bodies, unsuitable for consumption. Respondents over 70 years of age mentioned that they had previously used *Amanita muscaria* to get rid of flies at home.

Differences and similarity of mushroom uses

The analysis of the similarity of the mushroom species collected for food and medicinal purposes showed that the ethno-regions were clustered into three distinct groups (Fig. 7). Two groups depended on the predominant forest types (and, consequently, on the sets of the most common mushroom species): Suvalkija together with Northern Aukštaitija (predominantly hardwood and mixed forests) and Dzūkija together with Eastern Aukštaitija (predominantly coniferous forests). Both groups covered ethnologically different regions. However, Žemaitija formed a distinct cluster that was clearly defined only by local tradition.

Recognition of other mushrooms

Of the inedible mushrooms, *Tylopilus felleus* was the most recognised and named species in all regions (from 73 to 96% of respondents) (Fig. 8), presumably because of its similarity to the prized edible boletoid species and the need to be able to distinguish between them. *Chalciporus piperatus* was poorly distinguished and not named in Žemaitija and Eastern Aukštaitija, in other regions it was mostly confused with *Suillus bovinus*. *Sarcoscypha* spp.

were best identified in Northern and Eastern Aukštaitija (78% and 41% of respondents, respectively), and only in these regions was it named, although at least some of the respondents recognised this fungus in other regions but did not name it. *Coltricia* spp. were best recognised in Dzūkija and Eastern Aukštaitija (88% and 70% of respondents, respectively). They were named in all regions, except in Suvalkija, though 31% of respondents recognised it in this region. The highly toxic *Amanita phalloides* was recognised by the majority of respondents (63–100%).

Of the rare species, *Tricholoma joachimii* was best recognised in Dzūkija, where it was recently recorded [50], while in other regions its recognition was mostly questionable, as respondents did not distinguish it from *T. equestre* (the species was not shown in Žemaitija). *Aureoboletus projectellus*, a recent arrival in Lithuania and spreading in the Baltic region [51, 52], was doubtlessly identified in Dzūkija and Eastern Aukštaitija, where it is already present, although only one respondent in each of these two regions collected it for food. Notably, only in Dzūkija, where it has already spread, was *A. projectellus* named. In the other regions, the mushroom was mostly either not recognised or confused with red-capped *Lecanium* species. Of the three species in the Lithuanian Red Data Book [53] shown to respondents, the results were poor. The recognition of *Neoboletus luridiformis* was unclear, as most respondents who recognised or even collected this species did not distinguish it from *Suillus luridus*. *Lactifluus volemus* was identified by very few respondents and was only named in Žemaitija and Eastern Aukštaitija. *Sarcosoma globosum* was best recognised in Eastern Aukštaitija, where it is most commonly found, whereas in Suvalkija it was neither recognised nor named.

Discussion

Although mushrooms have lost the nutritional significance they had during times of food scarcity in Lithuania, their picking and consumption are still culturally

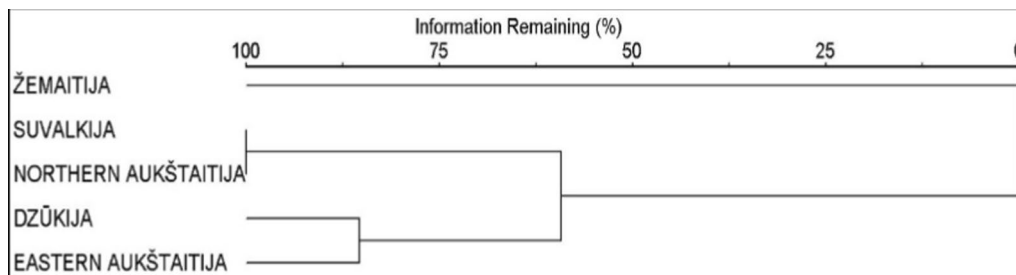


Fig. 7 Dendrogram of the cluster grouping (similarity) of the studied ethno-regions based on the percentage of respondents collecting sets of mushroom species for food and/or medicine

