Assessment of Gastrointestinal Tract Parasites of Equines in Asella Town, Ethiopia

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Abstract: A cross-sectional study was conducted from October 2011 up to March 2012 in Asella district, Ethiopia to estimate the prevalence of gastrointestinal tract (GIT) parasite and to identify the association of infection with species, sex, age and body condition of equines. The GIT parasites were examined by using quantitative and qualitative faecal analysis methods. Overall prevalence of the parasites was 53.5% (48.5-58.5). There was a significant ($p<0.05$) variation in frequency of infection between horses (73.93%), donkey (37.1%) and mule (28.9%). Out of the 214 faecal samples examined by McMaster Egg counting technique, 85.5, 10.28 and 4.2% were heavily, moderately and mildly infected, respectively. Strongyle type eggs were prevalent with a frequency of 50.9% in horse, 41.07% in donkey and 45.45% in mule. *Trichonema* spp. (2.9%) and *Anoplocephala* spp. (3.8%) in horses; *Fasciola* spp. (3.6%) and *Triodontophorus* spp. (3.6%) in donkeys; and first stage larvae of *Dictyocaulus* in mules were the least prevalent parasites. Gastrointestinal tract parasite prevalence was influenced by species ($p<0.05$), whereas sex, age and body condition did not show statistically significant association ($p>0.05$) with infection. Mean egg count was not affected by these risk factors. In conclusion, the study revealed that the occurrence of gastrointestinal tract parasite in equines in Asella town is a common phenomenon. As a result, awareness creation to the animal owners and proper deworming and prevention mechanisms should be implemented to reduce the burden of the infection.

Keywords: *Asella, Equine, Gastrointestinal tract, McMaster, Prevalence*

Introduction

The equine population of the world includes 59, 43 and 9.7 million horses, donkeys and mules, respectively (FAOSTAT, 2016). The number of equines in Africa is estimated at 27.8 million, comprising 6.3, 20.6 and, 0.9 million horses, donkeys and mules, respectively (FAOSTAT, 2016). In Ethiopia, there are an estimated 2.2, 8.4 and 0.4 million horses, donkeys and mules (CSA, 2016/17). Equine have a prominent position in the agricultural and transport sectors serving as a draft, pack and riding animals. In a country like Ethiopia where modern transport, particularly in the rural areas is not well developed, the natural choice rests on the use of pack animals as means of transport (Hagos, 2005). Only few regions in north western and south of Ethiopia use equines for ploughing (Tillage), but threshing of crops by using equines is common in most parts of the country (Gizaw, 1987). Despite the contribution of these animals, the health management accorded to equines has been far below that given to other livestock species (Hassan, 2000).

Although equines are often described as hardy and resistant animals, they do suffer from a number of health problems (Svendsen, 1986; Marquardt *et al*., 2000). They are vulnerable to a variety of biological diseases like endo-parasites dominated by gastrointestinal helminthes, which are serious health problem contributing to poor body condition, reduced work output, poor reproductive performance and short life span. Failures of young equines to grow properly and less efficient performance of horses that are moderately parasitized are among the greatest losses encountered due to these infections (Clayton, 1986; Radostits *et al*., 2006). Parasitic diseases have an economic impact on donkeys and mules as they cause loss through lowered fertility, reduced work capacity and increased treatment cost (Krecek *et al*., 1989). These diseases are also serious to the welfare of donkeys and mules by causing pain (Fikru *et al*., 2005).

Infections of equines with gastrointestinal parasites are recorded from most countries of Africa including Ethiopia, Kenya, Zimbabwe, Burkina Faso and Morocco, and large numbers of internal parasites were identified (Yilma *et al*., 1991). In Ethiopia, few studies were done in central and eastern parts of the country (Feseha, 1998; Gizachew *et al*., 2006; Getachew *et al*., 2008 & 2010) and some of them identified strongyles, *Parascaris equorum*, *Gastrophilus* spp., lungworms, tapeworms and liver flukes to be the most prevalent gastrointestinal parasites of equines (Yoseph *et al*., 2001). The study conducted in Sululta and Gefersa districts of Central Ethiopia reported prevalence rate of 99.5% strongyles, 53% *Parascaris equorum*, 9.8% *Fasciola* spp., 5.7% *Gastrodiscus aegypticus* and 2.8% *Anoplocephala* spp. in equines (Zerihun *et al*., 2011). Getachew *et al*. (2010) also reported prevalence rate of 99% *Strongylus* spp., 80% *Fasciola* spp. and 51% *Parascaris equorum* among working donkeys in selected districts of east Shewa and neighboring districts of central Ethiopia. Available information indicates that gastrointestinal parasites are the major cause of early demises of working donkeys, horses and mules in Ethiopia

