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Edible, medicinal wild mushrooms: A study in Estado de México

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ABSTRACT

Objective: To identify edible mushroom species with medicinal uses in Estado de México.

Design/Methodology/Approach: Based on the bibliographic review of local ethnomycological inventories, weekly market visits, semi-structured interviews with vendors, and the collection and taxonomic identification of mushrooms, information was gained regarding medicinal mushroom nomenclature, local knowledge and cultural importance.

Results: A list of 36 edible mushroom species was compiled, which can be divided into 11 categories of use, mainly in treating digestive and circulatory illnesses.

Study Limitations/Implications: This is a descriptive and exploratory study of edible mushrooms with medicinal uses, and therefore it is necessary to include more empirical and scientific evidence from other similar cases.

Findings/Conclusions: There is limited knowledge on medicinal fungi species, implying that they are underexploited as a resource among local inhabitants. *Lycoperdon perlatum* and *Lactarius indigo* were cited as having the highest quantity of medicinal uses.

Key words: Traditional knowledge, ethnomycology, macrofungi, order of mention.

INTRODUCTION

It is estimated that between 70 % and 80 % of the population in developing countries depends on plants and mushrooms as an alternative for treating various diseases (Luitel *et al*., 2014). Mushrooms have been widely used in traditional oriental medicine, which has had a global reach (Yu-Cheng *et al*., 2009). Medicinal wild mushrooms are part of Mexico's biological and cultural diversity. Their use has been recorded since pre-Colombian times and is manifested in practices still preserved by some groups who consume mushrooms or use them for their stimulating, medicinal, and hallucinogenic properties (Herrera 1992; Ruan-Soto and Ordaz-Velázquez, 2016).

In recent years, more ethnomycological studies with biological, ecological or cultural aspects have been carried out in temperate and tropical regions. However, inventory work is still far from complete. From this stems the importance of recording the diversity of medicinal mushrooms (Aguirre-Acosta *et al*., 2014) and therapeutic treatments based on their use (Barros *et al*., 2008).

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Approximately 371 species of wild mushrooms are consumed in Mexico (Garibay-Orijel *et al*., 2014) and 252 species in Estado de México (Burrola-Aguilar *et al*., 2012). Regardless, their medicinal knowledge and use have been scarcely documented. Bautisa-González (2013) reports the use of 121 species in six localities in the country; Guzmán (2008) describes 73 species for treating 46 illnesses. Vázquez (2012) mentions 21 species in the Northern Sierra of Puebla; Jiménez *et al*., (2013) highlight three species in Oaxaca. With respect to ethnomycological studies in the area, various contributions have been made to medicinal knowledge. In Estado de México, 16 species have been reported (Guzmán *et al*., 2009), three species in Acambay, (Estrada-Torres and Aroche, 1987), and one species in Ocoyoacac (García, 2009). Facing this lack of information, it is important to document the traditional knowledge associated with local fungi resources, not only because they contribute biodiversity, but also because they are part of the country's culture (Heywood, 2011). Because of this, the objective was to identify species of edible mushrooms with medicinal uses in Estado de México as a contribution to regional inventories about their use, value, and protection, not only of the mushrooms themselves, but also of their habitat and of the culture where they are used.

MATERIALS AND METHODOLOGY

The information on edible mushrooms and their medicinal use was obtained from the following literature: Estrada-Torres and Aroche (1987); Nava and Valenzuela (1997); Juárez (1999); Mariaca *et al*. (2001); Arteaga and Moreno (2006); Pérez-Moreno *et al*. (2008); Estrata *et al*., (2009); Frutis and Valenzuela (2009); García (2009); Guzmán *et al*. (2009); Franco *et al*. (2012); Bautista-Gonzales (2013); Lara-Vázquez *et al*. (2013); San Román (2014); Domínguez *et al*. (2015); and Jasso-Arriaga *et al*. (2016, 2019). Information regarding treated illnesses was organized according to the Manual of the International Statistical Classification of Disease, Injuries, and Death Causes (WHO, 2016).

To collect additional information on medicinal mushrooms in the central region of Estado de México and areas with high traditional use, visits were carried out to weekly markets in Amanalco, Villa Cuauhtémoc and Santa María del Monte during the months of August to October. During field visits, semi-structured individual interviews were conducted with vendors and collectors to gain information on nomenclature and local knowledge. The reported medicinal mushrooms were collected, dehydrated and characterized macroscopically and microscopically. Keys, specialized literature, and mycological guides were used for taxonomic identification. Order of mention was used to estimate the cultural importance of the mushrooms, obtained according to Moreno-Fuentes (2006).

