Prevalence and Risk Factors for *Eimeria* spp. Infections in Small Scale Dairy Farms in Hawassa and Arsi Negele Towns, Southern Ethiopia

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Abstract

The prevalence and intensity of *Eimeria* spp. infection was investigated and the potential risk factors identified in small scale dairy farms located at Hawassa and Arsi Negele towns. Faecal samples from a total of 768 cattle were examined by McMaster technique. *Eimeria* oocysts were detected in 38.2% of the animals and no significant difference was observed between the two towns ($P > 0.05$). The faecal oocyst counts were highly variable ranging from 50–100,000 oocysts per gram of faeces (OPG) with overall mean OPG of 1891. Unweaned calves had a significantly higher ($P < 0.05$) prevalence and relatively higher mean OPG than either weaned calves or yearlings. Majority (90%) of the study animals were sub clinically infected showing oocyst counts of <5000 OPG. The prevalence of *Eimeria* oocysts was associated with the water source for the animals, housing system and hygienic condition of the farms ($P < 0.05$). Those animals of <6 months, drinking water from river, housed in group pens and kept in poor hygienic conditions were at higher risk of contracting *Eimeria* spp. infection compared to their counterparts. *Eimeria* infection was independent of breed and sex of the animals ($P > 0.05$). The study revealed that age of the animal, river water, group housing and poor hygiene were the major risk factors for the occurrence of *Eimeria* infections in cattle in the study area. Furthermore, the prevalence of *Eimeria* spp. infection and mean OPG was considerably higher in diarrheic than non-diarrheic animals. Thus, all diarrhoeic cases should be treated with effective anticoccidial drugs. Regular use of suitable coccidiostats and improvement of management practices that contribute to infection are also recommended. Since all *Eimeria* spp. are not pathogenic, further study is needed to identify the major species of *Eimeria* circulating in the dairy cattle.

Key words: Cattle, Coccidiosis, Faecal oocyst
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INTRODUCTION

Eimeria infections are one of the most common and important disease of cattle worldwide. There are more than 20 species of *Eimeria* that infect cattle, but most cases of clinical diseases are caused by *E. bovis* and *E. zurnii*. All bovine *Eimeria* have a faecal-oral transmission cycle, with cattle as the sole host (Daugschies and Najdrowski, 2005; Radostits et al., 2007). The prevalence of *Eimeria* infection in cattle is generally high and can reach 100% in calves (Fox, 1985; Cornelissen et al., 1995). All age groups of cattle are susceptible to infection, but clinical disease is most common in calves 3 weeks to 6 months of age (Taylor and Catchpole, 1994; McAllister, 2007), indicating that immunity may play a role in the protection of older animals. High prevalence rates have also been documented in yearlings (Cornelissen et al., 1995).

The disease caused by *Eimeria* spp. is commonly known as coccidiosis. The disease occurs either in clinical or subclinical form. Almost all cattle shed *Eimeria* oocysts at one time or another; however, most remain subclinically infected without showing the clinical signs of the disease. The economic losses associated with subclinical coccidiosis even exceed those resulting from clinical coccidiosis (Fitzgerald, 1980) because the former occurs much more frequently and results in reduced feed consumption, feed conversion and growth performance (Fox, 1985; Cornelissen et al., 1995; Matjila and Penzhorn, 2002). The development of clinical coccidiosis in cattle mainly depends on factors like the species of *Eimeria* involved, age of infected animal, number of oocysts ingested and immunity due to a previous infection (Thomas, 1994; Cornelissen et al., 1995; Daugschies and Najdrowski, 2005). Economic losses from coccidiosis due to mortality, poor performance, cost of treatment and prevention may be considerable, especially in stud farms and calf rearing systems (Fitzgerald, 1980; Thomas, 1994). Coccidiosis costs cattle ranchers more than $ 400 million annually in lost profit due to reduced feed efficiency, slower weight gain and increased susceptibility to other diseases. This can set back calves' growth by as much as 2 months (Thomas, 1994). Animals that have survived severe coccidiosis show retarded growth and it has been suspected that they never become profitable (Fox, 1985).

In spite of the great economic significance of *Eimeria* infection on cattle production and the worldwide distribution, there is scarcity of information in Ethiopia and there are only few published studies on this subject. According to the available studies, the prevalence of *Eimeria* infection in different age groups of cattle falls within the range of 22.7 and 68.1% (Abebe et al., 2008; Dawid et al., 2012; Alemayehu et al., 2013; Yadessa et al., 2014; Tsegaye, 2016). Abebe et al. (2008) reported that there are 12 species of *Eimeria* infecting dairy calves in Ethiopia of which *E. bovis* and *E. zurnii* were the most prevalent. Nonetheless, the available reports on the subject do not depict a complete picture of the disease in Ethiopia and thus further studies are needed to fill the dearth of information. This study investigated the prevalence and intensity of *Eimeria* infections and the potential risk factors in selected small scale dairy farms in Southern part of the country.

