MEAT QUALITY ASSESSMENT IN RABBITS SUBJECTED TO RITUAL SLAUGHTER AND GAS STUN KILLING

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Abstract - Whereas animal welfare regulatory bodies would prefer that animals be rendered unconscious before exsanguination, followers of Islam and Judaism prefer that animals be exsanguinated while still alive. Moreover, meat processors prefer slaughter methods that yield the best quality meat. This has created a lot of debate among religious leaders, animal welfare officials and meat industrialists. This paper evaluates meat quality of rabbits killed by gas before exsanguination and those subjected to ritual slaughter. Pre-rigor, ritual slaughter (RS) resulted in significantly lower pH than gas stun-killing. However, post rigor, the pH values for both methods were not significantly different. RS had lower cooking loss than GK (p<0.05). On day 1, GK exhibited higher shear force than RS (p<0.05). However, on day 7, the shear force exhibited by both methods was not significantly different. The values for drip loss, redness and glycogen content were not significantly different for both RS and GK. Generally, the quality of meat from RS was comparable to that from GK. However, the procedure needs to be carefully carried out in order to avoid compromising the welfare of animals.

Key Words - Meat quality, Rabbit, Slaughter

I. INTRODUCTION

Due to its highly digestibility, medium-low juiciness, little coarseness, odour and flavour, low-calories, lowest fatty feeling in the mouth and tenderness, rabbit meat is gaining preference by many meat consumers. Moreover, meat processing industries in most part of the world, Europe inclusive are gradually expanding and improving the availability of rabbit meat in a large variety of processed ready- meat in order to meet the demands of consumers [1]. It is required by the federal humane slaughter law that all animals be stunned before exsanguination [2]. However, the law permits slaughtering in accordance with ritual requirements of any religious faith that prescribes a method of slaughter whereby the animal suffers loss of consciousness by severance of the carotid artery with a sharp instrument [2]. Slaughtering is governed by strict regulations related to food hygiene and safety, working conditions and animal welfare [3]. Traditionally, slaughter practices have dealt with factors that affect wholesomeness and quality of meat [4]. Although there has been some research on the effect of slaughter method on meat quality, most information originates from work in conventional slaughter methods with limited comparison to religious slaughter [5]. Thus the effects of stun killing rabbits before exsanguination and ritual slaughter on meat quality were examined.

II. MATERIALS AND METHODS

This study was conducted following the animal ethics guidelines of the Research Policy of Universiti Putra Malaysia.

A total of 80 male New Zealand white rabbits raised under identical conditions and fed the same diet, weighing between 1800g and 2000g were obtained from a commercial farm and transported for 1 h to the Department of Animal Science abattoir, Faculty of Agriculture, Universiti Putra Malaysia. The rabbits were randomly assigned to two groups [ritual slaughter (RS) and gas stun killing (GK)].

In the ritual method, the animals were humanely slaughtered according to the procedure outlined in the MS1500: 2009 [6]. The slaughter involved severing the jugular veins, carotid arteries. Gas stun-killing was carried out by dipping groups of ten rabbits in a gas chamber containing 61.4% CO_2, 20.3% O_2 and 18.3% N_2 for 5 min. After evisceration and carcass dressing, approximately 20g of *Biceps femoris* (BF) muscle from the left hind limbs were collected labeled, vacuum packaged and stored in a 4^{o}C chiller for drip loss determination. The left *Longisimus lumborum* (LL) between the 6th and 7th lumbar vertebra was divided into two, and snap frozen in liquid nitrogen before being stored at -80°C for subsequent determination of pH (pre-rigor) and glycogen. The carcasses were then hung in the 4°C chiller and the right LL muscle was dissected at 2 specific periods, that is, 24 h and 7 days post mortem, vacuum packed and transferred to a – 80 ^{o}C freezer and stored until subsequent analyses pH, colour, shear force and cooking loss.

The pH of the meat was measured indirectly using a portable pH meter (Mettler Toledo, AG 8603, Switzerland) following homogenization (Wiggen Hauser® D-500, Germany) of 0.5g of crushed LL muscle sample for 30 seconds in 10 ml ice cold deionized water in the presence of 5mM sodium iodoacetate (Merck Schuchardt OHG, Germany) to prevent further glycolysis. Colour was determined in triplicate using Color Flex spectrophotometer (Hunter Lab Reston, VA, USA) using International Commission on Illumination (CIE) Lab-values (L*, a*, b*) with D56 illuminant and 10˚ standard observer, tristimulus values (X, Y, Z) and reflectance at specific wavelength (400-700) nm to express the meat colour data following sample blooming for 30 min. To enhance the fraction of redness relative to yellowness and lightness, the enhanced redness (E*) was calculated following the equation of Lui et al. (2003) [7] as E* = a*/b* + a*/L*. Drip loss and cooking loss were determined by the methods described by Honikel, (1998) [8]. The samples used for cooking loss determination were collected and used for determining tenderness of the rabbit meat. Sample preparation was conducted following the procedure previously described by Sazili *et al*. (2005) [9]. The mechanical force (kg) required to shear the muscle fibers of 1cm× 1cm × 2cm cooked sample blocks was measured using the Volodkovitch bite jaw attached to a TA.HD plus® texture analyser (Stable Micro System, Surrey, UK).

