EISSN: 2707-0425

East African Journal of Science, Technology and Innovation, Vol. 4 (1): December 2022

The occurrence of helminths and coccidia in zebu calves among pastoralists in Isiolo County Kenya

[1]GAKURU M I., [1]GITAU G K., [1]MUTHEE J K., [1]MUASYA D., [2]IKIROR D

[1]Department of Clinical Studies, Faculty of Veterinary Medicine, University of Nairobi P.O. Box 29053, - 00625, Nairobi, Kenya
[2]Veterinaires Sans Frontières Suisse, Muthangari Road, Off Gitanga Road, P.O. Box 25656-00603, Nairobi, Kenya

Corresponding Author: mosesgakuru1@gmail.com

Abstract

In Kenya, helminthosis and coccidiosis in cattle, is reported to be the second highest cause of death in zebu calves up to 12 months old, estimated at 12% mortality rate. The aim of our study was to investigate the prevalence of gastrointestinal helminth and coccidia infections among zebu calves in Isiolo County in Kenya. A cross-sectional study was conducted in between November and December, 2020 in Isiolo North and South Constituencies. Garbatulla and Burat Wards in Isiolo North and Kinna Ward in Isiolo South were purposively selected due to high number of large cattle herds compared to other areas. A total of 411 calves from 34 cattle herds aged between 3 weeks and 12 months were randomly selected for the study. Faecal samples were obtained from the rectum or immediately after defaecation for laboratory analysis, in a veterinary laboratory located in Kinna Ward in Isiolo south Constituency that is virtually meant for research. Faecal egg counts and coccidian oocyst were identified and estimated using the McMaster faecal floatation technique. The prevalence was determined by dividing positive number by the total number tested and the converted to percentage form. The overall prevalence of helminth and coccidia infections was estimated at 66.9% (275/411). Concurrent helminth and coccidia prevalence were slightly low, estimated at 16.5% (68/411). Coccidia infection was the most prevalent type of infection estimated at 45.7% (188/411) while the prevalence of helminths was 38.4% (158/411). Strongyle infection was predominant among other helminths detected with a prevalence of 29.4% (121/411) followed by Strongyloides 6.5% (27/411), Monezia 2.7% (4/411), Toxocara 1% (4/411) and Trichuris 0.2% (1/411). The results of this study indicated that prevalence of helminth and coccidia infections in calves is high dominated by strongyles and coccidia. Robust integrated control program is therefore important to reduce the infections which should include proper clinical and laboratory diagnosis, deworming and treating calves with coccidia oocysts with anti-coccidial drugs.

Keywords: *Coccidia; Calves; Helminths; Pastoralism; Prevalence*

Cite as: *Gakuru et al.,*, 2022. The occurrence of helminths and coccidia in zebu calves among pastoralists in Isiolo County Kenya. *East African Journal of Science, Technology and Innovation 4(1).*

Received: 09/09/22
Accepted: 22/11/22
Published: 16/12/22

Introduction

Approximately 80% of Kenyan land is categorized as arid and semi-arid lands (ASALs). Pastoralism is the main source of income to large number of people inhabiting these areas (Amwata *et al.,* 2016). At least 75% of cattle herds in Kenya are under nomadic pastoralism and these supply the bulk of meat consumed in country (Tarawali, 2017). In African countries, pastoralism contributes 10% to 44 % of the gross domestic product that supports 1.3 billion people. (Karaimu, 2013).

Helminthosi is a gastrointestinal (GIT) infection caused by nematodes and cestodes, which cause sub-optimal production, reproduction, early culling, work capacity, extra cost of treatment, reduced market values of the affected animals and death (Rafiullah *et al.,* 2011; Regassa *et al.,* 2006). Helminthosis is among the most prevalent infections globally in freely grazing animals (Fitzpatrick 2013; Charlier *et al.,* 2017). Gastrointestinal parasitism mainly causes chronic and subclinical infections leading to low growth rate, poor production and infertility (Morgan *et al.,* 2013). In general, GIT infection cause loss in body condition, digestive problems, infertility, emaciation and anaemia (Keyyu *et al.,* 2005). Clinical Signs are experienced within several weeks post-exposure which include; listlessness, lethargy and unthriftiness, rough hair coat, dullness, dejection and development of pot-belly and diarrhoea (Smith and Archibald, 1968).

Bovine coccidiosis is associated with hemorrhagic diarrhoea, dehydration, loss of weight, anorexia, depression and death in severely affected (Squire *et al.,* 2013).

