MICROBIOLOGICAL, PHYSICOCHEMICAL, AND SENSORIAL CHARACTERISTICS OF SOUS VIDE "DONER"

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Abstract – Sous vide has been using as a cooking/pasteurizing technique since 1970 and became popular after 2000. Its application area in meat sector is limited to fresh red meat, poultry and fish. From this viewpoint, in this study, the usability of sous vide pasteurization and its effects on microbiological, physicochemical and sensory properties of doner, a globally known traditional Turkish meat product, was examined. In this respect, doners were produced, traditionally cooked, vacuum packed and pasteurized by using sous vide technique at 70 C for 2 min. Analyses were performed on traditionally cooked doners (TCD) and sous vide doners (SVD). Pasteurization by sous vide decreased approximately 1 log CFU/g the total mesophilic aerobic bacteria, total psychrophilic aerobic bacteria, lactic acid bacteria, total yeast and mold counts. Sous vide pasteurization did not affect the chemical composition and lipolytic changes in doners ($p>0.05$). But, this application resulted in lighter and less yellowness color formation and increased the tenderness of doner since shear force and work of shear values were measured lower ($p<0.05$) and improved sensory characteristics of doners. In conclusion, pasteurization by sous vide was found to be an effective thermal process to increase microbial safety and sensorial quality in doners.

Key Words – meat quality and safety, pasteurization, vacuum packaging

I. INTRODUCTION

Sous vide is a kind of cooking or pasteurization technique which allows longer shelf life and quality stability to foods. This technique is also described as cooking or pasteurizing of vacuum packed foods under certainly controlled time and temperature parameters [1, 2]. Sous vide foods have high nutritional quality, sensory and textural acceptance comparing with the other cooking, pasteurization and storage methods [3]. Because sous vide products do not lose their nutritional and flavor components with leakage and water vapor. Additionally, these products can be cooked or pasteurized in the required ratio without burning. On the other hand, this technique gives an opportunity to prepare foods quickly and easily at home and restaurants. Sous vide products may be stored in the refrigerator in its vacuum package up to 4 weeks [1]. In this respect, sous vide has found place in the food production, retail and wholesale market to meet the customers' expectations in nowadays.

Doner is a kind of traditional Turkish meat product and it has begun to consume frequently all over the world especially in Germany, Greek, UK, US, Canada, Pakistan and Arabia [4-8] where is known by other names, such as gyro, donair, dona kebab, shawarma and chawarma [9]. According to 2015 statistics, the consumption rate of doner was 500 ton per day in Turkey [10]. In addition, the number of doner sale points was more than 25000 for Germany and 50000 for Europe [11]. With the rising of retail sales, after cooking, doner has been packed by using different packaging techniques and offered for sale as frozen or refrigerated. During the retail sale, the initial microbial load and the higher fat amount of doner are the main factors that affect shelf life and quality of the products. From this point of view, in the current study, determination of the advantages of sous vide as a pasteurization technique in the production of doner was aimed.

II. MATERIALS AND METHODS

Doner meat was prepared based on the guideline of Turkish Standard Institution under hygienic conditions in Ankara University Meat Processing Room [12]. After the raw doner meat was taken for microbiological analysis, the meat block was placed in front of a vertical spit-gas oven with a distance of 15 cm and cooked by

rotating for half an hour. Then, the cooked surface was shaved off into 5 mm thick slices while the remaining meat block was rotated for cooking. Cooked doner slices were immediately cooled and 400 g of doner meat was separated for analysis as a traditionally cooked doner (TCD). Another 400 g of doner meat was vacuum packed (Reepack 25, Apack Co. Ltd., Istanbul, Turkey) by using polypropylene pouches with a trade name Barrier CPP 35. The properties of these pouches were as follow: PET/OPA/CPP, thickness: 63 µm, OTR (23°C %0 RH) 29.5 (cc/m²)x24h, WVTR (38°C %90 RH) 9.6 (g/m²)x24h. Then the packages were placed into sous vide cook machine controlled with a temperature-time panel and circulator (Professional Classic Series Cooking Kit, PolyScience, Illinois, USA). The packages were pasteurized at 70 C for 2 min after the core temperature of the packages reached to 70 C. That time temperature parameter was choosen based on the FDA regulation to ensure six log reduction in *Listeria monocytogenes*. These doner meats were also used for analysis as a sous vide doner (SVD) samples.

