EFFECT OF SUPPLEMENTATION WITH *ACACIA KARROO* LEAVES ON GROWTH AND MEAT QUALITY OF XHOSA GOATS UNDER ARTIFICIAL HAEMONCHOSIS

Marume U[1], Chimonyo M[2], Muchenje V[3] and Dzama K[4].

[1]Department of Animal Science, North West University Mmabatho 2735, South Africa
[2]Discipline of Animal and Poultry Science, University of Kwa-Zulu Natal, Scottsville 3209, South Africa
[3]Department of Livestock and Pasture Science, University of Fort Hare, Alice 5700, South Africa
[4]Department of Animal Sciences, Stellenbosch University, Matieland 7602, South Africa.

Abstract – The effect of dietary supplementation on meat quality was assessed in Xhosa lop-eared goats infected with haemonchosis. Supplemented goats received 200 g of fresh *A. karroo* leaves daily while goats in the infected groups were exposed to a single dose of 6 000 L3 *H. contortus* larvae. Significant decline in faecal larval counts were observed in the infected, supplemented goats. High growth rates were also observed in the infected, supplemented and not infected, supplemented goats, but no change in weight was observed in the infected, not supplemented goats. The observed high growth rates also resulted in heavier carcasses. The supplemented goat carcasses had a high ultimate pH and low cooking loss while the not infected, not supplemented goats had higher WB shear force values. Lightness parameter (L*) showed a decline after 24 h, but the a* and b* values showed an increase in redness and yellowness of the meat in all treatment groups after 24 h. Muscle temperature drastically declined in all treatments even though the pH remained high. Use of *A. karroo* could be an effective way of improving the growth and meat quality of goats infected with haemonchosis.

Key words: **Cooking loss, faecal larval counts, ultimate pH.**

I. INTRODUCTION

Chevon has been observed to be of acceptable nutritional quality with attributes that are concordant with present day consumer demands for cholesterol free and nutritious meat [1]. Goat meat production and quality, however, is being hampered by both internal and external factors, among them the gastrointestinal parasites, chiefly *Haemonchus contortus*. The major approach in the control of *H. contortus* has been the use of chemotherapy, which is expensive and inaccessible to many resource poor farmers and has health risks due to accumulation of residues in food products [2].

Supplementing goats with forages, such as *Acacia karroo* containing condensed tannins with antihelminthic properties on *H. contortus* has been suggested as an alternative to chemotherapy [3]. Consumption of *Acacia* leaf meal has been reported to reduce the establishment and fecundity of *H. contortus* [3].

Studies have been conducted on the influence of tannin-rich forages on resistance and resilience of indigenous goats to haemonchosis [3,4]. Research has also been conducted on the effect of feeding regime, genotype and other factors on goat meat quality [5,6]. However, the extent to which tannin and protein-rich forages used in the control of diseases in goats, such as *A. karroo*, influence the quality of meat in goats is largely unknown and requires investigation. The objective of the study was, therefore, to determine the effect dietary supplementation with *A. karroo* leaves on growth, carcass and meat quality characteristic of indigenous goat meat under experimental haemonchosis.

II. MATERIALS AND METHODS

The study was conducted at the University of Fort Hare Farm, Eastern Cape Province of South Africa (32.8^{o}S and 26.9^{o}E). Twenty-four castrated 4-month old Xhosa lop-eared goats with an average body weights of 13.5 ± 0.23 kg (mean ± SE) were used in the study. The experiment was a 2 × 2 (infection level × dietary level) factorial arrangement with two levels of nutrition (supplemented *versus* non supplemented) and two levels of *Haemonchus* infections (infected *versus* non infected). The goats were randomly allotted into four treatment groups: non infected non supplemented (NINS); infected, non supplemented (INS); infected, supplemented (IAK) and non infected supplemented (NIAK). Each pen contained six goats. Each of the goats was in the infected groups was exposed to a single dose of 6 000 freshly cultured L3 *H. contortus* larvae. All the goats had free access to a basal diet of 500 g/head/day of *Medicago sativa* hay (CP, 203 g/kg: CF, 335 g/kg). The supplemented goats received an additional 200 g per head per day of fresh *A. karroo* leaves collected each day for two months. Fresh leaves of *A. karroo*, mainly the new shoots, were hand harvested each day to feed the goats for a 60 day period. Samples of the fresh leaves were obtained and dried at 55^{o}C to a constant weight for the determination of nutritional composition [7], total phenolics and condensed tannins [8]. Faecal cultures were prepared fortnightly to determine the faecal larval counts (FLC). Goats were weighed fortnightly while body condition scoring was done concurrently. At Day 60, all the goats were slaughtered for worm recovery from the abomasa and meat quality assessment.

