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Effect of *Acacia karroo* Supplementation on Growth, Ultimate pH, Colour and Cooking Losses of Meat from Indigenous Xhosa Lop-eared Goats

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ABSTRACT: The objective of the study was to determine the effect of *Acacia karroo* supplementation on growth, ultimate pH, colour and cooking losses of meat from indigenous Xhosa lop-eared goats. Eighteen castrated 4-month-old kids were used in the study until slaughter. The kids were subdivided in two treatment groups *A. karroo* supplemented (AK) and non-supplemented (NS). The supplemented goats were given 200 g per head per d of fresh *A. karroo* leaves. The kids were slaughtered on d 60 and sample cuttings for meat quality assessment were taken from the *Longistimus dorsi* muscle. The supplemented kids had higher ($p<0.05$) growth rates than the non-supplemented ones. The meat from the *A. karroo* supplemented goats had lower ($p<0.05$) ultimate pH and cooking loss than the meat from the non-supplemented goats. *Acacia karroo* supplemented goats produced higher ($p<0.05$) b^* (yellowness) value, but supplementation had no significant effect on L^* (lightness) and a^* (redness) of the meat. Therefore, *A. karroo* supplementation improved growth performance and the quality of meat from goats. (**Key Words:** *Acasia karroo*, Supplementation, Goat, Performance, Meat Quality)

INTRODUCTION

The use of goats as meat animals has increased in recent years, as evidenced by the increased demand for goat meat by consumers (Gipson, 1999; Simela, 2005). The major advantage of chevon is its lower fat content compared to other types of red meat (Park et al., 1991). Meat quality is a highly subjective issue, however; there are no universally accepted criteria for defining meat quality throughout the world (Monin, 2004). A decision on good meat quality is dependent on the consumers and may vary according to culture (Borggaard and Andersen, 2004; Xazela et al., 2011). There are a number of important traits that consumers consider to decide on meat quality. At purchase point, consumers consider meat colour as an important meat quality indicator. Beef and mutton are expected to be bright red, while pork is expected to be more or less pink (Monin, 2004).

Meat colour, pH and cooking losses are also among measurements that are used to determine the quality of meat. Meat quality measurements are said to be affected by diet and thermal preparation. Under-feeding, which is a result of the inadequate availability of high quality feed in poorly resourced goat producers, is the major diet defect in goat productivity (Collins-Luswet, 2000). However; browse plants such as the *Acacia* species are reported to be an enormous potential source of protein supplementation (100 to 250 g/kg DM) for ruminants in the tropics (Ngongoni et al., 2007) and can easily meet nutrient requirements, mainly proteins (Aganga et al., 1998; Devendra and Sevilla, 2002; Kahiya et al., 2003; Marume et al., 2012), minerals (Aganga et al., 1998; Mukoboki et al., 2005) and they have antihelmintic properties (Xhomfulana et al., 2009).

In studies conducted by Priolo et al. (2005); Yayneshet et al. (2008); Marume et al. (2012), it was reported that tanniniferous-fed small ruminants produce meat of a lighter colour than other animals given same diet with no tannin effect. Tannins from different plant species have similar effects on lamb meat colour (Priolo et al., 2002). The effect of tannins on meat colour could be the result of a reduced microbial biosynthesis of vitamin B_{12} which is a precursor

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for the synthesis of haeme pigments (Vasta et al., 2008). Supplementation with browse plants, particularly *A. karroo* leaves, improves the body condition score, slaughter weight (Mapiye et al., 2009) and average daily gain (Nyamukanza and Scogings, 2008).

Acacia karroo has been reported to improve the quality of meat from Nguni cattle (Mapiye et al., 2009). While Marume et al. (2012) determined the nutrient composition and anthelminthic effects of *A. karroo*, there are no studies which have been done to evaluate its effect on meat quality measurements of Xhosa lop-eared goats. Therefore the objective of the current study is to determine the effect of *A. karroo* supplementation on growth and the quality of meat from indigenous Xhosa lop-eared goats.

