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Research Article
Quality Deterioration of Spent Hen Jerky Packed Using Different Packaging Methods and Stored at Ambient Temperature

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Abstract

Background and Objective: The packaging system of jerky, a semi-dried meat product, is one of the most important factors controlling product deterioration during prolonged storage, especially in the case of spent hen meat, which is susceptible to oxidation. This typical product is generally packed in vacuum (VAC) packaging or via heat sealing with an oxygen scavenger (HSOS). This study aimed to determine the suitable packaging and to assess the physicochemical, microbiological and sensory qualities of spent hen jerky packed using different packaging methods (VAC vs. HSOS) over 90 days of storage. **Methodology:** The jerky was prepared by grinding spent hen meat and mixing it with ingredients, followed by forming, dehydrating and roasting the jerky. The resulting products were randomly packed under VAC or via HSOS and stored at 32±2°C for 90 days. The changes in the physicochemical and microbiological qualities of the packed products were determined at 15 days intervals, while the changes in the sensory qualities were evaluated at 90 days by comparison with freshly prepared product (0 day) as a control. **Results:** The moisture content and water activity of the jerky increased with the storage period ($p<0.05$), with no significant differences observed between the packaging methods ($p>0.05$). Thiobarbituric Acid Reactive Substances (TBARS) increased in samples during storage ($p<0.05$), but the HSOS packaging retarded the lipid oxidation in jerky compared to the VAC packaging. Moreover, the HSOS-packed product showed higher redness, yellowness and vividness and lower microbial growth during storage than did the VAC-packed product ($p<0.05$). According to the sensory evaluation, the jerky packed via HSOS and stored at 90 days had higher flavor and overall acceptability scores than that packed under VAC ($p<0.05$) and had similar scores to the those of the freshly prepared product. **Conclusion:** The results indicated that the HSOS treatment is preferred for packing jerky processed from spent hen meat because it can retard lipid oxidation, color deterioration and microbial growth during storage.

Key words: Jerky, semi-dried meat, vacuum packaging, oxygen scavenger, spent hen meat

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Spent laying hens are birds culled from herds after 71 weeks of age or when their egg-laying ability falls below 65%, as it is uneconomical to retain these birds[1]. However, meat obtained from spent hens has a tough texture due to the increased cross-linking of collagen of older birds[2] and thus, does not meet consumer needs. As a consequence, the utilization of spent hen meat in whole meat or fresh meat applications has been precluded; therefore, the price of spent hen meat is likely quite low compared to that of broiler chicken meat. The apparent toughness of spent hen meat can be reduced by incorporation in comminuted meat products such as surimi-based products[3], chicken snacks[4] and emulsion sausage[5]. Recently, spent hen meat has been used to produce jerky. The production process is not complicated and has been developed to achieve acceptable sensory perception through drying and roasting, as reported by Sorapukdee *et al.*[6]. Jerky products are shelf-stable due to their low water activity (a_w), with a_w values below 0.85 and have no need for refrigeration during commercial distribution[7-9]. Generally, the term "shelf-stable product" refers to products that can be stored without refrigeration or freezing but still have safe and acceptable organoleptic characteristics[10]. Thus, jerky can be stored at "room temperature" or "ambient temperature". The shelf stability of the product is also often dependent on the proper packaging to control oxidation and potential microbial growth as well as to retain organoleptic acceptability.

The packaging system for semi-dried meats is very important for controlling their chemical and microbial shelf stability. To eliminate oxygen, jerky products are usually packed under vacuum (VAC) or in active packaging with an oxygen-scavenging sachet added during the packaging process[10]. Although the oxygen-scavenging sachet absorbs residual oxygen after packaging, some oxygen remains in VAC packaging[11-12]. A number of researchers have studied the effects of oxygen-scavenging sachets on fresh meat with respect to discoloration and lipid oxidation[13-15]. For example, Gill and McGinins[14] found that the discoloration of ground beef could be prevented by inclusion of commercial oxygen scavengers to decrease the residual oxygen below 10 ppm. Tewari *et al.*[15] reported that beef steaks packed without oxygen scavengers had more discoloration and significantly higher proportions of metmyoglobin than those packed with oxygen scavengers. Demirhan and Candogan[13] concluded that modified atmosphere packaging (MAP-70% CO_2/30% N_2) suppressed microbiological growth and retarded lipid and protein oxidation in chicken thigh meat, with a 9 days shelf-life extension and insignificant effects of iron-based oxygen scavengers, compared to that observed in the control (aerobic packaging). In fact, cooked meat products are more susceptible to oxidation than fresh meat[16]. Moreover, spent hen meat can promote higher lipid oxidation during processing and storage than broiler meat due to the higher fat content, which includes a high unsaturated fatty acid content, of the former[17]. However, there are no comparative scientific data evaluating the effect of packaging methods on the quality of jerky products during prolonged storage. For this reason, the objective of this study was to evaluate the effect of the packaging method [VAC packaging and heat sealing with an oxygen scavenger (HSOS)] on the physicochemical, microbiological and sensory qualities of spent hen jerky stored for 90 days at ambient temperature.