At slaughter, the total weight of the carcasses was recorded, and dressing out percentage (DOP) was calculated (dressing out % = carcass wt/slaughter wt × 100 %). Slaughter weight (SLW) of each goat was taken 24 h before slaughter and the left hand side (LHS) of each dissected carcass was used to measure the carcass length (CL). The pH and temperature measurements were done on the *longissimus* muscle immediately after slaughter and at 24 h post-mortem using a pH meter (Crison pH 25, Crison instruments, S.A., Alella, Spain). Cold dressed mass (CDM) for each carcass was also taken after 24 h. Meat colour (lightness, L*; redness, a*; yellowness, b*) was measured (immediately after slaughter and at 24 h postmortem) from the *longissimus* muscle using a colour-guide 45/0 (BYK-Gardener GmbH, Geretsried, Germany). Cooking loss was calculated as: Cooking loss % = [(weight before cooked – weight after cooked) ÷ weight before cooked] × 100. The cooked samples were used to determine Warner-Bratzler shear force (WB) shear force values.

Variations in carcass and meat quality parameters due to infection and diet were analyzed using ANOVA [5]. Data on body weight (BWT), body condition scores (BCS) and FLC were analyzed using the repeated measures procedure of SAS [9]. Trends in pH and temperature decline were analyzed by including polynomial statement in the repeated measures analysis. Mean separations were determined using the PDIFF option in SAS [9].

III. RESULTS AND DISCUSSION

Changes in mean FLC, BWT and BCS are shown in Fig. 1. Most significantly, the results of this experiment showed a decrease in FLC and low worm counts at necropsy in the goats that consumed the fresh *A. karroo* leaves culminating in improved growth rates. This can be attributed to the combinative effects of condensed tannins contained in *A. karroo* which have been observed have antihelmintic effects on *H. contortus* [3] and increase protein supply for digestion and utilization by the goats.

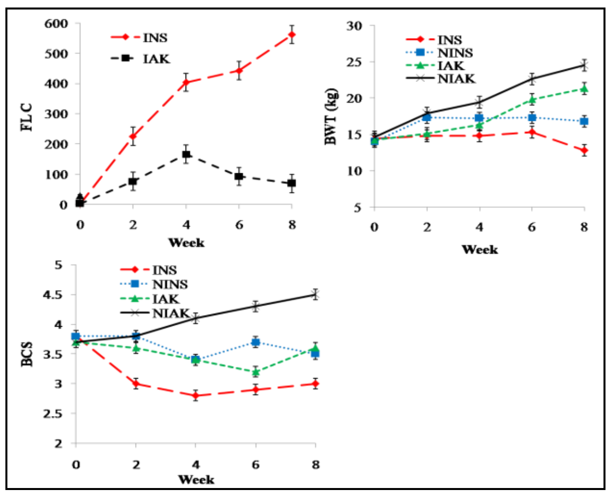

Fig. 1: Mean changes in faecal larval counts, body conditions scores and body weights of Xhosa goats.

The observed reduction in FLC and worm counts at necropsy resulted in improved growth rates of goats that consumed fresh *A. karroo* leaves.The higher growth rates of goats in the NIAK, IAK groups also resulted in significantly higher (P < 0.05) BWT at slaughter (Table 2). Goats in the NIAK and IAK groups also produced significantly heavier carcasses (P < 0.05) than those in the INS group, an observation made in cattle fed *A. karroo* leaf meal.

Table 1: Means for Carcass and Meat quality parameters of Xhosa goats.

Parameter	NINS	INS	IAK	NIAK
ADG (/kg)	50.1^{b}	30.1^{a}	120.6^{c}	130.4^{d}
SLW (kg)	16.8^{b}	12.8^{a}	21.3^{c}	24.5^{d}
BCS	3.42^{b}	2.91^{a}	3.5^{b}	3.8^{c}
CDM (kg)	5.63^{b}	3.8^{a}	7.14^{c}	8.91^{c}
DOP (%)	32.7^{b}	29.9^{a}	33.4^{b}	36.3^{c}
CL(cm)	59.5^{a}	57.8^{a}	60.4^{b}	63.2^{c}
pH_0	6.92	7.1	7.14	7.12
pH_{24h}	6.09^{a}	5.89^{a}	6.31^{b}	6.32^{b}
pH_{0-24h}	0.84^{a}	1.21^{b}	0.83^{a}	0.81^{a}
Cooking loss (%)	22.4^{c}	24.7^{d}	19.4^{b}	16.3^{a}
WB shear force (N)	29.8^{a}	35.6^{b}	31.9^{a}	31.6^{a}

^{a,b} Means with same letters in a rows are not significant different(*P < 0.05).

