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Effects of Storage on The Quality of Sous Vide Processed Lamb Liver

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Abstract

This study aimed to assess the changes in quality of lamb liver sous vide during refrigerated storage. Liver sous vide was prepared and stored at (3 °C). Samples were packaged under vacuum into polyamide-polyethylene pouches, cooked in a boiling water bath at 80 °C for 40 min, and stored at 3°C for 0, 2, 4, 6, 8 and 10 weeks. Sensory, microbiological (total aerobic), chemical (pH), color (L*, a*, b* values), cooking weight loss and water content were performed on liver samples every week. Minor changes in water content, cooking weight loss, Hunter Lab color, and sensory score were observed through 10 weeks. Major microbiological change was observed in 5 weeks (2 log cfu/g). The liver sample was unacceptable after 8 weeks. Instrumental texture measures (texture profile analysis, TPA) showed a small change in hardness, springiness and chewiness values in sous vide processed samples during storage time.

Key Words: Sous vide, Liver, Storage effect, Sensory, Chemical changes

Vakumda Paketlenip Pişirilmiş Kuzu Karaciğerinin Depolanma Esnasındaki Kalite Parametreleri

Öz

Bu çalışma da vakum altında paketlenip pişirilmiş (Sous vide) sonrasında da buzdolabı sıcaklığında (3 °C) saklanan kuzu ciğerinin kalitesindeki değişimler incelenmiştir. Numuneler vakum altında poliamid polietilen torbalar içine paketlenerek 40 dakika boyunca 80 °C'lik bir su banyosunda pişirilmiş ve 0, 2 ,4, 6, 8 ve 10 hafta süreyle 3 °C'de saklanmıştır. Her hafta ciğer örnekleri üzerinde duyusal, mikrobiyolojik (toplam aerobik), kimyasal (pH), CIE lab renk (L *, a *, b * değerleri), pişme ağırlığı kaybı ve su miktarı analizleri yapılmıştır. On hafta depolama esnasında su miktarında, pişme ağırlığı kaybı değerlerinde, CIE Lab renk değerlerinde ve duyusal analiz puanlarında küçük değişiklikler belirlenmiştir. Mikrobiyolojik olarak en fazla değişim beşinci haftada (2 log kob /g) gözlenmiştir. Ciğer örneklerinin 8 hafta sonra kabul edilemez hale geldikleri belirlenmiştir. Enstrümantal doku ölçümlerinde (doku profil analizi, TPA), depolama süresince numunelerde sertlik, adezif yapışkanlık kohezif yapışkanlık ve esneklik bakımından küçük değişiklikler olduğu gözlenmiştir.

Anahtar Kelimeler: Vakumda pişirme (sous vide), Ciğer depolama etkisi, Duyusal analiz, Kimyasal değişme

Introduction

The shelf life of internal organs of animals such as liver is limited due to the spoilage attributed to microbial activity, chemical and biochemical changes. It has been extensively adopted by catering services and food processing to provide foods of superior sensory quality with a longer shelf-life compared with conventional cook-chill, sous vide technologies (Sanchez et al., 2012). Processing meat products at low (<100 °C) temperatures and subsequent rapid chilling and storage under refrigerated conditions (0–3 °C) is considered to offer enhanced product quality and extended shelf-life (Church and Parsons, 1993; Armstrong and Mcilveen, 2000).

The French term *sous vide* is translated as 'under vacuum' and as the term suggests is a cooking technique where food products are heated under vacuum within sealed plastic pouches at low temperatures for long dwell times. This cooking technique is reported to improve meat flavor where the use of vacuum packaging reduces the development of potential oxidative off-flavours. Sous-vide cooking of vacuum packaged meats at relatively low temperatures and long cooking times has many advantages such as controlling the temperature (Baldwin, 2012). Therefore, the negative impact on nutrients (such as proteins and lipids) is minimized, while texture is changed. At the same time, the loss of liquids and volatile compounds is prevented or minimized, resulting in foods that taste and smell better (Díaz et al., 2008). Flow chart of "Sous Vide" technology is shown in Figure 1.

