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Ethnomycological Studies in Anatolia from Past to Present

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Abstract: Edible and medicinal wild mushrooms have been valuable natural sources of ethnofood and ethnomedicine since ancient times. Wild mushrooms growing in Anatolia have seasonally been collected from nature for traditional recipes and traditional treatments by indigenous people for hundreds of years. In addition, economically important wild mushrooms such as *Amanita caesarea*, *Boletus* spp., *Cantharellus cibarius*, *Craterellus cornucopioides*, *Hydnum repandum*, *Lactarius* spp., and *Morchella* spp. have been sold in local markets and exported abroad as a source of income by the people living in rural areas since the end of the 20th century. This review has aimed to keep and publish comprehensive traditional knowledge about the collection and consumption of wild mushrooms by compiling studies on ethnomycology in Anatolia in addition to their importance for gastronomy, culinary culture, and consumers.

Key words: Wild mushrooms, Indigenous beliefs, Ethnofood, Ethnomedicine, Traditional knowledge

Geçmişten Günümüze Anadolu'daki Etnomikolojik Çalışmalar

Öz: Yenilebilir ve medikal doğa mantarları, antik çağlardan beri değerli doğal etnogıda ve etnotip kaynakları olmuştur. Anadolu'da yetişen doğa mantarları, yüzlerce yıldır yerli halk tarafından geleneksel tarifler ve geleneksel tedaviler için doğadan mevsimsel olarak toplanmıştır. Ayrıca, *Amanita caesarea*, *Boletus* spp., *Cantharellus cibarius*, *Craterellus cornucopioides*, *Hydnum repandum*, *Lactarius* spp. ve *Morchella* spp. gibi ekonomik açıdan önemli doğa mantarları 20. yüzyılın sonlarından itibaren kırsal kesimde yaşayan halk tarafından bir geçim kaynağı olarak yerel pazarlarda satılmakta ve yurt dışına ihraç edilmektedir. Bu derleme, gastronomi, mutfak kültürü ve tüketiciler açısından önemini yanı sıra Anadolu'da etnomikoloji üzerine yapılan çalışmaları derleyerek, doğa mantarlarının toplanması ve tüketimine ilişkin kapsamlı geleneksel bilgilerin korunmasını ve yaygınlaşmasını amaçlamıştır.

Anahtar kelimeler: Doğa mantarları, Yerel inançlar, Etnogıda, Etnotip, Geleneksel bilgi

Introduction

Mushrooms are seasonal macrofungi, which occupy diverse niches in nature within the forest ecosystem of which some species have environmental functionality as decomposers and form mycorrhizal associations to sustain tree growths and healthy forests. Generally, they are economically important due to their

importance in food, medicine, biocontrol, chemical, biological, and other industries (Meena et al., 2020). Mushrooms are the fleshy and fruiting bodies of higher fungi largely Basidiomycetes and some extant *Ascomycetes*, which are present above the ground (epigeous) or underground (hypogeous) where they may be picked by hand. Mushrooms are classified as wild,



cultivated, edible, and poisonous species (Chang and Miles, 1989; Quadir, 2021).

“Edibility” can be defined by criteria that include the absence of poisonous effects on human beings and desirable taste and aroma (Rubel and Arora, 2008). “Medicinal” properties are attributed to the biologically active compounds of mushrooms (Venturella et al., 2021). In recent years, edible and medicinal wild mushrooms (WM) have been considered precious natural sources of multifunctional foods and medicines. Mushrooms are highly nutritive, low-calorie food with good quality proteins, vitamins, and minerals (Waktola and Temesgen, 2018) and have various biological activities correlated to their bioactive compounds varied depending on their locations and species (Turfan et al., 2019; Bulam et al., 2022). Edible mushrooms are considered a “superfood” and can be recommended as a valuable constituent in the daily diet of humans (Sganzerla et al., 2022).

“Ethnomycology” researches the traditional and indigenous knowledge of mushroom utilization and consumption patterns in nutrition, medicine, cosmetics and other uses such as religion, tinder, jewelry, spice, perfume, etc. by the local people from ancient civilizations to the present cultures (Martins, 2017; Meena et al., 2020). The beginning of ethnomycology as a field of scientific study started in 1957 when the book “Mushrooms, Russia and History” was published in which the usage of mushrooms was explained in Europe (Comandini and Rinaldi, 2020).

Although many ethnomycological studies have been conducted in Anatolia as well as in other mycophilic countries from past to present, there are three main problems in the development of these studies: (1) great destruction of wild vegetation in nature because of climate change, urbanization, chemical pollution, overgrazing and deforestation; (2) the small number of specialists on WM in the country; and (3) the loss of traditions among the rural people and villagers, owing to the advancement of modern civilization, migration to the urban areas, and increase in education level, which means that traditional knowledge on edible and medicinal WM has nearly become unavailable (Guzmán, 2001; Pekşen et al., 2016; Martins, 2017; Gizaw et al., 2018). Accordingly, ethnomycological and taxonomic studies including traditional knowledge have high importance due to passing information on next generations to keep traditional culture and memory in Anatolia as well as worldwide. Within this viewpoint, this review has aimed to compile some ethnomycological and taxonomic studies reported the traditional knowledge about the recognition,

collection, and consumption patterns of edible and medicinal WM in Anatolia. Additionally, a short evaluation on utilization of WM by local and national gastronomy and culinary culture and consumers living in urban areas was given.