Glycogen content in the LL muscles was determined using Glycogen Assay Kit # K646-100 (Bio Vision, USA) following the manufacturer's instructions for the colorimetric assay.

Data analysis was performed using the GLM procedure of Statistical Analysis System package (SAS) Version 9.2 software (Statistical Analysis System, SAS Institute Inc., Cary, NC, USA) and statistical significance was set at $p< 0.05$. Duncan multiple range test was used to test the significance of variance between the means of the studied parameters.

III RESULTS AND DISCUSSION

The results for drip loss are presented in Table 1. There was no significant difference between the drip loss of RS and GK.

Table 1 Differences in drip loss of *Biceps femoris* muscle of rabbits subjected to Ritual Slaughter and Gas Stun Killing

Parameter	RS	GK	SEM
Drip loss (%)	1.4968^{a}	1.4438^{aa}	0.1133

Least square means with similar superscripts in the same row are not significantly different.

Ultimate pH is the most widely used indicator of ante-mortem factors [10]. Meat from rabbits killed by gas presented higher pH pre-rigor ($p<0.05$) than meat from RS. However, the post-rigor pH for both methods was not significantly different (Table 2).

Table 2 Effects of Ritual Slaughter and Gas Stun Killing on pH of rabbit *Longissimus lumborum* muscle

Parameter	Days p.m.	RS	GK	SEM
pH (unit)	0	6.530[b]	6.734[a]	0.039
	1	6.188[aa]	6.290[a]	0.053
	7	6.038[aa]	6.115[a]	0.089

Least square means with different superscripts in the same row differ significantly.

Table 3 Effects of Ritual Slaughter and Gas Stun Killing on cooking loss and shear force of rabbit *Longissimus lumborum* muscle

Parameter	Days p.m.	RS	GK	SEM
Cooking loss	1	23.27[b]	25.70[a]	0.78
(%)	7	20.43[b]	24.51[a]	0.98
Shear force	1	0.82[b]	1.19[a]	0.10
(kg)	7	0.81[aa]	0.91[a]	0.06

Least square means with different superscripts in the same row differ significantly.

The effects GK and RS on cooking loss and shear force are as presented in Table 3. The cooking loss for RS was significantly lower than that of GK. Shear force is inversely related to tenderness and it is considered as one of the most important factors affecting consumer acceptability of meat [11]. On day 1, RS exhibited lower shear force values than GK (p<0.05). The shear force values reduced with aging and at day 7, there was no significant difference between the two methods.

The effects of slaughter method on the colour of rabbit LL muscle are presented in Table 4. On day 1, GK showed significantly greater lightness than RS. However, on day 7, the lightness of LL muscles from both RS and GK did not significantly differ. No significant differences were observed in meat redness or the enhanced redness at all aging periods. GK showed significantly greater yellowness than RS on day 1. However, the yellowness values did not differ significantly on days 7.

Table 4 Effects of Ritual Slaughter and Gas Stun Killing on colour values of rabbit *Longissimus lumborum* muscle

Variable	Days p.m.	RS	GK	SEM
L*	1	45.64[b]	47.51[a]	0.45
	7	43.55[aa]	44.23[a]	0.51
a*	1	8.88[a]	8.78[aa]	0.68
	7	6.92[aa]	8.35[a]	0.50
b*	1	14.96[a]	13.05[b]	1.03
	7	13.97[a]	12.96[aa]	0.46
E*	1	0.82[aa]	1.28[a]	0.16
	7	0.79[aa]	0.83[a]	0.03

Least square means with different superscripts in the same row differ significantly.

Table 5 Effects of Ritual Slaughter and Gas Stun Killing on glycogen content of rabbit *Longissimus lumborum* muscle

Parameter	Days p.m.	RS	GK	SEM
Glycogen	0	1.008[a]	1.007[aa]	0.008
(mg/kg)	1	0.868[a]	0.862[aa]	0.013
	7	0.486[a]	0.445[b]	0.012

Least square means with different superscripts in the same row are significantly different

Glycogen content is indicative of ante-mortem stress. Muscle glycogen content at the time of slaughter is one of the most influential factors of ultimate pH [12]. When glycogen reserves are low at the time of slaughter, little lactic acid is formed during rigor development resulting in high ultimate pH. The LL muscles from the RS group presented higher glycogen than those from the GK group (Table 5) although the values were only significant on day 7.

IV CONCLUSION

The results obtained from this study show that the quality of rabbit meat from RS was comparable to that from GK, particularly the ultimate pH, glycogen content, redness and drip loss. However, ritual slaughter may compromise animal welfare if the abattoir is not suitably designed, the slaughter man is not well-trained and the animals improperly restrained.

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