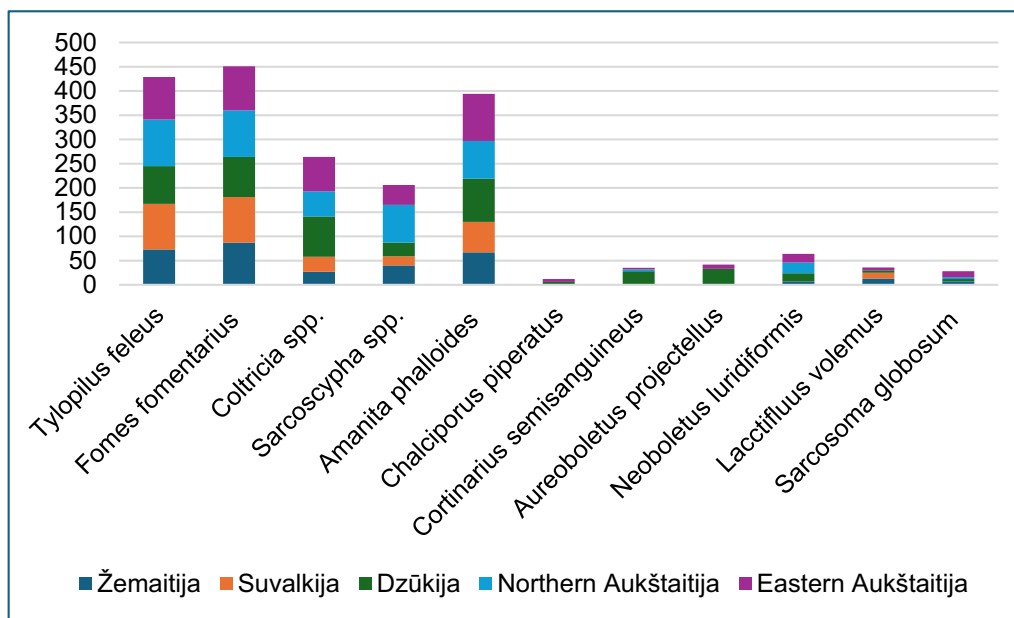


Fig. 8 Percentage of respondents recognising inedible, poisonous or rare mushroom species in different ethno-regions. Colour scheme refers to individual ethno-regions. Note: *Tricholoma joachimii* was not included in the graph as it was not shown in one of ethno-regions (see Material and Methods)

important and are sometimes considered a ‘natural right’ of people [22]. Despite increased migration between Lithuanian ethno-regions after the Second World War [54], which had an impact on local traditions, along with changes in rural life and the increasing influence of media coverage, a large part of the former traditions, including ethnomycology and attitudes to mushroom picking, have survived, as our study shows. The preservation of ethnomycological traditions is particularly pronounced in the differences between the ethno-regions studied, which depend not only on the predominance or abundance of forests but also on ethnological specificities. In Finland, regional differences in mushroom picking traditions also have been observed, which were more related to historical influences than to the prevailing forest types. These differences have also been observed to be long-term and conservative [11]. Similar differences were observed during the study of two ethnically different communities in Pskov Oblast, NW Russia [17]. On the other hand, Quiñónez-Martínez et al. [16] did not find any differences in the sets of mushroom species collected by different ethnic groups in Mexico. However, the differences or similarities in the Lithuanian ethnomycological tradition cannot be explained by historical influences or ethnic differences: long-term (more than 50 years) historical events were the same in all ethno-regions, and the respondents were ethnically homogenous.

The set of the most popular mushrooms collected in all Lithuanian ethno-regions studied (Additional materials,

Table 1) included almost all of the most popular species in Europe [55]. It should be noted that of the most popular mushrooms, only *Cantharellus cibarius* was mentioned by 100% of the respondents in all ethno-regions, although *Boletus* spp. were identified by the majority of respondents as the most prized mushrooms. However, other edible mushroom species differed in that they were popular among mushroom pickers, but only in part of the ethno-regions, while in other regions they were collected little or not at all, such as *Suillellus luridus*, *Calocybe gambosa* or *Gyromitra esculenta*. The lowest number of species used for food, specific to Dzūkija, is due to the traditional conservative attitude towards the range of mushrooms considered edible in this ethno-region, a phenomenon described in [23, 56].

The set of the most popular edible mushrooms was broadly similar to that of the northern and eastern Slavic areas [6, 9, 14, 17], and to a lesser extent to that of Sweden [57]. However, precise comparisons were difficult due to differences in the definitions of species groups in the publications listed or because in some cases the number of respondents who reported consuming mushrooms was not provided, e.g. in Stryamets et al. [58]. Only *Boletus* spp. and *Cantharellus cibarius* were equally popular in Lithuania, Slavic areas and Sweden. The coloured *Russula* species were popular among Lithuanians, Slavic and Seto people, but not among Swedes. *Imleria badia*, popular in all Lithuanian ethno-regions was either unpopular or not collected among Russians and Seto in Pskov

