



Morchella esculenta (L.) Pers. Wild of the Province of Taza, Morocco: Ethnomedicinal and Socio-Economic Survey and Perspectives

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ABSTRACT

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Morchella esculenta (L.) Pers. is an edible mushroom highly valued by consumers worldwide for its nutritional and therapeutic qualities. In the absence of studies on this mushroom in Morocco, this study aims to evaluate its ethnomedicinal use and its socio-economic impact on the local population. Therefore, an ethnomedicinal and socio-economic survey was conducted among 163 people in 6 stations in the province of Taza in Morocco in March, April and May 2019. The survey data were processed using Excel 2010. The study showed that *Morchella esculenta* (L.) Pers. is poorly known among the local population, with only 1.22% of the population considering that this mushroom has a therapeutic effect for diabetics and people suffering from cardiovascular problems, and 4.3% of the population includes it in their culinary habits as a spice or grilled. On the other hand, this study revealed that the mushroom provides a significant seasonal income, reaching MAD 3,000/€ 274.58 per collector, at MAD 60/€ 5.48 per kg. This study showed that *Morchella esculenta* (L.) Pers. is not well known and is not exploited ethnomedicinally, even though it represents an important economic resource for the local population. Therefore, there is a need for further research on *Morchella esculenta* (L.) Pers. from Taza in Morocco to reveal the benefits of this famous mushroom.

Keywords: *Morchella esculenta* (L.) Pers., Province of Taza-Morocco, Ethnomedicinal, Socio-economic.

Introduction

Edible mushrooms are considered highly valuable, not only from a nutritional point of view but also from a pharmacological and economic point of view, as they are a source of therapeutic substances and have long been used in traditional medicine.¹⁻² In addition, edible mushrooms offer significant economic returns.³⁻⁴⁻⁵ Among the most famous edible mushrooms are morels, which are regarded as among the most popular mushrooms in the world because of their organoleptic, nutritional and therapeutic qualities.⁶ They are known to be rare, and their domestication remains complicated, making them expensive to buy relative to other edible mushrooms. Several studies report that morels contain substances with anti-tumour activity,¹⁻⁷ antioxidants,⁸⁻⁹⁻¹⁰⁻¹¹ and antimicrobial.¹²⁻¹³ And incorporating edible mushrooms into culinary habits improves antioxidant enzyme activity in the body and may have a neuroprotective effect.¹⁴ Morels have also been used extensively and for a long time in traditional Chinese therapeutic practices to treat respiratory problems, excess phlegm and indigestion.¹⁵ The preferred conditions for morels to grow are in biotopes where there is a thermal shock from a period of cold to rapid warming, and in high-altitude areas.¹⁶

Morchella esculenta (L.) Pers. is a species of morel classified in the phylum Ascomycetes (or Ascomycota), composed of a cap carried by a stalk and can reach up to 8 cm in height with a more or less conical shape, yellow to brown colouration.¹⁷ According to the literature search, we found that no extensive scientific research has been carried out on Moroccan morels, except two studies,¹⁸⁻¹⁹ that take a general interest in the inventory, anatomy and marketing of edible mushrooms in Morocco. The province of Taza is a wetland at an altitude of over 1,900 m, with an immense plant biodiversity (over 60 species endemic to the Taza area).²⁰ Studies conducted by the Laboratory of Natural Substances, Pharmacology, Environment, Modeling, Health & Quality of Life (SNAMOPEQ) have confirmed the therapeutic potential of several plants found in the province of Taza, such as *Atractylis gummifera* L.,²¹ *Juglans regia* L. Bark,²²⁻²³ *Leopoldia comosa* (L.) parl. Bulbs,²⁴ *Ajuga Iva* subsp. *Pseudoiva* (DC.) Bric.,²⁵⁻²⁶ and *Haloxylon scoparium*.²⁷⁻²⁸ The Bab Lakhmiss forest at Maghraoua in the Taza region is a favourable biotope for various morel species, including *Morchella esculenta* (L.) Pers., which is the subject of this study. The present work carried out for the first time, aims to study the ethnomedicinal use and its socio-economic impact of *Morchella esculenta* (L.) Pers. in the province of Taza in Morocco. Therefore, an ethnomedicinal and socio-economic survey was conducted among the local population by direct interviews with collectors of the said mushrooms, sellers, herbalists and other members of the population (163 respondents) at 6 stations in the province of Taza (Tametrhouste, Bab Larbaa market and Douar Bab Larbaa, weekly market (souk) of Taza, centre of the town of Taza and Larbaa market of Gueldamen in the rural commune of Gueldamen).

