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SCIENTOMETRICS OF GLOBAL SCIENTIFIC PRODUCTION ABOUT ETHNOMYCOLOGY

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ABSTRACT

Ethnomycology is a branch of ethnoknowledge that describes the interaction between fungi and traditional communities over time. This study presents a scientometric analysis of global scientific production about Ethnomycology, based on a survey of articles indexed in Web of Science Core Collection database, between 1991 and 2019. The temporal distribution of the 173 articles obtained, showed a significant increase in over the years, indicating a growing interest in Ethnomycology by the scientific community. The most frequent journals were Journal of Ethnobiology and Ethnomedicine (18%) and Economic Botany (12%), and the principal authors were Luczaj, L (1.7%), Garibay-Orijel, R (1.5%), Estrada-Torres, A and Pieroni, A (both with 1.3%). The most studied locations involve indigenous communities and are in Mexico (22%), followed by India (9%) and China (7%), and over half of the institutions where the research was conducted were also Mexican. The primary focus of the studies was the purpose of fungal use (37%), the most frequently reported being as food (50%) and medicine (32%). Of the 838 species mentioned, the most prominent were *Cantharellus cibarius* Fr. (3.7%), *Boletus edulis* Bull. (3.3%) and *Agaricus campestris* sensu Cooke (2.6%), all edible. The data showed that the ethnomycological knowledge available is strongly concentrated in Mexico, and the primary focus of use of fungi is as food. The main trends point to Ethnomycology as a young Science, but of growing interest, whose ethnomycological knowledge is concentrated in Mexico and in indigenous communities, with focus in use of fungi as food. However, the major gaps demonstrate the need for further ethnomycological studies involving other traditional communities, which not only indigenous, and other regions around the world, which could reveal new relationships between humans and fungi, thereby contributing to the conservation of global mycodiversity.

KEYWORDS: Ethnoknowledge, Fungi, Mycology, Scientometry, Traditional communities.

CIENCIOMETRÍA DE LA PRODUCCIÓN CIENTÍFICA GLOBAL EN ETNOMICOLOGÍA

RESUMEN

La etnomicología es un área del etnoconocimiento que describe la interacción entre los hongos y las comunidades tradicionales a lo largo del tiempo. Este estudio presenta un análisis cienciométrico de la producción científica global sobre Etnomicología, basado en una encuesta de artículos indexados en la base de datos de Web of Science Core Collection, entre 1991 y 2019. La distribución temporal de los 173 artículos obtenidos, mostró un aumento significativo en los años, lo que indica un creciente interés por la etnomicología por parte de la comunidad científica. Las revistas más frecuentes fueron Journal of Ethnobiology and Ethnomedicine (18%) y Economic Botany (12%), y los autores principales fueron Luczaj, L (1.7%), Garibay-Orijel, R (1.5%), Estrada-Torres, A y Pieroni, A (ambos con 1.3%). Los lugares más estudiados involucran a comunidades indígenas y se encuentran en México (22%), seguido de India (9%) y China (7%), y más de la mitad de las instituciones donde se realizó la investigación también eran mexicanas. El enfoque principal de los estudios fue el propósito del uso de hongos (37%), siendo los más frecuentemente reportados como alimento (50%) y como medicamento (32%). De las 838 especies mencionadas, las más destacadas fueron *Cantharellus cibarius* Fr. (3.7%), *Boletus edulis* Bull. (3.3%) y *Agaricus campestris* sensu Cooke (2.6%), todos comestibles. Los datos mostraron que el conocimiento etnomicológico disponible está fuertemente concentrado en México, y el enfoque principal del uso de hongos es como alimento. Las principales tendencias apuntan a la Etnomicología como una Ciencia joven, pero de creciente interés, cuyo conocimiento etnomicológico se concentra en México y en comunidades indígenas, con foco en el uso de hongos como alimento. Sin embargo, las principales lagunas demuestran la necesidad de realizar más estudios etnomicológicos que involucren a otras comunidades tradicionales, que no solo son indígenas, y de otras regiones del mundo, que podrían revelar nuevas relaciones entre humanos y hongos, contribuyendo así a la conservación de la micodiversidad global.

PALABRAS CLAVE: Cienciometría, Comunidades tradicionales, Etnoconocimiento, Hongos, Micología.

INTRODUCTION

Considered one of the most recent areas of ethnobiology, ethnomycology is the study of traditional knowledge, cultural/environmental manifestations and implications of the relationships between humans and fungi over time and space (Moreno-Fuentes *et al.,* 2001). It can also be viewed as the study of the relationships between fungi and traditional communities, local knowledge and the use of these fungi, underscoring their ecological and cultural importance (Ruan-Soto *et al.,* 2009). Comandini & Rinaldi (2020) understand ethnomycology as observing and recording the interactions of fungi with people, in order to understand them as part of nature.

Ethnomycology had its origin marked by the publication of Valentina Pavlovna Wasson and Robert Gordon Wasson published in 1957, entitled Mushrooms, Russia and History, which discusses the use of neurotropic fungi (hallucinogens) in rituals by peoples of Siberia, Papua New Guinea and Mexico. In the same book, the authors used the terms “mycophobe” and “mycophile” for the first time to characterize the interactions of fondness for and/or aversion to fungi, respectively (Boa, 2004).

Ethnomycological studies began with a neurotropic approach, but other approaches were taken as researchers found evidence of other forms of use, such as medicinal and/or food (Pala *et al.,* 2013). However, the relationship between fungi and culture is deeply rooted in the history of humanity, particularly in China, where they have been consumed since before Christ (Aaronson, 2000). Strong interaction has also been

documented between the peoples of Central Africa, Mexico and Turkey and wild edible fungi (Boa, 2004).

The term scientometry is attributed to quantitative research aimed at assessing scientific progress in a certain topic. These analyses have contributed to elucidating the different approaches used in a particular field of knowledge (Strehl & Santos, 2002; Vanti, 2002). In this respect, the aim of this study is to present a global scientometric analysis of ethnomycology, revealing the trends and perspectives of this subject in the area of mycology. Specifically, we evaluate: the temporal evolution of the number and focus of the articles; the journals, authors and countries from the publication; and how the different populations of the world use fungi and which are these fungi.

MATERIALS AND METHODS

The data were obtained from a search on the Web of Science Core Collection (WoS) database. The search was made using the terms Ethnomycol* OR (Traditional knowled* AND (Fung* OR Mushroom*), without language restriction and indexed to the topics. An asterisk (*) was used in all the terms so that variations in spelling would be considered in the search.

The WoS was used for being recognized as the most authoritative scientific literature indexing tool available (Li *et al.,* 2018). Thus, only articles published in indexed journals were considered, making the search criteria, despite being restrictive, more homogeneous, recovering only publications with global reach.

All the studies published between 1991 (when article abstracts were first added to the Web of Science database) and 2019 were extracted and the title, abstract and keywords of all the articles read. Those that discussed at least one ethnomycological aspect were selected (see criteria viii). The following criteria of each of these articles were analyzed: (i) the journal in which it was published; (ii) year of publication; (iii) country where the study was conducted); (iv) authors; (v) affiliation of all the authors; (vi) keywords; (vii) type of community (indigenous or non-indigenous) addressed; (viii) focus of the work (categorizing it into fungal use, taxonomy, cultivation/commerce, ecology/conservation, gastronomy, medicinal and other importance); (ix) purpose of fungal use (categorized as food, medicinal, magical/religious, decorative and toxic); and (x) fungal species. It is important to underscore that in the purpose of use category, the same article sometimes describes multiple forms of fungal use, which explains why the number of uses recorded exceeded the total number of articles.

Pearson's correlation (r) ($P < 0.05$) between the years and number of published articles was calculated to determine whether the latter increased over the years. Likewise, the correlation between all the methods applied and reasons for fungal use was also calculated over the years. Positive r values indicate an increase in the number of published articles, while negative values suggest a decline.

