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RESEARCH PAPER

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Prevalence and risk factors associated with Nematode and *Eimeria* infection under smallholder dairy farming in North East Tanzania

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Abstract

A cross-sectional survey was carried out from October, 2016 to May 2017 to determine and describe the prevalence, intensity of gastrointestinal nematode (GIN) and *Eimeria* infection and associated risk factors under smallholder dairy farms in North East Tanzania. In this study a total of 384 dairy cattle were included to detect whether they are harboring GIN and *Eimeria* oocytes. Fecal samples were collected and coprological examinations were done by using standard flotation technique and the overall prevalence was 50.8% (n=195) and the prevalence was significantly associated with Age, Sex, deworming, body condition score and routine of dung removal at $p<0.05$. The major nematodes genera identified in this study were *Haemonchus* sp. *(33.49%)*, *Trichostrongylus* sp. (20.93%), *Oesophagostomum* sp. (17.21%), *Cooperia* sp. *(14.88%)* and *Bunostomum* sp. (13.49%). Questionnaires were administered to collect individual animal and management data. In conclusion, nematodes were common in the gastrointestinal track, therefore, prevention of dairy cattle from these nematode infection using strategic deworming and an improved feeding and management of cattle should be endeavored. Further detailed epidemiological study should be needed and identification of the nematode species should also be recommended.

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Introduction

Gastrointestinal nematode (GIN) infection in cattle are of considerable economic importance causing both subclinical, clinical and mortalities, but more importantly 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, 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 (Kabaka *et al.*, 2014). 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 Zimbambwe on 16,264 communally grazed cattle, by Pfukenyi *et al.* (2007), showed the prevalence of GIN to be 43%. In Tanzania the study carried out in Ngorongoro District on pastoral cattle found the prevalence of GIN to be 20% (Swai *et al.*, 2006). Parasites may cause both clinical and nonclinical diseases leading to economic losses. In Tanzania researchers' have carried out few regional studies, however, the results are outdated and limited. Therefore, the aim of the present study is to assess the prevalence of GIN and coccidian infection in dairy cattle and associated risk factors on smallholder dairy farms in North East Tanzania.

Materials and methods

Study area

This study was carried out in two districts (Lushoto and Korogwe) in Tanga region where as Lushoto is situated in northern part; lies between 4°25′–4°55′S and 30°10′–38°35′E (Fig. 1). It has an altitude of 1000-2100 meters above the sea level with average annual temperature of 17.3°C and 1074 mm of rainfall. Korogwe is located at 4°15′–5°15′S and 38°0′–38°45′E with annual average temperature of 26°C and rainfall of 1051mm. Selection of sites (villages) was based on availability of adequate number of improved dairy breeds kept under zero grazing management system.

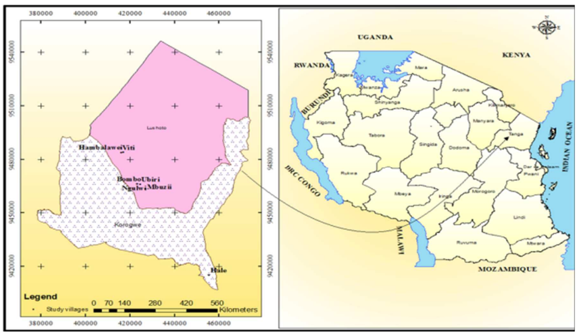

Fig. 1. Map of the study villages in Lushoto and Korogwe districts, North East Tanzania.

Study design and selection of farms and animals

The study was a cross-sectional study where dairy cattle from 130 smallholder dairy farms of North East Tanzania were selected using simple random sampling method. The sample size was determined by the formula given by Thrusfield (2005), where number of dairy cattle involved in the study was determined by using the formula.

$n = \{1.96^2 \times pexp\ (1\text{-}pexp)\}/d^2$

$= \{1.96^2 \times 0.5(1\text{-}0.5)\}/(0.05)^2$

= 384 Dairy Cattle

Where: n= sample size required Pexp= expected prevalence=50% 1.96= the value of Z at 95% confidence interval D= Desired level of precision at 95% confidence interval.