MATERIALS AND METHODS

Preparation of jerky samples and experimental design: Meat deboned from spent hens (breast, leg and fillet) was obtained from a commercial slaughter plant (Jai Phue Phae Butchery, Nongjok, Bangkok, Thailand). The meat was formulated into a jerky product according to the process of Sorapukdee *et al.*[6] by using ingredients purchased locally, including sodium chloride (0.8% w/w), sugar (4% w/w), soy sauce (2% w/w), monosodium glutamate (0.2% w/w), BBQ powder (0.5% w/w), paprika powder (0.5% w/w) and glycerol (15% w/w). The jerky was processed by the following procedure: (1) Grinding the meat, (2) Mixing with ingredients, (3) Forming jerky with a jerky gun, (4) Drying in an oven to reach a core temperature of 71.1°C and an a_w below 0.85 and (5) roasting at 180°C for 6 min. The resulting products had a dry yield (47.72±0.65%) with protein (37.29±0.30%), carbohydrate (35.51±0.35%), moisture (18.19±0.04%), fat (4.79±0.08%) and ash (4.24±0.01%). Jerky products (100 g/pack) were randomly packed in nylon/LLDPE bags with 2 packaging treatments: VAC packaging and HSOS. The jerky was VAC packed by using a VAC packaging machine (Ramon, AK-Ramon, Spain). The HSOS samples were packed with an impulse sealer (ME-305HC, Mercier Corporation, Taiwan). An iron-based oxygen scavenger (Oxyfree 504, 200 mL, Tianhua Science, China) was added inside each package (1 sachet/pack) prior to heat sealing. The physicochemical and microbiological qualities were measured at 0, 15, 30, 45, 60, 75 and 90 days of storage at room temperature (32±2°C), while the sensory qualities were evaluated at 90 days; freshly prepared product (day 0) served as a control. Each treatment was replicated three times to account for any differences among batches (n = 3).

Moisture content: The moisture content was determined according to AOAC methods[18]. The finely chopped samples (3 g) were placed in aluminum moisture dishes and dried in an air oven at 105°C for 24 h. The moisture content was measured as the weight lost during drying and expressed as a percentage of the original weight. The moisture content was determined in triplicate for each treatment.

Water activity (a_w): Jerky samples from each treatment were cut into small pieces using sharp scissors and ground prior to measurement of a_w. Ground samples were placed in water activity pans and a_w was determined using a Novasina® LabMaster-a_w (Axair Ltd., Switzerland). The a_w of each treatment was determined in triplicate.

Thiobarbituric Acid Reactive Substances (TBARS): TBARS were determined to detect the extent of lipid oxidation according to the method of Buege and Aust[19]. Briefly, a sample (5 g) was added to a centrifuge tube (50 mL) with 25 mL of TBARS solution containing 0.0375% (w/v) TBARS, 15% (w/v) TCA and 0.25 M HCl. The mixture was homogenized for 1 min, heated at 100°C for 10 min, cooled to room temperature with running water for 10 min and centrifuged at a speed of 3,600 rpm for 25 min at 25°C. The absorbance of the supernatant was read at 532 nm using a double beam UV-VIS spectrophotometer (UV-1601, Shimadzu Corporation, Japan). The amount of TBARS was calculated using a standard curve produced from 1,1,3,3-Tetraethoxypropane (0-10 ppm malondialdehyde, MDA) and expressed as mg kg^{-1} MDA meat. Triplicate determinations were performed for each treatment.

