

Review Article

Traditional Processing and Preservation of Wild Edible Mushrooms in Mexico

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Abstract

Wild edible mushrooms are relevant rural dietary resources during the rainy season across Mesoamerica. In Mexico 371 edible species have been recorded, along with vast traditional information that includes processing techniques specific to both the nature of the mushroom and the human groups that use them. This is a review of ethnomycological works in Mexico describing processing techniques to consume and preserve wild edible mushrooms. While recipes vary geographically, some patterns are discernible. In Mesoamerica, the "hot-cold" classification system dictates the proper ways to process food. Mushrooms are grouped differently in unrelated cultures, which influence how they are cooked. Additionally, physical and chemical features dictate pre-cooking treatments. Finally, the limited seasonality of mushrooms affects the way they are processed. While many may be "snacks" or prepared as plain dishes in the face of scarcity, some species are highly sought and specially prepared. This temporality has also motivated the development of preservation techniques to ensure off-season consumption. Preservation of wild edible mushrooms is mainly of two kinds in Mexico: drying and pickling. Despite the humidity of the season, drying is the most common of these and it is achieved mainly by hanging the specimens to be sundried or over a kitchen fire. Preserves are mostly self-consumed, but sometimes they are sold. The species selected for these processes are often the most appreciated for their flavor or for their market price. The processing of wild edible mushrooms is a reflection of the richness of Mexican Biocultural Diversity.

ABBREVIATIONS

WEM: Wild Edible Mushrooms

INTRODUCTION

Wild edible mushrooms (WEM) have historically been collected as food throughout the world and they still play an important part of rural alimentary strategies throughout the world during the rainy season [1]. Worldwide there are around 1000 species of WEM, which points to their relevance in rural resource use strategies [1].

Through the collection of mushrooms, people not only obtain high-quality alimentary resources, but also tradable goods for local markets. The nutritional value of mushrooms is frequently measured by its essential amino acid index, which is comparable to that of corn, soybeans, or beans. Proteins are the third most important component in fungal fruit bodies, ranging from 5 to 49% of their dry weight; additionally, they contain carbohydrates that

include dietary fiber, minerals like potassium and phosphorus, and soluble vitamins [1,2]. Furthermore, they are appreciated goods in markets, giving the family units dedicated to mushroom picking during the season a great source of income [1].

In Mexico, the tradition for wild mushroom consumption dates back to Pre-Hispanic times. Nowadays, around 371 different species of wild mushrooms are consumed (mostly by peasants and indigenous peoples) in this country [3].

In order to make use of these resources, indigenous and rural people have historically accumulated and transmitted deep knowledge of the seasonality, ecology, morphology, and general biology of the mushrooms in their environments [4].

This knowledge includes the very important aspects of processing for consumption. In general, in Mexico and Mesoamerica mushrooms are consumed fresh but, being a resource that has a very limited seasonality, traditional strategies have been developed to preserve them beyond this season.

This manuscript presents a review of the traditional ways in which Mexican rural and indigenous societies have developed techniques for the cooking and preservation of WEM, reproducing historically transmitted and refined traditional mycological knowledge to do so.

Processing WEM for immediate consumption

In addition to the richness of species consumed by Mexican peoples, there exists richness in the way wild edible mushrooms are prepared for consumption.

In order to cook mushrooms, they must first be rinsed with water to rid them of dirt, putrid residue, or other unwanted matter. During their cleaning, each carpophore is verified as edible, thus avoiding poisoning [5,6]. Although people are often unaware of the chemical components of mushrooms, they carry out different practices and processes before cooking some species. These practices are frequently destined to improve the flavor of the dish and extract certain substances perceived as noxious for their bodies.

Depending on the human group and the species of mushroom in question, the “feet” or stipes can be included or discarded, as can the epicutis or “skin” from the pileus [7]. Certain species, such as *Amanita rubescens*, *Boletus edulis*, and various *Suillus* species are consumed only after the cuticle of the pileus is peeled because this tissue can convey a slightly bitter flavor. In the case of *Tylopilus felleus*, *Turbinellus floccosus*, and *Russuladelica* the epicutis from the pileus, the stipe, the veins, scales, and lamellae respectively, are discarded [5,8-11]. Similarly, after *Amanita* sect. *caesarea* specimens are broiled, some people have been reported to rinse the mushrooms again to get rid of a “yellow substance” that can cause vomit when it is eaten in excess [5].