The chemical composition (moisture, protein, fat, and ash) and pH value were determined according to AOAC procedures [13]. *L**, *a**, *b** color values were measured by using Minolta colorimeter (CR 300, Japan). Free fatty acid (FFA) and thiobarbituric acid-reactive substances (TBARS) values were measured to determine the lipolytic changes [14, 15].

The additional effect of sous vide pasteurization on microbiological quality of doner was determined by calculating total mesophilic aerobic bacteria (TMAB), total psychrophilic aerobic bacteria (TPAB), lactic acid bacteria (LAB), total yeast and mold (TYM), *Staphylococcus aureus*, coliforms, *Escherichia coli*, and *Clostridium perfringens* counts. In addition, the presence/absence test was carried out for *Listeria monocytogenes*.

The doner meats were subject to texture profile analysis (TPA) using the Texture Analyzer (TA.XT plus, Stable micro systems, England). The doner meat with a 5 mm thickness was compressed to 30% of its original height twice in two cycles with a cylinder plunger of 2 mm diameter attached to a 30 kg load cell. The following parameters were measured: Hardness (N), cohesiveness, springiness (mm), gumminess (N), and chewiness (Nmm). In addition, A craft knife adaptor with a blade (code:A/CKB) was used to measure shear force (N) and work of shear (Nsec) values in doners by moving down 2 mm, at 1.5 mm/s.

An acceptance test was used to determine the liking rate of sous vide doners when compared to traditional ones. Eight experienced panelists evaluated doners in terms of appearance, color, odor, taste, texture and overall acceptability properties. The experiment was replicated three times and compiled results were statistically compared based on two sample t-test by using Minitab 16.

III. RESULTS AND DISCUSSION

In the present study, as is stated previously, the pasteurization effect of sous vide was investigated in doner in terms of its physicochemical, microbiological and sensorial properties. The moisture, protein, fat, ash contents and pH value of doners are shown in Table 1. As expected, no significant differences were seen between TCD and SVD regarding these analyses ($p>0.05$).

Table 1 Chemical composition, free fatty acid and TBARS values of TCD and SVD

	TCD*	SVD*
Moisture (%)	52.59±0.93	53.40±0.85
Protein (%)	23.06±0.35	23.91±0.38
Fat (%)	21.10±1.16	20.95±4.01
Ash (%)	2.80±0.20	2.23±0.02
pH value	5.97±0.07	5.86±0.07
FFA (%)	2.91±0.56	2.06±0.15
TBARS (mg MA/kg)	1.12±0.17	1.31±0.05

*Results were presented as mean±standard error of the mean

FFA value, a predictor for lipolysis reactions, was found to be 2.91% for TCD and 2.06% for SVD. In addition, TBARS value, a crucial analysis to measure lipid oxidation level, was calculated as 1.12 and 1.31 mg MA/kg regarding TCD and SVD, respectively. The pasteurization of doners by using sous vide did not affect FFA and TBARS value ($p>0.05$).

As can be seen in Table 2, no statistical difference was found regarding *a** value ($p>0.05$) but significantly higher *L** and lower *b** value were detected in SVD when compared to TCD ($p<0.05$). During sous vide pasteurization, the fat melts and leaks into the pouches. Depends on the fat leakage, the water distribution in the doner changes. It is clear that water distribution in the meat matrix has the dominant effect upon the evolution of lightness [16], while the fat content of the meat is the critical factor that affects yellowness value. Higher fat content leads to increase in *b** value. In the direction of these statements, it is possible to note that the pasteurization process induced the formation of lighter and less yellowness color in SVD due to the fat leakage and changes in water distrubition.

