

Effect of Packaging Methods and Storage Temperatures on the Quality of Erzurum Cheese Halva

Hayrunnisa ÖZLÜ¹, Meryem AYDEMİR ATASEVER^{2,*}, Sevda URÇAR GELEN², Mustafa ATASEVER²

¹ Ataturk University, Graduate School of Natural and Applied Sciences, Erzurum, Türkiye, hayrunnisa@atauni.edu.tr, ORCID: 0000-0002-5007-6121

² Ataturk University, Faculty of Veterinary Medicine, Department of Food Hygiene and Technology, Erzurum, Türkiye, meryematasever@atauni.edu.tr, ORCID: 0000-0003-2938-5808, surcar@atauni.edu.tr, ORCID: 0000-0002-1852-3614, atasever@atauni.edu.tr, ORCID: 0000-0002-1627-5565

ABSTRACT

Erzurum cheese halva is a traditional food registered with a geographical indication with its own taste and flavor, which is produced with saltless fresh civil cheese, fresh cream and flour mixture. This study was conducted to investigate the changes in the physical, chemical and microbiological properties of Erzurum cheese halva in different packaging and storage temperature. The produced cheese halva samples were stored for two months in two different packaging methods (aerobic and vacuum packaged) and at three different storage temperatures (room temperature, +4°C and -18°C). Some microbiological, chemical, physicochemical and sensory analysis of cheese halva samples were investigated during storage period. Furthermore, the dry matter, ash, protein, fat, salt and aw contents of cheese halva samples were determined on the 0th day of storage. The most obvious sign of deterioration were moldiness on aerobic packaged samples both the room temperature and +4°C stored, and they were spoiled on the 10th and 15th day of storage, respectively. It was observed that the acidity has increased and consumability has decreased in vacuum packaged samples stored at +4°C. Although neither chemical nor microbiological deterioration occurred in the vacuum packaged cheese halva samples stored on -18°C, negatively affects in the fibrous structure of the product and reduces the overall acceptability of the product. For this reason, future studies must be carried out that is necessary to search for more suitable packaging methods (e.g. modified atmosphere packaging) to protect the product's typical textural structure during the shelf life.

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*Corresponding author

1. Introduction

Natural and economic conditions, religion, culture and traditions are effective in changing the foods consumed in human nutrition from country to country. [1-2]. The identification of a particular origin is a necessary but not sufficient condition to classify a product as traditional; thus, only some local products can be considered traditional. In this regard, traditional food products are defined as those "frequently consumed or associated with specific celebrations

and/or seasons, transmitted from one generation to another, made in a specific way according to gastronomic heritage, naturally processed, and distinguished and known because of its sensory properties and associated with a certain local area, region or country"[3-4].

Throughout Türkiye, each region, steeped in rich cultural and historical heritage, and boasting diverse geographical and ecological landscapes, embraces a plethora of traditional culinary delights. In Türkiye, the recognition of many

traditional foods is limited to the rural regions where they are produced. Consequently, due to urbanization, awareness of these foods is gradually diminishing among younger generations, leading to insufficient utilization of these traditional products, which possess significant potential for added value [5-6].

"Erzurum cheese halva," bearing a protected geographical indication, is a traditional delicacy exclusive to the Erzurum province. It was officially recognized as a geographical indication within the "Bakery and pastry products, pastries, desserts" category on July 16, 2021. This savory halva is prepared in copper boilers, using Erzurum civil cheese, wheat flour or whole wheat flour, milk cream, and salt. Its production is primarily concentrated during the summer months when milk is plentiful. Referred to as "hoses" in the region, Erzurum cheese halva distinguishes itself with its fibrous texture, attributed to the usage of fresh and unsalted civil cheese [7-8]. Erzurum cheese halva is mostly produced in villages and consumed by households. Furthermore, a small portion of Erzurum cheese halva production is undertaken by select businesses within the city, catering to the local market demand. Although cheese halva is known in Erzurum province of Türkiye, it is not well known throughout the country. There are many products called cheese halva made with cheese in various regions of Türkiye. Erzurum cheese halva stands apart from other cheese halvass due to its distinct lack of sweetness, as it contains no sugar. This unique characteristic extends to both its ingredients and preparation methods