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Materials and Methods

Study area

This study was carried out in the province of Taza, which is a mountainous region, comprising both Rif and Atlas zones. It serves as a junction of the Rif and the Middle Atlas and is bordered by the provinces of Al Hoceima and Driouch to the north, Sefrou to the south, Guercif to the east and Taounate to the west. The province covers an

area of 7098 km² and has a population of 526 986.²⁹ The main urban centres of the province are: Taza, Aknoul, Tahla and Oued Amlil, with smaller populations in areas such as Tainast, Saka, Bab Merzouka and Bab Boudir.

Data collection

Ethnomedicinal and socio-economic data on *Morchella esculenta* (L.) Pers. were collected in the field over three months (March-April-May 2019) using a questionnaire completed by the population (collectors, vendors, herbalists and other members of the population) at 6 stations (163 respondents) in the province of Taza (3 stations in the rural commune of Maghraoua, namely: Tametrouste, market Bab Larbaa

and Douar Bab Larbaa, in addition to the weekly market (souk) in Taza, the centre of the town of Taza with herbalists and market Larbaa Gueldamen). The stations were selected based on their proximity to the *Morchella esculenta* harvesting area and are illustrated in Figure 1. The questionnaire form includes the items listed in Table 1, which have been developed by the Laboratory of Natural Substances, Pharmacology, Environment, Modelling, Health & Quality of Life Laboratory (SNAMOPEQ). The questionnaire form was presented in the work carried out by Boulfia and his collaborators.³⁰