Region and in Sweden. It was difficult to evaluate its popularity in Poland because it was not separated from *Xerocomus* spp. [14], though judging from its occurrence in Polish markets [9] it is one of collected edible species. It was also difficult to compare popularity of *Suillus* spp. because species were not separated in most of the publications and often include species that are rare and not collected in Lithuania (e. g. *S. grevillei*). Of the regionally popular mushrooms in Lithuania, only *Macrolepiota procera* was eagerly collected in Slavic areas and in Sweden. *Gyromitra esculenta*, commonly collected in part of Lithuanian ethno-regions, was only popular among Russians (but not among Seto in the same Pskov Region) [17]. *Armillaria* spp., collected in all ethno-regions of Lithuania, except Dzūkija and most frequently picked in Northern Aukštaitija, was popular only among Slavic ethnic groups, but not among Seto or Swedes. *Agaricus* spp., not popular in Lithuania, were popular only among Poles and Swedes. *Hydnum* spp., popular in Žemaitija, were not mentioned or collected in Slavic areas, although they were rather popular in Sweden. *Russula delica*, collected in all ethno-regions of Lithuania and popular in Northern Aukštaitija, was not mentioned in any of the references above. *Lycoperdon* spp., which are not consumed at all in Lithuania, are collected by a small number of mushroom pickers in the Slavic countries and Sweden, but in the latter (and maybe in other cases, too) they were not separated from *Calvatia*.

Respondents also mentioned the changes in the sets of mushroom species used for food over time, which also differed according to ethno-regions, at least in parts. The general trend, characteristic to all regions, is a decrease in the popularity of mushrooms that require special preparation and/or were mainly used for preservation, such as the bitter-tasting *Lactarius* species. This is due to the time-consuming and/or requiring special knowledge preparation techniques for these mushrooms, as well as the virtual disappearance of old preservation techniques such as salting or fermenting, which were particularly important during periods of food scarcity, as noted by the majority of the respondents aged over 70. The impact of media campaigns on the toxicity of *Paxillus involutus* and *Gyromitra esculenta* was also significant in reducing the consumption of these mushrooms, although the former remains quite popular in Suvalkija and the latter in Dzūkija, in contrast to, for example, Poland, where the consumption of these mushroom species has almost completely stopped after identical media campaigns [14]. Meanwhile, Belichenko [17] notes that Russians in the Pskov region still often collect *Gyromitra esculenta*, but Seto people in the same area pick them rarely, as do mushroom pickers in Sweden [57]. *Paxillus involutus*, on the other hand, was only rarely collected by Russians

and not by other ethnic groups. Overall, the three species with the greatest decline in consumption in our study were *Paxillus involutus*, *Lactarius torminosus* and *L. turpis*.

The most significant increase in the variety of mushrooms consumed was also recorded in Dzūkija. According to [23, 56] and a large part of our respondents, previously only *Boletus* spp., *Cantharellus cibarius*, *Tricholoma equestre* and *Gyromitra esculenta* were collected in Dzūkija, and very rarely *Suillus* spp., red-capped *Leccinum* and *Lactarius* sect. *Deliciosi*. Even the word mushroom (*grybas*) was exceptionally reserved for *Boletus* spp. only, the others being considered inferior in this ethno-region. Nowadays, they collect more species, such as brown-capped *Leccinum*, *Imleria badia* and *Cortinarius caperatus*, mushrooms that were not collected by the generation of our respondents' parents. According to the respondents, the reason for this change in the set of mushrooms consumed is the increasing scarcity of forests suitable for their favourite mushrooms, due to intensive deforestation and climate change, especially frequent droughts, the reasons stated by the mushroom foragers in Poland, too [13]. An interesting example of a recent addition to mushroom consumption is *Macrolepiota procera*, which of all studied regions was the most popular mushroom among the most mushroom-conservative respondents in Dzūkija. Meanwhile, its use has started relatively recently in this region [56]. *Macrolepiota procera* was not previously collected in other regions and is only slowly making its way onto mushroom pickers' tables. For example, Lubienė [34] stated that *M. procera* was almost unknown and not collected in Žemaitija. Our interviews showed that *M. procera* is only slowly gaining popularity, although a number of respondents admitted to having tried it and even liking the taste, but they are still reluctant to pick it themselves. However, it is difficult to assess the temporal changes in the sets of consumed mushroom species in other ethno-regions, as no previous studies have been conducted in Žemaitija, Suvalkija and Aukštaitija.

In general, mushroom consumption in Lithuanian ethno-regions shows a very conservative attitude towards this tradition, and new species are not accepted for a long time. Meanwhile, traditional species are still collected, although they pose health risks, such as *Paxillus involutus* and *Gyromitra esculenta*. Personal preferences also play an important role in the choice of mushrooms. Some respondents admitted that their favourite mushrooms are those that remain crisp when cooked (e.g. *Russula* or *Lactarius*), while others prefer species that become soft and slimy (Boletales).