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(Svendsen, 1997; Feseha, 1998; Basaznew *et al*., 2012). Internal parasites affecting eqiuds are ubiquitous with equines being continually exposed throughout their lives. Although they are often heavily parasitized by helminthes (Graber, 1975), the prevalence and type of internal parasites affecting eqiuds have not been determined to a great extent in Ethiopia, particularly in Asella town. Therefore, this study was designed with the objectives of estimating the prevalence, determining the level of infection based on the count of eggs per gram of faeces, and assessing the associated risk factors of equine GIT parasites infection.

Materials and Methods

Study Area

Asella and its surrounding areas of Tiyo district is located in Arsi Zone of the Oromia Region at an elevation ranging from 1650 to 3000 meters above sea level. About 37% of Asella area is highland (>2400 meters above sea level); 52% midland (1800-2400 meters above sea level) and 11% is lowland (<1800 meters above sea level) (TDARDB, 2003) with a subtropical highland climate. Monthly temperature variation is small, due to its elevation and closeness to the equator. The seasons are only distinguished by the intensity of rain, which is highest in August and lowest in December.

Study Animals

Animals studied were equine species (horses, mules and donkeys) of different age, sex and body condition score (BCS). The age of the animals was determined from estimated birth date by owners and by dentition (Crane and Svendsen, 1997). Body condition score (BCS) was subjectively estimated based on the guideline published by Svendsen (1997). Accordingly, the animals were grouped into three age categories, as a young when the age is less than 2 years, adult when the age is 2-10 years and old when the age is beyond 10 years as described by Yoseph *et al.* (2001). During the study period all donkeys, horses and mules were allowed to graze on communal grazing land through the year and strategic deworming was not practiced at all.

Study Design and Sample Size

A cross-sectional study was conducted to estimate the prevalence of gastrointestinal parasite and to identify the association of infection with species, sex, age and body condition of equines (horse, donkey and mule). As a part of the observational study, a questionnaire survey was administered to collect data on practices of feeding and health care. Selection of study *kebeles* was based on the availability of large numbers of equines. Based on the record obtained from the districts Agricultural Office, households having at least one equine were selected randomly by a lottery system and the study animals were randomly selected for assessment. A total of 400 equines consisting of 202 horses (157 males and 45 females), 188 donkeys (106 males and 72 females), and 45 mules (27 males and 18 females) were selected for the study based on judgment. The sample size was determined using standard procedures described by Thrusfield (2005) for an infinite population, 50% estimated prevalence, 95% confidence interval and 5% allowable error for the estimate. Based on this formula, the sample size was supposed to be 384 animals. However, in order to increase representativeness of each equine species, the number was increased to 400.

Faecal Sample Collection

Faecal samples were taken directly from the rectum using rectal gloves and were kept in sterilized universal bottle, which were tightly closed until examination. Each sample was labeled with animal identification, owners name, date and place of collection with indelible ink. Then samples were subjected to gross faecal examination for presence of parasite like *Anoplocephala* spp., within 48hrs using qualitative, quantitative, and McMaster egg counting methods (Soulsby, 1982; MAFF, 1986). The samples were kept in a refrigerator at 4^{o}C and analysis of samples was performed at Asella Regional Veterinary Laboratory.

Qualitative Techniques of Sample Examination

Sedimentation technique: Three grams of faeces was homogenized with water and the suspension was passed through a coarse mesh sieve (250ml) and the debris was discarded. The filtrate was transferred to a conical flask and allowed to stand for 2 minutes after which the supernatant was removed and the remainder was transferred (approximately 12-15ml) to a flat-bottomed tube. After further sedimentation for 2 minutes, the supernatant is again drawn off, a few drops of 5% methylene blue were added and the sediment screened using a low power stereomicroscope (Urquhart *et al*., 1996).

