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Nematode worm burdens in Nguni cattle on communal rangelands in a semi-arid area of South Africa

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Abstract

A one year monitoring study was conducted to determine the egg loads and seasonal prevalence of gastrointestinal (GI) nematodes of Nguni cattle on communal rangelands in the Eastern Cape Province, South Africa. Faecal samples were collected per rectum once a season and examined by the modified McMaster technique using a saturated solution of sucrose and sodium chloride. Results revealed that 57.8 % of the cattle were infected with at least one GI nematode species. Strongyles (58.7 %) were the most prevalent GI nematode species. The prevalence and mean egg counts of all the parasite species identified showed a seasonal sequence with the highest faecal egg counts occurring in hot-dry season and the lowest in post-rainy season. Nguni cattle (0.09 ± 0.04) had significantly lower egg counts for *Strongyloides* species than non-descript cattle (0.30 ± 0.05) throughout the study period. The results suggest that GI nematodes have a moderate prevalence in Nguni cattle in the sweet and sour rangelands. Strategic control of these parasites needs to be done during hot-dry season to prevent clinical nematodoses.

Keywords: Coccidia, Indigenous Cattle, Season, Strongyles

Introduction

Cattle production contributes significantly to the livelihoods of resource-poor farmers in South Africa. In the Eastern Cape Province, for example, where approximately 25% (3.1 million) of the total cattle population in South Africa is found, more than half of these are kept under traditional communal grazing management (Palmer and Ainslie, 2006). Resource-poor farmers in communal areas of the Eastern Cape have limited access to veterinary support services, information about the prevention and treatment of livestock diseases, and preventive and therapeutic veterinary medicines (Dold and Cock, 2001). The cost of veterinary medicines is unaffordable for most of these farmers. Besides tick-borne diseases, gastrointestinal nematodes (GI) are among the important factors limiting cattle productivity in South Africa.

Infections with GI nematodes reduces feed intake and feed conversion efficiency, and can result in loss of blood and even death (Dreyer et al., 1999). These parasites are a significant impediment to the efficient raising of cattle on rangelands (Gasbarre et al., 2001). Only the presence of worms and deaths in cattle are noticed by resource-poor farmers and viewed as the most important economic losses (Dreyer et al., 1999). The greatest economic losses associated with nematode parasitic infections however, are subclinical (Dimander et al., 2000) and these go unnoticed in cattle on rangelands. For the objective assessment of economic losses caused by GI nematodes in cattle on communal rangelands, there is a need to identify common nematodes and determine their load and prevalence.

Most of the available information on nematodes loads and prevalence have been conducted under controlled on-station conditions. For example, Ndlovu (2007) compared three breeds across seasons on sweet rangeland in South Africa and found that indigenous Nguni cattle had the lowest faecal egg counts compared to Bonsmara and Angus. Indigenous cattle, especially the Nguni breed is attracting international interest due to its resilience to diseases and external parasites (Muchenje et al., 2007). No information, however, is available on the adaptation of the Nguni breed, raised under communal grazing management, to internal parasite infections.

Surveys have been done to determine the helminth species and their prevalence in communal cattle in southern Africa (Tsotetsi and Mbati, 2003; Carmichael, 2006; Pfukenyi et al., 2006). The authors recommended various treatment regimes based on their study environments. No such studies have been conducted on the loads and prevalence of cattle helminths across seasons and breeds on communal rangelands in the Eastern Cape. Treatment regimes in the Eastern Cape are often based on extrapolation of studies carried out elsewhere, and these are often inappropriate due to differences in ecological factors and management practices that exist among different areas. It is essential, however, to determine the loads and prevalence of GI nematodes across rangelands types, seasons and cattle breeds that occur in the communal areas. Sour rangeland occurs in areas with acid soils of quartzite and andesitic origin, higher (> 600 mm) rainfall and high elevation (> 1400 m) while the sweet rangeland occurs on eutrophic soils under arid and semi-arid conditions (Ellery et al., 1995). The sour rangeland is more likely to have higher prevalence of GI nematodes than the sweet rangeland. Comparing the prevalence of GI nematodes in different rangeland types assists policy makers to design appropriate control programmes for each particular rangeland type.

