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The effect of dietary energy content on quality characteristics of Boer goat meat

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ABSTRACT

The palatability and chemical composition of *Longissimus lumborum* muscles from 24 Boer goat castrates (eight goats per treatment), finished on diets varying in energy content (9.7, 10.2 and 10.6 MJ ME/kg feed), were evaluated by a trained sensory panel on a line scale ranging from low to high intensity for aroma, flavour and texture attributes. Physical measurements as well as proximate analysis were performed for each sample. No differences ($P > 0.05$) were found between the dietary treatments for any of the attributes analysed. Lamb flavour and aroma were the most prominent attributes, while only low levels of goat-like flavours were detected. Juiciness and tenderness had a strong correlation ($r = 0.864$) and were rated to be moderate. The findings suggest that energy density of feedlot diets can be varied to still produce chevon with uniform meat quality characteristics.

1. Introduction

The level of meat consumption, as well as the type of meat consumed, varies between different population groups according to traditions and gross income (Sans & Combris, 2015). Typically, goat meat is largely consumed by communities that seek a cheaper alternative to lamb or mutton. People in more developed urbanised areas are often prejudiced against the consumption of goat meat due to its toughness and flavour qualities. However, its acceptance may be improved by expanding the familiarity of the consumers as a cheaper alternative to lamb (Borgogno, Corazzin, Saccà, Bovolenta, & Piasentier, 2015). The negative quality attributes associated with goat meat may also be linked to the past where older goats were consumed and age had a renowned effect on tenderness and goat-like flavour. However, there is a new trend to market chevon (young goat meat). The perceptions of the modern consumer may be further altered by the nutritive quality of chevon. Chevon has a low fat and cholesterol content, which is appealing to health conscious consumers, while still resembling the flavour attributes of lamb or mutton (Sheridan, Hoffman, & Ferreira, 2003a, 2003b; Webb, 2014).

Goat meat remains an important source of nutrients for people in developing regions, particularly around the tropics. Traditionally, goats are reared in extensive free-range systems or herded communally with low management inputs, as goats are well adapted to drier climates and exhibit selective foraging preferences (Casey, 1992). The Boer goat, developed in South Africa, is considered to be the ideal meat goat breed due to its high growth rates and good body conformation (Casey & Van Niekerk, 1988). An increase in demand for chevon/goat meat applies pressure to increase the volume of goat meat produced and farmers opt to finish goats in feedlots in order to attain a desirable slaughter weight at an earlier age (Sheridan, Ferreira, & Hoffman, 2003). In finishing systems, animals are fed concentrate based diets with high energy and protein contents in order to promote optimal growth and fat accretion, which in turn affects the chemical and sensory characteristics of the meat (Webb & O'Neill, 2008).

Chevon is regarded as a lean red meat, with favourable nutritive characteristics, that is derived from weaned goat kids (Babiker, El Khider, & Shafie, 1990; Sheridan et al., 2003a, 2003b; Webb, 2014; Webb, Casey, & Simela, 2005). The leanness of goat meat can be attributed to the nature of goats to deposit greater quantities of fat internally in the abdominal cavity and less in subcutaneous and intramuscular fat (IMF) depots (Casey, 1992; Goetsch, Merkel, & Gipson, 2011). The lack of a thick subcutaneous fat layer renders goat carcasses to be prone to cold shortening during rapid chilling, resulting in less tender meat (Kannan, Lee, & Kouakou, 2014). The lack of tenderness of meat from older goats can also be ascribed to higher levels of collagen in the muscles, which have a lower solubility when compared to mutton (Schönfeldt et al., 1993; Tshabalala, Strydom, Webb, & De Kock, 2003).

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The perceived tenderness, as well as juiciness, is further influenced by the IMF content of the meat, as it stimulates saliva production and acts as a dilution factor which consumers indirectly correlate with meat tenderness (Webb & O'Neill, 2008). As goat meat is considered to be leaner than lamb when slaughtered at a similar age, it is perceived as being less juicy due to a lower IMF content (Sheridan et al., 2003b; Tshabalala et al., 2003). The palatability of meat is determined by its complex flavour attributes that are perceived from interactions with sensory systems associated with taste and smell. The concepts of meat flavour and aroma are developed from interactions of fatty acids (Webb & O'Neill, 2008), as well as volatile compounds, and non-volatile precursors such as amino acids, reducing sugars and nucleotides during heating (Madruga, Elmore, Oruna-Concha, Balagiannis, & Mottram, 2010). The components that contribute to species specific flavours are found in the lipid fractions of meat (Madruga et al., 2010; Webb & O'Neill, 2008). Chevon is described as having a flavour and aroma profile which resembles that of mutton or lamb (Sheridan et al., 2003b). This sheep-like flavour was found to be stronger in fat tissues (Schönfeldt et al., 1993). However, goat meat does present an additional species specific flavour and odour although the intensities of these attributes are weaker compared to lamb or mutton (Madruga, Elmore, Dodson, & Mottram, 2009), but do become stronger as the animals grow older and fatter (Schönfeldt et al., 1993). The musty-sour aromas that are experienced from cooked sheep and goat meat, can be associated with higher levels of 4-methyloctanoic, 4-ethyloctanoic and 4-methylnonanoic branched chain fatty acids (Wong, Nixon, & Johnson, 1975), while the goat-like species flavour has also been associated with hexanoic (caproic) acid and other volatile components (Madruga et al., 2010).

