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Effect of Different Treatment Processes and Preservation Methods on the Quality of Truffles: I. Conventional Methods (Drying/Freezing)

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Abstract: Two varieties of local truffles were blanched in 2 or 4% boiling salt solutions (NaCl) for 2 or 4 minutes or by dry salting and or spraying with 5% vinegar. The treated samples were dried in an oven at 110°C or were immediately frozen at -18°C and stored for one year. In conclusion, colour/texture/flavour were the best preserved by blanching in 4% boiling NaCl solution for 4 min. Freezing was superior to dehydration as a preservation method.

Key words: Truffles, blanched, preservation, drying, freezing, hedonic, organoleptic

Introduction

Truffles (Hypogeous ascomycetes or mycorrhizal fungi) are locally known as "Al-Kamaa or Al-Fag'a". In the United States of America (USA), truffles are also called black diamond (Garland, 1995). Truffles are a delicacy in Saudi Arabia and many other countries especially being an important ingredient of many favorite dishes in Middle Eastern families. These usually appear after the rainy season in the months of February to April in Saudi Arabia (Bokhary and Parvez, 1988). Truffles grow naturally in many parts of the world including the Middle East and North Africa. Among the various known truffle varieties, only two species of the dark brown colour truffles belong to the genus *Terfezia* i.e. Kamaeh or Khlassi (*Terfezia claveryi* and *Terfezia hafizi*) and one species of the white colour truffles belong to the genus *Tirmania* i.e. Zabide (*Tirmania nivea*) are found in the Arabian Peninsula (Al-Rahmah, 2001).

Growth of truffles depends on many factors such as rainy season and its timing, soil characteristics, water availability, and climatic conditions etc. The cost of truffles may reach as high as US \$ 55 kg⁻¹ in Saudi Arabia (Bokhary, 1987). The high cost might be due to the poor production of truffles in a certain season in country. Popularity of truffles is believed to be due to their nutritional value and delicious taste (Anonymous, 1973).

Most vegetables require a short heat treatment or blanching to inactivate enzymes and stabilize quality prior to long preservation processes. Halpin and Lee (1987) found that a gradual loss of green peas quality due to poor flavour in the long time/low temperature blanching. Shams and Thompson (1987) stated that moisture content did not change significantly during blanching but increased after canning. However, alcohol insoluble solids increased for all grain sizes of peas in each cultivar after blanching. Levi *et al.* (1988) observed degradation in non-blanched fruits, which resulted in low re-hydration capacity. Postmayr *et al.* (1956) found that heat processing affect both the texture and pectin content of the canned peaches.

Truffles, like other similar fresh vegetables, are considered a perishable commodity and need proper preservation to maintain shelf life. Due to high price and increasing demand for truffles, it is important to evaluate different methods of preservation for truffles to increase shelf life, maintain quality and taste for palatability. The present study was carried out to determine the effect of different preservation methods including heat, salt and vinegar alone and in different combinations on the quality and shelf life of local truffles.

Materials and Methods

The study was carried out at Nutritional Laboratory, Food Resources Programme at the Natural Resources and Environment Research Institute (NRERI), King Abdulaziz City for Science and Technology (KACST), Riyadh, Kingdom of Saudi Arabia during 1998-1999.

Experimental materials: Two well known varieties of truffles namely *Terfezia claveryi* (Khlassi) and *Tirmania nivea* (Zabide), commonly found in the sandy deserts, were collected from the local market for experimentation. The other materials included: NaCl solution (0, 2 and 4%), 5% vinegar solution and granules of NaCl.

The various combinations of different treatments were blanching and unblanching in boiling salt solution with and without vinegar, spray of salt granules with and without vinegar treatment. In case of control treatment, the product was evaluated without any treatment as fresh product. The equipment included are Advanced FG-220 forced convection oven, a chest freezer and other miscellaneous things required for experiment.