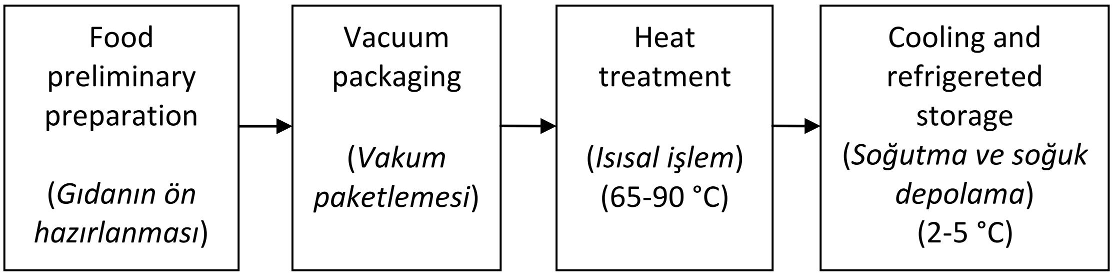

Figure 1. Process steps of "Sous Vide" technology
Şekil 1. "Sous vide" teknolojisinin üretim aşamaları

Sous vide has been extensively adopted by catering services and food processing to provide foods of superior sensory quality with a longer shelf-life compared with conventional cook-chill technologies (Sanchez et al., 2012). Several studies (Creed, 1995; Armstrong and Mcilveen, 2000; Vaudagna et al., 2002) have shown that the sous vide technique has a positive effect on meat and meat products. Sous-vide products provide further benefits, in that they need smaller amounts of preservatives and the retention of natural juices could enhance the texture and nutritional value of the product. Sous vide has considerable potential in the development of meat products suitable for elderly consumers. (Botinestean et al., 2016)

The aim of the present research was to evaluate the physical, chemical and sensory properties of *sous vide* cooked liver during refrigerated storage.

Materials and Methods

Fresh sheep liver was bought from a local butcher at Gaziantep, Turkey. After cleaning and removing the membrane, 150 ±10 gram liver samples are packed in 90 µm polyethylene (PE) and polyamide (PA) pouches (composed of %30 PA and %70 PE). The size of pouches was 20x30 cm. These packs were placed in an boiling water bath for cooking, cooking was continued for 40 min when core temperature reached 80 ^{o}C. Core temperature was monitored using a Digisense 12 channel Cole Palmer **(**Vernon Hills, IL, USA) data logger**.** After heat processing, the products were immediately chilled by immersion in ice-cold water mixture. After cooling, packs were kept in a refrigerator (3ºC). Duplicate samples were taken from each batch at regular intervals and were analyzed for changes in chemical, microbial, and sensory quality of liver.

Water content

The moisture content was determined by the oven method according to Official Method of Analysis (AOAC, 1995).The measurements were carried out in triplicate.

pH

The pH value of the sample was determined using a pH meter (Jenway 3010; Jenway LTD, Essex, UK) equipped with a J95, 924001 electrode (Jenway LTD, Essex,UK). The measurement of pH value was carried out on 1 g of sample homogenized in distilled water (1/10: sample/water).

Cooking weight loss

After cooking treatment, liver samples were cooled at room temperature, surface-dried with a filter paper, and re-weighed using an analytical balance. Cooking losses were calculated from differences in raw weight and cooked liver.

Surface color determination

The surface color measurement of liver samples were performed using HunterLab ColorFlex (A60-1010-615 Model Colorimeter, HunterLab, and Reston VA) during production. The L*, a*, b* color values were used to express the color changes. The color values are express as L* (darkness/whiteness), a* (greenness /redness), b* (blueness/yellowness) values. Five measurements were taken for all samples and average values were shown. The instrument was calibrated against the standard reference white tile "L*=93.41, a*=-1.12, b*=1.07".

Aerobic plate counts

Aerobic plate counts (APC) were made using the Spread Plate Method on Aerobic Plate Count Agar as described by Erkmen (2000). The plates were incubated at 37 °C for 24 to 72 h.

Instrumental Texture Profile Analysis (TPA)

TPA tests were performed using a TA.XT2 Texture Analyzer (Texture

Technologies Corp., Scarsdale, NY/Stable Microsystems, Godalming, UK) after liver samples' temperatures were equilibrated to room temperature (~20°C). Test conditions were: aluminum rectangular probe (4 cm × 5 cm); test speed 1 mm/s; pre-test speed 2 mm/s, post-test speed 1 mm/s; compression (strain) 25%; and 25 kg load cell. Data collection and calculation were done using the Texture Expert Exceed Version 2.3.

Sensory Analysis

Sensory attributes (flavour, colour and ease of cutting) of 25 g of liver samples were evaluated during the storage period, twice for each sample, by a panel of 10 trained panelists (Bozkurt and Erkmen, 2004). Panelists gave a score for each sample with respect to their perceptions of flavour and colour from 1 (worst) to 10 (best). Cutting scores were evaluated by panelists by assessing whether the liver was easily cut or stuck to the knife, on a scale of 10 (best) to 1 (worst). The overall sensory quality of liver samples was determined from the below equation 1.

$$\text{Overall sensory quality} = (\text{flavor} \times 0.50) + (\text{color} \times 0.25) + (\text{cutting} \times 0.25) \quad (1)$$

Statistical Analyses

All statistical analyses were performed using SPSS for Windows v.16.0 (SPSS, Chicago, IL, USA). Depending on obtained results, variance analyses were achieved and Duncan multiple range test was applied to all the results.

