

# PREVALENCE OF BOVINE GASTRO INTESTINAL PARASITIC INFECTION IN AND AROUND KOMBOLCHA TOWN

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Supporting Information

**ABSTRACT:** A cross-sectional study was conducted in and around Kombolcha from October 2017 to April 2018 to determine the prevalence of gastro-intestinal helminthes parasites in cattle. A total of 384 randomly selected cattle were sampled and examined using standard coprological procedure. The overall prevalence was 39.8% of gastrointestinal (GI) helminthes and the prevalent helminthes eggs identified were 15.6% *Paramphistomum* species (spp), 10.4% strongly type eggs, 8.6% *Fasciola* spp., 3.1% *Trichuris* species and 2.1% *Toxocara* species. This result indicated the highest prevalence of *Paramphistomum* spp. eggs than other helminthes egg and the lowest prevalence of *Toxocara* species egg. There was statistically significant difference among the age groups in paramphistomum and strongly infection ( $\chi^2=24.960$ ,  $p\leq 0.001$ ) and ( $\chi^2=17.047$ ,  $p\leq 0.001$ ) respectively. Higher prevalence rate was shown in 2-5 years age of cattle. Between body conditions there was also significant ( $p\leq 0.000$  and  $p\leq 0.013$ ) difference in paramphistomum and strongly and which was higher in moderate animals and lower in animals with good body condition. Sex had no significant effect on the prevalence of helminthes parasite, except for strongly type of egg. The present study revealed that there is high prevalence of GI helminthes infection in cattle in the study area. Therefore, strategic prevention should be advocated to prevent the problem in and around Kombolcha.

**Keywords:** Cattle, Gastrointestinal, Prevalence, Helminthes parasites, Kombolcha

## INTRODUCTION

Ethiopia is a home for about 54 million cattle, 25.5 million sheep, 24.06 million goats, 7 million equines, 1.25 million camels and 42.1 million poultry. From the total cattle population 98.95% is local breeds with the remaining bear hybrid and exotic breeds (CSA, 2013). In Ethiopia, livestock play an important role in the livelihood of poor farmers as it provides a vast range of services and products such as meat, milk, skin, hair, horns, bones, manure and urine, security, gifts, religious rituals and medicine (Yami and Merkel, 2008). In spite of the large population of cattle, productivity in Ethiopia is low. According to studies in the country, this is due to poor nutrition, reproduction familiarity, management constraints and prevailing animal diseases (Alsan, 2012).

Gastrointestinal helminthes are one of the main problems causing economic losses and diseases in animals. The effect of infection is determined by a combination of factors of which the varying susceptibility of the host species, the pathogenicity of the parasite species, the host/parasites interaction and the infective dose are the most important. The direct losses caused by these parasites are attributed to acute illness and death, premature slaughter and rejection of some parts during meat inspection. Indirect losses include the diminution of productive potential such as reduction of milk production in dairy cow, decreased growth rate, weight loss in young growing calves and late maturity of slaughter stock (Hansen and Perry, 1994).

The most important helminthes parasites in cattle include nematodes (round worms), trematodes (flukes) and cestodes (tape worms). These parasitic infections are problem for both small- and large-scale farmers worldwide, but their impact is greater in sub-Saharan Africa in general and Ethiopia in particular due to the availability of a wide range of agro-ecological factors suitable for diversified hosts and parasite species (Tefaye, 2006). A number of helminthes species are known to infect cattle worldwide. The most important ones include nematodes like *Strongyle* species (*Haemonchus*, *Ostartagia*, *Trichostrongylus*, *Cooperia*) and trematodes of economic importance *Fasciola* species (*Fasciola hepatica* and *Fasciolagigantica*) and *Paraphistomum* species (*Paraphistomum cerveri*), while cestodes like *Monezia* species (*Monezia benedeni* and *Monezia expanza*) could also be important constraints in animal production (Onah and Nawa, 2000).