Description of truffles: Various local names are attributed but most commonly, it is known as "Al-Fag'a". The classic Arabic name for truffles is "Al-Kamae or Kameh" (Bokhary, 1987). *Terfezia* spp., by virtue of its blackish ascocarps are locally known as "Al-Kame-Al-Souda" and "Al-Kame-Al-Bunia" (Khlassi). *Phaeangium lefebvrei*, which is commonly known as bird truffle, has also other local names "Faga altoy" or "heberi" or "hober". This truffle is commonly eaten by birds in Kuwait (Al-Sheik and Trappe, 1983) and also in Saudi Arabia.

Ascocarps of truffles are generally hypogeous, i.e. potato like, with basal attachment. Fresh weight ranges between 101-173 g per ascocarps and is light brown to dark brown or blackish brown. Asci are variously shaped, double layered, haline, and thin walled with 2-8 spored (mainly 6-8 spored). The size of asci varied from 2500 - 5600 μm^2 (Bokhary and Parvez, 1988). Bencivenga and Urbani (1996) found the largest size truffle (white) that had a diameter of about 8 cm and weighed 236 g.

Preparation of truffles: Fresh truffles having uniform spherical shape (approximately; 4 cm diameter) were cleaned with distilled water to remove dirt particles, dried with ordinary tissue paper, peeled with a manual peeler to remove only the skin and then were cut into 1 cm thick slices with a manual slicer (an ordinary simple device used for peeling potatoes in the kitchen).

Preparation of testing material: The testing material contained the following ingredients.

Truffle = 1 kg.
Rice = 3 kg.
Water = 5 liters

Mixture of coriander, cumin seeds and cardamum in equal parts (250 g). Salt and red pepper according to the taste.

Corn oil = 1/4 liter.

Peeled onion = ½ kg

Automatic (electric) Rice Cooker with a capacity of 10 liters. One big spoon for stirring the mixture.

In a frying pan add oil, turn on the electrical heater, and heat it, then add onion and mixture (No. 4) and brown it. Now take the rice cooker, put water, truffles, brown mixture and rice (after cleaning and washing with ordinary water) into it. Turn on the cooker and set it to cooking. The recipe will be ready in about 30 min for evaluation.

Experiment 1

Blanching of truffles: a) Truffle slices were blanched in the boiling NaCl solution (0, 2 or 4%) for 2 or 4 min. One half portion of the treated samples was then soaked in 5% vinegar for 5 min at room temperature (25°C). The samples were properly marked, packed in sealed polyethylene bags and stored at -18°C for one year. Each treatment was replicated three times.

b) Truffle slices were blanched, salted and acidified as explained above were placed on trays (23 x 33 cm²), dehydrated in a circulating air drier at 110°C to a constant weight for about 24 h, packed in sealed polyethylene bags and stored in the laboratory at room temperature (25°C) for one year.

Experiment 2

Treatment of unblanched truffles: Truffle samples were treated according to the procedure as described in Part I (blanched truffles) except that the treatment solution was taken from the laboratory where room temperature of 25°C was maintained. Additionally, the samples were also treated with granules of common salt (NaCl) and vinegar spray alone and in different combinations. These included vinegar/salt granules separately, vinegar + salt granules, NaCl solution 2 or 4% + vinegar spray). This was done to determine the effect of different salt and vinegar treatments on shelf life and quality of un-blanched truffles with and without heat treatment as followed for food preservation under traditional methods. The preservation procedure for the final product regarding freezing and drying was the same as given in experiment 1a. i.e. freezing was at -18°C and stored for one year in polyethylene bags and dried at 110°C to a constant weight and stored for one year at 25°C.

Physical and chemical analysis: Moisture was determined in a drying oven (Memmert, KARL KOLB, D-6072 Dreiech, W. Germany) at 70°C. Protein was calculated from total nitrogen by multiplying it with a factor 4.38. Total nitrogen was determined by Kjeldahl method, fat was determined with a Soxtec apparatus (Tecator AB, Sweden) and crude fiber was determined by Fiber Tech. Ash was determined in a Furnace 30400, Thermolyne, USA. All the analyses were done in triplicates according to AOAC methods (Anonymous, 1999).

