SYSTEMATIC REVIEW ON GASTROINTESTINAL HELMINTHS OF DOMESTIC RUMINANTS IN ETHIOPIA

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ABSTRACT: This systemic review was conducted to identify, critically assess, and bring together available data from primary researches conducted so far on gastrointestinal (GI) helminthes of domestic ruminants in Ethiopia. In the country, GI helminths of domestic ruminants have been identified; examined and informative statistics has been extracted since a few decades ago. For this review, relevant articles were retrieved from English databases: PubMed, Google Scholar, Science Direct, Web of Science and Scientific Information Database (SID). Additional studies were recognized by scanning the African Journal Online (AJOL) that includes the Ethiopian Veterinary Journal and Bulletin of Animal Health and Production. Out of retrieved (n = 154) articles, thirty three (n = 37) articles which fulfilled the eligibility criteria were selected. Accordingly, twenty three GI helminthes species which belong to the three classes of helminthes have been found to occur in domestic ruminants in the country. The main genera reported so far are Haemonchus, Strongyloides, Trichostrongylus, Oesophagostomum, Bunostomum, Fasciola, Monezia and Paramphistomum whereas, Haemochus contortus, Monezia expansa and Fasciolahepatica are the most frequently reported species from Nematode, Cestode and Trematode classes respectively. The overall GI helminths prevalence ranged from 2.3% to 100% were reported. Simple flotation, sedimentation, modified McMaster technique and faecal culture are the most common and routine diagnostic methods which have been used in the country. Management aspects like husbandry practices, climate and host influences are found to be the principal contributing factors that affect GI helminths infections. So far, the control of GI parasites in the country is mainly focusing on the use of anthelmintics. Consequently, due to the lack of effective control strategies, anthelmintics are exclusively used which result in anthelmintics resistance. Generally, occurrence, epidemiological features, realistic control strategies, common diagnostic procedures and frequently encountered species are reviewed. Finally, the relevance of epidemiological knowledge and the development of efficient, sustainable and conventional control measures which cover wider agro-climatic zones of the country are suggested for controlling GI helminths infections and should be assessed timely.

Keywords: Anthelmintics, Domestic ruminant, Ethiopia, Gastrointestinal helminthes.

INTRODUCTION

As a result of having different agro-ecological zones and favorable environmental situations in Ethiopia, the country is believed to be endowed numerous livestock species and suitable for livestock production. It has the largest livestock population in Africa (Tilahun and Schmidt, 2012; CSA, 2013). According to CSA (2013) report, an estimated statistics showed that about 54 million cattle, 25.5 million sheep and 24.06 million goats are found in the country. Of the total cattle population, 98.95% are local breeds and the remaining are hybrid and exotic breeds. Furthermore, 99.8% of the sheep and nearly all goat population of the country are local breeds (CSA, 2013).

However, diseases have numerous negative impacts on production and productivity. Among diverse animal diseases encountered in the country, helminthes infections remain one of the most important limiting factors and a bottlenecking production and productivity these days (Elsa et al., 2012). By chance, the gastrointestinal tract of ruminants harbors variety of parasites particularly helminthes which can cause both clinical and subclinical parasitism. As stated by Lebbie et al. (1994), GI helminthes infections are of a global concern for livestock industry, which have devastating impact in Sub-Saharan Africa in general and in Ethiopia in particular as a result of wider range of agro-ecological factors which are fitting for diversified hosts and parasite species. Hence, gastrointestinal (GI) helminthiasis has become among the most important diseases encountered by livestock sector of Ethiopia and has been considered to be one of the major constraints in the development of the sector (Regassa et al., 2006). In Ethiopia, helminthiasis is responsible for 25% mortality and 3.8% weight loss in highland sheep (Bekele et al., 1992).
According to Zahid et al. (2005), the helminthes infections of ruminants are mostly caused by nematodes like Strongyloides spp., Ostertagia spp., Bunostomum and Trichuris spp.; Cestodes such as Moniezia spp., Taenia spp. and Trematodes such as Paramphistomum spp., Fasciola spp. and Shistosoma spp. Perry et al. (2002) reported that GI nematodes have been ranked highest on globalindex with Haemonchus contortus on top. Moreover, Trichostrongyloidea that include genera such as Haemonchus, Trichostrongylus, Cooperia, and Nematodirus, and the Strongyloidea and Ancylostomatoida with Oesophagostomum and Bunostomum, are the economically most important and widely prevalent GI nematodes (Takele et al., 2013; Winter et al., 2018). In addition, such a pervasive occurrence of the metacestodes; Cysticercus ovis and Cysticercus tenuicollis; Hydatid cyst (E.granulosus); Fasciola hepatic and Fasciola gigantic are most prevalent in the country and considered to be of great economic importance (Lemma et al., 1985; Regassa et al., 2009; Negatu et al., 2009; Kebede et al., 2009; Feyesa et al., 2010; Negatu, 2010; Endale et al., 2013; Abebe et al., 2015; Beyene and Hiko, 2019).

There are many associated risk factors influencing the occurrence and epidemiology of GI helminthes including age, sex, weather condition and husbandry or management practices (Khan et al., 2009). Factors such as host age, physiological status, breed, parasite species involved, and the epidemiological patterns (husbandry practices and climate variables) determine the degree of infection (Tembely and Hansen, 1996; Menkir et al., 2007). In Ethiopia, several studies have been conducted on ruminant helminthiasis in various regions reporting a prevalence ranged from 2.3–100% (Fikru et al., 2006; Abebe and Esayas, 2001; Yirsaw and Zewdu, 2015).

A number of published research reports have been found on GI helminthes of domestic ruminants in Ethiopia. However, these reports are found in a separate and unorganized way. So, comprehensive and well organized documentation about GI helminthes of domestic ruminant in the country is essential to support researchers, professionals and policy-makers to develop further actions on the control and prevention strategies. Therefore, the aim of this systematic review was to identify, assess critically, and bring together available data from primary research conducted so far on gastrointestinal (GI) helminthes of domestic ruminants in Ethiopia.