There are many risk factors influencing the prevalence and severity of gastro intestinal (GI) helminthes. These include age, sex, weather condition and husbandry or management practices of host species (Khan et al., 2009). Young animals are most susceptible. The effect of these parasites is strongly dependent on the number of parasites and the nutritional status of the animals they are infecting. The major clinical signs are weight loss, reduced feed intake, diarrhea,

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and mortality reduced carcass quality and reduced wool production or quality (Radiostits et al., 2000). Young animals do not have a great deal of immunity to parasites during their first year at pasture. The second year, they have partial immunity and, although they may appear healthy, they eliminate many eggs. Adult animals are much less susceptible to most parasites, unless they are in poor living conditions (Hansen and Perry, 1994).

Animals are sometimes kept in conditions that make them highly susceptible to parasites. In the case of recently dewormed animals, internal parasites no longer exist. There is thus no equilibrium and such an animal put into a contaminated pasture may be seriously affected. Animals in poor condition (e.g., recent illness, food shortages) are also highly susceptible (Keyyu et al., 2003).

Previous reports on prevalence of helminthes parasites of cattle in different areas of Ethiopia showed that 71%, 82.8%, 50.2%, 54.4%, 47.1% and 77.6% which is reported by Manaye, 2002 from highlands of Asella and its surrounding, Etsehiwot, 2004 in dairy cows in and around Holeta, (Regassa et al., 2006) in Western region of Oromia, Berhanu, 2008 in West Shoa zone, Ephrem (Ephrem, 2007) in Addis Ababa dairy farms and Cherinet, 2009 in small holder dairy farms of Jimma town, respectively. A study conducted in and around Holeta in Ormama region, Ethiopia, indicated that the overall prevalence parasitic infections of cattle were 82.8%. The predominant helminthes egg identified were trematodes (*Fasciola* and *Paraphistomum species*) (80.6%), *Strongyle* (66.25%), mixed infection (trematodes and *Strongyle*) 63.12%, while others such as *Trichuris* and *Monezia* 1.5% (Etsehiwot, 2004). Therefore, the aim of this study was to determine the current prevalence of Gastro intestinal helminthes parasites of cattle and its associated risk factors.

To identify and determine the major GI helminthes, and its potential risk factors associated with the occurrence of gastro intestinal parasites in affecting cattle's in and around Kombolcha.

## MATERIALS AND METHODS

### Study area

The study was conducted in Kombolcha town. It is situated in North Eastern part of Ethiopia, at 11°4' 37"N and 39°44'42"E at a distance of about 375 km from Addis Ababa, the capital of Ethiopia, at south Wollo administration zone of Amhara national regional state. The area has an altitude range of 1500-1840 meter above sea level with three topographic categories 14% high altitude-Dega, 34% mid highland-weinadega, and 52% of low altitude-kola. The area experiences a bimodal rain fall with a minimum annual rain fall of 750-950 mm and a relative humidity from 25-80%. The average monthly recorded minimum and maximum temperature is 11.7°C and 27°C respectively (CSA, 2008).

### Study animals

The study was performed on cattle which were randomly selected from those that were brought to the three veterinary clinics that are found in and around Kombolcha. A total of 384 heads of cattle were examined during the study period.

### Sample size and sampling methods

Sample was taken from all animals come to three veterinary clinics available in and around Kombolcha town starting from October, 2017 to April 2018 to examine the prevalence of GI parasite infections of bovine in the area. The sample size was determined according to Thrusfield (2005). The other determinants considered in sample size determination were 95% confidence interval and 5% desired absolute precision. Based on the formula a total of 384 cattle were taken as total sample size. Hence the sample size is estimated as:

$$N = \frac{1.96 [P (1-P_{exp})]}{d^2}$$

where;

N = required sample size

P<sub>exp</sub> = Expected prevalence of nematode parasites

d2 = desired absolute precision

1.96 = the value of "z" at 95% level of confidence

d = 5% = 0.05

### Study design

A cross sectional study was carried out from October, 2017 to April 2018 to estimate the prevalence of bovine GI parasite infection and to identify possible risk factors for the occurrence of GI parasite infection in the area.

### Study methodology

Fecal samples were collected directly from rectum of animals using disposable plastic globe. The samples were transferred into a clean fecal sampling bottle carefully and each sample was labeled accordingly and transported to Kombolcha regional veterinary laboratory for parasitological examination. Samples were kept in refrigerator at 4 °C if immediate processing was not possible; however, all samples were processed within 48 hours. During the sample collection different factors like the breeds of animals, age and code given for individual animals as well as sample collection date were recorded for each sampled animals. Also their body conditions were registered. Parasitological

techniques including direct fecal smear, sedimentation and floatation techniques were used to identify the eggs in feces microscopically for presence of parasite ova following their procedures. Identification of the eggs was made on the basis of their morphology. The presence of at least one parasite egg in either of the tests revealed as positive.