In Kenya, helminthosis in cattle, is the second highest cause of death in zebu calves up to 12 months old, estimated at 12% mortality rate, ranked after East Coast Fever (ECF) with a mortality rate estimated at 50% (Thumbi *et al.,* 2013). Mortality rate in indigenous calves raised in traditional manner is very high and can reach 33%, with ECF accounting for about 21% of the fatalities and this is higher among farmers with poor tick control strategies (Thumbi *et al.,* 2013).

In India, coccidiosis prevalence of 33.2% in dairy calves has been estimated (Das *et al.,* 2015). In Sweden, a prevalence of 32% has been reported in calves, both in dairy and beef calves with *Eimeria bovis* being the most dominant species (Forslid *et al.,* 2015).

In Japan, prevalence of 69.1% of coccidiosis in calves that suffered haemorrhagic diarrhoea, with 83.6% of the cases attributed to *Eimeria zurnii* has been estimated (Kirino *et al.,* 2015). The animals that are under pastoralism system have a higher risk of suffering from helminthosis (Keyyu *et al.,* 2006) due to high level of exposure, and in animals getting fodder from distant lands through cut and carry in stall-feeding system (Kabaka *et al.,* 2012).

In Egypt, coccidiosis prevalence of 24% in calves has been reported, which was highly associated with large herd sizes above 10 animals, poor hygiene, poor body condition, and the infection with coccidian has been highly associated with calves with diarrhoeic faeces with such cases testing positive (Zerihun *et al.,* 2018; Kimeli *et al.,* 2020).

Haemonchus, Cooperia, Oesophagostomum, Trichostrongylus, Nematodirus and Trichuris, are the commonly reported nematodes in Kenya, with higher prevalence during wet season than in dry seasons (Waruiru *et al.,* 2000; Thumbi *et al.,* 2013). Point prevalence of nematode and coccidia in indigenous cattle calves in Magadi south-western Kenya was estimated at 69.2% and 30% respectively (Maichomo *et al.,* 2004). Infection with coccidiosis has also been reported to be a problem in Kenya affecting dairy calves under zero-grazing system with estimated prevalence as high as 71% in wet season in calves between one and a half months and 3 months of age with risk of infection diminishing with age (Waruiru *et al.,*2000). In Kenya, four species of *Eimeria* have being reported with *Eimeria bovis* and *Eimeria zuernii* leading in prevalence with 43% and 29% respectively in calves about 3 months old, while *Eimeria ellipsoidalis* and *Eimeria cylindrical* had less than 10% prevalence (Kimeli *et al.,* 2020). In dairy calves aged between 4 to 6 weeks in Kenya, the estimated prevalence of *Cryptosporidia* was 8.2% to 6.5% respectively (Peter *et al.,* 2015).

Some helminths have been able to tolerate recommended doses of several drugs that initially killed the particular species, transmitting the resistant gene to the future generations (Prichard *et al.,* 1980). Development of resistance depends on genetic diversity of the parasite, selection pressure caused by exposure to a particular drug and time (Prichard, 2001). Farmers over rely on anthelmintic treatment as a way of controlling gastrointestinal helminthes leading to development of resistance.

The gastrointestinal parasitic infection has a high prevalence in Kenya and globally, with freely grazing animals being highly exposed than zero-grazed animals (Kanyari *et al.,* 2010). Studies on helminthosis and coccidiosis and the predisposing factors are mainly focused on dairy cattle with little epidemiological information available in indigenous and traditionally raised cattle. Research on prevalence of gastrointestinal parasitism like helminthosis and coccidiosis in cattle under nomadic pastoralism system is scanty in Kenya, and targeted research in these areas will help add the knowledge on epidemiology of helminths and coccidia infections.

There is an ever increasing human population globally which translates to high demand for proteins, including animal sourced proteins. Control of diseases of animals particularly gastrointestinal parasitic infections help in improving livestock production to meet the demand of animal proteins and to fit the reduced natural resources for production and meet global requirement for greenhouse gas emission (Charlier *et al.,* 2017). Understanding the epidemiology of gastrointestinal parasites help in determination of control measures to be applied (Ento, 2005).

The aim of this study was to estimate the prevalence of the gastrointestinal parasites in calves among the pastoralists of Isiolo County in Kenya.

Materials and methods

Study area

The study was carried out in Isiolo County, which is located 285km North of Nairobi at 0.3524° N, 38.4850° E (Isiolo County Government, 2018). The average altitude is 770 meters above sea level. The County is categorized as semi-arid and arid land receiving rainfall of between 400mm and 650mm annually. The weather is hot and dry and has two rainy season, with long rain experienced from March to May and short rain occurring from October to December. The mean annual temperature is 29^0C (Republic of Kenya, 2017).