MATERIALS and METHODS

Source, selection strategies and protocol

This systematic review was carried out on GI helminthes of Ethiopian ruminant using available electronic and non-electronic databases. The electronic search was managed as the primary search method. The main electronic databases used were PubMed, Google Scholar, Science Direct, Web of Science, Scientific Information Database (SID) were accessed from University of Gondar, Ethiopia. Relevant studies have been identified from English databases in Pub Med, Google Scholar, Science Direct, Web of Science, Scientific Information Database (SID). Additional studies were recognized by scanning the African Journal Online (AJOL) that includes the Ethiopian Veterinary Journal and Bulletin of Animal Health and Production. Moreover, complete and congress articles like original descriptive studies (designated as cross-sectional study) in sheep, goats and cattle were also considered. Epidemiological parameters such as prevalence of GI helminthes infection among sheep, goat and cattle, and main contributing factors like age, sex, and geographical sub-regions of Ethiopia were considered thoroughly. An intensive data searching was made to collect available information (Figure 3). The searching strategies used were combining the phrases close to GI helminths in large and small ruminants in Ethiopia as indicated in Figure 1. Searches were restricted to peer-reviewed articles published nationally or internationally in English language.

![Figure 1 - A diagram showing a strategy for words combination to access relevant articles.](image-url)
Data type and collecting methods

Published papers were scanned by quick reading to select relevant articles. Important articles were defined and included in the current review as one that contained information on GI helminthes of cattle, sheep and goat in Ethiopia. References of all relevant articles were searched to identify articles that were missed by the electronic search. Any
identified article was subjected to the same inclusion process as a data type. Following that all relevant articles were reviewed, extracted and compiled in a searchable database (Microsoft Access software, ver. 2007). Extracted information included authors name, study sites, year of the study commenced and ended, year of publication, study design, species of animals, sampling procedure, number of animals selected, body condition, sex, altitude of the study site, laboratory procedure to detect the parasite, testing methodology and prevalence of GI helminthes reported including their associated risk factors.

**Reports collected on GI helminths in Ethiopia**

The initial electronic searches yielded a total of (n=154) studies. After scrutinizing these and eliminating duplicates, thirty three (n=37) were considered (Figure 4) including thesis containing relevant information concerning GI helminths of ruminants in Ethiopia. This review work documented that of the relevant articles about 8% (3) were not retrieved by any of the search engines, 19% (7) were retrieved by a single search engine, 27% (10) by two, 16% (6) by three and 30% (11) by all four databases. Providing a balanced and an impartial summary of the topic using these representative studies was at the core of this review. No restrictions other than identifying ovine, caprine and bovine GI helminthes in Ethiopia were imposed on the inclusion criteria. This minimized literature selection bias and provided an exhaustive list of GI helminths. However, for factors associated with domestic ruminant GI helminthes in Ethiopia, strict inclusion criteria were applied in order to only select the critical studies. In order for the current review to be critically appraised, repeatability was crucial. This was achieved by documenting every step of the review process.

**Occurrence and spatial distribution**

The present review work revealed that the occurrences of GI helminthes infections were reported in different parts of the country (Figure 2). The prevalence of GI helminthes is summarized in table 1. The majority of the prevalence studies were specific on some helminthes genera like Strongyles, *Fasciola*, *Shistosoma* and some families like GI nematodes, Trematodes and Cestodes. However, adequate sources were not accessed compared to the number of studies done on specific species and families of the GI helminthes of domestic ruminants. In addition, most studies are based on the coprological examinations and few studies were conducted on abattoir surveys in the country.

According to the result obtained from the review, the overall prevalence of GI helminthes is ranged from 13.2% in Awash River Basin (Afar region) to 81.5% in Debre Zeit/Bishoftu (Bersissa et al., 2011; Moti et al., 2013). Furthermore, the review underlined that the majority of the identified species are found from nematodes and the lowest from Cestode. On the other hand, *Haemochus contortus*, *Monezia expansa* and *Fasciola hepatica* are the predominant species from Nematode, Cestode and Trematode classes respectively. Furthermore, *Nematodirus* spp., *Toxocara vitulorum* and *Schistosoma* spp. are less prevalent (Table 2). In Ethiopia the majority of the studies were focusing only on small ruminants’ GI helminthes than large ruminants. Therefore, the highest prevalence of the parasite was reported from sheep (91.2%) in Gode (Ogaden), Southern Ethiopia than cattle (21.9%) in Nekemete in Western part of Ethiopia (Table 1). On the other hand, most Abattoir survey reports have also shown a status of GI helminths of cattle than small ruminants.

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**Figure 4 - Frequency of articles relevant to the systematic review on GI helminths of domestic ruminants in Ethiopia.**