### Data analysis

The collected data during the study periods were recorded carefully into MS- Excel spread sheet and descriptive statistics was used to determine the prevalence, while Chi-square analysis was employed to test the presence of variation between ages, sex, breed and body conditions of the animals involved in the study. Confidence level was set at 95% with statistical significance tested at  $p < 0.05$  was set for significance. All statistical analysis was performed using Statistical Package for Social Sciences (SPSS) software package version 20.0.

## RESULTS

A total of 384 cattle were sampled and examined for GI helminthes parasites and 153 (39.8%) were found to infected with one and/or more parasites. The prevalence of different type of parasites in cattle recorded were 60 (15.6%) *Paramphistomum* spp., 40 (10.4%) Strongyle type eggs, 33 (8.6%) *Fasciola* spp., 12 (3.1%) *Trichuris* species and 8 (2.1%) *Toxocara* species. The present study indicated that a higher prevalence of *Paramphistomum* species.

The results showed association between prevalence of GI helminthes parasite and gender of the animal. Out of 130 male animals examined, prevalence of *Paramphistomum*, *Strongyle*, *Trichuris*, *Fasciola*, and *Toxocara* were reported as 25 (6.5%), 9 (2.3%), 7 (1.8%), 3 (0.8%), (0.3%); whereas 254 female animals examined were infected with *Paramphistomum* 35 (9.1%), *Strongyle* 31 (8.1%), *Fasciola* 26 (6.8%), *Trichuris* 9 (2.3%), and *Toxocara* 7 (1.8%) parasite. There was relatively higher occurrence of all GI helminthes in female animals than male animals. But sex had no significant effect on the prevalence of helminthes parasite, except for strongyle type egg.  $P \leq 0.001$ . The prevalence study in the different age groups was also conducted and it was observed to be 9.6%, 20.9% and 9.3% in age categories of less than 2 years, 2 year to 5 year, and greater than 5 years respectively (Table 1). Higher prevalence rate was shown in 2- 5 years age of cattle. There was statistically significant p-value difference among the age groups in paramphistomum and strongyle ( $\chi^2=24.960$ ,  $P \leq 0.001$ ) and ( $\chi^2=17.047$ ,  $P \leq 0.001$ ). Comparison of different breeds of animals showed that there was significance difference only in strongyle type eggs ( $\chi^2=6.163$ ,  $P \leq 0.001$ ) with the prevalence of helminthes parasites (Table 3).

**Table 1 - Prevalence of the helminthes parasite between sexes of animals**

Items	Male	Female	Total	$\chi^2$	p value
<b>Paramphistomum</b>	25 -6.50%	35 -9.10%	60 -15.60%	1.938	0.164
<b>Strongyle</b>	9 -2.30%	31 -8.10%	40 -10.40%	17.047	0
<b>Fasciola</b>	7 -1.80%	26 -6.80%	33 -8.60%	2.577	0.108
<b>Trichurus</b>	3 -0.80%	9 -2.30%	12 -3.10%	0.434	0.51
<b>Toxocara</b>	1 -0.30%	7 -1.80%	8 -2.10%	1.664	0.197
<b>Total</b>	45 -11.70%	108 -28.10%	153 -39.80%	-	-

**Table 2 - Prevalence of helminthes parasite in different age groups**

Items	<2 age	2-5 age	>5 age	Total	$\chi^2$	p value
<b>Paramphistomum</b>	9 -2.30%	43 -11.20%	8 -2.10%	60 -15.60%	24.96	0
<b>Strongyle</b>	15 -3.90%	17 -4.40%	8 -2.10%	40 -10.40%	17.047	0
<b>Fasciola</b>	9 -2.30%	16 -4.20%	8 -2.10%	33 -8.60%	5.138	0.077
<b>Trichurus</b>	3 -0.80%	3 -0.80%	6 -1.50%	12 -3.10%	1.939	0.379
<b>Toxocara</b>	1 -0.30%	1 -0.30%	6 -1.50%	8 -2.10%	4.445	0.108
<b>Total</b>	37 -9.60%	80 -20.90%	36 -9.30%	153 -39.80%	-	-

