



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

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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 desertificat-

ion [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 little-known environment, its rarity, the very low quantity harvested, the difficulty of accessing truffle-growing areas and its high price both nationally and internationally [39]. Their gastronomic value is reflected in their richness in proteins, lipids, carbohydrates, minerals, amino acids, fatty acids and vitamins, *etc.* Their 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, antioxidant properties, enzymes of medical and industrial interest, antimicrobial activities, antiviral, hepatoprotective and immunostimulant activities, their use in traditional biotherapy has been known since antiquity [38,41-52].

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 Bouziani (2009) to white terfez (*genus Tirmania*), red terfez (*genus terfezia boudieri*) and black terfez (*genus Picoa Junniperi Viittadini*) in the eastern region (Table 1) [39].

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
NO3-*	0	0	0
NH4+*	1280	425	78

Truffle size measurement

Truffle sampling and size measurement (Figures 1 and 2).



Figure 1: Truffle sampling.

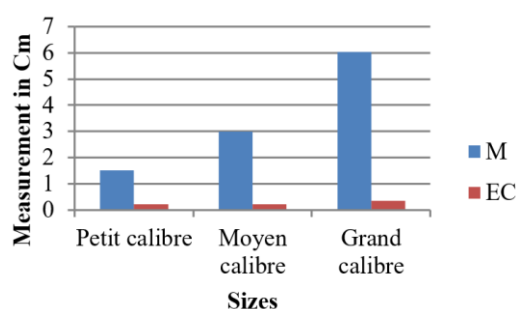


Figure 2: Size measurement. Small gauge >1.7 cm-2 cm; Medium size >3 cm-4 cm; Large size >5 cm-7 cm.

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% (Figure 3).

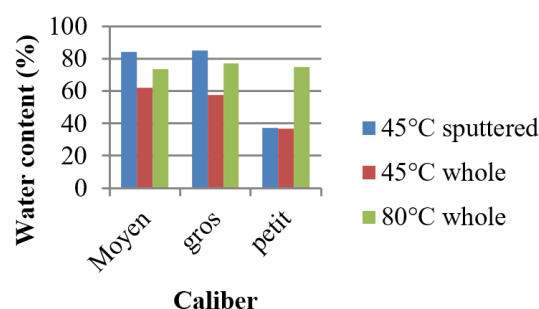


Figure 3: Water consent.



The different types of preservation

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 (**Figure 4**).



Figure 4: Sample in the open air after storage at room temperature.

Oven at 45°C

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 (**Figure 5**).



Figure 5: Peeled and whole carpophores in the oven.

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) (**Figures 6 and 7**).

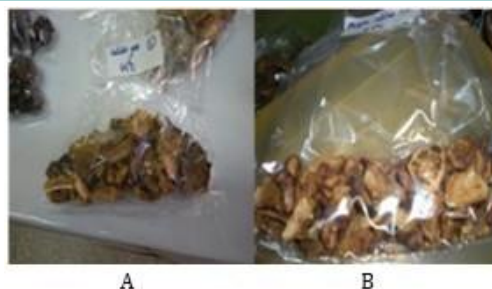


Figure 6: Sliced carpophores after 3-day drying at 45°C (A: Anaerobic and B: Aerobic).



Whole aerobic



Whole anaerobic

Figure 7: Whole carpophores after drying for 3 days (aerobiosis and anabiosis).

Oven at 80°C

The sliced truffles are stored in plastic bags under aerobic conditions. Those in anaerobic conditions are so far intact to the naked eye (**Figure 8**).



Figure 8: Preservation of white *Terfess* slices after steaming at 80°C for 48 hours.



Autoclave in aqueous media

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. 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 (**Figures 9 and 10**).



Figure 9: Sample autoclaved at different PH levels.



Figure 10: pH and different temperatures.

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 (**Figure 11**).



Figure 11: NaCl + citric acid solutions.

Freezing

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 (**Figure 12**).



Figure 12: Freezing at -20°C.

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 (**Figure 13**).



Figure 13: *Terfess* preserved in powder form.

Processing into jam

The jam jars have a caramelized, sweet taste and keep for over a year (**Figure 14**).



Figure 14: Truffles in jam.