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| Study site(s) | Study animals and Sample size | Study period | ST | Diagnostic technique | Prevalence (%) | Sample | Author(year) |
|--------------|-------------------------------|--------------|----|----------------------|----------------|--------|-------------|
| Addama       | 92 - 208 - 852 - 1129         | Nov 2007-Apr 2008 | CS | PME                  | 29.3           | 4.7    | 46.8        | Live         | Getawa et al. (2010) |
| Addis Ababa  | 560                           | Sep 1985 - Jun 1986 | CS | PME                  | 19.6           | -      | -           | F            | Etana (2004) |
| Ambo         | 50 - 120                       | Feb-May 2013 | CS | DS,FL,SD             | 47.8           | 53.3   | -           | F            | Temezage and Walanso (2015) |
| Arba Minch   | 241 + 20 357.42 - 598 + 45   | Jan 2010-Aug 2011 | CS | SD,FL, MM, PME       | 79.7, 85       | 63.6   | 68 -        | 70.1;        | F, GIT        | Nejib et al. (2014) |
| Asella       | 408                           | Nov 2008-Apr 2009 | CS | MM                   | 68.1           | -      | -           | F            | Bekele et al. (1988) |
| Awash        | 3,697 - 3,697                 | Jan-Dec 2005 | CS | EAC                  | 13.2           | -      | -           | F            | Ahmed et al. (2007) |
| Bahir Dar    | 340 - 420                     | May-Dec 2005 | CS | SD                   | 10.6           | -      | 34.05       | -            | F, Live       | Negatu et al. (2009) |
| Bahir Dar    | 384 - 384 - 768                | Nov 2010-Mar 2011 | CS | SD, P                     | 10.5, 16.9     | 31.5   | 45.3        | -            | F, Liver       | Ayalew and Erdalkachew (2013) |
| Bahir Dar    | 384 - 4134                     | Nov 2008-Mar 2009 | CS | SD, P                     | 32.3           | -      | -           | F            | Mezitu et al. (2013) |
| Bedele       | - 500 500                     | Oct 2011-Mar 2012 | CS | SD, FL, MM            | 64.2           | -      | 64.2        | F            | Mezitu et al. (2013) |
| Bishoftu (D) | 1,152 - 1,536                 | Dec 2005 - Jun 2006 | CS | PME                | 58.5           | 43.8   | -           | -            | F             | Etemadi et al. (2008) |
| Bishoftu (D) | 157 - 65 - 222                 | Nov 2007-Aug 2008 | CS | FLSD, CC            | 81.0           | 83.0   | 81.5        | F            | Berissa et al. (2011) |
| Bishoftu (D) | - 326 326                     | Nov 2011-Dec 2012 | CS | FL, SD, F           | -              | 61     | 61          | F            | Cheru et al. (2014) |
| Debere Berhan | 2500 - 2500                   | 1987          | CS | SD, FL, P            | 18             | -      | 18          | F, PME       | Njau et al. (1999) |
| Dembi Dolo   | 255 - 248 - 257 - 757          | 2003-2004     | CS | DS, SD, FL, MM       | 75.3           | 84.1   | 50.2        | 69.6         | F, Live, MS  | Fikru et al. (2006) |
| Dessie       | 510 - 420                     | Nov 2011-Mar 2012 | CS | PME                | 21.04          | 27.84  | -           | -            | F, OM, F, Live, MS  | Abebe et al. (2015) |
| Dire Dawa    | 425 - 420                     | Nov 2011-Apr 2012 | CS | PME                | 22.8           | 26.4   | -           | 24.6         | F, Live, PE OM | Endale et al. (2013) |
| Durbete      | 202 - 330                     | Oct 2014 - Apr 2015 | CS | SD                   | 2.3            | -      | 24.8        | 26.9         | F             | Yirsiw and Zewdu (2015) |
| Gondar       | 458 - 100                     | Oct 2003 - Dec 2004 | CS | SD, F                | 46.57          | 55     | 47.67       | -            | F             | Shimeles et al. (2011) |
| Gondar, Finote Seisam, Injibara | - 22,755 22,755 | Sept 2002-2007 | CS | PME                | -              | 79.5   | 19.5        | Live         | Negatu (2010) |
| Haremayo, Harar, Dire Dawa, Jigiga | 655 - 632 | May 2003-Apr 2005 | CS | PME                | -              | -      | -           | GIT          | Menkir et al. (2007) |
| Hawassa      | 284 - 226                     | Dec 2008 - Mar 2009 | CS | PME                | -              | 52.8   | 52.6        | -            | F             | Abebe et al. (2010) |
| Hawassa      | 180 - 132                     | Jan-Jun 2006 | CS | PME                | 91.1           | 87.1   | -           | -            | A             | Thomas et al. (2007) |
| Jimma        | 210 - 210                     | Nov 2006-Apr 2009 | CS | FLSD, MMM            | -              | -      | 77.6        | 17.6         | F             | Hallu et al. (2011) |
| Ketika       | 230 - 154                     | Sept 1997-Apr 1998 | CS | FL, SD               | 53             | -      | 38          | -            | F             | Tesfaye (1998) |
| Kombolcha    | 400 - 400                     | 2011          | CS | PME                | -              | 17     | 17          | Live         | Fafa et al. (2012) |
| Mekele       | - 1023 1023                   | Nov 2007 - Feb 2008 | CS | PME                | -              | 7.23   | 7.23        | Live         | Getachew and Ashwari (2013) |
| Mekele, Adigrat, Asum, Humera, Maichew, Shire | - 5,194 | 2007/8 | CS | PME                | -              | 22.2   | 22.1        | Live         | Kebede et al. (2009) |
| Metehara, Semera, Jigiga | 92 - 91 | 183 | Nov 1998-Apr 1999 | CS | PME, MM, PME        | 97.03          | 100    | -           | F, GIT       | Abebe and Esayaw (2001) |
| Nekhentie    | 384 - 384                     | Nov 2011-Mar 2012 | CS | PME                | -              | 21.9   | -           | GIT          | Asfaw et al. (2013) |
| Ogaden-Gode  | 114 - 82                      | Aug 2003-Mar 2004 | CS | PME                | 91.2           | 82.9   | -           | -            | A             | Kumssa and Wossene (2006) |
| Wolaita Soddo | 415 - 415                      | Nov 2007 - Apr 2008 | CS | PME                | -              | -      | 11.3        | -            | Live         | Regassa et al. (2009) |
| Wolumo       | 384 - 384                     | Nov 2013-Apr 2014 | CS | PME                | 40.9           | -      | -           | 40.9         | A             | Lidya and Berihu (2015) |