Deep-rooted mushroom foraging traditions and conservative attitudes towards the species consumed explain

the very low number of mushroom poisonings known to respondents. Only five persons reported known cases of poisoning in the neighbourhood or among acquaintances (four cases, as two respondents reported the same case). All cases were related to the consumption of *Gyromitra esculenta*, three of them from Dzūkija, where this mushroom is most popular. The interviews showed that when people are not sure about the identity of a mushroom, they are more likely to classify it as inedible or as a toadstool (*šungrybis* or *budė*). For example, respondents who did not differentiate between *Kuehneromyces* and *Armillaria* did not pick either, while those who attributed *Agaricus* and *Macrolepiota* to *Amanita* did not pick the former two either. In contrast to south-eastern Poland [14], no respondents mentioned a fear of mushroom poisoning, which is again probably related to the conservative set of species used and the 'inherited knowledge': learning to pick mushrooms at an early age under the guidance of parents or older family members (acknowledged by almost all respondents). Belichenko [17] also identified conservative set of collected species learned from family members among Seto and Russian mushroom pickers in Pskov region as the cause of non-existent cases of mushroom poisoning.

Traditionally, Lithuanian folk medicine did not use many mushroom species for medicinal purposes [34, 59], which is in line with the European tradition, although the species listed by Gründemann et al. [8] are not entirely identical to the Lithuanian ones. Our study revealed that only four species—*Amanita muscaria*, *Gyromitra esculenta*, *Inonotus obliquus* and *Phallus impudicus*—are still used in at least one ethno-region and the use does not seem to be declining. In accordance with our study, *Phallus impudicus* was also noted as the most popular medicinal mushroom in Žemaitija by Pranskuniene et al. [60]. The mushrooms are mainly used as water- or alcohol-based extracts for internal and/or external use to treat a wide range of ailments, from cancer to rheumatoid pains. Meanwhile, the use of mushrooms as wound dressing (*Calvatia* and *Lycoperdon*), hot poultices (*Boletus* and *Leccinum*) or as internal treatment for some complaints (*Suillus* and *Boletus*), as described in the historical literature [61] and the unpublished ethnological records of Lithuanian Folklore Archives at the Institute of Lithuanian Literature and Folklore (see Materials and methods), have become obsolete. It should be noted that none of our respondents identified *Morchella* spp. as medicinal. *Morchella* spp. were listed as medicinal in Lithuania by Prakofjeva et al. [62], Fig. 3. Judging from some errors in Lithuanian names (e. g., elninės kerpės for *Cetraria islandica* [62], Table 20), the absence of *Gyromitra*

esculenta in their list (the fungus was reported by a number of our respondents as medicinal), the absence of Lithuanian name for *Morchella* spp. and similarity of some dialect names of *G. esculenta* to Belorussian name applied to *Morchella* spp. (compare *šmarška*, *šmarčkas* (Additional materials, Table 1) to *smarchok* [62], Table 2), it is likely there was a case of misidentification in the above mentioned study.

Ethnotaxonomy and the use of folk mushroom names can be an obstacle to the assessment of mushroom use, as sometimes respondents apply a specific name to a species, a genus or a part of a genus [14, 58], which was also the case in our study. Our study additionally showed that close lying ethno-regions or even different villages in the same region speaking the same dialect may use different names for the same mushroom species (e.g. the case of the brown-capped *Leccinum* species, Additional materials, Table 1) or even use the same name but for different species from different genera (cases of *Imleria badia* and *Suillus variegatus* or *Gyromitra esculenta* and *Morchella* spp.). In some cases, people may distinguish between different species of a genus while giving them the same name, only stating that it is a 'different' or 'other' species. Contrary to what has been found in Poland [14], in at least one ethno-region of Lithuania (Suvalkija) the diversity of coloured *Russula* species was not only perceived, but also expressed in descriptions. Large part of mushroom names are, however, region- and dialect-specific, underlining language diversity of the dialects involved.

Mushroom species that had no economic value to the respondents (not collected for food or medicine, poisonous or with a very acrid taste, and easily confused with edible species) were generally not well identified and/or named in all ethno-regions. A similar phenomenon was observed by Gyozo [63], who noted that Hungarian respondents attributed aesthetic value only to the species collected for food. The only exceptions in our study were *Lycoperdon* and *Calvatia*, whose spore dispersal mechanism makes them easily identifiable as a group, and they were often mentioned as a play object for children. In other cases, mushrooms that were not used or used very rarely were slightly better recognised in areas where they are more common (*Tricholoma joachimii* and *Aureoboletus projectellus* in Dzūkija), and species with a distinctive appearance (e.g. *Sarcoscypha* spp. in all areas, or *Gyroporus cyanescens* in Dzūkija and Eastern Aukštaitija) were better recognised. Such patterns clearly correspond to three of the four factors defining cultural recognition of biological taxa: (1) economic significance; (2) morphological significance; (3) ecological/geographical significance; (4) size significance [5, 64].