As goats are more commonly reared in extensive conditions, it is uncommon to finish goats in a feedlot. However, in order to improve production by intensive feeding, it is important to determine the optimal energy content of the diet required by the goat, as well as its effect on the meat product. It is also beneficial for producers to know if they can market heavier goats, > 40 kg, whose meat would still be deemed acceptable by consumers. Therefore, the aim of this study was to investigate the effect of finisher rations formulated for goats, with different energy levels on the chemical and sensory properties of meat from Boer goats weighing between 40 and 50 kg at slaughter.

2. Materials and methods

2.1. Experimental design

Ethical clearance for this study was obtained from the Western Cape Department of Agriculture Departmental Ethical Committee for Research on Animals (DECRA R12/49). In this study, Boer goat slaughter kids were subjected to intensive feeding over a 20 week period. The meat samples were obtained from 24 Boer goats that were housed in individual pens at Elsenburg Research farm, in the Western Cape province of South Africa, and supplied one of three diets under intensive feeding conditions. Goats were weaned from their dams at an average age of ~18 weeks of age and then introduced to the intensive feeding conditions (Brand, Van Der Merwe, Swart, & Hoffman, 2017). The goat kids were randomly allocated to one of three finisher diets ($n = 8$ kids per diet). The diets were similar in composition and only varied in energy content to give a low energy (9.7 MJ ME/kg feed), medium energy (10.2 MJ ME/kg feed) and high energy (10.6 MJ ME/kg feed) diet, expressed on an as fed basis with a moisture content of 10.4%. The compositions of the diets are outlined in Table 1. The trial diets were supplied to the goats *ad libitum* for a period of 20 weeks.

2.2. Slaughter and sampling

The goats were slaughtered, at a registered abattoir (Swartland abattoir, Malmesbury, South Africa), at an average live body weight of 48.3 ± 3.8 kg. Goats were electrically stunned for 5 s at 200 V, to render them unconscious prior to exsanguination and evisceration. The carcasses were not subjected to electrical stimulation prior to chilling. After the slaughter process was completed, the carcasses were chilled at the abattoir at 2 °C for 24 h, after which the carcasses were transported to a nearby commercial processing facility where they were divided into retail cuts. The left *Longissimus lumborum* (LL) muscle was excised from the loin cut of each animal, between the 13th rib and the 3rd and 4th lumbar vertebrae. Visible fat and sinew were removed from the LL muscles, after which they were weighed, vacuum packed and frozen at − 18 °C for approximately 3 weeks before descriptive sensory analysis was performed.

Table 1
The formulation of the trial diets fed to Boer goat kids.

	Diets (% as fed)		
	LE	ME	HE
Ingredients			
Maize	44.30	54.90	65.50
Lucerne hay	39.00	24.90	10.80
Cottonseed oilcake	8.00	11.44	14.89
Molasses powder	2.50	2.50	2.50
Salt (NaCl)	1.00	1.00	1.00
Bicarbonate of soda	2.00	2.00	2.00
Ammonium sulphate	1.00	1.00	1.00
Slaked lime	0.90	1.10	1.30
Urea	0.50	0.50	0.50
Mono calcium phosphate	0.34	0.18	0.02
Vitamin and mineral premix	0.25	0.25	0.25
Sulphur	0.20	0.20	0.20
Commercial growth promoters and coccidiostat premix	0.020	0.020	0.020
Nutrient Composition of diets[a] *(as fed)*			
Metabolisable energy (MJ/kg)	9.73	10.19	10.60
Protein (%)	14.30	14.28	14.98
Fibre (%)	12.7	10.4	6.3
Ash (%)	10.12	8.63	7.57
Fat (%)	1.16	1.37	1.31
Calcium (%)	1.25	1.08	1.00
Phosphorous (%)	0.45	0.41	0.40

LE – Low energy diet. ME – Medium energy diet. HE – High energy diet.
[a] Nutrient composition of diets determined by proximate analysis of the feeds.

2.3. Sample preparation

The frozen muscles were removed from the freezer 24 h before testing and were allowed to thaw in a refrigerator at 4 °C. A thermocouple probe attached to a handheld temperature monitor (Hanna Instruments, South Africa) was inserted into the centre of each muscle, which was placed in an oven bag (GLAD®) and closed. The muscles in the oven bags, along with the inserted temperature probes, were then placed in an industrial oven (Hobart, France) (preheated to 160 °C) and cooked until an internal temperature of 72 °C was reached (AMSA, 1995). No salt was added to enhance the flavour. The cooked muscles were then allowed to cool before the outer edges were trimmed off and the muscles cut into 1 cm^3 cubes. The cubes were then wrapped in 10 cm^2 tin foil squares. Two wrapped samples per judge were placed into ramekins, which were coded with randomised three-digit codes, and covered with a petri dish. Before the samples were evaluated, the ramekins (containing the wrapped samples) were heated in the industrial oven at 70 °C for 10 min after which they were placed in cups positioned in water baths set at 70 °C, from where they were served to the panel.

2.4. Descriptive sensory analysis

Descriptive sensory analysis (DSA) was performed on the meat from the goats fed the three different energy treatments. A tasting panel