Table 1 - List of selected studies on GI helminthes of domestic ruminants in Ethiopia
| Table 2 - GI helminthes species/genus composition; collected from each selected studies in Ethiopia. |
|---------------------------------------------------------------|
| **Species of parasite identified (%)**                        | **Location** | **Altitude of study area** | **Author (year)** |
| **Nematode** | **Species of animal** | **Cestode** | **Location** | **Altitude of study area** | **Author (year)** |
|---------------------------------------------------------------|
| H. contortus | - | - | 852 | Hydatid cyst | 40.0 | 55.6 | 37.1 | - | - | - | - | Getaw et al. (2010) |
| Strongyloidesspp. | - | 30.3 | - | - | - | - | - | - | - | - | - | - | - |
| Trichostrongylus spp. | - | 16.4 | - | M. expansa | - | 14.6 | - | - | - | - | - | Adami Tulu (2010) |
| Trichuris spp. | - | 2.2 | - | M. benedeni | - | 4.0 | - | - | - | - | - | - | - |
| Nematodirus spp | - | 2.8 | - | - | - | - | - | - | - | - | - | - | - |
| Chabertia ovina | - | 5.0 | - | - | - | - | - | - | - | - | - | - | - |
| Bunostomum spp. | - | 5.4 | - | - | - | - | - | - | - | - | - | - | - |
| Strongyles spp. | 47.8 | 53.3 | - | - | - | - | - | - | - | - | - | - | - |
| Strongylodes spp. | 64.0 | 7.4 | - | - | - | - | - | - | - | - | - | - | - |
| Trichurisspp | 3.7 | - | - | - | - | - | - | - | - | - | - | - | - |
| E. granulosus | 25.0 | 16.1 | - | - | - | - | - | - | - | - | - | - | - |
| F. hepatica and F. gigantica | 16.9 | 45.3 | - | - | - | - | - | - | - | - | - | - | - |
| F. hepatica | - | 89.7 | - | 3.63 | 6.67 | - | - | - | - | - | - | - | - |
| F. gigantica | - | 32.3 | - | - | - | - | - | - | - | - | - | - | - |
| St. hepatica | 9.5 | 12.1 | - | - | - | - | - | - | - | - | - | - | - |
| C. tenuicollis | 5.2 | 8.3 | - | - | - | - | - | - | - | - | - | - | - |
| Strongyle type | 56.60 | 61.0 | - | - | - | - | - | - | - | - | - | - | - |
| Strongylodes spp. | 8.2 | 15.4 | - | - | - | - | - | - | - | - | - | - | - |

Citation: Fentahun T (2020). Systematic review on gastrointestinal helminths of domestic ruminants in Ethiopia. Online J. Anim. Feed Res., 10(5): 216-230.
| Helminth Species | Prevalence |
|------------------|------------|
| Trichostrongylus spp. | 5.0 | 0.0 |
| Trichuris spp. | 41.4 |
| Toxocara spp. | 5.2 |
| Trichuris spp. | 5.2 |

**Trichuris ovis**

| Debre Berhan | Njau et al. (1990) |
|--------------|-------------------|
| 25.4 |

**Ascaris spp.**

| Dembi Dolo | Fikru et al. (2006) |
|------------|---------------------|
| 1.6 |

**Dictyocaulus spp.**

| Dessie | Abebe et al. (2015) |
|--------|---------------------|
| 2.8 |

**Trichuris ovis**

| Bishoftu | Cheru et al. (2014) |
|----------|---------------------|
| 0.0 |

**Trichuris spp.**

| T. axei | |
|---------|-----|
| 0.0 |

**H. contortus**

| Trichuris spp. | |
|----------------|-----|
| 0.0 |

**Nematodirus spp.**

| F. hepatica | Paramphistomum sp. |
|-------------|--------------------|
| 8.52 |