Results and Discussion

The cooking weight loss (CWL) was determined for fresh and sous vide processed liver samples (Figure 2). This was an indication of the difference between the weight of the liver meat before and after cooking on a sous vide system at 80 °C. Storage affected cooking weight slightly by storage time. CWL was improved by cooking under vacuum in plastic pouches. In an open system we expect more cooking weight loss after heat treatment. The cooking yield has been reported as an important criteria to predict behaviour of the meat products during cooking (Pietrasik and Duda, 2000).

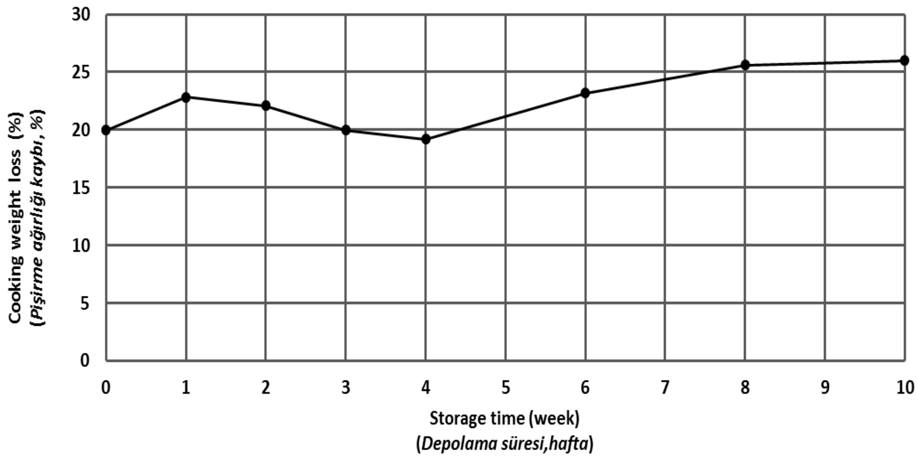

Figure 2. Cooking weight loss (%) by storage time at 3°C

Şekil 2. Depolama süresince (3 °C) pişirme ağırlığı kaybı (%)

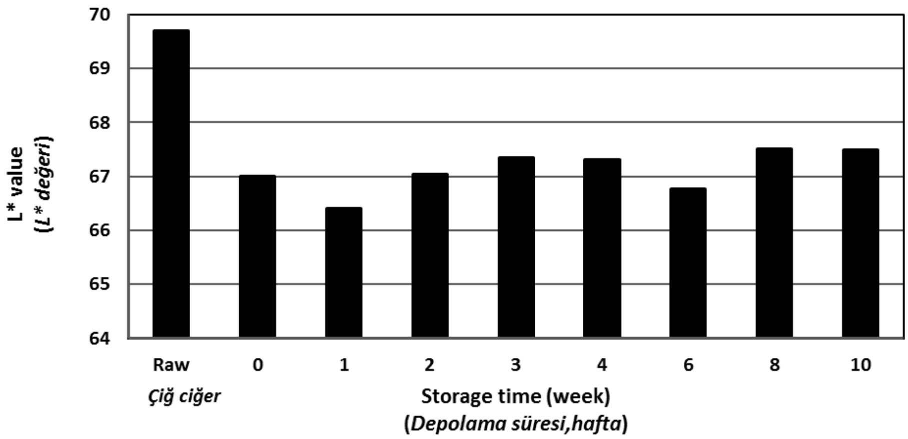

Figure 3. Water content by storage time at 3°C

Şekil 3. Depolama süresince (3°C) su içeriğindeki değişimler

Water content of raw liver meat was measured as 69.7%. As it is seen in Figure 3, water content of processed samples was around 67.3%. Cooking under vacuum within sous vide pouches provided only about 2.8 % water loss during 10 weeks storage time.

pH values of liver samples were followed during the storage and the results are given in Figure 4. During the 8 weeks of storage, the pH values were around 6.15-6.23. After 8 weeks, the pH value decreased ($P < 0.05$) from 6.25 to 4.45. After 8 weeks, the activity of bacteria would be maximum for production of organic acids.

The color of the meat is an important characteristic from a commercial point of view because consumers reject meat with darker color in general as a result of associating dark coloration with deterioration. With cooking several changes in the appearance and physical properties of meats occur due heating processes. These changes include discoloration of the meats, due to the oxidization of pigment heme groups.

