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Effect of different temperature-time combinations on chemical, microbiological, textural and sensorial attributes of sous vide turkey breast meats cooked for extended periods

Einfluss unterschiedlicher Temperatur-Zeit-Kombinationen auf chemische, mikrobiologische, sensorische und texturelle Eigenschaften von Sous-Vide gegarten Putenbrustfleisch

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Summary

Chemical, microbiological, instrumental textural and sensorial attributes were determined for turkey breast meat samples cooked at 65 °C or 75 °C for three different extended cooking times (24 h, 36 h or 48 h). According to results obtained, there were no significant differences observed among the chemical compositions, instrumental textural and microbiological attributes of samples (P>0.05). When sensorial analyses scores of the samples are taken into account in terms of consumer preferences, no statistically significant difference was observed among samples. So it is concluded that shortest cooking period should be preferred in terms of saving for energy and cooking time. On the other hand, cooking for extended times like 36 or 48 **hours,** did not show any nugatory affect on eating and sensorial quality of turkey breast meat samples.

Keywords: Sous vide, turkey breast meat, quality

Zusammenfassung

Es wurden chemische, mikrobiologische, sensorische und texturelle Eigenschaften von Putenbrustproben bestimmt, die bei 65 °C bzw. 75 °C unterschiedlich lange gegart wurden (24 h, 36 h oder 48 h). Die Ergebnisse zeigten keine signifikanten Unterschiede der chemischen Zusammensetzung, der texturellen oder mikrobiologischen Eigenschaften der Proben (P>0,05). Die sensorischen Untersuchungen ergaben ebenfalls keine statistisch signifikanten Unterschiede bezüglich der Verbraucherpräferenz. Daraus wird geschlossen, dass die kürzere Garzeit in Hinblick auf die Einsparung von Energie und Kochzeit bevorzugt werden sollte. Andererseits hatten längere Garzeiten von 36 oder 48 Stunden auch keinen wertlosen Einfluss auf die sensorische Qualität der Putenbrustproben.

Schlüsselwörter: Sous-Vide, Putenbrustfleisch, Fleischqualität

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Introduction

The term "sous vide" means "under vacuum" in French (Ghazala et al., 1995) and sous vide cooking technique originated in France in 1970s (Gahazala, 1993). According to Rhodehamel (1992) process was explained as the replacement of fresh, raw products in pouches or semi-grid trays, vacuum sealing, cooking slowly under mild heating conditions, then cooling and storing in refrigerator until to be served. With the beginning of 1984, sous vide cooking method has received a large amount of application area ranking from commercial and institutional caterers, in flight catering and schools, to retailers and food processors (Creed, 1995).

According to Baldwin (2012), sous vide cooking differs from traditional cooking methods in two fundamental ways: the raw food is vacuum-sealed in heat-stable, food-grade plastic pouches and the food is cooked using precisely controlled heating. Vacuum sealing brings several advantages to this method. Heat can be efficiently transferred to food from water or steam by using vacuum packaging materials. It also helps to increase the shelf life of the product by avoiding contaminations and also inhibits off flavors and prevents the losses of moisture and flavor volatiles because of evaporation (Church and Parsons, 2000).

As reported by Nyati (2000), advantages associated with sous vide cooking include a superior flavor to frozen foods. Also, in the same report it was concluded that increased tenderness and moistness, improve color retention and reduced nutritional loss were observed for sous vide foods when compared to traditional cooking.

The three main factors which determine the microbiological safety of sous vide products are (i) the intensity of heat treatment, (ii) the rapidity of cooling and the temperature reached and (iii) the control of chilled storage (temperature and time) (Gonzales-Fandos et al., 2005). Two of the main factors that affect the chemical and microbiological quality of sous vide meat are the cooking temperature and cooking period. According to Baldwin (2012), meat cooked at 55 °C for 48 h is noticeably paler than the meat cooked at the same temperature for 3 h. In the same study it was reported that poultry meats were usually cooked well done at 70–80 °C about 4–6 h until it became tender, about 4–6 h at 80 °C and 8–12 h at 70 °C by sous vide cooking technique.

In restaurants and caterers according to the intensity of demand and number of daily consumer, the products offered to sale may be subjected to be waited in water bath for prolonged cooking periods. In this research it was aimed to determine the quality characteristics of turkey breast meat cooked for prolonged periods by using sous vide technique.

