THE EFFECT OF GENDER ON THE MEAT QUALITY CHARACTERISTICS OF KUDU *(TRAGELAPHUS STREPSICEROS)*

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Background

The kudu, one of Africa's most majestic animals shows strong sexual dimorphism, the male bears enormous spiral horns, which attains full length (≈120 cm) at six years of age, reaches a larger size (≈250 kg live weight) than the female (≈180 kg live weight) and is more predominantly adorned with manes of hair on the back and neck. Kudu are predominantly browsers, but will occasionally graze. Kudu occur throughout the savannah regions in central Africa south of the equatorial forests, through East Africa to Ethiopia, Sudan and Chad down to the Eastern Cape (South Africa), and are common throughout bushveld areas where there are stands of bush, they do not occur in open grassland and forest. Within South Africa, this species is hunted regularly for local consumption, particularly in the form of biltong (slices of meat, lightly salted and air-dried, similar to jerky). Of the R843m generated by the game industry in South Africa during 2000, 53.4% was generated by the biltong hunting industry and a further ≈3% by the game meat industry (Bothma, 2002). Kudu meat is also a regular item in most South African restaurants that serve game meat and is also frequently exported (Hoffman & Bogalke, 1999).

Objectives

Although this species is consumed regularly, very little data seems to have been published as pertaining to the muscle chemical composition and other quality attributes of its meat. In the present investigation, the proximate and fatty acid chemical composition of the *M. longissimus dorsi et lumborum* of eighteen animals are presented.

Materials and methods

Eighteen kudu were harvested early in the evening during winter in the Tussen die Riviere Nature Reserve in the Free State Province, South Africa. Of these, eight were males (varying in live mass from 111 to 179 kg) and ten females (live mass from 68 to 152 kg).

Standard harvesting techniques were utilised (Hoffman, 2003) with the animals all being killed instantaneously with a head shot using a .270 calibre rifle fitted with a telescopic sight. Live mass was recorded on the hot carcasses after being bled, approximately 60 min *post mortem*. The animals were then eviscerated, skinned and cleaned, followed by the removal of the head, gut and other edible and non-edible parts of the body. These included the kidneys, liver, lungs, internal fat as well as the leg from the hoof to the knee. The carcasses were then moved into a cooling facility overnight. The dressed carcasses were removed from the cooler (set at 4°C) early the next morning (≈12 h *post mortem*) and weighed for calculation of the dressing percentage and for removal of the muscle samples for chemical analysis. For chemical analysis the *M. longissimus dorsi et lumborum* (MLD) was removed from between the 12th and 13th rib to between the 4th and 5th lumbar vertebra.

The lean meat samples (MLD) were placed in polyethylene bags, vacuum-sealed and placed in a freezer at –20°C until further chemical analyses could be carried out. Proximate analysis was conducted on the MLD samples. After removing the subcutaneous fat and superficial connective tissue, the frozen muscle samples were cut into smaller portions, minced three times through a 2 mm sieve to ensure homogeneity, and analysed chemically. Total percentage moisture, protein and ash were determined according to standard AOAC methods (AOAC, 1997). The moisture content was analysed by drying a 2.5 g sample at 100°C for a period of 24 h. The protein (N x 6.25) content was determined by the block digestion method (AOAC, 1997), while ashing was done at 500°C for a period of 5 h. The total fat content was determined by extracting the fat with a 2:1 mixture of chloroform:methanol (Lee, Trevino & Chaiyawat, 1996).

The fatty acid content was determined using the same method described by Tichelaar *et al*. (1998). After thawing the meat, the lipids in a 2 g sample were extracted with chloroform/methanol (CM 2:1; v/v). All the extraction solvents contained 0.01% butylated hydroxytoluene (BHT) as an antioxidant. A polytron mixer (Kinematica, type PT 10-35, Switzerland) was used to homogenize the sample within the extraction solvent. Heptadecanoic acid (C17:0) was used as an internal standard to quantify the individual fatty acids. A sub-sample of the extracted lipids was transmethylated for 2 h at 70°C using methanol/sulphuric acid (19:1; v/v) as transmethylating agent. After cooling, the resulting fatty acid methyl esters (FAME) were extracted with water and hexane. The top hexane phase was transferred to a spotting tube and dried under nitrogen. The FAME were purified by TLC (silica gel 60 plates) and analysed by GLC (Varian Model 3300 equipped with flame ionisation detection) using a 60 m BPX70 capillary columns of 0.25 mm internal diameter (SGE, Australia). Gas flow rates were, hydrogen, 25 ml/min; and hydrogen carrier gas 2-4 ml/min.