Instrumental color: The surface color of the jerky sample was measured by the CIE L*a*b* system using a MiniScan EZ 4000L spectrophotometer (Hunter Lab Inc., USA) standardized with a white plate and black plate. Three replicates of each treatment were taken. The lightness (L*), redness (a*) and yellowness (b*) values were recorded. The chroma (1) and hue angle (2) were calculated from the Hunter L*, a* and b* values as follows:

$$\text{Chroma } (C^*) = (a^{*2}+b^{*2})^{1/2} \quad (1)$$

$$\text{Hue angle } (h^\circ) = \tan^{-1}(b^*/a^*) \quad (2)$$

Shear force: The shear force value was measured on the middle area of a jerky sample (10 mm × 30 mm × 5 mm) using a Warner-Bratzler shear blade attached to an Instron universal testing machine (model 1011, USA). The maximum force required to shear a sample was expressed in Newtons. Ten replicates of each treatment were analyzed.

Microbiological analysis: The samples (25 g) were placed in 225 mL of peptone water (0.1% sterile peptone, w/v) in a sterile stomacher bag. Samples were then homogenized using the Stomacher BagMixer 400 VW (Interscience Co., France) for 6 min and diluted with peptone water for microbial counts. Serial dilutions were performed in triplicate. The total plate count (TPC)[20] and *Staphylococcus aureus* count[21] in the product were determined according to methods in BAM. The number of colonies was counted and expressed as the logarithm of colony forming units per gram (log CFU g^{-1}).

Sensory evaluation: Three groups of jerky products underwent sensory evaluation: (1) Freshly prepared jerky at 0 day, (2) Jerky packed under VAC at 90 days and (3) Jerky packed via HSOS at 90 days. The sensory attributes, with regards to the color, flavor, texture, juiciness and overall acceptability of samples were evaluated using a 7-point hedonic scale by 20 trained panelists comprising researchers and meat science graduate students of the Department of Animal Production Technology and Fishery, KMITL. The evaluated scores ranged from 1-7 with the following ratings: 7 = Extremely liked, 6 = Moderately liked, 5 = Slightly liked, 4 = Indifferent, 3 = Slightly disliked, 2 = Moderately disliked and 1 = Extremely disliked. Panelists were served an unsalted cracker and water to refresh their palates between samples.

Statistical analysis: The variables regarding the physicochemical and microbiological quality were analyzed using the Generalized Linear Model (GLM) procedure. The model used the packaging method (VAC and HSOS) and storage time (0, 15, 30, 45, 60, 75 and 90 days) as fixed factors. When a significant effect was found, mean values were compared by Duncan's Multiple Range Test (DMRT). Pearson's correlation coefficients were calculated to find the correlations among parameters. Sensory results were evaluated by one-way ANOVA and means were compared by DMRT. Analysis was performed using the SPSS package (SPSS 17.0 for windows, SPSS Inc., Chicago, IL, USA).

RESULTS AND DISCUSSION

Changes in the moisture content and a_w during storage: The changes in the moisture content of jerky over 90 days are shown in Fig. 1a. The moisture contents were stable at 0 and 30 days, with values ranging from 18.6-19.8% and then rapidly

