How to Preserve White Truffles from the Orientale Region

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Article

How to Preserve White Truffles from the Orientale Region

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Abstract: The preservation of truffles is one of the major problems facing this quality product of the Moroccan terroir. The aim of the present work is to contribute to the development of certain conservations techniques for white *terfess* (*Tirmania nivea* and *Tirmania pinoya*) from the eastern region. Various preservation methods are used : air drying, steaming at different temperatures in whole and sliced form, autoclaving at varying temperatures and pH levels, as well as in a sodium chloride solution with citric acid, freezing, powdering, jamming, to give an idea of their advantages. The major drawback is shelf life. The processes for preserving carpophores in the form of oven slices, freezing, powder or jam show very satisfactory results. Organoleptic assessment by tasting has also produced acceptable results for oven-dried tench and freezing methods.

Keywords : White Truffles; *Tirmania nivea*; *Tirmania pinoya*; eastern Morocco; conservation

Introduction

The truffle industry is one of Morocco's top products. Terfess are edible ascomycete mushrooms native to the desert, with a symbiotic mycorrhizal association that looks like tubers and thrives in favorable climatic conditions.

The terfess provides a very special biological association, playing a very important role in fragile ecosystems. Mainly herbaceous or shrubby plants (annual or perennial) of the Cistaceae family, belonging to the *Helianthemum* and *Cistus genera* [1–12]. But also with some forest plant species [13–15].

They show an astonishing adaptation to desert conditions, mitigating desertification thanks to their xerophytic host plants. Its geographical distribution is mainly in arid and semi-arid regions around the Mediterranean basin (North Africa and southern Europe) and in the Middle East [4,5,9,13,16–27].

Host plants play an important role in preserving vegetation cover, thus preventing erosion and desertification [28].

High productivity is present in Mediterranean countries, particularly in North Africa and most Middle Eastern countries. It is also highly appreciated by the local population, as well as worldwide. Whatever the Terfez species, it reflects the edible and highly sought-after hypogeous mushroom; considered a luxury foodstuff [29].

Their popularity is due to their taste and nutritional value. Their chemical composition has been the subject of numerous studies showing their richness in proteins, amino acids, fibers, fatty acids, minerals and carbohydrates etc. [30–38].

Among the special features of the terfez are its strange isolation in a littleknown environment, its rarity, the very low quantity harvested, the difficulty of accessing truffle-growing areas and its high price both nationally and internationally. Their gastronomic value is reflected in their richness in proteins, lipids, carbohydrates, minerals, amino acids, fatty acids and vitamins, etc. Their

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nutritional and medicinal values have been known since antiquity and appreciated by the Greco-Roman populations who imported them from Tunisia and Libya, where they were widely traded and consumed.

Their therapeutic properties and extracts have been used for centuries in traditional Arab medicine to treat certain eye ailments and hair loss [40]. They are also an untapped source of therapeutic compounds with anti-inflammatory, immunosuppressive, antimutagenic and anti-carcinogenic properties [41], antioxidant properties [38,42,43], enzymes of medical and industrial interest [44], antimicrobial activities [45–52], antiviral, hepatoprotective and immunostimulant activities, their use in traditional biotherapy has been known since antiquity.

The major constraints encountered with these edible fruiting bodies are conservation, but also preserving as much as possible of their gustatory and culinary qualities.

Terfess is of great socio-ecological interest in arid and semi-arid regions, promoting good prospects for social and economic development in a region characterized by a difficult environment and scarcity of natural resources.

Methods and Results

This part was based on biochemical and/or chemical analyses applied by [39]. to white terfez (*genus Tirmania*), red terfez (*genus terfezia boudieri*) and black terfez (*genus Picoa Junniperi Viittadini*) in the eastern region.

Table 1. Nutritional characterization of harvested terfez - values are expressed in (%) of fresh matter.

Dosages	**Types of terfez**		
	White	**Red**	**Black**
(%)			
Water	68	75	77
Dry matter	38	25	23
Protein	1,9	1,7	1,2
Lipids	1	1	0,35
Sugars	8,5	5,1	2,1
Ash	1,4	1,8	2,1
(µg. g$^{-1)}$			
N**	640	125	391
P*	3,46	1,58	2,54
K***	28,9	28,1	32,8
Ca***	25,4	14,9	146,8
Mg***	24,4	20,3	25,6
Na***	13,7	8,4	10,7
NO_3^{-*}	00	00	00
NH_4^{+*}	1280	425	78

