

The prevalence of gastrointestinal nematode infection and their impact on cattle in Nakuru and Mukurweini districts of Kenya

W. M. Kabaka^{a*}, G. K. Gitau^b, P. M. Kitala^a, N. Maingi^f and J.A. VanLeeuwen^d

^aDepartment of Public Health, Pharmacology and Toxicology, Faculty of Veterinary Medicine, University of Nairobi

^bDepartment of Clinical Studies, Faculty of Veterinary Medicine, University of Nairobi

^cDepartment of Veterinary Pathology, Microbiology and Pathology, Faculty of Veterinary Medicine, University of Nairobi

^d Centre for Veterinary Epidemiologic Research, Department of Health Management, Atlantic Veterinary College, University of Prince Edward Island, Canada

*Corresponding author e-mail: wkabaka@gmail.com. Cell phone: +254726700700.

Abstract

A cross-sectional study was conducted in Nakuru and Mukurweini districts of Kenya to estimate the prevalence of gastrointestinal nematodes (GIN) and the financial impact of such infections among smallholder dairy farms. Parasitological examination involving faecal egg count and larval culture was employed to determine prevalence and burden of GIN. Questionnaires were administered to collect individual animal and farm management data. The impact of GIN infection on average daily milk production in lactating cows was also estimated using generalized linear regression analysis. The prevalence of GIN infection was significantly different ($p < 0.05$) between Nakuru and Mukurweini, at 19.8% and 8.3%, respectively (13.8% overall), for a relative risk of infection of 2.3. Farm-level prevalence of infections were estimated at 28.1% (36/128) for *Haemonchus*, 19.5% (25/128) for *Trichostrongylus* and 14.8% (19/128) for *Oesophagostomum*. Average daily milk production in litres in the GIN-infected milking cows was 5.4 compared to 7.8 in the non-infected cows. GIN infection was associated with 1.4 litres per cow per day less milk and this difference was statistically significant ($p < 0.05$). The observed difference in milk production translated to a daily loss of 0.35 US dollars (USD) per cow per day at a cost of 0.25 USD per litre, which was the average farm gate price of milk at study time in the area under study.

Keywords: Cattle, Gastrointestinal nematode infections, Milk production, Cross-sectional study.

<http://dx.doi.org/10.4314/evj.v17i1.8>

Introduction

Gastrointestinal nematode (GIN) infections in cattle are of considerable economic importance, causing clinical disease and mortalities, but more importantly, by causing subclinical chronic production losses as a result of weight loss, reduced weight gain, and reduced milk production (Over *et al.*, 1992).

GIN infections have been observed to affect younger cattle more than adults, with the super family *Trichostrongyloidea* having the biggest impact, leading to clinical manifestations including pale mucous membranes due to anemia, poor body condition (Urquhart *et al.*, 1996), and reduced immunity (Charlier *et al.*, 2009). In Africa, a study carried out in Ouagadougou, Burkina Faso, on the prevalence of GIN in cattle showed that *Cooperia* was most prevalent (89.4%), followed by *Haemonchus contortus* (66%), and *Oesophagostomum radiatum* (42.6%), whereas *Haemonchus* became predominant in the rainy season as it was able to withstand harsh climatic condition through arrested development in the L4 stage (Belem *et al.*, 2001). In Kenya, infestation with GIN in dairy cattle was common (Maingi *et al.*, 1998). A study carried out on cattle in Central Kenya showed that *Haemonchus*, *Trichostrongylus*, *Cooperia* and *Oesophagostomum* were responsible for parasitic gastroenteritis, *Haemonchus placei* being the predominant nematode (Waruiru *et al.*, 2001). A study done in Zimbabwe on 16,264 communally grazed cattle, by Pfukenyi *et al.*, (2007), showed the prevalence of GIN to be 43%. Another study carried out in Ngorongoro District of Tanzania on pastoral cattle found the prevalence of GIN to be 20% (Swai *et al.*, 2006).

The milk yield after anthelmintic treatment on pastured dairy cattle in the Netherlands was estimated to increase by 1 kg/cow/day (Charlier *et al.*, 2009). There is limited information on the economic impacts of GIN on milk production in Africa. The objectives of this study were to estimate the prevalence of GIN infection and the financial impact of such infections among smallholder dairy farms.