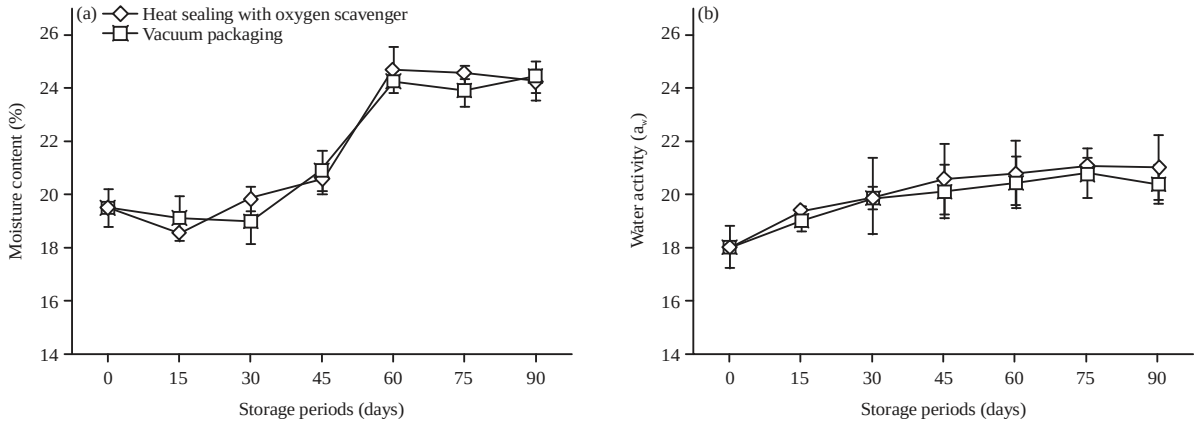

Fig. 1(a-b): Changes in the (a) Moisture content and (b) a_w of spent hen jerky packed using different packaging methods during 90 days of storage at room temperature

Bars represent the standard deviation among the jerky processing batches (n = 3)

Table 1: Pearson's correlation coefficients (r) between the quality parameters of jerky processed from spent hen meat

	Moisture	a_w	TBARS	L*	a*	b*	Chroma	Hue angle	Shear
a_w	0.569‡								
TBARS	0.214	0.222							
L*	0.400‡	0.621‡	-0.011						
a*	-0.514‡	-0.534‡	-0.791‡	-0.196					
b*	-0.381†	-0.344†	-0.845‡	-0.047	0.902‡				
Chroma	-0.448‡	-0.421‡	-0.840‡	-0.090	0.960‡	0.986‡			
Hue angle	0.583‡	0.557‡	0.527‡	0.189	-0.856‡	-0.590‡	-0.713‡		
Shear	0.674‡	0.451‡	0.333†	0.230	-0.505‡	-0.487‡	-0.517‡	0.489‡	
TPC	0.637‡	0.535‡	0.501‡	0.321†	-0.708‡	-0.664‡	-0.697‡	0.594‡	0.594‡

†Correlation is significant at p<0.05. ‡Correlation is significant at p<0.01

increased, with the highest value observed at 60 days (24.3-24.7%) (p<0.05). Thereafter, the moisture contents of samples were stable between 60 and 90 days (p>0.05). However, an effect of the packaging method on the moisture content was not found (p>0.05). The a_w values of products stored between 45 and 90 days in both types of packaging were also higher than those stored for 15 days (p<0.05) (Fig. 1b). Unsurprisingly, the a_w values of jerky packed using different packaging methods were not significantly different (p>0.05). There was a positive significant correlation between the water content and a_w (r = 0.569, p<0.01) (Table 1). In fact, the absorption of moisture by semi-dried products such as jerky during storage depends on the Water-Vapor Transmission Rate (WVTR) of the packaging bags. In the case of a laminated nylon/ Linear Low Density Polyethylene (LLDPE) film bag, which was the packaging material used in this study, nylon provides excellent thermostability, high tensile strength and good barrier properties against oxygen and other gases, while PE acts as a moisture barrier (WVTR of approximately 7-24 g mm^{-2}/day at 38°C) and has heat sealability[22]. Since the type of bags used in the VAC and HSOS treatments was the same, provided similar amounts of water transfer from the environment into the jerky product and resulted in jerky with increased moisture contents and a_w values during prolonged storage.

Changes in TBARS during storage: The differences in TBARS between packaging methods during storage are shown in Fig. 2. Obviously, jerky packed under VAC contained more TBARS than that packed via HSOS over 90 days of storage (p<0.05). Notably, there were small changes in the levels of TBARS in the HSOS samples during storage, but the amount of TBARS progressively increased in the VAC samples as the storage time increased. The fat (approximately 4.8% in the present study) contained in jerky generally deteriorates upon reaction with oxygen. Furthermore, light and heat could facilitate oxidation during prolonged storage; this enhanced oxidation increased the content of TBARS in jerky packed under VAC at 90 days (~10.97 mg MDA kg^{-1} meat) compared to that at 0 day (~7.22 mg MDA kg^{-1} meat) (p<0.05). However, the content of TBARS in jerky packed via HSOS at 90 days (~7.83 mg MDA kg^{-1} meat) was similar to that at 0 day (~7.22 mg MDA kg^{-1} meat) (p>0.05). These findings indicated that jerky packed under VAC was more susceptible to lipid oxidation than that packed via HSOS during storage. VAC