Measurement of organoleptic and hedonic properties: Sensory analyses of truffles were determined by a panel of 50 scientists from various disciplines from different Research Institutes, KACST. Samples of preserved truffles for one year in different experiments were provided to each scientist for evaluation after they were cooked and served with rice in a traditional way. Using a hedonic scale of five (Stone and Siedel, 1983) descriptive i.e. highly desirable (HD), mildly desirable (MD), neutral (N) [no-taste (desirable or undesirable)], mildly undesirable (MUN) and highly undesirable (HUN). Furthermore, the panel members were asked to grade the three characteristics: colour (40-points), texture (20-points) and flavour (40 points) for both types of truffles.

Statistical analysis: The data were subjected to analysis of variance (ANOVA) (Snedecor and Cochran, 1973).

Results

Analysis of truffles: The ranges for different food constituents were: 79.2-81.6% (moisture), 1.53-2.15% (crude fiber), 1.15-1.30% (ash), 4.61-8.32% (crude protein), 0.89-1.10% (crude fat) and 5.32-7.25% (carbohydrates). The level of all the food constituents was higher in Zabide truffles except crude protein which was appreciably low in Zabide than Khlassi truffles (Table 1). This difference in food constituents between the two types could be attributed to genetic variation, handling or storage conditions or various preservation techniques.

Organoleptic scoring of dried truffles: Depending upon different treatments, Zabide and Khlassi truffles blanched in 4% boiling NaCl solution for 4 min without vinegar scored higher points than all other treatments (Table 2). There was a significant (LSD 0.05 = 1.772 (Zabide), 7.209 (Khlassi) for 2 min and 1.563 (Zabide) and 5.997 (Khlassi) for 4 min) decrease in total score of Zabide and Khlassi truffles in high salt solution (4%) with vinegar. In other words, the vinegar treatment adversely affected the quality of treated product in particularly the flavour/taste. Therefore, it appears that preservation of truffles by drying could be better in salt solution alone without vinegar treatment. The colour of frozen truffles treated with vinegar became very dark after defrosting. Whereas, the colour of dried truffles was brown or less dark than frozen.

Hedonic testing of dried truffles: The scoring for the hedonic testing without vinegar treatment (Table 3), indicated the desirability level of the preserved product. The desirability evaluation was done based on total scoring in each category rather than overall total scoring for respected treatment. The Zabide truffle was mildly desirable according to 80% of the judges when blanched in 2% boiling salt solution. Without vinegar was very undesirable according to the judgement of 96% of the panel members when blanched in 4% boiling salt solution for 2 min. However, 95% of the panel members found it very desirable when blanched in 4% boiling salt solution for 4 min. The Khlassi truffle was found very desirable based on the evaluation of 96-100% of judges of panel. By blanching in either 2 or 4% boiling salt solution for 2 or 4 min, both the truffles could easily be preserved without vinegar treatment.

Zabide truffle was mildly undesirable (90% of the judges) when blanched in 2% boiling salt solution for 2 or 4 min (Table 3). The product was mildly desirable when blanched in 4% boiling salt solution for 4 min by 80% of the judges. Khlassi truffle showed poor response to the combined treatment of vinegar and salt solution as indicated by the low scoring except for blanching in 2% NaCl for 4 min. The product judgement ranged between neutral and mildly undesirable (by 90% of the judges) when blanched in either 2 or 4% boiling salt solution for 2 or 4 min except for the 2% salt blanched for 4 min. So preservation of truffles was quiet possible by treating with salt solution of different concentrations without vinegar.

Organoleptic scoring of frozen truffles: Both the truffles received high scores for acceptance when blanched in either 2 or 4% boiling salt solution for 4 min as compared with 2 min blanch

Table 1: Proximate analysis of food composition of Zabide and Khlassi

Parameters	Truffle varieties	
	Zabide	Khlassi
Moisture	81.6	79.2
Crude fiber	2.15	1.53
Ash	1.30	1.15
Crude Protein	6.58	11.9
Crude Fat	1.10	0.89
Carbohydrates	7.25	5.32

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Table 2: Organoleptic scoring of dried truffles

