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Effect of Delayed Bleeding on Carcass and Eating Qualities of Rabbit Meat

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Abstract: A total of forty eight matured New Zealand rabbits with an average weight of 2.06±0.45 kg were used to evaluate the effect of delayed bleeding on carcass and organoleptic characteristics of rabbit meat. The rabbits were fed concentrate diet containing 19.11% Crude Protein (CP) and 2514.3 Kcal/kg Metabolizable Energy (ME) for a period of thirty five days. The rabbits were randomly assigned to four treatment groups in a completely randomized design. Each treatment was replicated thrice with each replicate consisting of four rabbits. Treatment one served as control where the 12 rabbits were bled immediately after stunning while treatments 2, 3 and 4 comprised of rabbits that were bled 5, 10 15 minutes after stunning. After proper bleeding, the rabbits were skinned, washed and eviscerated and cut into primal cuts. Samples for sensory evaluations were taken from the thigh muscle and the remaining carcasses were aged at 4°C for 24 and 72 hours. The result showed that the dressing percentage, chilled carcass weight and the pH were not affected ($p>0.05$) by delayed bleeding while the volume of blood drained decreased ($p<0.05$) as the period between stunning and bleeding increased. The drip loss and cooking loss increased as the time between stunning and bleeding increased while the Water Holding Capacity (WHC) decreased. The effect of delayed bleeding on shear force, WHC, drip loss and cooking loss became more pronounced with ageing. Apart from the colour and juiciness rating that significantly ($p<0.05$) decreased, the other eating qualities were not affected ($p>0.05$) by delayed bleeding.

Key words: Bleeding, stunning, ageing, carcass and organoleptic

Introduction

The nutritional and eating qualities of meat are influenced by numerous factors. Such factors include the amount of blood retained in the carcass as this will determine among other things the blooming time (Jakobsen and Bertelsen, 2000), the colour-which is the first criterion consumers use to judge meat quality and acceptability (Comfort, 1994) and the rate of bacteria degradation of the muscle fibre.

Meat quality is defined as a combination of traits that provide an edible product that is attractive, appetizing, nutritious and palatability after cooking (Kauffmann *et al.*, 1969). A major requirement for these qualities is the removal of as much blood as possible from the carcass since too much blood in the carcass results in an unpleasant appearance and create conducive environment for the growth of spoilage microorganisms. However, Williams *et al.* (1983) reported that delayed bleeding had little or no effect on the eating quality of meat though, they said this does not imply that animals should not be properly bled. In another study with pigs, Van Oeckel *et al.* (1999) reported that a poorly bled carcass was observed to be less appealing to consumers, since the appearance of the meat on display is the most important factor that determines retail selection. Gregory and Wilkins (1989) observed poor bled out to increase prevalence of carcass down-grading conditions.

It is therefore the aim of this study to evaluate the effects of delayed bleeding on carcass characteristics, ageing and eating qualities of rabbit meat.

Materials and Methods

A total of forty eight (48) matured New Zealand rabbits with an average weight of 2.06±0.45 kg were used for the study. The rabbits were reared in hutches and fed concentrate diets containing 19.11% Crude Protein (cp) and 2514.3Kcal/kg metabolizable energy (Table 1) for a period of thirty five days. At the end of the feeding period, the rabbits were staved of food for 16 hr prior to stunning and exsanguinations.

The rabbits were randomly assigned to four-treatment group in a completely randomized design. Each treatment group was replicated thrice with each replicate

Table 1: Feed composition

Ingredients	Percentage composition
Maize	30.00
Brewer dry grain	22.00
Palm kernel meal	30.00
Groundnut cake	15.00
Di-calcuim phosphate	2.50
Mineral premix	0.25
Salt (NaCl)	0.25
Total	100.00
Crude protein (%) =	19.11
Metabolizable energy =	2514.3Kcal/Kg

Table 2: Carcass characteristics of Rabbit as influenced by delayed bleeding

Parameters	T_1	T_2	T_3	T_4
Live weight (kg)	2.00±0.39	2.11±0.18	2.08±0.12	2.05±0.76
Fasted weight (kg)	1.93±0.42	2.00±0.21	1.99±0.28	1.97±0.26
*Blood (%)	6.73±0.12^{a}	5.50±0.63^{b}	4.52±0.81^{c}	4.06±0.63^{c}
Dressing %	52.80±3.66	52.98±2.30	53.11±3.20	53.27±4.10
Chilled carcass Wt (kg)	1.02±0.07	0.97±0.03	0.96±0.04	1.00±0.01
Drip loss %	11.11±0.12^{b}	12.57±2.06^{b}	14.30±0.88^{a}	14.65±0.55^{a}
PH (at 3hr P.M)	5.98±0.01	5.99±0.01	5.97±0.02	5.97±0.02