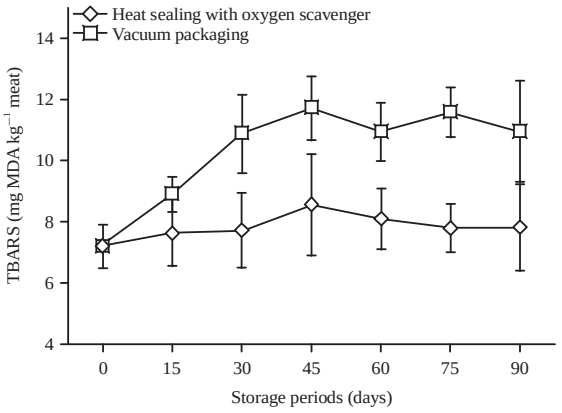

Fig. 2: Changes in TBARS in spent hen jerky packed using different packaging methods during 90 days of storage at room temperature

Bars represent the standard deviation among the jerky processing batches (n = 3)

packaging and active packaging with an oxygen-scavenging sachet have been widely applied to exclude oxygen from the headspace[23]. However, VAC technology does not remove oxygen completely and a residual oxygen concentration of approximately <1% (v/v) is commonly observed in VAC packaging[11-12]. Moreover, the oxygen that permeates through the packaging cannot be removed by this technique[24]. More appropriate approaches include the use of an oxygen-scavenging sachet that is able to reduce and maintain the oxygen concentration at levels below 0.01% (v/v) in the package[24-25]. Normally, spent hen meat is particularly susceptible to lipid oxidation, as it has a high proportion of unsaturated fatty acids such as oleic acid (43.85%) and linoleic acid (18.65%)[17]. However, in contrast to the VAC conditions, oxygen-free conditions are maintained in the HSOS packaging. Such oxygen-free conditions limits the oxidation of these lipids and potentially decreases the generation of peroxides, radical species and secondary oxidation products that impact the flavor, color and product texture, thereby increasing the shelf life of jerky packed via HSOS during extended storage.

Changes in color during storage: The instrumental surface color parameters including the CIE L*, a* and b*; chroma and hue angle are illustrated in Fig. 3. During storage, the lightness of the product represented by L* continuously increased ($p<0.05$) (Fig. 3a), where an increase in L* was significantly correlated with increases in the moisture content ($r = 0.400$, $p<0.01$) and a_w ($r = 0.621$, $p<0.01$) (Table 1). This correlation implied that a lightening in the color of jerky during prolonged storage might be indicated by increased light scattering. The redness and yellowness of jerky samples significantly decreased during storage ($p<0.05$), with greater declines detected in the VAC than HSOS treatment ($p<0.05$), as shown in Fig. 3b and c. Regarding the chroma value, which refers to the vividness or dullness of a color, the vividness of the jerky color decreased during storage, as indicated by reductions in the chroma values ($p<0.05$) (Fig. 3d). Moreover, the product packed under VAC also rapidly decreased in vividness compared to the product packed via HSOS ($p<0.05$). The hue angle parameter represents the perceived meat color and provides a good indicator of the color stability of meat during display[26]. The hue angle in meat and meat products typically ranges from 0° (red color) to 90° (yellow color), with larger angles indicating less red color[26]. In the present study, jerky with short storage times had lower hue angles than jerky with longer storage times ($p<0.05$), which had values ranging from 51.5° to approximately 54.1-58.5° (depending on the packaging method), representing a change from the red to orange axis. In addition, the effect became stronger for the product packed under VAC, indicating that jerky packed under VAC had a lower redness, as indicated by a higher huge angle than that packed via HSOS ($p<0.05$). These results are in agreement with those of Moller *et al.*[27], who investigated the color stability of cured ham under different packaging and storage conditions. These authors found that the redness, which was measured by CIE a*, decreased with an increased residual oxygen level in the packaging and increased storage time. In another case, a decrease in chroma could be considered an indicator of the accumulation of metmyoglobin on the meat surface[28].