Global Usage of Edible and Medicinal Wild Mushrooms in History

From the view of consumption as food, a total of 1.154 edible and food species was recorded from the total of 2.327 useful WM species compiled from 85 countries (Martins, 2017). The oldest evidence for the usage of WM (possibly bolete mushrooms) as a food source has been determined in Spain belonging to the human diet during the Magdalenian phase of Europe’s Upper Palaeolithic Period (Old Stone Age) between 18.000 and 12.000 years ago (Power et al., 2015). The usage of edible WM by people living in Chile 13.000 years ago was documented in archaeological records (Rojas and Mansur, 1995). Edible WM were collected in the forests during Greek and Roman antiquity but were mainly appreciated by people having higher status (Buller, 1914). The Roman Empire was well-known for the mushroom consumption of its emperors, who employed food tasters to ensure that the WM were safe to eat (Jordan, 2015). The Caesar mushroom (*Amanita caesarea*) referred to an ancient Italian tradition that still exists in many parts of Italy, using a diversity of edible species dominated today by *Tuber* spp. (truffles) and *Boletus edulis* (porcini). In China, many WM species collected from the forests and fields have been traditionally valued for food for centuries. Today, China is the leading country with an 85% share of production of cultivated mushrooms. Although less well known, countries like Mexico and Türkiye and wide areas of Central and Southern Africa also have a long and important tradition of edible WM consumption (Martins, 2017; Royse et al., 2017).

Until today, edible WM have been traditionally collected from gardens, meadows, and forests, consumed in tasty recipes as seasoned cooked WM, soups, simmered, roasted, teas, etc. and preserved for off-season usage by drying, freezing, brining, and sold worldwide by local inhabitants for hundreds of years (Zsigmond, 2010; Sitta and Davoli, 2012; Kim and Song, 2014). In Korea, China, Japan, Hong Kong, the Russian Federation, and some other European countries such as Bulgaria, Ukraine, Austria, France, Italy, Spain, Switzerland, and the Slavic countries, some African countries (e.g., Benin, Congo), and Mexico, the tradition of eating edible WM is much stronger (Peintner et al., 2013; Martins, 2017). Some proverbs including



“mushroom” are used in various mycophilic countries. One of them belongs to the Estonians describing Russian passion towards WM as “Where there is a mushroom coming up, there is always a Russian waiting for it.” (Azeem et al., 2020).

On the other hand, economically important edible WM species including *A. caesarea*, *B. edulis*, *Cantharellus cibarius*, *Craterellus cornucopioides*, *C. tubaeformis*, *Hydnum repandum*, *Lactarius* spp., *Morchella* spp., and *Tuber* spp. were recently reported among the most valuable bioeconomic non-wood forest products with 8.1 billion Euro (€) year⁻¹ total economic value and 1.017 billion kg year⁻¹ collected amount in Europe (Lovrić et al., 2020; 2021). Today, edible WM are commercially sold in local and national markets as fresh or processed as sources of income by indigenous people, especially in developing countries and bought by urban consumers, restaurants, and tourism establishments for the vegan, vegetarian, and local/international gastronomic menus, and trading companies for the exportation worldwide (Sitta and Davoli, 2012; Bulam et al., 2018a, b; De Frutos, 2020).

The total number of useful WM, defined as having edible and medicinal value, is estimated to be over 2.300 species (Martins, 2017). In terms of ethnomedicine, they have been used for preventing and treating diseases in Asian countries for centuries, and their usage in Western countries has been increasing over the past decades (Lindequist et al., 2005). Therapeutic applications of medicinal WM as an adjuvant in Traditional Chinese Medicine have been documented in Far Eastern Countries mainly in China, Japan, and Korea for centuries, where WM have been used by traditional knowledge for their medicinal properties. *Agaricus brasiliensis*, *Cordyceps sinensis*, *Flammulina velutipes*, *Ganoderma lucidum*, *Grifola frondosa*, *Lentinula edodes*, *Pleurotus ostreatus*, *Polyporus umbellatus* and *Trametes versicolor* were among the most valuable medicinal WM species used in Traditional Chinese Medicine with the name of “elixir of life” (Wasser, 2002; Sullivan et al., 2006; Zhao, 2013; Gopal et al., 2022). Medicinal applications of several WM to maintain human health was recorded in “Materia Medica” in China as early as 500 BC by Shen-Nong who was known as “God of Chinese herbal medicine”. *Dendropolyporus umbellatus* and *Ganoderma lucidum* with the power of healing were described by Tao Hongjing (456-536 AD) who was a Chinese alchemist and pharmacologist. Edible and medicinal practices of WM in India is quite common, some of which dated to 1.700-