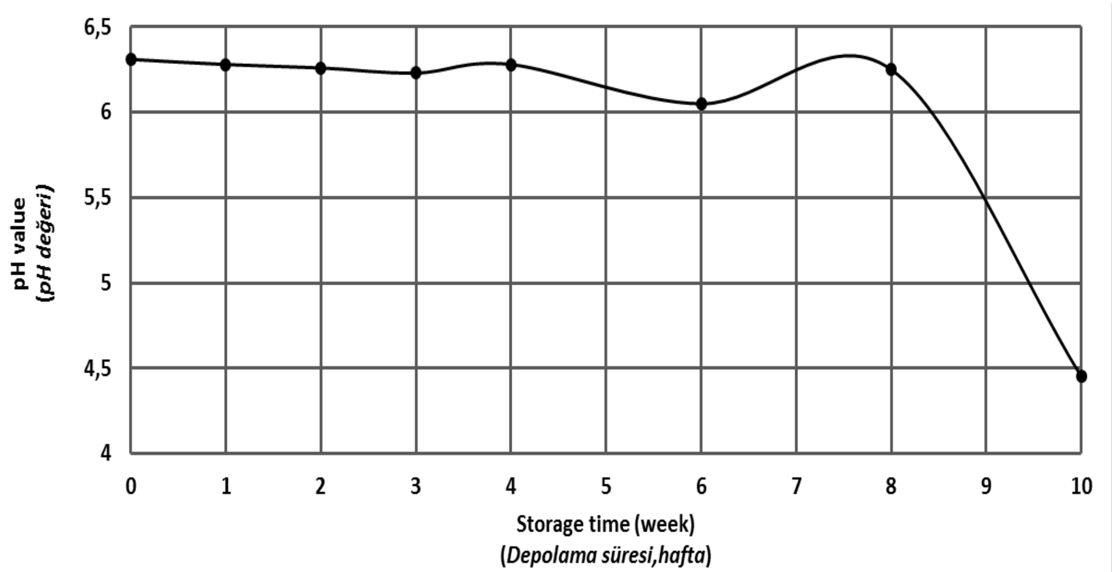

Figure 4. pH values change by storage time at 3°C
Şekil 4. Depolama süresince (3 °C) pH değerindeki değişimler

Color values of liver samples were followed during the storage and the results are given in Figures 5-7. There was no difference statistically (P > 0.05) in L*, a*, and b* indices of the processed liver samples during storage period (Figures 5-7).

However, heat treatment caused an increase in the L *(P < 0.05), and b* values (P < 0.05), as well as a decrease in a* index (P < 0.05) compared to fresh liver meat.

The liver samples cooked at cook-vide system had *L** values that were significantly higher (*p* < 0.05) than the values corresponding to raw samples. A higher *L** value indicates a lighter color, which is desirable in order to ensure that the meat products will have high consumer acceptance (Resurrección, 2003).

Meat color is an important predictor of tenderness and is dictated by the pH level, which, in turn, defines the water retention capacity of the surface structure for increasing and decreasing light absorbances, thus explaining the correction among the L*,a*, and b*variables. However, no attempt made for correlating color values to hardness.

The *a** values were lower (*p* < 0.05) for liver samples cooked at sous-vide system than raw liver samples. This indicates less myoglobin degradation occurred by sous vide cooking. The blue-yellow chromatically (*b**) values were also significantly lower for the raw samples than for the samples cooked at the vacuum.