**F. gigantica**

| Haemonchus spp. | |
|------------------|-----|
| 0.96 |

**Dicrocoelium dendriticum**

| | |
|-------------------|-----|
| 0.56 |

**Oesophagostomum spp.**

| | |
|-------------------|-----|
| 0.56 |

**Haemonchus spp.**

| | |
|-------------------|-----|
| 0.56 |

**Trichostrongylus spp.**

| | |
|-------------------|-----|
| 0.56 |

**Strongyle spp.**

| | |
|-------------------|-----|
| 0.56 |

**M. expansa**

| | |
|-------------------|-----|
| 0.56 |

**Av. centripunctata**

| | |
|-------------------|-----|
| 0.56 |

**St. globipunctata**

| | |
|-------------------|-----|
| 0.56 |

**St. hepatica**

| | |
|-------------------|-----|
| 0.56 |

**Cysticercus ovis**

| | |
|-------------------|-----|
| 0.56 |

**F. hepatica**

| | |
|-------------------|-----|
| 0.56 |

**F. gigantica**

| | |
|-------------------|-----|
| 0.56 |

**Cysticercus ovis**

| | |
|-------------------|-----|
| 0.56 |

**E. granulosus (cysts)**

| | |
|-------------------|-----|
| 0.56 |

**H. contortus.**

| | |
|-------------------|-----|
| 0.56 |

**T. axei**

| | |
|-------------------|-----|
| 0.56 |

**T. vitrinus**

| | |
|-------------------|-----|
| 0.56 |

**Trichostrongylus spp.**

| | |
|-------------------|-----|
| 0.56 |

**Nematodirus spathir**

| | |
|-------------------|-----|
| 0.56 |

**Cooperia curticei**

| | |
|-------------------|-----|
| 0.56 |

**Strongyloides spp.**

| | |
|-------------------|-----|
| 0.56 |

**Bunostomum spp**

| | |
|-------------------|-----|
| 0.56 |

**Oes. columbianum**

| | |
|-------------------|-----|
| 0.56 |

**Oesophagostomum spp.**

| | |
|-------------------|-----|
| 0.56 |

**Chabertia ovina**

| | |
|-------------------|-----|
| 0.56 |

**Trichuris spp**

| | |
|-------------------|-----|
| 0.56 |

**E. granulosus (cysts)**

| | |
|-------------------|-----|
| 0.56 |

**Hydatid cysts**

| | |
|-------------------|-----|
| 0.56 |

**Debre Berhan**

| | |
|-------------------|-----|
| 0.56 |

**Bishoftu**

| | |
|-------------------|-----|
| 0.56 |

**Hawassa**

| | |
|-------------------|-----|
| 0.56 |

**Menkir et al. (2007)**

| | |
|-------------------|-----|
| 0.56 |

**Shimelis et al. (2011)**

| | |
|-------------------|-----|
| 0.56 |

**Feyesa et al. (2010)**

| | |
|-------------------|-----|
| 0.56 |

**Abebe et al. (2010)**

| | |
|-------------------|-----|
| 0.56 |

**Abebe et al. (2015)**

| | |
|-------------------|-----|
| 0.56 |

**Thomas et al. (2007)**

| | |
|-------------------|-----|
| 0.56 |

**Shimelis et al. (2011)**

| | |
|-------------------|-----|
| 0.56 |

**Menkir et al. (2007)**

| | |
|-------------------|-----|
| 0.56 |

**Nigatu (2010)**

| | |
|-------------------|-----|
| 0.56 |

**Yirsaw and Zewdu (2015)**

| | |
|-------------------|-----|
| 0.56 |

**Feyesa et al. (2010)**

| | |
|-------------------|-----|
| 0.56 |

**Abebe et al. (2010)**

| | |
|-------------------|-----|
| 0.56 |

**Feyesa et al. (2010)**

| | |
|-------------------|-----|
| 0.56 |

**Menkir et al. (2007)**

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|-------------------|-----|
| 0.56 |

**Menkir et al. (2007)**

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**Menkir et al. (2007)**

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**Menkir et al. (2007)**

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**Menkir et al. (2007)**

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**Menkir et al. (2007)**

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**Menkir et al. (2007)**

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|-------------------|-----|
| 0.56 |

**Menkir et al. (2007)**

| | |
|-------------------|-----|
| 0.56 |

**Menkir et al. (2007)**

| | |
|-------------------|-----|
| 0.56 |
| Species                     | Prevalence | Location | Author(s)      | Year |
|-----------------------------|------------|----------|----------------|------|
| Strongyloides spp.          | 27.58      | Jimma    | Hailu et al.   | 2011 |
| Trichuris spp.              | 2.95       |               |                |      |
| Nematodirus spp.            | 0.49       |               |                |      |
| Strongyles spp.             | 38.09      | Kombolcha | Tesfaye       | 1998 |
| Trichuris spp.              | 3.20       | Mekelle   | Getachew and Ashwani | 2013 |
| Nematodirus spp.            | 0.49       |               |                |      |
| Strongyles spp.             | 27.6       | Metehara, Adigrat, Axum, Maiche, Shire | Abebe and Esayas | 2001 |
| Trichostrongylus spp.       | 91.2       | Wukro     | Lidya and Berihun | 2015 |
| H. contortus                | 40.9       |               |                |      |

- : No information available, A* = no specific prevalence is mentioned
Species composition and seasonal dynamics

In Ethiopia, the presence of GI helminthes infections in domestic ruminants is reported by many authors (Thomas et al., 2007; Menkir et al., 2007; Abebe et al., 2010; Shimelis et al., 2011; Diriba et al., 2013; Addisu and Berihu, 2014 and Churu et al., 2014). According to the current review, about twenty three (23) GI helminthes species belonging to Nematode, Cestode and Trematode categories have been reported from infected cattle, sheep and goats (Table 2). Whereas, Menkir et al. (2007), Abebe et al. (2010), Hallu et al. (2011) and Shimelis et al. (2011) who reported that the most prevalent genera of GI helminthes were Haemonchus, Trichostrongylus, Oesophagostomum, Nematodirus, Cooperia, Toxocara and Bunostomum from Nematodes; Monezia and Cysticercus from Cestodes and Fasciola, Paramphistomum and Shistosoma from Trematode classes (Table 3).

Table 3 - Summary of Species compositions of GI helminthes of domesticated ruminants in Ethiopia.

| Major Class | Species | Host | Predilection site(s) |
|-------------|---------|------|----------------------|
| Nematode    | Haemonchus contortus | Cattle, sheep, goats | Abomasums |
|             | Haemonchus placei     | Cattle | Abomasums |
|             | Ostertagia circumcincta | Cattle, Sheep, Goats | Abomasums |
|             | Trichostrongylus axei | Cattle, Sheep, Goats | Small intestine |
|             | Trichostrongylus colubriformis | Cattle, Sheep, Goats | Small intestine |
|             | Cooperia curticei     | Cattle, Sheep, Goats | Small intestine |
|             | Strongyloides papillosus | Cattle, Sheep, Goats | Small intestine |
|             | Ostertagia Spp.       | Cattle, Sheep, Goats | Large intestine |
|             | Chabertia ovina       | Cattle, Sheep, Goats | Large intestine |
|             | Oesophagostomum columbianum | Cattle, Goats | Large intestine |
|             | Strongyloides papillosus | Cattle, Sheep, Goats | Small intestine |
|             | Trichuris ovis        | Cattle, Sheep, Goats | Large intestine |
|             | Nematodirus filicollis | Cattle, Sheep, Goats | Small intestine |
|             | Nematodirus pathiger  | Sheep | Small intestine |
|             | Trichostrongylus vitrinius | Sheep | Small intestine |
|             | Toxocara vitulorum    | Cattle (calves) | Small intestine |
|             | Monezia expansa       | Sheep, Goat | Small intestine |