We present a distribution map of the number of articles by country to analyze how these studies are distributed, using the Quantum GIS software (QGIS Development Team, 2020). The keywords with similar meanings were combined with a view to verifying ethnomycological research trends over time through principal component analysis (PCA). All the analyses were performed in the R Studio software, version 1.1.453 (RStudio Team, 2018).

RESULTS AND DISCUSSION

The search extracted a total of 530 articles, but only 173 (see appendix) met the inclusion criteria established. The oldest article was published in 1991. Temporal distribution of the articles showed a substantial increase ($r = 0.87$; $P < 0.0003$) over the years, especially in the last decade (Figure 1). This rise in articles reflects the increase interest of researchers in this study area. In general, the number of studies in all the areas of knowledge has risen over the years, and the number of articles is the primary way of measuring this (Verbeek, 2002).

The articles are distributed among 67 journals, 72% of which contain a single article and 12% five or more.

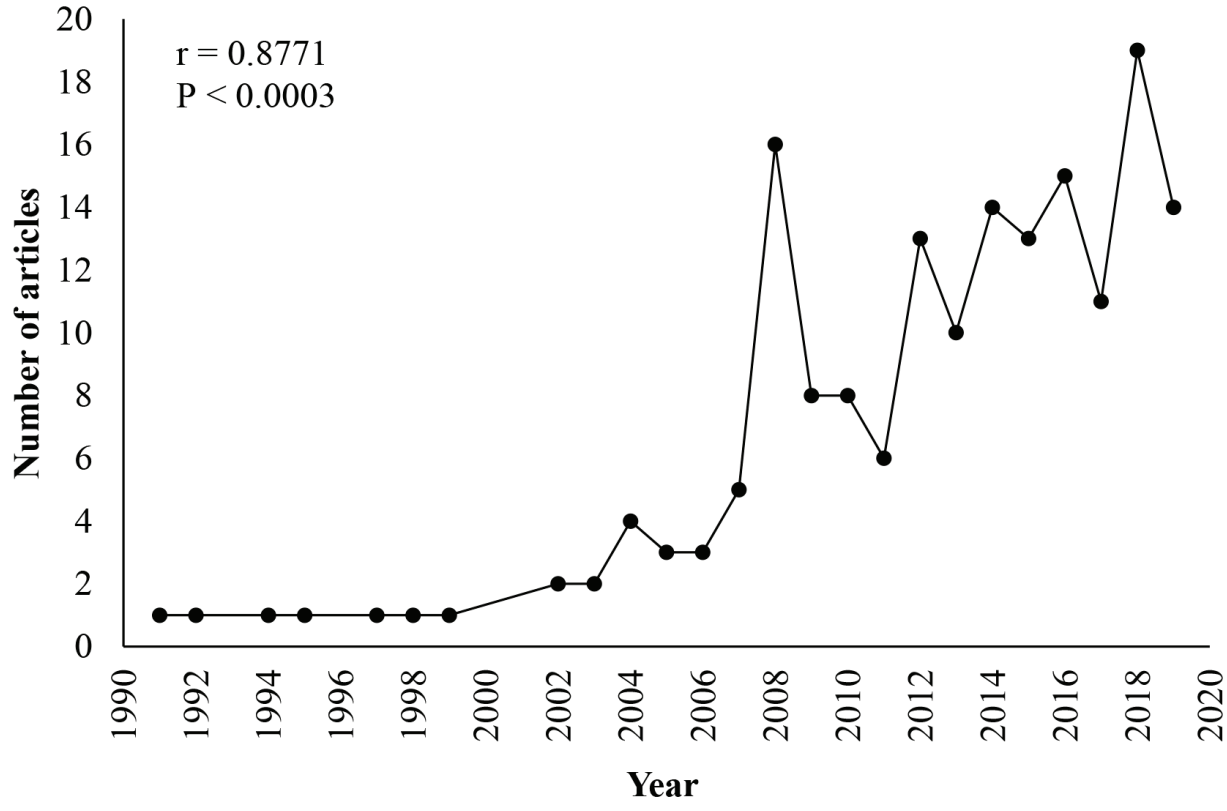

Figure 1. Temporal distribution of ethnomycological articles published between 1991 and 2019.

This shows a heterogeneous distribution between the number of publications and the journals that publish on the topic. The most frequent journals are the Journal of Ethnobiology and Ethnomedicine (covering 18% of the articles) and Economic Botany (12%) (Figure 2), both with more than 1.86 impact factor. The fact that nearly all the articles were published in journals that do not focus specifically on ethnomycology, but ethnobiology, shows that this is still an incipient area of science, studied only since the 1950s (Ruan-Soto, 2017). Of the 521 authors found, 87% published a single article, 11% two to four and 2% five or more; they are Luczaj, L (9 articles), Garibay-Orijel, R (8 articles), Estrada-Torres, A and Pieroni, A (7 articles each; Figure3).

Of the 173 articles, 164 contained the locations from which the study data collection was carried out. These are distributed in 62 countries highlighted in figure 4. The distribution of studies according to location shows that research efforts were concentrated mainly in Mexico (22%), followed by India (9%) and China (7%) (Figure 4). Ethnomycology has not been studied in many countries, demonstrating knowledge gaps in a number of regions worldwide.

A total of 302 institutions were identified from the authors' affiliations. Most (71%) hosted a single author. Only 5.3% employed five or more authors and 43.5% of these institutions were Mexican (Table 1). The fact that Mexico is the most studied country and has the largest number of ethnomycological researchers is likely due to the many mycophile communities in which fungi play an important cultural role and the development of a strong ethnomycological school with several researchers focused on this theme. In this respect, Ruan-Soto (2007) reported that Mexico is the cradle of ethnomycology.

We observed that 14.4% (25 articles) of the publications were made by single authors. The authors with the largest number of publications collaborate with

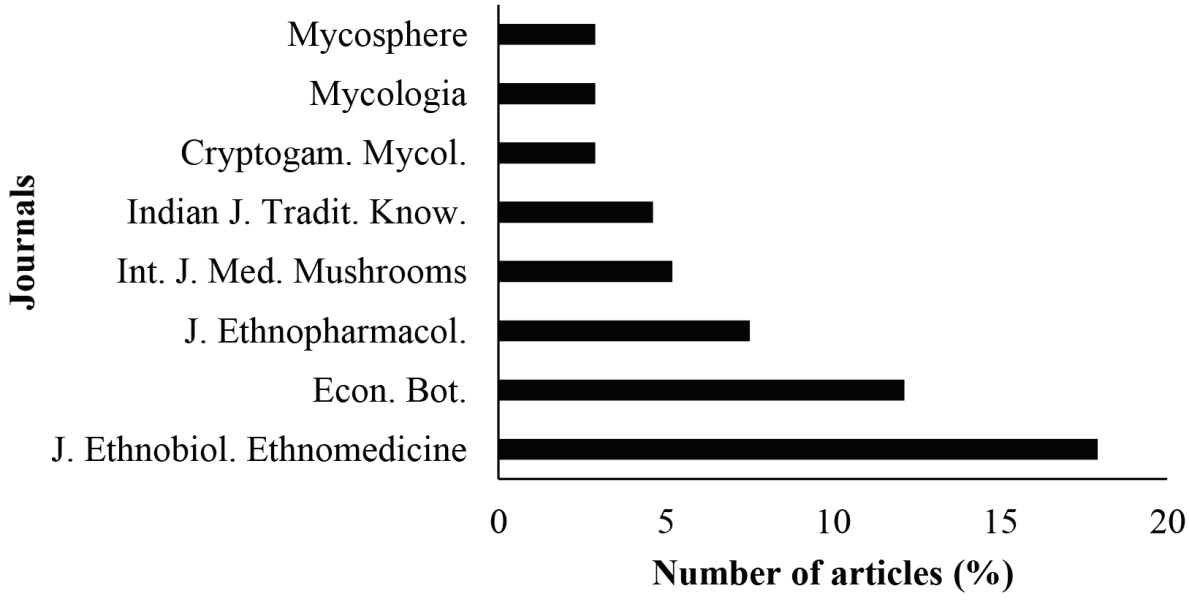

Figure 2. Distribution of ethnomycological articles published between 1991 and 2019, according to journal (n = 67 journals). Only journals with four or more articles were considered.