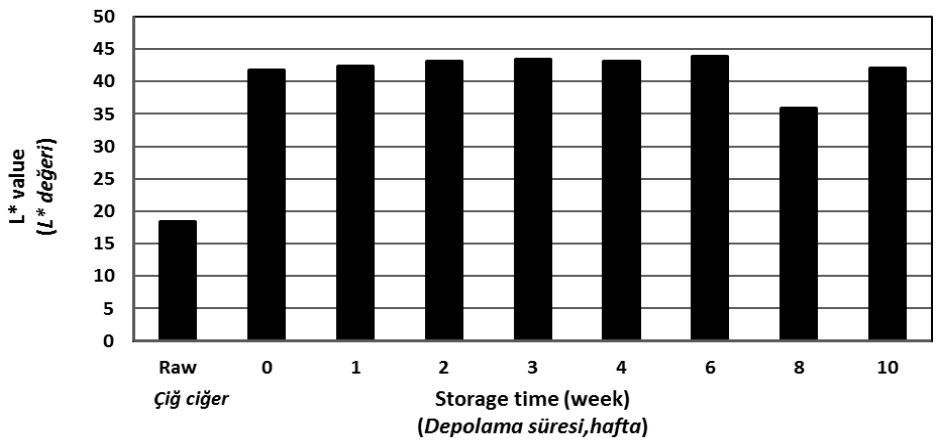

Figure 5. L*(color) values by storage time at 3°C

Şekil 5. Depolama süresince (3 °C) L renk değerleri*

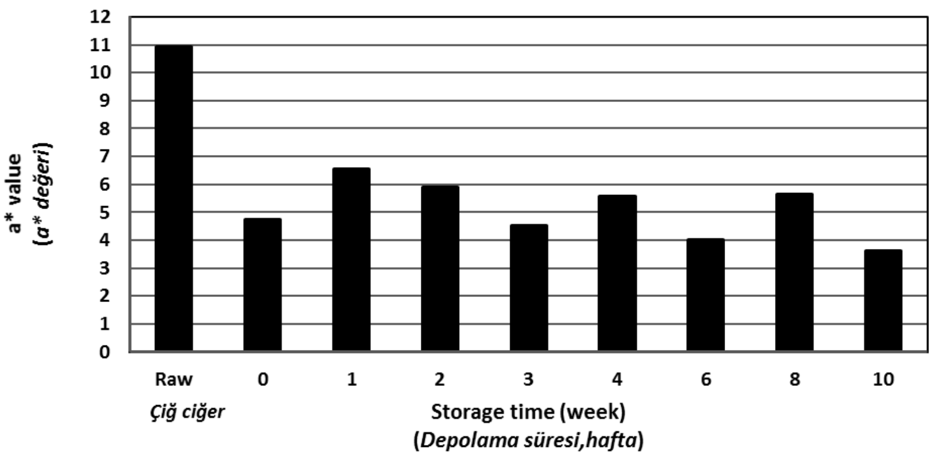

Figure 6. a*(color) values by storage time at 3°C

Şekil 6. Depolama süresince (3 °C) a renk değerleri*

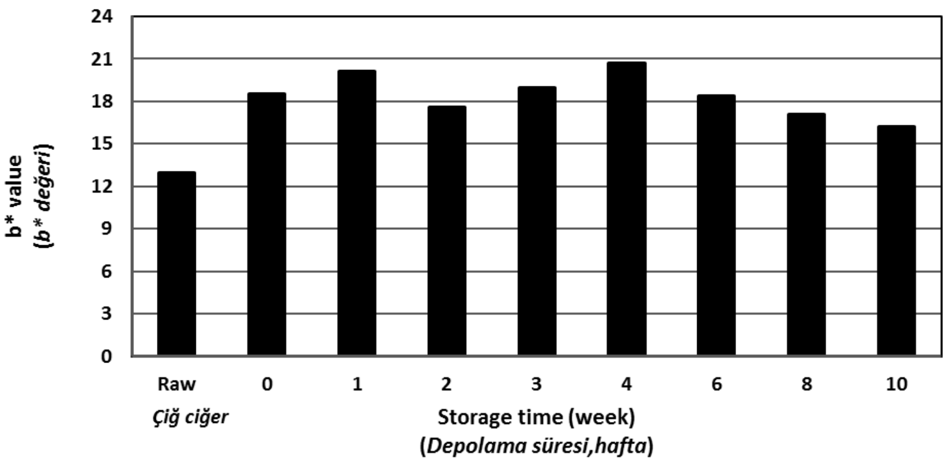

Figure 7. b*(color) values by storage time at 3°C

Şekil 7. Depolama süresince (3 °C) b renk değerleri*

Overall sensory quality scores were evaluated using an equation 1 proposed by (Bozkurt and Erkmen, 2004) and the results are given in Figure 8. It was found that the overall sensory quality of liver was not affected till the end of week 8. The results of sensory analysis suggest that the liver samples were unacceptable after 8 weeks of storage at 3°C. This result is supported by microbial quality assays which indicated that liver samples were extremely high in microbial load after 8 weeks (Figure 9). Since it was impossible to count number of microorganisms after 6 weeks. The sensory analysis can be considered as the most effective method for determining the shelf life of the samples.

The results of the microbial quality assays in liver samples treated with *sous vide* cook–chill procedure is shown in Figure 9. For liver samples, no aerobic plate count was detected in any samples studied up to 4 weeks. Total plate counts in the products studied were in the range of 0-3.69 log_{10} cfu g^{-1} in 4 weeks. These are all under the maximum 5 log_{10} cfu/g specification given in the microbiological guidelines (Hassell and Salter, 2003). For liver samples, the two higher values of the APC, 5.0 and 5.4 log_{10} cfu g^{-1}, were obtained with 5 and 6 weeks storage, respectively (Figure 9). The literature indicates that microbiological quality of cooked meat can be ensured by Sous Vide pasteurization. Nyati (2000) studied the microbiological quality of several SV meat-based dishes cooked at an internal temperature of 70 °C for 2 min and stored up to five weeks at 3°C. For SV pork loins, total plate counts of 3 log cfu g^{-1} were found after five weeks. No aerobic plate count (too numerous to count, TNTC) was possible after 6 weeks. It was decided to observe chemical (pH), color (L*, a*, b* values), cooking weight loss, water content and TPA values up to 10 weeks since sensory scores were still good in 6 and 8 weeks.

