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Journal of Ethnopharmacology

journal homepage: www.elsevier.com/locate/jep

Research paper

Ethnomycological survey of traditional usage and indigenous knowledge on desert truffles among the native Sahara Desert people of Algeria

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ARTICLE INFO

Article history:

Received 17 November 2014

Received in revised form

15 December 2014

Accepted 20 December 2014

Keywords:

Algeria

Northern Sahara

Ethnomycology

Desert truffles

Traditional knowledge

Medicinal use

ABSTRACT

Ethnopharmacological relevance: Desert truffles are edible hypogeous fungi, highly appreciated by the inhabitants of hot-desert settlements. Native Saharan people use truffles for food, promoting tourism, increasing fertility, and treatment of eye diseases and fatigue.

Aim of the study: This study consists of a cross-sectional survey focusing on the knowledge, use and ethnomycological practices of desert truffles among the native people of the Algerian Northern Sahara.

Materials and methods: The study was conducted through direct interviews with 60 truffle-hunters in the regions of Ouargla and Ghardaia.

Results: Three species were harvested and consumed by the surveyed subjects: *Terfezia claveryi* was the most appreciated and most expensive species, followed by *Terfezia areanaria* moderately preferred, then *Tirmania nivea* the least appreciated and least expensive. Among the 60 interviewees, 90% rely on the abundance of symbiotic plants (*Helianthemum lippii*) to harvest truffles, 65% begin harvesting from mid-February to March, after rains of the autumn (38%) and winter (36%), particularly in the Wadi beds (37%) and Daya landscapes (32%). Interviewees harvested truffles mainly for home consumption; however 26.7% sell any harvest surplus, and of those only 15% generate significant revenue from this source, and 73% considered the sale of desert truffles to have low financial value. Desert truffles are used in traditional medicine, especially against eye infections (22%), weakness (19%) and to promote male fertility (19%). In the case of desert truffles for consumption, the surveyed population preferred to prepare the truffles with couscous and meat, or in porridge. Respondents used price as the main criterion for deciding whether to purchase desert truffles.

Conclusions: The surveyed truffle harvesters use the knowledge passed from one generation to the next to help ensure a good harvest of truffles during each foray into the desert. Our findings highlight the various uses of truffles in the Sahara Desert, and how these relate to the lifestyle of local people.

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1. Introduction

Desert truffles are the fruiting bodies of some edible fungi belonging to the phylum Ascomycota and the class Ascomyceta. They were long related to the order of Pezizales (Trappe, 1979) and it is only in modern classification they have been grouped under the order of Tuberales, which is classified into two families: Tuberales and Terfeziaceae that are represented by many genera, such as *Terfezia*, *Tirmania*, *Delastria*, *Balsamia*, *Mattirolomyces*, *Picoa*, *Phaeangium*, *Leucangium*, *Delastreopsis* and some species of *Tuber* (Ammarellou and Trappe, 2007; Kagan-Zur et al., 2014).

Desert truffles grow in arid and semi-arid lands, particularly in countries around the Mediterranean, especially in countries of Southern Europe including Spain, Portugal, Italy, France, Hungary and Turkey (Janex-Favre et al., 1988; El-Kholy, 1989; Gücin and Dülger, 1997; Ławrynowicz et al., 1997; Moreno et al., 2000), North Africa that extends from Mauritania to Egypt (Malençon, 1973; Bokhary, 1987; Khabar et al., 2001; Slama et al., 2006; Fortas, 2009), and the Middle East (Alsheikh and Trappe, 1983; Al-Ruqaie, 2002; Mandeel and Al-Laith, 2007). However, some species of desert truffles were also found in Botswana, South Africa (Marasas and Trappe, 1973; Trappe et al., 2008a; Kagan-Zur et al., 2014) and in North America (Trappe and Sundberg, 1977; Kagan-Zur et al., 2014).

Desert truffles live in mycorrhizal association with Cistaceae plants, especially of the genus *Helianthemum* and *Cistus* (Khanaqa, 2006). Their development in hot deserts occurs after the fall of rains

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heralding the end of winter and the beginning of the hot season, with a specific temporal distribution of rainfall amounts along the year (Bradai et al., 2015), but also depending on the type of soil and climate, and abundance of host plants (Kagan-Zur and Roth-Bejerano, 2008; Kagan-Zur et al., 2014). In general, the distribution of truffle species is closely linked to climatic and edaphic conditions (Kagan-Zur and Roth-Bejerano, 2008; Bradai et al., 2014, 2015). In Algeria, desert truffles mainly colonize habitats of the Steppe and the Sahara Desert (Fortas, 2009), and are represented by three genera *Terfezia*, *Tirmania* and *Picoa* (Zitouni, 2010). Moreover, their taxonomy, ethnomycology and ecology are very little studied, not only in Algeria but at North African scale (Volpato et al., 2013).