other authors, such as Garibay-Orijel, R., Ruán-Soto, F., Estrada-Torres, A., Caballero, J., Kong, A. and Montoya, A., all affiliated with Mexican institutions. This shows the significant contribution of these collaborators to the scientific production in this area. Similarly, Luczaj, L published in collaboration with Kang, J. and Kang, Y. X., who are affiliated with Chinese institutions; and Pietras, M., associated with the Academy of Science in Poland. By contrast, Guzman, G., who is among the 10 most frequently cited authors, collaborated with co-author in

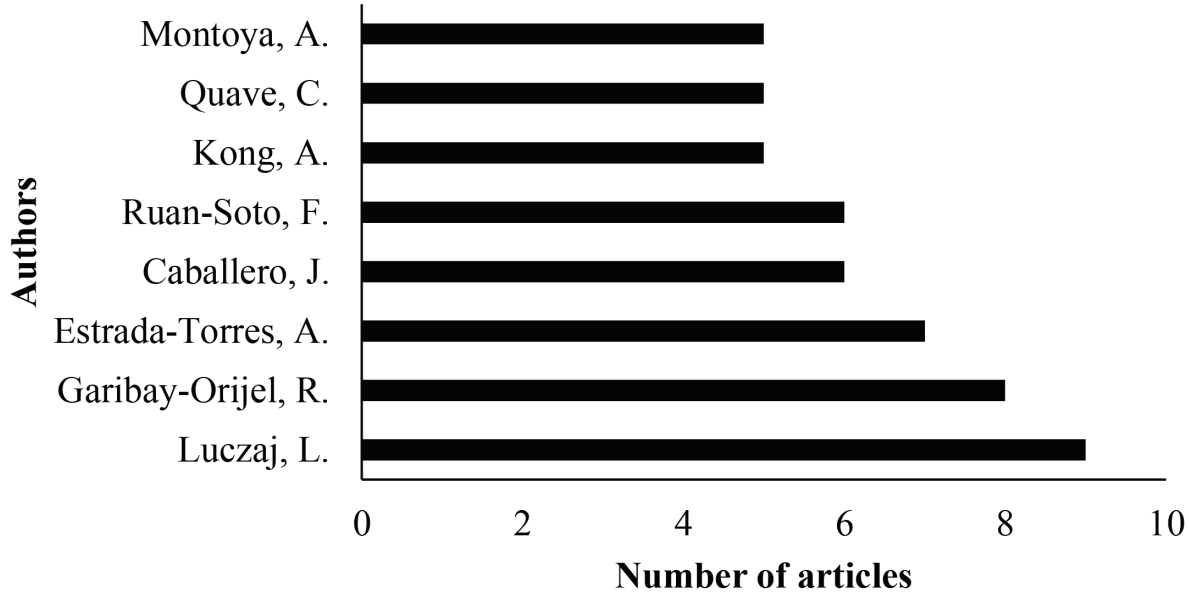

Figure 3. Authors with the largest number of ethnomycology articles published between 1991 and 2019 (n = 521 authors). Only authors who published five or more articles were included.

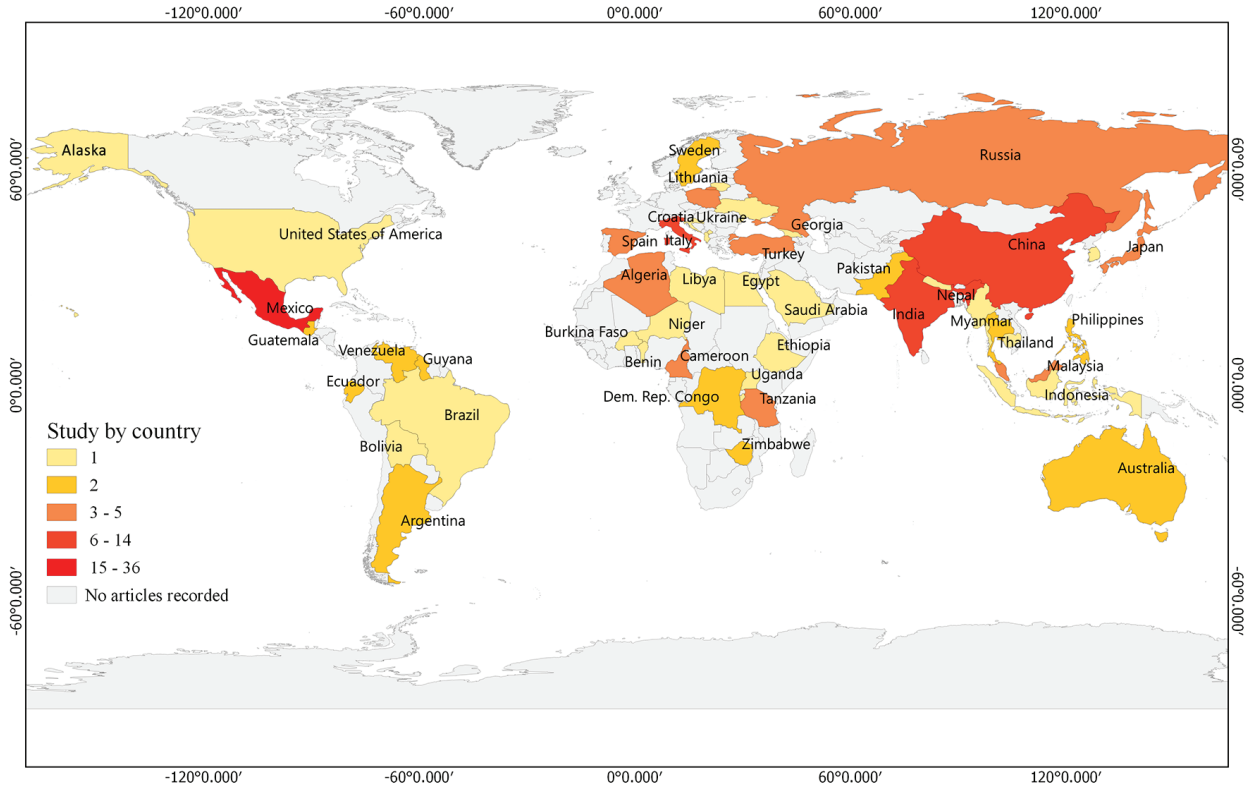

Figure 4. Distribution of ethnomycology articles published between 1991 and 2019, according to studies by country.

three publications. According to Nabout *et al.,* (2014), co-authorships tend to increase the quality of research and raise the probability of achieving a larger number of citations.

The articles that mentioned a community or ethnic group contained 65 names, 65% of which were indigenous, with the Zapotec accounting for 7.1% of the communities/ethnicities, located mainly in Oaxaca state, Mexico. For this indigenous population, mushrooms have considerable cultural significance, such as the species *Cantharellus cibarius* Fr., used as a food source (Garibay-orijel *et al.,* 2007).

When the primary focus of each study was identified, some had more than one object, resulting in 223 different approaches in the 173 articles. Analysis of the articles according to the primary focus produced the following seven categories: use of the fungi (37%); taxonomy (17%); cultivation/commerce (13%); gastronomic (10%); medicinal importance (10%); ecology/conservation (9%); and others (4%).

The temporal evolution of the study focus, according to Pearson's r, showed a moderate positive correlation for the "fungal use" category ($r = 0.66$; $P < 0.0005$) (Figure 5), with an increase in the number of studies in this area of ethnomycology. Within this category, five subcategories related to the type of use were identified, as follows: food (50%), medicinal (32%), decorative (8%), magic/religious (7%) and toxic (3%).