**Table 3 – Prevalence of different GI helminthes in animals of different body condition**

Items	Poor	Moderate	Good	Total	Total	$\chi^2$
Paramphistomum	20 -5.20%	35 -9.10%	5 -1.30%	60 -15.60%	18.512	0
Strongyle	20 -5.20%	20 -5.20%	0 0.00%	40 -10.40%	6.163	0.013
Fasciola	5 -1.30%	26 -6.80%	2 -0.50%	33 -8.60%	5.867	0.053
Trichurus	1 -0.30%	9 -2.30%	2 -0.50%	12 -3.10%	1	0.607
Toxocara	2 -0.50%	5 -1.30%	1 -0.30%	8 -2.10%	0.697	0.706
Total	48 -12.50%	95 -24.70%	10 -2.60%	153 -39.80%	–	–

**Table 4 - Prevalence of different GI helminthes between cattle breeds**

Items	Male	Female	Total	$\chi^2$	p value
Paramphistomum	51 -13.30%	9 -2.30%	60 -15.60%	2.67	0.102
Strongyle	37 -9.60%	3 -0.80%	40 -10.40%	6.163	0.001
Fasciola	22 -5.70%	11 -2.90%	33 -8.60%	2.091	0.148
Trichurus	7 -1.80%	5 -1.30%	12 -3.10%	2.378	0.123
Toxocara	6 -1.60%	2 -0.50%	8 -2.10%	0.015	0.902
Total	123 -11.70%	30 -28.10%	153 -39.80%	–	–

## DISCUSSION

The overall prevalence of helminthes infection of cattle in the present study was 39.8%. This result is very close to the report on gastrointestinal helminthes prevalence rate of 41.2% (Ephrem, 2007) and 26.3% (Darsema, 2009) in Western Amhara region, Ethiopia respectively. In addition, Keyyu et al. (2006) reported an overall prevalence of 44.4 and 37.0% for large and small scale dairy cattle, respectively in Tanzania. In contrast, the present study was lower as compared to the prevalence of GI helminthes obtained in dairy cows by Cherinet (2009) and Etsehiwot (2004) who indicated 77.6% in small holder dairy farms of Jimma town and 82.8% in dairy cows in and around Holeta respectively. Differences in the prevalence of GI parasite (Table 4) between the different studies could be due to variation in management system, topography, deworming practices, and climatic condition that favor the survival of infective stage of the parasite and intermediate hosts.

According to the current study result which indicated the prevalent helminthes egg were 60 (15.6%) *Paramphistomum* spp., 40 (10.4%) Strongyle type eggs, 33 (8.6%) *Fasciola* spp. 12 (3.1%) *Trichuris* species and 8 (2.1%) *Toxocara* spp. In this result, the *Paramphistomum* species were highly prevalent than other parasite.

The present study showed that, there was higher occurrence of all GI helminthes in female 108 (70.6%) animals than male 45 (29.4%) animals. But sex (Table 1) had no influence on the prevalence of helminthes parasite. Insignificant difference between sexes is similar with previous results reported (Tekla, 2008; Manaye, 2002) except significant difference between sexes on the prevalence of strongyle species which was 31 (12.2%) in females and 9 (6.9%) in males.

A significant variation was observed between different age (Table 2) groups in which young animals were higher number of eggs than adults particularly for paramphistomum and strongyle. This might be due to a limited previous exposure and immaturity of the immune system that resulted in higher development of the parasite. This finding is in harmony with reports of (Manaye, 2002) on bovine GI helminthes in Asella and its surrounding highlands. Watson and Gill (1991) reflected common ground which young animals are believed to be more susceptible to parasitic and non-parasitic infections.

The coprological examination of collected fecal sample revealed there was significant difference among body condition) of paramphistomum and strongyle. Which was higher in lower body condition animal's and lower in good body condition animals. This finding contradicts the findings of Manaye (2002) who reported absence of significant difference on the prevalence of helminthes in animals of different body condition. This might be that the animal in previous study

done by Manaye (2002) could be in the good plane of nutrition that enables them to support parasite infection without showing clinical helminthiasis. But animals in the current study were possibly feed on crop residue like wheat and teff straw that is less nutritious, and infected animals can easily show clinical helminthiasis.