*Blood percent was calculated based on fasted weight, Means in the same row with similar superscript are not significantly ($p>0.05$) different from each other

consisting of 4 rabbits. Treatment 1 (T_1) served as control where the 12 rabbits were bled immediately after stunning, while treatment 2, 3 and 4 comprised of animals that were bled 5, 10 and 15 minutes after stunning respectively. Stunning was achieved by the use of a wooden club directed at the base of the occipital lobe of the head between the two ears. The carcasses were hung upside down on a rail for ten minutes to allow proper bleeding. The bled weights were taken after proper draining of the blood. The blood loss was obtained by difference.

The pelts of the slaughtered rabbits were removed with sharp scalpel and scissors according to the method described by Omojola and Adesehinwa (2006). After skinning, the carcasses were washed and eviscerated. The warm carcass weight and the dressing percentage were determined. Samples for sensory evaluations were taken from the thigh muscle. The carcasses were aged at 4°C for 24 and 72 hours respectively. After ageing, the following parameters were taken.

Shear force value: The objective evaluations of tenderness were performed using the modified Warner-Bratzler shear force procedure (Bouton and Harris, 1978) by using the Instron Universal Testing Machine. The meat samples were cooked to an internal temperature of 75°C. Three cores of 0.5 cm in diameter were removed from each cooked meat sample after the broiled meat has been allowed to cool to room temperature. The cores were removed using an electric coring machine. Each core was sheared at three locations parallel to the orientation of muscle fibre.

Drip loss: This was measured by the method of Barton-Gade *et al.* (1993) with some modifications. Each thigh was weighed prior to ageing, hung in a laminate bag, closed tightly and allowed to age at 4°C for 24 and 72 hours respectively. After ageing, the meat samples were taken out, mopped and re-weighed and the drip loss calculated.

Cooking loss: Meat samples of known weight were broiled in a gas oven to an internal temperature of 75°C as measured using Fluke type K temperature probe attached to Fluke 52 meters. Each cooked sample was cooled to room temperature, blotted dry and weighed.

$$\text{Cooking loss} = \frac{W_1 - W_2}{W_1} \times 100$$

Where

W_1 = Weight of meat before cooking

W_2 = Weight of meat after cooking

Water Holding Capacity (WHC): This was determined in triplicate by the press method as modified by Tsai and Ockerman (1981). Approximately 0.5 g of the meat samples were weighed onto a 9cm Whatman No 1 filter paper (model C, Carver Inc, Wabash, USA) and pressed between two 10.2×10.2 cm^2 plexi glass at approximately 35.2Kg/cm^3 for 1 minute. The area of the free water was measured using a compensatory planimeter (planis 5000, Tamaya Technique, Inc. Tokyo, Japan) and percent free water was calculated based on sample weight and moisture content (Tsai and Ockerman, 1981) percent bound water (WHC) was calculated as 100% minus free water %.

Taste panel evaluation: Samples for sensory evaluations were taken from the thigh muscle and cooked to an internal temperature of 75°C. A total of 16 trained individuals aged between 25 and 40 years (43.75% male and 56.26% female) were used to assess the cooked meat samples. Equal bite size from each treatment was coded, replicated four times and served in an odourless plastic plate. Each sample was evaluated independent of the other. The samples were evaluated on a 9-point hedonic scale for colour, flavour, juiciness, tenderness and overall acceptability.

Statistical analysis: All data obtained were subjected to analysis of variance and where statistical significance was observed, the means were compared using the Duncans Multiple Range (DMR) test. The SAS computer soft ware package (1999) was used for all statistical analysis.