1.100 BC (Zhao, 2013; Stamets and Zwickey, 2014; Debnath et al., 2019; Quadir, 2021).

In Europe, Ötzi, the Ice Man, who lived nearly 5300 years ago, carried *Fomes fomentarius* and a *Fomitopsis betulina* tethered in a pouch to help him survive in the Alps of northern Italy. Hippocrates (450 BC), the famous Greek physician, classified the *Fomes fomentarius* among anti-inflammatory agents and for cauterizing wounds. First people of North America used *Calvatia* genus as wound healers (Stamets and Zwickey, 2014). Pope Gregory IV (827-844 AD) suggested that soldiers consume truffles (*Tuber* spp.) to strengthen them in the war against their enemies (Hall et al., 2007). In Mexico, the traditional usage of medicinal WM by Mexican and Guatemalan Indians as curative adjuvant against diseases such as asthma, colds, diabetes, dysentery, epilepsy, eye infections, fever, gastrointestinal disorders, insect bites intestinal ulcers, nervous disorders, pellagra, and stomach-tooth aches in Maya, Purepecha, and Aztec cultures was dated to 2.500 BC-1.521 AD (Guzmán, 2001).

Nowadays, WM are used as therapeutic and functional foods, as they prevent diseases such as hypertension, hypercholesterolemia, atherosclerosis, and cancer due to primarily their chemical composition and bioactive compounds such as lentinan and lovastatin of which global market values are also expected to rise (Wasser, 2014; Woldegiorgis et al., 2015; Zhang et al., 2016; Niego et al., 2021). Their bioactivities such as antioxidant, anticancer, antitumor, anti-inflammatory, and antimicrobial properties depend on how the WM are prepared and eaten or used (Heleno et al., 2015; Martins, 2017).

Medicinal WM are still locally consumed by traditional knowledge in rural areas and mushroom-derived preparations containing bioactive components of some medicinal WM after cultivation are globally used by pharmaceutical companies to produce novel nutraceuticals including immunoceuticals, dietary supplements, and mushroom pharmaceuticals for modern applications in prevention and treatment of cancer and other chronic diseases and boosting the human immune system (Wasser, 2014; Üstün et al., 2018, Tieu et al., 2022). Nowadays, enzymatic and nonenzymatic antioxidant-rich mycochemicals (Islam et al., 2019) and polysaccharides (Chen and Li, 2014) obtained from fruiting bodies and the mycelium of mushrooms make them attractive for alternative and complementary medicines. However, different manufacturing standards, criteria of purity, and



underpowered clinical trials make the assessment of efficacy and toxicity difficult in clinical evidence-based Western medicine. Thus, *in vivo*, *in vitro*, and clinical studies searching the pharmacological properties or side effects of WM consumption are increasing to be able to use traditional Eastern medicinal WM practices in Western therapies and their bioactive compounds for medicines (Sullivan et al., 2006; Badalyan et al., 2019; Venturella et al., 2021; Panda et al., 2022; Panda and Luyten, 2022). In addition, some patented products of active metabolites of medicinal WM were presented by Bhambri et al. (2022). Moreover, WM are also used to produce antibiotics and natural biocontrol agents against bacteria, fungi, viruses, and insects (Anguix, 2011), cosmeceuticals (Badalyan et al., 2022), enzymes (Dutta et al., 2022) as well as functional foods (Sganzerla et al., 2022).

From another perspective, ceremonial and religious roles played by WM in different cultures are closely associated with their hallucinogenic properties. Hallucinogenic WM (e.g., *Psilocybe* spp., *Cordyceps* spp.) are occasionally consumed for recreational or religious purposes but can produce severe nausea and disorientation. Therefore, they are not commonly considered edible although they are not poisonous. The Egyptians and Greeks referred to WM as “the food of the gods”, “celestial food”, and “the flesh of the gods” (Abdel-Azeem, 2010). The Mexican Indians had a mythological thought that hallucinogenic WM were mediators with God, while Nahum Aztecs considered sacred WM (*Psilocybe* spp. including psilocybin/psilocin) as “teonanácatl” with the meaning of “God’s flesh” (Singh, 1999). Guzmán (2015) stated that Mexican people also used these hallucinogenic WM for their therapeutic value which had some modern applications in psychiatry. In addition, *Amanita muscaria* including ibotenic acid and muscimol, which is a poisonous and hallucinogenic WM, has been used for sacred purposes and shamanic and religious ceremonies in diverse cultures (Guzmán, 2001; Martins, 2017; Quadir, 2021).

Apart from the utilization of WM as traditional food (spice, delicacy, beverage, etc.) for everyday use or feasts, ethnomedicine, and religious ceremonies, WM have also been used for many other purposes such as ware, raw material, decorative motif, symbol (immortality, fertility), poison for humans and animals, fumigation of bees, perfume, lubricant, and manure in Hungarian folk tradition. On the contrary, the mycophobic people who did not appreciate WM, called them “the bread of the devil”, “food of the dead”, and “stool” (Zsigmond, 2010). Today,

lack of public awareness, lack of available markets, high transportation cost, large number of middlemen, very limited wholesale market, lack of advertising, and storage limitations are a few of the challenges and limiting factors of edible and medicinal WM commercialization and consumption (Gopal et al., 2022).