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Truffe Size Measurement

Photo 1. Truffle sampling

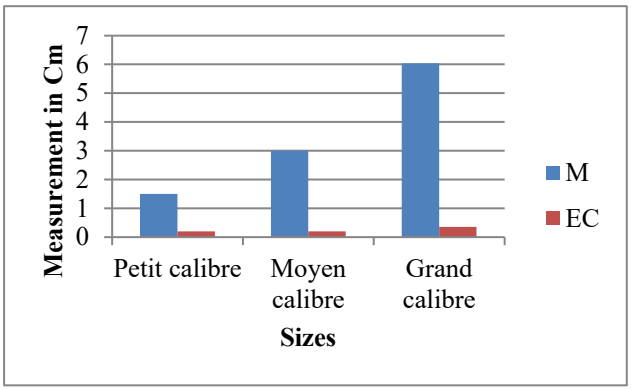

Figure 1. Size measurement

Small gauge > 1.7cm-2cm

Medium size >3-4cm

Large size>5cm-7cm

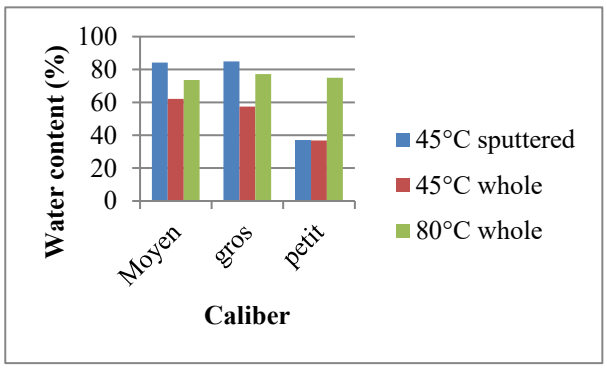

Figure 2. Water content

Water Content

For the most part, our results are in line with literature averages, with 60% water content. According to Alais and Linden, 1987, hydrated foods have a water content approaching 95%, e.g. lettuce: 94%; tomato: 93%; milk: 87% and mutton is around 60%. For the most dehydrated foods, this content can drop to less than 10%. For example, wheat seeds: 14%, bean seeds: 12% and soybeans: 8%.

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The Different Types of Preservation

1. **In the open air**

After 3 days in ambient air, the crop is completely infested. So it's this method of storage that is easily infected and ends up rotting after a few days. (**Photo 2**)

Photo 2. Sample in the open air after storage at room temperature

2. **Oven at 45°C**

Photo 3. Peeled and whole carpophores in the oven

Samples of large and medium-sized whole and sliced products are steamed for 3 days at 45°C. Peeled and whole products are then placed in plastic bags under anaerobic (vacuum) and aerobic conditions.

Peeled carpophores are placed in hermetically sealed bags (anaerobic conditions), and under aerobic conditions are highly resistant to decay. Even after 4 years, they remain visually intact and free from rot. Whereas whole carpophores susceptible to rot are attacked by fungi after 1 month for hermetically sealed bags (anaerobiosis) and 2 weeks for aerobic bags (simple sealing).

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A B

Photo 4. Sliced carpophores after 3-day drying at 45°C (anaerobic: A and aerobic:B)

Whole aerobic

Whole anaerobic

Photos 5 and 6. Whole carpophores after drying for 3 days (aerobiosis and anabiosis)

3. **Oven at 80°C**

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Photo 7. Preservation of white terfess slices after steaming at 80°C for 48 hours

The sliced truffles are stored in plastic bags under aerobic conditions. Those in anaerobic conditions are so far intact to the naked eye.

4. Autoclave in aqueous media

Photo 8. Sample autoclaved at different PH levels

Photo 9. pH and different temperatures

Preservation at an acidic pH but at different temperatures shows that truffles can be preserved over a long period of time, with different efficacy. In fact, samples can be kept for up to 15 months.

We can therefore conclude that samples at any pH level and at 100°C are best preserved for up to 15 months. Followed by samples at temperatures of 80°C, which have a shelf life of 1 year.

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Those at 60°C are the last with 9 months. The lower the temperature, the more carpophores stored under these conditions are susceptible to attack, whatever the acid pH used.

5. NaCl + citric acid solutions



Photo 10. NaCl + citric acid solutions

In this experiment, we can see that shelf-life is 17 months at a temperature of 100°C, while those at 80°C and 60°C are around 1 year. It can also be seen that preservation with a NaCl/citric acid solution lasts up to 17 months at a temperature of 100°C, compared with other temperatures. Contamination is rare, unless errors are made in applying the process.

6. Freezing



Photo 11. Freezing at -20°C

Samples stored in boxes and sachets have a long shelf-life of over 3 years, keeping their original appearance intact and avoiding endogenous and exogenous contamination.

7. Powder

Oven dried at 80°C for 3 days, then ground into small pieces using a pestle and mortar, and finally electrically ground. The powder is still preserved even after several years. (**Photo 12**)

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Photo 12. Terfess preserved in powder form

8. Processing into jam

Photo 13. Truffles in jam

The jam jars have a caramelized, sweet taste and keep for over a year.