| Cestode      | Cysticercus tenuicollis (Taenia hydatigena) | Sheep, Goat | Omentum Mesenteries, Peritoneum, Liver |
|             | Ecchinoccocus granulosus | Sheep, Goat | Omentum Mesenteries, Peritoneum, Liver |
|             | Cysticercus ovis (Taenia ovis) | Sheep, Goat | Small intestine |
|             | Avitellina centripunctata (Av. centripunctata) | Sheep, Goat | Small intestine |
|             | Stilesia globipunctata (St. globipunctata) | Sheep, Goat | Liver |
|             | Stilesia hepatica (St. hepatica) | Sheep, Goat | Liver |

| Trematode    | Fasciola hepatica | Sheep, Goat Cattle | Liver |
|             | Fasciola gigantica | Sheep, Goat Cattle | Liver |
|             | Paramphistomum cervi | Sheep, Goat Cattle | Rumen |
|             | Paramphistomum microbothrium | Sheep, Goat Cattle | Rumen |
|             | Schistosoma bovis | Sheep, Goat Cattle | Liver, intestine, mesenteric lymph nodes and mesenteric veins |

According to this systemic review, GI helminthiasis in domestic ruminants is severe and increasingly become an important focusing area of research in the country situation. A study conducted in western Oromia on GI parasites showed that Strangles were the most prevalent parasites encountered in the area (Moti et al., 2013). Similar study by Shimelis et al. (2011); Churu et al. (2014), Nejib et al. (2016) and Diriba et al. (2013) reported that Strongyles were the most prevalent parasites encountered in North Gondar, Debre Zeit (East Shoa zone), Arbaminch (GamoGofoza zone) and Asella respectively. As it has been reported by Abebe et al. (2015); Endale et al. (2013); Feyesa et al. (2010); Nigatu (2010); Kebede et al. (2009); Nigatu et al. (2009); Regassa et al. (2009); Jibat et al. (2008); Menkir et al. (2007); Bekele et al. (1988), metacestodes (larval cestodes) Cysticercus ovis (Taenia ovis), Cysticercus tenuicollis (T. hydatigena) and Hydatid cysts (Echinococcus granulosus) are the most prevalent species in Eastern Ethiopia. On the other hand, gastrointestinal infections as a result of adult cestodes such as Avitellina centripunctata, Monezia expansa and Stilesia globipunctata, and bile duct infections with Stilesia hepatica were frequently reported in different parts of the country (Abebe and Esayas, 2001; Etana, 2002; Menkir et al., 2007; Bersissa et al., 2011). Nonetheless, a higher prevalence of strongyles infection was recorded in the midland and highland than the lowland, and in wet season than the dry season. The mean fecal egg count was found to be significantly higher in the midland area and in wet season (Nejib et al., 2016). However, according to a study by Abebe and Esayas (2001) in the arid and semiarid zones of Eastern Ethiopia revealed that during the dry seasons of the year, a greater prevalence rates of GI helminthes were recorded in sheep and goats, 95.6 % and 100 % respectively. Furthermore, according to an abattoir survey by Menkir et al. (2007) at 4 abattoirs located in the semi-arid zone of Eastern Ethiopia, the mean burdens of adult nematodes were generally moderate in both sheep and goats and showed patterns of seasonal abundance that corresponded with the bi-modal annual rainfall pattern, with
highest burdens around the middle of the rainy season. There were significant differences in the mean worm burdens and abundance of the different nematode species between the four geographic locations, with worm burdens in the Haramaya and Harar areas greater than those observed in the Dire Dawa and Jijiga locations (Abebe and Esayas, 2001; Menkir et al., 2007; Abebe et al., 2010; Bersissa et al., 2011; Endale et al., 2013). The seasonality of the GI helminthes distribution is associated with the relative humidity and rainfall (Debela, 2002; Menkir, 2007). A number of reports throughout the country indicated that there are remarkable changes in faecal egg counts and prevalence of helminths infection as a result of seasonal variation and seasonal rainfall pattern (Fikru et al., 2006; Menkir et al., 2007; Takele et al., 2013). Furthermore, relatively higher GI Helminths egg counts were found in mid altitude and highland zones than in lowland due to the influence of existing fluctuations in geographic and climatic conditions between each zone (Demelash et al., 2006; Takele et al., 2013).

Epidemiological factors

The epidemiology of the GI helminthiasis relies on factors such as the infection pressure in the environment and the susceptibility of the host, species and pathogen factor (Tilahun, 1995). From epidemiological point of view, the infective stages which eventually become available to the host depend on the independent and interactive influences of several factors in the macro- and micro-environment (Urquhart et al., 1994; Woleademariam, 2005; Regassa et al., 2006; Takele et al., 2013). Parasitic, host and environmental factors are the most frequently reported determinants for the epidemiology of helminths (Etana, 2002; Fikru et al., 2006; Ahmed et al., 2007; Menkir, 2007; Shimelis et al., 2011; Yirsaw and Zewdu, 2015). As stated by Shimelis et al. (2011), the prevalence of helminthiasis at species level was about 46.07% and 55% in sheep and goats, respectively. Almost similar report was documented in and around Ambo town with the proportion of 47.8% and 53.3% in sheep and goats, correspondingly (Temesgen and Walanso, 2015). Among the collected articles, the highest post mortem examination result was reported in Eastern Ethiopia (100%) (Abebe and Esayas, 2001). Strong association between GI helminths and poor body condition was coupled with heavy intensity of infection in the majority of infected animals (Abebe et al., 2010; Diriba et al. 2013; Atula et al., 2013; Temesgen and Walanso, 2015). According to Abebe et al. (2010) and Cheru et al. (2014), the burden of GI parasites and total EPG was significant in different body conditions.

