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Effect of Islamic ritual slaughter on beef quality

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ABSTRACT - The aim of this study was to evaluate several quality characteristics of meat obtained from 20 Limousine calves slaughtered either according to conventional methods (n=10) or by the Islamic ritual slaughtering procedure (n=10). After 7 days of ageing under *vacuum*, pH, drip loss, colour and oxymyoglobin percentage were measured on *longissimus dorsi* muscle after 2h, 2 and 6 days of storage to study their evolution. With conventional slaughter pH remained stable until the 6th day of storage, while with ritual slaughter it increased from the 2nd to 6th day of storage. Drip loss increased considerably from the 2nd to 6th day of storage in conventional slaughter, while in ritual slaughter the drip loss increase was lower. Meat colour was not influenced by the slaughtering system but only by the different lengths of storage.

Key words: Islamic ritual slaughter, Beef, Meat quality.

Introduction - Islamic law prescribes a set of dietary rules, called "*halal*" (legal, permitted by Allah) which lists permitted food and prohibits the consumption of meat not obtained according to Islamic rules, concerning livestock handling before and during slaughter (Bonne, 2007; Regenstein *et al.*, 2003). Stunning prior to slaughter is not permitted and slaughter must be executed by a throat cut in order to bring the animal to a quick death without suffering, by resection of carotid arteries, jugular veins, trachea and esophagus and absence of previous stunning, allowing a rapid and complete bleeding (Eliasi and Dwyer, 2002; Grandin and Regenstein, 1994). Several studies have been carried out on this topic in order to assess the suffering of animals slaughtered without stunning. Anil *et al.* (1995) claimed that the time needed to reach brain death is quite long and very variable; Gilli and Piscopo (2007) argued that after ritual slaughter animals agony lasts longer than that of animals subjected to stunning: persistence of both the corneal reflex and respiratory activity for more than 1 minute after cutting the throat, testifying that brain activity does not cease immediately after cutting the large blood vessels of the neck; on the contrary, immediately after stunning with the percussive captive bolt, both respiration and the corneal reflex cease due to the occurrence of brain death. Slaughter preceded by stunning could cause less suffering than slaughter carried out without stunning. Italian legislation is based on this assumption and, following European Union directives regarding cattle protection during slaughter, the stunning of animals before bleeding is required, although religious ritual slaughter is also permitted (D.M. 11 June 1980). Considering the increasing Islamic population in Italy, and since the slaughtering method may affect meat quality, the purpose of this work is to assess the ritual slaughter effects on some beef qualitative characteristics.

Material and methods - Trial was carried out on 20 purebred female Limousine cattle from the same farm, slaughtered at an EU licensed abattoir at the average age of 14 months: 10 animals were slaughtered by Islamic ritual method, while 10 animals were slaughtered by traditional method. Twenty-four hours after slaughter, from each right half-carcass a double steak between the 7th and 8th thoracic vertebra was taken; the *longissimus dorsi* muscle was isolated, *vacuum*-packaged and preserved at +4°C. After 7 days of ageing *longissimus dorsi* was subdivided into two samples for the

determination of several meat quality characteristics: the first sample was weighed, placed in a plastic container with a double bottom, covered with polyethylene film and kept in standardized conditions at +4°C; pH (pH-meter Hanna pH 211) and colour (Minolta 2500 spectrocolorimeter, observation angle of 2°, Illuminant D65; Renerre, 1990) were measured at 2h, 2 and 6 days of storage in order to determine their evolution; drip loss (Lundström and Malmfors, 1985) was evaluated at 24h, 2 and 6 days of storage. The second sample was divided into 6 sub-samples which, placed in a plastic container with a double bottom, covered with polyethylene film and kept in standardized conditions at +4°C, were utilized to evaluate the chemical forms of the myoglobin at 2h, 2 and 6 days of storage. For the direct evaluation of the percentage of oxymyoglobin, the AMSA formula (1991) was applied:

$$\text{Oxymyoglobin} = \frac{\frac{\text{K/S 610 nm of 100\% M Mb}}{\text{K/S 525 nm of 100\% M Mb}} - \frac{\text{K/S 610 nm of sample}}{\text{K/S 525 nm of sample}}}{\frac{\text{K/S 610 nm of 100\% M Mb}}{\text{K/S 525 nm of 100\% M Mb}} - \frac{\text{K/S 610 nm of 100\% OMb}}{\text{K/S 525 nm of 100\% OMb}}} \times 100$$