Aqueous extraction

Aqueous extraction (**Figure 15**).



Figure 15: Aqueous extraction of truffles.

Discussion

The results show that the three *terfess* varieties have a water content ranging from 68%-77%. In the literature, the water content of the carpophores of different *Terfess* species has been found to range from 78%-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: 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 clavaryi* has 10 [57].

The lipids obtained by Bouziani (2009) are 0.35 and 1%. Fatty acids are present in *Terfess* at relatively low levels of 2 to 2.5% of dry matter [33,39,54-58].

According to Alais and Linden (1987); 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 [56].

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 clavaryi*; 21.53 in *Tirmania nivea*; 24.87 in *Tirmania pinoyi* and 28% in *Terfezia clavaryi* [33,59].

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 for consumption 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.

References

1. Awameh A, Alsheish M (1978) Laboratory and field study of four kinds of truffle (Kameh); *Terfezia* and *Tirmania* species, for cultivation. *Mushroom Science*: 507-517.
2. Alsheish M (1984) Mycorrhizae of annual *Helianthemum* species formed with desert. *Proceedings of the Sixth N Am Conf on Mycorrhizae*: 25-29.
3. Dexheimer J (1985) Comparison ultrastructural study of symbiotic mycorrhizal associations between *Helianthemum salicifolium* *Terfezia* Claveryi and *Helianthemum salicifolium* *Terfezia leptoderma*. *Canadian Journal of Botany* 63: 582-591.
4. Fortas Z (1990) Study of three species of terfez, cultural characteristics and cytology of the mycelium isolated and associated with *Helianthemum guttatum*. PhD thesis, University of Oran (Es-Sénia) and INRA Clermont-Ferrand.
5. Roth-Bejerano N, Livne D, Kagan-Zur V (1990) *Helianthemum-Terfezia* relations in different growth media. *New Phytologist* 114: 235-238.
6. Fortas Z, Chevalier G (1992a) Characteristics of ascospore germination of *Terfezia arenaria* (Moris) Trappe, collected in Algeria. *Cryptogamie Mycology* 13: 21-29.
7. Fortas Z, Chevalier G (1992b) Characteristics of ascospore germination of *Terfezia arenaria* (Moris) Trappe, collected in Algeria. *Cryptogamie Mycology* 13: 21-29.
8. Morte A, Honrubia M (1994) Patent no. P9402430. Madrid.
9. Khabar L (2002) Etude pluridisciplinaires des truffes du Maroc et perspectives pour l'amélioration de production des *Terfess* de la forêt de la Mamora.
10. Zitouni M (2010) Etude des associations mycorrhiziennes entre quatre espèces de terfez et diverses plantes cistacées et ligneuses en conditions contrôlées.
11. Slama A (2010) Biochemical composition of desert truffle *Terfezia boudieri* Chatin. *Acta Horticulturae* 853: 285-289.
12. Slama A, Gorai M, Fortas Z, Boudabous A, Neffati M (2012) Growth, root colonization and nutrient status of *Helianthemum sessiliflorum* Desf. *Saudi Journal of Biological Sciences* 19: 25-29.
13. Diez J, Manjon JL, Martin F (2002) Molecular phylogeny of the mycorrhizal desert truffles (*Terfezia* and *Tirmania*), host specificity and edaphic tolerance.
14. Chafi MEH, Fortas Z, Bensoltane A (2004) Bioclimatic survey of the terfez zones of the South West of Algeria and an essay of the inoculation of *Pinus halepensis* Mill. with *Tirmania pinoyi*. *Egyptian Journal of Applied Science* 19: 88-100.
15. Morte A, Honrubia M, Gutiérrez A (2008) Biotechnology and cultivation of desert truffles. In: Varma, A. (ed) *Mycorrhiza*: 467-483.
16. Awameh A, Alsheish M (1979) Mycorrhizal synthesis between *Helianthemum ledifolium*, *H. salicifolium* and four species of the genera *Terfezia* and *Tirmania* using ascospores and mycelial cultures obtained from ascospore germination.
17. Awameh A (1981) The response of *Helianthemum salicifolium* and *H. ledifolium* to infection by the desert truffle *Terfezia boudieri*. *Mushroom Science* 11: 843-853.
18. Alsheish M, Trappe J (1983) Desert truffles: The genus *Tirmania*. *Transactions of the British Mycological Society* 81: 83-90.
19. Alsheish M, Trappe J (1983) Taxonomy of *Phaeangium lefebvrei*, a desert truffle eaten by birds. *Canadian Journal of Botany* 61: 1919-1925.
20. Chevalier G, Rioussat L, Dexheimer J, Dupre C (1984) Synthèse mycorrhizae between *Terfezia leptoderma* Tul. and various *Cistaceae*. *Agronomie* 4: 210-211.
21. Fortas Z, Chevalier G (1988) Effect of growing conditions on mycorrhization of *Helianthemum guttatum* by three species of the genus *Terfezia* and *Tirmania* (desert truffles). 2ème Congrès International Sul Tartufo, Spoleto: 197-203.
22. Fortas Z (2009) Diversity of terfez (sand truffle) species from Algerian arid zones. Oran.
23. Bratek Z, Jakucs E, Szedlay G (1996) Mycorrhizae between black locust (*Robinia pseudoacacia*) and *Terfezia terfezioides* V. *Mycorrhiza* 6: 271-274.
24. Morte A, Lovisolo C, Schubert A (2000) Effect of drought stress on growth and water relation of the mycorrhizal association