Conclusions

The work presented herein is the first comprehensive study of mushroom picking and use tradition in major ethno-regions of Lithuania. Speciation of ethnomycological knowledge and tradition does not seem to be determined by long-term historical influences, ethnicity or religion, but rather by prevailing forest types and regional ethno-culture. The predominant forest types determine mushroom species sets most commonly used for food and medicine, although not entirely—the specificity of mushroom use in one region is due solely to ethno-cultural traditions. Although the sets of mushrooms used for food in Lithuanian ethno-regions are broadly similar to those of North-eastern Slavic areas and Sweden, they differed from both of them.

Respondents demonstrated a good knowledge of edible mushrooms, which is considered to be inherited from the older generation. Knowledge is also conservative: changes in the set of species consumed are slow and depend more on environmental changes, especially deforestation, and less on external information. Mushroom-related gastronomy also adheres to traditional dishes, with some exceptions in preservation techniques, wild mushrooms remaining a source of dietary diversification albeit having lost their importance of food shortage periods. Despite the loss of importance as a food source, mushrooms and their gathering remain important from a biocultural point of view in terms of linguistic diversity, traditional knowledge systems and their transmission, even raising to patrimonial values.

The extremely rare cases of mushroom poisoning, due to traditional attitudes towards mushrooms and the ‘inherited knowledge’ acquired by learning to mushroom with family members, show the importance of field education led by an experienced forager to prevent mushroom poisoning among ‘new’ mushroom pickers, especially from urban areas. Furthermore, the attitude of the vast majority of traditional mushroom pickers among the respondents towards economically unimportant mushrooms shows that they do not distinguish, observe or even take an interest in species that are not consumed, and are therefore not a good source of information for the recording of rare or newly discovered species or related ecological changes.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s13002-024-00730-8>.

Additional file 1.
Additional file 2.
Additional file 3.

Acknowledgements

The authors would like to thank all the respondents and especially the people who helped to contact the respondents: Aldona Kuprelytė and Gitana Sidabriėnė (Plateliai), Dalia Blažulionytė (Marcinkonys), Ramunė Sinkevičienė (Puvočiai), Domincėlė Iršėnienė (Panevėžys), Jaunius Vylius and Regina Mocevičienė (Kazlų Rūda), Kęstutis Baronas (Biržai), Sigutė Mudinienė (Palūšė), Raimondas Guobis (Anykščiai). Žydrūnas Sinkevičius (Veisiejai) is thanked for placing the photograph used in Figure 2c at our disposal. We are grateful to both reviewers for their help in improving the manuscript.

Author contributions

J.M. wrote the main manuscript and prepared Figs. 3–5; VD and RI prepared methodology of interviewing, VD, EK and RI prepared Figs. 2 and 6 and analysed the interview data, EK prepared part of literature review, RI prepared Figs. 1 and 7; RI and JK made calculations, all authors took part in at least some interviewing the respondents, and all authors reviewed the manuscript.

Funding

The research was funded by the Lithuanian Research Council (Grant No P-LIP-22–95).

Availability of data and materials

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

Prior oral informed consent was obtained from all study participants before the data collection.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Author details

¹Institute of Botany, Nature Research Centre, Žaliojių Ežerų Str. 47, 12200 Vilnius, Lithuania. ²Institute of Lithuanian Literature and Folklore, Antakalnio Str. 6, 10308 Vilnius, Lithuania. ³Department of Botany and Genetics, Institute of Biosciences, Life Sciences Center, Vilnius University, Saulėtekio Ave. 7, 10257 Vilnius, Lithuania.

Received: 8 July 2024 Accepted: 11 September 2024

Published online: 18 September 2024

References

- Boddy L. Chapter 11 - Fungi, Ecosystems, and Global Change. In: Watkinson SC, Boddy L, Money NP, editors. *The Fungi*. 3rd ed. Academic Press; 2016. p. 361–400.
- Dugan FM. Fungi in the ancient world: how mushrooms, mildews, molds and yeast shaped the early civilizations of Europe, the Mediterranean and the Near East. St. Paul: APS Press; 2008.
- Wasson VP, Wasson RG. *Mushrooms, Russia and history*, vol. 1–2. New York: Pantheon Books; 1957.
- Yamin-Pasternak S. Ethnomycology: mushrooms in cultural entanglements. In: Anderson EN, Turner N, editors. *Ethnobiology, a textbook*. Wiley Blackwell Publications; 2011. p. 213–30.
- Motiejūnaitė J, Børja I, Ostonen I, et al. Cultural ecosystem services provided by the biodiversity of forest soils: an European review. *Geoderma*. 2019;2018(343):19–30. <https://doi.org/10.1016/j.geoderma.2019.02.025>.
- Łuczaj Ł, Stawarczyk K, Kosiek T, et al. Wild food plants and fungi used by Ukrainians in the western part of the Maramureș region in Romania. *Acta Soc Bot Pol*. 2015;84:339–46. <https://doi.org/10.5586/asbp.2015.029>.
- Yamin-Pasternak S. A means of survival, a marker of feasts: mushrooms in the Russian Far East. *Ethnology*. 2007;47:95–107.