Erzurum civil cheese, one of the main ingredients of cheese halva, is a local cheese produced from skim milk.. This product obtained a geographical indication certificate under the name "Erzurum civil cheese" in 2009. It is a local product with a salt-free, fat-free/low-fat, produced from cows' milk fed on the high-altitude pastures of Erzurum province [9]. The fibrous structure of Erzurum cheese halva is the most important textural feature of this product. For this reason, the civil cheese to be used in the production of cheese halva is not salted and is asked to be kept in the hanger for a longer time to gain a more fibrous structure and release its water thoroughly. In addition, the temperature at which the cheese is added into the halva is of great importance in order to form the desired fibrous structure in the cheese halva.

It is stated that standard production method cannot be provided in traditional products, new technologies cannot be used, capacities cannot be increased much and high efficiency cannot be achieved [10]. Due to the fact that the production of Erzurum cheese halva does not use standard production methods and does not provide hygienic conditions, there are differences in the colour, taste, smell and aroma of the product, which leads to negative effects on the quality of the product. On the other hand, the packaging used in cheese halva sold in the market negatively affects the consumer's perception that the product does not protect the quality parameters, thus reducing the interest in the product. It is very

important to determine an appropriate packaging method that will preserve the quality parameters, extend its shelf life and increase its appeal of traditionally produced Erzurum cheese halva during storage.

The geographical indication registration certificate of Erzurum cheese halva is states that the product should be stored at +4°C for a maximum of 10 days, and if longer storage is required, it should be frozen. However, they are offered for sale in the market under different packaging and storage conditions. For this reason, there is a need to standardize the packaging method and storage temperature that better preserve the microbial and textural properties of cheese halva during storage. In this study, the effects of different packaging methods and storage conditions of Erzurum cheese halva on the quality characteristics of the product were investigated. In addition, some chemical and microbiological properties of cheese halva obtained from the market were determined and compared with experimentally produced cheese halva.

2. Materials and methods

2.1. Materials

The cheese and cream used in production were provided by Atatürk University, Food and Livestock Application and Research Center.

In the production of halva, daily fresh cream, wheat flour and unsalted civil cheese, which was kept for about 4 hours after production to gain the desired stringiness (fibrousness) were used.

2.2. Methods

Erzurum cheese halva production was made based on the procedure obtained as a result of interviews and preliminary tests with local businesses and village producers (Figure 1).

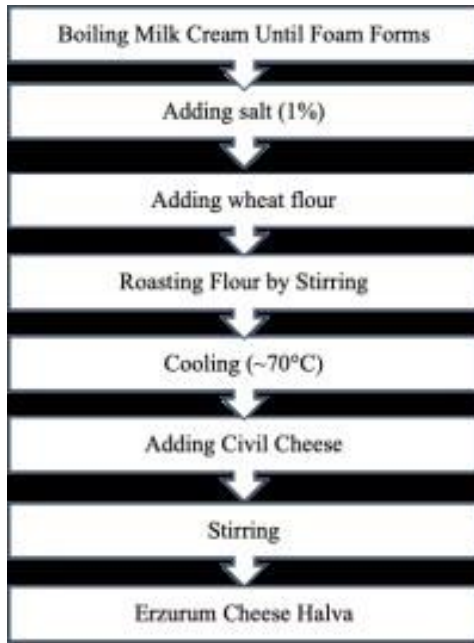


Figure 1. Production flow chart of Erzurum cheese halva

In order to determine the general properties of the produced Erzurum cheese halva, dry matter, ash, aw, protein, fat and salt analyses were performed on 0th day. The produced fresh cheese halva samples was packed under normal atmosphere and vacuum packaged. Packaged cheese halva samples were stored at $-18\pm 1^\circ\text{C}$, $4\pm 1^\circ\text{C}$ and room temperature ($24\pm 1^\circ\text{C}$) for 60 days. Microbiological, chemical, physicochemical and sensory analyzes of the samples were performed on the 0th, 5th, 10th, 15th, 30th, 45th and 60th days of storage.

In addition, cheese halvass sold in local markets in Erzurum were collected and some microbiological, chemical and physicochemical analyzes were performed.