RESULTS AND DISCUSSION

In all, 36 species of edible and medicinal wild mushrooms were registered, corresponding to 21 families (Table 1). These species represent 15.8% of the total reported for Estado de México (Burrola-Aguilar *et al*., 2012) and can be considered functional foods (Ruan-Soto and Ordaz-Velázquez, 2016).

Eleven categories of use were identified, the most frequent being those related to diseases of the digestive tract, including signs and symptoms. Metabolic, dermatologic, inflammatory, and nervous system conditions were mentioned to a lesser degree. The mushroom species could have from one to eleven different uses. Eighty-three percent (83%) of species were used in more than one way, and from those, 52% were used for four or more purposes. *Lycoperdon perlatum* took first place in terms of medicinal uses (nine different illnesses), followed by *Lactarius indigo* with eight uses.

The more frequently treated conditions were related to the digestive tract (28 species). Twenty-seven (27) species were useful for treating fever, pain on different parts of the body, nausea, etc., associated with different diseases or ailments (signs-symptoms). Regarding genitourinary problems, 19 species were registered.

Various species described as medicinal in this study have also been reported in other research. Bautista-Gonzales and Herrera (2019) suggest that in Mexico, more than 350 fungi species are used in traditional medicine to treat 150 conditions of different systems of the body and ailments related to maternity, "the evil eye," and fright or shock.

In Santa María del Monte, 11 interviews were carried out, of which just one person used *Cantharellus subalbidius* (white chanterelles known as "calabacitas") to treat digestive problems. For this, the mushroom is grilled and eaten twice a day. In Villa Cuauhtémoc, of the 13 interviews conducted, five people mentioned

Table 1. Edible mushroom species with medicinal uses reported in the literature.

Family	Species	Medicinal use	Family	Species	Medicinal use
PHYLUM ASCOMYCOTA					
Pyronemataceae	*Aleuria aurantiaca*[F]	0	Morchellaceae	*Morchella esculenta*[A]	5
Helvellaceae	*Helvella crispa*[F]	1,3,5,8,9	Pyronemataceae	*Otidea onotica*[A]	0
	Helvella lacunosa[F]	1,3,5,8,9	Pezizaceae	*Peziza vesiculosa*[A]	0
PHYLUM BASIDIOMYCOTA					
Amanitaceae	*Amanita basii*[F]	1,5,9,11.	Hygrophoropsidaceae	*Hygrophoropsis aurantiaca*[F]	3,5,9
	Amanita tecomate[D,E]	11	Russulaceae	*Lactarius deliciosus*[E]	4,5,6,8,9,10
	Amanita vaginata[F]	1,5,9.		*Lactarius indigo*[B,E,F]	1,2,3,5,8,9,10,11
Diplocystaceae	*Astraeus hygrometricus*[E]	2,7		*Lactarius pubescens*[F]	4,5,6,8,9,10,11
Boletaceae	*Boletus aestivalis*[E]	1,4,5,6,8,9,10		*Lactarius salmonicolor*[E]	4,5,6,8,9,10,11
	Boletus edulis[E,F]	1,4,5,6,8,9,10		*Russula* sp.[F]	3,5,9
	Boletus pinophilus[E,F]	1,4,5,6,8,9,10	Lycoperdaceae	*Lycoperdon caudatum*[E,F]	2,3,5,8,9,10
	Leccinum rugosiceps[F]	5,8,9,10		*Lycoperdon perlatum* [B,E,F]	2,3,5,6,7,8,9,10,11
Agaricaceae	*Calvatia cyathiformis*[B,E,F]	2,5,9,11	Lyophyllaceae	*Lyophyllum* secc. *Difformia*[F]	3,5,9
	Macrolepiota procera[F]	3,5,9	Pleurotaceae	*Pleurotus opuntiae*[E]	4,9,10
Cantharellaceae	*Cantharellus cibarius*[F]	3,5,8,9,10		*Pleurotus smithii*[F]	4,9,11
Gomphidiaceae	*Chroogomphus rutilus*[E]	3,5,8,9,10	Gomphaceae	*Ramaria* sp.[E,F]	5,9
Tricholomateceae	*Infundibulicybe gibba*[E,F]	1,3,4,5,8,9,10	Suillaceae	*Suillus granulatus*[F]	5,10
	Gymnopus sp.[C]	0		*Suillus luteus*[F]	5,11
Geastraceae	*Geastrum triplex*[E]	2,3,6,10			
	Geastrum triplex[E,F]	2,3,6,10			