9. Aqueous extraction

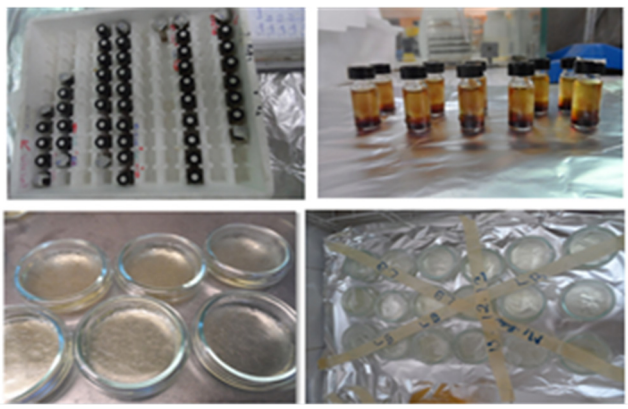

Photo 14. Aqueous extraction of truffles

Discussion

The results show that the three terfez varieties have a water content ranging from 68 to 77%. In the literature, the water content of the carpophores of different terfess species has been found to range from 78 to 81% of their fresh matter [30,31,53–55].

In all three terfess species, dry matter is between 23 and 32% and protein content between 1.2 and 1.9%. Compared with other foods: beef: 17%; chicken meat: 21%; chicken eggs: 13%; cow's milk:

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3.5%; lettuce: 1.2%; soya beans: 35%; soft wheat grains: 11.5%; oranges: 1%; lentils: 26%; sunflower seeds: 30% and potatoes: 9% [56]. According to Ashour et al. 1981, Terfezia boudieri has 9 essential amino acids, while Terfezia claveryi has 10 [57].

The lipids obtained by [39] are 0.35 and 1%. Fatty acids are present in terfess at relatively low levels of 2 to 2.5% of dry matter [33,54,55,58].

According to [56] ; of certain foods beef meat: 20; chicken meat: 8; chicken eggs: 12; cow's milk: 3.9; lettuce: 0.2; soya beans: 18; soft wheat grains: 1.5; oranges: 0.2; lentils: 1; sunflower seeds: 45 and potatoes: 0.4.

Comparison with the values found for white terfess sugars: 8.5%; red: 5.1% and black: 2.1%. Certain foods beef: 0.5; chicken eggs: 0.6; cow's milk: 4.8; lettuce: 3; soya beans: 30; soft wheat grains: 68; oranges: 9; lentils: 56; sunflower seeds: 22 and potatoes: 82 [56].

Carbohydrate levels generally vary between 16 and 28% of dry matter: 16.66 in *Terfezia claveryi*; 21.53 in *Tirmania nivea*; 24.87 in Tirmania pinoyi [59] and 28% in *Terfezia claveryi* [33].

Visual observations show that anaerobic and aerobic storage in the open air by steaming whole products does not prevent the development of carpophore rot. As a result, the high water content of terfess facilitates the manifestation of spoilage, whether endogenous (browning, rancidity, putrefaction, etc....) or exogenous (rotting due to fungal, mould and bacterial attack).

However, terfess dried in slices or sterilized by autoclaving (different pH and NaCl/citric acid solution), powdering, jamming and freezing appeared to be free from infection. These results are confirmed by those found by [39]. Finally, it can be seen from the results that freezing is the best preservation method, and from a phenotypic point of view, it gives good texture and taste.

Desiccation seems to preserve protein and sugar content, due to its efficiency and speed. The decrease in mineral content may be linked to the difficulty of extracting certain mineral elements from very firm material.

Preservation in powder form and desiccation does not bring any real improvement in the state of preservation, but it does have certain advantages over preservation in the whole state, leading among other things to the presentation of goods that are more manageable forconsumption when preparing certain specific dishes.

Conclusion

The white terfess harvested in the eastern region has two species belonging to the Tirmania genus: Tirmania pinoyi and Tirmania nives. Harvesting takes place from mid-January to the end of April. The high content of carpophores makes them difficult to preserve. The preservation methods we have used show both advantages and disadvantages in preserving the nutritional quality of terfez.

Our contribution aims to exploit harvests and enhance the value of this local product against rot and damage, by making the product available over a longer period of the year. Tests have shown that postharvest conservation is very delicate due to the fragility of terfez in the open air.

The choice of preservation methods depends on the process used : sterilization by autoclave, freezing, drying by steaming of sliced or powdered samples, and jam appear to be suitable preservation methods. The product's destiny is decisive in the choice of preservation methods.

This local product deserves further study for each technique's effect on preserving nutritional quality, duration and handling. As for the different preservation processes used, tasting tests clearly show that freezing appears to be the best preservation process, preserving at least taste and color.

What's different about powdered truffles is the drying process : the naked eye will notice a change in color due to the temperature. In the case of jam, the sweet taste predominates.

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