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THE EFFECT OF DAY AND NIGHT CROPPING ON THE MEAT QUALITY OF IMPALA (*AEPYCEROS MELAMPUS*)

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Introduction

The impala's wide distribution in southern Africa and its relative abundance make it well suited to continuous cropping for game meat production (Bourgarel *et al*, 2002). In South Africa, the impala is the single most important species in the Lowveld and Bushveld areas in terms of its population numbers (Hoffman, 2000). A recent study by Eloff (2002) showed that impala are the most popular game species at game auctions, making up almost a third of the total animals sold. This is the case because of their relative abundance when compared to other species and the fact that new game farmers who wish to establish game populations on their farms are able to buy them without stretching their financial resources. They tend to be seen as the "bread and butter" of a game farming operation because of their rapid population growth rates (Fairall, 1985) and so they are easily traded. The smaller and newer game farms do not usually have resident predator populations. Without this natural form of population control it soon becomes necessary to crop animals in order to prevent overgrazing and destructive interspecies competition. In the light of this growing industry the development of efficient cropping methods for game has become an aspect that requires urgent attention.

Objectives

This study was conducted to determine the effects of day- and nighttime cropping on the meat quality parameters of impala.

Methodology

The cropping of impala herds took place at the Mara Research Station (23° 05' S and 29° 25' E; 961 m.a.s.l.) in the Limpopo Province, South Africa. During the nighttime operation 16 animals of random age and sex were harvested. Targeted animals were shot high in the neck or the head. Ambient temperatures varied between 2-11 °C. During the daytime, 24 animals were harvested. The animals were hunted on foot and high neck shots were used. Ambient temperatures varied between 19-27 °C.

Following the shooting, the dead animals were immediately exsanguinated. pH (pH_{45}) and temperature ($temp_{45}$) readings were taken in the *M. longissimus lumborum* using a calibrated Crison 506 portable pH meter. The animals were then transported to the slaughtering facility where they were skinned, eviscerated and the carcasses cleaned and cooled (4°C). pH profiles (measuring the pH and temperature every two hours for the first 12h, and then every four hours for the following 12h post mortem) were taken from five animals shot in the day and ten animals from those cropped at night. pH_u readings were taken from all of the carcasses 24 hours post mortem. Loin (*M. longissimus lumborum* between the 1st and 4th) samples for physical analysis were taken from the carcasses 36 hours after cropping. Steaks (15mm in thickness) cut perpendicular to the longitudinal axis of the muscle on the caudal side of the sample were used to determine the drip loss and cooking loss according to the methods set out by Honikel (1998). For the Warner Bratzler shear force test, five 12.7mm diameter samples were cut randomly from the cooked block of meat perpendicular to the longitudinal axis of the muscle fibre, at a crosshead speed of 200mm/min. Freshly cut steaks were allowed to bloom for 20 minutes where-after the colour (L*, a*, b* h_{ab} and chroma) was measured using a Color-guide 45°/0° colorimeter (BYK-Gardener, USA).

Analyses of variance were performed on all the variables measured within treatments (SAS, 1989). No significant age or sex differences were found and so the data were pooled for further analysis. Standard t-tests were then conducted with the time of cropping as the main effect. The non-linear regression procedure (Proc NLIN) of SAS (1989) was used to fit exponential decay models ($y = a + b\, e^{(-ct)}$) to the rate of pH decline (t=time, h) and the rate of temperature decline for both the day and night cropped groups. The a, b, and c values from the above mentioned regression model were then analysed using the t-test procedure of SAS (1989) to test for differences between the time of cropping. As there were differences found in the rate of muscle temperature decrease between the day and night treatments, the pH readings were standardized at 4 °C using the formula of Bruce *et al* (2001). The $pH_{adjusted}$ was then re-analysed.

Results & Discussion

The temperature drops for both treatments could be represented by an exponential decay model (Day: a = 8.03, b = 31.66, c = -0.15; Night: a = 4.49, b = 45.33, c = -0.31). The temperature drop of the night cropped group fell twice as fast as that of the day cropped group, thus indicating rapid cooling in the night cropped muscles.

The pH decline under the prevailing ambient temperatures in the day and night differed significantly (Table 1), with the day cropped group having a more rapid rate of pH decline. Although the analysis was repeated after the temperature was adjusted to a standard 4°C for both treatments, this difference still persisted. The pH_{45} of the animals cropped at night were significantly higher than those shot in the day (Table 2). However, the pH_u of the day cropped animals were higher than those of the group harvested at night. The night-cropped animals had a lower average drip-loss compared to the day-cropped animals whilst the cooking loss did not differ (Table 2). The Warner-Bratzler shear force tests showed that the meat from the night cropped group was significantly more tender than that of the day cropped group. No significant differences between the two treatments were noted in so far as the colour of the meat was concerned.