## CONCLUSION AND RECOMMENDATIONS

Based on the current study the most predominant GI helminth parasites identified in this study were *paramphistomum*, *st rongyle*, *Fasciola*, *Trichuris* and *Toxocara*. Geographical location of the study area, body condition, age, sex, and anthelmintic therapy status considered as risk factors for helminthes infection; and had a varying degree of contribution for helminthes infection. The overall prevalence and the prevalence of the different types of parasites of cattle recorded in the current study are high enough to limit and constraint cattle production of the district. Based on the above conclusion, the following recommendations are forwarded:

- Intensive emphasis should be given for prevention of GI helminthes parasites in and around Kombolcha as the prevalence was found high.
- Cattle should be treated with effective broad spectrum anthelmintic as there were many co-infection cases in the study areas.
- Young cattle should receive great attention as they were found significantly susceptible categories to helminthiasis.
- This study did not consider the management and feeding systems, seasonal helminthes dynamics, and identification of parasite to species level. Therefore, future detailed works should be undertaken.

## DECLARATIONS

### Consent to publish

Not applicable.

### Competing interests

The authors declare that they have no competing interests.

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### Authors' contributions

MB conceived the study, coordinated the overall activity, and carried out the statistical analysis, drafted the manuscript and participated in the design of the study, and reviewed the manuscript. All authors read and approved the final manuscript. AY participated in drafting and reviewing the manuscript. MA conceived the study, coordinated the overall activity, and reviewed the manuscript and participated in drafting and reviewing the manuscript.

### Availability of data and materials

Data will be made available up on request of the primary author

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## REFERENCE

- Abebayehu A, Mammo F, & Kibret B (2016). Isolation and characterization of terpene from leaves of *Croton macrostachyus* (Bissana). *Journal of Medicinal Plants Research*, 10(19): 256–260. <http://doi.org/10.5897/JMPR2016.6082>
- Adeyinka A, Owolabi B, and Isiaka A (2013). Effects of seed coat absence on the chemical composition of croton (*Croton penduliflorus*) seed and its oil. *International Journal of Science and Research*, 2(11): 132–136. [Google Scholar](#) | [Direct Link](#)
- Ahmadi R, Mangunwidjaja D, Suparno O, and Pradono I (2017). Extraction process optimization of kamandrah (*Croton tiglium* L.) seed with expression and identification of active ingredient as botanical larvacide of dengue fever preventive. *J. Tek. Ind. Pert. Vol.*, 21(3), 154–162. [Google Scholar](#) | [Direct Link](#)
- Alsan M (2012). The effect of the tsetse fly on African development. National Bureau of Economic Research, 105 Massachusetts, Avenue, Suite 418, Cambridge, MA 02138, USA. [Google Scholar](#) | [Direct Link](#)