In terms of the correlation between lipid oxidation and color, there were significant correlations between the content of TBARS and a* ($r = -0.791$, $p<0.01$), b* ($r = -0.845$, $p<0.01$), chroma ($r = -0.840$, $p<0.01$) and hue angle ($r = 0.527$, $p<0.01$) (Table 1). Varnam[29] suggested that the lipid oxidation of dried meat is often accompanied by metmyoglobin formation. Under some circumstances, this hematin pigment may degrade, with the formation of green, yellow or colorless pigments as well as globin[29]. Therefore, in the presence of a sufficient oxygen scavenger to maintain a low oxygen level in the package, the lipid oxidation and discoloration of spent hen jerky, especially in terms of the brightness, redness and yellowness, were prolonged. These results could be confirmed by the jerky picture illustrated in Fig. 3f, where jerky packed via HSOS and stored for 90 days had a brighter and more intense red color, while that packed under VAC exhibited a duller color, with gray (lower chroma value) being more dominant.

Changes in the shear force during storage: The shear forces of the packed products are reported in Fig. 4. The shear force

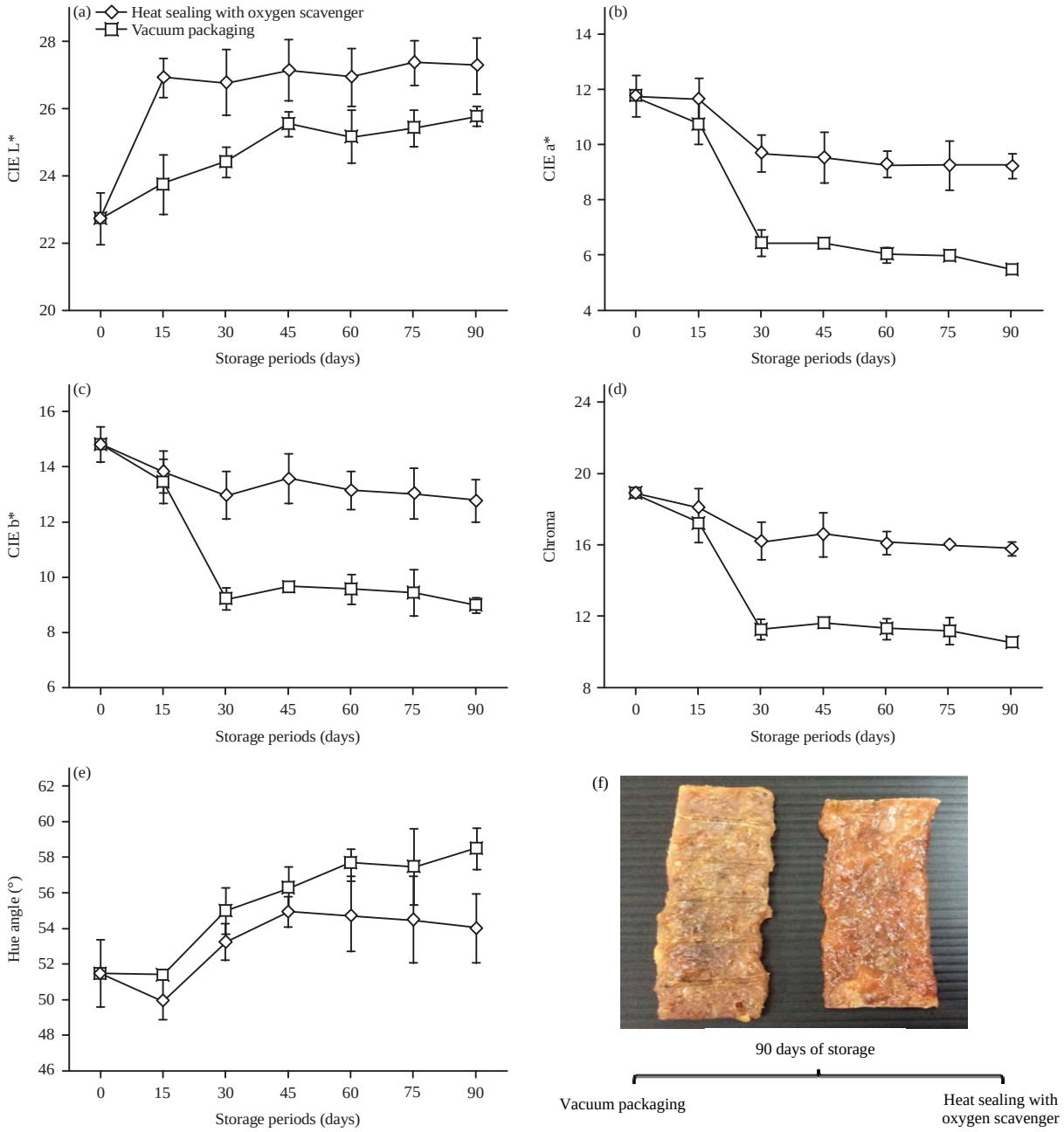

Fig. 3(a-f): Changes in the (a) CIE L*, (b) CIE b*, (c) CIE a*, (d) Chroma, (e) Huge angle and (f) Representative product images of spent hen jerky packed using different packaging methods during 90 days of storage at room temperature
Bars represent the standard deviation among the jerky processing batches (n = 3)