On the other hand, many WM are simply inedible even they are not toxic. In comparison, the number of poisonous WM species is very small, and just a very few are mortal. However, this very small group of lethal species has significantly influenced the attitudes of consumers to eat WM, creating mycophobic behavior and potential barriers to wider marketing in many places. Before assuming that any wild mushroom is edible, it should be exactly identified. Accurate determination and proper identification of a wild species is the only safe way to ensure edibility and the only protection against mushroom poisonings. Furthermore, some WM that are edible for most people can cause allergic reactions in some individuals, and old or improperly stored species can cause food poisoning. The risk associated with poisonous and lethal species is often exaggerated since occurrences of poisoning and deaths are few when compared to the regular and safe consumption of edible WM. Publicity, cultural attitudes, and the increasing urban, nature-ignorant population continue to spread out an intrinsic fear of WM in some countries (Rubel and Arora, 2008; Peintner et al., 2013; Martins, 2017). In Finland, Italy, Spain, and the United Republic of Tanzania, the opinion towards WM varies even among different parts of the same country. In mycophobic countries like Britain, people are afraid of consuming them. However, this fear is disappearing, and the usage of WM is expanding because of immigrants from mycophilic regions (Azeem et al., 2020).

The inability to distinguish WM collected from nature and included in the group of poisonous WM leads to severe illnesses and can even lead to death. A wise old Croatian proverb also known in Poland and Hungary says that “All mushrooms are edible, but some only once” (Zsigmond, 2010). Mushroom poisoning cases, in which *Amanita phalloides* (death cap) was in the first place, were globally reported (Tang et al., 2022). In addition, *Amanita ocreata*, *Conocybe filaris*, *Galerina marginata*, and *Gyromitra esculenta*, and *Gyromitra infula* (false morels) were reported among the most poisonous WM (Gopal et al., 2022). Therefore, different machine learning algorithms were recently developed to classify the poisonous and edible WM using their morphological or physical properties with a success ratio of up to 100%



apart from morphological identification and biochemical/molecular characterization which need an expert and longer time, respectively (Erkan and Kahramanlı Örnek, 2019; Tutuncu et al., 2021).

Historical Usage of Edible and Medicinal Wild Mushrooms in Anatolia

In Anatolia, edible and medicinal WM have been most widely valued as a source of food and flavouring, medicine, and local/national income from the past to the present. Additionally, they have had considerable direct and indirect economic, social, and cultural value in our country. Edible WM are collected and consumed by the rural people and economic species are sold in local markets by mostly woman villagers and vendors. Edible WM species of *A. caesarea*, *Boletus* spp., *Calocybe gambosa*, *C. cibarius*, *C. cornucopioides*, *Hydnum repandum*, *Lactarius* spp., *Morchella* spp., *Rhizopogon* spp., *Terfezia* spp., *Tricholoma* spp., and *Tuber* spp. are exported to some European, Middle East, and East African countries, Japan, USA, Canada, the Turkish Republic of Northern Cyprus, and Georgia as fresh or processed including frozen, dried, and pickled. Edible WM are cooked as fresh by different methods including roasting, grilling, baking, and frying, consumed in various meals, and preserved as frozen, dried, and brined on the local and urban household scale in Anatolia (Okan et al., 2013; Allı and Şen, 2016; Pekşen et al., 2016; Yılmaz and Zencirci, 2016; Bulam et al., 2018a, b; Turfan et al., 2019). Another importance of WM is to create a good outdoor activity. People considered it as a sports activity to relax and rest with outdoor nature walks while picking WM (Acar, 2016; 2018).

On the contrary, poisoning cases mostly occurred in autumn with the first symptoms such as nausea, vomiting, dizziness, and abdominal pain were reported in the country which were accidental, i.e. consumption of WM collected from open fields and woodlands or purchased from local markets (Eren et al., 2010; Yordan et al., 2010; Özdemir et al., 2022). A decrease was detected in the poisoning cases due to the changes in consumer attitudes and behaviors and lifestyles of people during the COVID-19 pandemic (Özdemir et al., 2022).

From another perspective, although WM have mostly been used as a source of food in Anatolia for centuries, there is also a historical background in terms of their medicinal applications. The great Turkish-Islam scientist Ibn Sina (Avicenna) recommended truffles (*Tuber* spp.) as a remedy for weakness, vomiting, pain, and wound healing in the 11th century (Hall et al., 2007).

Local Names of Edible Wild Mushrooms in Anatolia

The word mushroom was transferred to Turkish from Greek (New Greek) "Manitári" (μανιτάρι) (Akalin vd., 2015). It was used in Anatolia dialects as "Göbelek, Göbek, Göbeleğ, Göfek, Gömelek, and Gövelek". The fact that the WM are buried in the soil and that they have a repeating continuity supports this view. Additionally, it was determined that in both Kastamonu and Sinop, the word "mushroom" is used in some idioms, and sayings and observations and experiences are expressed for the weather forecast related to less/more WM presence. Moreover, local people say that "I prefer mushrooms to meat" (Acar, 2016; 2018). When evaluated in terms of onomastics (the science of naming), using local mushroom names of 233 (Acar, 2016) for 25 edible WM species in Sinop and 266 (Acar, 2018) for 26 edible WM species in Kastamonu according to socio-cultural, economical and historical traditional knowledge regarding morphological characteristics, shape (size-smallness), cap/stalk, color, taste, sound, smell, and texture of WM, place/region where they grow, time of growth, and names of organs, animals and plants (tree, grass, flower), names of clothes and goods, tools and equipment, gender, kinship, names of religious and literary figures, nicknames, numbers and elements such as belief were found to be more determinative among indigenous people. In addition, a general and bad name was given to the bitter inedible and poisonous WM and it was determined that it was very few.