2.3. Microbiological analyses

To determine the microbial quality of experimentally produced Erzurum cheese halva samples; total mesophilic aerobic counts (TMAB), total psychrophilic aerobic bacteria count (TAPB), lactic acid bacteria counts (LAB), coliform bacteria counts and total yeast and mold counts were determined on specific days of storage during storage the halvass at room, $+4^\circ\text{C}$ and -18°C temperature. TMAB, TPAB, LAB, yeast and mold counts were determined as log cfu/g using Plate Count Agar (PCA, Merck) (48 hours at 37°C), PCA (10 days at 7°C), de Man Rogosa and Sharpe (MRS, Merck) Agar (48 hours at 37°C , anaerobic conditions (5% CO_2)), Rose Bengal Chloramphenicol (RBC, Merck) Agar (5 days at 20°C) culture media, respectively. In addition, the

coliform group bacterial count of cheese halva samples obtained from local markets was determined using Violet Red Bile Agar (VRBA, Merck) (24 hours at $35\text{-}37^\circ\text{C}$) [11-12].

2.4. Chemical and physicochemical analyses

Dry matter and ash (gravimetric method), protein (micro-Kjeldahl method) and titratable acidity (% lactic acid) of Erzurum cheese halva samples were determined using the AOAC (2007) standard method [13]. Fat determination was made using the Van Gulik method [14]. The salt content of cheese halva samples was calculated using the Mohr method [15].

The aw values and the color values of Erzurum cheese halva samples were determined using a water activity device (Aqualab 4TE, USA) and a color measuring device, respectively. (Konica Minolta CR-400, Osaka, Japan). In color measurement, measurements were taken at 3 different points on the cross-sectional surface of the cheese halva; L^* ($L^*=0$, black; $L^*=100$, white; brightness/darkness); a^* ($+a^*$ = red, $-a^*$ = green; redness/greenness) and b^* ($+b^*$ = yellow, $-b^*$ = blue; yellowness/blueness) values were made three-dimensional measurements [16-17].

2.5. Sensory analyses

Sensory analysis was conducted by 7 panelists (between 25 and 55 age) in the Food Hygiene and Technology Department of Atatürk University, Erzurum, Turkey. The panelists were selected based on their interest, non-smoker and non-food allergic. Samples (15-20 g portions) were served in a plate along with bread and water. Plates were labelled with one-digit random codes. Each sample was evaluated using the hedonic scale (1-9) anchored on the left with 'dislike extremely' and on the right with 'like extremely'. Sensory evaluation was based on color, appearance, structure, taste/odor and general acceptability. The panelists were asked to evaluate the cheese halvass in terms of quality criteria and to indicate in writing the defects that caused the cheese halvass to decrease in score.

2.6. Statistical analysis

It was carried out using the IBM SPSS Statistics 20.0 package program according to variance analysis (ANOVA) method. Mean values were considered significant at $p < 0.05$ using the Duncan multiple comparison method.

3. Results and Discussion

Some chemical and physicochemical analysis results of Erzurum cheese halva samples after production were given in Table 1. Erzurum cheese halva is an important food for human nutrition because it contains high amounts of protein and fat [18].

Table 1. Some chemical and physicochemical analysis results of Erzurum cheese halva samples

Parameters	Mean±SD	Parameter	Mean±SD
Dry matter (%)	76.41±4.53	Protein (%)	16.25±1.18
Ash (%)	1.81±1.56	Fat (%)	28.85±3.15
aw	0.946±0.016	Salt (%)	1.17±0.12

The TMAB, TPAB, LAB and total mould-yeast counts of Erzurum cheese halva samples varied between 4.37-5.83, 1.71-4.17, 4.35-6.76 and 3.23-4.81 log cfu/g, respectively during of 60 days storage at different temperature (Table 2). There was a significant increase in the TAMB, TAPB, LAB and yeast/mould counts of experimentally produced cheese halva during storage period at +4°C and room temperature, both air and vacuum packing (p<0.05). When the microbial counts of samples differently packaged at the same temperature were examined, it was determined that vacuum packaging extended the shelf life of the product. It had no

effect on the storage time of cheese halva stored at -18°C (Table 2).