For rational and sustainable control of helminth parasites in communal grazing animals, a comprehensive knowledge of the epidemiology and dynamics of parasites is a prerequisite (Barger, 1999). The objective of the present study was, therefore, to determine the gastrointestinal nematode loads of Nguni cattle on communal rangelands in the Eastern Cape Province of South Africa.

Materials and Methods

Faecal sample collection was carried out in two sites, sweet rangeland as represented by Magwiji in Ukhahlamba district and sour rangeland as represented by Cala in Chris Hani district in the Eastern Cape Province, South Africa. These communities were selected on the basis of the availability of infrastructure for research and willingness of the farmers to participate in the study.

Magwiji is located on 30°37′ S and 27°22′ E and lies at an altitude of 1507 m above sea level. The climate varies from hot-wet to extreme cold with heavy frost and snowfall along the mountain area. Average annual rainfall is less than 500 mm in the hot-wet season and less than 200 mm with frost and snow in the cold-dry season. Highest mean temperature is recorded in January (22°C) and lowest in July (9°C). The most common grass species are *Themeda triandra*, *Setaria sphacelata*, *Microchloa caffra*, *Elionurus muticus* and *Heteropogon contortus* (Acocks, 1988). The slope and soil depth ranges between 3.1-5.0% and 501-700 mm, respectively. Soils are generally sandy with the clay content ranging from 15 - 24.9% and silt content from 15 - 20%, soil organic content ranges between 0.6 and 2%. The soil pH ranges from 6.5 to 7.5.

Cala is located on 31°33′ S and 27°36′ E with an altitude of 1441 m above sea level. The area receives moderate rainfall of 600–800 mm in the hot-wet season (November to February) and low rainfall of 200 mm in the cold-dry season (mid-May to August). Average monthly temperature is highest in January (20°C) and lowest in July (11°C). The most common grass species are *Themeda triandra*, *Heteropogon contortus*, *Sporobolus africanus* and *Microchloa ciliate* (Lesoli, 2008). The soil depth ranges between 501 and 700 mm. Soil clay content range between 15 to 24.9% and silt content from 20.1 to 30%, soil organic content ranges between 1.0 and 2%. The soil pH is within the range of 5.6 and 6.5.

A total of 144 cattle of different ages and both sexes were sampled during the period of study (Table 1). These animals were composed of two breeds, Nguni and non-descript (indigenous-exotic crosses). They were selected on the basis of the owners' willingness to participate in the study and availability of the cattle throughout the study period. Clinically healthy cattle were selected and ear-tagged, for easy identification, at the beginning of the study. The cattle were grazed on communal rangelands and body weights and condition scores were recorded for each animal before sampling. Weights were measured using a cattle weigh-band while visual assessment of the body condition was made using the five-point European system (Edmonson et al., 1989). Those animals that developed signs of GI nematodosis during the study were sampled, treated and removed from the egg count study, as they were considered to be outliers, but they were included in the prevalence study.

Faecal samples were collected per rectum for each tagged animal between 08h00 and 10h00 using a glycerine lubricated latex glove once in the cold-dry (August 2007), hot-dry (October 2007), hot-wet (January 2008) and post-rainy (April 2008) season. The samples were stored in a cooler box at 4°C before being transported to the laboratory for analysis. The modified McMaster's technique, as described by the Ministry of Agriculture, Fisheries and Food (1986) was used to prepare the faeces for identification and quantification of worm eggs. The modified McMaster's technique involves mixing 4g of the faeces with 56 ml of saturated sucrose and sodium chloride flotation solution (specific gravity 1.28). After counting the number of eggs on both chambers of the McMaster slide, the number of eggs per gram (EPG) of faeces was calculated by multiplying the total number of eggs counted by the dilution factor of 50. The specificity of the method was 50 eggs per gram. All nematode eggs were identified using a combination of keys given by Soulsby (1982), Uhlinger (1991) and Foreyt (2001). The prevalence of each species of GI nematodes was computed as:

Table 1: Composition of the study animals

	Sweet rangeland							
	Cold-dry		Hot-dry		Hot-wet		Post-rainy	
Breed[a]	NG	ND	NG	ND	NG	ND	NG	ND
Age								
1	4	6	1	5	3	2	6	4
2	4	5	1	4	1	2	1	4
3	3	6	1	4	1	3	2	7
4	3	5	1	2	2	3	2	5
5	5	6	3	5	4	4	6	7
	Sour rangeland							
	Cold-dry		Hot-dry		Hot-wet		Post-rainy	
Breed	NG	ND	NG	ND	NG	ND	NG	ND
Age								
1	4	5	5	7	2	7	1	6
2	3	2	4	6	2	5	1	6
3	4	7	4	7	4	6	2	7
4	3	5	7	7	5	7	2	7
5	2	2	4	7	2	6	2	6

[a] NG = Nguni breed and ND = non-descript breed

$$P = \frac{d \times 100}{n}$$

Where: P is the prevalence, d is the number of animals having the GI nematode at a particular point in time; and n the number of animals in the population at risk at that point in time (Thrusfield, 1995).

Statistical analysis

Because the egg count data and body condition scores (BCS) were not normally distributed, transformation using $\log_{10}$ (x + 1) and square root, respectively, was performed to confer normality. Correlations among BCS, body weight and GI parasite mean egg counts were determined using PROC CORR of SAS (2003). The mean and standard error of the eggs per gram (EPG) of faeces for each GI nematode species were computed using PROC MEANS of SAS (2003). The chi-square test was used to determine the association between parasite prevalence and rangeland type, season, breed, age and sex (SAS, 2003). The effects of rangeland type, season, breed, age, sex and their first order interactions on the transformed mean egg counts (MEC) of the GI parasites, BCS and body weight were determined using PROC GLM for repeated measures of SAS (2003).

Results

The seasonal changes in BCS in communal cattle in the sweet and sour rangelands are shown in Figure 1. Sex significantly affected the BCS of the study animals with male animals (3.0 ± 0.08) having higher (P<0.05) BCS than females (2.6 ± 0.06). Rangeland type, breed and age did not affect the BCS of the communal cattle. Rangeland type, season, breed, sex and age significantly affected the body weight of the study animals (Table 2).

Out of a total of 324 faecal samples that were collected during the study period, 57.8 % were positive for the eggs of at least one GI nematode species, while 19.1 % were positive for the eggs of more than one GI nematode species. The prevalence of three GI nematode egg types and coccidial oocysts that were identified in each season in the sweet and sour rangelands are shown in Table 3. There was significant association (P<0.05) between the prevalence of strongyles, *Trichuris* and coccidia. The interaction of rangeland type and season was significantly associated with the prevalence of strongyles, *Trichuris* and coccidia. Breed, sex and age were not significantly associated with GI nematode prevalence.

Table 4 indicates the transformed ($\log_{10}$ [x + 1]) mean egg counts and standard error of strongyles, *Strongyloides*, *Trichuris* and coccidia in the sweet and sour rangelands. Figure 2 shows the seasonal changes in their MEC in the study animals throughout the study period. The highest (P < 0.05) MEC were recorded in the hot-dry season while the lowest (P<0.05) occurred in the post-rainy season for strongyles, *Strongyloides* and coccidia.

Breed significantly affected the MEC of *Strongyloides* species with the Nguni breed having lower (P<0.05) MEC than the non-descript breed (Table 5). Breed did not significantly affect the MEC of other GI parasite species identified. Table 6 shows the mean counts of coccidial oocysts in the different ages of cattle. Age significantly affected the mean oocyst

Table 2: Effect of rangeland type, season, breed, sex and age on body weights (kg) of cattle in the communal areas