Local names of edible WM can be used in common for the same species or may differ from province to province. While the same type of edible WM can be given different local names in different places, the same local names can be sometimes given to different types of edible WM in different places (Yılmaz and Zencirci, 2016; Bulam et al., 2018b). Şimşek and Önek (2021) determined that in Kastamonu, the Kuzu Göbeği mushroom, Truffle mushroom, and Porcini (Bolet) mushroom were called "Kuzukulağı", "Kara mantar" and "Tavşan Göbeği", and "Ayuca", respectively. Pekşen and Kaplan (2017) showed that Ordu edible WM were very similar to Giresun species (Pekşen et al., 2016) in terms of both species' diversity and naming. However, they stated that instead of the word "Mushroom/Mantar", the words "Kirmit" or "Tirmit" were also used (e.g., Tavuk kirmiti, Fındık kirmiti, Geyik tirmiti, Beyaz dağ tirmiti, etc.). The Turkish names of the edible and medicinal WM were recently stated and published in a book to maintain the



usage of common names of WM species belonging to Anatolia flora by Sesli et al. (2020).

Historical Background of Ethnomycological Studies in Anatolia

2.728 Ascomycota and 2.782 Basidiomycota species including edible and medicinal WM, which grow naturally in the rich vegetation of Anatolia, were previously identified by various taxonomic studies (Sesli et al., 2020). Moreover, current checklist studies reporting previously known species and new records are continuously performed in the country (Akata et al., 2022). The importance of edible and medicinal WM species depending on cultural and ecological factors has been reported in many ethnomycological and taxonomic studies reporting recognition level and consumption patterns of WM in Anatolia since the 1980s. Information about some of these studies is given as follows.

Akman and Baysal (1984) examined WM consumption status of 200 households randomly selected from Bergama district center and 5 villages of İzmir province. 3 species of WM in the region, namely Grass/Çayır (*Agaricus campestris*), Pine/Çam (*Clavaria salmonicolar*), and Morel/Kuzu Göbeği (*Morchella esculenta*) grew naturally in the months of March-April, and October-December. It was reported that 44% of the households in the district center bought them, and 78% of them in the villages collected WM by themselves and consumed them. Monthly consumption per individual varied between 170 and 2.727 g, with an average of 1.448 g. Among the households consuming WM, 54.6% in the district center and 23.0% in the villages reported that they were mildly or moderately poisoned by WM.

In taxonomic research conducted by Sesli (1998) in Giresun, a total of 42 species of WM, including 5 species belonging to the Ascomycetes class and 37 species belonging to the Basidiomycetes class were identified. It has been reported that 24 of them were edible, 14 were inedible, and 2 were poisonous (*A. muscaria* and *Hypholoma fasciculare*), and it was not known whether the 2 species were edible. It was stated that people living in the region recognized and used some identified edible species such as *H. repandum*, *Lactarius deliciosus*, *Macrolepiota procera* and *Ramaria aurea* as food, but did not recognize the other edible WM.

From the recent taxonomic studies, Keleş et al. (2014) identified 7 WM taxa within 11 orders, 40 families and 69 genera in Ayder (Rize/Türkiye) plateau. 3 of them belonged to the division Ascomycota and 124 belonged to Basidiomycota. Among them, 54 (%42.52) were edible, 59 (%46.46) were inedible. It was reported that *Agaricus*

essettei, *A. langei*, *A. lanipes*, *Cantharellus cibarius*, *Macrolepiota procera*, and *Russula delica* were collected and consumed locally. Although 14 (11.02%) poisonous taxa existed in the region, no incidence was reported officially.

In the research of Akata et al. (2016), 182 WM species belonging to 117 genera in 60 families were listed in the Zigana Mountains (Gümüşhane) study area. The list included 38 Ascomycota and 144 Basidiomycota. 46 of 182 WM species were edible WM, but only 4 species (*A. campestris*, *C. cibarius*, *Lactarius volemus* and *M. procera*) were collected and consumed by local people.

In an ethnomycological and taxonomic study conducted in Samsun, 78 edible WM species were identified. 20 of these species were known by the public, consumed, and sold in local markets. It has been reported that in addition to domestic market consumption, especially *Chanterelle* spp. (Sarı mantar), *Hydnum* spp., and *Morchella* spp. (Kuzu Göbeği) were also exported abroad (Pekşen and Karaca, 2000). In addition, the species that were not sold in local markets and consumed by the public were *Agaricus* spp. (Top top mantarı), *Coprinus comatus* (Kumyaran), *Fistulina hepatica* (Öküz Dili), *Lactarius fuliginosus* (Tirmit), *Lepiota kondradii*, *M. procera* (Dede mantarı), and *R. delica*. It has been also determined that the WM known and consumed in the province by local inhabitants were evaluated as fresh, pickled (*Cantharellus* spp., *Lactarius* spp.) or dried (*Marasmius oreades*, *Morchella* spp.). However, *Clitopilus prunulus*, *C. cornucopioides*, *Lepista* spp., and *Pleurotus* spp. were some delicious edible WM that were not recognized by the indigenous public.