The results of the chemical and physicochemical analyses of Erzurum cheese halva during the storage period are given in Table 3. The dry matter content, fat content, pH, titratable acidity, and aw values of the analyzed samples varied between 74.16 -79.98 g/100 g, 22.50-30.50 g/100 g, 3.55-5.55, 0.22-0.42 g/100 g, 0.9329-0.9616, respectively during of 60 days storage at different temperature.

Table 2. Microbiological properties of Erzurum cheese halva samples during the storage period (log cfu/g)

Packaging- Storage temperature	Storage time (day)							
	1	5	10	15	30	45	60	
TAMB	-18 VP	4.47±0.27	4.52±0.08c	4.54±0.20c	4.15±0.12c	4.58±0.12b	4.54±0.05a	4.39±0.06
	-18 AP	4.52±0.15	4.64±0.14b c	4.59±0.38c	4.28±0.23c	4.65±0.10b	4.60±0.06b	4.46±0.10
	+4 VP	4.37±0.20	4.73±0.29b c	4.85±0.14b c	5.17±0.02b	5.06±0.17a	5.24±0.13a	
	+4 AP	4.45±0.12	4.80±0.01b c	5.16±0.02b	5.83±0.16a			
	RT-VP	4.56±0.16	4.88±0.07b	5.65±0.18a				
	RT-AP	4.73±0.28	5.52±0.20a					
	p		***	***	***	**	***	
TAPB	-18 VP	1.71±0.22	1.88±0.06b	2.45±0.36b c	2.28±0.06d	2.33±0.10b	2.78±0.15b	3.00±0.09
	-18 AP	1.86±0.10	1.86±0.10b	2.95±0.10a	2.58±0.25c	2.45±0.36b	2.80±0.14b	3.05±0.17
	+4 VP	1.79±0.21	2.12±0.38b	3.88±0.12a	3.95±0.19b	3.72±0.45a	3.24±0.10a	
	+4 AP	1.89±0.05	2.75±0.28a	3.11±0.19a	4.17±0.10a			
	RT-VP	1.83±0.14	2.02±0.20b	2.18±0.05b				
	RT-AP	1.88±0.07	2.05±0.26b					
	p		**	***	***	**	*	
LAB	-18 VP	4.85±1.18	4.72±0.29b	4.85±0.14c	4.84±0.31c	4.72±0.37b	4.84±0.24b	5.10±1.48
	-18 AP	4.93±1.56	4.63±0.37b	4.79±0.48c	4.72±0.33c	4.86±0.24b	4.80±0.13b	4.94±0.59
	+4 VP	4.82±1.10	4.78±0.42b	5.84±0.54a b	6.32±0.12a	6.56±0.93a	5.25±0.86a	
	+4 AP	4.35±3.19	4.68±0.25b	5.66±0.10b	5.95±0.44b			
	RT-VP	4.73±2.61	4.92±0.31b	6.18±0.25a				
	RT-AP	4.89±1.18	5.54±0.10a					
	p		**	***	***	**	**	
Total Mould/ Yeast	-18 VP	3.27±0.12	3.23±0.10d	3.32±0.16b	3.69±0.27b	3.32±0.16	4.21±0.11b	4.39±0.06
	-18 AP	3.31±0.13	3.35±0.09d	3.41±0.05b	3.42±0.06b	3.41±0.05	4.25±0.08b	4.46±0.10
	+4 VP	3.30±0.10	3.48±0.07c d	3.59±0.08b	3.60±0.16b	3.59±0.08	4.81±0.42a	

+4 AP	3.36±0.09	3.71±0.18b c	4.35±0.19a	4.20±0.36a
RT-VP	3.40±0.24	3.89±0.30b	4.41±0.20a	
RT-AP	3.56±0.22	4.35±0.19a		
p		***	**	**

-18 VP: vacuum packaging and -18 AP: aerobic packaging Erzurum cheese halva stored at -18°C; +4 VP: vacuum packaging and +4 AP: aerobic packaging Erzurum cheese halva stored at +4°C; RT-VP: vacuum packaging and RT-AP: aerobic packaging Erzurum cheese halva stored at room temperature

: in the same column indicates significant differences (:p<0.05; **:p<0.01; ***:p<0.001) between different packaging methods and storage temperature Erzurum cheese halva for each parameter at fixed storage time.

