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The Occurrence of Gastro Intestinal Parasites of Donkeys in and Around Holeta Town, Oromia Regional State, Ethiopia

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Abstract: A cross-sectional study was conducted in Holeta Town, Finfinne Zuria Special Zone, Oromia Regional State, Ethiopia from November 2016 to April 2017 to determine the prevalence and evaluate the correlation between quantifiable factors and the occurrence of gastrointestinal parasitosis in donkeys. From 384 fecal samples obtained by simple random technique and evaluated by flotation, sedimentation, and Baerman fecal examination techniques, an overall prevalence of 95.39% was discovered. The major parasites identified by qualitative faecal examination techniques were Strongyles spps. (74.7%), Parascaris equorum (8.1%), Strongyloides spps. (3.6%), Gastrodiscus aegypticus (18.5%), Oxyrus equi (15.1%), Fasciola spps. (19%), Anoplocephala spps. (3.1%) and Trichonema spps (62.5%). Coproculture of positive samples revealed the occurrence of Strongylus vulgaris (51.8%), Strongylus edentates (35.3%), Strongylus equinus (26.3%), Trichostrongylus axei (4.7%) Strongyloides westeri (3.6%), and Triodonthophorus tenuicollis (30.2%). There was statistically significant association ($p < 0.05$) between the prevalence of Strongyliodes westeri infection and body condition score, being more prevalent (57.1%) in animals with poor body condition score than moderate, ideal and fat (35.7%' 7.1%' 0%) body condition scores respectively. There was no statistically significant difference ($P > 0.05$) among different age and between both sex groups, except for P. equorum and Strongylus vulgaris which were found prevalent in different age groups. Deworming status was found to be significant ($P < 0.05$) for Triodontophorus tenuicolis and Trichonemia spps, with higher prevalence found in non-dewormed donkeys in both cases. The current study strongly suggested that donkey gastro intestinal parasites are still common and economically significant in the study area, severely limiting the productivity of donkeys there. Given the significance of these animals to the economy, additional and intensified treatment and control intervention is therefore strongly advised.

Keywords: Baerman, Coproculture, Floatation, Prevalence, GIT Parasite, Holeta, Sedimentation, Donkeys

1. Introduction

One of the earliest domesticated equine that have traveled across the world is the donkey (Equus asinus). There are more than 40 million donkeys living in the globe today [12].

There are an estimated 13 million donkeys in Africa [32], and Ethiopia is home to roughly 6.21 million of them, or 32% of all the donkeys in Africa and 10% of the world's population [3]. Ethiopia, a country in Eastern Africa, depends heavily on agriculture. The nation's various agro-ecological zones have influenced the development of various agricultural production techniques. All of the nation's ecological zones are used for animal production. Donkeys are most commonly found in our country's arid and mountainous regions [6].

Donkeys continue to be excellent candidates for the title of beasts of burden notwithstanding the rise of mechanization in society. They play a significant role in many developing nations' agricultural systems. The widespread use of donkeys in both rural and urban parts of Africa serves as evidence of this. Donkeys are said to have a significant impact on social equality and food security frameworks in nations with high levels of food insecurity [28]. Donkeys are the most valued, suitable, and cost-effective pack animals due to the country's difficult terrain and low level of development of the road

transportation network [14].

Donkeys have reduced the domestic burden of rural people especially for women and have created employment and income generating opportunities for many people. They are kept and often used for pack purposes, riding, providing of manure for both energy and soil fertility [22]. Also in areas where draft power is a constraint for crop cultivation a pair of well-conditioned donkeys could be used as an alternative draft power sources for secondary and tertiary land preparation [1].

Donkeys appear to be an effective entry point for assisting women not only in domestic responsibilities, but also enabling women to be engaged in income-generating activities which otherwise they may not have had access to perform [21].

Although there are large numbers of donkeys in the country with the great contributions to national economy, certain impediments hinder the maximum utilization of these animals to their potential. Some of these are the abundantly occurring infectious and parasitic diseases and the poor management system to these animals in the country [24]. Infectious and non-infectious disorders can affect donkeys in many ways. GIT helminthes are one of the most prevalent conditions that globally limit the health and wellbeing of donkeys among these contagious diseases [41].