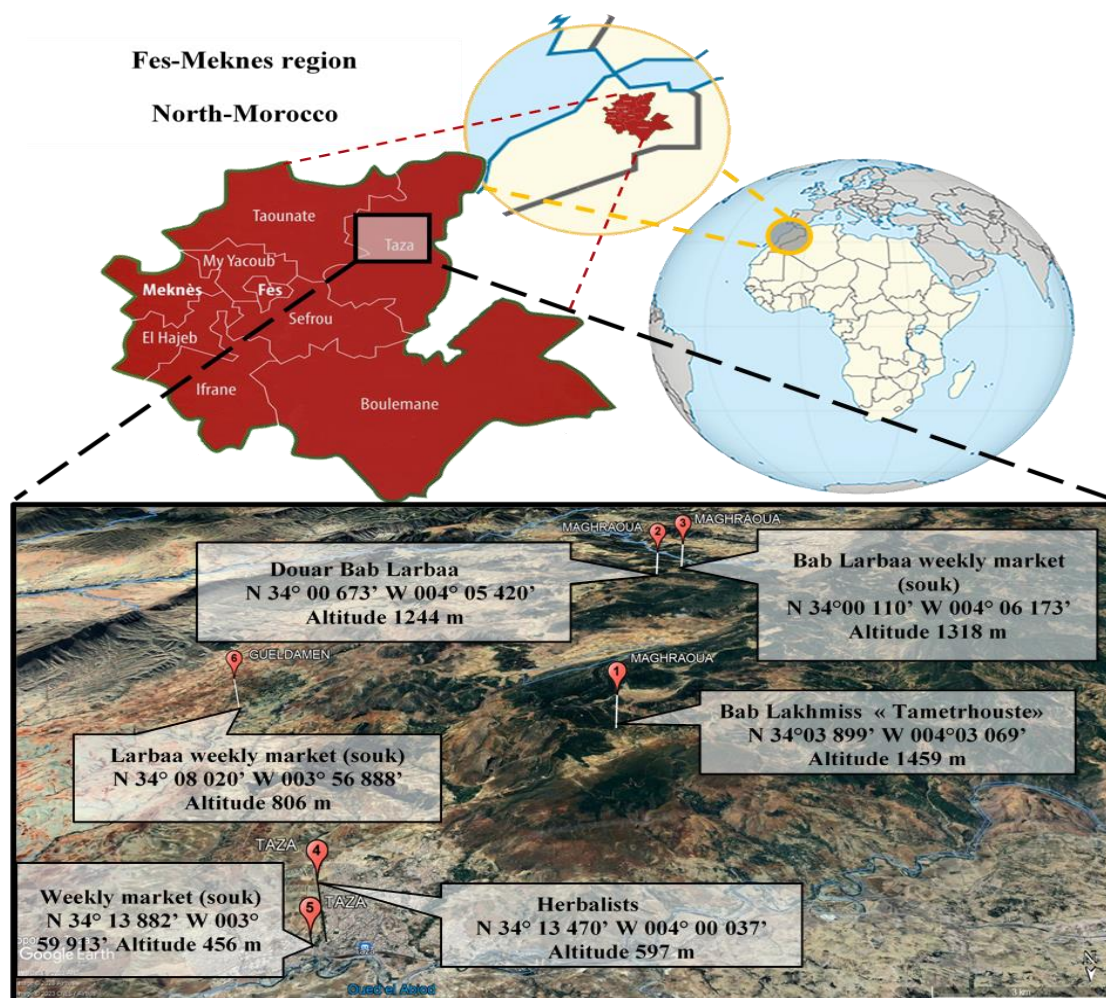


Figure 1: Geographical representation of the study area and map describing the survey communes in the province of Taza – Morocco

Table 1: Headings on the questionnaire form

Headings	Information
Heading 1	Personal information about the informant
Heading 2	Information about the mushroom
Heading 3	Uses of mushrooms
Heading 4	Medicinal aspect
Heading 5	Socio-economic impact of the mushroom
Heading 6	Reserved for associations/cooperatives

Mushroom sample

Field trips were made to collect the mushroom *Morchella esculenta* (L.) Pers. in the Bab Lakhmiss / Maghraoua forest (with geographical coordinates N 32°03.704' W 004°02.834' altitude: 1445 m), located between Tamdrouste and Bab Larbaa, on the R 507 national road 26.1 km from the town of Taza, Morocco (Figure 2), during the spring of 2019, 2021 and 2022. Botanical identification was carried out with the assistance and in consultation with Professor Abdelilah Rahou of the Faculty of Science at Moulay Ismail University in Meknes, Morocco, and the species identification was validated. A reference specimen has been deposited in the herbarium, with code ME- 2019/04. The harvested mushroom was dried in the shade with ventilation, after which it was stored in dark conditions. Figure 3 depicts the mushroom transitioning from harvesting to the drying stage in the laboratory.



Figure 2: Bab Lakhmiss Forest - Province of Taza, Morocco (geographical coordinates: N34°03.899' w 004°03.069' Altitude 1459 m)



Figure 3: (a) and (b) *Morchella esculenta* (L.) Pers. wild in the Bab Lakhmiss forest (N 32°03.704' W 004°02.834' Altitude: 1445m) ; (c). Drying of *Morchella esculenta* (L.) Pers.; (d). A longitudinal section of the carpophore (fruiting body) of *Morchella esculenta* (L.) Pers.; (e). Samples reserved for the herbarium; (f). *Morchella esculenta* (L.) Pers. in different stages of growth.

Statistical analysis

The survey was analyzed to produce a table with two entries, one corresponding to the number of the questionnaire form and the other to the different items covered. The graphical representations of the results obtained were created using Microsoft Excel 365 version 2010.