Flotation technique: About 2g of fresh faeces was added to 10ml of flotation solution and the thoroughly mixed suspension was poured into a test tube and more flotation solution was added to fill the tube to the top. A cover glass was then placed on the top of the surface of the liquid and the tube and cover slip were left standing for 10-15 minutes. The cover slip was removed vertically and placed on a slide and examined under the microscope (Urquhart *et al*., 1996). Microscopic examination of faeces was done as described by Hendrix (1998).

Quantitative Techniques of Sample Examination

The faecal egg count (egg/g) was considered as a quantitative indicator of infestation level and it was determined by a modified McMaster technique. Two gram of faeces was mixed in 28ml of saturated NaCl solution with a lower detection limit fixed at 50 eggs/g of faeces (MAFF, 1986). The level of infestation was determined according to the procedure described by

Zajac and Conboy (2012) as mild (<500 EPG), moderate (500-1000 EPG) and high (>1000 EPG). Moreover, first (L_1) stage larvae of *Dictyocaulus arnfieldi* were recovered by using modified Baermann technique (MAFF, 1986).

Data Management and Statistical Analysis

The data collected during sampling and laboratory findings were entered and stored in MS-excel. Before it is subjected to statistical analysis, the data were thoroughly screened for errors and properly coded. Stata/SE9 was used to perform the statistical analysis. Descriptive statistics was used to summarize and present the data. Equine GIT parasites prevalence was calculated as percentage by dividing the number of animals positive to the total sample animals. Pearson chi-square (χ^2) test was employed to assess the existence of association between parasite results and different potential risk factors considered in the study.

Results

The overall prevalence of parasites in equines in the study area was 53.5% (Table 1). Among the observed animals, 139 horses, 62 donkeys and 13 mules were identified positive for different helminthic parasites and the prevalence for each species were 73.9%, 37.12% and 28.9%, respectively. Among the infected, 55.3% of horses, 33.50% of donkeys and 24.4% of mules harbored only one type of parasite (single infection), whereas 18.6% of horses, 3.6% of donkeys and 4.4% of mules harbored two or more types of parasites (mixed infection) (Figure 1).

Strongyle type eggs were the highly prevalent parasite in all equine species while *Trichonema* spp. (3%) and *Anoplocephala* spp. (4%) in horses, and *Fasciola* spp. (3.8%), *Triodontophorus* spp. (3.8%) in donkeys and *Oxyuris equi* (10.0%) in mules were the least frequent (Table 2). Among the total 67 (31 horses, 23 donkeys and 7 mules) randomly taken faecal samples, *Dictyocaulus arnfieldi* larvae was recovered in 5 (16.12%), 3 (13.04%) and 1 (14.28) horses, donkeys and mule, respectively. The overall prevalence of lung worms was 13.43 (Table 2).

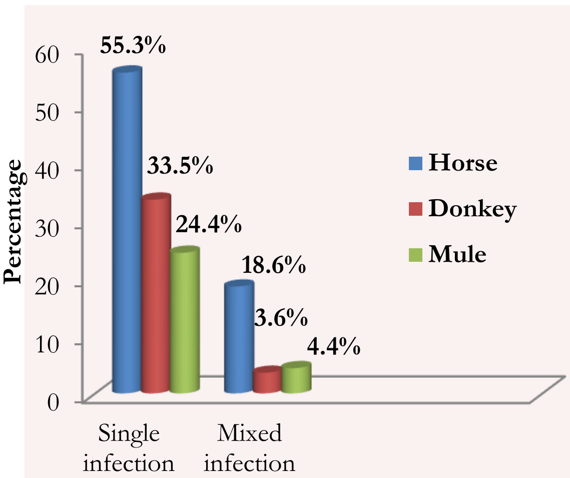

Figure 1: Prevalence of single and mixed infection of equine species with gastro intestinal parasites

Table 1. Prevalence of gastrointestinal helminthes in equines

Species of equine	No. of examined animals	No. of positive animals	Prevalence (%)	CI
Horse	188	139	73.9	67.0-80.0
Donkey	167	62	37.1	29.8-44.9
Mules	45	13	28.9	16.4-44.3
Total	**400**	**214**	**53.5**	48.5-58.5