MATERIALS AND METHODS

Study area

This study was carried out between November 2010 and April 2011 in two selected towns located in southern Ethiopia: namely Hawassa and Arsi Negele. Hawassa is the capital town of Southern Nations, Nationalities and Peoples Regional State and among the fast growing towns in the country. The town is located 275 km south of Addis Ababa with area coverage of 162,804 hectares. It is situated at an altitude of 1750 m.a.s.l between 4°27´ and 8°30´ N latitude and 34°21´ and 39°1´ E longitude. The mean annual rainfall and temperature is about 800mm and 20 °C, respectively (SZPEDD, 2001). Arsi Negele is a town located at 210 km south of Addis Ababa on the road taking to Hawassa and it is found in the west Arsi Zone of the Oromia Regional State. It is situated at an altitude of 2043 m.a.s.l between 38°42′N latitude and 7°21′E longitude.

Study population, design and sampling method

The study population constituted those cattle owned by small scale dairy farms found at Hawassa and Arsi Negele towns. Based on the agricultural sample enumeration report of 2001-2002, there are about 6189 and 8376 cattle in Hawassa and Arsi Negele towns, respectively (CSA, 2008). All the farms included in the study had 10 or less cows. The study animals were both local and cross breeds (Local x Holstein Friesian). Cattle of all age groups and both sexes were included in the study.

A cross-sectional study design was used to achieve the objective of the study. The sample size required for the study was determined by using the simple random sampling technique (Thrusfield, 2005) with 5% absolute precision and 95% level of confidence. Due to lack of similar previous study in the study areas, 50% expected prevalence was considered during sample size calculation. Accordingly, a total of 768 cattle (384 from each town) were selected randomly from the study population and examined for *Eimeria* oocysts.

Sample collection and laboratory investigation

About 30 g of fresh faecal sample was collected per rectum from each animal using sterile disposable plastic glove. The sample was placed in a labelled clean plastic container and transported in a cool box to the parasitology laboratory of the School of Veterinary Medicine on the same day of collection, and preserved at refrigeration temperature until processing within 48 hours of arrival. At the time of sampling, the name of the farm, date of sampling, consistency of the faeces (soft, diarrhoea or normal), housing condition, hygiene of the farms and the age, sex, breed, and tag number of the animals were recorded.

In the laboratory, the faecal samples were analysed by McMaster technique to detect *Eimeria* oocysts and determine the number of oocysts per gram of faeces (OPG) (Kaufmann, 1996). Based on faecal oocyst counts, the animals were classified as sub clinically infected (<5000 OPG) or clinically affected (>5000 OPG) (Rebhun, 1995; McAllister, 2007).

Statistical analysis

Data collected from the study animals were analysed with STATA 11 (Stata Corp. College Station, Texas, USA). The prevalence was calculated for all data as the number of infected individuals divided by the number of animals sampled × 100. The association between the prevalence of *Eimeria* infection and the hypothesized risk factors (study area, age, breed, sex, water source, housing and hygiene) was analysed by Chi-square (χ^2) test for independence. Faecal oocyst counts in different age groups and faecal consistencies were summarized by using descriptive statistics like range, frequency, proportion and mean.

RESULTS

From the total of 768 cattle screened, 293 animals (38.2%) were positive for *Eimeria* oocysts. No significant difference (P > 0.05) was observed in prevalence of *Eimeria* infection between the two study areas (Table 1).

The faecal oocyst counts were highly variable ranging from 50 – 100,000 OPG. The overall mean OPG was 1891. The maximum OPG belonged to two diarrheic female calves of two and three months old. Nearly 90% animals had OPG values of < 5000 and consequently considered as sub clinically infected, while only 10% of the animals were excreting >5000 OPG and thus, had clinical infection (Table 2).