Some species require repeated boiling before being cooked. This can be due to their consistency or to their chemical composition, either perceived or real. Different species of *Pleurotus* and *Ramaria* are boiled once or twice before cooking, discarding the first batch of water to get rid of both bitterness and chewiness in western and central Mexico [12,13].

Across Mesoamerica, cooking techniques for mushrooms depend on the properties assigned to food beyond intrinsic features, namely those related to the worldviews of different peoples. For instance, Zapotecs from southern Mexico consider food prepared with mushrooms to be “cold”. This quality is related to the places and season (rains) in which these organisms grow [14]. Contrastingly, some Tzeltal communities in the southeastern state of Chiapas consider mushrooms to be “hot” food which is easily digested [15]. This hot-cold quality in foods is widespread across peoples from Mexico and Central America and it is a reflection of the duality in the worldview of Mesoamerican peoples in general [16]. A consequence for WEM processing is that they are cooked in diverse forms and sometimes raw, depending on their placement within this classification system.

Of course, physical features are also taken into consideration when choosing a processing technique for mushrooms in general or specific “groups”. Thus “softer” mushrooms will be eligible for some recipes, while “coarse” or “chewy” species will receive different treatments before being cooked [13].

There are some general cooking techniques across the country, but some species may be used in the preparation of special dishes. Mushrooms can be roasted over a *comal* (a large cast-iron pan), made into broth, soups, creams, pasties, *memelas* (thick corn *tortillas* folded and cooked on a *comal*), *quesadillas*, fried in stews, in *atole* (a maize-based traditional drink), or as a complement to other food. Frequently, WEM are cooked along with meats or vegetables and seasoned with typical spices from Mexican cuisine such as: peppers (*Capsicum annum* L.), *epazote* (*Dysphania ambrosioides* L.), *hojasanta* (*Piper auritum* Kunth), peppermint (*Mentha spicata* L.), maize (*Zea mays*), beans (*Phaseolus vulgaris* L.), and *nopal* (*Opuntia ficus-indica* (L.) Miller) [5,7,11,14,18,19].

Some recipes depend on the quantity of carpophores that are picked, the species that are found at one time, the degree of mycophilia in a culture, and other aspects. The preparation method for *Agaricus campestris*, for example, is based on the quantity that is picked. When few mushrooms are obtained, they can be roasted and made into *quesadillas* or pasties. However, when they are picked in larger quantities, they can be the main ingredients of special dishes like “*Amarillo*” (a kind of *mole*). *Mole Amarillo* is a typical dish from the southern state of Oaxaca; it is prepared with ground yellow corn and scented with bell pepper (*Capsicum annum* L.), clove (*Syzygium aromaticum* L.) and *hojasanta* (*P. auritum* Kunth). Although other species can be prepared this way, mushrooms are never mixed for this dish since each species requires a different cooking time and conveys a different final taste [5]. Similarly, *Amanita* sect. *caesarea* is reported not to be mixed with other mushrooms so that its flavor can be appreciated [13].

There are special ways to prepare certain species, such as *Ustilagomaydis*. This species is prepared boiled with sugar, for example [8], or as “*agua de pastor*” (shepherd’s water) mixed with green peppers, onion, coriander, water, and salt. This last recipe is an important meal before leaving to work the fields [14].

If mushrooms are consumed raw, they are generally sliced or threaded and they are eaten by themselves or with *tortillas*. Some species, like *Melanogaster umbrinogleba*, *Clavariadelphu truncatus*, *Rhizopogon* sp., and *Calostomacinnabarina* can also be eaten as snacks [7]. Among certain groups, such as the Nahuatl from central Mexico, WEM are thought to be inedible and even toxic when they are raw due to their “coldness” [8,10]. Similarly, a Mestizo (non-indigenous) community in the Lacandon Rainforest in southeastern Mexico considers consumption of raw mushrooms to cause harm [20].

While WEM are mostly cooked within family units for meals, some are cooked specifically for sale or instead are sold along with all the ingredients necessary for special recipes [21,22].