Moreno-Fuentes (2001) showed that since the 1980s ethnomycological studies have no longer focused primarily on hallucinogenic fungi, like Wasson's pioneering studies in 1957. This author reported the fungal use in rituals and the general ethnomycological concepts involving the different interactions between humans and fungi (Moreno-Fuentes, 2001; Ruan-Soto, 2007).

In his research on ethnomycology worldwide between 1960 and 1998, Moreno-Fuentes (2001) also showed a rise in the number of studies, most of which were conducted in Mexico and Japan. In the present study, articles on ethnomycology continued to increase over

Table 1. Main institutions affiliated with the authors of ethnomycology articles published between 1991 and 2019 (n = 302 institutions). Only institutions with five or more authors were considered.

INSTITUTION	FREQUENCY	
	ABSOLUTE	RELATIVE (%)
Universidad Nacional Autónoma de México, México	33	10.9
Universidad Autónoma de Tlaxcala, México	26	8.6
University of Malaya, Malaysia	15	5.0
Universidad Autónoma del Estado de México, México	13	4.3
University of Rzeszów, Poland	13	4.3
Instituto de Ecología, México	12	4.0
University of Innsbruck, Austria	11	3.6
Instituto Tecnológico del Valle de Oaxaca, México	7	2.3
University of Gastronomic Sciences, Italy	7	2.3
Northwest A&F University, China	6	2.0
Nanjing Agricultural University, China	6	2.0
Swedish University of Agricultural Sciences, Sweden	6	2.0
University of Prishtina, Kosovo	5	1.7
Universidad de Ciencias y Artes de Chiapas, México	5	1.7
Universidad Autónoma del Estado de Morelos, México	5	1.7
University of Buea, Cameroon	5	1.7

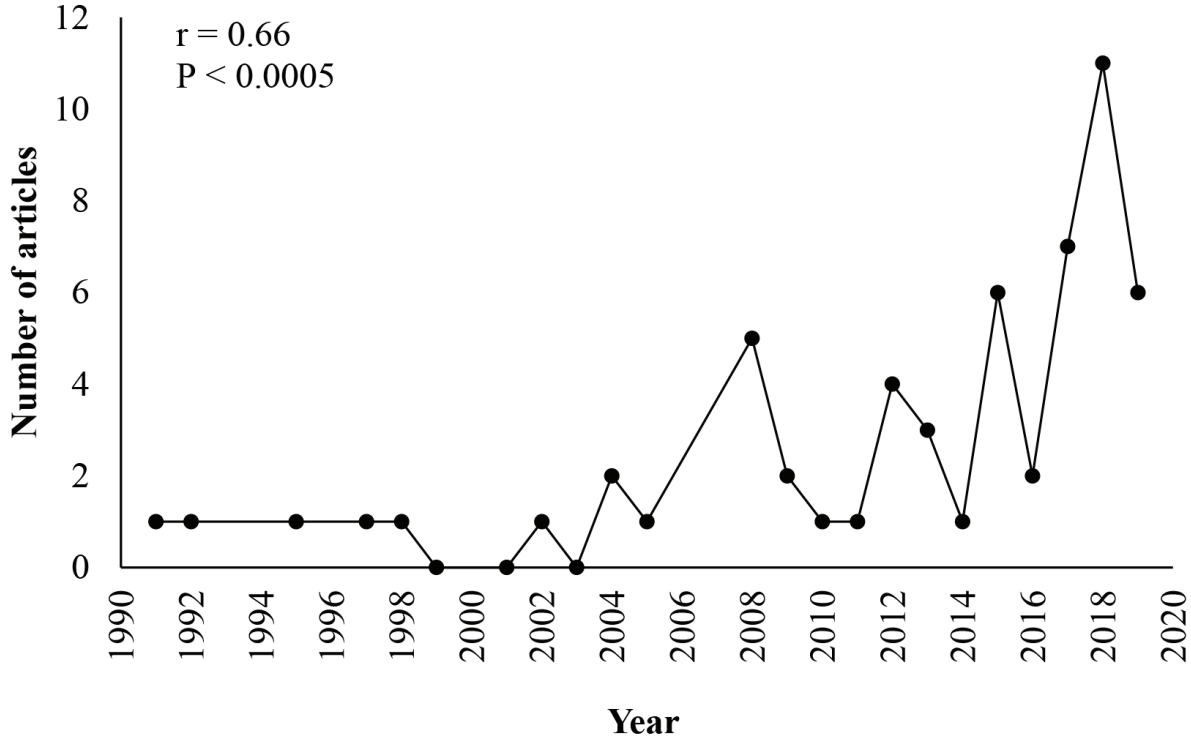

Figure 5. Temporal distribution of ethnomycology articles published between 1991 and 2019, whose primary focus was the use of the fungi.

the years, with Mexico the site of most of the research and only two Japanese studies. This variation may be due to the search mechanism used, where only articles indexed in high-circulation journals were considered.

According to Garibay-Orijel and Ruan-Soto (2014), Mexico has 371 wild mushroom taxa, second only to China, the country with the largest number of wild mushrooms used as a food source. However, despite its rich history in the use of edible and medicinal mushrooms and being the largest exporter of cultivated mushrooms (FAO, 2006), China is not the main producer of scientific knowledge in ethnomycology, according to the results of the present study. This may be because the articles produced there are published in local journals, with low circulation and/or impact factors, or in Chinese, precluding their use here. Moreover, commercial production has no relation with the studies conducted in the country.

The evaluation of the variation in keywords over the years, showed the first two components of principal component analysis (PCA) explain 58.5% of data variances (Figure 6). Studies in the last decade used terms with more restricted meanings and characteristic of ethnomycological studies, being that the words listed were directed, mainly the publications of the last 10 (component 1). Component 2 shows a negative correlation between keywords and the years between 1994 to 2007 and 2009, since they are not specifically related to ethnomycology, but can be used in other areas such as ecology.

A total of 838 fungal species were cited in the studies. Of the species with 10 or more citations (Table 2), the

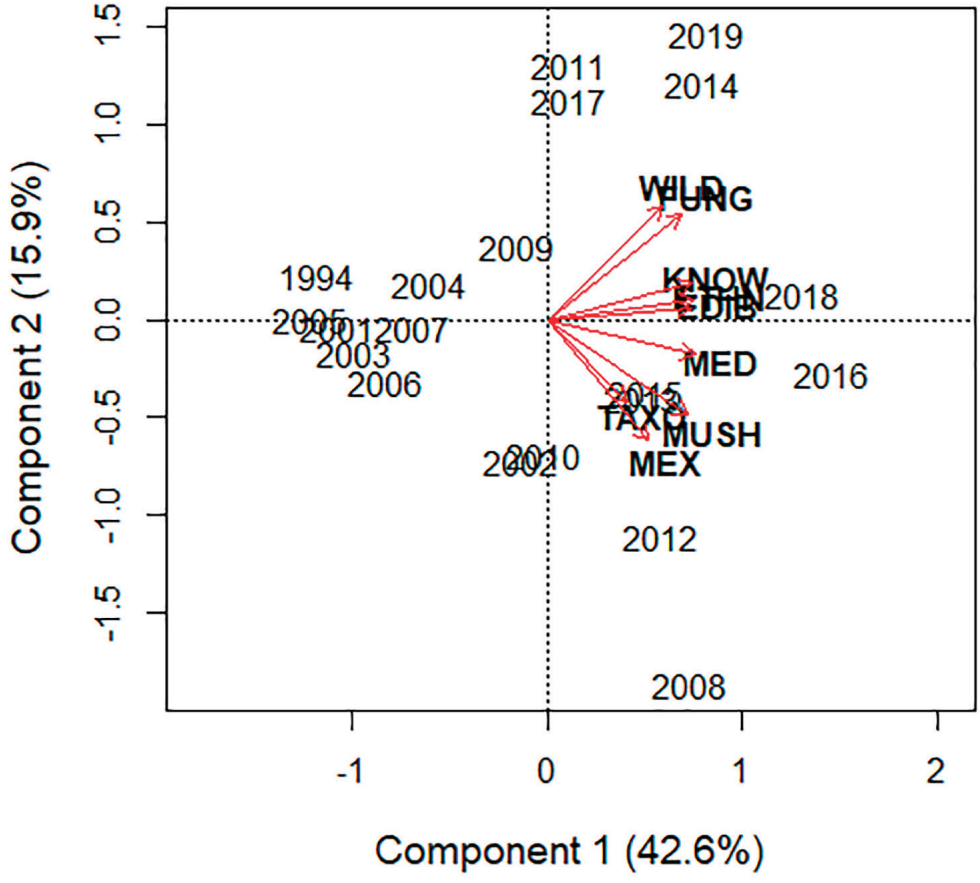

Figure 6. Principal component analysis (PCA) of keyword variation over the years in ethnomycology articles published between 1991 and 2019.