Figure 1. Map of Isiolo County Kenya

Study design

A cross-sectional study was carried among pastoralists' households in Isiolo North and Isiolo South Constituency. Garbatulla and Ngaremara Wards from Isiolo North and Kinna Ward from Garbatulla Sub-County in Isiolo South areas were selected purposively due to availability of large number of cattle herds. A total of 34 herds were selected in the entire study; in Isiolo North a total of 16 herds were selected and from Isiolo south, 18 herds were selected. All herds were conveniently selected, considering accessibility of various locations, security and willingness of the pastoralists to participate in the study. Selection of the animal for the study was done by simple random selection. Calves were aged between 3 weeks to 12months. The animals were given a random number, and all the calves bearing even numbers were selected in ascending order until the numbers required in a herd were achieved. Each herd contributed between 3 to 20 calves.

Sample size calculation

The sample size was calculated using 50% as the expected prevalence due to lack of previous studies in the selected study sites and based on confidence interval of 95% and a 5% precision (Thrusfield, 2007),

$$N = \frac{z^2 \times pexp\,(1-pexp)}{d^2} = \frac{1.96^2 \times 0.5(1-0.5)}{0.05^2} = 384$$

A total of 411 calves aged between 3 weeks and 12 months were randomly selected from 34 herds

Where:

N = required sample size

z=is the statistic corresponding to level of confidence

pexp=expected prevalence

d = desired absolute precision

Data collection

Data were obtained from the principal farmer relative/person with full knowledge of the household and animals. The data were collected using semi-structured questionnaires and this included information on demographics, constraints affecting pastoralists, land ownership for grazing, control of gastrointestinal parasites, dewormer used, dosing and frequency of administration.

Faecal sample collection

Fresh faecal samples were obtained from rectum or immediately post defecation using gloved hand and transported to a veterinary laboratory located in Kinna Ward in Isiolo south Sub-County, at 4°C in cool boxes packed with ice and refrigerated prior to processing within 12 hours post collection. While collecting faecal samples, details including owner, date of sampling, sex, age, estimation of individual weight of the selected using a weighing band by measuring the heart girth circumference, calves breed, body condition score on a scale of 1 to 5, calf management, housing, hygienic status in respect to being dryness or wetness of the floor and prophylactic treatment, feeding were recorded.

Laboratory analysis of faecal samples

McMaster technique was used to identify and quantify helminth (nematodes and cestodes) eggs and coccidia oocysts and counted as helminths/coccidian oocysts/eggs per one gram (epg/opg) of the faecal sample (Zajac and Conboy, 2012). The two McMaster slide chambers were filled with a processed faecal sample using sodium chloride solution with 1.2 specific gravity with two grams of the faecal sample mixed with 28mls of sodium chloride solution. The light microscope was used (magnification of x10) and all eggs and oocysts in the marked areas of the chambers were identified and estimated. The epgs were calculated as the number of eggs within the grid of each chamber multiplied by a factor of 50 (Soulsby, 1982). The estimated egg/oocyst counts were thereafter used to determine the prevalence of the parasites of interest.

Data analysis

Data collected were entered and stored in Microsoft Excel spread sheet version 10, (Microsoft office professional plus 2016) and then coded for analysis where applicable. Descriptive

analysis on management and calf factors was done first using proportions and frequencies. The prevalence and or proportions were calculated as the number of infected calves (for either helminths or coccidia) divided by the total number of calves selected and then changed into percentage. Statistical analysis was done using STATA version 13 statistical software.

Results

Household and farm demographics

The household and farm demographic data are summarized in Table 1. The principal farmers were mainly male, comprising of 88% (30/34) and 12% females (4/34). A slight majority of principal farmers (53%) were aged between 25 and 55 years with 47% of the farmers aged above 55 years. The level of education of the principal farmer was as follows: 24% having no formal education, 38% with primary level, while 32% with secondary level and only 6% had tertiary level of education. The size of the families of the respondents were: 38% with between 4-6 family members and 62% having between 7-11 family members.

Mixed livestock rearing was the most common with 72% of the cattle herds mixed with other species such as sheep, goats, camels, donkeys and only 38% of the households reared cattle only. The average number of cattle was 37 in the selected herds. Goats were the most common among animals co-reared with cattle at 62% with a mean of 35 goats. Only 18% of the participants had camels with an average of 3. Sheep were reared by 59% of the selected herds, having an average of number of 22 sheep. All participants relied on community land for grazing with only 21% having private land used mainly as a back-up for grazing during dry seasons and human settlement.