Yılmaz and Zencirci (2016) conducted research in 6 provinces (Bolu, Düzce, Karabük, Zonguldak, Bartın and Kastamonu) of Western Black Sea Region and in 70 different local markets, especially during WM gathering seasons. It was determined that 33 species from 14 families were used as food (55.4%), income (43.8%) or medicine (0.8%). In addition, 169 different Turkish local names were recorded, and 5 marketing channels were identified, 3 for cultivated mushrooms and 2 for WM. *L. deliciosus* and *Lactarius salmonicolor* (Kanlıca) were the most affordable species, while Morel WM (Kuzu Göbeği) were the most expensive species among all collected WM.

In another study, 22 species of edible WM belonging to 13 families that were collected from nature and had economic importance in Giresun province were identified and listed with their local names (Pekşen et al., 2016). It has been also determined that these WM were



consumed as food by collectors or intermediaries and were sold in local markets to generate income. *A. campestris*, *Boletus aestivalis*, *B. edulis*, *C. cibarius*, *H. repandum*, *Lactarius* spp., *Laetiporus sulphureus*, *Lepista saeva*, *M. procera*, *M. oreades*, *Morchella* spp. and *Sparassis crispa* were consumed as fresh in different recipes, especially by roasting, as a meal, or they were frozen, dried, or preserved as pickled for winter consumption. *B. edulis*, *C. cibarius*, *H. repandum* and *Morchella* spp. were delivered to foreign trade companies by intermediaries and exported as fresh, frozen, or dried. It was reported that most of mushroom pickers and sellers were women. This was important in terms of women's contribution to the family budget. Edible WM prices varied according to season, species, and amount of WM collected.

Akyüz et al. (2017) interviewed 230 truffle gatherers in the Elazığ-Malatya region. It was determined that truffle gatherers looked for truffle types in areas where the soil bulged and cracked (97.0%), or where kumi plant grew (95.2%), and they found truffles using their personal experience (94.8%). The local people have expressed that they collected about 2 kg or less truffles per day (68.7%), and the financial profit was high (68.3%). They acquired information from their families and elders (92.6%) about WM, and they gathered truffles for nutrition (97.8%), for their high nutritious value (67.8%), as they were a natural food source (94.3%), and because of the feeling of satiety they provided (95.7%). Truffles were usually fried with eggs when cooking (84.8%), preserved in refrigerators (93.0%), and the quality of edibility was high (83.9%). *Terfezia boudieri* was preferred for commercial usage, whereas other species (*Picoa lefebvrei*, *P. juniper*, and *T. olbiensis*) were mostly used for daily consumption because they did not provide financial profit.

In the study conducted by Pekşen and Kaplan (2017), the WM species that had current economic importance in the macrofungi mycobiota of Ordu province and collected by the villagers and sold in local markets were reported as 22 WM species belonging to 13 families. In addition, it has been determined that there were species with high nutritional value, such as *B. edulis*, *C. cibarius*, *H. repandum* and *Morchella* species, which had the potential to be exported abroad in fresh and dried forms. Moreover, although they were not sold in the market, *M. procera* and *Polyporus squamosus* edible WM, which were collected and consumed by the people of Ordu, were as valuable and delicious as meat. In the province, edible WM was generally consumed as fresh,

and they were preserved by pickling, drying, canning, or freezing for winter consumption. Many of these WM sold in the market were roasted and consumed by the public. Edible WM could be sold by the villagers in the market, as well as by the stalls set up on the roadside and by peddlers. The prices of WM, which were an important source of income for the villagers, varied depending on the season, species and the amount of WM collected.

According to Bulam et al. (2018b) *B. edulis*, *C. cibarius* and *Morchella* spp. were the exported WM species in Vezirköprü district of Samsun where *A. caesarea*, *B. edulis*, *C. cibarius*, *Cantharellus ferruginascens*, *Clitocybe geotropa*, *C. cornucopioides*, *H. repandum*, *Hydnum rufescens*, *L. deliciosus*, *Lactarius semisanguifluus*, *Lactarius vellereus*, *Lactarius vinosus*, *M. procera*, *Morchella* spp., *Ramaria* spp., *R. delica* and *Tricholoma terreum* were identified as edible WM species with high eating quality and economic importance.

Uzun and Kaya (2020) reported that 88 of the 404 WM taxa were edible, but only 6 taxa of *A. campestris*, *Coprinus comatus*, *Pleurotus ostreatus*, *Terfezia boudieri*, *Tricholoma anatolicum*, and *Volvopluteus gloiocephalus* were collected and consumed in the Gaziantep region by local people. *T. boudieri* had local economic importance while *T. anatolicum* had international economic importance. 283 WM of the determined taxa were classified as inedible while 33 were poisonous.