most belong to phyla Basidiomycota and Ascomycota. The most frequent species were *Cantharellus cibarius* Fr. (3.7%), *Boletus edulis* Bull. (3.3%) and *Agaricus campestris* sensu Cooke (2.6%), all edible (Table 2). Garibay-Orijel & Ruan-Soto (2014), who listed the traditionally edible species in Mexico, found similar results, reporting the following wild edible species: *Agaricus campestris* sensu Cooke, *Amanita caesarea* (Scop.) Pers., *A. rubescens* Pers., *Cantharellus cibarius* Fr., *Clitocybe gibba* (Pers.) P. Kumm, *Helvella lacunosa* Afzel., *Lactarius indigo* (Schwein.) Fr., *Ustilago maydis* (DC.) Corda and *Lyophyllum decastes* (Fr.) Singer

Table 2. Distribution of the main fungal species cited in ethnomycological studies published between 1991 and 2019, according to the family and number of citations. Only species cited 10 or more times were considered (n = 838).

SPECIES	FREQUENCY	
	ABSOLUTE	RELATIVE (%)
Cantharellus cibarius Fr.	31	3.7
Boletus edulis Bull.	28	3.3
Agaricus campestris sensu Cooke	22	2.6
Hypomyces lactifluorum (Schwein.) Tul. & C. Tul.	21	2.5
Schizophyllum commune Fr.	20	2.4
Amanita caesarea (Scop.) Pers.	19	2.3
Morchella esculenta (L.) Pers.	19	2.3
Lactarius deliciosus (L.) Gray	19	2.3
Helvella crispa Bull.	17	2.0
Hydnum repandum L.	17	2.0
Lactarius indigo (Schwein.) Fr.	17	2.0
Lycoperdon perlatum Pers.	16	1.9
Lyophyllum decastes (Fr.) Singer	16	1.9
Amanita rubescens Pers.	14	1.7
Amanita muscaria (L.) Lam.	14	1.7
Pleurotus ostreatus sensu Cooke	14	1.7
Auricularia auricula (L.) Underw.	13	1.6
Ramaria flava (Schaeff.) Quél.	13	1.6
Helvella lacunosa Afzel.	13	1.6
Clitocybe gibba (Pers.) P. Kumm.	13	1.6
Tricholoma magnivelare (Peck) Redhead	13	1.6
Gomphus floccosus (Schwein.) Singer	12	1.4
Morchella elata Fr.	12	1.4
Amanita basii Guzmán & Ram.- Guill	11	1.3
Boletus pinophilus Pilát & Dermek	11	1.3
Ganoderma lucidum (Curtis) P. Karst.	11	1.3
Ustilago maydis (DC.) Corda	11	1.3
Calvatia cyathiformis (Bosc) Morgan	10	1.2
Ramaria botrytis (Pers.) Bourdot	10	1.2
Lactarius salmonicolor R. Heim & Leclair	10	1.2
Pycnoporus sanguineus (L.) Murrill	10	1.2

which demonstrates the cultural importance of wild mushrooms in Mexico.

CONCLUSION

The results of this study indicate that the main trends in scientific production in ethnomycology were: (i) an increase in the number of articles over the years; (ii) most of the studies were conducted in Mexico; (iii) most of the articles are in journals that are not specific to mycology; and (iv) the primary focus is on the useof fungi, and among these uses, as food source is the most frequent. On the other hand, the main gaps are the lack of studies on Africa, South America and Asia (except China and India). These gaps suggest the need to study traditional communities around the world in order to record the ethnomycological knowledge of these peoples, which may contribute to conserving local biodiversity, given that communities have their own mechanisms to manage and exploit resources more sustainably. It is worth noting that studies involving other search criteria may express results different from these, especially if non-indexed and with a regional reach publications are included.

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REFERENCES

Aaronson, S. 2000. Fungi. In: Kiple K., F. & Ornelas K., C. eds. *The Cambridge world history of food*. Cambridge University Press. Cambridge, UK.

Boa, E. 2004. *Wild edible fungi: A global overview of their use and importance to people*. Foof and agriculture organization of the United nations, Rome.

Comandini, O., and A. C. Rinaldi. 2020. *Ethnomycology in Europe: The Past, the Present, and the Future*. In Mushrooms, Humans and Nature in a Changing World, Springer, Cham. Italy.

FAO - Food and Agricultural Organization. 2006. Corporate Document Repository: Wild Edible Fungi: A Global Overview of their Importance to People for Education and Data Analysis. Palaeontologia Electronica. FAO. Roma.

Garibay-Orijel, R., J. Caballero, A. Estrada-Torres y J. Cifuentes. 2007. Understanding cultural significance, the edible mushrooms case. *Journal of Ethnobiology and Ethnomedicine* 3(1). http://dx.doi.org/10.1186/1746-4269-3-4.

Garibay-Orijel, R. y F. Ruan-Soto. 2014. Listado de los hongos silvestres consumidos como alimento tradicional em México. En: Moreno-Fuentes A. and R. Garibay-Orijel (eds.). *La etnomicología em México, estado del Arte.* Conacyt-Uaeh-Unam. México.

Li, K., Rollins, J. y E. Yan. 2018. Web of Science use in published research and review papers 1997–2017: a selective, dynamic, cross-domain, content-based analysis. *Scientometrics* 115: 1-20. https://doi.org/10.1007/s11192-017-2622-5.

Moreno-Fuentes, Á., R. J. A. Garibay-Orijel, V. Tovar y J. Cifuentes. 2001. Situación actual de la etnomicología en México y el mundo. En: Memorias del Primer Encuentro Nacional de Etnomicólogos. *Etnobiología* 1: 75-84.

Pala, S. A., A. H., Wani y M. Y. Bhat. 2013. Ethnomycological Studies of Some Wild Medicinal and Edible Mushrooms in the Kashmir Himalayas (India). *International Journal of Medicinal Mushrooms* 15(2): 211-22.

QGIS Development Team, 2020. QGIS Geographic Information System. Open Source Geospatial Foundation Project. https://qgis.org/en/site/

Nabout, J. C., M. R. Parreira, F. B.Teresa, F. M. Carneiro, H. F. Cunha, L. S. Ondei, S. S. Caramori y T. N. Soares. 2014. Publish (in a group) or perish (alone): the trend from single to multiauthorship in biological papers. *Scientometrics* 102(1): 357-364. https://doi.org/10.1007/s11192-014-1385-5.

R Studio Team. 2018. RStudio: Integrated Development for R. RStudio, Inc., Boston, MA. http://www.rstudio.com/

Ruan-Soto, F., J. Cifuentes, M. R. Marianca, F. Limon, L. Pérez-Ramiry y S. Sierra. 2009. Uso y manejo de hongos silvestres en dos cumunidades de la Selva Lacadona, Chiapas, México. *Revista Mexicana Micologia* 29: 61-72.

Ruan-Soto, F. 2007. 50 años de etnomicología em México. *Lacandonia* 1(1): 97-108.

Strehl, L. y C. A. Santos. 2002. Indicadores de qualidade da atividade científica. *Ciência Hoje* 31 (186): 34-39.