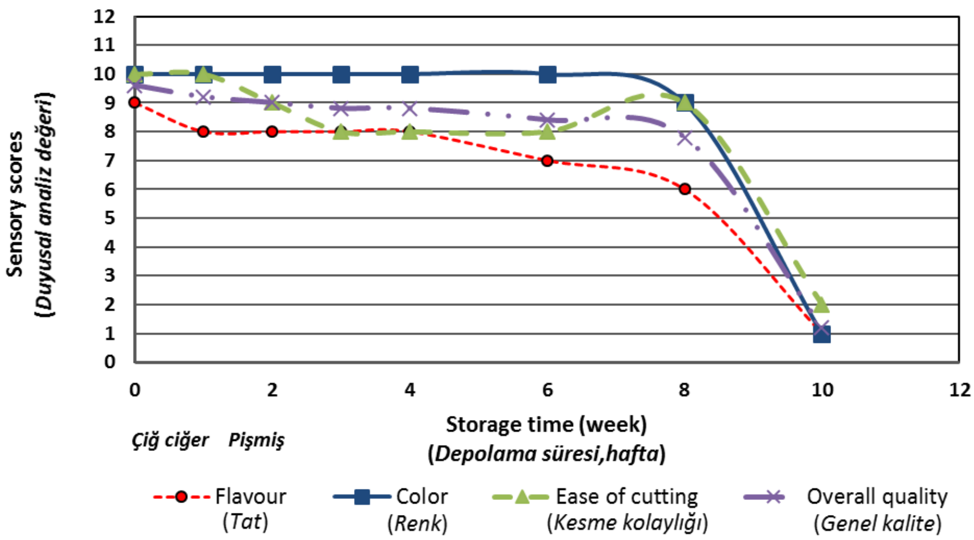

Figure 8. Sensory score values of liver samples by storage time at 3°C

Şekil 8. Depolama süresince (3 °C) ciğerlerin duyusal analiz değerleri

Texture profile of sous vide treated liver was followed during the 10 weeks storage at 3°C and the results are shown in Figures 10-13. When texture has been assessed by means of a TPA, values of springiness and of chewiness, of adhesiveness were almost constant as storage time increased. Hardness was the most variable parameter, and it increased by time ($P<0.05$). Hardness ranged from 6 to 10.6 N for cooked samples.

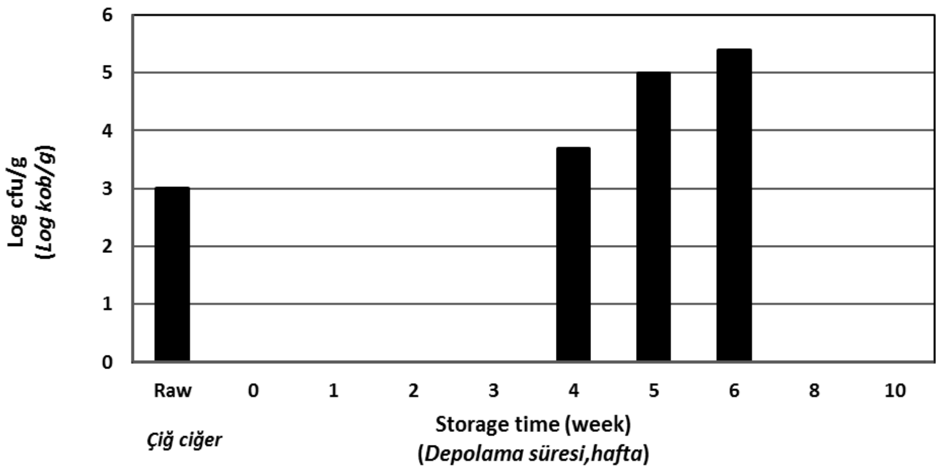

Figure 9. Microbiological profile (APC) of liver samples elaborated with sous vide method
Şekil 9. Vakumda paketlenip pişirilen ciğerlerin toplam mezofilik aerobik bakteri (TMAB) sayım değerleri