8. Gründemann C, Reinhardt JK, Lindequist U. European medicinal mushrooms: do they have potential for modern medicine?—An update. *Phytomedicine*. 2020;66:153131. <https://doi.org/10.1016/j.phymed.2019.153131>.
9. Kasper-Pakosz R, Pietras M, Łuczaj Ł. Wild and native plants and mushrooms sold in the open-air markets of southeastern Poland. *J Ethnobiol Ethnomed*. 2016;12:45. <https://doi.org/10.1186/s13002-016-0117-8>.
10. Nanagulyan S, Zakaryan N, Kartashyan N, Piwowarczyk R, Łuczaj Ł. Wild plants and fungi sold in the markets of Yerevan (Armenia). *J Ethnobiol Ethnomed*. 2020;16(1):26. <https://doi.org/10.1186/s13002-020-00375-3>.
11. Turtaianen M, Saastamoinen O, Kangas K, et al. Picking of wild edible mushrooms in Finland in 1997–1999 and 2011. *Silva Fenn*. 2012;46(4):569–81.
12. Torres-Gómez M, Garibay-Orijel R, Pérez-Salicipur DR, et al. Wild edible mushroom knowledge and use in five forest communities in central México. *Can J For Res*. 2023;53:1–13. <https://doi.org/10.1139/cjfr-2022-0043>.
13. Kotowski MA, Molnár Z, Łuczaj Ł. Fungal ethnoecology: observed habitat preferences and the perception of changes in fungal abundance by mushroom collectors in Poland. *J Ethnobiol Ethnomed*. 2021;17:1–23. <https://doi.org/10.1186/s13002-021-00456-x>.
14. Łuczaj Ł, Nieroda Z. Collecting and learning to identify edible fungi in southeastern Poland: age and gender differences. *Ecol Food Nutr*. 2011;50:319–36. <https://doi.org/10.1080/03670244.2011.586314>.
15. Garibay-Orijel R, Ramírez-Terrazo A, Ordaz-Velázquez M. Women care about local knowledge, experiences from ethnomycology. *J Ethnobiol Ethnomed*. 2012;8:25. <https://doi.org/10.1186/1746-4269-8-25>.
16. Quiñónez-Martínez M, Ruan-Soto F, Aguilar-Moreno IE, et al. Knowledge and use of edible mushrooms in two municipalities of the Sierra Tarahumara, Chihuahua, Mexico. *J Ethnobiol Ethnomed*. 2014;10:67. <https://doi.org/10.1186/1746-4269-10-67>.
17. Belichenko O. "Setos pick russula and purovik, and not the red ones, they are slimy": Cultural preferences in edible mushroom use of the Setos and Russians of Pechory District of Pskov Oblast, NW Russia. *Études finno-ougriennes*. 2022;54:137–66.
18. Laužikienė A, Laužikas R. *Senieji lietuviški receptai. Lietuvos gospodinių receptai: dvi dešimtys ir vienas būdas, kaip gaminti gardžius senoviškus valgius, kuriais pavyks ne tik šeiminykščius nudžiuginti, bet ir svečių papenėti/Old Lithuanian recipes. Recipes of Lithuanian ladies of the house: twenty and one way to make delicious old-fashioned dishes that will not only make your household happy, but also suitable for your guests*. Vilnius: Vilniaus universiteto leidykla; 2016.
19. Jurginis J. Lietuvos valstiečių istorija (Nuo seniausių laikų iki baudžiavos panaikinimo)/ History of Lithuanian peasants (From ancient times until the abolition of serfdom). Vilnius: Mokslas; 1978.
20. Cerri A. Grybų pavadinimai Kristijono Donelaičio „Metuose“: vertimo ir identifikavimo problemos/ Names of mushrooms in Kristijonas Donelaitis' "Metai": translation and identification problems. In: Vaicekuskas M, editor. Kristijono Donelaičio reikšmės. Vilnius: Lietuvių literatūros ir tautosakos institutas; 2016. p. 343–59.
21. Grzywacz A. Tradycje zbiorów grzybów leśnych w Polsce/Forest mushroom harvesting traditions in Poland. *Studia i Materiały CEPL w Rogowie*. 2015;44(3):189–99.
22. Džekčiorūtė-Medeišienė V. Mitinė grybų samprata lietuvių kultūroje/ Mythical notion of mushrooms in Lithuanian culture. *Tautosakos Darbai*. 2016;52:119–44.
23. Baltėnas A, Droblienė O. Šilų džūkai. Vilnius: R. Paknio leidykla; 2009.
24. Karvelytė A, Motiekaitytė V. Laukinių grybų ir uogų, vaistažolių rinkimo įvertinimas pagal ekonominius, socialinius ir gamtosauginius kriterijus/ Evaluation of wild mushroom, berry and herb collection in terms of economic, social and environmental criteria. *Journal of Young Scientists*. 2013;1(39):101–10.
25. Minkevičius A. Valgomieji ir nuodingieji grybai Kauno apylinkėse ir Kazlų Rūdoje 1938 m./ edible and poisonous mushrooms in the vicinity of Kaunas and Kazlų Rūda in 1938. *Kosmos (Kaunas)*. 1939;20:71–80.
26. Minkevičius A. Grybai Kačerginės miške 1940 metais/ Mushrooms in Kačerginė forest in 1940. *Mūsų girios*. 1944;1–2:51–60.
27. Movšovičius J. Vilniaus prekyvietėse parduodami grybai/Mushrooms sold in Vilnius markets. *Gamta*. 1940;5(1):35–8.