Table 2. Prevalence of helminth parasite of equines for coprological examination

Egg/larvae of parasite	Horse		Donkey		Mule	
	Positive	Prevalence (%)	Positive	Prevalence (%)	Positive	Prevalence (%)
Strongyles	53	53.5	23	43.3	5	50.0
Parascaris equorum	21	21.2	11	20.8	2	20.0
Oxyuris equi	13	13.1	7	13.2	1	10.0
Trichonema spp.	3	3.0	3	5.7	0	0
Fasciola spp.	0	0	2	3.8	2	20.0
Anoplocephala spp.	4	4.0	5	9.4	0	0
Triodontophorus spp.	5	5.0	2	3.8	0	0
Over all	**99**	**55.3**	**53**	**33.5**	**10**	**24.4**

Chi-square analysis of different risk factors showed that age, sex and BCS were not significantly associated with the infection of GIT parasite ($p>0.05$), but age tended to be significant ($p=0.061$). The species of the animal was significantly associated ($p<0.05$) with GIT parasite infection (Table 3).

Evaluation of the degree (severity) of parasitic infection showed heavy infestations of helminthiasis in horses than donkeys and mules (Table 4).

Table 3: The association between risk factors and helminth parasites infestation of equine

Variables	Categories	No. of animals examined	No. of animals positive	Prevalence (%)	χ^2	P-value
Species						
	Horse	188	139	73.9		
	Donkey	167	62	37.1	60.5157	0.001
	Mules	45	13	28.9		
Sex						
	Female	207	127	61.35	1.1114	0.292
	Male	193	87	45.07		
Age						
	Young	105	74	70.47		
	Adult	177	45	25.4	5.6052	0.061
	Old	118	95	80.5		
BCS						
	Poor	137	94	68.6		
	Medium	162	79	48.8	1.2148	0.545
	Good	101	41	40.7		
Total		**400**	**214**	**53.5**		

Table 4. Helminth infestation levels of equines based on EPG of faeces in Asella district

Species	No. of animals examined	Degree of infestation		
		Mild (<500)	**Moderate (500-1000)**	**Heavy (>1000)**
Horse	139	4 (2.87%)	10 (7.19%)	125 (89.9%)
Donkey	62	3 (4.8%)	7 (11.29%)	52 (83.87%)
Mule	13	2 (15.38%)	5 (38.46%)	6 (46.15%)
Total	**214**	**9 (4.2%)**	**22 (10.28%)**	**183 (85.5%)**

DF= 2; p<0.005; χ^2= 60.5157; Coef.= -0.2721337; SE= 0.0344763; 95% confidence interval= -0.3399122- -0.2043552.

Discussion

The high prevalence of GIT parasite in horse and donkeys than mules might be associated with the less attention given to horses and donkeys by the owners than mules. In the study area, many equines are allowed to graze together on small plots of land throughout the year. This creates conducive condition for contamination between animals. The prevalence of helminthes in the current study was higher than that reported by Sawsan *et al.* (2008) who reported prevalence of 15.7% for horse and 37.5% for donkeys in South Darfur state. The current finding, however, was lower than other findings in Ethiopia which noted a 100% prevalence of helminthic parasites in donkeys in Wonchi, West highland of Oromia, Highlands of Wollo and Dugda Bora district (Yoseph *et al.*, 2001; Fikru *et al.*, 2005; Mulate, 2005; Gizachew *et al.*, 2006). A prevalence of 80.5% of equines parasites were also reported in Nepal (Mattioli *et al.*, 1994). The relative low occurrence of helminthic parasites in equines in the present study areas than earlier studies might be associated with the agro-ecological differences and the practice of veterinary services provided by Asella Regional Veterinary Laboratory and district clinic for equines. High number of types of helminthic parasites is probably due to suitable humidity, moisture and temperature available throughout the year for the eggs to develop to larval stage (L_3) (Andrews, 1999), development and maturation of the larvae (Lima *et al.*, 1990) and ample amount of water that facilitated the migration of larvae from manure to the herbage (Lima, 1998) and development and multiplication of snails for transmission of *Fasciola* species.