Wild edible mushroom preservation

Two forms of traditional wild mushroom preservation techniques among Mexican peoples have been reported: drying and, less importantly, pickling [7]. Very few studies mention other forms of preservation such as freezing or canning [11]. Most wild edible mushrooms are reported to be consumed fresh throughout geographical regions and ethnicities in Mexico [11,18,20,23,24].

While mushroom preservation has seldom been studied in detail among rural people in Mexico, it has been reported as important among groups inhabiting the Central part of the country. For instance, drying is practiced by up to 79 and 78% of the people in two Otomi-Mestizo communities in Estado de Mexico [9].

Drying is in fact an important preservation technique for the long-term storage of different basic foods among rural people in Mexico. Given that mushrooms appear during the most humid part of the year, their preservation by drying requires special care and dedication; risk of spoilage is very high [7]. Moreover, in Mexico's tropic and in the highlands of the southeast, some people eat WEM mostly when basic or preferred foods, such as maize, are scarce. Furthermore, they are linked to social representations of poverty [20,25]. In this context, the concept of "emergency food" that Fidalgo [26] coined may be applicable to WEM in certain regions of the country, which makes preservation in these environments a rare occurrence.

The ready availability of WEM during the rainy season, along with widely spread social convention that these resources are common rights in forest land, can contribute to their under appreciation. Even among mycophilic societies, such as the Nahua from Morelos, certain species like *Suillus punctipes* are considered "less desirable food" [8]. Contrastingly, many human groups from central Mexico and the southern state of Oaxaca view mushrooms as "special seasonal foods" and even delicacies or economically depend on their collection during the season [10,13,22]. Thus, it is far more common for preservation techniques to be practiced in the temperate forests of these areas, where mushroom species are larger and often appreciated as part of special dishes or where these are sold and preservation represents higher market prices [10,11,27]. Only where commercial chains of importance exist are these processes carried out in a bigger scale [10].

Drying of mushrooms is a common practice in central Mexico, although it is also reported in northern and southern parts of the country. Groups as diverse as Mixtecs from southern Oaxaca, Otomi from central Mexico, Raramuri from northern Mexico, and Mestizos (non-indigenous groups) keep mushrooms beyond the rainy season by drying them [5,9,24,27].

Although in his world review Boa [1] points out that mushrooms are pickled only in Asia, in Mesoamerica preserves are also made, albeit mainly for self-consumption. This practice has been reported in both central and northern Mexico among indigenous and mestizo groups [24,28]. Among the Tarahumara, previously boiled crystal jars are used to contain the pickled mushrooms in order to prevent them from spoiling and even, sometimes, sell those [24].

As is the case with freshly consumed mushrooms, some previous preparation is sometimes needed to process mushrooms for drying. Sometimes, the stipes, lamellae, or epicutis of a mushroom is discarded previous to initiating this process [7,9]. The reasons behind this selective drying seem to respond to flavor perceptions and no studies report these practices to be related to drying efficiency. Regarding this aspect, there is mention of slicing of the larger fleshy species in order to shorten the drying time [9].

Another preparation step for drying WEM is threading them in a string. This way, they are manageable and can be easily hung during the process. Some species are simply sliced to be sundried [10].

Drying is done mainly in warm areas such as the kitchen, near the stove or fireplace. These are used as heat sources and often drying is completed in the sun [7]. Elsewhere mushrooms are dried using solely the energy and heat from the sun [9]. If this is the case, the mushrooms will hang in a well ventilated area where the sun can reach them for several days. Otherwise, they can be set down on a *petate* (woven dry-palm mat) or other surface to be dried [29].

In order to consume dried mushrooms they are simply rehydrated, sometimes previously washed, and strained [9,27]. The specimens are said to keep their flavor mostly intact after this process [29].

Regarding the reasons behind WEM preservation, some selected species are kept beyond the rainy season exclusively for self consumption. Many times these are the most appreciated species because of their flavor. In Tlaxcala, mushrooms are said to be dried "*para el antojo*" (for cravings). The Raramuri in northern Mexico seem to preserve mushrooms mostly for this purpose, either dried or pickled. Additionally, preserved WEM serve as high-price tradable goods during winter or Easter [24].