- Helianthemum almeriense*-*Terfezia claveryi*. Mycorrhiza 10: 115-119.
25. Slama A (2006) Etude taxinomique de quelques Ascomycota hypogés (Terfeziaceae) de la Tunisie méridionale. Bulletin of the Society of Mycology of France 122: 187-195.
26. Mandeel QA, Al-Laith AA (2007) Ethnomycological aspects of the desert truffle among native Bahraini and non-Bahraini peoples of the Kingdom of Bahrain. Journal of Ethnopharmacology 110: 118-129.
27. Trappe J (2008) Desert truffles of the African Kalahari: Ecology, ethnomycology and taxonomy. Economic Botany 62: 521-529.
28. Honrubia M, Cano A, Molina-Niñirola C (1992) Hypogeous fungi from Southern Spanish semiarid lands. Persoonia 14: 647-653.
29. Bradai MN, Saïdi B, Enajjar S, Bouaïn A (2006) The Gulf of Gabès: a spot for the Mediterranean elasmobranchs. Turkish Marine Research Foundation: 107-117.
30. Al-Delaimy M (1977) Protein and amino acid composition of truffle. Journal of the Canadian Institute of Food Science and Technology 10: 221-222.
31. Bokhary HA, Bokhary MA (1987) Chemical composition of desert truffles from Saudi Arabia. California Institute of Science and Technology 20: 336-341.
32. Ahmed AA, Mohamed MA, Hami MA (1981) Libyan truffles "*Terfezia boudieri* Chatin": chemical composition and toxicity. Journal of Food Science 11: 927-929.
33. Bokhary HA, Parvez MS (1993) Chemical composition of desert truffles *Terfezia claveryi*. Journal of Food Composition and Analysis 6: 285-293.
34. Omer M (1994) The volatiles of desert truffle: *Tirmania nivea*v. Plant Foods for Human Nutrition 45: 247-249.
35. Hussain G, Al-Ruqaie IM (1999) Occurrence in chemical composition and nutritional value of truffles: overviewv. Pakistan Journal of Biological Sciences 2: 510-514.
36. Dabbour I, Takuri A (2002) Protein quality of four types of edible mushrooms found in Jordan. Plant Foods for Human Nutrition 57: 1-11.
37. Dabbour I, Takuri A (2002) Protein digestibility using corrected amino acid score method (PDCAAS) of four types of mushrooms grown in Jordan. Plant Foods for Human Nutrition 57: 13-24.
38. Murcia M (2002) Antioxidant activity of edible fungi (truffles and mushrooms): Losses during industrial processing. Journal of Food Processing 65: 1614-1622.
39. Bouziani M (2009) Contribution to the study and development of the truffle potential of the eastern region of Morocco Thesis Doc Sc Agro Univ Mohame 1er d'Oujda.
40. Haloubi A (1988) Plants of dirty and desert lands, as seen by the ancient Arabs; comparison of historical data with the classification of plants, their condition and their current distribution in the Near East.
41. Hannan MA, Al-Dakan AA, Aboul-Enein HY, Al-Othaimeen AA (1989) Mutagenic and antimutagenic factors extracted from a desert mushroom using different solvents. Mutagen 4: 111-114.
42. Pervez-Gilabert M, Sanchez-Felipe I, Garcia-Carmona F (2005) Purification and partial characterization of lipoxygenase from desert truffle (*Terfezia claveryi* Chatin) ascocarps. Journal of Agricultural and Food Chemistry 53: 3666-3671.