Rangeland type	Season				
	Cold-dry	Hot-dry	Hot-wet	Post-rainy	Overall mean
Sweet rangeland	336.6 ± 12.94	304.7 ± 17.5	391.7 ± 18.06	382.4 ± 12.75	348.9 ± 7.10 [a]
Sour rangeland	387.7±16.74	323.8 ± 11.61	409.1 ± 15.00	452.2 ± 15.3	392.8 ± 6.70 [b]
Breed					
Nguni	359.2 ± 15.7	304.1 ± 16.0	385.1 ± 17.4	413.4 ± 16.73	361.8 ± 7.50 [a]
Non-descript	365. 3 ± 13.0	324.4 ± 12.3	415.7 ± 14.50	421.2 ± 11.0	379.9 ± 5.80 [b]
Sex					
Male	388.2 ± 18.61	344.8 ± 15.11	457.4 ± 20.00	466.3 ± 15.25	410.0 ±7.80 [b]
Female	326.1 ± 11.63	283.8 ± 13.40	3443.5 ± 12.51	367.3 ± 13.05	331.6 ± 6.00 [a]
Age (years)					
>1-2	307. 3 ± 15.58	246.7 ± 21.56	359.3 ± 27.07	389.4 ± 3.00	319.2±10.00 [a]
>2-3	342.4 ± 28.52	275.0 ± 28.00	361.0 ± 30.00	384.2 ± 4.40	335.8± 2.80 [b]
>3-4	387.7 ± 18.15	328.9 ± 19.22	417.1 ± 22.76	432.2 ± 19.82	392.5 ± 9.50 [c]
>4-5	381.8 ± 25.05	377.0 ± 17.81	441.2 ± 18.00	438.0 ± 17.28	409.8 ± 9.00 [d]
>5	391. 7 ± 25.53	344.0 ± 26.64	423.5 ± 26.27	442. 7 ± 23.2	396.9 ± 1.60[e]

[a,b,c,d,e]Values with different superscripts in the last column are significantly different (P < 0.05).

Table 3: Prevalence (%) of gastrointestinal parasites of cattle in communal areas of the sweet and sour rangelands

	Sweet rangeland				Sour rangeland			
	Cold-dry	Hot-dry	Hot-wet	Post-rainy	Cold-dry	Hot-dry	Hot-wet	Post-rainy
Strongyles	62.5	64.0	40.0	32.8	68.6	76.6	43.5	27.5
Strongyloides	6.3	16.0	4.0	6.8	5.7	15.6	8.7	10.0
Trichuris	8.3	0.0	0.0	0.0	22.9	0.0	0.0	0.0
Coccidia	6.3	24.0	8.0	15.9	2.9	34.8	10.9	0.0

Table 4: Faecal egg counts (mean ± standard deviation) of GI nematodes in cattle in the sweet and sour rangelands of the Eastern Cape

	Sweet rangeland	Sour rangeland
Strongyles	1.2±1.11[d]	1.1±1.10[d]
Strongyloides	0.2±0.57[b]	0.2±0.55[b]
Trichuris	0.1±0.37[a]	0.1±0.31[a]
Coccidia	0.3±0.72[c]	0.3±0.71[c]

[a, b, c, d] Values with different superscripts differ (P < 0.05)

Table 5: Mean egg counts and standard error of gastrointestinal nematodes ($\log_{10}$ (x+10) in the Nguni and Non-descript breeds

	Nguni	Non-descript
Strongyles	1.08 ± 0.101[a]	1.11 ± 0.077[a]
Strongyloides	0.09 ± 0.054[b]	0.21 ± 0.041[a]
Trichuris	0.06 ± 0.033[a]	0.08 ± 0.003[a]
Coccidia	0.18 ± 0.064[a]	0.28 ± 0.049[a]

[a,b] Values with different superscripts are significantly different (P < 0.05)

Table 6: Mean oocyst counts ($\log_{10}$ (x+1) of coccidia in the different ages of cattle

Age (years)	Mean	Standard Error
>1-2	0.4 [c]	0.08
>2-3	0.3 [c]	0.11
>3-4	0.3[c]	0.08
>4-5	0.2[b]	0.08
>5	0.1[a]	0.10

[a,b,c] Different superscripts indicate significant differences in the means

counts, with the one year age group having higher (P<0.05) mean oocyst counts compared to the older cattle. Rangeland type, breed, age and sex did not (P>0.05) affect the MEC of strongyle species. Table 7 shows the correlations among body weight, BCS, and MEC of the GI nematode species identified. The MEC for strongyles and coccidia were negatively correlated (P<0.05) with body weight and BCS.