Host factor

Sex, age, breed, nutrition, physiological status and presence or absence of interstitial infections aggravate the severity of infection (Demelash et al., 2006; Menkir et al., 2007). Clinical parasitic gastroenteritis has been reported in young animals whilst infections in mature animals are generally subclinical in nature (Thomas et al., 2007). The lower occurrence in adults has been attributed to immunological maturity as the animals grow and the increase in acquired resistance due to repeated exposure (Biffa et al., 2004). While, some local breeds are known to be genetically resistant to GI helminths infections than others (Tibbo, 2006). In Ethiopia, the local sheep breeds (Wasbera, Farta, Afar, Menz, Horo); Goat breeds (Begait, Abewrgelie, Keffa,) and Cattle breeds (Boran , Fogera, Raya, Horro, Abigar, Shekko, Arssi) are relatively resistant to GI worms than exotic breeds (Frisch and O’Neill, 1998; Negussie et al., 2000; Tibbo, M. 2006; Menkir et al., 2007; Solomon et al., 2009; Kebede et al., 2012). In addition, Moti et al. (2013) reported that Physiological status of ruminants like level of host immunity to the parasites is subjected to the number of eggs produced by adult female helminths. In the females, the females are readily infected and existing worm burdens become more active and increase egg spassed in the feces and develop Larvae (L3) on the pasture (Woleademariam, 2005).

Environmental factor

As far as Ethiopia is among the tropical African countries, the temperature is permanently favorable for larval development in the environment. The favorable environment for larval development is ranged at temperature about 10–36 °C and humidity proportion of 85% (Debela, 2002). In the arid tropical climates of lowland areas of the country has an environment which ranges from extensive pasturelands and browse plants to intensive grazing areas (Nejib et al., 2016). This environment is ranged from harsh to favorable for growth and survival of free-living stages of the GI helminthes (Tilahun, 1995; Debela, 2002).

Pathogen factor

The epidemiology of GI helminthes is also strongly influenced by host-parasite biology after infection has been occurred (Abebe et al., 2010; Diriba et al., 2013). Hypobiosis has been undergone by GI helminthic the abomasal or intestinal mucosae of the host (Cheru et al., 2014). Whereas, Abebe and Esayas (2001) stated that the immune status of the host influenced the rates of hypobiosis and usually arrested during external environments are unfavorable for the development and survival of eggs and larvae. Such development cycle usually coincides with the onset of rainy seasons and favourable period for larval development and transmission (Kumsa and Wossenie, 2006; Feyisa et al., 2010; Hailu et al., 2011; Nejib et al., 2016).

Currently applied diagnostic techniques

The diagnosis of helminthes of ruminants is based on demonstrating the presence of eggs or larvae in fecal samples or parasites recovered from the digestive tracts or other viscera of the animals (Hailu et al., 2011; Addisu and Berihun, 2014). Although a great variety of methods and modifications have been described for diagnosis, standardized techniques such as egg or larval counts, worm counts and pasture larval counts did not exist. Therefore, most diagnostic laboratories
as well as teaching and research institutions were applied their own set of protocols and test procedures (Kassai, 1999). Common diagnostic procedures for helminths infections in Africa in general and in Ethiopia in particular are simple flotation, sedimentation, modified McMaster and faecal culture methods (Hansen and Perry, 1994; Kassai, 1999; Waller, 1997). Some nematode genera such as strongyloids produce eggs that are identical in appearance which couldn’t be identified easily by faecal examination alone. So to identify these faecal cultures are required (Hansen and Perry, 1994; Urquhart et al., 1996; Kassai, 1999; Van Wyket al., 2004). However, Nematodirus, Strongyloides and Trichuris species have eggs that can be differentiated by their distinct morphological features. Post-mortem examinations and identification of adult worms and arrested larvae in animals are the definitive means of identifying the parasite. Similar to faecal egg counts; there are many procedures that are described for post-mortem examination for nematode parasites (Hansen and Perry, 1994; Urquhart et al., 1996; Kassai, 1999).

Chemotherapies and control options

Effective helminthic control is a major element in ensuring the sustainability of animal production. The main aim of control is therefore to ensure that the biotic potential of a parasite is restrained at a level compatible with the biological requirements of economic livestock production (Waller, 1997). Since eradication of gastrointestinal parasites is not practical, only integrated control methods can be envisaged. Some of the basic principles include grazing management, acquisition of natural or artificially induced immunity, biological control and the judicious use of anthelmintics (Hazelby et al., 1994). The main methods for control of helminthic parasites are prophylactic treatment with anthelmintics combined with grazing management (Van Wyk et al., 1999). Despite the accumulation of drugs in animal products and undesirable effects on non-target organisms in the environment, together with an increase in anthelmintic resistance, the use of anthelmintics still remains the cornerstone of helminth control (Waller, 1997; Van Wyk et al., 1999; Bersissa and Girma, 2009). Since animals are often infected with a wide range of helminths, the need for broad-spectrum compounds against trematodes, cestodes and nematodes, and their larval stages is obvious (Hazelby et al., 1994). The epidemiological information on GI helminths parasites of domestic ruminants gathered in Ethiopia can be used to design appropriate control measures. In principle, control should aim at the reduction of transmission rates. Several control methods, which include cultural husbandry, chemical, biological, ethno-veterinary medicine and immunological control, have been proposed (Nejib et al., 2016).

Husbandry pattern, control and prevention

A thorough husbandry practices such as controlling stocking rates, rotational grazing, and providing hygienic grazing can be considered as an alternative husbandry control technique (Diriba and Birhanu, 2013; Abebe et al., 2015; Temesegen and Walanso, 2015). The best way to prevent GI helminthes is to keep animals away from potentially dangerous environment. An absolute separation of stock from intermediate host zone is only practical in intensive farming husbandry systems (Woldemariam, 2005) which the country has a limited effort to do so. However, in communal grazing condition which is very common and traditional in Ethiopia, animals are communally grazed and therefore; practices such as rotational grazing and provision of clean pastures would not be feasible (Menkir et al., 2007; Cheru et al., 2014).