Results and Discussion

The survey consisted of a random sampling of 163 respondents, of whom 69% were men and 31% were women (Figure 4). This may be due to the rural nature of most of the stations and the reserved nature of the inhabitants of most of the stations visited, this is in accordance with the results of a study by Lachkar and his collaborators, who carried out

a survey of various stations in Taza Province and found that the percentage of men (60.75%) exceeded that of women (39.75%).³¹ Although women are the ones who preserve and pass down the therapeutic remedies and types of medicinal plants from one generation to the next.³² The ages of the participants ranged from 10 to 82 years (Figure 5), with an average age of 40 years. Figure 6 shows that illiterate respondents represent a small percentage (37.42%) compared to literate respondents (61.96%), of whom 28.22% have primary education, 13.5% have a college education, 12.88% have secondary education and 7.36% have university education.

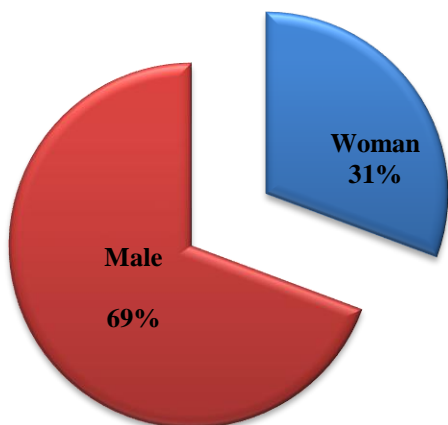


Figure 4: Distribution of survey participants by gender

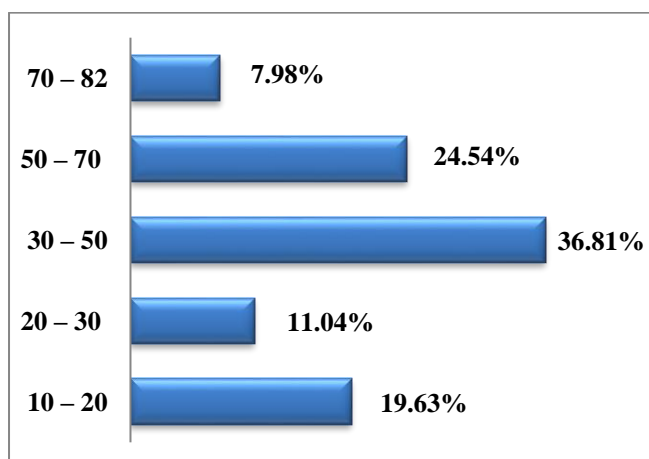


Figure 5: Percentage of age groups

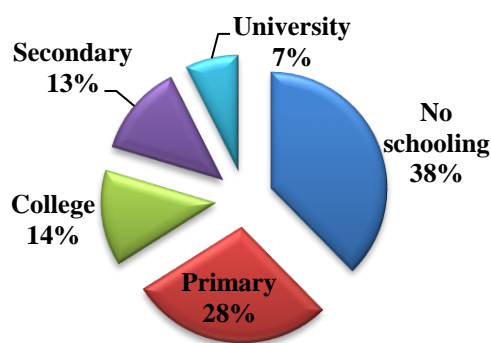


Figure 6: Educational level of respondents

The vernacular name of *Morchella esculenta* (L.) Pers. given by the local population is Gourcele with a percentage of 38.64%, while 0.62% gave the name Fougaa to this mushroom and 60.74% of respondents did not know the local name of this mushroom. It should be noted that the population does not distinguish between the different species of morel that exist in the region. Moroccans generally use the vernacular name Fougaa to refer to mushrooms. Table 2 lists the vernacular names given to *Morchella esculenta* in other countries³³ which are different from the name given to *Morchella esculenta* in Taza, Morocco. The analysis of the data presented in Figure 7 shows that 20.24% of the population considers that April is the harvest season for *Morchella esculenta*, in line with the literature and, in particular, with the work of Comola,¹⁷ which states that morels generally appear in the spring, which is in agreement with the study of García-Pascual and his collaborators, who state that *Morchella esculenta* is a seasonal mushroom and that its harvest period takes place during a very defined and short period of the year.³⁴ Another study indicates that *Morchella esculenta* is harvested in the spring, summer and autumn.³⁵