- Bassetto C, Da Silva F, Fernandes S and Do Amarante F (2009). Pasture contamination with infective larvae of gastrointestinal nematodes after grazing by sheep resistant or susceptible to parasitic infection. *The Brazilian Journal of Veterinary Parasitology*, 18: 63-8. [Google Scholar](#) | DOI: <https://doi.org/10.4322/rbpv.01804012>
- Berhanu G (2008). A cross sectional study of major gastrointestinal parasites of cattle in Bako District of West Shoa. DVM Thesis, JUCAVM, Jimma, Ethiopia.
- Central Statistical Agency (CSA) of Ethiopia, (2008): [www.csa.gov.et](http://www.csa.gov.et)
- Central Statistical Agency (CSA) of Ethiopia, (2013): [www.csa.gov.et](http://www.csa.gov.et)
- Cherinat A (2009). Prevalence of bovine gastrointestinal helminthes parasites and socio economic survey in small holder dairy farms of Jimmatown. DVM Thesis, JUCAVM, Jimma, Ethiopia.
- Darsema G (2009). Epidemiological study on major gastrointestinal helminthes parasites of calves in three cattle farms in the western part of Amhara Region, Ethiopia. *Ethiopian Veterinary Journal*, 2: 9-18. [Google Scholar](#) | [Direct Link](#)
- Domke V, Chartier C, Gjerde B, Leine N, Vatn S, Osteras O and Stuen S (2011). Worm control practice against gastrointestinal parasites in Norwegian sheep and goat flocks. *Acta Veterinaria Scandinavica*, 53: 29. [Google Scholar](#) | DOI: <https://doi.org/10.1186/1751-0147-53-29>
- Dorchies P, Lacroux C and Navetal H (2006). A retrospective study on the metacercarial production of *Fasciola hepatica* from experimentally infected *Galba truncatula* in central France. *Parasitology Research*, 98: 162-166. [Google Scholar](#) | DOI: <https://doi.org/10.1007/s00436-005-0048-0>
- Ephrem W (2007). Prevalence of Bovine GI helminthes in selected Dairy farms of Addis Ababa, DVM Thesis, JUCAVM, Jimma, Ethiopia.
- Etsehiwot W (2004). Study on bovine gastrointestinal helminthes in dairy cows in and around Holeta, DVM thesis, FVM, AAU, DebreZeit, Ethiopia. [Google Scholar](#)
- Gunn A and Irvine J (2003). Subclinical parasitism and ruminant foraging strategies: A Review. *Wildlife Society Bulletin*, 31(1): 117-126. [Google Scholar](#) | [Direct Link](#)
- Hansen J and Perry B (1994). *The Epidemiology, Diagnosis and Control of Helminthes Parasite Ruminants*, A handbook. 2<sup>nd</sup> ed. ILRAD (International Laboratory for Research on Animal Diseases), Nairobi, Kenya. [Google Scholar](#) | [Direct Link](#)
- Hendrix M (1998). *Diagnostic Veterinary Parasitology*, 2nd edition. U.S.A: Mosby. p. 239-260. [Google Scholar](#) | [Direct Link](#)
- Hoste H and Dorchies H (2000). Bovine Strongylosis: Pathophysiology and immunity. *Journal of French Society of Animal Production*, SFB-Paris, p. 13.
- Houdijk G and Athanasiadou L (2003). Direct and indirect effects of host nutrition on ruminant gastrointestinal nematodes: In matching Herbivore Nutrition to Ecosystem Bio diversity, p. 213-236. [Google Scholar](#)
- Kahn M (2005). *The Merck veterinary manual*. 10th ed. White-house Station, NJ: Merck and Co., Inc., p. 273-1036. [Google Scholar](#)
- Keyyu D, Kassuku A, Kyvsgaard C and Willingham L (2003). Gastrointestinal nematodes in indigenous Zebu cattle under pastoral and nomadic management systems in the lower plain of the southern highlands of Tanzania. *Veterinary Research Communication*, 27: 371-380. [Google Scholar](#) | DOI: <https://doi.org/10.1023/A:1024706120270>
- Keyyu D, Kassuku A, Msalilwa L, Monrad J and Kyvsgaard C (2006). Cross-sectional Prevalence of Helminthes Infections in Cattle on Traditional, small-scale and Large-scale Dairy Farms in Iringa District, Tanzania. *Veterinary Research Communication*, 30: 45-55. [Google Scholar](#) | DOI: <https://doi.org/10.1007/s11259-005-3176-1>
- Khan M, Ijaz A, Shraf K, Ali M and Khan U (2009). Infection Rate and Chemotherapy of Various Helminthes in Diarrheic Sheep in and Around Lahore, Department of Clinical Medicine and Surgery, University of Veterinary and Animal Science, Lahore. *Journal of Animal Plant Science, Pakistan*, 19: 13-16. [Google Scholar](#) | [Direct Link](#)
- Knox R and Steel W (1996). Nutritional enhancement of parasite control in small ruminant production system in developing countries of Southeast Asia and the Pacific. *International Journal for Parasitology*, 26: 963-970. [Google Scholar](#) | DOI: [https://doi.org/10.1016/S0020-7519\(96\)80072-5](https://doi.org/10.1016/S0020-7519(96)80072-5)
- Kohler P (2001). The biochemical basis of anthelmintic action and resistance. *International Journal for Parasitology*, 31: 336-345. [Google Scholar](#) | DOI: [https://doi.org/10.1016/S0020-7519\(01\)00131-X](https://doi.org/10.1016/S0020-7519(01)00131-X)
- Lefevre P, Blancou J, Chermette R and Uilenberg G (2010). *Infectious disease of livestock*. 1st ed. CABI Publishers, Paris: p. 1561-1588. [Google Scholar](#) | [Direct Link](#)
- Manaye M (2002). Study on bovine gastrointestinal helminthes in Asella and its surrounding highland areas in the Oromia regional state. DVM Thesis DebreZeit, Ethiopia.
- Morgan E (2011). Water quality of cattle. *Veterinary Clinic of North America: Food Animal Practice*, 27: 285. [Google Scholar](#) | [Direct Link](#)
- Niezen H, Charleston G, Hodgson J, Mc Kay D and Leathwick M (1996). Controlling internal parasites in grazing ruminants without recourse to anthelmintics approaches, experiences, prospects. *International Journal of Parasitology*, 26: 983-992. [Google Scholar](#) | DOI: [https://doi.org/10.1016/S0020-7519\(96\)80076-2](https://doi.org/10.1016/S0020-7519(96)80076-2)
- Onah N and Nawa Y (2000). Mucosal Immunity against Parasitic Gastrointestinal Nematodes. *Korean Journal of Parasitology*, 38: 209-236. [Google Scholar](#) | PMID: [11138315](https://pubmed.ncbi.nlm.nih.gov/11138315/) | DOI: <https://dx.doi.org/10.3347/kjp.2000.38.4.209>
- Radiostits M, Blood C and Gay C (2000). *A Text book of the disease of cattle, sheep, pigs, goats, and horses*. 9th ed. BaillierTindall, London, p. 563-613. [Google Scholar](#)
- Regassa F, Sori T, Dhuguma R and Kiros Y (2006). Epidemiology of Gastrointestinal Parasites of Ruminants in Western Oromia, Ethiopia. *The International Journal of Applied Research in Veterinary Medicine*, 4: 51-57. [Google Scholar](#)