Animals in each farm were categorised into sex, three age groups, i.e. calves (<8 months), Weaners/yearlings (8-12 Months) and adult (>24 months), body conditions (poor, Medium and Good), as described by Jodiel (2009). For this study, a dairy farm was defined as any livestock establishment with a minimum of one dairy cattle/animal. Cattle management system in the area was a small-scale dairy system, mainly zero grazing; which is a cut and carries system.

Sample collection and processing

A total of 384 faecal samples collected directly from the rectum of selected animals using a gloved hand and placed in Air and water proof sample vials. Samples were immediately transported to the Laboratory of Parasitology, Department of Parasitology, Microbiology, Biochemistry and Physiology, Sokoine University of Agriculture. During sampling the data with regard to age, sex, body condition, date of collection, name of the owner date and place of sample collection were recorded for each sampled animal. The samples were examined for the quantitative assessment of worm burden using modified floatation technique (Iqbal *et al.* 2006) and Modified Mc-Master egg counting technique was used to identify the degree of infection based on the previous work by MAFF (1981) and the eggs of different parasite species were identified using keys given by Soulsby (1982). The Level of the worm infection were extrapolated from severity index defined by RVC/FAO (2009), where cattle are said to have low, moderate and severe nematode infections if their faecal egg counts are less than 100 to 250, >250 to 500 and more than 500, respectively.

The positive samples were subjected to coproculture according to the method described by Zajac and Conboy (2006). The third-stage strongyle larvae (L3) were isolated through Baermann test and identified by the descriptions given by MAFF (1986) and Zajac and Conboy (2006); (Khan. 2010).

A well-structured questionnaire was prepared using closed ended questions (dichotomous and multiple choice) which was refined through informal and formal surveys (Thrusfield, 2007). Included in the questionnaire were: (a) farm and owner details; (b) details of animals including age, sex, body condition score (c) source of fodder (d) on farm management and husbandry practices.

Statistical analysis

The data collected from the study area were coded and analyzed by using IBM SPSS version 21.0. The prevalence was calculated by dividing the number of animals' harbourling a given parasite by the total number of animals examined. The percentage to measure the prevalence of nematode and *Eimeria* infection and chi-square (χ^2) to measure the association between prevalence, intensity of infection and age, sex, body condition, deworming history and management practices.

Software by applying Chi square (χ^2) test and subjected to multivariate binary regression model analysis with significant association at $p< 0.05$ (Two sided). The p values for data inclusion and exclusion were at set at 0.05 and 0.1 respectively. The final model was constructed with a significance level of $p< 0.05$.

Results

Prevalence and risk factors of nematode and coccidian infection

Out of 384 cattle tested, 195 (50.8%) cattle were positive to nematode, *Eimeria* and mixed infection. Three GIN, parasite egg type was detected together with *Eimeria* and mixed infection (Table 1).

Table 1. Overall prevalence gastrointestinal nematodes and *Eimeria* in 384 examined dairy cattle

Type of parasite eggs	No. of cattle tested positive	Percentage
Strongyles	107	27.9
Trichuris	22	5.7
Strongyloides	40	10.4
Eimeria	20	5.2
Mixed infection	6	1.6
Total	195	50.8

The prevalence was high in adult cattle 21.1%, followed by calves 15.6% and Weaner/yearlings 14.1%; and was significantly different between sex, age, deworming history, Body condition score and routine of dung removal ($p<0.05$) (Table 2).