Table 1. Descriptive statistics for demographic variables on 34 herds in Isiolo County between November and December 2020

Categorical variables

Variable	Category	Frequency	Percentage
Gender of principal farmer	Male	30	88
	Female	4	12
Age (years)	25 to 55	18	53
	Above 55	16	47
Level of education	None	8	24
	Primary	13	38
	Secondary	11	32
	Tertiary	2	6
Size of the family	4 to 6	13	38
	7 to 11	21	62
Livestock species reared	Beef cattle only	13	38
	Goats	21	62
	Sheep	19	59
	Camels	6	18
Land for grazing	Private and community	7	21
	Community land only	27	79

Continuous Variables

Variable	Mean	Median	Range

Private land (acres)	3.5	8	2-200
Distance covered during dry Seasons in such of water/pastures (km) 93.3	80	20-500	
Cattle	37	118	10-200
Goats	35	80	20-320
Sheep	22	58	12-175
Camels	3	37	9-60

Distribution of calf management factors

The calf management factors are summarized in Table 2. All calves were kept in temporary circular enclosures made of thorny tree branches, with majority (64.7%), being located under a tree shade, while 35.3% were left in open field. The floor was natural dirt ground with no modification or beddings provided. In these calf enclosures, 52.9% of the dirt floors were wet at the time of the study while 47.1% were dry. Only 14.7% of the participants reported having extension services available to them and most farmers, 52.9% solely treated their animals without consulting animal health service providers. Most farmers, 94.2% reported to strategically deworming their animals during the rainy season and only 5.8% of the participants reporting to regularly deworming their animals at an interval of 3 months. Control of ticks was reported to be by the use of acaricides which were administered through hand spraying with 55.8% of the farmers doing control at weekly interval while 44.2% did it beyond one-week interval. Unspecified vaccines in cattle were administered in 64.7% of the herds mainly funded by the government and non-governments organizations and was reported to be carried out during research projects as incentives. Some of the constraints that were reported to negatively impact nomadic pastoralism were drought, animal diseases, cattle rustling, tribal conflicts and community grazing land grabbing in the descending order.

Table 2. Descriptive statistics on farm management in the 34 herds in Isiolo County, between November and December 2020

Factors	**Categories**	**Number of farms**	**Percentage**
Calf accommodation	Under tree shade	22	64.7
	Open field	12	35.3
Floor condition	Dry floor	18	52.9
	Wet	16	47.1
Grazing land	Private and community	7	20.5
	Community land only	27	79.5
Livestock species	Cattle only	13	38.2
	Mixed species	21	61.8
Extension services	Available	5	14.7
	Unavailable	29	84.3
Provider of	Animal health assistant	5	14.7

Veterinary Services	Owner/herdsman	18	52.9
	Animal health assistant/owner	11	32.3
Deworming strategy	Regular, 3month interval	2	5.8
	Strategic, during wet season	32	94.2
Use of acaricides	Weekly	19	55.8
	Beyond 1 week	15	44.2
Vaccinations	Available	22	64.7
	Unavailable	12	35.3
Major constraints	Drought	34	100
	Diseases	31	91.2
	Cattle rustling	24	70.6
	Tribal conflicts	5	14.7
	Land grabbing	1	2.9

Description of individual animal characteristics

All the calves selected in this study were indigenous breeds. Calves aged between 3 weeks' ad 12 months were included in this study, with 54% and 46% represented male and female calves included in this study respectively. Description of individual animal characteristics, are summarized in Table 3**.** Majority, 86.8%, (357/411) were of Boran breed, 5.8% Sahiwal and 7.2% were Boran and Sahiwal crosses. The average age was 5.5 months while the range was 3 weeks and 12 months, with majority (48%) aged between 3 weeks and less than 4 months, 26% aged >4 and 9 months and 25.5% were between 9 to 12 months old. The number of male calves was higher at 54% compared to female calves at 46%. The average body condition score was 2.7 and most calves, 55% were in poor body condition between 2 and 2.5 while 45% were in between 3 and 3.5, on a scale of 1 to 5 which was estimated by measuring the circumference of heart girth using a weighing band for bovine and porcine that gave the estimated weight corresponding to the circumference measurement (Sherwin *et al.,* 2021). The average estimated weight was 84kg, with the lightest calf weighing about 36kg while the heaviest weighing about 166kg.