With regard to their nutritional value, the desert truffles are rich in various chemical compounds, including carbohydrates, proteins, amino acids, fiber, vitamins, minerals, sterols, terpenes and fatty acids, which imbue them with a unique musky flavor that makes them taste very different from truffles of the genus of *Tuber* (Bokhary and Parvez, 1993; Omer et al., 1994; Hussain and Al-Ruqaie, 1999; Dabbour and Takruri, 2002a; Murcia et al., 2002). Desert truffles are highly appreciated by people of North Africa, Middle East and Gulf countries; they are even eaten raw in some areas. In Europe, several recipes, based on or having desert truffles as major constituent, are presented in high-class restaurants (Fortas and Chevalier, 1992; Slama et al., 2006; Fortas, 2009; Bradai et al., 2013).

In addition, desert truffles are an untapped source of therapeutic compounds with anti-inflammatory, immunosuppressants, anti-mutagenic and anti-carcinogenic characteristics (Hannan et al., 1989; Kagan-Zur et al., 2014). Besides, they have been proven to contain compounds with antioxidant and antiradical activities (Al-Laith, 2010).

Their popularity is not only due to their specific taste and nutritional value, but also to their therapeutic properties (Mandel and Al-Laith, 2007; Kagan-Zur and Roth-Bejerano, 2008; Slama et al., 2010; Wang and Marcone, 2011; Kagan-Zur et al., 2014). Indeed, their chemical composition has been the subject of numerous studies that have demonstrated their richness in proteins, amino acids, fiber, fatty acids, minerals and carbohydrates (Ahmed et al., 1982; Alsheikh and Trappe, 1983; Bokhary et al., 1989; Bokhary and Parvez, 1993; Murcia et al., 2003). Truffles are also used as food sources to survive in arid regions where food is scarce (Harris and Mohammed, 2003; Boa, 2004; Benucci et al., 2012), since they contribute to the incomes of populations after sale or simple exchanges against other products (De Roman, 2010; Benucci et al., 2012).

At Northern Sahara of Algeria, three species of desert truffles have been identified: *Tirmania nivea* (Desf.) Trappe 1971, *Terfezia arenaria* (Moris 1829) Trappe 1971 and *Terfezia claveryi* Chatin 1892 (Bradai et al., 2014). In this region, local settlements consider desert truffles, regardless of the species, as the most highly appreciated hypogeous fungi due to traditional knowledge that is transmitted from one generation to another (Bradai, 2006). Moreover, Bedouins of the region rely on a wide range of natural products, mostly medicinal plants, in traditional medicine (Bensizerara et al., 2013). Through this investigative approach, we will try to qualitatively analyze the ethnological knowledge of desert truffles among the Aboriginal people of the Algerian Sahara Desert, through the emphasis of aspects related to practices of researching and harvesting desert truffles, their economic importance and their valorization in traditional pharmacopoeia.

2. Materials and methods

2.1. Study area

The present study was conducted in the Northern Sahara Desert of Algerian, including the regions of Mzab (Ghardaia) and Oued Mya (Ouargla) (Fig. 1). Both areas are subjected to extreme

severe edaphic and climatic conditions of the Sahara. The main types of Saharan landscapes include expanses of sand dunes and desert pavements “Hamada and Reg”. Habitats with alluvial soils and soil crusting are local phenomena (Ozenda, 1991).

The climate of the study area is hot hyperarid (desertic). It is characterized by low and erratic rainfall chiefly occurring in winter with annual isohyets that range between 50 and 100 mm. Average annual temperatures are high ($\sim 30^{\circ}\text{C}$), with absolute maxima exceeding 50°C in July–August and minimum temperatures in January ranging from 2 to 9°C (Bradai et al., 2013, 2015).

The people have multiple ethnical origins: Berber, Arab, African and mestizos from mixed marriages. The main activity of the population typically is oasis agriculture, which is mainly based on the cultivation of date palm (*Phoenix dactylifera*) associated with underlying crops, and the extensive livestock farming of camel in the large Saharan pastoral areas.

In both regions, a pilot-community was chosen to conduct the survey: (i) the locality of Metlili ($32^{\circ}16'N$, $03^{\circ}37'E$) lies approximately at the center of the Algerian Sahara, at 40 km south-east of the province Ghardaia, and (ii) the location of Rouisset ($31^{\circ}26'N$, $05^{\circ}40'E$) lies about 12 km south of the capital of the province of Ouargla.

2.2. Data collection

2.2.1. Description of species of desert truffles

The three species of truffles: *Terfezia claveryi* (Chatin), *Terfezia arenaria* (Morris. Trappe) (Terfeziaceae) and *Timania nivea* Desf. Trappe (Pezizaceae) are common in the Northern Sahara. Their main characteristics are shown in Table 1. According Bradai et al. (2014), these three species live in symbiosis with *Helianthemum lippii* (Cistaceae) in sandy soils of the Northern Sahara where ascocarps appear from early February until mid-April. Most ascocarps were produced at soil depths less than 60 mm. *Tirmania nivea* is the most common species in different sites producing desert truffles, while *Terfezia arenaria* and *Terfezia claveryi* are considered rare (Table 1).

2.2.2. Survey and questionnaire

A preliminary investigation lasting two weeks (from late February to early March 2014) was carried out to test the questionnaire prepared to that effect. The collection of specimens and



Fig. 1. Location of the study sites (Ouargla and Ghardaia) in the Sahara Desert of Algeria

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