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Production and Quality Assessment of a New Dry Cured Turkey Product (Turkey Pastirma) Processed by Two Different Types of Packaging Techniques (Modified Traditional Coating and Vacuum Packaging)

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ABSTRACT

The objective of the current study was to evaluate the suitability of turkey meat for production of a new dry cured product (Turkey pastirma) by two different packaging techniques (modified coating and vacuum packaging). To achieve this objective, 100 boneless and skinless chilled turkey breasts were trimmed and dry cured. After that, 50 dry cured turkey breasts were coated with modified traditional coating and the other 50 were sliced and vacuum packaged. Coated and vacuumed turkey pastirma were stored at 4℃ till deterioration occurred and examined for sensory, physicochemical and microbiological quality parameters. The results revealed that there were non- significant differences in sensory analysis, mesophilic bacterial and mold counts between both pastirma treatments. However, the application of vacuum packaging resulted in significant decrease in protein, fat, ash contents, TBARS, TVBN, L*, b* values, lactic acid bacterial and yeast counts and significant increase in moisture content and a* value when compared with coated one. It can be concluded that, turkey meat can be a good choice raw material used for production of more tender and juicy pastirma and the application of vacuum packaging can improve all quality parameters of the product with shelf life may reach to 16 weeks at 4℃.

Key words: Turkey, Pastirma, Curing, Vacuum, Coating, Packaging

INTRODUCTION

In the last decade, world consumption of poultry and its products has been increased due to their nutritional benefits and lower price when compared with beef. Poultry meat provides high quality protein with essential amino acids, polyunsaturated fatty acids, vitamins and minerals. Moreover, it contains lower fat and cholesterol contents than those of beef (Zhang *et al*., 2016). Thus, poultry meat products are characterized by high digestibility, palatability and nutritional value for young and adults. Broiler chicken is the most common raw meat material used in the formulation of poultry products. However, turkey meat has higher protein and lower fat contents than those of chicken meat which render it to be healthier for human (Chettri *et al*., 2012). Furthermore, turkey meat has special taste and texture which enhance all sensory attributes of the final product formulated with it. Bacon, bologna, hotdogs and ham are considered the most common cured turkey products. Conversely, the dry cured turkey products are limited within few types of products as dry sliced turkey breast and pastrami (Mozdziak, 2014). However, pastirma is a common type of dry cured products; it is not processed by turkey meat till now.

Pastirma is a traditional dry-cured, shelf stable, ready to eat meat product that distributed mainly in Turkey and many countries including Egypt. It is recognized as an intermediate moisture product where meat is pressed by mechanical mean to lose about 50% to 60% of its water content (Demirezen and Uruc, 2006). Pastirma is produced mainly from whole muscle parts of cattle, buffalo and camel (Abd-Allah and Ismail, 2012). Muscles are trimmed from fat and connective tissue, cured, dried, pressed and coated with a paste containing garlic and fenugreek which is known as a çemen then dried again to achieve a maximum 40% moisture level (Gök *et al*., 2008).

Subsequently, pastirma is regarded as a safe product where most microorganisms can't survive at high salt concentration and low moisture content except yeast and molds. Moreover, application of the cemen paste to pastirma act as another way for preservation and also, it gives a characteristic and pleasant flavor to the product

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(Kaban, 2009). However, many problems associated with application of cemen have been reported such as cracks and mold growth which affect the consumer's acceptance and may result in rapid deterioration of the product. These problems forced meat processors to search for another way for preservation of pastirma that can improve the quality and prolong the shelf life of the product.

Vacuum packaging is considered to be the most important preservation technique for production of cured meat products with high quality and extended shelf life. Preservation effect of vacuum packaging is originating from formation of anaerobic condition at the surface of the product which prevents the growth of spoilage bacteria. Moreover, vacuum packaging provides good product presentation and appearance through prevention of color oxidation and shrinkage of the product (Genigeorgis, 1986).