of jerky packed in both the VAC and HSOS packages slightly increased during storage ($p<0.05$) and there were no significant differences between the packaging methods ($p>0.05$). A significant correlation between the shear force and content of TBARS ($r = 0.333$; $p<0.05$) was found (Table 1). Although lipid oxidation in the VAC samples was higher than that in the HSOS samples, this difference was not enough to differentiate the texture among these jerky samples ($p>0.05$). These results are in agreement with those of Choi *et al.*[30], who found that the hardness of jerky increased as the storage time increased and there were no significant differences between jerky packed in plastic and VAC packaging. In meat, the oxidation of protein progresses via a free radical chain reaction similar to lipid oxidation, resulting in decreases in several of the edible qualities, such as reduced tenderness and juiciness, flavor deterioration and discoloration[31]. The increase

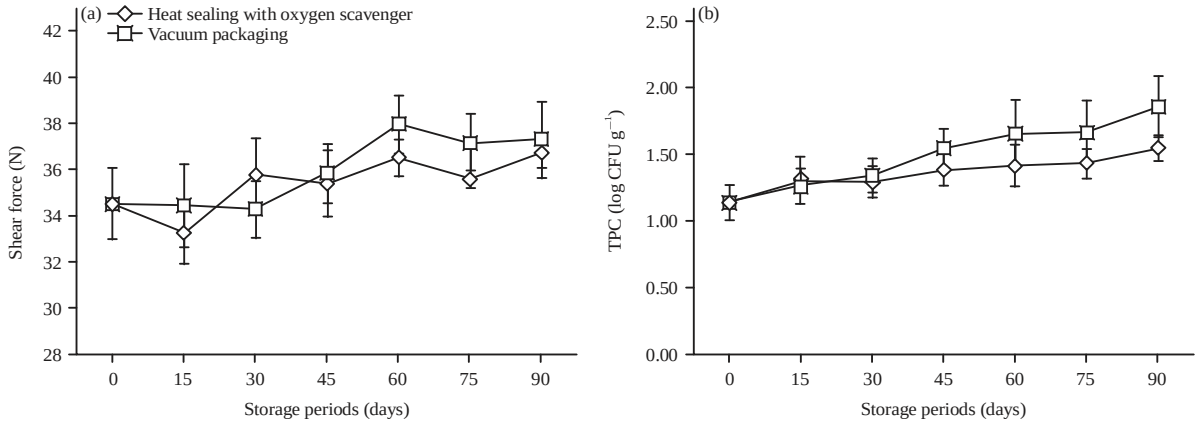

Fig. 4(a-b): Changes in the (a) Shear force and (b) TPC of spent hen jerky packed using different packaging methods during 90 days of storage at room temperature

Bars represent the standard deviation among the jerky processing batches (n = 3)

Table 2: Hedonic scores of the sensory attributes of jerky packed using different packaging methods stored at 0 day (freshly prepared jerky) and 90 days

		90 days	
Attributes	0 day	VAC	HSOS
Color	5.30±1.08[a,†,‡]	4.10±0.85[b]	4.70±0.69[ab]
Flavor	5.42±0.89[a]	4.03±0.75[b]	5.04±0.99[a]
Texture	4.71±1.07[a]	4.52±0.97[a]	4.57±1.29[a]
Juiciness	4.61±0.85[a]	4.37±1.06[a]	4.51±1.27[a]
Overall acceptability	5.20±0.99[a]	4.00±0.79[b]	5.09±1.24[a]