Chemotherapeutic interventions

Nowadays, the control of GI parasites of livestock in Ethiopia is mainly based on the use of anthelmintics. The most commonly used general broad spectrum anti-helminthic that are available in Ethiopia are the Benzimidazoles, Imidazothiazoles and Macrocyclic lactones which consist albendazole, levamisole and ivermectin, respectively (Woldemariam, 2005; Kumsa, and Wossene, 2006; Menkir et al., 2007). It is readily available wherever in the country since it has been imported massively by the government and non-government institutions; and used by every individual including farmer. However, the use of anthelmintics at regular intervals for a long period of time and treating by mass whenever an animal manifest clinical syndrome has become the major issue for the development of multiple resistances; for instance against benzimidazoles (Woldemariam, 2005). Targeted or selective application of anthelmintic treatment might be an important tool to keep susceptible GI nematode strains in livestock and to delay this case. An alternative approach for selective anthelmintic treatment was studied using experimental small ruminants for the management of haemonchosis by using the FAMACHA® method in the Mid-Rift Valley of Ethiopia by Woldemariam (2005) and Menkir (2007). Such system can be used by the farmers themselves by checking their animals for signs of anaemia (VanWyketal, 2004). Unfortunately, it was not practiced very well in Ethiopia where mixed parasitic infection, and where traditional feeding practice is followed (VanWyk et al., 2004; Kumsa and Wossene, 2006). A cost-effective preventive control programs for helminth infection in ruminants is based on sound epidemiological knowledge of the time relationship between contamination of pastures and the seasonal availability of infective larvae in a given geographic area. Epidemiological knowledge, its application in grazing management whenever feasible and access to anthelmintics of high efficacy are key factors for the success of controlling helminth infections in domestic ruminants (Aynalem et al., 2009; VanWykand Mayhew, 2013). Projecting models derived from more complete information on the ecology of GI helminth infection and anthelmintic resistance, climate and local management factors provide a basis for improved control schemes based on chemotherapy, management and immunization within similar climate (VanWyk and Mayhew, 2003; Woldemariam, 2005; Menkir et al, 2007).
Ethno-veterinary practices

As a result of the gradually increasing anthelmintic resistance, residual effect on animal products, environmental pollution, scarcity and high cost of such drug especially to poor farmers have enforced to reconsider other alternative helmintic control technique in the country (Bersissa and Girma, 2009). Of these, Ethno-veterinary medicine has become a substantial and most expanding interest of options for Ethiopian farmers. Although such a kind of conventional veterinary medical system was yet very poor in the country, a very limited effort have been done to encourage the widely used ethno-veterinary plants in the country (Lulekal et al., 2008; Fullas, 2010; Asfaw and Fentahun, 2020). In order to do so, several Ethno-veterinary surveys were conducted so far in the country which indicated as if several traditional healers use medicinal plants for de-worming livestock (Jemal et al., 2011). To mention few examples, Herbal preparations from fresh leaves of Dodonea viscosa, Albizia gummiifera and Vernonia amygdalina against mixed natural infections in sheep was evaluated by Biffa et al. (2004) to show the anthelmintic activities. In addition, an In-vitro anthelmintics activity study from Rhus glutinosa, Syzygium guineenusa, Albizia gummiifera, Croton macrostachyus, Ekebergia capensis, Acacia nilotica and Terminalia schimperiana against Haemonchis contortus have been reported by Eguale et al. (2006) and Jemal et al. (2011). Furthermore, anthelmintic activity of plants such as Allium sativum, Zingiber officinale, Cucurbita mexicana, Ficus religiosa, Artemisia brevifolia, Calotropis procera, Nicotiana tabacum, Butea monosperma, Coriandrum sativum, Ocimum, Thymus schimperi and Echinops kebericho have been reported by Abera (2003), Biffa et al. (2004) and Giday et al. (2007).

CONCLUSION

This review work assessed the GI helminthes in Ethiopia and provides a clue on perspectives and constraints encountered in researches which were done on GI helminthes in ruminants. Twenty three (23) GI helminthes species that belong to all the three major classes of helminthes have been found to occur in domestic ruminants in Ethiopia. In addition, nematodes are the most commonly encountered GI helminthes while Cestodes are the least. In most reports, a higher rate was recorded in small ruminants. The most prevalent genera of GI helminths reported in order of prevalence are Haemonchus, Trichostronglyus, Oesophagostomum, Nematodirus, Cooperia, Toxocara and Bunostomum from Nematodes; Moneziaand Cyticercus from Cestodes. Whereas, Fasciola, Paramphistomum and Shistosoma are found from Trematode category. Both the abattoir and coprological studies have indicated that infection by GI helminthes in ruminants is highly prevalent and widespread in all agro-ecologies and livestock production systems in Ethiopia. Fecal diagnostic techniques such as simple flotation, sedimentation, modified McMaster have been used routinely in Ethiopia. It has been also shown that prevalence of GI helminthes parasites was related to the agro-climatic conditions such as quantity and quality of pasture, temperature, humidity and grazing behavior of the host and the susceptibility of any intestinal helmintic parasites were also influenced by age, breed, species, health status, physiological factors and previous exposure to parasites.

Due to the lack of effective helmintic control strategies in Ethiopia, antihelmintics are exclusively used. Though Ethiopia has a huge amount of small and large ruminants population, the country is facing a direct and indirect economic lose as a result of GI helminthes infection. Hence, immediate remedies shall be taken into action on control and prevention methods against such anthelmintic resistant GI parasites. In order to this, it is advantageous to collect and looking over the previous researches done so far to reconsider their gaps for the future short and long term actions on prevention and control strategies. So, all-inclusive and well organized documentation about GI helminthes of ruminants in the country is essential to support researchers and policy makers to develop such remedies. Finally, applicable field diagnostic technique should be introduced as far as mixed parasitic infection and traditional feeding practice is common in the country which can aggravate GI helminthes infection.

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Consent to publish
Not applicable.

Competing Interests
The authors declare that they have no competing interests.

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