It was observed that acidity increased and consumability decreased in the vacuum-packed samples stored at +4°C. The LAB counts of the vacuum packaged samples than the aerobically packaged samples showed a greater increase during the storage period, but a decrease occurred in the vacuum packaged sample after the 30th day of storage. There was a decrease in the counts of LAB due to the increase in acidity in the cheese halva samples. Similarly, was reported in the study by Akarca et al., (2015) [19] study comparing different packaging methods for cheese, they reported that the acidity in vacuum-packaged samples increased after a certain day of storage.

besides manufacturing stage [20]. No study was found in the literature reviews to determine the effect of packaging method and storage temperature will affect on the microbiological, chemical and sensory properties of Erzurum cheese halva. However, it has been reported that the packaging method and storage time affect the microbiological, chemical and sensory properties of the Erzurum Civil Cheese, one of the main components of Erzurum cheese halva [21]. Moreover, it is stated that vacuum packaging is one of the effective preservation methods in preserving the microbiological quality and sensory properties of the civil cheese [21-22].

Physical, chemical and microbiological hazards in traditional foods; it can also occur during packaging and storage stages

Table 3. The chemical and physicochemical properties of Erzurum cheese halva samples during the storage period

Packaging-Storage temperature	Storage time (day)							
	1	5	10	15	30	45	60	
pH	-18 VP	3.55±0.15 b	4.13±0.15 c	4.22±0.07 d	4.49±0.04 b	4.56±0.09 c	4.68±0.04 c	4.86±0.10 b
	-18 AP	3.93±0.14 a	4.19±0.08 c	4.35±0.10 dc	4.68±0.24 b	4.80±0.14 b	4.93±0.11 b	5.10±0.05 a
	+4 VP	3.87±0.33 ab	4.53±.13b	4.53±0.28 c	5.18±0.08 a	5.32±0.06 a	5.55±0.09 a	
	+4 AP	3.90±0.16 a	4.56±0.12 b	5.14±0.04 b	5.44±0.26 a			
	RT-VP	3.72±0.12 b	4.57±0.16 b	5.32±0.07 ab				
	RT-AP	3.68±0.18 b	4.75±0.05 a					
	p	*	**	***	***	***	***	*
Titratable Acidity (% LA)	-18 VP	0.22±0.05	0.23±0.02 c	0.24±0.01 d	0.25±0.01 d	0.28±0.02 b	0.31±0.01 b	0.31±0.02
	-18 AP	0.27±0.05	0.24±0.03 c	0.23±0.02 dc	0.24±0.01 bc	0.28±0.02 b	0.42±0.04 a	0.34±0.02
	+4 VP	0.24±0.02	0.26±0.02 bc	0.27±0.02 bc	0.29±0.03 b	0.33±0.03 a	0.34±0.06 b	
	+4 AP	0.22±0.04	0.28±0.03 ab	0.29±0.03 b				
	RT-VP	0.27±0.03	0.29±0.03 ab	0.33±0.02 a	0.36±0.04 a			