Source: [A]Chio *et al*., 1988; [B]Estrada-Torres and Aroche, 1987; [C]Villarruel-Ordaz *et al*., 1993; [D]García, 2009; [E]Guzmán *et al*., 2009; [F]Bautista-Gonzales, 2013.
Medicinal use: 0. Undefined; 1. Musculoskeletal; 2. Skin; 3. Respiratory; 4. Metabolic; 5. Symptoms; 6. Culture-bound syndrome; 7. Nervous; 8. Urinary; 9. Digestive; 10. Circulatory; and 11. Anti-inflammatory.

using *Amanita* sp. and *A. novinupta* ("tecomates") to treat renal problems: "The mushroom is boiled and the cooking water is drunk at room temperature". *Boletus edulis*, known as "cemita", is used to alleviate digestive problems, chiefly in children with upset stomachs; it is prepared by dehydrating and then grinding it, then "the powder is taken with one teaspoon of olive oil, twice a day." It is also used to reduce cholesterol, whether grilled or sautéed, boiled with epazote, tomato, onion, and chili pepper (green or dried). In Amanalco, 14 interviews were conducted and only two people reported the medicinal use of "tecomate" (*Amanita* sp. and *A. novinupta*), but did not specify preparation. In general, the interview respondents indicated that they have heard of the medicinal uses of mushrooms, but did not know them, as was reported by Lara-Velázquez *et al*. (2013).

The potential of the mushrooms studied can be deduced from research showing their high content in B2, B3, and D vitamins, iron, fiber, iodine, potassium, and water. Their consumption may be beneficial for healthy skin, hair, nails, bones, teeth, eyesight, as well as the nervous and digestive systems (Cano-Estrada and Romero-Bautista, 2016). Their medicinal value includes anticancer, antibiotic, antioxidant, antithrombotic, and antidiabetic properties, as well as cholesterol and hypertension-reducing properties (Chang and Miles, 2004).

In that regard, the use of Gasteromycetes stands out for treating skin conditions (Guzmán, 2008; Bautista-Gonzales, 2013; Bautizta-Gonzalles and Herrera, 2019). Boletes are used for conditions of the skeletomuscular system, such as rheumatic diseases or pain in the tendons of extremities and fingers (Guzmán, 1994; 2008; Bautista-Gonzales, 2013). *Boletus edulis*, *B. aestivalis* and *B. pinophilus* are used for headache, rheumatism, and as purgative (Guzmán, 2008; Bautista-González, 2013). *Lactarius deliciosus* demonstrates antimicrobial activity (Barros *et al*., 2007).

Mushrooms of the genus *Amanita*, mentioned both in interviews and in bibliographic searches and considered

favorites of traditional gastronomy (Romero-Bautista, 2016), possess anti-inflammatory properties (Guzmán, 1994; 2008; Bautista-González, 2013). *Cantharellus subalbidius* is used for stomach ailments. Bautista-González (2013) reports that *C. cibarius* is used for treating gastrointestinal disorders, headache, and fever, which agrees with the information obtained, in addition to possessing antitumor, antioxidant, and antibacterial properties (Barros *et al*., 2008; Queiros *et al*., 2009; Yu-Cheng *et al*., 2009).

With regards to traditional mycological knowledge in communities, learning occurs at an early age. Eighty percent of interviewees learn about mushrooms between the ages of 5 and 13, during which time the children acquire identification skills and general knowledge, although adults can still gain knowledge. Collecting season is from May to October. The interview respondents indicated that the mushrooms are harvested directly and are consumed once a week (21%), two to three times per week (58 %), or more than three times per week (21%). The mushrooms are prepared by sautéing (66%), in stews (24%), and eaten raw (10%). For preservation, *Helvella* spp. *Infundibulicybe* spp. and *Morchella* spp. are strung together.