Blanched sample treatments	Salt conc.	Boiling time (min)	Total score			
			Colour 40 mean	Texture 20 mean	Flavour 40 mean	Total 100 mean
I-Without vinegar						
Zabide	0	2	20.05ab	19.64a	5.05e	44.74
	2	2	24.34ab	19.90a	30.04c	74.28
	4	2	29.50c	15.03c	29.56c	74.09
	0	4	25.33c	19.74a	25.19d	70.26
	2	4	34.67b	20.00a	40.00a	94.67
	4	4	39.34a	20.00a	39.00a	98.34
Khlassi	0	2	38.33a	20.00a	38.00a	96.33
	2	2	39.01a	20.00a	35.00b	94.01
	4	2	35.67b	20.00a	40.00a	95.67
	0	4	34.90b	19.55a	9.85bc	64.30
	2	4	38.66a	20.00a	38.00a	96.66
	4	4	40.00a	20.00a	40.00a	100.00
II-With vinegar						
Zabide	0	2	39.76a	19.74a	30.25c	89.75
	2	2	35.05b	19.03b	20.15d	74.23
	4	2	5.33e	9.87e	5.33e	20.53
	0	4	35.66b	20.00a	35.00b	90.66
	2	4	25.20c	19.55a	19.98d	64.73
	4	4	4.67e	10.05d	5.11e	19.83
Khlassi	0	2	38.91a	20.00a	38.00a	96.91
	2	2	30.07c	19.64a	20.31d	70.02
	4	2	20.51ab	19.75a	15.11ab	55.37
	0	4	39.94a	20.00a	40.00a	99.94
	2	4	25.33c	19.91a	35.21b	80.45
	4	4	15.05bc	14.96c	30.31c	60.32

Table 3: Hedonic testing of dried truffles

Blanched sample treatments	Salt conc.	Boiling time (min)	% of judgments				
			Very desirable	Mildly desirable	Neutral	Mildly undesirable	Very undesirable
I-Without vinegar							
Zabide	0	2	00	10	80	10	00
	2	2	50	80	15	00	00
	4	2	00	00	00	04	96
	0	4	05	05	04	34	52
	2	4	05	80	15	00	00
	4	4	95	05	00	00	00
Khlassi	0	2	05	05	03	32	55
	2	2	00	00	00	10	90
	4	2	95	05	00	00	00
	0	4	00	00	00	05	95
	2	4	00	00	00	05	95
	4	4	100	00	00	00	00
II-With vinegar							
Zabide	0	2	00	05	80	15	00
	2	2	00	00	00	90	10
	4	2	05	80	15	00	00
	0	4	00	05	80	15	00
	2	4	00	00	00	90	10
	4	4	05	80	15	00	00
Khlassi	0	2	05	80	15	00	00
	2	2	00	00	00	90	10
	4	2	00	05	80	15	00
	0	4	05	80	15	00	00
	2	4	80	20	00	00	00
	4	4	00	00	00	90	10

Figures followed by the same letters are not significantly different by LSD_{0.05}.

where the scoring was considerably lower (LSD_{0.05} = 2.692 for Zabide and 3.623 for Khlassi) (Table 4). This suggests that longer blanching in boiling salt solution might be required for the improvement of organoleptic properties of truffles.

The combined effect of salt solution and vinegar on organoleptic properties of Zabide and Khlassi truffles (Table 4) showed that both the truffles had low scores when blanched in either 2 or 4% boiling salt solution for 2 or 4 min (LSD_{0.05} = 3.446 for Zabide

and 4.693 for Khlassi). This indicated that the addition of vinegar might have adversely affected the taste and palatability. Overall, it appeared that preservation of truffles by freezing could be possible by first blanching in NaCl solution without vinegar treatment.