Vanti, N. A. P. 2002. Da bibliometria à webometria: uma exploração conceitual dos mecanismos utilizados para medir o registro da informação e a difusão do conhecimento. *Ciência da Informação* 31(2): 152-162.

Verbeek, A., K. Debackere, M. Luwel y E. Zimmermann. 2002. Measuring Progress and Evolution in Science and Technology-I: The Multiple Uses of bibliometric Indicators. *International Journal of Management Reviews* 4(2): 213-231. https://doi.org/10.1111/1468-2370.00083.

Appendix 1. List of articles on ethnomycology published between 1991 to 2019, indexed in the Web of Science Core Collection database.

ARTICLE TITLE	AUTHOR, YEAR
Ethnomycological data from siberia and north-east asia on the effect of *Amanita muscaria*	Saar, 1991
Psychoactive mushroom use in Koh Samui and Koh Pha-Ngan, Thailand	Allen & Merlin, 1992
Ethnomycology, biochemistry, and cultivation of *Psilocybe samuiensis* Guzmán, Bandala and Allen, a new psychoactive fungus from Koh Samui, Thailand	Gartz *et al.,* 1994
Ethnomycological notes from western Burundi	Buyck & Nzigidahera, 1995
Haploporus odorus: a sacred fungus in traditional Native American culture of the northern plains	Blanchette, 1997
The iceman's fungi	Peintner *et al.,* 1998
Studies in tropical African *Lactarius* species 7. a synopsis of the section Edules and a review on the edible species	Verbeken & Walleyn, 1999
Fomes fomentarius (L.: Fr.) Fr.: a mushroom with varied uses.	Roussel *et al.,* 2002
Ethno-pharmacological knowledge of Juang and Munda tribes of eastern India	Mahapatra & Panda, 2002
Traditional knowledge about mushrooms in a Nahua community in the state of Tlaxcala, Mexico	Montoya *et al.,* 2003
Amanita muscaria: chemistry, biology, toxicology, and ethnomycology	Michelot & Melendez-Howell, 2003
Edible wild mushrooms of the Cofre de Perote region, Veracruz, Mexico: An ethnomycological study of common names and uses	Jarvis *et al.,* 2004
Useful wild fungi of La Malinche National Park, Mexico	Montoya *et al.,* 2004
Knowledge and use of fungi by a mycophilic society of the Venezuelan Amazon	Zent *et al.,* 2004
Manufacturing procedures and microbiological aspects of Parakari, a novel fermented beverage of the Wapisiana Amerindians of Guyana	Henkel, 2004
Phlebopus sudanicus or "la viande des Bobos", edible mushroom in Satiri (Burkina Faso)	Guissou *et al.,* 2005
Food for two seasons: culinary uses of non-cultivated local vegetables and mushrooms in a south Italian village	Pieroni *et al.,* 2005
Parakari, an indigenous fermented beverage using amylolytic *Rhizopus* in Guyana	Henkel, 2005
People using macro-fungal diversity in Oaxaca, Mexico	Garibay-Orijel *et al.,* 2006
Process and dynamics of traditional selling wild edible mushrooms in tropical Mexico	Ruan-Soto *et al.,* 2006
DNA recovered and sequenced from an almost 7000 y-old Neolithic polypore, *Daedaleopsis tricolor*	Bernicchia *et al.,* 2006
Two new species and first records for 13 other *Russula* (Russulales) from Zimbabwe	Buyck & Sharp, 2007

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Ethnomycological aspects of the desert truffle among native Bahraini and non--Bahraini peoples of the Kingdom of Bahrain	Mandeel *et al.,* 2007
Ethnomycology: Medicinal and edible mushrooms of the Tzeltal Maya of Chiapas, Mexico	Lampman, 2007
Understanding cultural significance, the edible mushrooms case	Garibay-Orijel *et al.,* 2007
Wild food plants of popular use in Sicily	Lentini & Venza, 2007
Ethnomycological notes on *Marasmiellus inoderma* from Benin and Togo (West Africa)	De Kesel *et al.,* 2008
From disgust to desire: Changing attitudes toward Beringian mushrooms	Yamin-Pasternak, 2008
The socioeconomic impact of truffle cultivation in rural Spain1	Arora, 2008
The socioeconomic impact of truffle cultivation in rural Spain	Samils *et al.,* 2008
Hallucinogenic mushrooms in Mexico: an overview	Guzman, 2008
The collection and sale of wild mushrooms in a community of Tlaxcala, Mexico	Montoya *et al.,* 2008
Wild mushroom markets in central Mexico and a case study at Ozumba	Perez-Moreno *et al.,* 2008
The grace of the flood: classification and use of wild mushrooms among the highland Maya of Chiapas	Shepard *et al.,* 2008
Mushrooms for life among the Joti in the Venezuelan Guayana	Zent, 2008
Ethnomycology among the Nuaulu of the Moluccas: putting berlin's general principles of ethnobiological classification to the test	Ellen, 2008
Desert truffles of the Australian Outback: ecology, ethnomycology, and taxonomy	Trappe *et al.,* 2008
Desert truffles of the African Kalahari: ecology, ethnomycology, and taxonomy	Trappe *et al.,* 2008
Declining wild mushroom recognition and usage in Burkina Faso	Guissou *et al.,* 2008
The fungus maitake (*Grifola frondosa*) and its therapeutic potential	Illana-Esteban, 2008
Genomics of *Aspergillus oryzae*: learning from the history of Koji Mold and exploration of its future	Machida *et al.,* 2008
Diversity and use of traditional Mexican medicinal fungi. A review	Guzman, 2008
Using historical linguistics to describe Polynesian Ethnomycology	Fuller, 2009
The genus *Calvatia* ('Gasteromycetes', Lycoperdaceae): a review of its ethnomycology and biotechnological potential	Coetzee & Van-Wyk, 2009
Challenges for the maintenance of traditional knowledge in the satoyama and satoumi ecosystems, Noto Peninsula, Japan	Cetinkaya, 2009
Utilization of macrofungi by some indigenous communities for food and medicine in Peninsular Malaysia	Lee *et al.,* 2009
Thunder among the pines: defining a Pan-Asian soma	Dannaway, 2009
Documentation of inherited knowledge on wild edible fungi from Malaysia	Abdullah & Rusea, 2009
Contribution to ethnomycological knowledge of wild edible mushrooms from regional markets and communities of Sierra Nevada (Mexico)	Estrada-Martinez *et al.,* 2009
Cordyceps sinensis (Berk) Sacc. Keera-Jari: a life-chip from alpine meadows of Garhwal Himalaya	Bhatt *et al.,* 2009
Nutritional and medicinal importance of mushrooms	Wani *et al.,* 2010
Agaricus subsaharianus, a new edible species consumed in Niger, Burkina Faso and Tanzania	Hama *et al.,* 2010
Correlations between indigenous Brazilian folk classifications of fungi and their systematics	Cardoso *et al.,* 2010
The use of medicinal plants in the trans-himalayan arid zone of Mustang district, Nepal	Bhattarai *et al.,* 2010