Materials and Methods

Study area

The study was carried out in Mukurweini District of Nyeri County and Nakuru District of Nakuru County between June 16th 2010 and August 30th 2010. Nyeri County is one of the five counties of Central Province and forms part of Kenya's central highlands (The Constitution of Kenya, 2010). Dairy farming is an important

enterprise in Mukurweini District, with the farmers practicing zero-grazing methods, where pastures are cut and carried to the cattle. Nakuru County is one of the 14 Counties of the Rift Valley Province and it lies within the Great Rift Valley (The Constitution of Kenya, 2010). Dairy farmers in the area practice both zero-grazing, and semi-zero-grazing, where the cattle are housed but allowed to graze at certain times.

Study design

A cross-sectional study was carried out on 419 heads of cattle that were on 128 farms (64 farms in each district), to establish the prevalence and economic impact of gastrointestinal nematode infections in Nakuru and Mukurweini districts of Kenya. In Nakuru, a simple random selection was employed at the farm level using a sampling frame of the dairy farms provided by the District Livestock Production Officer. For logistical reasons, a purposive sampling method was used in Mukurweini, as the research was conducted alongside another project comparing smallholder dairy farms with and without biogas digesters (Dohoo *et al.*, 2012a; Dohoo *et al.*, 2012b). In that study, biogas digesters were distributed to a group of smallholder dairy farmers considered representative of the various sub-districts and demographics of smallholder dairy farmers in the area, and the referent group of farmers was randomly selected. Due to the similarity of farming practices across smallholder dairy farms in the district (virtually all zero-grazing units), the Mukurweini sample of farms was considered a fair representation of the population in the district. In Mukurweini district, all cattle that were above three months of age on the selected farms were sampled for the study. In Nakuru district, some farms were larger, and therefore on farms that had more than 10 heads of cattle, a systematic random selection method was used to ensure that no more than 10 animals were sampled per farm.

Data collection

Faecal samples from each animal on the selected farms were collected and analyzed for faecal egg counts (FEC) using a Modified McMasters technique (Ministry of Agriculture, Fisheries and Food, 1986), with a lower detection limit of 50 eggs per gram (epg). Faecal samples from a farm were pooled and larval cultures were conducted on the pooled sample.

Questionnaires were administered to the participating farmers to collect individual animal and farm management data, such as age, parity, sex, breed, body condition score, and feeding management. Animal weight was estimated using a heart girth tape.

Data regarding the stage of lactation of the milking cows and daily milk production were collected from the farmer for the purpose of estimating the milk production loss associated with GIN infection.

Data analyses

For comparison purposes of worm loads with other studies, the mean, 95% confidence interval, and range of FECs (in epg) was calculated per district in both the immature cattle (3-12 months) and the adults (above 12 months), to examine the effect of age on the FECs (Georgi et al., 1997). A binary outcome was preferred to a continuous data outcome because: 1) the McMasters egg counting method gave an output in multiples of 50 (each egg seen represented 50 eggs); and 2) the data had a right-skewed and a non-Gaussian distribution of the egg counts that could not be normalized with transformations. A threshold of 100 epg and above was considered GIN infection positive, and below 100 as negative (Hansen, 1994). One egg seen (representing 50 egg) could be a false positive due to the passing through of ingested eggs, or a very light level of parasitism.

A computation was carried out to establish whether there was an association between the district and the infection status using the chi-square (Thrusfield, 2007). Prevalence of infections in the different age groups was computed and tabulated to compare the risk of gin infection between the calves (<12 months) and the adults. Similarly the prevalence of gin infection by grazing management was tabulated, and a chi-square was calculated to compare the risk of gin infection in the zero-grazed and the free-range management systems.

Faecal samples from each farm were pooled and mixed, and the presence of each gin genus was determined following identification keys (Ministry of Agriculture, Fisheries and Food, 1986). the prevalence of each gin genus was calculated by taking the ratio of the farms infected with each genus to the total farms at risk of such infections.