To the best of our knowledge, previous studies were evaluating the different quality attributes of pastirma produced from muscle of large animals; however, production of pastirma from turkey meat is limited. Therefore, the main objective of the current study was to evaluate the suitability of turkey meat as a main raw material used for production of pastirma. Moreover, two different packaging techniques (modified traditional coating and vacuum packaging) were applied to assess which type can improve the different quality attributes and prolong the shelf storage period of turkey pastirma.

MATERIALS AND METHODS

Experimental design

Two trials based experiment (three independent replicates) was carried out to produce a new dry cured product (pastirma) from turkey breast meat. Turkey pastirma was processed by two different packaging techniques to investigate which type can enhance and preserve the quality attributes of the product. The 1st technique was packaging of the whole intact pastirma by ordinary coating with some modifications to match the turkey meat color characters, while the 2nd one was vacuum packaging of the sliced pastirma without coat application. Coated and vacuum packaged pastirma were stored at 4ºC and examined for determination of their different quality attributes (sensory, physicochemical and microbiological aspects). Examination was done weekly till deterioration occurs.

Raw materials

One hundred boneless and skinless chilled turkey breasts (each about 4-4.5 kg) enclosed in its polyethylene bags were obtained from a local supplier in the first third of their shelf life. The meat was transported immediately in a cooling icebox to the laboratory of Faculty of Veterinary Medicine, Cairo University, Egypt where it kept at 4ºC till processing. Spices in the form of oil extracts were purchased from Nubassa GewürzwerkGmpH (Viernheim, Germany). Sodium nitrite, ascorbic acid and glycerol were obtained from LobaChemie, Mumbai, India. On the other hand, sodium chloride, fenugreek powder, capsicum powder, fresh garlic and potato starch were obtained from Egyptian local markets in Cairo, Egypt.

Muscle preparation

Turkey breasts were trimmed from all visible fat, connective tissue and wing remnants. To ensure sufficient penetration of the curing mixture, four knife stabs (two at each side at vertical level) were done in each breast. The curing mixture / one kilogram of meat was composed of 500g sodium chloride, 0.680g sodium nitrite, 0.5g ascorbic acid, 8g fresh garlic, 0.5 ml fenugreek oil, 0.02 ml capsicum oil, 0.01 ml cumin oil, 0.03 ml cardamom oil and 0.03 ml thyme oil. The knife stabs were completely stuffed with the curing mixture and the remaining mixture was rubbed on the meat surface and kept chilled at 4 ºC for 18 hours. After 18 hours, the cured breasts were rinsed under running tap water to remove the excess curing mixture and pressed using locally manufactured hydraulic pressing machine at 0.01 kg/m2 for 16-18 hours. After pressing, pastirma loaves were hanged in electric oven at 50 ºC until complete surface dryness. After that, the dried pastirma were divided into two groups (50 for each), the 1st one was coated by modified cemen paste while, the 2nd one was sliced and vacuum packaged.

Application of the coat

For application of the traditional cemen, a mixture of fenugreek powder and ground fresh garlic at ratio of 2: 1 were rendered with sufficient amount of water to form a paste. This coat is dark in color (brown to grey) which gave an unacceptable color contrast with the light turkey meat. To overcome color problems of the traditional coat, some modifications were done by addition of paprika powder (quantum sufficient), gum arabic and potato starch at rate of 4.67 and 48% from the total weight of the cemen paste respectively. Glycerol was added to the coat at rate of 13% to make the coat more flexible and prevent surface cracks. A thin layer of the modified coat was applied over the suface of pastirma and left to dry again in hot air oven at 50 ºC until the coat dried completely.

Application of vacuum

Dried pastirma was sliced into 2mm slices using electric meat slicer (Orientsun semiautomatic, China, Mainland). Sliced pastirma were weighted into 200±50.00 g portions and packaged by transparent, low density polyethylene bags (40 microns thick, with moisture and oxygen transfer rate of 0.54 g/100 in^2/24hr and3.99 cc/100 in^2/24hr respectively, Vollrath Company, USA). Sealing of bags was carried out through Komet SD520 double chamber vacuum packing machine (KOMET MASCHINENFABRIK GMBH, Germany) at a pressure of 0.8 bars for 30 seconds.