Table 3. Descriptive statistics for 411 beef calf samples from 34 herds in Isiolo County, between November and December 2020

Categorical variables

Variable	**Levels**	**Total**	**Percentage**
Breed	Boran	357	86.8
	Sahiwal	24	5.8
	Boran and Sahiwal cross	30	7.2
Age-class	Immature (<4 months)	199	48.4
	Young (4 to<9 months)	107	26
	Young Adults (9 to 12 months)	105	25.5
Sex	Male	222	54
	Female	189	46

Body condition	2 to 2.5		227	55.2
	3 to 3.5		184	44.8
Continuous variables				
Variable	**Mean**	**Median**	**Range**	**SD**
Age (months)	5.5	4	0.75-12	3.7
Body condition	2.7	2.5	2-3.5	0.4
Weight (kg)	84	83	36-166	28.9
Height (cm)	79	78	47-155	11.4

General morbidity, mortality and case fatality rates of 1074 calves

The results of morbidity, mortality and case fatality rates were obtained through semi-structured questionnaires and clinical examination and are summarized in Table 4. Foot and Mouth Disease (FMD) had the highest reported morbidity rate estimated at 30.1% (323/1074) followed by diarrhoea, 24.3% (261/1074), East Coast fever, 7.9% (85/1074), trypanosomiasis, 1.4% (15/1074), lumpy skin disease, 1.3% (14/1074), anaplasmosis 1.1% (12/1074). Pneumonia, papillomatosis, emphemeral fever, wounds, eye infections, actinomycosis, bloat, and black quarter had a prevalence estimated below 1% each.

The overall mortality rate was estimated at 12.9% (139/1074), with the highest, 37.4% (52/139) reported to be associated with diarrhoea, followed by ECF at 32.4% (45/139), Foot and Mouth Disease at 15.8% (22/139), trypanosomiasis, 2.9% (4/139) and pneumonia, 1.4% (2/139).

The case fatality rate was highest in ECF which was estimated at 52.9% (45/85), followed by anaplasmosis 41.7% (5/12), pneumonia 26.7% (4/15), trypanosomiasis 22.2% (2/9), diarrhoea, 19.9% (52/261) and FMD 6.8% (22/323). There was one for bloating and another one for black quarter leading to death of both calves.

Table 4. Morbidity, mortality and case fatality rates in 1,074 calves from 34 herds in Isiolo County, between November and December 2020

Disease/Condition	Morbidity rate (%)	Mortality rate (%)	Case fatality rate (%)
Foot and mouth disease	30.1 (323/1074)	2 (22/1074)	6.8 (22/323)
Diarrhoea	24.3 (261/1074)	4.8 (52/1074)	19.9 (52/261)
East Coast fever	7.9 (85/1074)	4.2 (45/1074)	52.9 (45/85)
Trypanosomiasis	1.4 (15/1074)	0.3 (4/1074)	26.7 (4/15)
Lumpy skin disease	1.3 (14/1074)	0.2 (2/1074)	14.3 (2/14)
Anaplasmosis	1.1 (12/1074)	0.5 (5/1074)	41.5 (5/12)
Pneumonia	0.8 (12/1074)	0.2 (2/1074)	16.6 (2/12)
Eye infections	0.5 (5/1074)	-	-
Skin wounds	0.5 (5/1074)	-	-
Actinomycosis	0.09 (1/1074)	-	-
Black-quarter	0.09 (1/1074)	0.09 (1/1074)	100 (1/1)
Papillomatosis	0.8 (9/1074)	-	-

Prevalence of helminth eggs and coccidian oocysts

The laboratory results from the GIT egg and oocyst counts, and the prevalence and the level of infection by various parasites is summarized in Table 5. The helminths epg counts were mainly strongyle.

The overall prevalence of gastrointestinal parasitic infection was 66.5%, with coccidia being highest at 45.7% and helminths estimated at 38.4%. Prevalence of strongyles was 29.4% and highest among helminthes, followed by *Strongyloides* with a prevalence of 6.5%, *Monezia*, *Toxocara*, and *Trichuris*, recorded a prevalence of less than 5% each. Prevalence of coccidia and helminth coinfection was 16.5%.

