INFLUENCE OF BREED, GENDER AND AGE ON AVOIDANCE-RELATED BEHAVIOUR, BLEEDING TIMES AND THE QUALITY OF MEAT FROM SHEEP

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Abstract – The effects of breed, gender and age on avoidance-related behaviour (ARB) of sheep at slaughter, bleeding times (BT), and mutton quality were determined. The behaviour of 90 castrates and 110 ewes of different age categories (<10months, 11-12 months, >12 months) was observed during three stages of slaughter, at a commercial abattoir. The ARB was not affected by breed, gender and age. Ewes had longer (68.5±1.48s) BT than castrates (55.2±1.70s). Heavier sheep had longer BT than the lighter ones (r=0.149, P <0.05). Cooking loss (CL) was higher in meat from older sheep and in meat from ewes than from younger sheep and castrates, respectively. Meat from the Dorper breed had the highest CL (39.6±1.38%) and the lowest Warner Bratzler Shear Force (WBSF) (14.3±3.66N). Meat from the Merino breed had the highest WBSF (33.9±3.24N). It can therefore be concluded that breed, gender and age had no effect on ARB while these factors affected the quality of mutton. Only gender had an effect on BT.

Key Words – Bleeding rates, Meat quality, Slaughter-house

I. INTRODUCTION

Information of the behaviour of different species of livestock, as well as the behaviour of different breeds within a particular species is crucial for proper management and planning of facilities for livestock, mainly because different breeds of animals react differently to handling techniques and systems [1]. Abnormal behaviours are indicative of poor animal welfare, resulting in frustration, due to an inadequate environment or lack of control over their environment [2]. The choice of stress responses depends on the specific situation; and varies between individuals, species and breeds [3]. Several other factors such as age, gender, weight, and abattoir operations affect animal behaviour.

Certain sheep breeds, such as the Merino, tend to cluster together as a group, while the crossbred Finn sheep turn to face the handler and maintain visual contact; the Old Norwegian Sheep was reported to flee more readily than the heavier Suffolk when stressed [4]. Nonetheless, the behaviour of sheep does not differ much under conditions of reduced welfare, such as injury or overcrowding [5].

Abattoir operations and animal characteristics also affect the bleeding process. Blood is an ideal medium for the growth of bacteria hence efficiency of bleeding has an important bearing on maintaining good quality of the carcass [6, 7]. It is important for the bleed out time to be monitored [8], to decrease the risk of carcass contamination.

Commercial abattoirs have been reported to have greater willingness to invest in reliable/sophisticated equipment if there are carcass or meat quality advantages [9]. This study determined the effect of breed, sex and age on avoidance-related behaviour (ARB) of sheep at slaughter, bleeding times (BT) at exsanguination and the quality of mutton produced at a commercial abattoir.

II. MATERIALS AND METHODS

Animal description

Both castrates (90) and ewes (110) of the age groups 1, 2 and 3 (<10 months, 11-12 months, >12 months, respectively) were used from three types of breeds (90 Dorper, 90 polled Merino, and 20 of their Crosses). Sheep numbers and any other records of these sheep were dependent on what was brought to the abattoir for slaughter. The age of these sheep was determined using the dentition procedure. Sheep were kept in the abattoir holding pens overnight with access to water.

Slaughter procedure

Sheep were manually driven from the holding pens via a race onto a conveyer restrainer, which was used to introduce them onto the slaughter floor. There was minimal contact between sheep and the handlers. The stunning operator controlled the movement of the conveyer using a pedal at his feet. At the far end of the conveyer, sheep were stunned and allowed to fall on a horizontal bleeding stand were the process of bleeding was initiated. Stunning was done at 110V with a cone cave-shaped stunner (tongs) with a current of 0.6 amperes for 60 seconds with the electrodes placed on the sides of the head above the eye level. The animals were bled within sixty seconds after stunning by cutting the throat open from one end of the neck to another. After a few seconds of horizontal bleeding, the sheep was then hung vertically by its right hind leg. Carcass weights were also recorded.

Behaviour scoring

Behaviour categories (Table 1, modified from that described by Terlouw and Porcher [10]) were observed from the introduction of the animals onto the slaughter floor. Records were taken at three stages of slaughter; before and after stunning, and at bleeding; where it was assumed that the higher the response scores assigned the higher the avoidance behaviour.

Table 1 Avoidance-related behavioural scores of sheep at slaughter

Category	Code
Before stunning	
Standing (rests on four legs)-calm	1
Sitting (rests on thighs and front legs)-calm but threatened	2
Other e.g. jumping (unstable/trying to escape/aggression)	3
After stunning	
Stable (no movement)-calm	1
Kicks before cutting-aggression/panic	2
Kicks at cutting-aggression/panic	3
While bleeding	
Stable (no movement)-calm	1
Head/ and tail movement (wagging)-aggression/panic	2
Kicking (front/hind legs)-aggression/panic	3

Modified from Terlouw and Porcher (2005)

Bleeding times

The time interval between the start of the blood flow and the time the flow changed from a constant stream into drips [11] was recorded as bleeding times (BT) using a stop-watch.