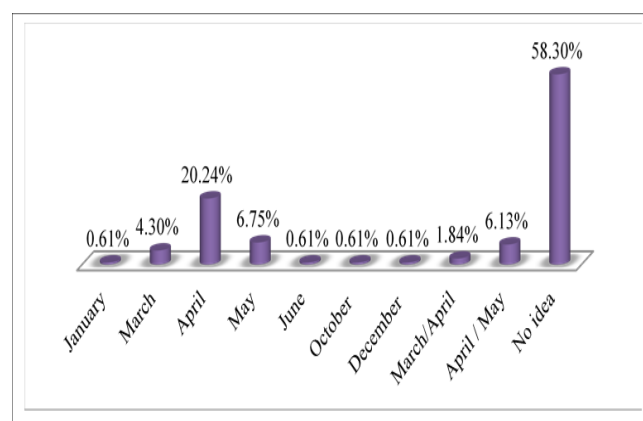


Figure 7: Harvesting period for *Morchella esculenta* (L.) Pers.

The difference in the harvest period can be explained by the different climatological elements that characterise each of the study areas. Mushroom collectors need to know all about the mushroom to harvest it at the right time in the species' development stage so that the mushroom retains its active ingredients and aromatic and therapeutic qualities.³⁶ And 58.30% of respondents have no idea about the harvesting season for this mushroom. Figure 8 shows that 40.49% of the respondents said that the mushroom *Morchella esculenta* can be found in the Bab Lakhmiss forest, especially under the oak trees. This is in line with the literature because mycorrhizal relationships are established between certain morel species and living trees, this enables them to produce organic matter and also makes some morels difficult to cultivate.³⁷