	RT-AP	0.25±0.04	0.32±0.04					
	p		a	**	***	***	*	**
aw	-18 VP	0.9511±0.03	0.9329±0.01	0.9477±0.05	0.9614±0.01	0.9549±0.04	0.9417±0.52	0.9488±0.01
	-18 AP	0.9396±0.02	0.9624±0.04	0.9495±0.05	0.9581±0.04	0.9432±0.06	0.9416±0.11	0.9442±0.03
	+4 VP	0.9495±0.03	0.9392±0.03	0.9537±0.02	0.9445±0.18	0.9461±0.03	0.9448±0.01	
	+4 AP	0.9468±0.05	0.9429±0.09	0.9462±0.07	0.9409±0.23			
	RT-VP	0.9584±0.42	0.9616±0.08	0.9445±0.03				
	RT-AP	0.9463±0.07	0.9599±0.01					
	Dry Matter (%)	-18 VP	79.51±4.83	78.91±1.79	79.44±1.08a	79.98±2.15	76.13±1.41	77.81±0.82
-18 AP		78.25±2.73	75.76±0.60	74.78±0.31bc	76.77±2.41	74.71±4.63	74.33±2.73	74.32±1.39
+4 VP		77.31±2.13	79.35±1.33	76.44±1.36b	75.60±4.53	79.16±0.52	76.28±0.85	
+4 AP		76.23±5.27	74.45±6.27	74.99±0.46c	74.16±4.02			
RT-VP		78.14±2.30	76.57±1.33	75.54±0.66b				
RT-AP		76.64±3.87	75.15±9.46					
Fat (%)		-18 VP	27.50±1.71	26.50±0.71	29.50±0.71	30.50±2.12	27.50±2.12	29.50±0.71
	-18 AP	26.75±1.06	26.00±2.83	27.00±1.41	29.50±0.71	27.50±0.71	28.50±0.71	29.50±1.41
	+4 VP	27.00±1.41	29.00±1.41	29.00±1.41	29.00±2.83	29.00±1.41	30.05±1.48	
	+4 AP	22.50±4.95	30.50±2.12	31.00±5.66	26.50±0.71			
	RT-VP	26.50±3.54	26.50±0.71	27.00±1.41				
	RT-AP	27.00±10.41	28.50±2.12					

-18 VP: vacuum packaging and -18 AP: aerobic packaging Erzurum cheese halva stored at -18°C; +4 VP: vacuum packaging and +4 AP: aerobic packaging Erzurum cheese halva stored at +4°C; RT-VP: vacuum packaging and RT-AP: aerobic packaging Erzurum cheese halva stored at room temperature

* in the same column indicates significant differences (*:p<0.05; **:p<0.01; ***:p<0.001) between different packaging methods and storage temperature Erzurum cheese halva samples for each parameter at fixed storage time.

The change in color values of Erzurum cheese halva over the storage period is detailed in Table 4. According to TPE (2021) [7], Erzurum cheese halva should be made available for sale in quantities matching demand and packaged in accordance with established food packaging standards. In the meantime, it has also been stated that it should be stored at +4°C for a maximum of 10 days, and if longer storage is necessary, it

should be stored by freezing. In our research, the primary factors contributing to the degradation of aerobically packaged cheese halva samples stored at room temperature and +4°C are mold growth and color deterioration. Mold development not only impacts the appearance but also compromises the aroma of the product.

Table 4. Color parameters of Erzurum cheese halva samples during the storage period

Packaging- Storage temperature	Storage time (day)							
	1	5	10	15	30	45	60	
L*	-18 VP	42.26±0.20	44.90±1.45	45.43±3.14	49.21±1.91	50.96±2.54	51.81±4.66	52.09±2.70
	-18 AP	42.29±0.29	44.78±2.21	46.12±0.72	50.36±4.44	51.11±1.95	52.11±3.95	52.78±3.75
	+4 VP	42.58±0.35	43.45±1.71	45.08±1.18	50.21±1.91	56.01±3.45	58.68±3.88	
	+4 AP	42.19±0.02	45.00±2.86	48.11±0.27	50.85±2.52			
	RT-VP	42.18±1.05	45.33±2.02	49.27±0.31				
	RT-AP	41.99±1.36	47.56±1.47					
a*	-18 VP	6.05±0.09	7.02±0.15	7.65±0.39	7.90±0.34	7.34±0.30	7.01±1.42	6.67±0.30
	-18 AP	6.01±0.17	7.12±0.09	7.62±2.34	7.92±0.26	7.13±0.43	6.89±1.29	6.49±0.33
	+4 VP	6.08±0.70	7.33±0.11	7.62±0.56	7.86±2.16	7.22±0.10	6.79±2.20	
	+4 AP	6.17±0.37	7.37±0.42	7.75±1.09	7.95±0.13			
	RT-VP	6.09±0.27	7.38±0.05	7.70±0.25				
	RT-AP	6.02±0.72	7.49±0.08					
b*	-18 VP	23.21±0.10	24.04±0.32	24.94±0.80	25.35±0.65	24.66±0.39	24.41±0.43	24.13±0.80
	-18 AP	23.32±0.29	24.24±1.21	24.95±0.23	25.29±0.52	24.70±2.37	24.17±1.26	24.04±0.22
	+4 VP	23.30±0.10	24.06±0.18	25.10±0.28	25.13±0.49	24.31±0.86	24.16±0.76	
	+4 AP	23.53±0.64	24.49±1.27	24.74±0.54	25.02±0.90			
	RT-VP	23.46±0.02	24.22±1.59	24.70±0.24				
	RT-AP	23.55±0.13	24.11±0.57					