Table 5 .Prevalence of helminth eggs and coccidian oocysts from 34 herds in Isiolo County, between November and December 2020

Variable	Total	Prevalence (%)
Coccidia	188	45.7
Helminths	158	38.4
Nematodes	153	37.2
Strongyles	121	29.4
Strongyloides	27	6.5
Monezia	11	2.7
Toxocara	4	1
Trichuris	1	0.2
Helminths and coccidia concurrently	68	16.5
Helminths or coccidia	275	66.9

Discussion

The study showed that the majority of herds were headed by males and most of the principal farmers had low level of formal education. Community land was relied on for grazing and cattle were the most popular livestock reared in the herds selected. All the calves selected in this study were indigenous breeds, dominated by Borana breeds, a few Sahiwal and their crosses. Pastoralists mainly keep indigenous livestock probably due to their adaptation to harsh environmental condition and diseases compared to exotic breeds like Friesian and Ayrshire breeds (Kagira and Kanyari 2010). Management practices of the calves and selected herds revealed that calves were kept on earthen floor, confined in circular portions using thorny branches with about a half of the herds raised in wet floors and in crowded conditions. Most farmers practiced mixed livestock rearing which involved cattle, goats, sheep and camels, with similar observation made in Kenya, making mixed livestock rearing a common practice among pastoralists (Ilatsia, 2012). Veterinary and extension services were unavailable to majority of the farms, leading to farmers and herdsmen treating sick animals. The poor delivery of veterinary and extension services among pastoralists is complicated by constant migration by the herders looking for water and pastures and security (Bett *et al.,* 2009). To control helminthosis, almost all farmers used dewormer during the wet seasons with a few following regular deworming protocol. Tick control was directed mainly at reducing the prevalence of East Coast fever which was done by hand-spraying the animals using acaricides. More than a half of the selected herds, the owners and their representatives reported that their animals were being irregularly vaccinated against diseases by the County government and researchers as a part of incentive for their cooperation to participate. The main challenges that were reported by the pastoralist included; drought, diseases, cattle rustling, tribal conflicts and land grabbing. In another study in Kenya, climate change was also indicated as the main challenge by the Pastoralists leading to shortage of water and pastures (Bobadoye *et al.,* 2016).

The crude mortality rate in calves was 12.4% which was mainly associated with diarrhoea, East Coast fever and Foot and Mouth diseases, which was in concurrence with other studies carried out in Kenya (Gitau *et al.,* 1999)

The overall prevalence of helminth and coccidia infection was 66.9% which was lower than a similar study conducted in Ghana, which was estimated at 95.5%. The higher prevalence in Ghana could have been attributed to age of the animals sampled with 78.3% of these cattle being adults. In addition, sedimentation technique test that was included to detect *Fasciola spp* and *Paraphistomes* spp eggs in this study (Squire *et al.,* 2013) was not part of our study. The prevalence of nematodes estimated in this study, at 37.2% was lower than other studies carried out in Kenya and worldwide. A cross-sectional study involving 109 zebu calves conducted in Kenya, estimated a higher prevalence of nematodes than our study at 69.2%, a lower prevalence of coccidia than our study estimated at 30% and a higher prevalence of *Strongyloides* estimated at 27.4% (Maichomo *et al.,* 2004). The difference in these two studies, could probably be explained by difference in material and methods used, and weather conditions and time difference. The study by Maichomo *et al.,* (2004) involved a smaller sample size of 109 calves and data collection was conducted from January to June in a very dry ecosystem.

The results from this study agreed with a study carried out in diarrhoeic calves in Iraq with prevalence of coccidia estimated at 46.7%, with calves aged between 3 to 6 months old showing the highest risk (Malek and Kuraa, 2018). The recorded prevalence of coccidia in exotic calves in Kenya was lower than the prevalence estimated in the current study (Peter *et al.,* 2015; Waruiru *et al.,* 2000), which could be attributed to high level of exposure in indigenous cattle raised traditionally (Kanyari *et al.,* 2013; Thumbi *et al.,* 2013). The estimated prevalence of *Monezia* was similar to a study conducted in Ghana (Squire *et al.,* 2013). In our study, the prevalence of strongyles (29.4%) was below several studies in Kenya and worldwide, 51% (Kanyari *et al.,* 2010), in Ethiopia, 37.9% (Kemal *et al.,* 2013), in Nigeria 85% (Sanda *et al.,* 2019). The variance was probably attributed to difference in age of the animals in the mentioned studies involving yearlings and adult cattle that are more predisposed due to full reliance on grazing/fodder (Waruiru *et al.,* 2000; Kimeli *et al.,* 2020).