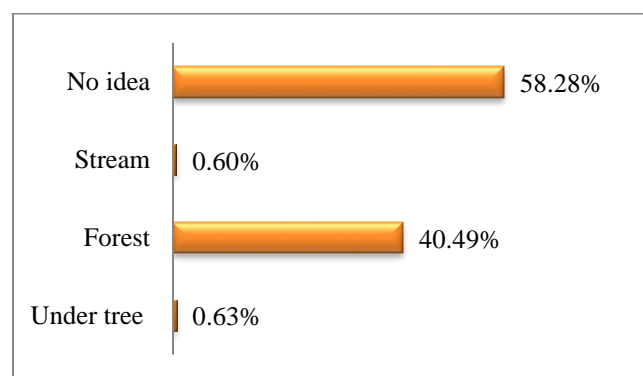


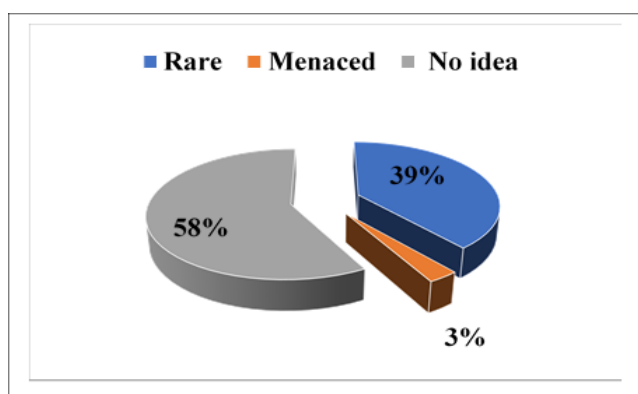
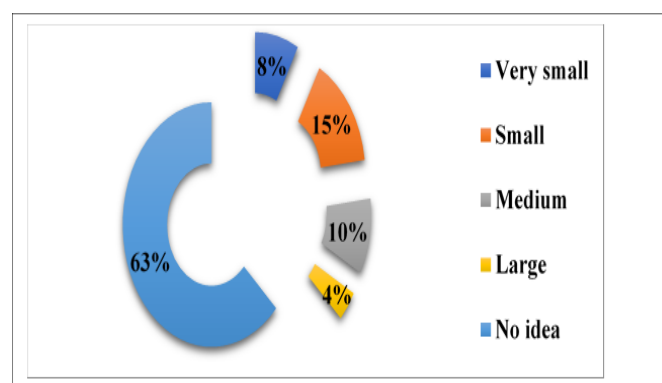
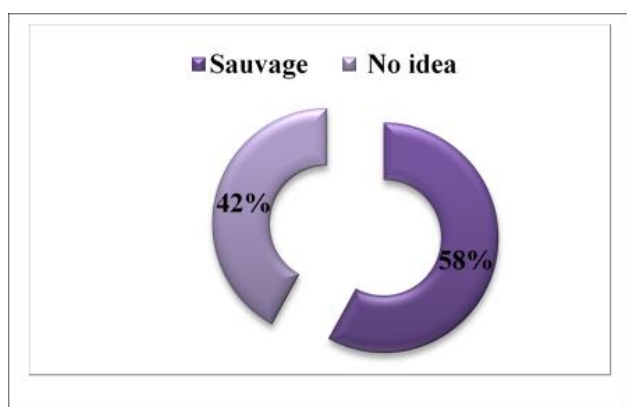
Figure 8: Harvesting locations for *Morchella esculenta* (L.) Pers.

Table 2: International vernacular names for *Morchella esculenta*

Country	France	Germany	Italy	Spain	Nepal	India
Common name	Morille	Speisemorchel	Spugnola bruna	Colmenilla	Guchi chyau	Guchhi

According to the inhabitants of Tamethrouste (a location very close to the Bab Lakhmiss forest), *Morchella esculenta* is found in massive quantities in the condensed areas of the forest and also on the less sunny slopes. For 39% of the population surveyed, *Morchella esculenta* is considered rare, which is the same description given by bibliographical research on morels,³⁸ while 3% consider it to be threatened (Figure 9), and it is a wild mushroom for 58% of the population (Figure 10), of which 15% have a small area covered by this mushroom (Figure 11). This is confirmed by the study carried out by Larson *et al*, which showed that morels represented 17.8% of each plot surveyed and that the maximum number of morels could reach 16 individuals per plot, given that each plot had an area of 3.14 m².³⁹ We also note that over 40% of the population have no idea about the status and type of mushroom, or how long it has been present.

has therapeutic value for diabetics and people with cardiovascular problems, for those who use the mushroom for therapeutic purposes, Table 3 provides more details on this use. The anti-diabetic activity of *Morchella esculenta* has been confirmed by the work of Zhang and his collaborators.⁴⁰ And 0.61% of respondents use the mushroom in animal feed. We found that *Morchella esculenta* is not widely used in Moroccan therapeutic practices, in contrast to the Chinese, Indian and Japanese populations, who consider morel mushrooms to be a natural source of therapeutic substances.¹ And also in Pakistan, the population uses edible mushrooms for therapeutic and other purposes, of which *Morchella esculenta* is considered to be the most widely used with a percentage equal to 28.42%.⁴¹ This difference in the importance of morels among the Moroccan population could be explained by the rarity of this type of mushroom, in addition to the wealth of medicinal plants