Time postmortem significantly affected both muscle pH (Fig. 2) and temperature (Fig. 3) decline (P < 0.01). The high ultimate pH (pH_{24}) and reduced rate of decline of pH in the NIAK and IAK group compared to the other two groups could be attributed to the effect of tannins and some phenolic compounds in *A. karroo* leaves on the enzymic reactions which enable the conversion of glycogen into lactic acid resulting in pH decline. Harbone [10] observed that consumption of secondary plant metabolites in forages such as *A. karroo* results in structural similarities between the secondary plant metabolites and some enzymes within animals.

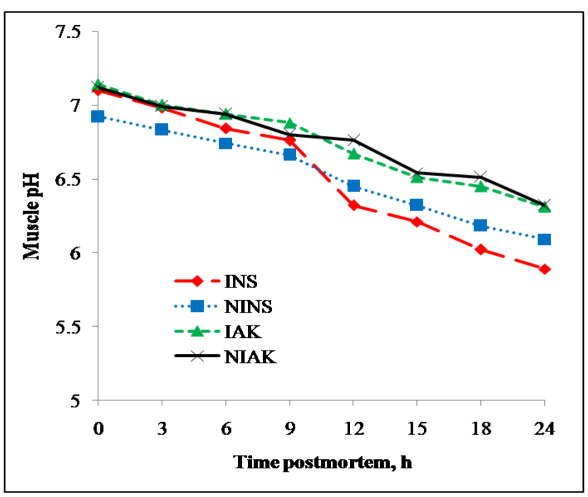

Fig. 2: Effects of diet, infection and postmortem time on muscle pH decline in Xhosa goat carcasses

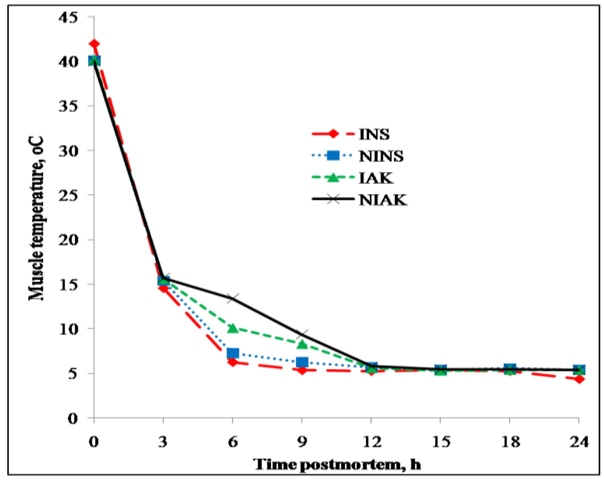

Fig. 3: Effects of diet, infection and postmortem time on muscle temperature decline in Xhosa goat carcasses

Such similarities in structure cause the secondary plant metabolites including tannins to interfere in enzyme functions [10], that could have interfered with enzymatic conversion glycogen into lactic acid in the NIAK and IAK groups. Ultimate pH varied from 5.9 to 6.3 and were above the recommended values of 5.5 to 5.8 [11][12] but are comparable to those observed by Argüello [13], [6]. NIAK had significantly low cooking loss. Observed differences in cooking loss can be linked to the differences in temperature of cooking, ultimate pH and fat contents [14]. The NINS goats had higher shear force values compared to the other three groups.

Significant differences were detected in most values for meat colour parameters between treatment groups at 0 and 24 h after slaughter (Table 2). However, redness (a^{*0h}) and yellowness (b^{*0h}) showed no difference for infection and supplementation. Whereas the lightness parameter (L^*) of meat colour declined after 24 h, the redness (a^*) and yellowness (b^*) values increased in all treatment groups after 24 h. The decline could be attributed to the high pH values observed in all treatments which could have altered the muscle myoglobin redox reactions resulting in reduced color stability of meat [15].