Examination of pastirma

Coated and vacuumed pastirma were kept refrigerated at 4 ºC and the examination was carried out after 24hr post processing (0 time) and weekly till deterioration occur. At each examination time, three samples from each trial were subjected for sensory; physicochemical and microbiological evaluation.

Sensory investigations

Sensory analysis was assessed according to AMSA (1995) guidelines. Nine qualified panelists from both sexes (30–45 years) were chosen from the staff members of the

Department of Food Hygiene and Control, Faculty of Veterinary Medicine, Cairo University, Egypt. Before examination, the panelists received an introductory session correlated to descriptive structure scaling of sensory quality parameters of pastirma (appearance, flavor, tenderness, juiciness and overall acceptability) before testing to ensure that each panelist could peripherally evaluate each parameter. Sensory analysis was performed under controlled conditions (good lighting, partition between the panelists and controlled temperature). Coated pastirma was peeled of coat and cut into slices before sensory examination, while vacuum packaged pastirma was serviced directly to the panelists. Tap water was provided between samples to rinse the palate and avoid the confusion of results between samples. Three replicates of each trial were received by the panelists for evaluation of appearance, flavor, tenderness, juiciness and overall acceptability using 1–9 hedonic scale, where 9 mean extremely acceptable and 1 mean extremely unacceptable.

Physicochemical analysis

Proximate chemical analysis

Each replicate from each trial were subjected for determination of moisture, protein, fat and ash contents according to the method established by AOAC (2000).

Thiobarbituric-acid reactive substances (TBARS) and total volatile base nitrogen (TVBN) values

TBARS value (mg Mal./ Kg) was determined according to (Du and Ahn, 2002) however, TVBN value (mg/100 gram) was measured following the method described by (Kearsley *et al.*, 1983).

Color evaluation

Color of pastirma was determined according to the methodology of Shin *et al.* (2008).

Microbiological examination

Sample homogenate and tenfold serial dilution were prepared according to Swanson *et al.* (2001). Standard Plate Count Agar (LAB 149) was used for enumeration of total aerobic mesophilic bacterial count at incubation temperature of 37°C for 24 hours (Dale Morton, 2001). Moreover, DeMan Rogosa Sharpe agar **(**Oxoid CM 1153**)** was used for enumeration of lactic acid bacteria at incubation temperature of 30 ºC in microaerophilic atmosphere (5% CO2) for 3 days (De Man *et al.*, 1960). Yeast and mold were counted by inoculation of Sabouraud Dextrose Agar plates (LAB 009) at incubation temperature of 25ºC for 5 days (Beuchat and Cousin, 2001). The average of each microbial counts of each sample was separately calculated and expressed as colony forming unit per gram meat sample (log_{10} cfu /g).

Statistical analysis

The resulting data were analyzed using SPSS statistics 16.0 for windows. The data of sensory, physicochemical and microbiological evaluations were analyzed using Paired-samples T test to compare the results between the two different types of turkey pastirma weekly (up to 4 weeks of storage). While, the data of each type of turkey pastirma were compared separately during the storage period (weekly for 4 and 16 weeks for coated and vacuum packaged turkey pastirma respectively) using one-way analysis of variance (ANOVA). Significances were determined by using least square difference test (LSD) procedure. Differences were considered to be significant at ($P<0.05$) level.

RESULTS AND DISCUSSION

Sensory analysis

Sensory panel scores of turkey pastirma revealed that there were a non-significant differences ($P>0.05$) among coated and vacuumed pastirma for all examined sensory parameters immediately after processing (0-time) and throughout the storage period at 4℃ for 4 weeks (Table 1). The results revealed that the unacceptable overall acceptability scores were observed at 4th and 16th week of chilled storage for coated and vacuumed pastirma respectively. These results may be due to the moisture loss during chilled storage of coated pastirma that was higher than the vacuumed one (Table 2). Moisture loss led to increase in salt content of the product which can accelerate oxidative rancidity and decrease tenderness, juiciness and the products shelf life (Keeton, 2001).