Material and Method

Turkey breast meat was used for the research and purchased from Bolca Hindi AS (Bolu, Turkey). Vacuum packaging material (polyethylene – polyamide) having an oxygen permeability of <15 cm^3/m^2 in 24 h at 22 °C and were obtained from Artı Ambalaj (İzmir, Turkey). Two water baths (65 °C and 75 °C) were used for sous vide cooking (Nuve). Meat samples (approximately 400–450 g) were replaced in vacuum packaging pouches. Vacuum packaging machine (Henkelman Vacuum Systems, Germany) was used for sealing the pouches and then pouches were replaced in water baths at 65 °C or 75 °C for 3 different extended times; 24, 36 or 48 hour. The temperature of the water in the bath was controlled by using a thermocouple Testo735-2 (Testo, Lenzkirch, Germany). After cooking, samples were soaked in cold water for 15 minutes in order to ensure rapid chilling and kept in refrigerator (+4±1 ºC) until being analyzed. Average chemical compositions of the turkey meat samples (% water, protein, fat and ash) and pH values were determined according to AOAC (2000). Cooking loss was calculated by measuring the differences in weight before and after cooking, while moisture content was determined by drying the samples (5 g) at 102 °C (AOAC, 2000).

Hunterlab L (lightness), a (redness) and b (yellowness) values were obtained by using a Minolta Colorimeter CR-300 (Minolta Camera Co., Osaka, Japan) with illuminant D65, a 0° standard observer and a 2.5 cm port/viewing area. The colorimeter was standardized before use with a white tile. The means of the readings were determined on six locations in each sample. The scores obtained for L, a and b were used to calculate the total color change (∅E) and chroma (C) (del Pulgar et al., 2012).

Texture analysis was performed by using a texture analyzer (TA-XT 2i Texture Analyser, Stable Micro Systems Ltd., Surrey, UK). Shear force values (N) of the samples were determined. 6 measurements were taken for each sample. Warner Bratzler probe was used and test speed was set as 2 mm/s. Shear force was determined as the maximum force required to compress the sample (peak force during the first compression cycle) (del Pulgar et al., 2012).

Microbiological attributes of both raw and cooked samples were determined according to ICMSF (1978). Enumeration of Total Mesophylic Aerobic Bacteria (TMAB), coliform group bacteria, fecal coliform bacteria, *Staphylococcus aureus, Salmonella* spp. and *Listeria* spp. were performed.

Ten grams of samples were aseptically weighed and homogenized in a Stomacher (IUL, Barcelona, Spain) for 90 sec with 90 ml of sterile peptone water (0.1 % peptone). Required decimal dilutions were made with the same diluents. The total number of total mesophilic aerobic bacteria was determined on Plate Count Agar (PCA, Oxoid, Basingstoke, UK) following the pour plate method, and incubated at 30 °C for 72 h (ICMSF, 1978). Total coliform bacteria and fecal coliform bacteria were enumerated on VRBA and VRBA with mug (Oxoid, Basingstoke, UK) respectively. *Staphylococcus aureus* was enumerated by plating on Baird-Parker agar (Oxoid) following the surface plate method. The incubation temperature used was 37 °C (18–24 h). Suspected colonies were subjected to a DNAse test (Difco, Detroit, MI) (ICMSF, 1978) The presence of *Listeria* spp. was investigated as follows: a 25 g sample was homogenized with 225 ml of *Listeria* Enrichment Broth (LEB, Merck, Darmstadt) in a Stomacher. The enrichment broth was incubated at 30 °C for 48 h. LEB cultures were streaked on Palcam Agar and then the plates were incubated at 37 °C for 48 h and analyzed for the presence of *Listeria* colonies (Gonzales-Fandos et al., 2004).

The sensorial analyses were carried out by a panel of 8 trained panelists (4 male and 4 female, average age was 28) selected from the staff of Food Engineering (ISO 8586-1, 1993). The quality of each sample was classified using characteristics to describe the appearance, texture, taste, juiciness, and overall scores were also calculated. Each characteristic was scored using a point scale ranging from 1 to 5 (Tab. 1).

All analyses were repeated three times and data obtained from experiments were evaluated by SAS statistical analyses programme. The procedure was "completely randomized" and ANOVA test was used in order to determine the differences (SAS, 2001).