Table 2: Means values for meat colour parameters of Xhosa lop-eared goats

Parameter	NINS	INS	IAK	NIAK
Colour parameter at 0h				
$(L^*)^{0h}$	53.2^a	53.1^a	58.6^b	59.4^b
$(a^*)^{0h}$	8.96^b	8.48^b	7.63^a	7.13^a
$(b^*)^{0h}$	6.47^b	5.11^a	6.71^b	6.66^b
Colour parameter at 24h				
$(L^*)^{24h}$	34.6^a	39.1^a	40.5^b	43.4^b
$(a^*)^{24h}$	11.9	10.2	11.2	11.3
$(b^*)^{24h}$	8.42^c	6.76^a	7.78^b	8.446^c

NS: Not significant ($P > 0.05$). ^{a,b} means carrying various letters in the same line are significant different ($^*P < 0.05$).

IV. CONCLUSION

Supplementation of infected goats with fresh *A. karroo* leaves resulted in higher growth rate, heavier carcasses and improved the meat quality attributes in infected goats. Therefore, fresh *A. karroo* leaves could effectively reduce the need for chemotherapy and improve the growth and meat quality of the goats in the resource-poor areas.

ACKNOWLEDGEMENTS

The authors are indebted to the National Research Foundation of South Africa for their financial support.

REFERENCES

1. Simela, L., & Merkel, R. (2008). The contribution of chevon from Africa to global meat production. *Meat Science 80*, 101–109.
2. Hoste, H., Jackson, F., Athanasiadou, S., Thamsborg, S.M., & Hoskin, O.O. (2006). The effects of tannin-rich plants on parasitic nematodes in ruminants. *Trends in Parasitology 22*, 253–261
3. Kahiya, C., Mukaratirwa, S., & Thamsborg, S.M. (2003). Effects of Acacia nilotica and Acacia karoo diets on Haemonchus contortus infection in goats. *Veterinary Parasitology 115*, 265–274.
4. Marume,U., Chimonyo,M., & Dzama,K. (2012) Influence of dietary supplementation with Acacia karroo on experimental haemonchosis in indigenous Xhosa lop-eared goats of South Africa. *Livestock Science 144, 1–2, 132-139.*
5. Arsenos, G., Fortomaris, P., Papadopoulos, E., Sotiraki, S., Stamataris, C., & Zygoyiannis, D. (2009). Growth and meat quality of kids of indigenous Greek goats (Capra prisca) as influenced by dietary protein and gastrointestinal nematode challenge. *Meat Science 82*, 319-323.
6. Ekiz, B., Ozcan, M., Yilmaz, A., Tölü, C., & Savas, T. (2010). Carcass measurements and meat quality characteristics of dairy suckling kids compared to an indigenous genotype. *Meat Science 85*, 245-249.
7. AOAC. (1990). Official methods of analysis. Association of Official Analytical Chemists. 15th Edition. Virginia, U.S.A.
8. Terrill, T.H., Rowan, A.M., Douglas, G.B., & Barry, T.N. (1992b). Determination of extractable and bound condensed tannin concentration in forage plants, protein concentrate meals and cereal grains. *Journal of the Science of Food and Agriculture 58*, 321–329.
9. SAS. (2003). In: SAS/STAT Guide to Personal Computers, Version 6, *Statistical Analysis System* Institute Inc, Cary, NC.
10. Harborne, J.B. (2001). Twenty-five years of chemical ecology. *Natural Product Reports 18*, 361–379.
11. Kadim, I.T., Mahgoub, O., Al-Ajmi. D.S., Al-Maqbaly, R.S., Al-Saqri, N.M. & Ritchie, A. (2003). An evaluation of the growth, carcass and meat quality characteristics of Omani goat breeds. *Meat Science 66*, 203–210.
12. Medruga, M.S., Torres, T.S., Carralho, F.F., Queiroga, R.C., Narain, N., Garrut, D., Souza Neto, M.A., Mattos, C.W. & Costa, R.G. (2008). Meat quality of Moxotó and Canindé goats as affected by two levels of feeding. *Meat Science 80*, 1019 – 1023.
13. Argüello, A., Castro, N., Capote, J., & Solomon, M. (2005). Effects of diet and live weight at slaughter on kid meat quality. *Meat Science 70*, 173–179.
14. Muchenje, V., Dzama, K., Chimonyo, M., Raats, J.G., & Strydom, P.E., (2008a). Meat quality of Nguni, Bonsmara and Aberdeen Angus steers raised on natural pasture in the Eastern Cape, South Africa. *Meat Science 79*, 20–28.
15. Mohan, A., Hunt, M.C., Barstow, T.J., Houser, T.A., & Muthukrishnan, S. (2010). Effects of malate, lactate, and pyruvate on myoglobin redox stability in homogenatesof three bovine muscles. *Meat Science 86*, 304-310.