Results and Discussion

The results of the carcass characteristics of rabbit as influenced by delayed bleeding are shown in Table 2. The percent blood lost were 6.73. 5.50, 4.52 and 4.06 for treatments 1, 2, 3 and 4 respectively. Rabbits that were

Table 3: Shear force, Water Holding Capacity (WHC), drip loss and cooking loss of aged rabbit meat as affected by delayed bleeding

Parameters	T_1	T_2	T_3	T_4
Shear force (kg/cm^3)				
A	4.11±0.15	4.56±0.28	4.58±2.30	4.71±2.15
B	3.06±0.52^a	2.96±0.19^b	2.30±0.66^b	2.15±0.75^b
Water holding capacity%				
A	61.37±3.11^a	56.71±1.82^b	52.11±2.22^c	51.98±3.17^c
B	57.16±5.21^a	51.11±3.10^b	41.75±2.16^c	40.15±2.82^c
Drip loss %				
A	11.11±0.12^b	12.57±2.06^b	14.30±0.88^a	14.65±0.55^a
B	12.16±1.17^c	13.81±2.01^b	15.92±1.52^a	15.42±1.41^a
Cooking loss %				
A	23.91±1.33^b	27.96±1.82^a	29.15±2.14^a	29.82±3.61^a
B	31.52±2.10^b	36.71±1.86^a	38.50±1.02^a	39.15±3.11^a

A = 24 hr ageing, B = 72 hr ageing, Means in the same row with similar superscripts are not significantly different from each other

bled immediately after stunning lost the highest amount of blood. There was a progressive decrease in the amount of blood lost as the time between stunning and bleeding increased; however, there was no significant difference (p>0.05) between the quantities of blood lost when bleeding was delayed for 10 and 15 minutes.

The dressing percentages were not significantly (p>0.05) affected by delayed bleeding. The dressing percentage values increased numerically as the time between stunning and bleeding increased. The values obtained in the present study were similar to the value obtained by Omojola and Adesehinwa (2006) when rabbits were conventionally dressed. The dressing percentage is an economic index and a one percent increase might translate into a huge sum of profit in a large-scale operation. The non-significant difference in the dressing percent despite the retention of more blood as the period between stunning and bleeding increased might be due to the fact that most of the blood retained were not in the carcass per se but within the offals (Warries and Leach, 1978).

The chilled carcass weight were not affected by delayed bleeding while the drip loss 24 hour post mortem increased as the time between stunning and bleeding increased, however, beyond 10 minutes delay, the values obtained were not significantly different (p>0.05) from each other. It is generally accepted that the source of drip from meat is intracellular water that is lost from the muscle fibre post-mortem, driven by pH and calcium induced shrinkage of myofibrils during rigor development (Honikel *et al.*, 1986). The rate and quantity of drip formation in fresh meat is believed to be influenced by the extent of rigor-shrinkage and the permeability of the cell membrane to water as well as other factors such as the extent of protein denaturation. It has also been recognized that an intact cytoskeleton within the muscle is necessary to translate shrinkage of myofibrils into shrinkage of the whole cell (Offer and Knight, 1988).

The percent drip loss obtained 24 hour post-mortem in this study were 11.11, 12.57, 14.30 and 14.65 for treatments 1, 2, 3 and 4 respectively. There was a direct relationship between the time of bleeding and the drip loss.

Smulders *et al.* (1990) outlined a range of pH values (5.9-6.3) at 3hr post-mortem as a good indicator for optimal tenderness. These authors stated that muscles in this pH range were superior in average tenderness and in tenderness uniformity. The result obtained in this study fell within the range obtained by Smulders *et al.* (1990). The non-significant shear force values obtained 24-hour post-mortem might be due to the influence of the pH that fell within the range ideal for superior tenderness score in all the treatment. The range value of 5.97-5.99 obtained in this study was in agreement with the value of 5.99±0.03 obtained by Omojola and Adesehinwa (2006) when rabbits were conventionally dressed.

The effects of delayed bleeding, although were not pronounced on the shear force 24 hour post-mortem, the effect became pronounced after the rabbit carcasses were aged for 72 hours. There was a reduction in the shear force value by 1.05, 1.60, 2.28 and 2.56 Kg/cm^3 across the treatment after ageing for 72 hours. The progressive decrease in toughness observed with ageing might be connected with bacteria degradation of the myofibrils since blood is a good medium for microbial growth.

Similar to what was observed in the shear force value, the WHC decreased considerably with ageing and the decrease became more as the time between stunning and bleeding increased. The initial WHC were 61.37, 56.71, 52.11 and 51.98 percent at 24 hour post-mortem as against 57.16, 51.11, 41.75 and 40.15 percent at 72 hour post-mortem for treatments 1, 2, 3 and 4 respectively. The leaking out hypothesis of Kim *et al.* (1993) explains the increase in the WHC observed across the treatments group 24 hour post-mortem, while the reduction in the WHC across the treatment 72 hour post-mortem could be due to the disruption of muscle fibre by increased bacteria activity. The observed increase in the drip loss with ageing might be due to the reduction in WHC. The trend observed in the drip loss 72-hour post-mortem were similar to the trend observed in drip loss 24 hour post-mortem.