The mean FEC was low 200 EPG. Only two clinical cases of helminthosis occurred, in non-descript cattle in the sweet rangeland during the hot-dry season and these necessitated anthelmintic treatments and were not sampled for GI nematode egg loads.

Table 7: Correlations among body weight, body condition score and mean egg counts of the gastrointestinal parasites

	Weight	BCS	Strongyles	*Strongyloides*	*Trichuris*	Coccidia
Weight	1.00	0.38***	-0.26***	-0.10	-0.08	-0.13*
BCS	0.38***	1.00	-0.30***	-0.08	-0.09	-0.13*
Strongyles	-0.26***	-0.30***	1.00	0.24**	0.18**	0.20**
Strongyloides	-0.10	-0.08	0.24***	1.00	0.12*	0.07
Trichuris	-0.08	-0.09	0.18*	0.12*	1.00	-0.08
Coccidia	-0.13**	-0.13**	0.20**	0.07	-0.08	1.00

** Indicates significance at $P < 0.05$. *** Indicates significance at $P < 0.01$.

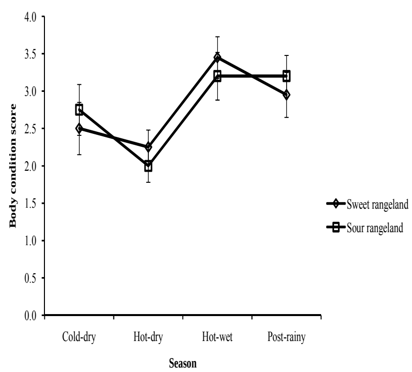

Fig. 1: Seasonal changes in BCS in communal cattle in the sweet and sour rangelands

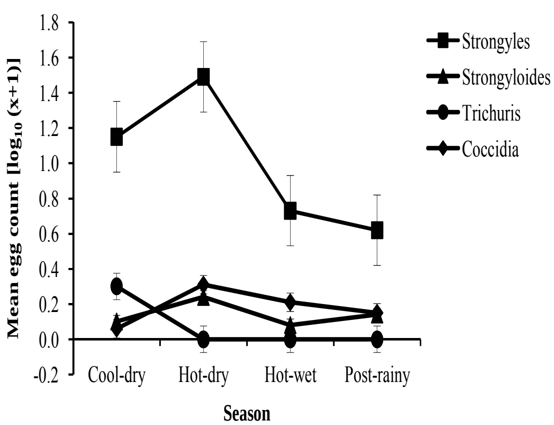

Fig. 2: Seasonal changes in mean egg counts (MEC) in the communal cattle in the sweet and sour rangelands of the Eastern Cape

Discussion

Three GI nematode egg types were observed in this study and this is in agreement with those reported in other studies on prevalence of internal parasites of cattle in South Africa (Dreyer et al., 1999; Tsoetsi and Mbati, 2003; Horak et al., 2004; Ndlovu, 2007). The prevalence of GI nematodes in cattle on communal grazing was moderate, suggesting that sub-clinical infections are more important in the study area. The low FEC might be related to a low level of rangeland contamination that is characteristic of a communal grazing sytem (Regassa et al., 2006).

The high egg loads observed during the hot-dry season coincide with low BCS and may be attributed to poor nutritional status in the cattle host which imparts a decreased immunity and resistance against internal parasites (Coop and Holmes, 1996). The high egg counts in the hot-dry season may also be attributed to the ‘spring rise’ phenomenon. In this phenomenon, an increase in worm infection that occurs in the hot-dry season (spring) arises from the resumption of development of larvae retarded in the fourth-stage during the cooler months of the year (Tembely et al., 1998). The drop in the prevalence of GI nematodes and MEC during the hot-wet season may be due to the high temperatures during the hot-wet season which may have resulted in the dessication of nematode larvae on rangeland (Soulsby, 1982) and thus reduced the infection of cattle by internal parasites during this season. The high BCS in the hot-wet season may have indicated a good nutritional status in the cattle host which imparts an increased immunity and resistance against internal parasites (Coop and Holmes, 1996).