28. Mazelaitis J. Lietuvos TSR. Valgomieji grybai, jų paplitimas ir resursų apskaičiavimas/Edible mushrooms of the Lithuanian SSR, their distribution and resource calculation. Lietuvos TSR Mokslų Akademija. Biologijos Instituto Darbai. 1954;2:59–76.
29. Visuotinė Lietuvių enciklopedija. Lietuva/The Universal Lithuanian Encyclopaedia. Lithuania. <https://www.vle.lt/straipsnis/lietuva-8/> Accessed 20 May 2024.
30. Visuotinė Lietuvių enciklopedija. Lietuvos gyventojai/The Universal Lithuanian Encyclopaedia. Population of Lithuania. <https://www.vle.lt/straipsnis/lietuvas-gyventojai/>. Accessed 20 May 2024.
31. Tumėnas V. Lietuvos etnografinių regionų koncepcijos ištakų ir sklaidos keliai/The origins and dissemination of the concept of Lithuanian ethnographic regions. *Etninė kultūra*. 2015;9:47–60.
32. Dundulienė P. Senovės lietuvių mitologija ir religija/ Ancient Lithuanian mythology and religion. Vilnius: Mokslas; 1990.
33. Jasiūnaitė B. Šventieji ir nelabieji frazeologijoje ir liaudies kultūroje/ Saints and devils in phraseology and folk culture. Vilnius: Vilniaus universiteto leidykla; 2010.
34. Lubienė J. Lietuvių kalbos mikonimai: nominacija ir motyvacija/Lithuanian folk names of fungi—nomination and motivation. Klaipėda: Klaipėdos universiteto leidykla; 2015.
35. Trinkauskaitė-Johnson E. Apie grybus, arba velniškas nuklydimas/about mushrooms, or a devilish diversion. *Liaudies kultūra*. 2006;2(107):10–8.
36. International Society of Ethnobiology Code of Ethics. <https://www.ethnobiology.net/what-we-do/core-programs/ise-ethics-program/code-of-ethics/>. Accessed 20 Aug 2022.
37. Turner NJ, Cuerrier A. 'Frog's umbrella' and 'ghost's face powder': the cultural roles of mushrooms and other fungi for Canadian Indigenous Peoples. *Botany*. 2022;100(2):183–205. <https://doi.org/10.1139/cjb-2021-0052>.
38. Kirk P. Index Fungorum. <http://www.indexfungorum.org> Accessed 3 Jun 2024.
39. Kranauskienė S, Pocyūtė S, Leiserowitz R, et al. Klaipėdos kraštas 1945–1960 m.: naujos visuomenės kūrimasis ir jo atspindžiai šeimų istorijose/ Klaipėda Region 1945–1960: the creation of a new society and its reflection in family histories. Klaipėda: Klaipėdos universiteto leidykla; 2019.
40. McCune B, Mefford MJ. PC-ORD. Multivariate analysis of ecological data. Version 6; 2011.
41. Official Statistics Portal. <https://osp.stat.gov.lt/> Accessed 31 August 2024.
42. Lithuanian Hydrometeorological Service under the Ministry of Environment. <https://www.meteo.lt>
43. State Forest Service database <https://amvmt.lrv.lt/lt/atviri-duomenys-1/misku-statistikos-leidiniai/valstybine-misku-apskaita/> Accessed 20 May 2024.
44. Geoportal.lt. <https://www.geoportal.lt/geoportal/paieska> [Lietuvos etnografiniai regionai (WMS peržiūros paslauga)] Accessed 31 May 2024.
45. Bukantis A, Ignatavičius G, Satkūnas J, et al. Lietuvos gamtinė aplinka. Būklė, procesai ir raida/ Lithuania's natural environment. State, processes and development. Vilnius: AB Kopa; 2013.
46. Navasaitis M, Ozolinčius R, Smaliukas D, et al. Lietuvos dendroflora/Dendroflora of Lithuania. Kaunas: Lututė; 2003.
47. Nacionalinė žemės tarnyba prie Aplinkos ministerijos, Lietuvos nacionalinis atlasas, I tomas, antrasis leidimas/ National Land Service under the Ministry of the Environment, National Atlas of Lithuania, Volume I, 2nd edition. Vilnius: Vilniaus universitetas; 2016.
48. Budriūnienė K, Drąsūnienė E, Kadžiauskienė L, et al. Lietuvių valgiai/Lithuanian dishes. Vilnius: Mokslas; 1983.
49. Uginčienė J. Žemaičių valgiai/Samogitian dishes. Vilnius: Mintis; 1977.
50. Iršėnaitė R, Kutorga E, Kvederavičiūtė K, et al. *Tricholoma joachimii* (Tricholomataceae, Basidiomycota), a rare European species new for the eastern Baltic region. *Nova Hedwigia*. 2022;144(1–2):77–89. https://doi.org/10.1127/nova_hedwigia/2022/0674.
51. Motiejūnaitė J, Kasparavičius J, Kačergius A. *Boletellus projectellus*—an alien mycorrhizal bolete new to Europe. *Sydowia*. 2011;63(2):203–13.
52. Wrzosek M, Motiejūnaitė J, Kasparavičius J, et al. The progressive spread of *Aureoboletus projectellus* (Fungi, Basidiomycota) in Europe. *Fungal Ecol*. 2017;27:134–6. <https://doi.org/10.1016/j.funeco.2017.02.003>.
53. Rašomavičius V, ed. Lietuvos raudonoji knyga. Gyvūnai, augalai, grybai/ Red Data Book of Lithuania. Animals, plants, fungi. Vilnius: Lututė; 2021.