Table 1. Overall prevalence of *Eimeria* spp. infections in cattle by study area

Study area	Number. examined	Number positive	Prevalence (%)	95% CI	χ^2	p
Arsi-Negele	384	137	35.7	31.0 – 40.7		
Hawassa	384	156	40.6	35.7 – 45.7		
Total	768	293	38.2	34.8 – 41.8	1.99	0.158

Table 2. Classification of *Eimeria* infection status based on OPG counts

Range of OPG	Infection status	Number of animals	Proportion (%)
<5000	Sub clinical	263	89.8
>5000	Clinical	30	11.2

Table 3. Description of the prevalence of *Eimeria* spp. infection and the mean OPG at different age groups of animals

Age of the animals	Number examined	Number. Positive (%)	Mean OPG
Unweaned calves (<6 months)	111	75 (67.6)	18148
Weaned calve (6-12 months)	75	50 (66.7)	1008
Yearlings (>12 months)	582	168 (28.9)	242

Eimeria oocysts were present in all age groups of animals. The first age at which oocysts detected was 15 days. Both prevalence of *Eimeria* infection and mean OPG decreased with increasing of age of the animals. Unweaned calves (<6 months) had the highest mean OPG than either weaned calves or yearlings (Table 3).

Eimeria infection was significantly associated with age of the animals, the source of water for the animals, housing condition and hygiene of the farms ($P < 0.05$), while it was found to be independent of breed and sex of the animals ($P > 0.05$) (Table 4).

Clinical examination of the study animals showed that out of the total animals screened 24 were diarrheic, 151 had soft faeces and 593 were non-diarrheic. The prevalence of *Eimeria* oocysts and mean OPG were relatively higher in animals with soft and diarrheic faeces than in non-diarrheic ones. The highest prevalence and oocyst counts were recorded in diarrheic animals (Table 5).

DISCUSSION

The overall prevalence (38.2%) observed in this study has shown that *Eimeria* infection is common in cattle in the study areas. This study was conducted between November and April, a season known to be dry or experiences little rain. The observation of such a level of infection in dry season might be associated with absence of the use of anticoccidial drugs by the dairy farmers and also with existence of conditions (such as poor hygiene) in the farms favourable for the survival and sporulation of oocysts. When compared to the available studies, the current prevalence is higher than the 22.7% report from Dire Dawa (Dawid et al., 2012) and 31.9% from Kombolcha (Alemayehu et al., 2013). However, it is lower than the findings of other studies, viz. 68.1% from Addis Ababa and Debre Zeit (Abebe et al., 2008) and 51.42% from Jimma (Yadessa et al., 2014). Unlike to the current study, the high level of prevalence in Debrezeit and Addis Ababa, and Jima studies could be attributed to the focus of the study only on calves < 1 year of age, which is the age group at most risk. On the other hand, the observed prevalence is comparable to the 38.9% prevalence noted in diarrheic calves in and around Asella (Tsegaye, 2016) and 35% report from Tanzania (Chibunda et al., 1997). In South Africa, the occurrence of *Eimeria* infections was reported to be between 29% and 52% in three localities (Matjila and Penzhorn, 2002). A Kenyan study also reported a higher prevalence of 67.4% (Munyua and Ngotho, 1990).

Table 4. Chi-square analysis of different risk with the prevalence of *Eimeria* spp. infection

Risk factor	No. examined	No. positive	Prevalence (%)	95% CI	χ^2	*P*
Breed						
Cross	658	249	37.8	34.1–41.6		
Local	110	44	40.0	30.9–49.8	0.19	0.666
Age						
Unweaned calves	111	75	67.6	58.0 – 76.0	Ref	
Weaned calves	75	50	66.7	54.8 – 74.9	0.02	0.897
Yearlings	582	168	28.9	25.3 – 32.8	61.29	0.000
Sex						
Male	188	72	38.3	31.4–45.7		
Female	580	221	38.1	34.2–42.2	0.0023	0.962
Water source						
Tap	377	127	37.7	32.8–42.8		
Well	361	153	42.4	37.3–47.7		
River	30	13	43.3	26.0–62.3	6.99	0.030
Housing system						
Individual pen	123	13	10.6	6.0–17.8		
Group	645	290	45.0	41.1–48.9	6.33	0.001
Hygiene						
Good	382	131	34.3	29.6–39.3		
Poor	386	192	49.7	44.6–54.8	18.69	0.0001

Table 5. Description of the prevalence of *Eimeria* spp. Infection and mean OPG in animals with different faecal consistencies

Faecal consistency	Number examined	Prevalence (%)	95% CI	Mean OPG
Normal	593	28.2	24.7 – 32.0	454
Soft	151	69.5	61.4 – 76.6	5,736
Diarrhoea	24	87.5	66.5 – 96.7	36,890

No significant differences were observed in prevalence between Hawassa and Arsi Negele towns showing that the animals were kept under the same management conditions and also the climatic conditions in both areas were not variable enough to induce fluctuations in prevalence of infection.