†Values are given as the Mean±SD among jerky processing batches (n = 3). ‡Different superscripts in the same row indicate significant differences (p<0.05)

in shear force during storage might be caused by the cross-linking of myofibrillar protein and strengthening of the myofibrillar structure, as occurs in pork. Lund *et al.*[32] stated that the myosin heavy chains (MHCs) of pork stored in a high-oxygen atmosphere were found to form intermolecular cross-links, leading to significantly less tender meat compared to storage without oxygen (no myosin cross-linking was observed). Moreover, Lund *et al.*[33] suggested that MHC cross-linking via disulfide bonds between cysteine residues with other MHCs also increased, thus strengthening the myofibrillar protein of pork stored in a high-oxygen atmosphere and potentially explaining the observed reduction in tenderness over time.

Changes in microbiology during storage: The TPC was determined to investigate the microbial growth under aerobic conditions. The results showed that jerky stored for 60-90 days had a higher TPC than that stored for 15 days ($p<0.05$) (Fig. 4b), reflecting microbial growth during prolonged storage. Moreover, a lower abundance of microbes was found in the HSOS samples than in the VAC samples ($p<0.05$). This result indicated that an oxygen scavenger could reduce aerobic microbial growth by removing the residual oxygen in the packed product. Nevertheless, *Staphylococcus aureus* (*S. aureus*) was not detected in all samples during storage (data not shown). Huang and Nip[34] suggested that in an intermediate-moisture meat product with an a_w of approximately 0.6-0.9, microbial spoilage is generally the most important problem during product storage. Of the photogenic bacteria, *S. aureus* is the most concerning due to its ability to produce toxins at a_w values as low as 0.85[35]. The lower level of microbial growth together with the non-detectable amount of *S. aureus* in jerky packed with both packing methods meant that these products were safe from spoilage and pathogenic bacteria when stored for 90 days.

Sensory evaluation of jerky stored for 90 days and a fresh sample: According to the sensory evaluation results (Table 2), after 90 days of storage, there were no significant differences in the texture and juiciness between jerky at 0 and at 90 days packed in both the VAC and HSOS packaging ($p>0.05$). Nevertheless, jerky packed under VAC at 90 days showed lower color and flavor scores, resulting in decreased overall acceptability, than the product at 0 day ($p<0.05$). The lower color score of these VAC samples evaluated by the panelists corresponded to a lower intensity of red color and higher dullness of the product, as described in a previous section. Furthermore, the lower score of the product flavor of the VAC sample at 90 days, which could be detected by the panelists, might be related to the deteriorated flavors or loss of flavor intensity via oxidation. Jayasena *et al.*[36] stated that because chicken meat contains higher levels of unsaturated fatty acids than red meat, chicken meat is more susceptible to lipid

oxidation, resulting in off-flavors. Therefore, the packaging that best prevented oxidative changes to lipids was HSOS; this protection led to the generation of desirable flavor compounds in jerky kept at ambient temperature.

CONCLUSION

The results from this study demonstrated that jerky made from spent hen meat packed in HSOS packaging underwent less oxidative deterioration, reflected by a less TBARS and higher vividness and redness and had less microbial growth during 90 days of storage than that packed under VAC. According to a sensory evaluation, the product packed via HSOS at 90 days had a better color and flavor than that packed under VAC at 90 days but was not significantly different in color or flavor from the product at 0 day. Therefore, the HSOS method is suitable packaging to retard microbial growth and lipid oxidation, maintain color and reduce off-flavors in spent hen jerky stored for 90 days under ambient temperature; jerky stored in this way remained comparable to a fresh sample.

SIGNIFICANCE STATEMENT

This study discovers that heat sealing with an oxygen scavenger is a more suitable packaging method for preserving the quality of spent hen jerky than vacuum packaging. This finding may be beneficial for extending the shelf life of this product. This study will help researchers to uncover the critical areas in the quality deterioration of jerky processed from spent hen meat with respect to physicochemical, microbiological and sensory qualities among these two candidate packaging methods, which had not been previously explored. Thus, information about these changes and effective packaging to increase the storage stability of spent hen jerky is provided.

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