Table 2. Risk factors that influenced prevalence of GIN in dairy cattle in the study area

Categorical factor	No. of Animals Examined	No. Positive Animals	Prevalence (%)	χ^2	*p*-value
Sex					
Female	297	131	34.1	23.358	0.0001
Male	87	64	16.7		
Age					
Calves	85	60	15.6	31.187	0.0001
Weaner/Yearling	87	54	14.1		
Adults	212	81	21.1		
Deworming					
Dewormed	204	74	19.3	36.643	0.0001
None dewormed	180	121	31.5		
Body condition score					
Good	124	48	12.5	38.106	0.0001
Medium	192	90	23.4		
Poor	68	57	14.8		
Dung removal routine					
Once daily	113	38	9.9	69.438	0.0001
Twice daily	135	32	8.3		
Twice per week	53	49	12.8		
Weekly	81	67	17.4		

Table 3. Risk factors associated with intensity of Nematode and *Eimeria* infection in dairy cattle from the study area

	Risk factors	No. Animals (N)	Mean EPG/OPG	F	95% CI	*p*-value
	Sex					
EPG	Female	297	108 ± 11.62	5.48	85.04 - 130.78	0.02
	Male	87	164 ± 20.32		123.97 -204.76	
	Age					
EPG	Calves	85	172 ± 22.57	10.53	127.47 -217.24	<0.0001
	Weaners	87	170 ± 25.16		120.09 -220.14	
	Adults	212	80 ± 11.59		56.87 - 102.56	
	Feeding troughs					
EPG	Yes	276	135 ± 12.86	5.36	110.01 -160.64	0.021
	No (ground)	108	83 ± 14.46		54.68 - 111.99	
	Dewormed					
EPG	Yes	204	80 ± 11.17	18.91	58.13 - 102.16	<0.0001
	No	180	167 ± 16.99		133.14 -200.19	
OPG	Yes	204	5 ± 1.90	6.48	1.15 - 8.66	0.011
	No	180	26 ± 8.72		9.17 - 43.60	
	BSC					
EPG	Good	124	66 ±10.36	41.431	45.22 - 86.23	<0.0001
	Medium	192	93 ± 11.91		69.22 - 116.20	
	Poor	68	300 ± 35.15		229.33 -370.17	
	Dung removal					
EPG	Once daily	113	115 ± 15.71	18.224	83.48 - 145.73	<0.0001
	Twice per day	135	40 ± 8.81		22.96 - 57.79	
	Twice per week	81	189 ± 26.62		135.90 -241.88	
	Weekly	55	230 ± 37.37		155.07 -304.93	

However, the prevalence was not associated with floor type (χ^2=3.557, *p=0.169*), drug used for deworming (χ^2=1.547, *p=0.214*), presence or absence of feeding troughs (χ^2=1.209, *p=0.271*), fodder source, (χ^2=0.167, *p=0.169*) and ecological zone (χ^2=0.167, *p=0.683*).

Risk factors associated with intensity of Nematode and Eimeria infection

There was significant difference in faecal egg count (FEC) among the sex, age groups, feeding troughs, deworming history, body condition score and routine of dung removal (*p<0.05*) and oocyst count (OPG) was significantly associated with deworming history, none dewormed cattle had the highest oocyst (26 ± 8.72 OPG) and dewormed cattle had the lowest OPG (5 ± 1.90 OPG) (*p=0.011*) (Table 3).

Coproculture

In coproculture, 215 infective strongyle nematode larvae were examined, the overall proportions of infective larvae from cultures indicated that the common GIN were *Haemonchus* sp. (33.49%), *Trichostrongylus* sp. (20.93%), *Oesophagostomum* sp. (17.21%), *Cooperia* sp. (14.88%) and *Bunostomum* sp. (13.49%).

Discussion

The overall prevalence of gastrointestinal nematodes (GIN) 44% estimated in this study was higher than that of 37% from a previous study by Keyyu *et al.* (2006), under small scale dairy cattle in Iringa. The high prevalence in our study may be attributed to the farmers obtaining grasses from pasture or valleys grazed by traditional cattle during the dry season and irregular deworming routine which varied from once per year, once after two months and once after three months regardless of the season. Smallholder dairy farmers should be educated on the importance of using personal pasture and dry season feed reserves with regular deworming as means of controlling GIN for the zero grazed dairy cattle.