-18 VP: vacuum packaging and -18 AP: aerobic packaging Erzurum cheese halva stored at -18°C; +4 VP: vacuum packaging and +4 AP: aerobic packaging Erzurum cheese halva stored at +4°C; RT-VP: vacuum packaging and RT-AP: aerobic packaging Erzurum cheese halva stored at room temperature

The results of the sensory analyses of Erzurum cheese halva made in the storage period are given in Figure 2.

Erzurum cheese halva has a fibrous structure due to the fresh and unsalted nature of Erzurum civil cheese. The cheese in the halva displays a uniformly stringy texture and readily disintegrates upon tasting, creating a pleasant mouthfeel. [7]. In sensory tests conducted to determine the effect of storage temperature and packaging on cheese halvans, panelists scored the appearance and structure properties of vacuum-packaged samples lower than aerobic packaged samples. Vacuum packaging negatively affects the fibrous structure of the product and reduces the overall acceptability of the product.

While vacuum packaged Erzurum Cheese Halva was not liked by the panelists, Cambaztepe et al. (2009) [21] reported that vacuum packaged civil cheese samples were preferred by consumers. When civil cheese is vacuum packaged, there is

no change in the structure of the cheese. However, during the production of Erzurum cheese halva, civil cheese transforms into a thinner fibrous structure, and the vacuum packaging process negatively affects this distinct fibrous structure. This situation causes negative perception in consumer preference.

Vacuum packaging is a method often used to prevent moldiness in products [23]. In our study, it was not observed moldiness in vacuum-packaged samples. However, the most obvious cause of deterioration in vacuum packaged products stored at room temperature and +4°C was determined to be acidification. However, although no microbial deterioration was observed in vacuum-packed cheese halva samples at -18°C, some changes in their textural properties were observed. Our results showed that vacuum packaging can't guarantee the complete acceptability of the product for the consumer.

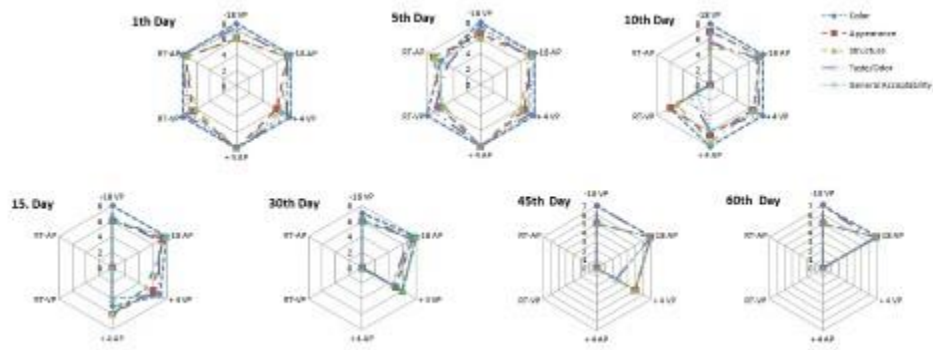


Figure 2. Changes in the sensory parameters of Erzurum cheese halva samples during the storage period

The results of the chemical, physicochemical and microbiological analyses of cheese halvans obtained from the market are given in Table 5 and 6.

When the microbiological analysis results of the experimentally produced cheese halva samples and the cheese halvans sold in the local markets were examined, it was found that both the TAMB and yeast/mould counts were higher in the cheese halva samples sold in the local market (Table 2 and Table 5). These results show that the necessary hygiene conditions are not complied with during the production, storage and marketing of Erzurum cheese halva sold in the Erzurum local markets. This situation is thought to pose some

public health risks. Likewise, Urçar Gelen and Ceylan (2020) [24] highlighted in their study that Erzurum civil cheese, a key ingredient in cheese halva, is often not produced under hygienic conditions by local producers.