The results also clarified that the chilling storage led to significant ($P<0.05$) reduction in all examined sensory parameters for both pastirma treatments which may be related to the increase in microbial load and chemical deterioration which led to product discoloration and unpleasant flavors (Gill, 2014).

Physicochemical analysis

Proximate chemical analysis

Coating of turkey pastirma with modified traditional coat resulted in a significant ($P<0.05$) decrease in the moisture and a significant ($P<0.05$) increase in the protein, fat and ash contents immediately after processing and throughout storage at 4℃ for 4 weeks when compared with vacuumed one (Table 2). The differences in the chemical composition among coated and vacuumed turkey pastirma may be related to the variation in moisture permeability of the two different packaging techniques. It has been reported that the vacuum packaging of meat and meat products has a good moisture barrier ability which prevent moisture loss during the shelf life storage (Turan and Kocatepe, 2013). However, traditional coating of pastirma had a poor moisture barrier ability which resulted in decrease in moisture content and increase in protein, fat and ash contents of the product during the storage period (Abdallah *et al.*, 2017). Moreover, addition of potato starch during formulation of traditional coat may be resulted in elevation in moisture loss, where the starch coating characterized by higher water vapor permeability due to its hydrophilic nature (Olivas and Barbosa-Cánovas, 2009). The variations in moisture permeability between modified traditional coating and vacuum packaging techniques may be also explain the variations in chemical compositions within the same treatment during the chilled storage. Where, there was a significant ($P<0.05$) reduction in moisture content and significant ($P<0.05$) elevation in protein, fat and ash contents of coated turkey pastirma at 4th week of chilled storage when compared with 0- time of processing. While, the vacuumed one showed non-significant ($P>0.05$) changes in moisture, fat and ash contents throughout chilled storage for 16th weeks.

Table 1: Changes in sensory panel scores of modified traditional coated and vacuum packaged turkey pastirma during chilling storage at 4°C for 16 weeks.

Storage time	Treatments	Appearance	Flavor	Tenderness	Juiciness	Overall acceptability
0 time	CP	7.71±0.22^{a,A}	7.00±0.25^{a,A}	8.09±0.11^{a,A}	8.75±0.22^{a,A}	7.89±0.20^{a,A}
	VP	7.71±0.18^{a,A}	6.75±0.14^{a,A}	8.14±0.19^{a,A}	8.90±0.15^{a,A}	7.88±0.17^{a,A}
1st week	CP	7.71±0.15^{a,A}	6.43±0.12^{a,A}	7.0±0.13^{a,A}	7.28±0.22^{a,AB}	7.12±0.16^{a,A}
	VP	6.43±0.13^{a,AB}	6.11±0.09^{a,A}	7.71±0.15^{a,A}	7.77±0.18^{a,AB}	7.00±0.14^{a,A}
2nd week	CP	6.43±0.21^{a,AB}	5.20±0.22^{a,AB}	6.40±0.21^{a,AB}	6.14±0.11^{a,B}	6.04±0.19^{aAB}
	VP	6.43±0.17^{a,AB}	5.14±0.25^{a,AB}	6.43±0.19^{a,AB}	6.44±0.23^{a,BC}	6.11±0.21^{a,A}
3rd week	CP	5.14±0.13^{a,B}	5.16±0.22^{a,AB}	5.14±0.24^{a,BC}	5.14±0.22^{a,AB}	5.15±0.20^{a,B}
	VP	5.13±0.18^{a,BC}	5.11±0.10^{a,AB}	5.25±0.12^{a,B}	6.43±0.19^{a,BC}	5.48±0.15^{a,B}
4th week	CP	4.83±0.23^{a,B}	4.02±0.19^{a,B}	4.44±0.14^{a,C}	4.52±0.26^{a,B}	4.45±0.21^{a,B}
	VP	5.10±0.25^{a,BC}	4.86±0.11^{a,AB}	5.20±0.22^{a,B}	6.04±0.21^{a,BC}	5.30±0.20^{a,B}
7th week	VP	5.08 ±0.15^{B,C}	4.55 ±0.22^{B}	5.16 ±0.12^{B}	6.00±0.18^{A,BC}	5.20±0.17^{B}
10thweek	VP	5.00±0.25^{B,C}	4.43±0.17^{B}	5.11±0.25^{B}	6.00±0.18^{A,BC}	5.14±0.21^{B}
13thweek	VP	4.97±0.17^{B,C}	4.14±0.14^{B}	5.11±0.11^{B}	5.86±0.15^{BC}	5.02±0.14^{B}
16th week	VP	4.00±0.12^{C}	4.07±0.22^{B}	4.99±0.15^{B}	5.43±0.13^{C}	4.62±0.16^{B}