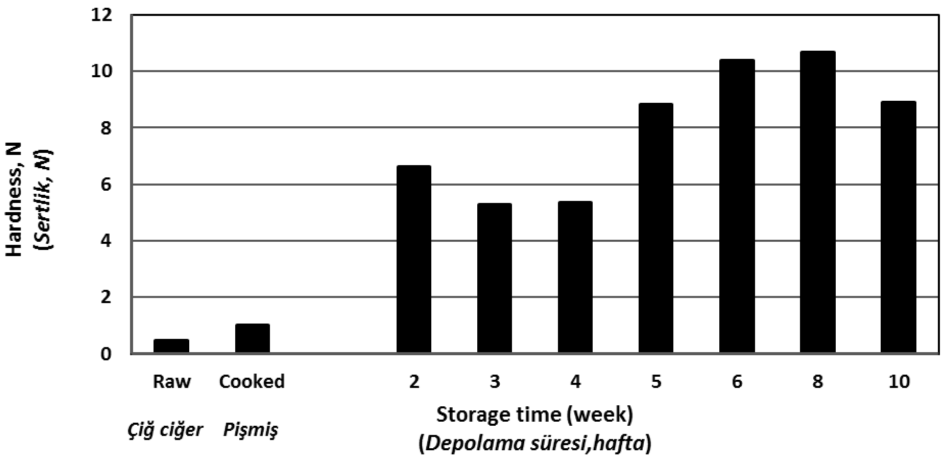

Figure 10. Hardness (TPA) of liver samples elaborated with sous vide method
Şekil 10. Vakumda paketlenip pişirilen ciğerlerinTPA sertlik değerleri

Absolute values are shown for adhesiveness (Figure 11). Adhesiveness (work necessary to pull the compression anvil away from the sample) was almost constant throughout the storage time for sous vide processed samples. Adhesiveness decreased with cooking process.

Springiness and cohesiveness values were almost constant throughout the storage time for all samples, Figure 12 and Figure 13, respectively.

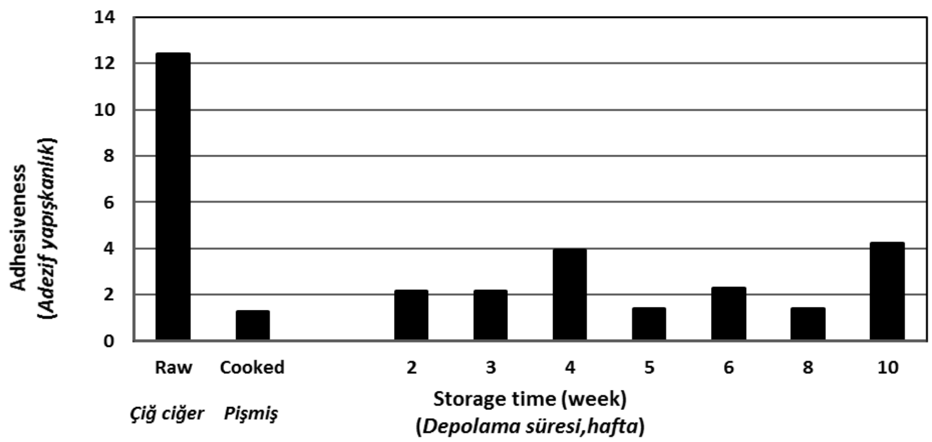

Figure 11. Adhesiveness (TPA) of liver samples elaborated with sous vide method
Şekil 11. Vakumda paketlenip pişirilen ciğerlerinTPA adezif yapışkanlık değerleri

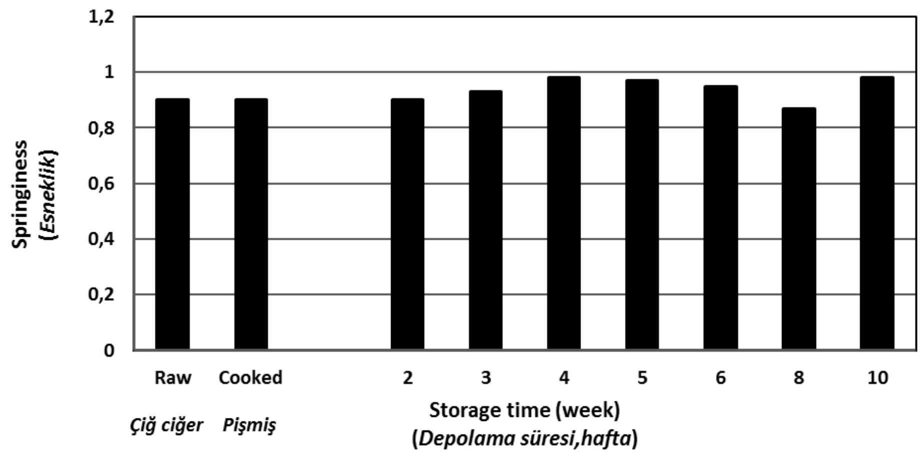

Figure 12. Springiness (TPA) of liver samples elaborated with sous vide method
Şekil 12. Vakumda paketlenip pişirilen ciğerlerinTPA esneklik değerleri