MATERIALS AND METHODS

Study site description

The study was conducted at the University of Fort Hare Honeydale Farm. The farm is 520 m above sea level and is located 32.8° S and 26.9° E. The farm receives an average annual rainfall of 480 mm and has a mean annual temperature of 18.7°C. It is situated in the False Thornveld of the Eastern Cape (Acocks, 1975). The topography of the area is generally flat with a few steep slopes. The vegetation is a mixture of several trees, shrubs and grass species. The predominant plant species on the farm are *A. karroo*, *Themeda triandra*, *Panicum maximum*, *Digitaria eriantha*, *Eragrostis* spp., *Cynodon dactylon* and *Pennisetum clandestinum*.

Animal management

Eighteen castrated 4-month-old goats with a mean body weight of 13.5±0.31 kg and a mean body condition score (BCS) of 3.3±0.16 were kept with their mothers on natural pastures and after they were moved to open sided barns where they were fed on 500 g/head/d of medicago sativa hay. The goats were then randomly split into two balanced treatment groups, one of which was supplemented while the other was not (control). The control group continued to receive 500 g/head/d of hay while The goats in the supplemented group were given 300 g/head/d of hay and 200 g/head/d of fresh daily collected *A. karoo* leaves The goats were fed the fresh leaves individually in feeding troughs.

Collection and nutrient composition of the *Acacia karroo* browse plant

Fresh leaves of *A. karroo* were hand harvested each day and dried for the determination of nutritional composition such as DM, Crude protein (CP), Crude fibre (CF), ether extract (EE) and tannin levels in the leaves. The dried leaves were fed to goats individually in feeding troughs for the period of 60 d. The Folin-Ciocalteau assays described by Terrill et al. (1992) were performed to determine the total polyphenolic content of the dried *A. karroo* whilst the butanol-HCl assay as described by Giner-Chavez et al. (1997) was done to determine the condensed tannins (CT). The approximate analysis and tannin levels of *A. karroo* leaves are shown in Table 1.

Slaughter procedure

After 8 wks, all the goats were humanely slaughtered complying with the local regulations of animal welfare. In the morning of the day of slaughter, the goats were weighed and transported from the Honeydale farm to the Adelaide commercial abattoir which is 60 km away. The goats were electrically stunned and immediately bled. The carcases were weighed and kept in the refrigerator overnight at a temperature of -4°C. Sample cuttings for meat tasting were made from the *Longissimus dorsi* muscle. Daily gain was calculated as the difference between the initial weight and slaughter weight divided by 60 d, which was the trial period. Dressing percentage was also determined by expressing carcass weight as a percentage of slaughter weight.

Meat quality measurements

The meat colour was measured through instrumental colour measurements using the colour-guide 45/0 BYK-Gardener GmbH. The instrumental meat colour measurements represented by three coordinates: L^* (lightness), a^* (redness) and b^* (yellowness) were measured on the *Longissimus dorsi* muscle using the colour-guide 45/0 (BYK-Gardener GmbH, Geretsried, Germany) machine with 20 mm diameter measurement area and illuminant D65-d light, 10° standard observer. The final meat colour value was calculated as the average value for the three readings taken from the colour guide. The guide was calibrated before use with the green standard. The meat pH was measured on the *Longissimus dorsi* muscle after 24 h using the pH meter (CRISON pH25, CRISON

Table 1. Nutritional composition of the experimental diets

Component	*Medicago sativa* (kg/DM)	*Acacia karroo* (kg/DM)
Dry matter	915	919
Crude protein	203	232
Crude fibre	335	259
Neutral detergent fibre	483	502
Acid detergent fibre	412	289
Ether extract	25	36
Calcium	14	40
Phosphorus	8	0.8
Ash	96	51
CT (Butanol-HCL assay)	-	21
Total phenolics (Folin assay)	-	5

instruments SA, Spain) which was calibrated using pH 4, pH 7 and pH 9 standard solutions before measurements. Cooking losses (CL) were measured in the *Longissimus dorsi* muscle, kept for 24 h. The meat muscles were allowed to defrost and their weight before cooking was recorded. Samples of meat from each treatment were then roasted for a period of 10 min on each side to make 20 min in total and cooled. After cooling, the sample weights were recorded. Cooking loss was calculated using the following formula: Cooking loss % = ((weight before cooked-weight after cooked)/weight before cooked)×100.