Conclusion

The prevalence of helminths mainly strongyles and coccidia was significantly high in our study. Occasional random sampling of faecal samples to screen for coccidiosis and other gastrointestinal parasites is therefore recommended for informed treatment and control measures. Robust deworming strategy and treatment for coccidiosis in the affected calves is recommended and organized extension services are important with emphasis to helminths and coccidia infections.

Acknowledgement

We would like to thank Biovision Foundation for Ecological Development for providing the funding that supported this study under the Project "Upscaling of integrated camel management for livelihoods and collaborative disease surveillance for animal health (in the climate-change affected ASAL region of Kenya)-UPICAM II", Project No.: BV DPA_002. We also want to thank the staff of the Isiolo County Government, VSF-Suisse and the University of Nairobi who supported and participated in this project. We also thank the camel owners and herders as well as the local administration who participated and provided the data.

References

Amwata, D. A., Nyariki, D. M., & Musimba, N. R. K. (2016). Climate factors as determinants of food security in semi-arid Kenya: a longitudinal analysis (No. 310-2016-5371).

Bett, B., Jost, C., Allport, R., & Mariner, J. (2009). Using participatory epidemiological techniques to estimate the relative

incidence and impact on livelihoods of livestock diseases amongst nomadic pastoralists in Turkana South District, Kenya. Preventive veterinary medicine, 90(3-4), 194-203.

Bobadoye, A. O., Ogara, W. O., Ouma, G. O., & Onono, J. O. (2016). Assessing climate change adaptation strategies among rural Maasai pastoralist in Kenya.

Charlier, J., Thamsborg, S. M., Bartley, D. J., Skuce, P. J., Kenyon, F., Geurden, T., ... & Claerebout, E. (2018). Mind the gaps in research on the control of gastrointestinal nematodes of farmed ruminants and pigs. Transboundary and Emerging Diseases, 65, 217-234.

Das, M., Deka, D. K., Sarmah, P. C., Islam, S., & Sarma, S. (2015). Diversity of Eimeria spp. in dairy cattle of Guwahati, Assam, India. Veterinary world, *8*(8), 941.

Forslid, A., Christensson, D., Dahl, J., Grandi, G., & Enemark, J. M. (2015). Bovine eimeriosis in Swedish calves: Epidemiology and insights into sampling procedures. Veterinary Parasitology: Regional Studies and Reports, 1: 16-20.

Fitzpatrick, J. L. (2013). Global food security: the impact of veterinary parasites and parasitologists. Veterinary parasitology, *195*(3-4), 233-248.

Gitau, G. K., Perry, B. D., & McDermott, J. J. (1999). The incidence, calf morbidity and mortality due to *Theileria parva* infections in smallholder dairy farms in Murang'a District, Kenya. Preventive Veterinary Medicine, *39*, 65-79.

Ilatsia, E. D., Roessler, R., Kahi, A. K., Piepho, H. P., & Zárate, V. (2012). Production objectives and breeding goals of Sahiwal cattle keepers in Kenya and implications for a breeding programme. Tropical animal health and production, 44(3), 519-530.

Tarawali, S. A. (2017). Better lives through livestock: ILRI overview.

Karaimu, P. (2013). Making visible the 'invisible benefits' of African pastoralism will spur national and pastoral economies both. https://clippings.ilri.org/2013/06/24/making-visible-the-invisible—benefits-of-african-downloaded. 10 Nov 2018.

Kabaka, W. M., Gitau, G. K., Kitala, P. M., Maingi, N., & Vanleeuwen, J. A. (2012). Risk factors associated with gastrointestinal nematode infections of cattle in Nakuru and Mukurweini Districts of Kenya. Bulletin of Animal Health and Production in Africa, *60*(4), 410-416.

Kanyari, P.W.N., Kagira, J.M., Mhoma, J.R.L., (2010). Prevalence of endoparasites in cattle within urban and peri-urban areas of Lake Victoria basin, Kenya, with special reference to zoonotic potential. Sci. Parasitol. 11: 171–178.

Keyyu, J. D., Kassuku, A. A., Msalilwa, L. P., Monrad, J., & Kyvsgaard, N. C. (2006). Cross-sectional prevalence of helminth infections in cattle on traditional, small-scale and large-scale dairy farms in Iringa district, Tanzania. Veterinary research communications, 30(1), 45-55.

Jelalu, K., & Yitagele, T. (2013). Prevalence of gastrointestinal parasitism of cattle in Gedebano Gutazer Wolene district, Ethiopia. Journal of Veterinary Medicine and Animal Health, *5*(12), 365-370.