Results and Discussion

Average chemical composition of raw turkey breast meat used for the research was determined and average pH value of raw samples was 6.31±0.28, whereas average water, protein, ash and fat contents of the samples were found 73.97±0.56 %, 22.62±0.66 %, 1.16±0.01 % and 2.18±0.71 % respectively. Also microbiological analyses were performed in order to determine the hygienic quality of raw turkey meat. When the results obtained were taken into account, it was determined that average TMAB count of samples was 2.96±0.10 log cfu/g, whereas total coliform bacteria count was enumerated as 1.22±0.27 log cfu/g. Fecal coliform, *S. aureus, Salmonella* spp. or *Listeria* spp. was not detected for the samples.

Chemical attributes of sous-vide turkey breast meats cooked for different prolonged times were given at Table 2. As seen, pH values of the samples were among 6.42 and 6.61. Although it was determined that there were significant differences among pH values of the samples, cooking period had no regular effect on these values. Because of the material used in the research is biological material, initial pH values of each batches might show differences. Average water contents of the samples cooked at 65 °C were higher than the samples cooked at higher temperature (75 °C). But the difference among these batches which were cooked at different cooking temperatures was approximately 1 %. Cooking loss of the sous vide turkey breast meat samples were among 20.69 % and 27.96 % (Tab. 5). Average cooking loss values of the samples which were cooked at 65 °C were significantly lower than the samples which were cooked at 75 °C (P<0.05).

Microbiological attributes of sous vide turkey breast meat samples cooked for different temperatures and times were also enumerated. TMAB, coliform, fecal coliform, *S. aureus, Salmonella* spp. and *Listeria* spp. were all lower than 1 log cfu/g. It has been reported that traditional cooking methods make poultry safe by cooking the coldest part to 74 °C or above. It is known that poultry could also be made safe in terms of food safety by cooking at lower temperatures for longer cooking times. Cooking chicken or turkey breast meat at 60 °C for at least 2 hours is reported as just as safe as cooking them to 74 °C (Baldwin, 2012). When our data related to microbiological attributes are taken into account, it can be concluded that the final temperature achieved is adequate for assuring food safety.

Changes in color values of sous vide turkey meat samples were given as Table 3. As seen from the table, there is no significant difference determined among the L values of cooked turkey breast samples (P>0.05). In other words, cooking time did not significantly affect the average L values of turkey breast meat samples. L values of each sample increased significantly during sous vide cooking (P<0.05) and were changing among the values of 70.51 and 72.38. Similarly, b values of the samples also increased during cooking, on the other hand average a values of the samples decreased during cooking (P<0.05). Before cooking, a values of the samples were 13.05, but after cooking average a values of the samples were changing among 0.27 and 1.56. It is thought that color pigments of meat were lost during cooking together with the water as cooking loss. It is known that color pigments of meat gives the red color to meat. Redness (a*) intensity in cooked meat is inversely related to the degree of denatured myoglobin, a denaturing process starting at 60 °C (del Pulgar et al., 2012). As it seen from the Table 3, there was no significant difference among the total color differences of the samples. Average ∅E values of the samples were among the values 25.49 and 28.50 (P>0.05). Average chroma values of the samples were among 16.92 and 19.70. Chroma or meat colour saturation relates to the concentration of myoglobin, but also to its degree of denaturation. This attribute is more predominant with greater concentrations of myoglobin and at a lower rate of denatured myoglobin (Ledward, 1992; del Pulgar et al., 2012). The chroma values of the samples cooked at 65 °C were lower than the chroma value of the samples cooked at 75 °C (P<0.05).

Average shear force values of the samples were given as Table 4. Shear force values of the samples were among 11.09 N and 18.34 N. All the analyzed variables were affected by the

TABLE 1: *Quality scale used by panelists in the sensorial analysis.*

Characteristic	Score				
	1	2	3	4	5
Appearence	Stale				Fresh
Texture	Firm				Tender
Juiciness	Dry				Soft
Taste	Cloying				Fresh
Overall	Overall score is the sum of the sensorial characteristics scores				

TABLE 2: *Chemical attributes of sous-vide turkey breast meat samples.*

Sample	pH	Water (%)	Cooking loss (%)
65–24	6.45c*	68.54a	20.69b*
65–36	6.61a	68.08a	21.26b
65–48	6.43c	67.81a	22.31b
75–24	6.42c	67.59ab	27.96a
75–36	6.56ab	66.40bc	25.91a
75–48	6.49bc	66.03c	26.78a

*Average values with a small letter in a column are statistically different from each other (P<0.05)