CP (coated pastirma), VP (vacuumed packaged pastirma); *Values represent the mean of three independent replicates ± standard deviation; * ^{a}Values with different superscript within the same column for different treatments differ significantly at P<0.05 ; * $^{A-C}$:Values with different superscript within the same column for the same treatment throughout storage period differ significantly at P<0.05

Table 2: Changes in proximate chemical analysis (%) of modified traditional coated and vacuum packaged turkey pastirma during chilling storage at 4°C for 16 weeks.

Storage time	Treatments	Moisture	Protein	Fat	Ash
0 time	CP	63.79±0.61^{a,A}	27.07±0.35^{a,A}	2.86±0.08^{a,A}	5.40±0.02^{a,A}
	VP	67.26±0.35^{b,A}	25.00±0.10^{b,A}	2.08±0.34^{a,A}	4.09±0.01^{b,A}
1st week	CP	54.11±0.42^{a,B}	31.89±0.56^{a,B}	4.11±0.35^{a,B}	6.18±0.15^{a,B}
	VP	67.07±0.25^{b,A}	26.00±0.50^{b,A}	2.24±0.02^{b,A}	4.10±0.10^{b,A}
2nd week	CP	53.97±0.40^{a,B}	32.82±2.88^{a,B}	4.50±0.14^{a,C}	6.46±0.01^{a,C}
	VP	67.48±0.10^{b,A}	27.06±0.75^{b,B}	2.08±0.01^{b,A}	4.11±0.02^{b,A}
3rd week	CP	53.61±0.50^{a,B}	33.53±2.86^{a,B}	4.50±0.15^{a,C}	6.55±0.24^{a,BC}
	VP	67.46±0.50^{b,A}	27.09±0.08^{b,B}	2.11±0.11^{b,A}	4.11±0.02^{b,A}
4th week	CP	53.48±0.30^{a,B}	33.95±1.67^{a,B}	4.62±0.104^{a,C}	6.79±0.13^{a,D}
	VP	67.40±0.25^{b,A}	27.13±1.00^{b,B}	2.00±0.20^{b,A}	4.17±0.01^{b,A}
7th week	VP	67.37±0.50^{A}	27.50±0.50^{B,C}	2.40±0.05^{A}	4.20±0.15^{A}
10thweek	VP	67.30±0.51^{A}	27.67±0.44^{B,C}	2.49 ±0.17^{A}	4.25±0.15^{A}
13thweek	VP	67.27±0.54^{A}	27.85±0.93^{B,C}	2.08±0.36^{A}	4.31±0.48^{A}
16th week	VP	67.13±0.23^{A}	28.48±0.14^{C}	2.74±0.03^{A}	4.40±0.05^{A}

CP (coated pastirma), VP (vacuumed packaged pastirma); *Values represent the mean of three independent replicates ± standard deviation; * $^{a-b}$ Values with different superscript within the same column for different treatments differ significantly at P<0.05. * $^{A-D}$ Values with different superscript within the same column for the same treatment throughout storage period differ significantly at P<0.05

Table 3: Changes in TBARS (mg mal/Kg) and TVBN (mg/100g) values of modified traditional coated and vacuum packaged turkey pastirma during chilling storage at 4°C for 16 weeks.