where: MMb = meta-myoglobin; OMb = oxymyoglobin; K = absorption coefficient; S = scattering coefficient. The 100% of meta-myoglobin (MMb) was determined with the Krzywicki method (1979), placing the meat sample in a solution of potassium ferrocyanide at 1% for 1 minute, keeping it at +2°C for 12h in a plastic container covered with polyethylene film and measuring the spectral colour with the Minolta 2500 spectrocolorimeter. The 100% of oxymyoglobin (OMb) was obtained by measuring the spectral colour of a meat sample subjected to a flow of oxygen at 100% for 10 minutes at a temperature between 0 and +2°C. The spectrocolorimeter Minolta 2500, equipped with an integrated sphere and the appropriate software (Spectramagic, 2002), performed the immediate conversion of the visible spectra of reflectivity (from 360 to 760 nm) in values of K/S, rendering the data more linear for the expression of absorption capacity and properties of dispersion, utilizing the Kubelka-Munk equation: $K/S = (1-R)^2/2R$, where: R is the factor of spectral reflection (Hunter, 1987; Mancini and Hunt, 2005). Results were subjected to a two-way analysis of variance, considering the effects of the slaughtering method, the storage time and the relative interaction (SAS, 1995).

Results and conclusions - The effects of slaughter method and storage time on meat quality traits are reported in Table 1. The pH showed significant differences in the main effects and their interaction: the pH value detected at 2h was lower in meat derived from conventional slaughter than in those from ritual slaughter. Probably the absence of stunning, prolonging the suffering of the animals before death, induced a lowering of muscle glycogen reserves and a consequent alteration of the fall in pH. In both groups pH increased slightly until day 2, and from 2nd to 6th day the conventional group showed a pH greater stability, while in the ritual slaughter group pH increased dramatically, with the risk to increase microbial growth, and lowering meat healthiness and shelf-life. Meat from animals slaughtered by the conventional method showed a higher drip loss than those from the ritual group; a gradual increase in drip loss from 24h to day 2 of storage was noted, while statistically significant differences were observed between the 2nd and 6th day in both groups: meat from conventional slaughter showed a sharp increase in drip loss, while in ritual slaughter group this increase was lower. This result, partially explained by the higher pH value found in these meats, is confirmed by Channon *et al.* (2002) who highlighted a higher water-holding capacity in meat from animals not stunned before slaughter compared to that derived from animals slaughtered according to the conventional system. As regard meat colour parameters, no statistical differences between the experimental groups were noted, so it is possible to affirm that the slaughtering system does not affect meat colour. However, it is interesting to highlight that meat derived from ritual slaughter had an unpleasant aspect due to some small red spots on the surface; this evidence is confirmed by other finding affirming that major negative effect on meat quality

of ritual slaughter without stunning is an increase of petechial hemorrhages caused by the increased blood pressure and the breaking of the vasal endothelium, probably linked to a short-term excitement of cattle prior to slaughter; petechial hemorrhages induce a notable worsening in meat quality and could compromise its acceptability to consumers (Gilli and Piscopo, 2007; Grandin and Smith, 2004). Always concerning colour parameters, a significant effect of storage time on some of them was noted: in both groups redness (a*) was stable until the 2nd day of storage, but diminished between the 2nd and 6th day, showing a discoloration of meat. Yellowness (b*) decreased between the 2nd and 6th day of storage, with a trend more evident in meat from the conventional group. Oxymyoglobin percentage was not significantly influenced by the slaughtering method or by storage time; nevertheless, with increased length of storage time, it is interesting to note that the oxymyoglobin rate tends to fall more rapidly in the ritual group, indicating a higher myoglobin oxidation and a consequent higher content of meta-myoglobin. In conclusion, the meat derived from animals slaughtered without stunning showed higher pH values, lower drip loss and some petechial hemorrhages; based on these results, further development and extension are required in order to better define the effect of ritual slaughter on animal welfare and bleeding efficiency and, consecutively, on quality and shelf- life of the meat.

Table 1. Effect of slaughter method and storage time on meat quality traits.

	Conventional slaughter			Ritual slaughter			SE
	2h**	2d	6d	2h**	2d	6d	
pH	5.55^{C}	5.61^{BC}	5.58^{C}	5.62^{BC}	5.67^{B}	5.80^{A}	0.029
Drip loss (%)	2.01^{CD}	2.83^{C}	7.54^{A}	1.12^{D}	1.82^{CD}	4.81^{B}	0.441
Colour:							
L*	46.19	45.74	43.61	44.53	44.96	45.47	0.973
a*	23.85^{A}	23.87^{A}	19.34^{B}	23.85^{A}	24.64^{A}	19.68^{B}	0.920
b*	12.43^{AB}	12.42^{AB}	10.26^{C}	11.77^{AB}	12.58^{A}	11.13^{BC}	0.508
OMb (%)	93.21	91.81	87.83	91.53	96.29	80.91	7.361

** *24h for drip loss;* ^{A,B,C,D} *=P< 0.05*

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