Temperature programming was linear at 3°C/min, with an initial temperature of 150°C, a final temperature of 220°C, an injector temperature of 240°C and a detector temperature of 250°C. The FAME in the total lipids were identified by comparison of the retention times to those of standard FAME mixture (Nu-Chek-Prep Inc., Elysian, Minnesota).

A standard analysis of variation was performed on the various parameters measured and differences were tested for by means of student's t-test using SAS version 8.2 (SAS, 2002) statistical software.

Results and discussion

Due to the fact that non-trophy status bulls (young animals) were cropped, there was no significant difference for the live weight (121.30±10.531 vs 137.79±7.680 kg), carcass weight (72.40±6.684 vs 79.25±4.709 kg) or dressout percentage (59.55±0.942 vs 57.45±0.651 %) between the females and males respectively. This value is similar to the 58% reported for other game species such as the impala (Hoffman, 2000). The proximate chemical composition of the MLD is shown in Table 1. None of the parameters differed significantly between the sexes and the low lipid values indicate that kudu meat could be considered as a healthy lean meat.

Table 1. The average (±se) chemical composition of the *M. longissimus dorsi et lumborum* of female and male kudu.

Parameter	Female (n=10)	Male (n=8)	Pr > |t|
Moisture (%)	74.15 ± 0.285	74.49 ± 0.162	0.3420
Protein (%)	24.29 ± 0.278	23.58 ± 0.181	0.0591
Lipid (%)	1.56 ± 0.093	1.58 ± 0.056	0.8802
Ash (%)	1.29 ± 0.021	1.23 ± 0.032	0.0897

In Table 2 the fatty acid content of the MLD is shown. The following fatty acids were not detected: C22:0, C22:4n-6, C24:0 and C24:1n-9. Only two of the longer chained polyunsaturated fatty acids (C20:3n-6 and C20:%n-3) differed between the females and males, the later having a higher concentration each time. Of the kudu muscle's fatty acids, 37% were saturated, 22% monounsaturated and 41% polyunsaturated. The level of arachidonic acid was particularly high (≈8%) and was 0.47 mg per 100 g meat. The kudu had a very high mean desirable fatty acid (stearic acid plus all unsaturated fatty acids) content of 83%. The mean polyunsaturated to saturated ratio (1.12) were all well above the recommended 0.45 advocated by the British Department of Health (Enser *et al*., 1998). The n-6:n-3 PUFA ratio (2.34) was also well below the British department of Health's recommended figure of 4.

Table 2. The mean (±se) fatty acid content (%) of the *M. longissimus dorsi et lumborum* of female and male kudu.

Fatty acid	Female (n=10)	Male (n=8)	Pr > |t|
C16:0	17.53 ± 0.688	16.10 ± 0.343	0.1058
C16:1n-7	0.70 ± 0.129	0.52 ± 0.054	0.2637
C18:0	20.00 ± 1.157	19.72 ± 1.086	0.8642
C18:1	21.94 ± 1.455	19.91 ± 0.967	0.2873
C18:2n-6	19.03 ± 1.313	20.53 ± 0.786	0.3701
C18:3n-3	4.67 ± 0.383	4.85 ± 0.395	0.7463
C18:3n-6	0.08 ± 0.028	0.05 ± 0.026	0.4774
C20:0	0.20 ± 0.035	0.11 ± 0.418	0.1147
C20:1n-9	0.10 ± 0.030	0.06 ± 0.033	0.3313
C20:2n-6	0.12 ± 0.032	0.15 ± 0.083	0.7227
C20:3n-6	0.92 ± 0.049	1.14 ± 0.050	0.0076
C20:4n-6	7.74 ± 0.455	8.44 ± 0.376	0.2702
C20:5n-3	2.50 ± 0.256	3.17 ± 0.147	0.0492
C22:5	2.42 ± 0.150	2.75 ± 0.139	0.1349
C22:6n-3	2.06 ± 0.2391	2.50 ± 0.227	0.2022

Conclusions

The chemical composition of kudu *M. longissimus dorsi et lumborum* indicates that this meat could be classified as nutrient dense. Of particular interest is the high protein (≈24 g per 100g meat) and low fat content (≈1.5 g per 100 g meat) of the meat. The fatty acid profile of the meat is also very advantageous for human consumption by being highly unsaturated (≈ 63%) with a positive n-6:n-3 ratio. Eighty-three per cent of the fatty acid found in the meat could be classified as being desirable for human consumption. Analysis of the levels of Vitamin E and other anti-oxidants will be of value to see how prone towards rancidity the meat is. Similarly, the effect of the low lipid content on consumer acceptability (flavour, juiciness, etc) requires elucidation. Further research is also required on the amino acid and mineral profile of this meat.

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