- Rodriguez-Palacios A, Pickworth C, Loerch S and Lejeune T (2011). Transient Fecal Shedding and Limited Animal-to-Animal Transmission of *Clostridium difficile* by Naturally Infected Finishing Feedlot Cattle. *Applied Environmental Microbiology*, 77: 3391-7. [Google Scholar](#) | DOI: <https://dx.doi.org/10.1128/AEM.02736-10>
- Teka M (2008). A study on prevalence of Gastrointestinal Helminthes in Cattle with Patent Natural Schistosoma Infection in and Around Bahir Dar, DVM thesis, FVM, AAU, DebreZeit Ethiopia.
- Tesfaye H (2006). Ovine and bovine helminthiosis in Kelela, South Wollo: In proceedings of EVA conference, Addis Ababa, Ethiopia, p., 30-34.
- Thrusfield M (2005). *Veterinary epidemiology*. 2<sup>nd</sup> ed. Oxford. Blackwell Science tropics. [Google Scholar](#) | [Direct Link](#)
- Urquhart M, Armour J, Duncan L, Dunn M and Jennings W (1996). *Veterinary Parasitology*, 2<sup>nd</sup> ed. Blackwell Science, United Kingdom.
- Waller J (1999). International approaches to the concept of integrated control of nematode parasites of livestock, *International Journal for Parasitology*, 29, p.155-164. [Google Scholar](#) | DOI: [https://doi.org/10.1016/S0020-7519\(98\)00178-7](https://doi.org/10.1016/S0020-7519(98)00178-7)
- Watson L and Gill S (1991). Effect of Weaning on Antibody Responses and Nematode Parasitism in Merino Lambs. *Research on Veterinary Science*, 51: 128-132. [Google Scholar](#) | DOI: [https://doi.org/10.1016/0034-5288\(91\)90002-6](https://doi.org/10.1016/0034-5288(91)90002-6)
- Yami A and Merkel C (2008). Sheep and Goat Production Hand Book for Ethiopia. Ethiopia Sheep and Goat Productivity Improvement Program (ESGPIP). [Google Scholar](#)
- Zajac M (2006). Gastro-intestinal nematodes of small ruminants: life cycle, anthelmintics, and diagnosis: *Veterinary Clinics, Food Animal Practice*, 22: 529-541. [Google Scholar](#) | DOI: <https://doi.org/10.1016/j.cvfa.2006.07.006>