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Meat quality of kudu (*Tragelaphus strepsiceros*) and impala (*Aepyceros melampus*): The effect of gender and age on the fatty acid profile, cholesterol content and sensory characteristics of kudu and impala meat

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ABSTRACT

Game meat has distinct sensory characteristics and favourable fatty acid profiles which differ between species. The SFA's percentage was found to be higher in impala meat (51.12%) than kudu meat (34.87%) whilst the total PUFA was higher in kudu (38.88%) than impala (34.06%). Stearic acid (22.67%) was the major fatty acid in impala and oleic acid in kudu (24.35). Linoleic acid, C20:3*n*-6 and C22:6*n*-3 were higher in kudu while C20:4*n*-6, C20:5*n*-3 and C22:5*n*-3 were higher in impala. The PUFA:SFA ratio for kudu (1.22) was higher than for impala (0.73) while impala had a higher *n*-6 PUFA's to *n*-3 PUFA ratio (3.76) than kudu (2.20). Kudu was higher in cholesterol (71.42 ± 2.61 mg/100 g muscle) than impala (52.54 ± 2.73 mg/100 g muscle). Sensory evaluation showed impala had a more intense game aroma and flavour while the initial juiciness of cooked samples of kudu was higher. The results show kudu and impala can be marketed for their unique flavours and aromas as well as being a healthy substitute for other red meats.

1. Introduction

In recent years, meat has been criticised for its fat content and fatty acid profile with many consumers overestimating the fat content of meat (Peterson, Van Eenoo, McGuirk & Preckel, 2001; Wood & Enser, 1997). Guidelines drawn up by the World Health Organisation (WHO, 2003) suggests that fat intake be restricted to provide between 15% and 30% of the calories in the human diet and not more than 10% of this should be from SFA's. Another point of concern regarding the modern diet is the unbalanced *n*-6:*n*-3 ratio. The fat content of meat is affected by a number of factor including species, muscle, gender and age (Hoffman, 2000; Jiménez-Colmenero, Carballo, & Cofrades, 2001; Miller, Field, Riley, & Williams, 1986; Rule, Broughton, Shellito, & Maiorano, 2002; Webb & O'Neill, 2008; Wood & Enser, 1997; Wood et al., 2008). Fat tissue of ruminants contains higher proportions of SFA and lower proportions of PUFA than monogastrics (Webb & O'Neill, 2008; Wood & Enser, 1997; Wood et al., 2008) due to the hydrogenating effect of the rumen and studies have shown that game meat has a substantially higher amount of polyunsaturated fatty acids (PUFA) than meat from domesticated animals (Crawford, Gale, Woodford, & Casped, 1970; Miller et al., 1986; Mostert & Hoffman, 2007) with diet being partly responsible for this (Phillip, Oresanya, & Jacques 2007; Wiklund, Manley, Littlejohn, & Stevenson-Barry, 2003b). Kudu (*Tragelaphus strepciceros*) and impala (*Aepyceros melampus*) occupy the same ecological region but their diets differ with kudu being a non-selective browser with a diet consisting mainly of grass, forbs (non-woody plants other than grasses) and browse and impala being a mixed feeder with a diet that changes according to habitat or season (Furstenburg, 2005a, 2005b). During winter (the period during which samples were collected), the impala will adapt its diet with browse and protein-rich fruit or pods constituting a higher proportion of the diet (Furstenburg, 2005b). It is well known that diet also influences the sensory characteristics of meat (Hoffman, Kroucamp, & Manley, 2007b; Melton, 1990; Muir, Deaker, & Bown, 1998; Wiklund, Johansson, & Malmfors, 2003a).

Bakula and Kêdzior (2001) found that sensory characteristics are the most important quality aspect of meat and meat products. Juiciness, tenderness and flavour seem to be key indicators of taste and quality of meat according to South African consumers (Radder & Le Roux, 2005) and differences between species may be used as a marketing tool for game meat. Pauw (1993) stated that game meat is a unique product and that meat from each species has its own distinct flavour.

The present research was conducted in order to determine the fatty acid profile and cholesterol content of meat from kudu and impala from the same geographical region and to investigate possible differences in these parameters between genders and age groups between these two species. In addition, since no data

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is available on the sensory characteristics of kudu or impala meat, the study was also undertaken to determine whether there are differences in sensory characteristics of kudu and impala meat from both genders within the same geographical region.

2. Materials and methods

2.1. Animals and sampling

In this study, 35 kudu (*Tragelaphus strepsiceros*) and 32 impala (*A. melampus*) were harvested in the Limpopo Province, Mabula District (S 24 52.611, E 27 56.862). The sample distribution in terms of species, gender and age is shown in Table 1. Harvesting took place over four months, starting in late autumn and extending into winter. Since animals were expected to lose physical body condition towards the end of winter due to a decline in available food, the day of harvest was used as a co-variant in the statistical analyses. All animals were harvested using standard techniques (Hoffman & Wiklund, 2006). The animals were killed instantaneously with head or upper neck shots using a .243 calibre rifle and shot from a hide to minimize their awareness of the hunters and thus minimize stress. Carcasses were bled, eviscerated, skinned and cleaned within 1 h post-mortem and then stored in a cold room at <4 °C. At 24 h post-mortem the *M. longissimus dorsi* (LD) was removed from between the 12th and 13th rib to between the 4th and 5th lumber vertebra. Samples for chemical and sensory analyses were vacuum packed and stored at −20 °C until analysed.