Storage time	Treatments	TBARS	TVBN
0 time	CP	0.15±0.02^{a,A}	8.63±0.57^{a,A}
	VP	0.15±0.02^{a,A}	4.62±0.28^{b,A}
1st week	CP	0.25±0.12^{a,A}	10.97±0.49^{a,B}
	VP	0.16±0.05^{b,A}	5.04±0.14^{b,AB}
2nd week	CP	0.47±0.03^{a,B}	11.81±1.05^{a,BC}
	VP	0.18±0.10^{b,AB}	5.65±0.29^{b,BC}
3rd week	CP	0.94±0.04^{a,C}	12.18±0.74^{a,BC}
	VP	0.21±0.01^{b,A,B}	5.88±0.28^{b,C}
4th week	CP	1.50±0.20^{a,D}	12.37±0.58^{a,C}
	VP	0.25±0.13^{b,AB}	5.88±0.50^{b,C}
7th week	VP	0.28±0.06^{A,BC}	6.16±0.14^{C}
10thweek	VP	0.37±0.02^{B,C}	7.84±0.14^{D}
13thweek	VP	0.47±0.02^{C}	8.17±0.45^{D}
16th week	VP	1.18±0.29^{D}	8.82±0.61^{E}

CP (coated pastirma), VP (vacuumed packaged pastirma); *Values represent the mean of three independent replicates ± standard deviation. * $^{a-b}$: Values with different superscript within the same column for different treatments differ significantly at P<0.05. * $^{A-E}$: Values with different superscript within the same column for the same treatment throughout storage period differ significantly at P<0.05

TBARS and TVBN

TBARS values of vacuumed turkey pastirma were significantly (P<0.05) lower than those of coated one from 1st week to 4th weeks of storage at 4℃ (Table 3). The results also revealed that the TBARS values were significantly (P<0.05) increased in both turkey pastirma treatments throughout chilled storage at 4℃. However, TBARS values remained within the acceptable limit (1 mg malonaldehyde/ kilogram, Warriss, 2000) until the 3rd and 13th week of storage at 4℃ for coated and vacuumed turkey pastirma, respectively. Lower TBA values of vacuumed turkey pastirma after processing and during chilled storage may be related to the antioxidant effect of the vacuum packaging through the removal of large amount of oxygen to prevent growth of aerobic spoilage organisms, shrinkage, oxidation, and color deterioration (Turan and Kocatepe, 2013). On the other hand, the rapid deterioration of the modified coated turkey pastirma may be explained by the high moisture permeability of this coat which resulted in an increase in moisture loss and salt content during storage period which act as a pro-oxidant (Keeton, 2001).

Application of vacuum packaging during processing of turkey pastirma resulted in a significant (P<0.05) reduction in TVBN content immediately after processing and during chilled storage period for 4 weeks when

Table 4: Changes in color of modified traditional coated and vacuum packaged turkey pastirma during chilling storage at 4°C for 16 weeks.