Meat samples preparation

Ninety carcasses were randomly selected from the 200 slaughtered and meat samples were obtained from the *longissimus dorsi* muscle from the 4^{th}-6^{th} ribs. The sample weights ranged between 10-20 grams with minimal or no fat cover. Samples were stored (vacuum packed in plastic bags each) in a chiller and taken out after 24 hours for pH_{24}, colour, cooking loss and tenderness measurements.

Statistical analysis

The data was analysed using the main effects model of Genstat [12]. The χ^2 (chi square) test was used to assess the effect of age group, breed, and gender on ARB scores. Analysis of covariance (ANCOVA) was used to test the effect of breed, age group, gender on the BT at exsanguination and meat quality variables, with carcass weight as a covariate. The model used was: $Y_{ijkl} = \mu + \alpha_i + \beta_j + \lambda_k + \beta_1 X_1 + e_{ijkl}$.

III. RESULTS AND DISCUSSION

Animal avoidance-related behaviour at slaughter

In the current study, the ARB did not vary ($P > 0.05$) with breed, gender and age groups. About 90% of the slaughtered animals showed similar behaviour responses which was categorised by standing on introduction to the slaughter floor; stable after stunning; and kicking after the process of exsanguinations had been initiated. The current results could be attributed to the fact that the same management procedures from introducing the animals to the slaughter floor using a conveyer restrainer were used throughout the investigation. Furthermore, the sheep rested overnight in the abattoir lairage pens, which may have contributed to the animals getting used to the environment [8]. The non-

variation in the ARB of these maybe due to the fact that animals were expected to be unconscious and rigid with no pain or any other sensation [8]. Any other behaviour at that point would be linked to ineffective stunning procedures. There was no (P>0.05) relationship between ARB and the quality of meat produced. These results contradict with the reports that agitation at slaughter can decrease meat quality [13].

Bleeding times at exsanguination

The BT times did not differ with age group and breed; but differed with the gender of the animals. The BT were longer in ewes than in castrates (Figure 1). On the contrary, Agbeniga [14] reported that blood loss in cattle did not differ with gender. The longer bleeding times obtained for ewes may be due to the fact that male aggressive behaviour is associated with testosterone levels [15] resulting in high levels of adrenalin hormone release, thus in stressful situations blood squeezes out of the animal very fast.

Apart from the gender of the animals, weight also had a positive correlation (r=0.149, P <0.05) with the BT. This result was also obtained in a study by Kirton and Woods [11].

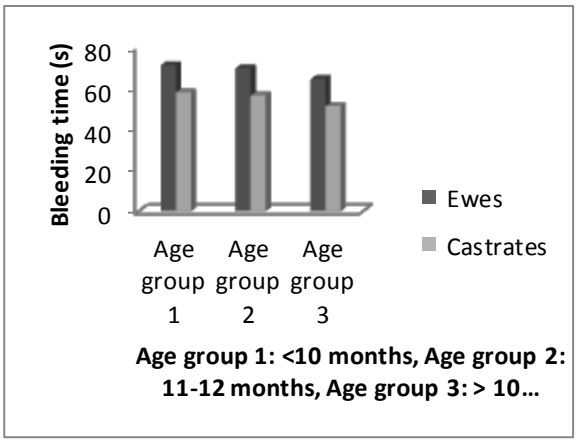

Figure 1. Interactions between gender and age class on bleeding times (s)

Meat quality

Meat colour variables L*, a*, and b* did not differ with age groups. However, meat from older sheep (> 12 months) had higher (P<0.05) CL values than meat from younger sheep. Similar results were obtained in a study by Schonfeldt and Strydom [16] on beef; they reported that cooking loss increased with increasing age of the animal and linked this to protein denaturing which results in decreased water holding capacity at heating. Younger sheep (<10 months) produced tougher meat compared to older animals. These results contradict reports that meat quality is reduced with increasing (maturity) age [16].

Table 2 shows that the L* of meat did not differ (P>0.05) with breed, but differences were observed in a* and b* values of meat from the three breeds with their crosses having the highest values. Meat from the Dorper had the highest cooking loss and the lowest WBSF. The Dorper x Merino crosses had the highest a* and b* values.

Table 2 The effect of breeds on the colour (L*, a*, b*), cooking loss and tenderness of mutton

Parameters	Dorper (LSmean± SEM)	Crosses (LSmean± SEM)	Merino (LSmean± SEM)	Significance
N	90	20	90	
Lightness (L*)	36.4±2.31	33.3±2.68	32.9±2.04	NS
Redness (a*)	16.2^{b}±1.2 2	22.7^{a}±1.4 2	17.3^{b}±1.0 8	**
Yellowness (b*)	11.5^{b}±1.3 7	17.7^{a}±1.3 7	13.5^{b}±1.0 5	**
Cooking loss (%)	39.6^{a}±1.3 8	32.9^{b}±1.6 0	34.7^{b}±1.2 2	**
WBSF (N)	14.3^{b}±3.6 6	30.7^{a}±4.2 4	33.9^{a}±3.2 4	**

Means in the same row with different superscripts are significantly different at P<0.05. NS- not significant, *P<0.05, **P<0.001, WBSF-Warner Bratzler Shear Force for meat Tenderness

The meat quality results shown by the Dorper x Merino crosses may be an indication of heterosis. Krzywicki [17] found that meat from the Merino x Dorper crosses had higher marbling than other breeds. The marbling could have contributed to the high b* values observed for the crosses. The higher a* values could be linked to higher myoglobin concentration [14]. Meat from the Dorper breed had the highest CL and was most

tender. This is supported by Snowder and Duckett [18] who reported that Dorper lambs had more tender meat than other breeds. WBSF increases with increasing CL.