High prevalence of strongyle type eggs (ranged 43.3% to 53.5%) in faeces of equines was expected since strongyles mostly represent 75% to 100% of whole nematodes infections (Bowman *et al.*, 2003). The high infection of horses and mules by GIT strongyles is associated with access of animals to grazing and the lack of strategic anthelmintics intervention for these animals in the study area, which is in accordance with the finding of Jemal (2008).

The prevalence of *Parascaris equorum* obtained in the present study agrees with the prevalence reported for horses and donkeys in Ethiopia. Yoseph *et al.* (2005) and Getachew *et al.* (2008) reported a prevalence of 15.7% and 16.2%, while lower and higher prevalence of *Parascaris equorum* was reported by Fikru *et al.* (2005) (7.3%) and Alemu *et al.* (2004) (40%) in horse from different parts of Ethiopia. The prevalence of *Parascaris equorum* in donkeys (20.8%) is similar with that reported by Fikru *et al.* (2005) who obtained 17.3% but higher than the value noted by Yoseph *et al.* (2001) who reported 5.7%. The prevalence of *Parascaris equorum* is not consistent among different studies, which could be attributed to the compromised immune responses related to concurrent disease and calls for further investigation. *Oxyuris equi,* which is the 3rd prevalent eggs of parasites detected in horses and donkeys in the current study was high as compared to 3% (Gizachew *et al*., 2006) and 2% (Getachew *et al*., 2008) in donkeys in central Ethiopia and 2.1% (Fikru *et al*., 2005) in horses in Western parts of Ethiopia.

The prevalence of *Fasciola* spp. in the current study in donkeys (3.8%) is lower than report of Getachew *et al.* (2010) who reported 80% in donkeys. Slightly lower prevalence (1.5%) of fasciolosis in donkeys was reported by Gizachew *et al.* (2006) from Dugda Bora district of central Ethiopia. The lower prevalence of *Fasciola* eggs in the current study compared to the reports of Getachew *et al.* (2010) is due to the geographical location of the area which is not suitable for the snail population, the intermediate host of *Fasciola* species. Moreover, the work of Getachew *et al.* (2010) was conducted in fasciolosis endemic area and is not representative for the whole country. In the current study area, only very few areas, where summer tributaries are dried off are found to be swampy to function as a reproduction area for snails. Hammami and Ayadi (1999) noted that permanent dampness, suitable luminosity, basic pH of soil, water and temperature influences the multiplication of snails. The low prevalence of *Anoplocephala* spp. in horses as compared to earlier studies (Yoseph *et al*., 2001; Desalegn, 2005) could be due to the seasonality of orbited mite's vectors (Soulsby, 1986).

The prevalence of *Trichonema* spp. in horses and donkeys is lower when compared to the previous studies (Mohammed, 1988; Alemayehu, 1995). The overall prevalence of *Dictyocaulus arnfieldi* in the present study (13.4%) was quite higher than reported by Hassan (2000) who reported 3.3%. However, this finding is similar with reports of Yoseph (1996) and Gazahegn (2000) who reported 9.38% and 20%. This variation might be due to the differences in agro-ecology of study areas and number of sampled donkeys. Donkeys act as reservoir of *Dictyocaulus arnfieldi* and serve as a source of infection for horses (Beelitz *et al*., 1996).

The present study confirmed the presence of statistically significant difference between species but there was no association in prevalence of GIT parasite versus age, sex and body condition score. Some previous studies noted that female equines than their male counterpart (Sapkota, 2009), old than young animals (Alemayehu, 1995; Sapkota, 2009), and poor body condition than well-conditioned animals (Gizachew *et al*., 2006; Nuraddis *et al*., 2011) have significantly higher infestation of GIT parasite due to lower immunity. In agreement with the present study, a previous work also recorded absence of statistical significance difference between some of the risk factors, which could be attributed to increased cultivated land, which restricts animals on small communal grazing land disposing all animals to continuous exposure (Gizachew *et al*., 2006). The severity of infection in donkeys reported in the current study was similar with that obtained in Sudan (58.6%, 21.9%, and 19.5% for mild, moderate and severe infections, respectively) (Seri *et al*., 2004). This may be attributed to management system and deworming strategy followed for donkeys, horses and mules in these places.

