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Nutritionally-related blood metabolites and faecal egg counts in indigenous Nguni goats of South Africa

F. Rumosa Gwaze[1], M. Chimonyo[2#] and K. Dzama[3]

[1] Department of Livestock and Pasture Science, University of Fort Hare, Faculty of Science and Agriculture, P. Bag X1314, Alice 5700, South Africa

[2] Discipline of Animal & Poultry Science, SASA, University of KwaZulu-Natal, P. Bag X01 Scottsville 3209

[3] Department of Animal Sciences, Stellenbosch University, P. Bag X1, Matieland 7602, South Africa

Abstract

The objective of the study was to determine the effect of season on faecal egg counts and biochemical profiles in indigenous Nguni goats of South Africa. Body weights, body condition scores, faecal and blood samples were collected from 96 goats. Faecal samples were analysed for nematodes and trematodes. Blood was analysed for packed cell volume (PCV), glucose, cholesterol, total protein, albumin, globulin, urea and creatinine. Significantly higher total protein and globulin values were recorded in the wet than the dry season. A significant positive correlation was recorded between body condition scores and albumin concentrations. Season had an effect on glucose, globulin, TP, creatinine, PCV and FEC of Nguni goats. It, therefore, is imperative to put measures in place to counteract the drop in any of these parameters, with season, if productivity of the indigenous goats is to be maintained. Further studies are required to determine the parasites causing chronic health challenges that were evidenced by elevated globulin concentrations in the flock studied. Since the high globulin levels were not accompanied by clinical cases, the reference levels used might be inappropriate for the indigenous Nguni goats.

Keywords: Alkaline phosphatase, creatinine, total protein
[#] Corresponding author. E-mail: chimonyo@ukzn.ac.za

Introduction

The ever-increasing rural human population of South Africa, which has led to a shortage of grazing land, makes goat farming an alternative proposition (Mmbengwa *et al*., 2000). The Nguni is the major indigenous goat breed (Lehloenya *et al*., 2005) raised in the communal areas of South Africa. The Nguni goat is reputable mainly for its adaptability and resistance to diseases and parasites (Barry & Godke, 2001). It is, however, important to further understand factors that affect nutritional status of this genotype so as to generate reference values that can be used to monitor goat health. Although traditional methods such as live-weight, body condition scores (Ndlovu *et al*., 2007) and worm identification have been employed in the determination of the nutritional status of livestock, they lack accuracy (Schroder & Staufenbiel, 2006). Analysis of biochemical properties of goats, coupled with the traditional methods, is essential in diagnosing the various nutritional and metabolic disorders (Daramola *et al*., 2005) in goats. The discovered importance of indigenous goat breeds might lead to their commercialisation in future. It, therefore, is important to find out how various parameters such as levels of glucose, cholesterol, total protein, albumin, globulin, urea and creatinine vary with season. There is dearth of information on nutritionally-related blood metabolites and faecal egg counts across seasons in Nguni goats. The objective of the study was, therefore, to determine the effect of season on the levels of blood metabolites, faecal egg counts (FEC), packed cell volume (PCV), body condition scores (BCS) and body weights in Nguni goats of the Eastern Cape Province of South Africa.

Materials and Methods

The study was conducted at the University of Fort Hare farm which is situated in the False Thornveld of the Eastern Cape Province of South Africa. The average annual rainfall is 480 mm whilst the mean annual temperature on the farm is 18.7 °C. The vegetation is composed mainly of *Acacia karroo*, *Themeda triandra*, *Sporobolus africanus*, *Panicum maximum*, *Digitaria eriantha*, *Eragrostis* species and *Cynodon dactylon*. Ninety-six female Nguni goats that were aged 16 months were selected for the study. The goats were clinically healthy throughout the study. The goats were grazed and browsed on natural vegetation (including browse) from 09:00 to 17:00 after which the goats were penned. The goats were weighed, body condition