**Figure 9:** Mushroom status**Figure 11:** Area covered by *Morchella esculenta* (L.) Pers.**Figure 10:** Mushroom type

By analysing the section of the survey devoted to the use of the mushroom, we tried to find out if and how the respondents used *Morchella esculenta* (L.) Pers. The results are presented in Figure 12 and show that 31.3% of the population does not use the mushroom, and only 4.3% of the population includes *Morchella esculenta* in their diet. The latter group eats *Morchella esculenta* fresh or roasted over an open fire but in very small quantities. Others use morels in vegetable dishes, or they are sun-dried and then ground and the powder is added to salads as a kind of seasoning. 1.22% of respondents said that this mushroom

in Morocco and very reasonable prices compared to the purchasing power of the population.²⁰⁻⁴² A study carried out by Nitha and his colleagues on the ethanolic extract of the cultured mycelium of *Morchella esculenta* showed that it has significant potential to inhibit acute and chronic inflammation. The extract also showed significant antitumor activity against solid tumours induced by Dalton's lymphoma ascites (DLA) cell line and ascites tumors induced by the Ehrlich ascites carcinoma (EAC) cell line in mice, which encourages the use of aqueous-ethanolic extract of morel mycelium in chemotherapy.⁴³ The economic aspects and prospects of *Morchella esculenta* were also evaluated in this study. Although, this mushroom is not fully integrated into the culinary habits and therapeutic practices of the population of the province of Taza, Morocco, according to the morel mushroom collectors in the commune of Maghraoua, this mushroom is a seasonal source of income for them. The selling price of the mushroom varies between 30 and 60 DH/kg, equivalent to 2.74 and 5.48 €/kg (the price varies according to demand and availability of the mushroom), which represents an income of up to 3000 DH/collector during the harvest season (equivalent to 274.58 €/collector), with several kilograms collected and sold approximately equal to 60 kg. Mushrooms are generally collected by men, with a small proportion of women. In comparison to the results with the results of a survey carried out by Sayeed and his colleagues in India, which showed that the price of dried morels varied between 310 and 620 dollars per kilogram,⁴ showed a very large gap between the economic value of morels in the two countries, which may be due to the Moroccan population's ignorance of the benefits and economic value of the mushroom. According to the

collectors/sellers, there is only one local buyer in the region who acts as an intermediary (wholesaler) between the mushroom collectors and a buyer in Marrakech (who uses morels in dishes in his restaurant). On the other hand, the morel mushroom collectors in the state of Michigan (USA) have several options for selling their morels, for example: in the farmers markets (46%), regional grocery stores (19%), local restaurants (62%), pubs and bars (62%), informal sales to friends (62%), online sales (19%).⁴⁴ This shows that the morel market sector needs to be better structured and developed. For 20% of respondents, regional demand for morels can be considered low, while for 25% and 33%, national and international demand is zero respectively (Figure 13).

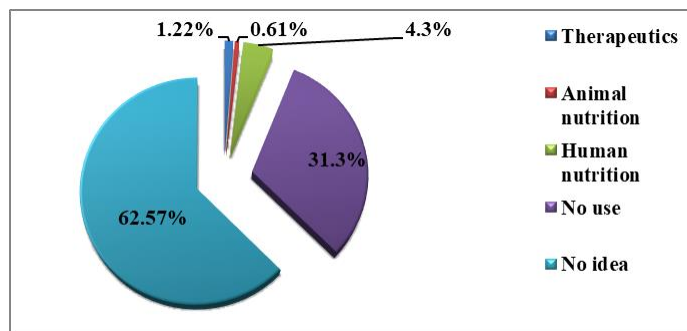


Figure 12: Uses of the mushroom by the population

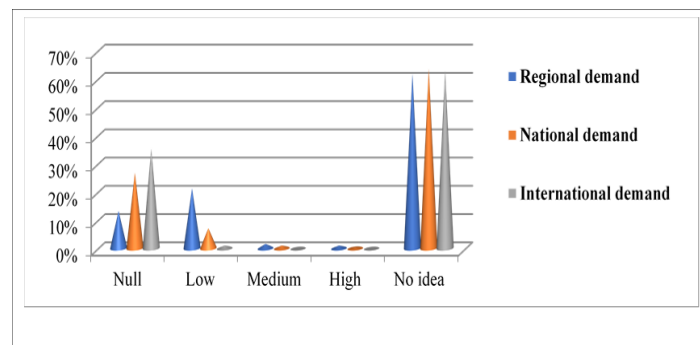


Figure 13: Local, national and international demand for *Morchella esculenta*

The study, therefore, shows that the distribution circuit in the Taza region is a short-circuit because it is limited to the collectors, with a single local wholesaler, who is also the distributor and finally to the consumer who is located in a single corner of Morocco. In comparison, to the economic value of morels in Morocco and that of other European and Asian countries, it is clear mushrooms are not valued in Morocco. In China, for example, annual exports of dried morel morels increased from 181 000 kg to 900 000 kg between 2010-2015, at an average price of US\$160 US dollars per kg.³