Oruç et al. (2021) identified 109 macromycete species belonging to 4 classes, 12 orders, 41 families and 64 genera in Çamburnu Nature Park (Sürmene/Trabzon). Of these, 6 belonged to Ascomycota and 103 belonged to Basidiomycota. Of the 109 macromycetes detected, 44 (40.37%) were edible, 51 (46.79%) were inedible, and 14 (12.84%) were poisonous. *L. deliciosus* was intensely collected and consumed by the local people under the name of "Kanlıca". *A. campestris* was also collected and consumed in the region, and it has not been given a special local name.

Sadullahoğlu et al. (2021) determined 9 and 55 edible WM species belonging to Ascomycota and Basidiomycota divisions in Oltu and Narman (Erzurum) districts, respectively. Although 64 edible WM have been identified, local people consumed as food only some well-known species belonging to the genera of *Agaricus*, *Morchella* and *Pleurotus*. It has been determined that the local people called *Agaricus* species "Çayır mantarı", *Morchella* species "Dana Burnu" and *Pleurotus* species (*P. ostreatus* and *Pleurotus populinus*) "Kavak mantarı," or "Ağaç mantarı". When the species collected during field



studies were shown to the local people, they stated that they did not eat any WM other than those species and that they knew the other WM as poisonous. Although there were suitable habitats in Oltu and Narman districts, there was no evidence that *Morchella* species collected and traded.

Uzun and Kaya (2022) presented a list of 216 WM species from the Tonya (Trabzon) district. Of these, 75 (34.72%) belonged to Ascomycota, and 141 (65.28%) belonged to Basidiomycota. According to the current literature, 52 of the identified taxa were edible. 8 of them were collected under different names and consumed by the local people. Locally consumed taxa and their local names were *C. cibarius* (Yumurta mantarı, Tavuk tiriti, Sarı mantar), *C. cornucopioides* (Huni mantarı, Borazan mantarı), *Fistulina hepatica* (Karacığer mantarı, Biftekl mantarı), *H. repandum* (Siğir Dili), *L. volemus* (Sütlü mantar), *Lepista nuda* (Mor mantar), *M. procera* (Turna Bacağı, Kartal Kanat) and *P. ostreatus* (Kavak mantarı). Among them, *C. cibarius*, *C. cornucopioides*, *L. volemus* and *M. procera* also had regional economic importance which were collected and sold in public markets.

On the other hand, Şimşek and Önek (2021) found that the methods of detecting non-poisonous WM differed from each other, among which the color, smell and appearance of the WM were influential, as well as the experiences of family elders and collectors in Kastamonu. In addition, some collectors stated that they collected only known WM. It was determined that the participants perceived WM with worms and milk coming out of their caps as non-toxic. In the same study, all of the participants stated that they collected WM species themselves and bought them from the local markets.

In terms of medicinal applications, it was determined that carpophor saps of edible WM species of *Morchella* spp. (Kuzu Göbeği) (Yılmaz and Zencirci, 2016) and *Pleurotus eryngii* (Karık/Kivark) (Sırrı and Sırrı, 2020) are used against eye infections and scorpion stings in Anatolia. Acar (2018) stated that the *Calvatia gigantea* (Pos/Fos mantarı) is used in folk medicine to stop the blood of open wounds in Kastamonu, while *F. fomentarius* (Kav mantarı) is used to make a fire.

From the perspective of WM gatherers, Arslan et al. (2021) reported the WM species most collected and benefited from by gatherers as *A. caesarea* (İmparator mantarı), *Boletus* spp. (Çörek mantarı, Ayı mantarı), *C. cibarius* (Yumurta mantarı), *C. cornucopioides* (Borazan mantarı), *H. repandum* (Siğirdili mantarı), and *Lactarius* spp. (Kanlıca mantarı). It has been seen that the collectors benefited from the WM in the form of selling

them as commercial products, generating income, and consuming them for their own needs. It has been understood that the converting potential of WM into products by the collectors selling them was low. It has been determined that 95% of the intermediaries working in the WM picking business were men and 5% were women. It has been seen that middlemen sold WM mostly to mushroom processing plants.

Gastronomic and Culinary Culture Perspective on Usage of Edible Wild Mushrooms

In Anatolia, there are traditional edible WM dishes prepared on a local cuisine scale. Examples of these dishes are mushroom stew, mushroom rice (with rice or bulgur), mushroom pasta, mushroom soup, grilled mushroom kebab, mushroom roasting, mushroom tas kebab, lamb roasting with mushrooms, mushroom pastry, mushroom roasting with egg, stuffed mushrooms, and mushroom frying (Tuzlacı, 2011). In Kastamonu, many dishes are made, such as bread, banduma, roasted on the stove, pickles, and WM made by hammering (cracked) eggs on them in the households (Acar, 2018). In Sinop cuisine, the mushroom's value is equated with meat, and consumed in various traditional recipes such as soup, pastry (börek), Turkish ravioli (mantı), tirid, roasting with onions, grilling, with eggs, Turkish pancake (gözleme), with garlic yoghurt, and pickles. In addition, WM are dried and stored for later usage and the WM sauce is prepared for meals. Some WM are even eaten raw in the region (Acar, 2016).