Conclusion

The results of the present study revealed that eight types of helminth parasites (strongyles*, Oxyuris equi, Triodontophorus* spp.*, Trichonema* spp.*, P. equorum, D. arnfieldi, Anoplocephala* spp.*, Fasciola* spp.) were found in horses, donkeys and mules with an overall prevalence of 53.5%. Horses were at higher risk of infestation than donkeys and mules. Among the identified GIT parasites, the highest relative percentage was recorded for strongyles while less occurrence was observed for *Trichonema* spp. followed by *Anoplocephala* spp. and *Triodontophorus* species. Statistically significant association was observed among equine species and prevalence of gastrointestinal parasites. Thus, strategic deworming using broad spectrum anthelmintic drugs shall be implemented to reduce pasture contamination and infection of susceptible hosts. Moreover, in depth understanding of the epidemiology of gastrointestinal helminths of equines could have significant importance for strategic control.

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Conflict of Interests

The authors declare that they have no competing interests.

References

Alemayehu Hailu (1995). Prevalence of equine helminthiasis in specific sites in Arsi and Bale regions, DVM Thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre-Zeit.

Alemu Gebrewold, Azage Tegegn & Alemu Yami (2004). Research needs of donkeys utilization in Ethiopia. In D. Fielding & P. Starkey (Eds.), *Donkey, people and Development*, A resource book of the animal traction network for Eastern and southern Africa (ATNESA) (pp. 77-81), Technical Center for Agriculture and rural Cooperation (TCA), Wagningeh, the Netherlands.

Andrews, S. J. (1999). The life cycle of *Fasciola hepatica*. In J. P. Dalton (Ed.), *Fasciolosis* (pp. 1-30), CABI Publishing, Walling Ford, UK.

Basaznew Bogale, Zelalem Sisay & Mersha Chanie (2012). Strongyle Nematode Infections of Donkeys and Mules in and Around Bahirdar, Northwest Ethiopia. *Global Veterinaria*, 9 (4): 497-501.

Beelitz, P., Gobel, E. & Gothe, R. (1996). Endoparsites of donkeys and horses kept in communal housing in upper Bavaria; species spectrum and incidence. *Tierarztliche Praxis,* 24 (5): 471-475.

Bowman, D. D., Lynn, R. C. & Eberhard, M. L. (2003). Georgis' parasitology for veterinarians; 8th ed. St. Louis: W.B. Saunders, Elsevier Science.

Clayton, H.M. (1986). Ascarids: Recent Advances. *Veterinary clinics of North America: Equine Practice*, 2: 313-328.

Crane, M. & Svendsen, E. (1997). The professional handbook of the donkey, 3rd ed., Whittet Books Limited, London, UK, pp: 29.

CSA (Central Statistical Authority) of Ethiopia (2016/17). Federal Democratic Republic of Ethiopia central statistical agency agricultural sample survey, volume II report on livestock and livestock characteristics (private peasant holdings) Addis Ababa. April 2017, 585 Statistical Bulletin 585.

Desalegn Amenu (2005). Status of parasitism in Donkeys of intervention and non-intervention areas, a comparative study. DVM Thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre-Zeit.

FAOSTAT (Food and Agriculture Organization Statistical Databases) (2016). FAOSTAT Database. FAO, Rome, Italy. Retrieved from http://www.fao.org/faostat/en/#data/QA

Feseha Gebreab (1998). Helminth parasites of working equids: the African perspective. In: U. Wernery, J. F. Wade, J. A. Mumford and O.R. Kaaden (eds.), Proceedings of the 8th International Conference on Equine Infectious Diseases, Dubai, pp: 318-323.

Fikru Regassa, Reta Duguma, Teshale Sori & Bizunesh Mideksa (2005). Prevalence of equines gastrointestinal parasites in western highland of Oromia. *Bulletin of Animal Health and Production in Africa*, 53 (3): 161-166.

Gazahegn Eshate (2000). A preliminary study on health and productivity status of "Ghari" mules in and around Bahir-Dar, DVM Thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre-Zeit.