The increase in halva diversity has been influenced by the use of cheeses produced in different ways in Anatolia [25]. Erzurum cheese halva is an important food for human nutrition because it contains high amounts of protein and fat [20]. It was determined that the dry matter, protein and fat contents of the cheese halva samples were high both produced experimentally and sold from the Erzurum local market (Table 1 and Table 6).

Table 5. Some microbiological analyses results of Erzurum cheese halva samples sold in local markets (log cfu/g)

Product Code1	A	B	C	D	E	p
TAMB	4.47±0.77c	6.99±0.19a	5.64±0.12b	5.24±0.37b	4.00±0.14c	**
TAPB	3.43±0.02a	3.14±0.41a	2.91±0.02c	3.56±0.01b	2.94±0.01c	**
Total Mould/ Yeast	3.69±0.09b	4.84±0.23a	4.77±0.15a	3.00±0.44c	2.74±0.04c	**
Coliform	3.00±0.74a	3.15±1.63a	2.77±0.33a	1.95±0.35b	1.95±0.05b	*

1: Erzurum Cheese Halva which purchased local market is given code.

p: in the same line indicates significant differences (*:p<0.05; **:p<0.01) between different Erzurum cheese halva for each parameter

Table 6. Some chemical and physicochemical analyses results of Erzurum cheese halva samples sold in local markets

Product Code1	A	B	C	D	E	p
Dry Matter (%)	85.21±0.68c	87.56±0.13b	78.92±2.21d	89.86±0.11a	89.61±0.66a	***
Ash (%)	1.52±0.24b	1.55±0.15b	1.45±0.65c	1.92±0.31a	1.85±0.22a	**
aw	0.87±0.001b	0.87±0.01b	0.94±0.001a	0.77±0.001c	0.67±0.02d	***
pH	4.48±0.2bc	4.69±0.1ab	4.30±0.5c	4.73±0.1a	4.59±0.1ab	**
Acidity (% L.A.)	0.077±0.005b	0.072±0.009b	0.12±0.014a	0.066±0.014bc	0.050±0.005c	***
Protein (%)	10.92±1.31b	13.75±0.94a	11.23±0.35a	14.57±1.24b	13.61±0.57a	*
Fat (%)	35.00±2.0b	44.00±1.50a	28.00±1.50c	44.00±2.00a	36.00±3.00b	***
Salt (%)	3.44±0.29d	2.29±0.23e	4.45±0.39c	6.88±2.29a	5.74±0.40b	***
L*	47.74±5.30b	51.44±20.30b	58.49±1.95a	48.74±1.74b	58.18±1.32a	*

Color	a*	6.54±0.72bc	5.92±0.68cd	5.23±0.84d	7.62±0.37ab	8.28±0.23a	**
Parameters	b*	24.49±0.68b	23.28±2.28b	24.49±1.63b	24.95±0.06b	31.17±0.44a	***

1: Erzurum cheese halva which purchased local market is given code.

p: in the same line indicates significant differences (*:p<0.05; **:p<0.01) between different Erzurum cheese halva for each parameter

4. Conclusion

The objective of this study was to determine appropriate packaging method and storage temperature for Erzurum cheese halva sold in the Erzurum local market. While vacuum packaging at -18°C extends the shelf life of the product, the general appearance of the product deteriorates due to vacuum packaging, which negatively affects consumer perception. It was determined that the fibrous structure, which is the most important feature of this traditional product, was preserved in the product aerobic packaged at +4°C stored. However, it was determined that the storage period of the product could be maximum 15 days under these conditions. For this purpose, studies should be carried out on the suitability of packaging methods such as vacuum-packaging, modified atmosphere-packaging (MAP) and reducing atmosphere-packaging (RAP) for the product.

In future studies, it would be beneficial to investigate alternative packaging methods (e.g., modified atmosphere packaging) that could potentially preserve the properties of this traditional product for a longer period during storage.

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