Some of the most valued species may also be preserved exclusively for sale. Such is the case among Nahua people in central Mexico and Zapotecs in southern Mexico [10]. While short-term preservation for sale is achieved simply by refrigerating WEM in bags with holes that allow for ventilation [29], in order to be sold at high prices, the mushrooms must be recently harvested and properly dried, so the technique for doing this at bigger scales is greatly valued among societies with a big WEM picking tradition. A small-scale option for unsold mushrooms is practiced among Nahua groups, who store mushrooms that have not been sold at the end of the season by drying them [10].

There have been reports of companies influencing both the recollection and preservation of certain species [22,24]. Pina de Mexico S. de R.L. advertised photographs of several species in northern Mexico, offering people training in collection and preservation techniques for those interested in selling those species to them [24]. A similar situation happened in Oaxaca, where Japanese buyers offered up to a week's salary per kilogram of *Tricholomamagnivel* are [22].

Not all mushrooms species are preserved. The water content of several of them is particularly high, making them bad candidates for traditional drying techniques. As is pointed out above, this can be avoided for some of the larger species with slicing [9]. Furthermore, the processing of mushrooms requires some dedication, which makes the group of species selected for this processes quite reduced in many cases.

Otomi and Mestizo communities in Estado de Mexico keep *Russulabrevipes*, *Hypomyceslactiflorum*, *Ramariaspp.*, *Lyophyllumdecastes*, *Marasmiusoreadesy* *Agaricuscampestris* dry for off-season consumption [9]. While the Nahua dry *Boletus pinophilus*, *Morchellaaelata*, *Morchellaesculenta*,

Cantharelluscibarius, and *Helvellaspp*, as well as *Russuladelica*, *Gomphusfloccosus*, *Lyophyllumdecastes*, and *Ramariaspp*, although less frequently [10].

Contrastingly, among the Tepehuan from central-northern Mexico from 15 used WEM only two *Pleurotus* species are sundried to be stored, while in Veracruz only the mushrooms locally named *escobetaor pechuga* (*Clavariaaurea* and *Ramaria botrytis*) are tied up for storage [23,30].

Amanita sect. caesareais one of the most appreciated groups of edible wild species in coniferous forest environments. Among the northern Raramuri it is the only sold species, mostly fresh and "occasionally preserved" [24]. Similarly, organized peasant groups in the state of Oaxaca have currently begun to create small community companies dedicated to the dehydration of mushrooms (mainly *Amanita sect. caesarea*) and their sale in urban areas at relatively high prices.

Similarly, *Schizophyllum commune*, one of the most appreciated species in tropical areas worldwide, is dried in the southern state of Oaxaca [29].

There appears to be a limited amount of reported information on the techniques for preserving mushrooms in Mesoamerica. In some cases, it has been reported that such techniques are kept "secret" even between members of a community [28]. Where mushrooms are sold to intermediaries or directly in markets, this may be due to the high price that can be obtained from preserved mushrooms. Maintaining the secret can ensure a limited competition in this market.

Some preservation techniques involving fruit drying machines or other forms of technology have been reported. In the case of the Raramuri in northern Mexico, these techniques were introduced by a company targeting some of the local wild edible mushrooms for international markets [24]. In Central Mexico, a limited amount of men have learned to dry the high-price mushroom *Morchellaesculenta*; this species has been observed by the authors to be sold at a price of over \$27 USD/ Kg in Mexico City. A man from the community where this was reported tells that he learned the drying technique from an Italian man who sold him the materials for this process [28].

CONCLUSIONS

Mexican culinary is an important expression of the Biocultural Heritage of the diverse peoples of this county. It combines aspects of traditions, the richness of species within diverse environments, and empirical knowledge of the features of the used species, as well as specific traditional techniques for their transformation.

This can be appreciated in the diversity of cooking techniques for WEM, which respond to the specific features of the consumed species as well as features that are culturally imposed over them.

While mushroom preservation is reported to be of certain importance among geographically spread groups, it is mainly focused on off-season household consumption. The potential for their inclusion in larger-scale commerce is wide with mycophilic societies spread all across the country and in other wider markets. However, in reality this is a limited strategy and experiences of community companies drying mushrooms in a large scale are still scarce.

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