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Comparative taxonomy of desert truffles of the Australian outback and the African Kalahari	Trappe *et al.,* 2010
Traditional knowledge of Nyishi (Daffla) tribe of Arunachal Pradesh	Srivastava & Community, 2010
Ethnomycological use of medicinal Chinese caterpillar fungus, *Ophiocordyceps sinensis* (Berk.) G. H. Sung *et al.,*. (Ascomycetes) in Northern Yunnan Province, SW China	Chen *et al.,* 2010
Termites (isoptera) as food in the Luhya community (Western Kenya)	Kagezi *et al.,* 2010
Wild edible fungal resources used by ethnic tribes of Nagaland, India	Bhaben *et al.,* 2011
The diversity of Terfezia desert truffles: new species and a highly variable species complex with intrasporocarpic nrDNA ITS heterogeneity	Kovacs *et al.,* 2011
Antroquinonol from ethanolic extract of mycelium of *Antrodia cinnamomea* protects hepatic cells from ethanol-induced oxidative stress through Nrf-2 activation	Kumar *et al.,* 2011
Ethnomedicinal practices and medicinal plant knowledge of the Yuracares and Trinitarios from Indigenous Territory and National Park Isiboro-Secure, Bolivian Amazon	Thomas et a 2011
Edible and tended wild plants, traditional ecological knowledge and agroecology	Turner *et al.,* 2011
Ethnomycological studies of edible and medicinal mushrooms in the Mount Cameroon region (Cameroon, Africa)	Kinge *et al.,* 2011
Folk taxonomy and use of mushrooms in communities around Ngorongoro and Serengeti National Park, Tanzania	Tibuhwa, 2012
Status and need of research on desert truffles in Saudi Arabia	Al-Qarawi *et al.,* 2012
Women care about local knowledge, experiences from ethnomycology	Garibay-Orijel *et al.,* 2012
Gender differences and regionalization of the cultural significance of wild mushrooms around La Malinche volcano, Tlaxcala, Mexico	Montoya *et al.,* 2012
An ethnobotanical survey of the Gollak region, Kosovo	Mustafa *et al.,* 2012
Molecular and morpho-anatomical description of mycorrhizas of *Lactarius rimosellus* on *Quercus* sp., with ethnomycological notes on *Lactarius* in Guatemala	Comandini *et al.,* 2012
Ethno-medicinal resources used by the Temuan in Ulu Kuang village	Azliza *et al.,* 2012
Wild food plants and wild edible fungi of Heihe valley (Qinling Mountains, Shaanxi, central China): herbophilia and indifference to fruits and mushrooms	Kang *et al.,* 2012
New taxonomical and ethnomycological observations on *Psilocybe* s.s. (Fungi, Basidiomycota, Agaricomycetidae, Agaricales, Strophariaceae) from Mexico, Africa and Spain	Guzman, 2012
Traditional knowledge and landscape management: evaluation and measurement of traditional knowledge on edible wild plants and mushrooms in the satoyama ecosystems in the Noto Peninsula, Japan	Cetinkaya *et al.,* 2012
Microorganisms and nutritional value of Ethnic fermented foods and alcoholic beverages of North East India	Tamang *et al.,* 2012
A preliminary checklist of macrofungi of Guatemala, with notes on edibility and traditional knowledge	Arzu *et al.,* 2012
An ethnomycological survey of macrofungi utilized by Aeta communities in Central Luzon, Philippines	De Leon *et al.,* 2012
Abies religiosa forests harbor the highest species density and sporocarp productivity of wild edible mushrooms among five different vegetation types in a neotropical temperate forest region	Burrola-Aguilar *et al.,* 2013
Bacterial and fungal diversity in the starter production process of fen liquor, a traditional Chinese liquor	Li *et al.,* 2013

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A reward for patience and suffering: ethnomycology and commodification of desert truffles among Sahrawi refugees and nomads of Western Sahara	Volpato *et al.,* 2013
Evaluation of the degree of mycophilia-mycophobia among highland and lowland inhabitants from Chiapas, Mexico	Ruan-Soto *et al.,* 2013
Wild food plants and wild edible fungi in two valleys of the Qinling Mountains (Shaanxi, central China)	Kang *et al.,* 2013
California Indian ethnomycology and associated forest management	Anderson & Lake, 2013
Wild food plants used in the villages of the Lake Vrana Nature Park (northern Dalmatia, Croatia)	Luczaj *et al.,* 2013
Mushrooms and truffles: historical biofactories for complementary medicine in Africa and in the Middle East	El-Enshasy *et al.,* 2013
Ethnomycological studies of some wild medicinal and edible mushrooms in the Kashmir Himalayas (India)	Pala *et al.,* 2013
Cyathus olla from the cold desert of Ladakh	Dorjey *et al.,* 2013
Traditional knowledge of wild food plants in a few Tibetan communities	Boesi, 2014
Knowledge and use of edible mushrooms in two municipalities of the Sierra Tarahumara, Chihuahua, Mexico	Quinonez-Martinez *et al.,* 2014
Advances in research of the artificial cultivation of *Ophiocordyceps sinensis* in China	Zhou *et al.,* 2014
Wild food in Europe: a synthesis of knowledge and data of terrestrial wild food as an ecosystem service	Schulp *et al.,* 2014
European medicinal polypores - a modern view on traditional uses	Grienke *et al.,* 2014
Pharmacology, phytochemistry and traditional uses of *Cordyceps sinensis* (Berk.) Sacc: A recent update for future prospects	Seth *et al.,* 2014
Psilocybe s. str. (Agaricales, Strophariaceae) in Africa with description of a new species from the Congo	Guzman *et al.,* 2014
The cultural significance of wild mushrooms in San Mateo Huexoyucan, Tlaxcala, Mexico	Alonso-Aguilar *et al.,* 2014
Desert truffles of the North Algerian Sahara: diversity and bioecology	Bradai *et al.,* 2014
Analysis of traditional knowledge for wild edible mushrooms consumed by residents living in Jirisan National Park (Korea)	Kim & Song, 2014
Traditional processing of non- timber forest products in Cachar, Assam, India	Dattagupta & Gupta, 2014
Wild food plants used by the Tibetans of Gongba Valley (Zhouqu county, Gansu, China)	Kang *et al.,* 2014
Traditional use of *Gymnopus nubicola* as food resource in a Kichwa community, Pichincha, Ecuador	Gamboa-Trujillo *et al.,* 2014
Nanganana (*Tremelloscypha gelatinosa*, Sebacinaceae), a wild edible fungus from the tropical deciduous forest of the Central Chiapas Basin, Mexico	Bandala *et al.,* 2014
Morels of Palas Valley, Pakistan: a potential source for generating income and improving livelihoods of Mountain communities	Sher *et al.,* 2015
Interactions of knowledge systems in shiitake mushroom production: a case study on the Noto Peninsula, Japan	Kohsaka *et al.,* 2015
Ethnobotanical survey of medicinal plants in Bozyazi district of Mersin, Turkey	Sargin, 2015
Plants, people and traditions: ethnobotanical survey in the Lombard Stelvio National Park and neighbouring areas (Central Alps, Italy)	Vitalini *et al.,* 2015
Names and classification of fungi according to the peasants from La Paz (Traslasierra valley, Cordoba, Argentina)	Flamini *et al.,* 2015
Where do fungi fit? The fungal domain in Mixtepec Zapotec	Hunn *et al.,* 2015