Hedonic testing of frozen truffles: Both the truffles were found very desirable by 98% of the judges when blanched in 4% boiling

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Table 4: Organoleptic scoring of frozen truffles

Blanched sample treatments	Salt conc.	Boiling time (min)	Total score			
			Colour 40 mean	Texture 20 mean	Flavour 40 mean	Total 100 mean
I-With vinegar						
Zabide	0	2	26.33c	19.67a	27.00c	73.00
	2	2	29.00bc	20.00a	32.67b	81.67
	4	2	30.33b	17.33b	33.00b	80.66
	0	4	28.33bc	19.67a	29.67cb	77.67
	2	4	36.33a	18.00b	38.00a	92.33
	4	4	38.33a	19.67a	37.67a	95.67
Khlassi	0	2	36.33ab	18.33a	30.67c	85.33
	2	2	33.67bc	16.33b	34.33bc	84.33
	4	2	31.67c	19.67a	34.33bc	85.67
	0	4	35.33bc	19.67a	16.33d	71.33
	2	4	34.67bc	18.67a	37.67ab	91.01
	4	4	39.33a	20.00a	39.67a	99.00
II-With vinegar						
Zabide	0	2	29.67a	14.67ab	19.00c	63.34
	2	2	18.67c	15.33ab	25.67b	59.67
	4	2	12.33c	14.33ab	10.67d	37.33
	0	4	28.67a	15.67a	32.33d	76.67
	2	4	19.33b	16.67a	30.00ab	66.00
	4	4	12.00c	11.33b	11.00d	34.33
Khlassi	0	2	34.67a	11.67c	32.00a	78.34
	2	2	28.67b	20.00a	21.33c	70.00
	4	2	19.33c	19.33a	24.33bc	62.99
	0	4	34.67a	15.00b	34.00a	83.67
	2	4	22.67c	20.00a	26.67b	69.34
	4	4	23.33c	18.33a	20.33c	61.99

Figures followed by the same letters are not significantly different by LSD _{0.05}.

Table 5: Hedonic testing of frozen truffles

Blanched sample treatments	Salt conc.	Boiling time (min)	% of judgments				
			Very desirable	Mildly desirable	Neutral	Mildly undesirable	Very undesirable
I-Without vinegar							
Zabide	0	2	85	11	3	1	0
	2	2	79	18	2	1	0
	4	2	73	21	5	1	0
	0	4	89	8	3	0	0
	2	4	75	15	8	2	0
	4	4	98	2	0	0	0
Khlassi	0	2	81	16	2	1	0
	2	2	83	12	3	2	0
	4	2	85	12	3	0	0
	0	4	74	17	7	2	0
	2	4	85	14	1	0	0
	4	4	98	2	0	0	0
II-With vinegar							
Zabide	0	2	66	19	11	3	1
	2	2	42	35	13	6	4
	4	2	56	31	12	1	0
	0	4	65	15	13	5	2
	2	4	38	34	22	4	2
	4	4	74	16	9	1	0
Khlassi	0	2	71	23	5	1	0
	2	2	48	35	14	3	0
	4	2	65	18	14	2	1
	0	4	63	13	15	5	3
	2	4	81	14	4	1	0
	4	4	58	16	15	6	5

salt solution for 4 min without vinegar. The scoring was slightly lower when blanched in 2% boiling salt solution (Table 5). The combined effect of salt solution and vinegar treatment on the level of desirability of Zabide and Khlassi truffles showed that both the truffles obtained low scoring when blanched in either 2 or 4% boiling salt solution for 2 or 4 min with vinegar (Table 5). However, vinegar treatment adversely affected the desirability according to 38-81% of the expert panel.

Treatment of unblanched truffles

I. Dried truffles

a. Organoleptic scoring of dried truffles: Dried Zabide truffles scored almost 100% marks when pre-treated with salt sprinkled without vinegar and when sprayed with vinegar and then sprinkled with granular salt (Table 6). Other treatments such as blanching in salt solution with and without vinegar spray scored very low marks and were rejected for evaluation. The response of

