CHANGES IN SELECTED QUALITY CHARACTERISTICS OF BEEF SUBJECTED TO DIFFERENT BLEEDING TIMES AFTER SLAUGHTERING

Dilek Ceyda Öztekin[1*] and Kezban Candoğan[1]

[1] Ankara University, Faculty of Engineering, Department of Food Engineering, Ankara, Turkey.

*Corresponding author email: candogan@eng.ankara.edu.tr

I. INTRODUCTION

The pre-slaughter, slaughter and post-slaughter practices are of vital importance to attain safe and wholesome meat with high quality [1]. Removal of blood during slaughter is a critical stage in the process since the amount of blood remaining within the meat could result in accelerated microbiological and chemical spoilage. Blood comprises approximately 7.5-8.0% of the live weight of beef cattle, and about 50% of the blood in the body is removed through bleeding during the slaughter process [2]. Regardless of the slaughtering method used, it has been suggested that the average bleeding time should be at least 5-6 minutes for cattle to provide sufficient blood removal [3]. To ensure the conversion of the carcass into high-quality meat, animals should be slaughtered according to the appropriate technique, and blood should be drained as much as possible. Therefore, care must be taken to ensure that the blood is efficiently removed during animal slaughtering, and sufficient time should be allowed to drain as much blood as possible [3]. The length of bleeding time which varies in commercial slaughterhouses would influence the amount of blood removal, thus the quality of meat after slaughter. The purpose of this study was to compare three different bleeding time periods (5 min, 10 min and 15 min) during slaughtering of beef cattle in terms of their effects on some microbiological, physicochemical, and biochemical quality characteristics of meat.

II. MATERIALS AND METHODS

The meat obtained from Brangus cattle was used as material in this study. The animals were fed with the same feed materials for an equal amount of time and under the same living conditions, and were transported to a commercial slaughterhouse located in Konya region (Turkey) under the same transportation conditions. Before slaughter, the animals were randomly divided into three groups each of which was slaughtered using the halal method, and then subjected to bleeding at different times as follows: 1) bleeding for 5 min (BRA-5), 2) bleeding for 10 min (BRA-10), and 3) bleeding for 15 minutes (BRA-15). The *Longissimus dorsi thoracis* muscles were removed from the carcasses after the rigor mortis was completed (24 h postmortem). The effects of bleeding time on some quality characteristics on the beef samples were investigated by determining the pH, water activity (aw), instrumental colour values (CIE L^*: lightness, a^*: redness, and b^*: yellowness), texture properties, and total mesophilic aerobic bacteria (TMAB) count as well as thermal properties using Differential Scanning Calorimetry (DSC) (scanning between 20°C and 100°C at a rate of 5°C/min), and structural compositions with Fourier Transform Infrared (FTIR) spectroscopy in the mid-infrared region (wavenumber range of 3500-500 cm^{-1}). Data were evaluated by analysis of variance with Tukey's multiple comparison test ($P<0.05$) using Minitab statistics software.

III. RESULTS AND DISCUSSION

The mean total blood collected from BRA-5, BRA-10 and BRA-15 groups were 13.5 kg (2.23%), 15.5 kg (2.54%) and 16.5 kg (2.73%), respectively. The BRA-5, BRA-10 and BRA-15 groups had pH values of 5.68, 5.64 and 5.63, respectively. BRA-5 group exhibited the highest pH value ($P<0.01$). There was no significant effect of bleeding time on the a_w value ($P>0.05$) which was determined as $a_w=0.99$ in all beef samples. Colour is one of the most important criteria which is influenced by pre-and post-

slaughtering processes. In the present study, the effect of different bleeding times on the *a** and *b** value was not statistically significant (P>0.05) while *L** value was affected by bleeding time significantly (P<0.01) (Table 1). The beef samples subjected to shorter bleeding time period (BRA-5) had higher *L** value (39.1) compared to the BRA-10 and BRA-15 samples which had *L** values of 34.4 and 34.5, respectively. It was observed that BRA-15 had the lowest firmness value (P<0.05) while the highest hardness value was observed in BRA-5 group (P<0.05). TMAB counts of beef samples from BRA-5, BRA-10, and BRA-15 groups which were 6.90 cfu/g, 6.70 cfu/g, and 6.84 cfu/g, did not show differences among the bleeding times (P>0.05).

Table 1. pH, a_w, CIE *L*, a** and *b**, firmness and hardness values of beef subjected to different bleeding times during slaughter

Samples	*L**	*a**	*b**	Firmness (N)	Hardness (N)
BRA-5	39.1[a]	16.0	4.80	37.7[a]	151[a]
BRA-10	34.4[b]	15.6	2.38	39.3[a]	112[b]
BRA-15	34.5[b]	16.3	3.33	25.3[b]	126[ab]
PSD*	2.24	2.65	2.03	2.57	13.0
P value	0.01	0.93	0.21	<0.01	0.03

Means within a column with different letters are significantly different (P<0.05). *PSD: Pooled standard deviation.

In the DSC thermograms of the beef samples subjected to different bleeding times, lower denaturation temperature of the proteins in the BRA-15 samples was observed in comparison to the other two groups. In the FTIR spectra, there was a change in the bands at wavenumbers between 3,000–2,850 cm^{-1} in the beef samples with bleeding time for 15 min. These bands generally originated from C–H stretching vibrations in aliphatic hydrocarbon compounds such as lipids and also from acyl chain C–H linkages [4]. Differences in the bands between the region at 1000-1500 cm^{-1} wavenumbers assigned to changes in the structure of proteins, lipids, carbohydrates, nucleic acids and phospholipids [4] were observed. When the bleeding time period increased, these changes became more noticeable with the most evident changes observed in the BRA-15 indicating a clear effect of longer bleeding time on protein structure in comparison to the other two samples.

IV. CONCLUSION

The results of this study indicated that the quality properties of beef were significantly influenced by applying different bleeding times during slaughter. The most noticeable changes appeared to be in the meat proteins. Detailed studies, particularly based on shelf-life evaluation need to be performed to further determine the effects of bleeding time on specific quality characteristics during storage of meats.

REFERENCES

1. Gregory, N.G. (2008). Animal welfare at markets and during transport and slaughter. Meat Science 80: 2-11.
2. Khalid, R., Knowles, T.G. & Wotton, S. B. (2015). A comparison of blood loss during the Halal slaughter of lambs following traditional religious slaughter without stunning, electric head-only stunning and post-cut electric head-only stunning. Meat Science 110: 15-23.
3. Gregory, N. G., Schuster, P., Mirabito, L., Kolesar, R. & McManus, T. (2012). Arrested blood flow during false aneurysm formation in the carotid arteries of cattle slaughtered with and without stunning. Meat Science 90: 368–372.
4. Candoğan, K., Altuntas, E. G. & Iğci, N. (2021). Authentication and quality assessment of meat products by fourier-transform infrared (FTIR) spectroscopy. Food Engineering Reviews 13: 66-91.