The harvesting process varies according to localities. In Amanalco and Santa María del Monte, women are in charge of this process (65 and 60%, respectively). Meanwhile, in Villa Cuauhtémoc, men make up the majority who carry out this activity (55 %). The collectors directly commercialize the mushrooms, and in general, women are in charge of sales (80%) and are the knowledge-bearers, having learned from their parents (67%), grandparents (31%), and aunts or uncles or other relatives (2%). As Jasso-Arriago *et al*. (2019) mention, culinary knowledge is shared by older women during commercialization. Income is used to cover food costs or to buy objects of personal use (Estrada-Flores *et al*., 2019). Order of mention (OM) was used to estimate cultural importance and to identify the most relevant mushrooms for the population (Table 2). For Villa Cuauhtémoc, "enchilado" mushrooms had the highest value with 40.12%, while in Amanalco, the white "gachupines" (31.47%), and in

Table 2. Traditional names with greatest cultural importance in study sites.

	Villa Cuauhtémoc		Amanalco		Santa María del Monte	
	Common name	Order of mention	Common name	Order of mention	Common name	Order of mention
1	Enchilado (spicy)	40.12	Gachupín blanco (white gachupin)	31.87	Pata de pájaro (bird foot)	20.48
2	Mazorca (corncob)	31.95	Gachupín negro (black gachupin)	30.62	Oreja (ear)	16.74
3	Mantecado café (brown buttery)	30.35	Tecomate amarillo (yellow tecomate)	27.72	Enchilado (spicy)	15.03
4	Oreja (ear)	28.96	Trompetas (cornet)	26.25	Clavo (nail)	14.82
5	Mantecado amarillo (yellow buttery)	28.33	Mantecados (buttery)	23.16	Señorita (miss)	14.44
6	Amargo (bitter)	26.75	Cemas	22.63	Pancitas (belly)	12.96
7	Cemita	22.91	Patitas de pájaro (bird foot)	22.5	Tecomate amarillo (White tecomate)	11.94
8	Tejamanil	18.1	Clavitos (nail)	22.08	Corneta (cornet)	6.6
9	Clavo (nail)	17.46	Orejas ears)	21.25	Bolita (small ball)	6.26
10	Cornetita (cornet)	6.86	Elotitos (corncob)	20.85	Elote (corn cob)	3.67
11	Soldadito (little soldier)	5.62	Ternerita	18.85	Xocoyol	3.52
12	Gachupín	4.7	Bombón (marshmallow)	18.7	Güila	3.02
13	Pata de pájaro (bird foot)	4.37	Xocoyol	18.05	Escobeta (broom)	2.09
14	Escobeta (broom)	3.1	Señorita (miss)	17.55	Trompeta (cornet)	2.06
15	Oyamel (sacred fir)	1.58	Enchilado (spicy)	15	Gachupín güero (blond gachupin)	2.01
16	Queta	1.2	Amarillo (yellow)	14.02	Ternerita	1.34
17	Duraznillo	0.69	Enchilado azul (blue spicy)	7.11	Gachupín negro (black gachupin)	1.18
18	Negrito (black)	0.44	Oreja blanca (white ear)	4.93	Tejamanil	1.1
19	Pajarito (birdie)	0.28			Colita de ratón (mouse tail)	0.69
20	Sopita (soup)	0.26				

Santa María del Monte, the "patas de pájaro" (20.48%). The cultural importance of mushrooms is associated with their nutritional importance, and those who are knowledgeable describe them as "natural meat" with a flavor similar to chicken, fish, or frog, depending on the species (Jasso-Arriaga *et al*., 2019).

Despite the high diversity of edible wild mushrooms in Estado de México, this resource is not used by local residents for medicinal purposes. This is evidenced by the low number of species mentioned in the interviews, which is consistent with other localities. Ruan-Soto *et al*. (2009) found that the Lacandon people in Chiapas only use one medicinal species; or in Oaxaca, Garibay-Orijel *et al*. (2006) mentioned that the Zapotec do not know any medicinal uses for mushrooms.

CONCLUSIONS

There is limited knowledge concerning the number of fungi species with medicinal uses in Estado de México, implying that this resource is under-exploited by its inhabitants. The 36 medicinal species that are used represent an alternative for treating problems related to the digestive tract, the circulatory system, and signs and symptoms; all highly prevalent diseases and some with grave health consequences and high medical treatment costs. Unfortunately, knowledge of medicinal properties in mushrooms is being lost with the passing of generations, therefore additional studies are needed to supply more information on the value of species of medicinal interest, in addition to phytochemical and pharmacological analyses to insure their efficiency and innocuity.

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