scored and had faecal and blood samples collected from them in the dry (August, 2007) and wet (January, 2008) seasons. Body condition scores were assigned on a scale of 1 to 5 following guidelines by Friedricks (1993). Faecal egg counts were determined by the modified McMaster technique (Whitlock, 1948) whilst the sedimentation technique was used in the determination of flukes (Soulsby, 1982). Ethylene diamine tetra acetic acid (EDTA) tubes were used to collect blood meant for PCV determination whilst serum samples were analysed by the enzymatic method for glucose and, spectrophotometrically for total protein (TP) (Weichselbaum, 1946), albumin (Doumas, 1972) and creatinine (Tietz, 1995). Globulin concentrations were computed as the difference between TP and albumin. Glucose was analysed using the method by Gochman & Schmitz (1972). The albumin content was determined by a method by Pinnell and Northam (1978). Data were analyzed using the GLM procedures of SAS (2003) to determine the effect of season on body weight, body condition score (BCS) (square root transformed), faecal egg transformed ($\log_{10}$ (FEC + 1)) counts, PCV and levels of blood parameters. The PROC CORR (SAS, 2003) was used to determine the correlations among body weight, BCS, PCV, FEC and levels of each blood metabolite.

Results

Results of the effect of season on the studied parameters are indicated in Table1. Season did not affect body weights and BCS. Packed cell volume values were, however, significantly affected by season. Higher counts of the *Trichlostrongylus* egg type, strongyles and total faecal egg counts (FEC) were observed in the wet than in the dry season as shown in Table 1. Blood glucose, total protein, albumin, globulin and creatinine levels were significantly affected by season. Glucose, albumin and creatinine levels were higher ($P < 0.05$) in the dry compared to the wet season as indicated in Table 1. Season affected TP and globulin with higher values in the wet than in the dry season (Table 1). Blood urea levels were not affected by season.

Body weights were positively correlated to BCS (r = 0.38), PCV (r = 0.37) and cholesterol levels (r = 0.31). Body weights were, however, negatively correlated to strongyles (r = -0.24) and FEC (r = -0.34). There were no correlations between body weights and several blood metabolites; TP, albumin, globulin, glucose and creatinine. Body condition scores were negatively correlated to strongyles egg type counts (r = -0.21), TP (r = -0.47), glucose (r = -0.40), globulin (r = 0.72) and creatinine (r = -0.66). There also were no correlations between body condition scores and, FEC and cholesterol. Packed cell volumes were positively correlated to body weights (r = 0.37), BCS (r = 0.42), albumin (r = 0.34) and glucose levels (r = 0.29). Packed cell volumes were negatively correlated ($P < 0.05$) to strongyle (r = -0.28) and FEC (r = -0.23), and globulin (r = -0.21). Glucose levels were positively correlated to creatinine (r = 0.44).

Table 1 Least square means (± standard errors) of performance, faecal egg counts and blood chemistry values in Nguni goats

Parameter	Dry season	Wet season
Body weights	36.0 ± 1.15	35.4 ± 1.44
Body Condition Score	1.5 ± 0.04	1.6 ± 0.01
Packed cell volume	31.3^{b} ± 0.64	24.3^{a} ± 0.93
Trichostrongylus egg type counts	0.8^{a} ± 0.72	1.1^{b} ± 0.12
Strongyle egg type counts	1.5^{a} ± 0.61	2.6^{b} ± 0.37
Total faecal egg counts	1.6^{a} ± 0.18	3.0^{b} ± 0.07
Glucose (mmol/L)	3.0^{b} ± 0.08	2.7^{a} ± 0.11
Total protein (g/L)	75.3^{a} ± 1.05	87.9^{b} ± 1.47
Albumin (g/L)	27.5^{b} ± 0.38	24.1^{a} ± 0.54
Globulin (g/L)	48.2^{a} ± 1.05	63.9^{b} ± 1.48
Creatinine (umol/L)	77.3^{b} ± 1.95	69.3^{a} ± 2.75

^{a,b}Values in the same row with the different superscript are different ($P < 0.05$).