Table 4: Organoleptic characteristics of Rabbit meat as influenced by delayed bleeding

Traits	T_1	T_2	T_3	T_4
Colour	5.50 ± 0.21^a	4.75 ± 1.76^{ab}	4.25 ± 1.41^b	3.50 ± 1.40^c
Flavour	5.25±0.37	6.00±0.81	6.50±0.79	6.30±0.61
Juiciness	5.00 ± 0.72^a	4.75 ± 1.76^{ab}	4.25 ± 1.05^b	3.25 ± 0.39^c
Tenderness	4.75±0.45	6.00±1.06	5.75±0.78	4.50±1.24
Overall accept	6.00±1.02	6.25±1.06	6.05±0.70	6.00±1.43

The parameters were evaluated on a nine point-hedonic scale with 9 = most preferred and 1 = least preferred, abc means on the same row with similar superscripts are not significantly different (p>0.05) from each other

The result of this study showed that cooking loss percent increased with ageing. The least (p<0.05) cooking loss value was obtained in the control treatment (where bleeding was done immediately after stunning) while the 5, 10 and 15 minutes delay bleeding gave values that were not significantly different (p>0.05) from each other. There was an inverse relationship between the cooking loss and the WHC. The highest cooking loss 24 and 72 hours post-mortem were obtained in treatment with the lowest WHC and vice versa.

The result of the organoleptic characteristics as influenced by delayed bleeding is shown in the Table 4. The taste panel score showed that as the time between stunning and bleeding increased, the colour rating became poorer (p<0.05). The highest colour score was given to meat of rabbits bled immediately after stunning with a value of 5.50 followed by 4.75, 4.25 and 3.50 for 5, 10 and 15 minutes delayed bleeding respectively. Meat colour is the first criterion consumers use to judge meat quality and acceptability (Comfort, 1994) while the appearance of meat influences the consumers acceptance of the meat (Van Oeckel *et al.*, 1999). The result of this study as assessed by the taste panelists showed no significant (p>0.05) difference irrespective of the time between stunning and bleeding.

Juiciness is directly related to the intramuscular lipid and moisture content of the meat (Cross *et al.*, 1986). In combination with water, the melted lipids constitute a "broth" which when retained in the meat is released upon chewing. Table 4 showed the mean values for juiciness. The taste panel scores showed a reduction in the average score from 5.00 to 3.25 as the time between stunning and bleeding increased form 0 to 15 minutes. As the WHC reduced, the cooking and drip losses increased thereby reducing the amount of juice released upon chewing (Table 3). The reduction in the WHC and an increase in the cooking and drip losses as the time between stunning and bleeding increased might be a probable reason for the observed low juiciness rating of the rabbit meat as time between stunning and bleeding increased.

Tenderness is regarded as the most important sensory attributes affecting meat acceptability (Quali, 1990; Warkup *et al.*, 1995). Tenderness has also been identified as the most critical eating quality characteristics, which determines whether consumers are repeat buyers. As stated by Quali (1990) and smulders *et al.* (1990) meat tenderization is a multi-factorial process dependent on a number of factors such as species, age sex, muscle type, ante-mortem stress and slaughter conditions. Table 4 indicated that there was no statistical difference (p>0.05) observed by the panelist for tenderness. This followed a similar result obtained for the shear force determination at 24 hour post-mortem in this study .

The taste panel rating showed that the overall acceptability of the rabbit meat was not dependent on immediate exsanguinations after stunning. Delayed bleeding within the time frame of this study did not have any deleterious effect on the overall acceptability of rabbit meat, as no significant (p>0.05) differences were observed among the treatment means.

Conclusion: The effect of delayed bleeding on dressing percentage, chilled carcass weight and the meat pH (3 hr post-mortem) were not treatment dependent (p>0.05). The drip loss and cooking loss increased as the time between stunning and bleeding increased while the WHC decreased. The effect of delayed bleeding became pronounced with ageing. The result of this study showed that apart from colour and juiciness rating that significantly decreased (p<0.05) as time between stunning and bleeding increased, the other eating quality such as the flavour, tenderness and overall acceptability were not affected (p>0.05) by the treatment effect within the limit of this study.

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