The first age at which *Eimeria* oocysts detected was 15 days. This concurs with previous reports in the country (Abebe et al., 2008; Yadessa et al., 2014) and also comparable to the 12 days reported in Tanzania (Chibunda et al., 1997). The prevalence of *Eimeria* infection was significantly higher in calves than yearlings. Similarly the oocyst count showed a highly significant decrease with increasing of age. The highest oocyst count was observed in unweaned calves (<6 months) and the lowest in yearlings (>12 months). This decrease in the level and intensity of *Eimeria* infection with increasing age is because animals develop immunity from earlier exposures and without further stressors will maintain this immunity through continuous exposure. It does not however eliminate infection, but decreases the amount of coccidial development in the intestinal tract (Smith and Sherman, 1994). The present finding is in agreement with many other studies (Cornelissen et al., 1995; Chibunda et al., 1997; Waruiru et al., 2000; Faber et al., 2002; Matjila and Penzhorn, 2002; Abebe et al., 2008). Even though prevalence is lower, *Eimeria* infected adult animals may serve as a source of infection for calves (Matjila and Penzhorn, 2002).

The maximum OPG observed in this study is less than half of what has been reported by a previous study (Abebe et al., 2008); however, it is much higher than other reports from Ethiopia and abroad (Munyua and Ngotho, 1990; Arslan and Tuzer, 1998; Lassen et al., 2009; Yadessa et al., 2014). While a count of 5000 OPG is considered high enough by some investigators to warrant the judgment that the animal has the disease (Rebhun, 1995; McAllister, 2007), the majority of animals (90%) in this study were sub clinically infected showing oocyst counts of <5000 OPG. Nevertheless, these subclinical infections could still negatively influence animal productivity and are even more important than clinical coccidiosis because they usually remain unrecognized by cattle producers and damage the absorptive surface of the intestine and weaken the immune system, leading to poorer feed efficiency, slow weight gain, weight loss, longer heifer development periods and increases susceptibility to other disease causing agents (Fitzgerald, 1980; Fox, 1985; Cornelissen et al., 1995; Matjila and Penzhorn, 2002). The present finding is consistent with previous studies (Chibunda et al., 1997; Abebe et al., 2008).

In the current study, the prevalence of *Eimeria* oocysts was significantly higher in animals kept in poor hygienic condition than those in good condition. In poor hygienic farms the animals' manure was not frequently removed which created conducive condition for the sporulation of oocysts. and consequently large numbers of animals were infected. Similarly, the infection was significantly higher in animals housed in groups than those individually penned. In most of the farms animals were kept in overcrowded pens with physical contact with each other. This condition allowed animals to lick each other and favoured transmission of *Eimeria* oocysts.. Moreover overcrowding led to build-up of infective oocysts in the immediate environment of the animals and subsequent massive intake resulting in increased level of infection. These findings are in line with many studies (Step et al., 2002; Daugschies and Najdrowski, 2005; Radostits et al., 2007; Yadessa et al., 2014; Tsegaye, 2016).

Similar to other bovine coccidiosis studies in Ethiopia, the prevalence of *Eimeria* oocysts in the present study was found to be independent of breed and sex of the animal (Dawid et al., 2012; Alemayehu et al., 2013; Tsegaye, 2016). In contrast to the current finding, Yadessa et al. (2014) reported a significantly higher prevalence in cross-bred than local cattle.

The source of water for the animals was significantly associated with the prevalence of *Eimeria* infection. Animals getting water from river had higher prevalence than those getting tap or well water. It is most likely that the river water was contaminated by run-off from pasture grazed by cattle.

In the present study, the prevalence of *Eimeria* infection was significantly higher in diarrheic than in non-diarrheic animals. This suggests that *Eimeria* species may contribute to the diarrhoea, which may also be caused by other microorganisms. This is supported by observation of a considerably higher mean OPG in diarrheic animals than in non-diarrheic ones. Similar findings were reported by other authors (Chibunda et al., 1997; Pérez et al., 1998; von Samson-Himmelstjerna et al., 2006; Abebe et al., 2008, Alemayehu et al., 2013).

CONCLUSION

This is the first study to address the problem of bovine coccidiosis in Southern Ethiopia. It has shown that the age of animals, the source of water for animals, housing and hygienic conditions are the most important risk factors affecting the occurrence of *Eimeria* infections in small scale dairy farms of Southern Ethiopia and therefore, should be considered when planning a control strategy. All diarrhoeic cases should be treated with effective antococcidial drugs. Regular use of suitable coccidiostats and improvement of management practices should be part of the prevention measures. Since all *Eimeria* species are not pathogenic, further studies are required to identify the *Eimeria* spp. circulating in the dairy cattle of the study area.

Acknowledgements
The authors are grateful to the owners of the dairy farms and farm workers for their collaboration during the study period.

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