43. Al-Laith AA (2010) Antioxidant components and antioxidant/antiradical activities of desert truffle (*Tirmania nivea*) from various Middle Eastern origins. Journal of Food Composition and Analysis 23: 15-22.
44. Pervez MS, Gilabert M, Sanchez-Felipe I, Garcia-Carmona F (2005) Purification and partial characterization of lipoxygenase from desert truffle (*Terfezia claveryi* Chatin) ascocarps. Journal of Agricultural and Food Chemistry 53: 3666-3671.
45. Rougieux, R (1963) Antibiotic and stimulant actions of the desert truffle (*Terfezia boudieri* Chatin). Annals of the Institute Pasteur 105: 315-318.
46. Chellal M, Lukasova E (1995) Evidence for antibiotics in the two Algerian truffles *Terfezia* and *Tirmania*. Mycologia 50: 228-229.
47. Dennouni A (1996) Demonstration of antibacterial and antifungal activities in two species of Terfez from Algeria (*Tirmania nivea* and *Tirmania pinoyi*). Magister's thesis, University of Tlemcen: 97.
48. Mohamed Benkada M (1999) Extraction and isolation assay of antimicrobial principles from *Terfezia Claveryi* Chat. Thèse de Magister. Univ. D'Es-Sénia Oran: 81.
49. Janakat S, Al-Fakhiri S, Sallal AKA (2004) A promising peptide antibiotic from *Terfezia claveryi* aqueous extract against *Staphylococcus aureus* *in vitro*. Physiotherapy Research 18: 810-813.
50. Janakat S, Al-Fakhiri S, Sallal AK (2005) Evaluation of antibacterial activity of aqueous and methanolic extracts of the truffle *Terfezia claveryi* against *Pseudomonas aeruginosa*. Saudi Medical Journal 26: 952-955.
51. Fortas Z, Bellahouel-Dib M (2007) Extraction of bioactive substances from Algerian terfez and demonstration of their antimicrobial activity. Revue des Régions Arides 1: 280-282.
52. Neggaz M (2010) Tests of antibiotic properties from *Tirmania pinoyi* against bacteria and fungi. 2ème Colloque International en Biotechnologie Bio Tech World 29.
53. Abdalla S (1979) Studies on the nutritive value of Saudi truffles and the possibility of their preservation by canning. Proceedings of the 2nd Arab Conf Food Sci Technol 2: 369-376.
54. Al-Shabibi MMA, Toma SJ, Haddad BA (1982) Studies on Iraqi Truffles. I. Proximate Analysis and Characterization of Lipids. Canadian Institute of Food Science and Technology Journal 15: 200-202.
55. Sawaya WN, Al-Shalhat A, Al-Sogair A, Mohammad M (1985) Chemical composition and nutritive value of truffles of Saudi Arabia. Journal of Food Science 50: 450-453.
56. Alais C, Linden G (1987) Biochimie Alimentaire. Ed. Masson.
57. Ashour RA, Mohamed MA, Hami MA (1981) Mushroom science. Mushroom Science XI, Part II. In: Proceedings of the 11th International Congress on the Cultivation of Edible Fungi, Sydney, Australia.
58. Ackerman LGJ, Vanwyk PJ, Du Plassis LM (1975) Some aspects of the composition of the Kalahari truffle or N'abba. South African Food Review 2: 145-147.
59. Al-Naama NM, Ewaze JO, Nema JH (1988) Chemical constituents of Iraqi truffles. Iraqi Journal of Agricultural Sciences 6: 51-56.