Getachew Mulugeta., Feseha Gebreab, Trawford, A. & Reid, S. W. J. (2008). A Survey of Seasonal Patterns in Strongyle Faecal Worm Egg Counts of Working Equids of the Central Midlands and Lowlands of Ethiopia. *Tropical Animal Health and Production*, 40 (8): 637-642.

Getachew Mulugeta, Trawford, A. Feseha Gebreab & Reid, S. W. (2010). Gastrointestinal Parasites of Working Donkeys in Ethiopia. *Tropical Animal Health and Production*, 42 (1): 27-33.

Gizachew Ayele, Feseha Gebreab, Bojia Endebu & Joe, A. (2006). Prevalence of Gastrointestinal Parasites of Donkeys in Dugda Bora District, Ethiopia. *Livestock Research for Rural Development*, 18 (10). Available at http://www.lrrd.org/lrrd18/10/ayel18136.htm

Gizaw Negussie (1987). Policy and strategy option towards rapid development of Ethiopia. Livestock improvement conference, IAR Ethiopia, pp: 191.

Graber, M. (1975). Helminths and Helminthiasis of Different Domestic and Wild Animals of Ethiopia. *Bulletin of Animal Health Production in Africa*, 23 (1): 57-86.

Hagos Ashenafi (2005). Serological and parasitological survey of Dourine (*Trypanosome equiperdum*) in selected sites of Ethiopia. MVSc Thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre-Zeit.

Hammami, H. & Ayadi, A. (1999). Ecology of *Lymnae truncatula* Muller, intermediate host of *Fasciola hepatica* Linne in the microclimate of Tozeur (southeast of Tunisia). *Bullestin de la Societe de Pathologie Exotique*, 92 (5): 302-4.

Hassan Kebede (2000). A preliminary study on the socio-economic importance, health problems and other management constraints of horse in mid and high land areas of north Gondar. DVM Thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre-Zeit, Ethiopia.

Hendrix, C. M. (1998). Diagnostic Veterinary Parasitology, 2nd ed., Mosby.

Jemal Said (2008). The study on the prevalence of GI strongyles among equine species in and around Assela and assessment of the magnitude of this parasitism in relation to age sex and management system. DVM Thesis, Faculty of Veterinary Medicine, Addis Ababa University, Debre-Zeit, Ethiopia.

Krecek, R.C., Reinecke, R. K. & Horak, I. G. (1989). Internal parasites of horses on mixed grassveld and bushveld in Transvaal, Republic of South Africa. *Veterinary Parasitology*, 34 (1&2): 135-143.

Lima, J. D., Lima, W. S. & Guimaraes, A. M. (1990). Epidemiology of bovine nematode parasites in Southeastern Brazil. In: J. Guerrero & W. H. D. Leaning (Eds.), Proceedings of MSD. AGUET symposium, Epidemiology of Bovine Nematode Parasites in Americas, Bahia, Brazil, pp. 49-63.

Lima, W. S. (1998). Seasonal infection pattern of gastrointestinal nematodes of beef cattle in Minas Gerais State-Brazil. *Veterinary Parasitology*, 74 (2-4): 203-214.

MAFF (Ministry of Agriculture, Fisheries and Food) (1986). Manual of Veterinary Investigation Laboratory Techniques, London, *Technical Bulletin*, 18: 129.

Marquardt, W. C., Demaree, R. S. & Grieve, R. B. (2000). Parasitology and Vector Biology, 2nd ed., Harcourt Academic Press, London, pp. 381-385.

Mattioli, R.C., Zinsstag, J. & Pfister, K. (1994). Frequency of trypanosomosis and gastrointestinal parasites in draught donkeys in the Gambia in relation to animal husbandry. *Tropical Animal Health and Production*, 26 (2): 102-108.

Mohammed Abdurezak (1988). Epidemiology and control of donkey endoparasitism, DVM Thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre-Zeit, Ethiopia.

Mulate Belay (2005). Preliminary Study on Helminthosis of Equines in South and North Wollo Zones. *Journal of Veterinary Association*, 9: 25-37.