<https://am.lrv.lt/uploads/am/documents/files/Raudonoji%20knyga/index.html>

54. Šaknys Ž. Etnografiniai regionai Lietuvoje: šiuolaikinio jaunimo požiūris/ Ethnographic regions in Lithuania: the attitudes of young people today. *Tautosakos darbai*. 2012;43:126–42.
55. Schulp CJE, Thuiller W, Verburg PH. Wild food in Europe: a synthesis of knowledge and data of terrestrial wild food as an ecosystem service. *Ecol Econ*. 2014;105:292–305. <https://doi.org/10.1016/j.ecolecon.2014.06.018>.
56. Šorys J. Su dalium ir grybais gerai...! Pokalbis su Dzūkijos nacionalinio parko ir Čepkelių valstybinio gamtinio rezervato direktorijos specialiste etnokultūrininke Dalia Blažulionyte/With fortune even mushroom foraging is good...! Interview with Dalia Blažulionytė, ethno-culturalist and specialist of the Dzūkija National Park and Čepkeliai State Nature Reserve Directorate. *Būdas*. 2021;3(198):50–60.
57. Svanberg I, Lindh A. Mushroom hunting and consumption in twenty-first century post-industrial Sweden. *J Ethnobiol Ethnomed*. 2019;15:42. <https://doi.org/10.1186/s13002-019-0318-z>.
58. Stryamets N, Elbakidze M, Ceuterick M, et al. From economic survival to recreation: contemporary uses of wild food and medicine in rural Sweden, Ukraine and NW Russia. *J Ethnobiol Ethnomed*. 2015;11:53. <https://doi.org/10.1186/s13002-015-0036-0>.
59. Mazelaitis J, Urbonas V. Lietuvos grybai/Lithuanian fungi. Vilnius: Mokslas; 1980.
60. Pranskuniene Z, Dauliute R, Pranskunas A, et al. Ethnopharmaceutical knowledges in Samogitia region of Lithuania: where old traditions overlap with modern medicine. *J Ethnobiol Ethnomed*. 2018;14:70. <https://doi.org/10.1186/s13002-018-0268-x>.
61. Petkevich G. Materialy ponarodnoi medicine litovcev/materials on Lithuanian folk medicine. *Zhivaja starina*. 1911;3–4:167–218.
62. Prakofjewa J, Sartori M, Kalle R, et al. "But how true that is, I do not know": the influence of written sources on the medicinal use of fungi across the western borderlands of the former Soviet Union. *IMA Fungus*. 2024;15:22. <https://doi.org/10.1186/s43008-024-00156-7>.
63. Gyozo Z. The meanings and functions of mushrooms as food in Hungarian folk tradition. *Acta Ethnogr Hung*. 2010;55(1):115–38. <https://doi.org/10.1556/AEthn.55.2010.1.8>.
64. Hunn ES. Size as limiting the recognition of biodiversity in folkbiological classifications: one of four factors governing the cultural recognition of biological taxa. In: Medin DL, Atran S, editors. *Folkbiology*. Cambridge: MIT Press; 1999. p. 47–69.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.