TABLE 3: *Hunter Lab color values of sous-vide turkey breast meat samples.*

Sample	L		a		b		ØE	Chroma
	raw	cooked	raw	cooked	raw	cooked		
65–24	51.45B	70.51A	13.05A	0.37B*b**	6.58B	17.78Ad	25.49	16.92b
65–36	51.45B	71.69A	13.05A	0.27Bb	6.58B	19.96Ac	27.42	18.50ab
65–48	51.45B	70.53A	13.05A	0.83Bab	6.58B	20.64Abc	26.67	18.63ab
75–24	51.45B	72.38A	13.05A	0.79Bab	6.58B	21.54Aab	28.50	19.34a
75–36	51.45B	70.68A	13.05A	1.24Bab	6.58B	22.25Aa	27.47	19.62a
75–48	51.45B	70.59A	13.05A	1.56Ba	6.58B	22.58Aa	27.47	19.70a

*Average values with a capital letter in a row are statistically different from each other for each color parameter (P<0.05); **Average values with a small letter in a column are statistically different from each other (P<0.05)

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TABLE 4: *Average shear force values of sous-vide turkey breast meat samples.*

Sample	Shear force (N)
65–24	18.34±2.53
65–36	17.27±1.74
65–48	18.34±1.98
75–24	11.09±3.13
75–36	15.11±1.64
75–48	15.11±2.01

interaction of time x temperature. Thus, it seems that 65 °C or 75 °C treatments for 12, 24 or 36 h did not produce any significant changes in shear force values of the turkey breast meat samples (P>0.05).

Sensorial analyses scores of the samples were given as Table 5. As seen from the table, appearance scores of the samples were among 3.11 and 3.89 out of 5. It was determined that, there was no statistically significant difference among the appearance scores of the samples (P>0.05). Average texture scores of the samples were changing among 2.17 and 2.72. As it is seen from the table, average texture scores of the samples were not significantly different from each other (P>0.05). Time or temperature did not affect the changes in texture scores of the samples. Juiciness scores of the samples which were cooked at 75 °C for 24, 36 or 48 h were lower than the samples cooked at 65 °C. But similar to appearance and texture, juiciness scores were not significantly influenced by the cooking time or temperature (P>0.05). Taste scores of all samples were extremely high and changing among the values 3.33 and 3.94, and there was no statistically significant difference observed among the taste scores of the samples cooked for different periods at different temperatures (P>0.05). Overall sensorial scores of the samples were calculated by the sum of appearance, texture, juiciness and taste scores. Average overall scores of the samples were among 11.00 and 13.56, but there were no significant differences was observed among the overall scores of the samples (P>0.05).

TABLE 5: *Sensorial analysis scores of sous-vide turkey breast meat samples.*

Sample	Appearance	Texture	Juiciness	Taste	Overall
65–24	3.89	2.56	3.22	3.89	13.56
65–36	3.61	2.67	3.06	3.61	12.95
65–48	3.22	2.56	3.11	3.72	12.61
75–24	3.11	2.17	2.39	3.33	11.00
75–36	3.44	2.28	3.00	3.94	12.66
75–48	3.67	2.72	2.94	3.83	13.16

Average values with a small letter in a column are statistically different from each other (P<0.05)

Conclusion

In order to produce safe sous-vide poultry meat products, a thermal process at 65 °C for at least 2 hours is sufficient. But in restaurants and caterers according to the intensity of demand and number of daily consumer, the products offered to sale may be subjected to be waited in water bath for prolonged cooking periods. In such a situation, chemical, microbiological, textural and sensorial attributes of prolonged cooked poultry meat should be studied. As results of our study indicating the quality attributes of prolonged cooked sous-vide turkey breast meat, keeping sous-vide turkey breast meat in waterbath at 65 °C or 75 °C for 12, 24 or 36 hours did not significantly affect the sensorial attributes of the samples. It can be said that all samples kept their fresh taste during these extended cooking periods. Also hardness of the samples were not affected by both temperature or cooking time. When microbiological analyses results of the samples were taken into account, it was seen that samples were all pasteurized well. Initial coliform bacteria count of the samples was 1.22 log cfu/g, whereas it was determined as <1 log cfu/g after cooking. Also TMAB counts of the samples were declined to <1 log cfu/g from 2.96 log cfu/g. As a result, cooking for extended periods did not significantly affected the sensorial and quality attributes of turkey breast meat samples and also there were no microbiological risk was determined related to these products in terms of food safety and consumer health.

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