Table 2 *L**, *a**, *b** color values of TCD and SVD

	*L**	*a**	*b**
TCD	45.73±1.10^{B}	7.57±0.27	14.33±0.45^{A}
SVD	48.64±0.80^{A}	7.46±0.26	12.94±0.29^{B}

$^{A, B}$: Means with different uppercase letters are significantly different ($p<0.05$).

An impressive and successful results were observed in microbiological analysis with the positive effect of sous vide pasteurization. As is seen in Table 3, the initial TMAB, TPAB, LAB, and TYM load of raw doner meat were found to be 6.59, 5.56, 4.41, 4.35 log CFU/g, respectively.

Table 3 Microbial load of raw doner, TCD and SVD

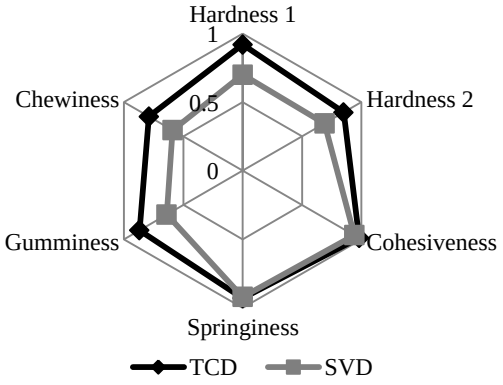
	Raw doner meat	TCD	SVD
TMAB [a]	6.59	4.02^{A}	2.94^{B}
TPAB [a]	5.56	3.27	<2
LAB [a]	4.41	<2	<1
TYM [a]	4.35	2.92	<2
Staph. aureus [a]	<1	<1	<1
Coliforms [b]	1100	<3	<3
E.coli [b]	1100	<3	<3
Cl. perfringens [a]	<1	<1	<1
Listeria monocytogenes [c]	0	0	0

$^{A, B}$: Means with different uppercase letters are significantly different ($p<0.05$).
[a]: log CFU/g; [b]: most probable number/g; [c]: detection methods

After traditional cooking, these results decreased and reached to 4.02, 3.27, <2, 2.92 log CFU/g, respectively. Moreover, approximately 1 log decrease in these microbial counts was determined as a crucial result of the pasteurization process. It is possible to report that pasteurization by using sous vide is a practical and easy way to increase the final microbial safety of doners. On the other hand, *Staph. aureus and Cl. perfringens* counts were determined lower than 1 log CFU/g in raw doner meat, TCD and SVD. *Listeria monocytogenes* was not detected in 25 g of these samples. Initial coliforms and *E.coli* counts were 1100 most probable number/g and this value decreased after traditional cooking.

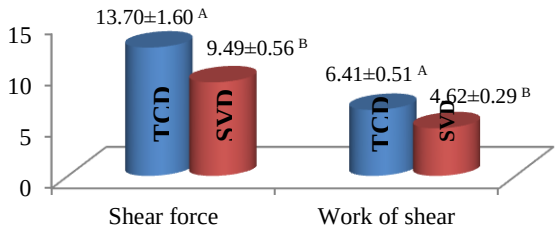
As shown in Figure 1, pasteurization process did not affect textural properties of doner. No significant differences were measured between TCD and SVD regarding TPA ($p>0.05$).

Figure 1 Texture profile analysis of TCD and SVD



However, shear force and work of shear values of TCD were found to be higher than SVD ($p<0.05$). In brief, craft knife results demonstrated that more tender doner was produced due to the microstructural changes in meat fibers as a result of heat during sous vide pasteurization (Figure 2).

Figure 2 Craft knife results of TCD and SVD



$^{A, B}$: Means with different uppercase letters are significantly different ($p<0.05$).

Table 4 presents average of scores given by panelists regarding each sensory property of TCD and SVD. For appearance, color, and texture, no significant differences were determined ($p>0.05$). Panelists did not notice the differences measured by instrumentally for color and texture. But, SVD had higher scores than TCD concerning odor, taste and overall acceptability ($p<0.05$). In addition, SVD was graded with higher scores for remaining properties. Moreover, panelists wrote in their score sheet that doners treated with sous vide were more tender and juicy than those of cooked by traditionally. With that said, it is crucial to note that sous vide pasteurization improved sensory properties of doners.