Meat colour and tenderness did not differ with the gender of the animal. Ewes had higher CL values than castrates. This can be linked to the reproductive role the ewes play thus reducing the muscle water holding capacity. Meat quality and palatability is known to decline with animal maturity, mature females (parity 6) had reduced muscle growth potential [20]. Hence this could also be attributed to the age differences between the ewes and the castrates. Cloete *et al.* [21] reported that rams had a higher CL thus tougher meat compared to ewes which had lower CL and tender meat.

IV. CONCLUSION

It can be concluded that breed, gender and age had no effect on ARB while these factors affected the quality of lamb/ mutton. Only gender had an effect on the BT.

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REFERENCES

1. Grandin T. (1999). Behavioural principles of handling Livestock (update). Professional Animal Scientist. Dec 1989 pp. 1-11.
2. Broom D. M. & Fraser A. F. (2007). Domestic animal behaviour and welfare, fourth edition. CAB International, UK.
3. Koolhaas J. M., Korte, S. M., De Boer, S. F., Van Der Vegt, B. J., Van Reenen, C. G., Hopster , H., De Jong, I. C., Ruis, M. A. & Blokhuis, H. J. (1999). Coping styles in animals: current status in behaviour and stress physiology. Neuroscience Biological Behaviour Review 23: 925-935.
4. Hansen I., F. Cristiansen, H. S. Hansen, B. Braastad & M. Bakken. (2001). Variation in behaviour response of ewes towards predator-related stimuli. Applied Animal Behaviour Science 70: 227-237.
5. Knowles T. G. (1998). A review of road transportation of slaughter sheep. Veterinary Record 143: 212-219.
6. Thornton H. & Gracey, J. F. (1974). Textbook of Meat Hygiene, sixth edition. Bailliere Tindall. London.
7. Red Meat Abattoir Association (RMAA) (2011). Animal handling practical guidelines for abattoirs. Accessed: February 2012.
8. Gregory N. G. (2008). Animal welfare at markets and during transport and slaughter. Meat Science 80: 2-11.
9. Gregory N. G. (2005). Recent concerns about stunning and slaughter. Meat Science 70: 481-491.
10. Terlouw E. M. C. & Porcher, J. (2005). Repeated handling of pigs during rearing. I. Refusal of contact by handler and reactivity to familiar and unfamiliar humans. Journal of Animal Science 83: 1653-1663.
11. Kirton A. H. & Woods, E. G. (1977). Blood weights, bleeding times of electrically stunned sheep slaughtered by three different methods. New Zealand Journal of Agricultural Research 20: 441-451.
12. GenStat (2008). GenStat 11th Edition, VSN International. Hemel Hempstead, U.K.
13. Voisinet B. D., Grandin, T., Tatum, J. D., O'Connor, S. F. & Struthers, J. J. (1997). Feedlot cattle with calm temperaments have higher average daily gains than cattle with excitable temperaments. Journal of Animal Science 75: 892-896.
14. Agbebiga B. (2012). Influence of conventional and Korsher slaughter techniques in cattle on carcass and meat quality. MSc Agriculture thesis. University of Pretoria, South Africa.
15. Ross C. N., French, J. A. & Pater, K. J. (2004). Intensity of aggressive interactions modulates testosterone in male marmosets. Physiology and Behaviour 83: 437-445.
16. Schonfeldt H. C. & Strydom, P. E. (2011). Effect of age and cut on cooking loss, juiciness and flavour of South African beef. Meat Science 87: 180-190.
17. Krzywicki K. (1979). Assessment of relative content of myoglobin, oxymyoglobin and metmyoglobin at the surface of beef. Meat Science 3: 1-10.
18. Snowder G. D & Ducket, S. K. (2003). Evaluation of the South African Dorper as a terminal sire breed for growth, carcass, and palatability characteristics. Journal of Animal Science 81: 368-375.

19. Jeremiah L. E., Dugan, M. E. R., Aalhus, J. L. & Gibson, L. L. (2003). Assessment of the chemical and cooking properties of the major beef muscles and muscle groups. Meat Science 65: 985-992.
20. Cabaraux J. E., Hornick, J. L., Dotreppe, O., Dufrasne, I., Cliquart, A. & Istasse., L. (2004). Effects of the calving number on animal performance carcass and meat consumption in finishing Belgian Blue double muscled culled females. Livestock Production Science 87: 161-169.
21. Cloete J. J. E., Hoffman, L. C. & Cloete, S. W. P. (2012). A comparison between slaughter traits and meat quality of various sheep breeds: Wool, dual-purpose and mutton. Meat Science 91: 318-324.