Storage time	Treatments	Color		
		L*	a*	b*
0 time	CP	49.12±0.43^{a,A}	14.16±0.11^{a,A}	10.57±0.21^{a,A}
	VP	45.59±0.54^{b,A}	18.10±0.26^{b,A}	10.02±0.17^{b,A}
1st week	CP	48.60±0.34^{a,A}	14.00±0.35^{a,AB}	11.22±0.56^{a,B}
	VP	45.33±0.78^{b,A}	17.65±0.52^{b,AB}	10.65±0.21^{a,A}
2nd week	CP	47.67±0.37^{a,B}	13.71±0.18^{a,BC}	11.57±0.33^{a,BC}
	VP	45.25±0.59^{b,A}	16.94±1.16^{b,B}	10.73±0.15^{b,A}
3rd week	CP	46.73±0.56^{a,C}	13.41±0.01^{a,CD}	11.92±0.17^{a,C}
	VP	44.92±0.87^{b,AB}	16.97±0.42^{b,B}	10.81±0.48^{b,A}
4th week	CP	46.04±0.54^{a,C}	13.24±0.05^{a,D}	13.87±0.12^{a,D}
	VP	44.88±1.11^{b,AB}	16.97±0.17^{b,B}	10.88±0.27^{b,AB}
7th week	VP	44.51±0.77^{B}	16.87±0.22^{B}	11.38±0.05^{B,C}
10thweek	VP	44.33±1.08^{B}	16.80±0.29^{B}	11.45±0.55^{C}
13thweek	VP	43.89±0.03^{C}	16.19±0.41^{B}	11.84±0.26^{C,D}
16thweek	VP	43.80±0.62^{C}	15.83±0.24^{C}	11.98±0.28^{D}

CP (coated pastirma), VP (vacuumed packaged pastirma); *Values represent the mean of three independent replicates ± standard deviation; * $^{a-b}$: Values with different superscript within the same column for different treatments differ significantly at P<0.05; * $^{A-D}$: Values with different superscript within the same column for the same treatment throughout storage period differ significantly at P<0.05

Table 5: Changes in bacterial counts (log_{10} cfu/g) of modified traditional coated and vacuum packaged turkey pastirma during chilling storage at 4°C for 16 weeks.

Storage time	Treatments	APC	LAB	Yeast	Mold
0 time	CP	3.72±0.65^{a,A}	2.95±0.65^{a,A}	1.49±0.41^{a,A}	<2.00±0.00^{a,A}
	VP	3. 69±0.36^{a,A}	2.68±0.59^{a,A}	<2.00±0.00^{b,A}	<2.00±0.00^{a,A}
1st week	CP	3. 46±1.39^{a,A}	4.10±0.33^{a,B}	1.74±1.15^{a,AB}	1.00±1.73^{a,AB}
	VP	3.25±0.60^{a,A}	3.29±0.39^{b,AB}	<2.00±0.00^{b,A}	<2.00±0.00^{a,A}
2nd week	CP	3.53±0.50^{a,A}	4.69±0.39^{a,B}	2.90±0.82^{a,AB}	1.40±1.91^{a,AB}
	VP	3.21±0.34^{a,A}	4.32±0.75^{a,BC}	<2.00±0.00^{b,A}	1.10±2.24^{a,AB}
3rd week	CP	4.43±0.61^{a,B}	4.72±0.10^{a,B}	3.04±1.63^{a,B}	1.67±1.36^{a,A,B}
	VP	4. 21±0.34^{a,B}	4.67±1.00^{a,C}	<2.00±1.56^{b,A}	1.53±1.53^{a,AB}
4th week	CP	4.71±0.67^{a,B}	5.10±1.03^{a,B}	1.49±2.59^{a,B}	2.67±0.91^{a,B}
	VP	4. 35±0.97^{a,B}	4.94±0.35^{a,CD}	0.67±0.00^{b,A}	2.00±1.73^{a,AB}
7th week	VP	4.84±0.54^{BC}	6.02±1.38^{DE}	0.90±1.15^{AB}	2.10±1.83^{AB}
10thweek	VP	5.20±0.17^{C}	6.68±0.57^{EF}	1.08±1.86^{BC}	2.43±2.21^{AB}
13thweek	VP	5.09±0.57^{C}	7.45±0.06^{F}	1.89±1.63^{BC}	3.00±0.00^{B}
16th week	VP	5.39±0.27^{C}	7.55±0.23^{F}	1.90±1.65^{BC}	3.08±1.12^{B}