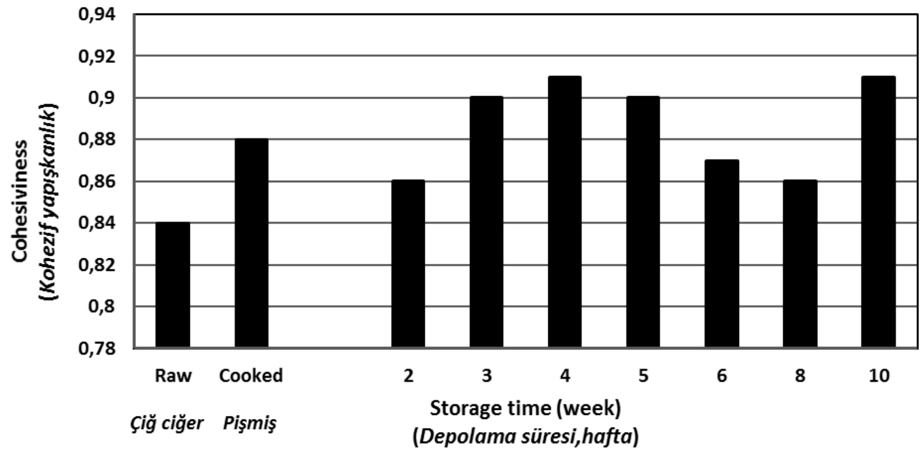

Figure 13. Cohesiveness (TPA) of liver samples elaborated with sous vide method
Şekil 13. Vakumda paketlenip pişirilen ciğerlerin TPA kohezif yapışkanlık değerleri

An attempt made to correlate sensory scores to instrumental parameters (TPA values), however sensory parameters are very poorly correlated to instrumental parameters.

The findings of this study also indicate that the application of sous vide technology to liver meat samples has the capability to satisfy consumer demands for extended durability. The chill chain requirement for this type of products in the retail market and catering industry should also not be forgotten.

References

AOAC, 1995. Official methods of analysis (16th ed.). Arlington, VA: Association of Analytical Chemists.

Armstrong, G.A., Mcilveen, H., 2000. Effects of prolonged storage on the sensory quality and consumer acceptance of *sous vide* meat-based recipe dishes. *Food Quality and Preference*, 11: 377–385.

Baldwin, D.E., 2012. Sous vide cooking: A review. *International Journal of Gastronomy and Food Science*, 1 (1): 15-30.

Botinestean, C., Keenan, D,. Kerry, J.P., Hamill, R.M., 2016. The effect of thermal treatments including sous-vide, blast freezing and their combinations on beef tenderness of *M. semitendinosus* steaks targeted at elderly consumers. *LWT - Food Science and Technology*, 74: 154-159.

Bozkurt, H., Erkmen O*., 2004.* Effect of nitrate/nitrite on the quality of sausage (sucuk) during ripening and storage. *Journal of The Science of Food and Agriculture*, 84*:* 279–286.

Church, I.J., Parsons, A.L. 1993. Review: sous vide cook–chill technology. *International Journal of Food Science and Technology*, 28(6): 563–574.

Creed,P.G., 1995. The sensory and nutritional quality of 'sous vide' foods. *Food Control,* 6 (1) : 45-52.

Díaz,P, Nieto,G, Garrido, M.D., ND Bañón, S., 2008. Microbial, physical-chemical and sensory spoilage during the refrigerated storage of cooked pork loin processed by the sous vide method. *Meat Science*, 80 (2): 287-292.

Erkmen,O., 2000. Basic methods for the microbiological analysis of foods. University of Gaziantep Press, Gaziantep, Turkey.

Hassell, S.K., *Salter*, M.A., 2003*.* Review of the microbiological standards for foods*. Food Control (*14): 391–398*.*

Nyati, H., 2000. An evaluation of the effect of storage and processing temperature on the microbiological status of sous vide extended shelflife products. *Food Control,* (11):471–476.

Pietrasik, Z., Duda,Z., 2000. Effect of fat content and soy protein/carragenan mix on the quality characteristics of comminuted, scalded sausages. *Meat Science*, (56): 181-18.

Resurrección, A.V.A., 2003. Sensory aspects of consumer choices for meat and meat products. *Meat Science*, (66): 11-20.

Sanchez del Pulgar, J., Gazquez, A., Ruiz-Carrascal, J., 2012. Physico-chemical, textural and structural characteristics of sous-vide cooked pork cheeks as affected by vacuum, cooking temperature, and cooking time. *Meat Science*, (90): 828–835.

Vaudagna, S.R.,Sanchez,G. Neira, ME., Insani,M Picallo, A.B., Gallinger, M.M., 2002. Sous vide cooked beef muscles: Effects of low temperature-long time treatments on their quality characteristics and storage stability. *International Journal of Food Science and Technology*, 37 (4): 425-441.