Statistical analysis

The general linear model procedure of the SAS (2003) program was used to analyse the effect of *A. karroo* supplementation on meat quality. Turkey's HSD procedure was used for the comparison of means. The model used was as follows:

Model: $Y_{ij} = \mu + D_i + E_{ij}$

Where: Y_i = response variable (slaughter weight, carcass weight, daily gain, dressing percentage, meat pH, cooking losses and meat colour)

μ = overall mean common to all observations

D_i = effect of *A. karroo* supplementation

E_{ij} = random error.

RESULTS

The effects of *Acacia karroo* supplementation on meat quality measurements of the Xhosa Lop-eared goat breed

The effect of *A. karroo* supplementation on growth and meat quality is shown in Table 2. The supplemented goats had a better ($p<0.05$) growth performance than the non-supplemented goats. The ultimate pH (pH_u) of meat from the *A. karroo* supplemented goats was significantly lower ($p<0.05$) than that from the non-supplemented goats. There were no significant differences ($p>0.05$) in the L^* and a^* values of meat from the *A. karroo* supplemented goats and non-supplemented goats. *Acacia karroo* supplementation produced meat that was more yellow than the one from non-supplemented goats. Meat from the non-supplemented goats had higher ($p<0.05$) cooking losses than the one from the *A. karroo* supplemented goats.

DISCUSSION

Acacia karroo significantly improved growth performance and lowered meat pH of the supplemented goats. This is due to its high nutritive value (Ngongoni et al., 2007; Mapiye et al., 2009; Marume et al., 2012), given that the nutritional level of an animal's diet can be influential on its ability to maintain productivity (Albers et al., 1987). The high amount of proteins (Ngongoni et al., 2007) in *A. karroo* browse plant improved the ability of the goats to retain desirable muscle energy (Marume et al., 2012). The retained muscle energy, the result of the high average daily gain and slaughter weight of *A. karroo* supplemented goats (Mapiye et al., 2010), assisted in *post mortem* lactic acid production, resulting in the lower pH_u of the supplemented goats than that of the non-supplemented goats.

These results in the current study suggest that the consumption of tanniniferous browse plant species (21 g/kg DM) has a positive influence on chevon pH. This, however, contradicts the results reported by Priolo et al. (2002), who reported that the consumption of tannin in plants (20 g/kg DM) will not affect chevon pH. This argument may have arisen because of the type and form of browse plant used, given that; the browse plants differ in tannin content. The other reason could be the season in which the browse plant was consumed, as natural pastures vary in their chemical composition and structure with the seasons (Bakare and Chimonyo, 2011). Goats adapt to the changes that occur in the chemical composition and structure of vegetation with

Table 2. Effect of *A. karroo* supplementation on growth, carcass characteristics and meat quality attributes of Xhosa lop-eared goats

Parameters		AK	NS	Significance
Initial body weight		13.5±0.31	13.6±0.30	NS
Average daily gain (g/d)		105±7.81	43±8.61	*
Slaughter weight		19.8±0.76	16.2±0.69	*
Carcass weight (kg)		9.4±0.61	7.0±0.56	*
Dressing percentage (%)		49.7±0.58	43.4±0.62	*
Ultimate pH		5.4±0.55	6.6±0.55	*
Cooking loss		27.4±4.41	33.6±4.41	*
Colour	L^*	44.1±1.95	39.8±1.95	NS
	a^*	12.5±1.90	8.2±1.90	NS
	b^*	10.1±0.64	4.4±0.64	*

AK = *Acacia karroo* supplementation, NS = Non-supplemented. *L* = Lightness of the meat colour, a^* = Redness of meat, b^* = Yellow meat colour.

* Significant difference ($p<0.05$) NS = Not significant.

the seasons (Silanikove, 2000). This also suggests further research to establish the cause of the difference in the effect of browse plants on chevon pH, since this was not investigated in the current study. Meat pH affects meat colour and it has been reported that higher pH values produce meat that is darker in colour (Priolo et al., 2001).