The difference in pH profiles is likely as a result of the difference in ante mortem conditions experienced by the animals prior to death between the day and night treatments. It is likely that the difference arose as a result of the heightened stress level of the day cropped animals because of their awareness of the hunters. Another influence could be the heightened level of physical activity during the day, particularly during the rut, which would cause the glycolytic enzyme activity to remain high for a longer period inducing a more rapid pH decline. The relative unawareness of the animals of the croppers (and thus unstressed state) during the night cropping, would result in a lowered glycolytic enzyme activity and a slower rate of pH decline.

All the other physical quality attributes can be correlated with the difference in pH decline profiles between the day and night cropping.

Conclusions

From the results of this study it is evident that night cropping of impala has a beneficial effect on the meat quality as opposed to day cropping. The results of the pH data, drip loss and shear force analyses clearly show that the method of night cropping yields a better meat quality than the day cropping method. Night cropping does not seem to have any detrimental effects on meat quality and it can be deduced that this is as a result of lower ante mortem stress to the animals.

Owing to the very low nighttime ambient temperatures, it is possible that animals cropped at night could develop cold shortening, however this specific aspect requires further research.

References

Bourgarel, M., des Clers, B., Roques-Rogery, D., Matabilila, J. & Banda, M. (2002). The sustainable use of game: Production of cheap edible meat for local communities in a Zimbabwean communal area. In: Sustainable Utilisation – Conservation in Practice. eds. H. Ebedes, B. Reilly, W. van Hoven & B. Penzhorn, pp 199–206.

Bruce, H.L., Scott, J.R. & Thompson, J.M. (2001). Application of an exponential model to early post mortem bovine muscle pH decline. Meat Science, 58, 39–44.

Eloff, T. (2002). The economic realities of the game industry in South Africa. In: Sustainable Utilisation – Conservation in Practice. eds. H. Ebedes, B. Reilly, W. van Hoven & B. Penzhorn, pp 78–86.

Fairall, N. (1985). Manipulation of age and sex ratios to optimize production from impala Aepyceros melampus populations. South African Journal of Wildlife Research, 15(3), 85–88.

Hoffman, L.C. (2000). The yield and carcass chemical composition of impala (Aepyceros melampus), a southern African antelope species. Journal of the Science of Food and Agriculture, 80, 752–756.

Honikel, K.O. (1998). Refernce methods for the assesment of physical characteristics of meat. Meat Science, 49, 447–457.

SAS, (1989). SAS/STAT Users Guide. The SAS System for Windows, Version 8.2, ed. SAS Institute Inc., Cary, NC. 1028p.

Tables and Figures

Table 1: The calculated constants (LS Mean ± SE) for the exponential equations fitted to the pH decline under normal temperature conditions and under adjusted standard temperature (4 °C) for day (n = 5) and night (n = 10) cropped impala

$y = a + be^{-ct}$ constants	T	Normal pH decline	P < |t|	pH decline adjusted to std temp	P < |t|
a	D	5.38 ± 0.006	< 0.01	5.46 ± 0.006	< 0.01
	N	5.41 ± 0.004		5.42 ± 0.004	
b	D	2.93 ± 0.124	< 0.01	2.90 ± 0.086	< 0.01
	N	2.14 ± 0.083		2.47 ± 0.057	
c	D	-0.72 ± 0.040	< 0.01	-0.58 ± 0.027	< 0.01
	N	-0.53 ± 0.026		-0.45 ± 0.018	

T (Time) = D (Day) or N (Night)

Table 2: Mean pH values and physical meat quality parameters (LS Mean ± SE) for the day (n = 24) and night (n = 16) cropped impala at Mara

	Day cropped	Night cropped	P < |t|
Mean pH_{45}	6.55 ± 0.235	6.67 ± 0.111	0.05
Mean pH_u	5.45 ± 0.108	5.39 ± 0.081	0.05
Drip loss (%)	4.15 ± 2.339	2.93 ± 1.597	0.05
Cooking loss (%)	32.87 ± 4.101	32.99 ± 5.109	0.90
Warner Bratzler shear force (g/mm^2)	23.42 ± 8.128	19.11 ± 5.675	0.05