Furthermore, the prevalence of GIN was significantly higher in adults compared to young age groups (χ^2=31.187, p= 0.0001) an observation that is similar to findings reported by Barhanu *et al.* (2011) and Muktar *et al.* (2015), although this finding is not in agreement to what was reported by Chanei *et al.* (2012) and Ramzan *et al.* (2017), whose prevalence's were higher in calves. High prevalence in adults observed in this study may be influenced by the difference in sample size and stress including lactation, pregnancy and nutritional deficiency (Hansen and Perry, 1994; Radostits *et al.*, 2007). The prevalence of GIN was observed to vary from place to place (Kanyari *et al.*, 2010; Degefu *et al.*, 2011; Haftu *et al.*, 2014; Muktar *et al.*, 2015) due to general animal husbandry practices and climatic condition (Smith, 2009).

Body condition score (BCS) was significantly associated with the prevalence of the GIN (χ^2=38.106, *p= 0.0001*), this is in line with the study done by Kagenda *et al.* (2018), however it is not in agreement with the study done by Awraris *et al.* (2012). It is known that, gastrointestinal helminths have been shown to have harmful health effects on domestic animals such as impaired growth and development (Falvey and Bambridge,1975: Vander Waal *et al.*, 2014) with subclinical cases occasionally resulting in depressed feed intake, impaired tissue deposition, and consequently decrease in growth rate (Thumbi *et al.*, 2013). Whereas it is very difficult to single out the effect of helminth infections and nutritional stress on body condition in the traditional pasture based livestock system of the tropics where supplemental feeding is either limited or non-existent (Domy *et al.*, 2011)

The prevalence of *Eimeria* was lower than 30.3% reported by Getahun *et al.* (2017), 43.87% reported by Moussounuan *et al.* (2017) and 25.6% reported by Pinto *et al.* (2021). The wide prevalence variations may be associated with the differences in agro ecology, farm management and animal husbandry, however the lowest prevalence of *Eimeria* observed in this study was probably influenced by the fact that majority of sampled dairy cattle were adults (n=212) compared to yearlings (n=85) and calves (n=85). This is due to the fact that usually, *Eimeria* causes coccidiosis mainly in calves that is manifested with diarrhoea of varying severity from watery faeces to one containing blood, dehydration, weight loss and depression, loss of appetite and occasionally death of the affected animals (Barger, 1999; Kassai, 1999).

The study has indicated high faecal egg count (FEC) in calves (172 ± 22.57) compared to adults (80 ± 11.59), this finding is in consistent with previous works done by Keyyu *et al.*, (2006) and Ramzan *et al.*, (2017). On the contrary, Holland *et al.*, (2000), Keyyu *et al.* (2005), and Jime´nez *et al.* (2007) reported statistically higher faecal egg count in adult dairy animals than yearling in Costa Rica, Tanzania and Vietnam, respectively. The high FEC in calves in this study might be due to limited previous exposure and immaturity of immune system resulting in a large proportion of ingested larvae developing into adults.

All the nematode parasites recovered in faecal culture have been reported previously in Tanzania (Keyyu *et al.*, 2005 and 2006;) and in other tropical countries (Kabaka *et al.*, 2014; Gizawa *et al,* 2018), however in this study revealed *Haemonchus* sp. as a major contributor to the nematode population which is similar to the findings reported by Kabaka *et al.* (2014); Renwal *et al.* (2016) and Yohans *et al.* (2018), although this result is not in agreement with the study done by Keyyu *et al.* (2006) who reported *Cooperia* sp. as a dominant GIN infection in Iringa. The dominance of *Haemonchus* sp in this study is due to the fact that development and survival of pre-parasitic stages of *Haemonchus* sp. require total monthly rainfall more than 50mm and mean monthly maximum temperature 18.3^{0}C (Gordon, 1953) which is close to the meteorological condition of the present study.

The survey of dairy cattle in smallholder farms on basis of faecal examination had provided insight into the current prevalence of GIN and *Eimeria* in the study area, however further research should be done to determine the seasonal temporal distribution of gastrointestinal parasites and intensity of infection for the design of affordable and cost-effective worm control programmes.

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