CP (coated pastirma), VP (vacuumed packaged pastirma), APC (aerobic measophilic bacteria), LAB (lactic acidbacteria); *Values represent the mean of three independent replicates ± standard deviation; * $^{a-b}$: Values with different superscript within the same column for different treatments differ significantly at P<0.05; * $^{A-F}$: Values with different superscript within the same column for the same treatment throughout storage period differ significantly at P<0.05

compared to the coated one (Table 3). Higher TVBN content of coated turkey pastirma may be correlated to their higher protein and salt contents than those of vacuumed one due to the greater water loss. High salt content of dry cured meat products led to rapid protein hydrolysis and subsequently increase in TVBN values (Mills, 2014). It is also clarified that TVBN values of both turkey pastirma treatments were significantly (P<0.05) increased but still within the permissible limits (20 mg/100 g, ESS 1042/2005) at 4th and 16th week of chilled storage for coated and vacuumed turkey pastirma, respectively.

Color evaluation

Instrumental color evaluation revealed that the vacuum packaging of turkey pastirma resulted in a significant (P<0.05) decrease in L* and b* values and significant (P<0.05) increase in a* values at 0-time and during chilled storage for 4 weeks when compared with coated pastirma (Table 4). There was an inverse relationship between moisture content and L* values of meat and meat products (Parra *et al.*, 2010), therefore higher L* value of coated turkey pastirma may be related to its lower moisture content. On the other hand, higher a* and lower b* values of vacuumed turkey pastirma may be explained by the antioxidant effect and gas barrier properties of vacuum packaging which prevent the color oxidation (Turan and Kocatepe, 2013). The results also showed that the chilled storage of coated and vacuumed turkey pastirma led to a significant (P<0.05) decrease in L* and a* values and significant (P<0.05) increase in b* values. Moisture loss and increased salt concentration of turkey pastirma during storage may be the main reasons which were responsible for the dramatic changes of all color parameters where salt act as a pro-oxidant for fat and myoglobin pigment (Keeton, 2001).

Microbiological examination

Yeast counts of vacuumed pastirma were significantly (P<0.05) lower than those of coated one immediately after processing till the 4thweek of chilled storage (Table 5). Moreover, vacuumed pastirma showed significantly (P<0.05) lower lactic acid bacterial count at 1st week of chilled storage than that of coated one. Lower lactic acid bacterial counts of vacuumed turkey pastirma may be attributed to the combination between many preservative factors as using of salt, sodium nitrite and vacuum packaging (hurdle technique) which can protect the product against spoilage and consequently prolong its shelf life (Mills, 2014). Conversely, there were a non-significant (P>0.05) differences in mesophilic bacterial and mold

counts between coated and vacuumed turkey pastirma at 0-time and throughout chilled storage period for 4 weeks. Generally, the vacuum packed films did not provide absolute anaerobic conditions and it had some oxygen permeability therefore, the total viable count can grow but with a lower rate than in aerobically packaged meat products (Baranenko *et al.*, 2013). The results also presented that there were significant ($P<0.05$) increase in all examined microorganisms for both turkey pastirma treatments during storage period. Elevation of lactic acid bacterial counts particularly in coated pastirma during chilled storage may be attributed to the creation of microaerophilic conditions from the coat, presence of salt and nitrite which can enhance the growth of lactic acid bacteria (Von Holy *et al*., 1991). Moreover, poor gas barrier of modified traditional coat and alteration of vacuum package permeability at the end of storage period were considered the main causes that led to increase in microbiological profile of turkey pastirma.

Conclusion

The data obtained in the current study revealed that turkey meat is a good raw material used for production of more palatable and healthier pastirma. Moreover, the application of vacuum packaging resulted in enhancement of the sensory, physicochemical and microbiological quality attributes of pastirma because of its antioxidant and antibacterial effects which led to extension of the product's shelf life. It is clarified that, lower tenderness, juiciness and rapid deterioration of coated pastirma may be due to the poor moisture and gas barrier properties of the coat. Therefore, we recommended that addition of biodegradable edible coating materials during preparation of the cemen paste to improve the moisture and gas barrier properties of the coat.

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