The high prevalance and MEC of strongyles observed throughout the study period is probably related to their high fecundity, as a result, their larvae are likely to be ingested by cattle on rangelands in higher numbers than those of other genera (Nyingi et al., 2001). The lower egg counts of *Strongloides* species observed in the Nguni breed than in the non-descript breed may suggest a higher innate and/or acquired resistance in the Nguni cattle. This observation agrees with that of Ndlovu (2007). Nguni cattle are adapted to the local environment (Schoeman, 1989; Scholtz et al., 2000) and, thus, may have developed an increased resistance to GI parasites. Coccidia infections were higher in the young cattle and this concurs with results obtained by Matjila and Penzhorn (2002). Coccidiosis is generally a disease of younger animals, older animals usually develop age-immunity and, therefore, have low infection rates (Matjila and Penzhorn, 2002). Older animals however remain a source of infection for younger animals (Smith and Sherman, 1994).

Though not statistically significant, cattle in the sweet rangeland tended to have lower MEC than those in the sour rangeland. Cattle in the sweet rangeland had on average better body condition scores than those in the sour rangeland and thus may have been getting a higher plane of nutrition. In ruminants, a strong relationship exists between nutrition and GI parasite infection, where animals with higher levels of protein and/or energy are better able to control establishment of new parasites and reduce fecundity of existing parasites, both of which would result in reduced FEC (Coop and Kyriazakis, 2001).

The study revealed negative correlations between parasitic MEC against body weight and body condition scores in both rangeland types. These results agree with those observed by Keyyu et al. (2003) who observed a significant correlation between parasite prevalence and body condition score. Gastrointestinal nematode infections decrease feed intake and utilization (Coop and Holmes, 1996), thus having a negative effect on the animal's body weight and condition. In addition, gastrointestinal parasitism induces loss of proteins from the blood into the gastrointestinal tract resulting in changes in the host metabolism that cause reduced protein and energy retention in infected animals (Holmes, 1987). These metabolic disturbances are a drain on the body's protein and energy reserves and thus reduce body weight and condition in infected animals.

The prevalence of GI nematodes was found to be moderate and only two clinical cases of nematodosis were diagnosed indicating that clinical nematodoses may not be important in communal areas. Faecal egg counts (200 EPG) were generally lower than 500 EPG, the recommended minimum level for treatment of GI nematodes in cattle (Hansen and Perry, 1994). Farmers however need to be wary of clinical cases of nematodosis during the hot-dry season. Development of strategic antihelminthic control to abate such cases in the communal areas is important. The low BCS during the hot-dry season warrants the use of protein supplements such as the indigenous browse legume *Acacia karroo* (Mapiye et al., 2011). This browse species is also rich in condensed tannins and is a readily available, cheap option for the resource-poor farmers. The use of good grazing management practices, such as rotational grazing, rather than the current uncontrolled extensive grazing, is also recommended to reduce rangeland contamination and infectivity to cattle. Indigenous Nguni cattle are recommended for use in the integrated control of GI nematodes in the communal areas of South Africa as they are better able to cope with nematode infections than non-descript breeds.

Conclusion

Gastrointestinal nematodes were moderately prevalent in communal areas of the sweet and sour rangelands of the Eastern Cape. Strongyles were the most prevalent GI nematode species and had the highest MEC throughout the study period. Nguni cattle had low MEC for *Strongyloides* species compared to non-descript cattle. The use of the Nguni breed in the integrated control of GI nematodes of cattle in communal areas of the Eastern Cape is recommended. Further studies on the effect of supplementation with condensed tannin-rich browse legume leaf-meals on parasite levels in Nguni cattle on communal rangelands are essential.

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