Table 6: Organoleptic scoring of dried truffles

Fresh sample treatments	Total score			
	Colour 40 mean	Texture 20 mean	Flavour 40 mean	Total
I-Zabide				
(Control)	39.67a	19.33a	39.33a	98.33
(Granules Salt sprinkled)	39.33a	19.67a	40.00a	99.00
(Vinegar + Salt Granules sprinkled)	39.33a	19.33a	39.00a	97.66
(Vinegar)	19.00b	17.67ab	28.00b	64.67
(2% NaCl + Vinegar Spray)	20.33b	12.00c	12.33d	44.66
(4% NaCl + Vinegar Spray)	18.67b	18.33ab	19.67c	46.67
(2% NaCl)	19.33b	15.67b	05.00e	40.00
(4% NaCl)	19.67b	20.33a	23.00c	63.00
II-Khlassi				
(Control)	39.00a	19.67a	39.67a	98.34
(Granule Salt sprinkled)	36.67ab	19.33a	39.00a	95.00
(Vinegar + Salt Granules sprinkled)	35.00b	19.67a	39.33a	94.00
(Vinegar)	08.33c	08.33c	07.00c	23.66
(2% NaCl + Vinegar Spray)	07.00c	17.67a	08.67bc	33.34
(4% NaCl + Vinegar Spray)	10.00c	14.67b	11.00b	35.67
(2% NaCl)	36.67ab	18.67a	38.00a	93.34
(4% NaCl)	35.00b	19.67a	39.00a	93.67

Table 7: Hedonic testing of dried truffles

Fresh sample treatments	% of judgments				
	Very desirable	Mildly desirable	Neutral	Mildly undesirable	Very undesirable
I-Zabide					
(Control)	98	2	00	00	00
(Granules Salt sprinkled)	95	5	00	00	00
(Vinegar + Salt Granules sprinkled)	89	9	02	00	00
(Vinegar)	02	7	82	06	03
(2% NaCl + Vinegar Spray)	00	0	05	15	80
(4% NaCl + Vinegar Spray)	02	7	82	06	03
(2% NaCl)	00	0	03	05	92
(4% NaCl)	00	0	07	85	08
II-Khlassi					
(Control)	96	03	01	0	0
(Granule Salt sprinkled)	68	28	04	0	0
(Vinegar + Salt Granules sprinkled)	87	11	02	0	0
(Vinegar)	76	16	08	0	0
(2% NaCl + Vinegar Spray)	83	05	02	3	7
(4% NaCl + Vinegar Spray)	88	07	05	0	0
(2% NaCl)	34	52	04	0	0
(4% NaCl)	04	83	11	2	0

Figures followed by the same letters are not significantly different by LSD_{0.05}.

Khlassi was quite different from that of Zabide. Dried Khlassi truffle scored highest when blanched in 2 and 4% boiling salt solution without vinegar and when sprayed with vinegar and sprinkled with salt. The scoring for other treatments was appreciably low and could not be accepted for application to preserve the unblanched truffles (LSD_{0.05} = 1.906 for Zabide and 3.307 for Khlassi). This indicated that unblanched truffles required different treatment for preservation and quality control.

b. Hedonic testing of dried truffles: Zabide truffle scored the highest when dry-salted without vinegar or dry-salted and sprayed with vinegar as compared with other treatments (Table 7). Likewise, Khlassi truffles scored the highest points (89-98% of the judges) when dry-salted with and without vinegar, vinegar spray alone and, blanched in 2 and 4% NaCl solution and then sprayed with vinegar. The scores for other two treatments were low although dried Khlassi truffles pre-treated blanching in 4% boiling NaCl solution were mildly desirable. The only other treatment such as 2 and 4% NaCl was mildly desirable (80% of the judges).

II. Frozen truffles

Organoleptic scoring: The organoleptic scoring was higher for frozen Zabide truffles sprinkled with salt and sprayed with vinegar than all other treatments (Table 8). In case of Khlassi truffles, the scoring was the highest for 2% NaCl blanching treatment without

vinegar spray (LSD_{0.05} = 2.686 for Zabide and 2.927 for Khlassi). The differential behaviour of both the truffles towards different treatments could be due to the difference in their chemical composition like elements present Ca, Na, Mg, K, etc., (Bokhary and Parvez, 1988).

Hedonic testing: Zabide truffles were found very desirable by 80-90% of the judges panel when pre-treated with dry salt and sprayed vinegar, respectively and were more desirable than those treated otherwise (Table 9). Khlassi truffles blanched in 4% boiling NaCl solution or treated with dry salt and vinegar spray were very desirable. The product was mildly desirable when blanched in 2% boiling NaCl solution without vinegar. The remaining treatments were not successful.