A number of studies have been published reporting the effect of diet on meat quality, particularly meat colour (Nyamukanza and Scogings, 2008). Priolo and Vasta (2007) reported that tanniniferous fed ruminants produce meat of a light colour. The effect of tannins on meat colour can be explained as a reduced microbial biosynthesis of vitamin B_{12} which is a precursor for the synthesis of haeme pigments. Diet has been reported to have an influence on slaughter weight and the cold dress weight of four goat breeds (Xazela et al., 2011). However; in the current study *A. karroo* supplementation does not influence the L^* value of supplemented goats. The two groups; the *A. karroo* supplemented and non-supplemented groups had similar results on the L^* value and this can be attributed to the effect of the intensive production system used. Intensively fed ruminants have been reported to produce light colour in meat (Vestergaard et al., 2000). Mapiye et al. (2010) also reported no differences in water holding capacity, tenderness and cholesterol values of meat from Nguni cattle supplemented with *A. karroo* and those relied on rangelands.

Therefore, the L^* value in the current study seems to be affected by external factors such as age and gender which were not considered in the current study, since the age of an animal affects meat quality (Simela, 2005). A similar situation applied in a^*-coordinate where *A. karroo* supplemented goats were not significantly different from the non-supplemented goats. However; the positive effect of *A. karroo* on the redness (a^*) of meat from Nguni cattle was reported (Muchenje at al., 2008a, 2008b; Mapiye et al., 2010). The argument arising could be attributed to the effect of animal species. The other reason supporting the difference in a^* can be associated with the variation in the nutrient content of *A. karroo* leaves which is attributed to differences in climate, season and stage of growth in which the plants were harvested (Rubanza et al., 2005).

They can differ according to the environmental factors such as the season of grazing (Bakare and Chimonyo, 2011). Likewise; in the current study, the effect of *A. karroo* supplementation on meat colour was observed in yellowness. Higher b^* values of meat from the supplemented goats imply that *A. karroo* supplementation has improved the yellow colouring of chevon. The findings agree with the report by Priolo and Vasta (2007) who reported that tannins can be responsible for the differences found in meat colour. Moreover, the improvement observed from the *A. karroo* supplemented goats was attributed to additional dietary protein, energy and mineral intake (Muchenje et al., 2009a; Mapiye et al., 2009). In addition, the use of *A. karroo* as a supplement might increase the proportions of desirable omega 3 fatty acids (Muchenje et al., 2009b; Mapiye et al., 2010; Marume et al., 2012). Furthermore; increase in fat and muscle marbling could affect the muscle cooking losses (Yu et al., 2005).

The cooking loss levels of the supplemented goats in the current study were slightly higher than those reported by Jama et al. (2008) which averaged 23% but lower than those reported by Razminowicz et al. (2006) which averaged 30%, while the cooking losses of the non-supplemented goats were higher than those of Razminowicz et al. (2006) from steers reared in pasture. Low cooking losses in the supplemented goats is attributed to the effect of reported pH_u in this study which, however, improves the potential of proteins deposited from the *A. karroo* supplement (Marume et al., 2012) to retain more water in the meat (Miller, 2001). The ability of ultimate pH to influence muscle capability to retain natural water has been reported by Bruce et al. (2003). Therefore, a muscle of lower water holding capacity is associated with higher cooking losses hence lower juiciness and a less tender muscle (Sheard et al., 2005). The low amount of cooking losses in the current study can also be attributed to the fact that goats produce lean meat and they are the major sources of proteins (Devendra, 1981; Simela, 2005) therefore, water holding capacity will be improved. The results have shown that the meat has a higher water holding capacity which therefore suggests juicier meat. Levels of fat in meat generally affect cooking losses (Yu et al., 2005; Jama et al., 2008). Goats store fat in visceral organs and the carcass is generally lean (Park et al., 1991; Simela, 2005) and that supports lower cooking losses.

CONCLUSION

The current study revealed that *A. karroo* supplementation improved growth and the quality of meat from goats. Supplementing goats with *A. karroo* can be practically implemented by resource-limited goat producers since *A. karroo* is easily accessible and the plant species is preferred by goats across seasons.

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