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Ethnomedicinal uses, pharmacological activities, and cultivation of *Lignosus* spp. (tiger's milk mushrooms) in Malaysia - A review	Lau *et al.,* 2015
Effects of climate on the productivity of desert truffles beneath hyper-arid conditions	Bradai *et al.,* 2015
From economic survival to recreation: contemporary uses of wild food and medicine in rural Sweden, Ukraine and NW Russia	Stryamets *et al.,* 2015
Towards a traditional ecological knowledge-based monitoring scheme: a proposal for the case of edible mushrooms	Pacheco-Cobos *et al.,* 2015
Ethnomycological survey of traditional usage and indigenous knowledge on desert truffles among the native Sahara Desert people of Algeria	Bradai *et al.,* 2015
The importance of domestication in the conservation of edible wild fungi in Mexico	Alvarado-Castillo *et al.,* 2015
Wild food plants and fungi used by Ukrainians in the western part of the Maramures region in Romania	Luczaj, L *et al.,* 2015
Polysaccharides from traditional Chinese medicines: extraction, purification, modification, and biological activity	Chen *et al.,* 2016
A local knowledge-based approach to predict anthropic harvesting pressure zones of wild edible mushrooms as a tool for forest conservation in Central Mexico	Franco-Maass *et al.,* 2016
Forty-five years later: the shifting dynamic of traditional ecological knowledge on Pantelleria Island, Italy	Quave & Saitta, 2016
Wild and native plants and mushrooms sold in the open-air markets of southeastern Poland	Kasper-Pakosz *et al.,* 2016
Ethnomycology of macrofungi in the Western black sea region of Turkey: identification to marketing	Yilmaz & Zencirci, 2016
The kinome of edible and medicinal fungus *Wolfiporia cocos*	Wei *et al.,* 2016
Natural remedies used by Bunong people in Mondulkiri province (Northeast Cambodia) with special reference to the treatment of 11 most common ailments	Chassagne *et al.,* 2016
Traditional knowledge and use of wild mushrooms by Mixtecs or Nuu savi, the people of the rain, from Southeastern Mexico	Santiago *et al.,* 2016
Wild food plants and fungi used in the mycophilous Tibetan community of Zhagana (Tewo County, Gansu, China)	Kang *et al.,* 2016
The changing ethnoecological cobweb of white truffle (*Tuber magnatum* Pico) gatherers in South Piedmont, NW Italy	Pieroni, 2016
Ethnomycological knowledge of wild edible mushrooms in Tlayacapan, Morelos	Alvarez-Farias *et al.,* 2016
Diversity of edible and medicinal mushrooms used in the noun division of the West region of Cameroon	Njouonkou *et al.,* 2016
Biocultural heritage, mycological tourism and ethnoknowledge	Ruiz *et al.,* 2016
Exploiting indigenous knowledge commonwealth to mitigate disasters: from the archives of vulnerable communities in Zimbabwe	Lunga & Musarurwa, 2016
Differences between European regulations on wild mushroom commerce and actual trends in wild mushroom picking	Kotowski, 2016
Edible wild mushrooms of Ethiopia: neglected non-timber forest products	Dejene *et al.,* 2017
Edible wild mushrooms of the Western Ghats: data on the ethnic knowledge	Karun & Sridhar, 2017
Characterization of natural habitats and diversity of Libyan desert truffles	Bouzadi *et al.,* 2017
Traditional uses of wild food plants, medicinal plants, and domestic remedies in Albanian, Aromanian and Macedonian villages in South-Eastern Albania	Pieroni, 2017
Truffle renaissance in Poland - history, present and prospects	Rosa-Gruszecka *et al.,* 2017

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Wild edible macrofungi consumed by ethnic tribes of Tripura in Northeast India with special reference to antibacterial activity of *Pleurotus djamor* (Rumph. ex Fr.) Boedijn	Das *et al.,* 2017
Ethnomycological aspects of traditional usage and indigenous knowledge about the arid-semi arid truffles consumed by the residents of the Eastern Anatolia region of Turkey	Akyuz *et al.,* 2017
Ethnomycological and nutritional analyses of some wild edible mushrooms from Western Himalayas, Azad Jammu and Kashmir (Pakistan)	Ullah *et al.,* 2017
The genus *Podaxis* in arid regions of Mexico: preliminary ITS phylogeny and ethnomycological use	Medina-Ortiz *et al.,* 2017
Ethnobotanical survey and toxicity evaluation of medicinal plants used for fungal remedy in the Southern Highlands of Tanzania	Mbunde *et al.,* 2017
Ethnomycological use of *Fomes fomentarius* (L.) Fr. and *Piptoporus betulinus* (Bull.) P. Karst. in Transylvania, Romania	Papp *et al.,* 2017
Missing pieces in the story of a caterpillar fungus - *Ophiocordyceps sinensis*	Liang, 2018
Cultural, economic, and ecological factors influencing management of wild plants and mushrooms interchanged in Purépecha markets of Mexico	Farfan-Heredia *et al.,* 2018
Ethnopharmaceutical knowledge in Samogitia region of Lithuania: where old traditions overlap with modern medicine	Pranskuniene *et al.,* 2018
Eschewing poisons: an ingenious wisdom of foraging macrofungi by Karbi ethnic group in North East India	Hansepi & Teron, 2018
An ethnobotanical survey of edible fungi in Chuxiong City, Yunnan, China	Liu *et al.,* 2018
Ethnomycological report on the macrofungi utilized by the indigenous community in Ifugao Province, Philippines	De Leon *et al.,* 2018
Useful and toxic fungi according to the yuyeros of La Paz and Loma Bola (Valle de Traslasierra, Cordoba, Argentina)	Flamini *et al.,* 2018
Sociodemographic differences in the cultural significance of edible and toxic mushrooms among Tsotsil towns in the Highlands of Chiapas, Mexico	Ruan-Soto, 2018
Ethnomycological study in the Kilum-Ijim mountain forest, Northwest region, Cameroon	Teke *et al.,* 2018
Ethnomycological knowledge of three indigenous communities of Assam, India	Borah *et al.,* 2018
Ethnomedical Knowledge among Slavic Speaking People in South Kosovo	Hajdari *et al.,* 2018
Uses and importance of wild fungi: traditional knowledge from the Tshopo province in the Democratic Republic of the Congo	Kamalebo *et al.,* 2018
Ethnomycological knowledge in three communities in Amealco, Queretaro, Mexico	Robles-Garcia *et al.,* 2018
Ethnoecology of the interchange of wild and weedy plants and mushrooms in Phurepecha markets of Mexico: economic motives of biotic resources management	Farfan-Heredia *et al.,* 2018
The current status of ethnobiology in Ecuador	Gonzalez-Rivadeneira *et al.,* 2018
If you want to get married, you have to collect virdura: the vanishing custom of gathering and cooking wild food plants on Vulcano, Aeolian Islands, Sicily	Cucinotta & Pieroni, 2018
Traditional Knowledge of Gucchi, Morchella esculenta (Ascomycetes), in Doda District Jammu and Kashmir, India	Paul *et al.,* 2018
Cell proliferation and DNA repair ability of *Ganoderma neo-japonicum* (Agaricomycetes): an indigenous medicinal mushroom from Malaysia	Tan *et al.,* 2018
Unequal brothers - plant and fungal use in Guria and Racha, Sakartvelo (Republic of Georgia), Caucasus	Bussmann *et al.,* 2018
Identifying indigenous practices for cultivation of wild saprophytic mushrooms: responding to the need for sustainable utilization of natural resources	Wendiro *et al.,* 2019

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Traditional knowledge, uses, and perceptions of mushrooms among the Wixaritari and mestizos of Villa Guerrero, Jalisco, Mexico	Haro-Luna *et al.,* 2019
Mushroom hunting and consumption in twenty-first century post-industrial Sweden	Svanberg & Lindh, 2019
Ethnomycological knowledge among Kaqchikel, indigenous Maya people of Guatemalan Highlands	Ponce *et al.,* 2019
Management of wild edible fungi in the Meseta Purepecha region, Michoacan, Mexico	Castro-Sanchez *et al.,* 2019
Local knowledge and economical significance of commercialized wild edible mushrooms in the markets of Uruapan, Michoacan, Mexico	Larios-Trujillo *et al.,* 2019
Conceptualising the factors that influence the commercialisation of non-timber forest products: the case of wild plant gathering by organic herb farmers in South Tyrol (Italy)	Schunko *et al.,* 2019
Yi ethnomycology: wild mushroom knowledge and use in Yunnan, China	Brown, 2019
Prospective as a framework of analysis for the tourist use of wild edible mushrooms (WEM) in the center of Mexico	Gomez-Vazquez *et al.,* 2019
Extreme levels of mycophilia documented in Mazovia, a region of Poland	Kotowski *et al.,* 2019
Phytogeographical and sociolinguistical patterns of the diversity, distribution, and uses of wild mushrooms in Cote d'Ivoire, West Africa	Soro *et al.,* 2019
Genotoxic profile and morphological variation of the *Amanita rubescens* complex: traditional knowledge for safe consumption in Mexico	Hernandez-Rico *et al.,* 2019
Viking games and saami pastimes: making balls of *Fomitopsis betulina*	Svanberg & Lidstrom, 2019
Occurrence and ethnomycological notes on *Phallus indusiatus* (Phallaceae, Basidiomycota) in the Reserva Extrativista Tapajos-Arapiuns, Para, Brazil	Santana *et al.,* 2019