Discussion

Many methods are being applied for the preservation of different types of perishable food commodities to increase shelf-life and to accommodate off-season consumer's requirements. The production of truffles is very limited and require timely action to preserve it. The study found that the colour/texture/flavour were the best preserved by blanching in 4% boiling NaCl for 4 minutes. The research finding do not agree with those of Halpin and Lee (1987), who found a gradual loss of green peas quality due to poor flavour when blanched at low temperature for a long time.

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Table 8: Organoleptic scoring of frozen truffles

Fresh sample treatments	Total score			
	Colour 40 mean	Texture 20 mean	Flavour 40 mean	Total 100
I-Zabide				
(Control)	36.33a	16.67a	31.67a	84.67
(Vinegar + Salt Granules sprinkled)	36.33a	16.00a	27.67b	78.00
(Vinegar)	19.67c	18.33a	27.33b	65.33
(2% NaCl + Vinegar Spray)	21.33bc	14.33a	17.00cd	52.66
(4% NaCl + Vinegar Spray)	22.33bc	14.67a	15.67d	52.67
(2% NaCl)	24.00b	15.33a	20.00c	59.33
(4% NaCl)	20.67c	16.67a	24.67b	62.01
II-Khlassi				
(Control)	25.33a	16.67a	34.33a	76.33
(Vinegar + Salt Granules sprinkled)	34.00a	12.00b	29.33b	75.33
(Vinegar)	15.33c	15.33ab	15.33d	45.99
(2% NaCl + Vinegar Spray)	12.00d	16.67a	14.00d	42.67
(4% NaCl + Vinegar Spray)	11.67d	14.62ab	12.33d	38.62
(2% NaCl)	34.33a	17.33a	25.00c	76.66
(4% NaCl)	31.33a	16.00a	28.67b	76.00

Table 9: Hedonic testing of frozen truffles

Fresh sample treatments	% of judgments				
	Very desirable	Mildly desirable	Neutral	Mildly undesirable	Very undesirable
I-Zabide					
(Control)	96	4	0	0	0
(Granules Salt sprinkled)	90	5	5	0	0
(Vinegar + Salt Granules)	80	6	10	5	0
(Vinegar)	0	0	20	35	45
(2% NaCl + Vinegar Spray)	0	0	0	52	48
(4% NaCl + Vinegar Spray)	0	0	0	57	43
(2% NaCl)	0	0	1	29	67
(4% NaCl)	0	0	10	26	64
II-Khlassi					
(Control)	97	3	0	0	0
(Granule Salt sprinkled)	4	12	76	7	1
(Vinegar + Salt Granules)	85	13	2	0	0
(Vinegar)	0	0	0	29	71
(2% NaCl + Vinegar Spray)	0	0	0	24	76
(4% NaCl + Vinegar Spray)	0	0	0	22	78
(2% NaCl)	6	82	12	0	0
(4% NaCl)	98	2	0	0	0

Figures followed by the same letters are not significantly different by LSD_{0.05}.

Levi *et al.* (1988) observed degradation in non-blanching fruits, which resulted in low re-hydration capacity. Whereas, Postmyer *et al.* (1956) found that heat processing affected both the texture and pectin content of the canned peaches. This could be attributed to the difference in the food type and chemical composition of each vegetable/fruit. Freezing was superior to dehydration as a preservation method. Although not much has been accomplished on the preservation of truffles yet FAO/WHO (1973) advocated the popularity of truffles due to their nutritional value and delicious taste, and emphasized for their preservation. Dried and frozen Khlassi truffles blanched in 4% boiling salt solution for 4 min scored 100 points for colour/texture/flavour whereas Zabide truffles scored 98 points. Blanching for 2 min. in 2 or 4% boiling salt solution was less effective for colour, texture and flavour retention. In general, soaking in vinegar and blanching for 2 or 4 minutes in salt solution did not preserve the quality of Zabide truffles. Vinegar treatment did not improve the quality of either truffle variety. Freezing appears to be more effective than drying in maintaining the quality of preserved products. Overall, blanching for 4 minutes in 4% salt solution and storage at -18°C was proved to be the best preservation method in terms of overall quality of the truffles for both the varieties.

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