Kirino, Y., Tanida, M., Hasunuma, H., Kato, T., Irie, T., Horii, Y., & Nonaka, N. (2015). Increase of Clostridium perfringens in association with Eimeria in haemorrhagic enteritis in Japanese beef cattle. Veterinary Record, *177*(8), 202-202.

Kimeli, P., VanLeeuwen, J., Gitau, G. K., Heider, L. C., McKenna, S. L., & Greenwood, S. J. (2020). Management factors associated with time-to-onset and fecal egg/oocyst counts of gastrointestinal parasites in heifer calves on Kenyan smallholder farms. Veterinary Parasitology, 283, 109-174.

Maichomo, M. W., Kagira, J. M., & Walker, T. (2004). The point prevalence of gastro-intestinal parasites in calves, sheep and goats in Magadi division, south-western Kenya. Onderstepoort Journal of Veterinary Research, 71(4), 257-261.

Malek, S. S., & Kuraa, H. M. (2018). Detection and identification of Eimeria species in naturally infected calves at Assiut

Governorate. Zagazig Veterinary Journal, 46(1), 60-69.

Morgan, E. R., Charlier, J., Hendrickx, G., Biggeri, A., Catalan, D., von Samson-Himmelstjerna, G., ... & Vercruysse, J. (2013). Global change and helminth infections in grazing ruminants in Europe: impacts, trends and sustainable solutions. Agriculture, 3(3), 484-502.

Rafiullah, T. A., Sajid, A., Shah, S. R., Ahmad, S., & Shahid, M. (2011). Prevalence of gastrointestinal tract parasites in cattle of Khyber Pakhtunkhwa. J. Agri. Biol. Sci, 9, 6.

Regassa, F., Sori, T., Dhuguma, R., & Kiros, Y. (2006). Epidemiology of gastrointestinal parasites of ruminants in Western Oromia, Ethiopia. International journal of applied Research in Veterinary Medicine, 4(1), 51.

Republic of Kenya. 2017. Isiolo County integrated development plan. 2018-2022.

Sanda, M. E., Uwalaka, E. C., Idika, I. K., & Agbaji, L. E. (2019). Prevalence of helminths in cattle in Anyigba, Kogi state, Nigeria. Journal of Entomology and Zoology Studies, 7(5), 171-174.

Sherwin V, Hyde R, Green M, Remnant J, Payne E, & Down P (2021). Accuracy of heart girth tapes in the estimation of weights of pre-weaned calves. Vet Rec Open. 7;8(1)

Smith, H. J., & Archibald, R. M. (1968). Experimental helminthiasis in parasite-free calves on marshland pastures. The Canadian Veterinary Journal, *9*, 46.

Soulsby, E.J.L. (1982). Helminths, Arthropods and Protozoa of Domesticated Animals. 7th ed. Bailliere Tindall, London. 787-792.

Squire, S. A., Amafu-Dey, H., & Beyuo, J. (2013). Epidemiology of gastrointestinal parasites of cattle from selected locations in Southern Ghana. Livestock Research for Rural Development, 25(7), 1-13.

Thrusfield, M. (2007). Veterinary Epidemiology, 3rd ed., London: Blackwell Science, pp. 222-234.

Thumbi, S. M., Bronsvoort, M. B., Kiara, H., Toye, P. G., Poole, J., Ndila, M., ... & Woolhouse, M. E. (2013). Mortality in East African shorthorn zebu cattle under one year: predictors of infectious-disease mortality. BMC veterinary research, 9(1), 1-14.

Thumbi, S. M., Bronsvoort, B. D. C., Poole, E. J., Kiara, H., Toye, P., Ndila, M., ... & Woolhouse, M. E. (2013). Parasite co-infections show synergistic and antagonistic interactions on growth performance of East African zebu cattle under one year. *Parasitology*, *140*(14), 1789-1798.

Waruiru, R. M., Kyvsgaard, N. C., Thamsborg, S. M., Nansen, P., Bøgh, H. O., Munyua, W. K., & Gathuma, J. M. (2000). The prevalence and intensity of helminth and coccidial infections in dairy cattle in central Kenya. Veterinary Research Communications, 24(1), 39-53.

Zajac, A. M., & Conboy, G. A. (2012). Veterinary Clinical Parasitology 8th edition, American Association of veterinary parasitologists.

Zerihun, A. R., Belay, M., & Temesgen, K. G. (2018). Study on calf coccidiosis in dairy farms in and around Holeta Town, Finfine Zuria Liyu Zone, Oromia, Ethiopia. Journal of Veterinary Medicine and Animal Health, 10(6), 153-158.