To estimate the impact of gin infection on milk production, the mean and the 95% confidence interval of the milk yield in the milking cows, by gin status, was calculated. a generalized linear regression analysis was used to estimate the effect of gin infection on milk production, controlling for significant confounders, such as breed, animal weight, parity, lactation stage, cmt status and the amount of concentrates fed to the animals.

Results

Mean faecal egg counts of gastrointestinal nematodes

The overall mean, 95% confidence interval, fecs were 48.0, 35.2 to 60.8 in cattle less than 12 months of age, and 18.4, 12 to 24.8 in cattle more than 12 months of age, respectively. the mean egg counts were significantly higher($p = 0.05$) in cattle less than 12 month compared to older cattle, in both districts(table 2).

Table 2. Mean faecal egg counts of gastrointestinal nematodes and the 95% confidence intervals for all the 419 cattle Sampled, by age group and district, between June 16th 2010 and August 30th 2010.

District	3 months to 12 months - mean epg and 95% CI	Above 12 months - mean epg and 95% CI
Nakuru	62.8 [58.2, 67.4] n=43	29.6 [17.8, 41.4] n=159
Mukurweini	36.4 [26.2, 46.6] n=55	7.4 [2.7, 12.1] n=162
Overall	48.0 [35.2, 60.8] n=98	18.4 [12.0, 24.8] n=321

95% CI = 95% confidence interval

3.2 Gastrointestinal nematode species

The pooled larval cultures showed that *Haemonchus*, *Trichostrongylus*, and *Oesophagostomum* were the most common gastrointestinal nematodes found in the animals. Overall farm level prevalence of infections were estimated at 28.1% (36/128) for *Haemonchus*, 19.5% (25/128) for *Trichostrongylus*, and 14.8% (19/128) for *Oesophagostomum*.

In Nakuru District, *Haemonchus* was present in 33% (21/64) of the farms, *Trichostrongylus* was found in 25% (16/64) of the farms, while *Oesophagostomum* was found in 19% (12/64) of the farms. In Mukurweini District, *Haemonchus* was present in 23% (15/64) of the farms, *Trichostrongylus* was found in 14% (9/64) of the farms, while *Oesophagostomum* was found in 11% (7/64) of the farms.

Crude prevalence of gastrointestinal nematode infection

A 2 X 2 table was constructed to show the distribution of GIN infections in the Mukurweini and Nakuru districts (Table 3).

Table 3. Comparison of gastrointestinal nematode infection status in 419 cattle on 128 dairy farms per district between June 16th 2010 and August 30th 2010.

District	Infection +ve	Infection -ve	Total
Nakuru	40 (19.8%)	162	202
Mukurweini	18 (8.3%)	199	217
Total	58 (13.8%)	361	419

There was a significant ($\chi^2 = 11.6$, $p < 0.05$) difference in GIN prevalence between the two districts. The relative risk was 2.3 showing that the risk of the GIN infection was more than twice in Nakuru as compared to Mukurweini.

The prevalence of GIN infection in free range cattle was 20.7%, (22/106) compared to 11.5% (36/313) in the zero-grazed animals. The difference was significant ($\chi^2 = 5.7$, $p < 0.05$). Fifty-two percent (106/202) of cattle in Nakuru were on free-range grazing, while all the cattle in Mukurweini were on zero-grazing farming systems.

The prevalence of GIN infection in animals less than 12 months of age was 21.9% (32/146) and 9.5% (26/273) in animals more than 12 months old; the difference was statistically significant ($\chi^2 = 12.2$, $p < 0.05$). An odds ratio of 2.7 showed that the odds of infection was more than two times in cattle less than 12 months compared to animals above 12 months of age. All the male animals sampled were calves less than 12 months of age, and there was no significant difference in prevalence of infection by gender.

Impact of gastrointestinal nematode infection on milk production

Mean milk production in the cows that showed no GIN infection (n=170) was estimated at 7.8 Kg/cow/day with a 95% confidence interval of 4.16 to 6.77, while mean milk production in the GIN-positive group (n=48) was 5.5 Kg/cow/day with

a 95% confidence interval of 6.93 to 8.61. However, this difference of 2.3 kg/cow/day did not control for the effects of other factors likely to affect milk production, such as cow breed, weight, parity, lactation stage, CMT, and the amount of concentrates fed.