Discussion

Animals in the current study grazed and browsed for 8 hours at a stocking rate of 4 ha/AU. The communal grazing of goats on the veld increases the risk of transfer of eggs of nematodes and trematodes from infected goats to uninfected goats thereby increasing the level of the eggs of helminthes in the goat flock. The observation that body weights did not increase in the wet season, regardless of lush pastures that existed during this period, might indicate that goats were adversely affected by gastrointestinal parasites. The higher gastrointestinal parasites egg loads in the wet than in the dry season agrees with findings from other studies (Regassa *et al*., 2006; Mbuh *et al*., 2008). Wet environmental conditions are favourable for the development, survival and translocation of pre-parasitic stages of gastrointestinal nematodes and trematodes during the wet season leading to a steady build up of adult worms in grazing goats. In winter, however, the level of gastrointestinal parasites drops (Yadav *et al*., 2006). This drop might be attributed to unfavourable conditions for the proliferation of helminthes and/or the effect of antihelminthic properties of *A. karroo* (Xhomfulana *et al*., 2009) that the goats browsed on during that period.

The lower blood glucose concentrations in goats in the wet compared to the dry season may be attributed to the increase in body temperatures and respiration rate of the animals as a physiological response to thermal stress that is characteristic of the wet season in the study area (Grunwaldt *et al*., 2005). The observed increase in cholesterol with a decrease in faecal egg counts could be ascribed to elevated glucose concentrations in blood, during the dry season, that, through cascading reactions, trigger cholesterol synthesis (Grunwaldt *et al.*, 2005).

The higher globulin levels in the wet season, might be attributed to helminth infestation, contributed to the higher TP values in the wet season compared to values in the dry season. The higher globulin values obtained in the wet compared to the dry season might be attributed to inflammation due to gastrointestinal parasites whose load was higher in the wet season. The finding that globulin was negatively correlated to BCS indicates that goats in poor condition usually experience feed scarcity. The globulin concentration becomes elevated to counterbalance the lower concentrations of albumin to support osmotic pressure (Payne & Payne, 1987). These results are further supported by the negative correlation between globulin levels and PCV which indicates that it is in goats that are stressed; with low PCV values that elevated levels of globulin will be produced. The low A/G ratio can be ascribed to an increase in globulin concentration caused by chronic parasitism or compensation for the albumin loss signifying protein malnutrition which might be characteristic of helminthosis (Van Hutert & Sykes, 1996).

The elevated levels of creatinine in the dry season could be attributed to recycling of urea which is a response to limited dietary protein intake as indicated by the lower TP in the dry compared to the wet season. Blood creatinine concentrations are related to reduced filtration in the kidneys and increased production due to muscle catabolism (Wisloff *et al*., 2003). The observed positive correlation between BCS and body weights, PCV and albumin levels might indicate that BCS is a useful tool in estimating the energy and protein status of goats (Cabiddu *et al*., 1999). This improvement of body condition score with most of the blood metabolites indicates that goats in good condition have a better nutritional status compared to goats in poor condition. The observed negative correlation between BCS level and globulin concentration could probably mean that goats in good condition had less faecal egg counts and, therefore, would have little of globulin being produced in response to the inflammation caused by helminths.

Conclusions

The current study has shown that helminthes have a negative effect on performance of Nguni goats as evidenced by lack of an improvement in body weights and body condition scores in the wet season when lush pastures prevailed. It, however, is imperative to culture faecal samples in order to establish the strongyles that are affecting this goat flock. The negative correlation between globulin levels and BCS and between BCS and PCV indicate that globulin levels can be used to determine whether Nguni goats are stressed or not. It is recommended that studies covering longer periods should be conducted to increase the validity of the results obtained in the current study.

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