Animals were classed into age groups according to tooth eruption and horn development (where relevant) (Table 1). For the purpose of this study impala with full adult dentition were placed in the adult group and animals that had not established permanent dentition were placed in the sub-adult group. According to Roettcher and Hofmann (1970), male impala attain permanent dentition at about 30 months of age, while female impala attain permanent dentition between 24 and 30 months of age. Accuracy of ageing decreases after the animal has attained permanent dentition therefore all adults were grouped together. Kudu reach physical maturity (complete adult dentition) at 34 months of age (Simpson, 1966). Consequently, kudu that have not reached full adult dentition and are younger than 34 months were placed into the sub-adult group. All kudu with full adult dentition were placed in the adult group i.e. they were physically mature.

2.2. Fatty acid content

The fatty acid content was determined by using the method of Tichelaar, Smuts, Van Stuiivenberg, Faber, and Benadé (1998). After thawing the meat, the lipids in a 2 g sample were extracted with chloroform/methanol (2:1) and 0.01% (v/v) butylated hydroxytoluene (BHT) as antioxidant. The samples were homogenised for 30 s in a polytron mixer (Kinematica, type PT 10-35, Switzerland) and transmethylated for 2 h at 70 °C with methanol/sulphuric acid (19:1; v/v). After cooling to room temperature, the 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 a flame ionization detector), using a 60 m BPX70 capillary column of 0.25 mm internal diameter (SGE, Australia). The hydrogen gas flow rate was 25 ml/min; and the hydrogen carrier gas rate 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 was identified by comparison of the retention times with those of a standard FAME mixture (SuplecoTM 37 Component FAME Mix, Catalogue number 18919-1AMP, Lot number, LB-16064. Sigma Aldrich Inc. North Harrison Road, Bellefonte, PA 16823-0048, USA).

Table 1
Sample distribution of kudu (n = 35) and impala (n = 32) according to age and gender.

	Kudu		Impala		Total
	Male	Female	Male	Female	
Adult	7	14	11	7	39
Sub-adult	7	7	6	8	28
Total	14	21	17	15	67

2.3. Cholesterol content

From the same lipid extraction used for the fatty acid determination, a sub-sample was used for cholesterol determination. After drying the sub-sample under nitrogen, Stigmasterol (3-B-hydroxy-24-ethyl-5.22-cholestadiene; Sigma Chemical Co., St Louis, MO, USA) was added as internal standard and 6% ethanol KOH used to saponify the extraction for 2 h at 70 °C in a heating block. After cooling, distilled water and hexane were added and the resultant extraction was analysed by GLC (Varian Model 3700, equipped with flame ionization detection). A 1.2 m glass column of 2 mm internal diameter packed with 3% SP2401 on 100/120 mesh Supelcoport (Supelco Inc., Bllefonte, PA, USA) was used. Gas flow rates were: hydrogen, 20 ml/min; air, 200 ml/min and nitrogen (carrier gas), 25 ml/min. Temperatures were: injector temperature 280 °C; column temperature 255 °C and detector temperature 290 °C.

2.4. Sensory evaluation

The *M. longissimus dorsi* samples were defrosted at 3–4 °C for a 24 h period prior to cooking. The samples were placed on foil covered metal racks. Each metal rack was placed in a coded cooking bag with a thermocouple inserted into the centre of each piece of meat. The samples were roasted in a Defy 835 oven connected to a computerised temperature control system (Viljoen, Muller, De Swart, Sadie, & Vosloo, 2001) at 160 °C to an internal temperature of 68 °C. After cooking the meat were left to rest for 5 min, in which time an internal temperature of 72 °C were reached. The samples were then cut into 1 × 1 × 1 cm cubes, wrapped individually in aluminium foil and placed in labelled ramekins and kept in a pre-heated oven (100 °C). The samples were tasted by a trained panel within 10 min from being placed back into the oven.

The tasting panel consisted of ten members, who were trained in accordance with the guidelines for the sensory evaluation of meat of the American Meat Science Association (AMSA, 1995). Panel members were further trained using the consensus method as described by Lawless and Heymann (1999). The meat was evaluated for the following sensory characteristics: intensity of aroma, texture, initial and sustained juiciness, tenderness and flavour. The judges rated the samples on a 100 mm unstructured line scale with the left side of the scale resultant to the lowest rating (zero) and the right side of the scale resultant to the highest rating. Table 2 gives the verbal definitions of the characteristics used in the sensory analyses. The meat was evaluated in seven sessions, serving four samples in each session (kudu male, kudu female, impala male and impala female). As there were only six samples of impala male available, the last tasting session was incomplete.

2.5. Statistical analyses

The data was analysed using an analysis of covariance which included species, gender and age as main effects. This was done using