Table 4 Sensory scores of TCD and SVD

	TCD	SVD
Appearance	7.83±0.39	8.17±0.26
Color	7.67±0.37	8.25±0.25
Odor	$7.42±0.38^{B}$	$8.46±0.15^{A}$
Taste	$7.58±0.35^{B}$	$8.57±0.16^{A}$
Texture	7.67±0.42	8.25±0.25
Overall acceptability	$7.54±0.40^{B}$	$8.44±0.19^{A}$

$^{A, B}$: Means with different uppercase letters are significantly different ($p<0.05$).

IV. CONCLUSION

The current study shows that sous vide can be used as a pasteurization process of cooked doner to ensure microbial safety, improve eating quality and extend shelf life. In addition, sous vide process may be considered as a new packaging method for doners in retail sale.

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REFERENCES

1. Nyati, H. (2000). An evaluation of the effect of storage and processing temperatures on the microbiological status of sous vide extended shelf-life products. Food Control 11: 471-476.
2. Wang, A. H., Chang, M. H. & Chen, T. C. (2004). Shelf life and microbiological profiler of chicken wing products following sous vide treatment. International Journal of Poultry Science 3: 326-32.
3. Baldwin, D. E. (2012). Sous vide cooking: a review. International Journal of Gastronomy and Food Science 1: 15–30.
4. Lentz, C. (1999). Changing food habbits, case studies from Africa, South America and Europe. Germany: Harwood Academy Publishers.
5. Advisory Committee on the microbiological safety of food. (2004). Microbiological control of doner kebabs. ACM 702.
6. Health Canada. (2013). Management of the risks related to consumption of donairs and similar products (Gyros, Kebabs, Chawarmas and Shawarmas). Canada.
7. Ahmad, F., Abbas, S., Butt, Z. A., Ali, A. S., Mahmood, R., Ahmad, M., Farhan, M., Wahid, A., Nawaz, M. & Iftikhar, A. (2013). Bacterial contamination in processed chicken shawarma (meat) sold in various parts of lahore, Pakistan. Pakistan Journal of Nutrition 12: 130-134.
8. Ayaz, M., Othman, F. A., Bahareth, T. O., Al-Sogair, A. M. & Sawaya, W. N. (1985). Microbiological quality of shawarma in Saudi Arabia. Journal of Food Protection 8: 811-814.
9. Bostan, K., Yilmaz, F., Muratoglu, K. & Aydin, A. (2011). A study on the microbiological growth and microbiological quality in the cooked doner (in Turkish). Journal of the Faculty of Veterinary Medicine, Kafkas University 17: 781-786.
10. http://beefandfish.com/genel/turkiyede-doner pazari.html. Doner market in Turkey. A magazine journal of "Beef and Fish". 9 September 2015.
11. http://www.donercihasanusta.com/icerik.asp?islem =hoku&hid=399. A review. 21 November 2014.
12. Turkish Standard Institution. Rules for producing uncooked of döner (TS 11658).
13. AOAC. (2000) Official methods of analyses, Association of Official Analytical Chemists, Washington, DC.
14. Mauriello, G., Casaburi, A., Blaiotta, G. & Villani, F. (2004). Isolation and technological properties of coagulase negative staphylococci from fermented sausages of southern Italy. Meat Science 67: 149-158.
15. Mielnik, M. B., Olsen, E., Vogt, G., Adeline, D. & Skrede, G. (2006). Grape seed extract as antioxidant in cooked, cold stored turkey meat. LWT-Food Science and Technology 39, 191–8.
16. Aleson-Carbonell, L., Fernάndez-López, J., Sendra, E., Sayas-Barnerά, E. & Pérez-Alvarez, J. (2004). Quality characteristics of a non-fermented dry-cured sausage formulated with lemon albedo. Journal of the Science of Food and Agriculture 84, 2077-2084.