Nuraddis Ibrahim, Tilahun Berhanu, Benti Deressa & Tadele Tolosa (2011). Survey of Prevalence of Helminth Parasites of Donkeys in and Around Hawassa Town, Southern Ethiopia. *Global Veterinaria*, 6 (3): 223-227.

Radostits, O. M., Gay, C. C., Hinchcliff, K. W. & Constable, P. D. (2006). Veterinary medicine: a textbook of the diseases of cattle, Horses, sheep, pigs and goats, 10th ed., Saunders Elsevier, Edinburgh, London, New York, Oxford, Philadelphia, St Louis, Sydney, Toronto.

Sapkota, R. C. (2009). A report on prevalence of helminthes parasites in mules of Brick Kiln of Lalitpur District, Himalayan College of Agricultural Sciences and Technology, Purbanchal University Gatthaghar, Bhaktapur. Retrieved from https://animalnepal.files.wordpress.com/2012/01/report-ram-chandra-sapkota.pdf

Sawsan, M. A. I., Hassan, T., Seri, H. I. & Hidaia, B. Z. (2008). Field investigation of gastrointestinal nematodes in horses and donkeys in South Darfur State Sudan, 13th scientific congress, Faculty of Veterinary Medicine, Assiut University, Egypt, pp: 723-729.

Seri, H. I., Hassan, T., Salih, M. M. & Abakar, A. D. (2004). A survey of gastrointestinal nematodes or donkeys (*Equus asinus*) in Khartoum State. *Journal of Animal and Veterinary Advances*, 3 (11): 736-739.

Soulsby, E. J. L. (1982). Helminthes, Arthropods and Protozoa of Domesticated Animals, 7th ed., Bailliere, Tindall, London, pp: 650-700.

Soulsby, E. J. L. (1986). Helminths, Arthropods and Protozoa of Domesticated animals. 7th ed., Lea and Febiger, Philadelphia, USA, pp: 357-504.

Svendsen, E. D. (1986). The professional handbook of donkeys, sovereign printing group, England, pp: 77-78.

Svendsen, E. D. (1997). Parasites abroad: The professional handbook of the donkey, 3rd ed., Whittet Books Limited, London, pp:166-182.

TDARDB (Tiyo District Agricultural and Rural Development Bureau) (2003). Technical report.

Thrusfield, M. (2005). Veterinary Epidemiology, 3rd ed., Blackwell Science Ltd., U.K., pp: 229-245.

Urquhart, G. M., Armour, J., Duncan, J. L & Jennings, F. W. (1996). Veterinary Parasitology, 2nd ed., Blackwell Science, pp: 42-47.

Yilma Jobre Mokonen, Feseha Gebreab, Svendsen, E. D & Mohammed, A. (1991). Health problems of working donkeys in Debere-zeit and Menagesha regions of Ethiopia. In: D. Fielding and R. A. Pearson (eds.), Donkeys, mules and horses in tropical agricultural development, Proceedings of a colloquium, 3-6 September, 1990, Edinburgh, Scotland, pp: 151-155.

Yoseph Legesse (1996). Preliminary survey on management Aspects and Helminth problems of Donkeys in Dire Dawa and East Oromia, DVM Thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre-Zeit, Ethiopia.

Yoseph Shiferaw, Feseha Gebreab & Abebe Wossene (2001). Survey on Helminthosis of Equines in Wonchi, Ethiopia. *Ethiopia Journal of Veterinary Association*, 5: 47-61.

Yoseph Shiferaw, Smith, D. G., Mengistu, A., Teklu, F., Firew, T. & Betere, Y. (2005). Seasonal Variation in the Parasite Burden and Body Condition of Working Donkeys in East Shewa and West Shewa Regions of Ethiopia. *Tropical Animal Health and Production*, 37 (1): 35-45.

Zajac, M. A. & Conboy, A. G. (2012). Veterinary clinical Parasitology 8th ed., London, Blackwell publishing, UK, pp: 67-72.

Zerihun Asefa, Bersissa Kumsa, Bojia Endebu, Ayele Gizachew, Tesfaye Merga & Elana Debela (2011). Endoparasites of donkeys in Sululta and Gefersa District of central Oromia, Ethiopia. *Journal of Animal and Veterinary Advances*, 10 (14): 1850-1854.