Table 3: Therapeutic uses of *Morchella esculenta* (L.) Pers

Part used	State of the mushroom	Drying method	Form of employment	Method of preparation	Method of administration	Dose used	Dosage	Duration of use
All the mushroom	Dried	Drying in the sun	Powder	Mixing mushroom powder with honey	Oral	Pinch	1 to 2 times a day	Until recovery

And also, in western Nepal wild morels are exported in large quantities, accounting for more than 50% of all morels harvested in the Karnali province.⁴⁵ This demonstrates the economic undervaluation of morels in Morocco and the need to develop this sector by moving from collection to marketing at the national level and also for export. The current situation can be explained by the irregularity in the rate of the annual mass collected, which is due to climatic changes and in particular the lack of rainfall in recent years, as well as the sensitivity of the morel, which is easily damaged and rots. This last problem can be avoided during collection and storage by using well-ventilated bags, such as those made from the *Chamaerops humilis* plant, which grows abundantly in the Taza region: "Basket in Doum",³⁰ *Chamaerops humilis* is widely used in traditional phytotherapy in the Taza region and its potential has been confirmed by studies carried out by the Laboratory of Natural Substances, Pharmacology, Environment, Modeling, Health & Quality of Life (SNAMOPEQ).²⁷⁻⁴⁶ In addition, care must be taken when storing morels on the forager's premises before sale; they must be stored in dry, well-ventilated, dark places and temperature fluctuations must be avoided, as these can alter the nutritional and organoleptic quality of the mushrooms, making them difficult to market.⁴⁷ Income from the collection and commercialization of this type of mushroom can be improved by supporting associations.⁴⁸ Collectors/sellers must also be trained and certified as collectors/sellers of wild edible mushrooms, as is the case in the State of Michigan in the United States.⁴⁴ This would encourage young rural people to get involved in the development of the mushroom industry in the mushroom collection area (Maghraoua), which is rich in several species of edible mushrooms, as well as the need to take into account the conditions of harvesting, storage and marketing to preserve the quality of the mushrooms and, consequently, their economic viability.

Conclusion

The ethnomedicinal and socioeconomic survey carried out during the present study on *Morchella esculenta* (L.) Pers. wild in the province of Taza, Morocco, showed that this mushroom is known by the vernacular name Gourecele among the local population under the popular name of Gourecele, which can be considered unknown because it is very little integrated into the culinary habits and therapeutic practices at the level of the local population. However, the survey showed that the harvesting and marketing of *Morchella esculenta* is an important seasonal economic source for the local population, providing a significant seasonal income (3000 MAD/274.58 € per collector) and its price reaches 60 MAD/5.48 € per kg. This economic activity could be improved by an associative framework that takes into account the harvesting, storage and marketing conditions to preserve the organoleptic, nutritional and therapeutic qualities, and therefore the economic value, of *Morchella esculenta* (L.) Pers. In addition, there is also a need for further pharmacological studies to evaluate the biological activity of *Morchella esculenta* (L.) Pers. from Taza, which could be a source of therapeutic substances. Similarly, *in vitro* and *in vivo* toxicity studies can be carried out to ensure the safety, as well as the nutritional potential of this mushroom to encourage the population to make use of its benefits. Our literature search revealed that this is the first survey on the ethnomedicinal and socio-economic potential of *Morchella esculenta* in the Taza Province of Morocco.

Conflict of Interest

The authors declare no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

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