A generalized linear regression analysis with milk production as the outcome and GIN status as an explanatory variable, controlling for the effect of cow breed, weight, parity, lactation stage, CMT, and the amount of concentrates fed to the animals, showed that GIN infection was associated with 1.4 kg per cow per day less milk ($p < 0.05$).

Discussion

Our study showed that a prevalence of GIN infection, observed in Nakuru was significantly higher than the prevalence observed in Mukurweini. The relative risk indicated that the risk of GIN infection was more than twice as high in Nakuru compared to Mukurweini, and this difference was partially a function of the fact that over half of the cattle sampled in Nakuru district were free-ranging, which were more likely to be GIN infected than zero-grazed cattle. The overall prevalence of 13.8% estimated in this study was lower than that of 20% from a previous study by Swai *et al.* (2006), in Ngorongoro, in free-range pastoral cattle. The results also differed with another study carried out by Waruiru *et al.*, (2001) in Kiambu District on *Bos indicus* and *B. taurus* crosses on free range pasture which showed a prevalence of 75.9% in adults and 87.6% in immature animals. The lower prevalence in our study may be attributed to the improved management practices in both districts, especially in Mukurweini district, where the dairy farmers use zero-grazing units and treat for GINs regularly. In the two districts under study, dairy production is the biggest economic activity and as a result, the farmers have appeared to step up management activities, such as housing, feeding and helminth control. This anecdotal improved management may have resulted in a reduction in GIT nematodes infections. Due to the large variation in cattle management practices from various districts in Kenya, it is likely that the results of this study are limited to districts with similar management practices and therefore cannot be extrapolated as estimates for the country. The prevalence deduced here may therefore tend to underestimate the true prevalence in the whole country.

The current study agrees with a previous study carried out in Kiambu District in Kenya, which demonstrated that nematode prevalence was higher in cattle less than 12 months of age (Waruiru *et al.*, 2000).

The pooled larval culture showed that *Haemonchus*, *Trichostrongylus*, and *Oesophagostomum* were the most common nematodes found on the farms, with *Haemonchus* being present in 28% of the farms followed by *Trichostrongylus* (19.5%) and *Oesophagostomum* (12.5%). *Haemonchus* was also the predominant species of GIN in a previous study that was carried out in Kiambu District by Waruiru *et al.*, (1998) that showed the following prevalence: *Haemonchus placei* (67.0%), *Cooperia pectinata* (53.0%), and *Cooperia punctata* (41.7%). It is unclear why *Cooperia* were not identified in our study.

The current study showed that GIN-infection was associated with 1.4 liters per cow per day less milk, after controlling for farm clustering and significant confounders. This agrees closely with a similar study carried out in the Netherlands that estimated the milk yield response after anthelmintic treatment of pastured dairy cattle to be 1 kg/cow/day more milk (Charlier *et al.*, 2009). As milk is the most important output in a dairy enterprise, GINs lead to direct loss in production and income. At the price of 0.25 USD (US Dollars) per liter, which was the average farm gate price of milk in the study area at that time, a loss of 0.35 USD per cow per day was attributable to nematode infection. With dewormers costing 2.5 to 5 USD per cow at the time of the study, anthelmintic treatment would likely to be a cost-beneficial management tool among infected cattle.

Conclusion

GIN infection was relatively common (14%), with a higher prevalence observed in Nakuru District compared to Mukurweini District, and among calves as compared to adults. The most prevalent genus was *Haemonchus*. GIN infection was associated with 1.4 kg per cow per day less milk, costing Ksh 28/cow/day. To avoid such losses in production, efforts should be directed towards GIN control in groups of animals that are considered at higher risk of infection.

Acknowledgement

The study was sponsored by Farmers Helping Farmers, a Canadian non Governmental organization, the Atlantic Veterinary College, Veterinarians without Borders-Vétérinaires sans Frontières-Canada, and the XXIII World Veterinary Congress Foundation. Mr. R. Otiemo and Miss. R. Githinji are hereby acknowledged for their contribution in processing the samples, and Ms. Laura Bourque and Vionna Kwan for assisting in sample and data collection

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