From the gastronomic point of view, some vegan, vegetarian, and fusion menu options including recipes such as soup, rice, pastry (börek) and sauté consisting of edible WM and other ingredients are available at restaurants, hotels, and other professional kitchens in recent years and offered to guests as "alternative taste sources" (Erdem et al., 2018a). In a study, it was determined that chefs from the Mengen district of Bolu province recognized 19 WM species with their local names of Kanlıca, Cincile, İçi Kızıl, Ayıca, Kedi Kırışı, Mihlıca, Tellice, Ebişge, Kuzugöbeği, Ayıköşkü (kökü), Döbelen, Porçini, Porsuk, Duvaklıca, Polet, Yumurta mantarı, Sarıkız, Malkadın, and Cirol/Elik (Erdem et al., 2018b). However, while 45.5% of the culinary chefs stated that they used local WM such as Kanlıca, Cincile, Polet, Sarıkız, and Porcini in their kitchens, 54.5% of the chefs could not use local WM in the kitchens of the food and beverage businesses they worked for due to the reasons such as supply/continuity problems, not knowing by the customers, not having a commercial market,



having risk or not finding products with the same quality standards in the same study.

Karakayalı et al. (2022) conducted a gastronomy and culinary culture study in Giresun. It was determined that among the 45 species known and consumed as WM, Sığırdili (*Hydnum repandum*-Ak Sığırdili and *Hydnum rufescens*-Sarı Sığırdili), Tellice, Gelinparmağı, Halı Saçağı (*Ramaria* spp.), Kiremit Balaban mantarı (*Sarcodon imbricatus*) were dried, Kayışkıran mantarı (*Russula chloroides*) and Akçintar mantarı (*Russula delicata*) were canned and pickled, and species suitable for shock freezing were stored in the freezer/deep freezer with/without boiling and consumed off-season. In the same study, it was stated that WM affected social and cultural relations in Giresun province by an example of offering the difficult and rare collected Çanşur mantarı (*Pleurotus eryngii* var. *ferulae*) to the guests coming to the house was an indication of the given importance and value to the guest by the host.

Consumers' Perspective on Consumption of Edible Wild Mushrooms

Apart from the ethnomycological and taxonomic studies reporting traditional knowledge on consumption of edible and medicinal WM in Anatolia, some studies were performed about the consumption patterns and consumer attitudes towards WM in urban areas.

When the reasons for consuming mushrooms were examined, it was seen that consumers consume WM because they liked the taste and flavor. In addition, it has been determined that the answers related to being healthy and nutritious, being a protein source, habit, easily obtaining of WM and being affordable were among the reasons for WM consumption (Kibar, 2015; Şimşek and Önek, 2021; Yılmaz et al., 2016). In a study, it was determined that 54.7% of the mushroom consumers obtained the mushroom from the local market, 36.8% from the shopping malls and markets, and 8.4% from nature themselves in Antalya urban area (Uysal, 2014). In the study conducted in Iğdır, of those who consumed mushrooms, 56.6% reported that they consumed only cultivated mushrooms, 37.2% consumed both cultivated and wild mushrooms, and 6.2% only consumed edible WM (Kibar, 2015). In another research conducted by Yılmaz et al. (2016) in Trabzon, 74.6% of the 260 participants of whom 50 lived in rural areas were indicated that they consumed cultivated mushrooms while 38.1% of them consumed WM.

Unfortunately, there is a tendency of less frequent usage of WM because of non-recognition of species,

poisoning suspicion, not thinking that WM are healthy and nutritious, disliking of WM taste, not having the habit of WM consumption, and high price as people move away from the rural areas and have a higher education level as well as advancing age and higher income like in many urban areas of mycophilic countries (Kibar, 2015; Yılmaz et al., 2016; Bulam et al., 2018c).

Results and Discussion

The aim of this review was to keep and publish traditional knowledge about the awareness, collection, and consumption patterns of WM by compiling the studies on ethnomycology in Anatolia. According to literature information, WM are collected from nature and mostly consumed as food after cooking with various methods and stored after preserving with processes in a household scale for winter usage in the country. In addition, a few of WM are also used for medicinal applications. For our population's health, more ethnomycological and taxonomic studies should be performed to identify edible, inedible, and poisonous WM species and the results of the studies should be shared with people living in Anatolia primarily to prevent mushroom poisoning cases. It is not a correct practice to think that the mushroom is non-toxic according to its shape or color. All generalizations circulating among the public about the edibility of WM can have deadly results. Therefore, in order not to consume WM unconsciously and to ensure sustainability, education should be given to consumers about edible and medicinal WM.

On the other hand, more ethnomycological studies should be conducted in edible and medicinal WM research areas to determine WM species and their consumption patterns among the local people and their cultivation potential for sustainable, healthy, adequate, and balanced diet of the population in Anatolia. Moreover, ethnomycological studies could be useful to be learned the WM known and preferred by rural and urban people, so some new standard recipes could be prepared in the gastronomic field for the consumers appreciating WM and vegans, vegetarians and those who need high-quality vegetable protein. Furthermore, more edible and medicinal WM should be conserved and cultivated to produce commercial functional foods by the food industry, and some new biotechnological enzymes, drugs, and products by national or international pharmaceutical and cosmetic industries in the near future after ethnomycological studies conducted in Anatolia.



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