Of the diseases that cause serious problems, parasitism represents a major impact on donkey production in the Ethiopia. Donkeys harbor a large quantity of parasite that prevail in the GIT including round worms (families: Stronglidae, oxyuridae, Trichostronglidae and Ascaridae) and tapeworm (family: Anopiocephalidae) which act up and damage the intestine depend on the age and natural defense of the individual equine [29]. These parasites share with the equine digestive nutrients and lead to retard growth or reduce work out put, discomfort and pains of various degrees and even mortality of the animals [11].

Despite the huge numbers and the increasing importance of donkeys in the Ethiopian economy the attention given by Governmental and non-Governmental organizations to donkeys has been far below to what it deserves and very little research relating to donkeys helminthosis has been carried out. This might be partly due to the wrong perception that the donkey does not require a lot of care, that when donkeys do get sick they are quick to die, and the donkey's low traditional status [21].

Therefore, the objectives of this study are:

1. To estimate the prevalence of major GIT parasites affecting donkeys and
2. To assess the association of measurable parameters with GIT parasitosis.

2. Materials and Methods

2.1. Study Area

From November 2016 to April 2017, the research was carried out in and around the Holeta town of Finfinne Zuria, Special Zone, Oromia Regional State, Ethiopia. Holeta Town is located 33 kilometers (km) west of Addis Abeba, at 38° 30' East and 9° 3' North latitude, and at a height of around 2400 meters above sea level. The location is known for its cool sub-tropical climate, with mean maximum and lowest temperatures of 22.3 and 6.16 degrees Celsius, respectively, and a mean relative humidity of 59 percent. The average annual rainfall was 1014 mm, but the range was 818 to 1247 mm. There are three seasons: the dry season (October to February), the long rainy season (June to September), and the short rainy season (March to May) (October to February).

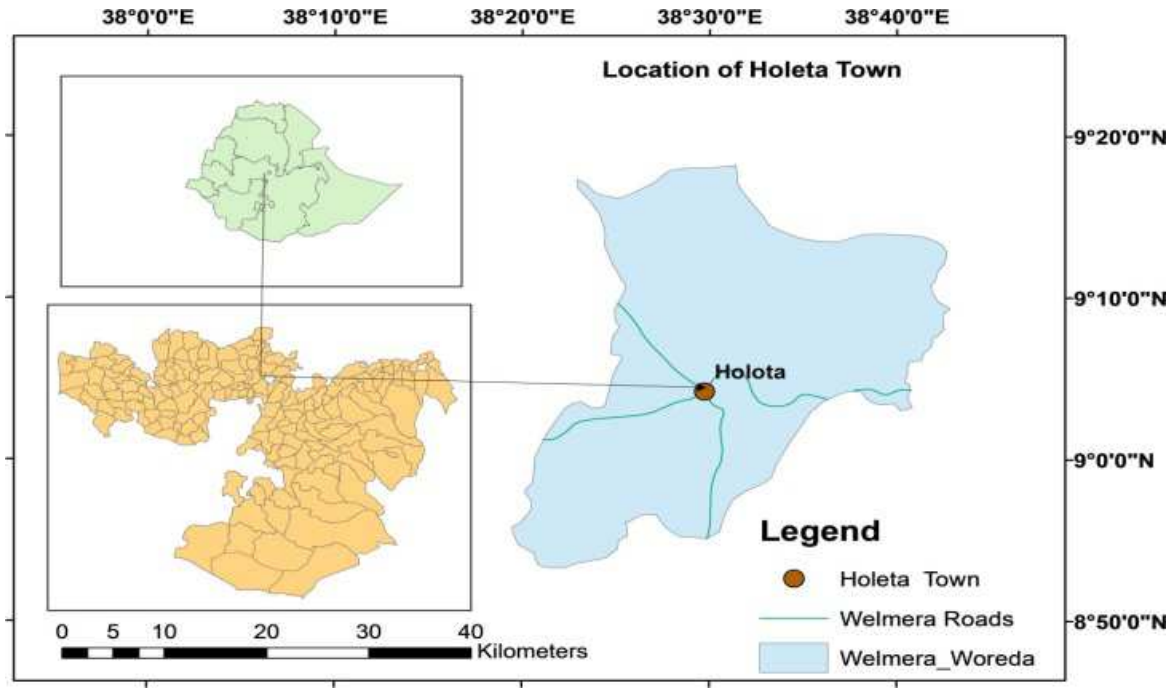

Figure 1. *Map of Holeta Town.*

2.2. Study Animals and Sampling Technique

384 donkeys in and around Holeta town in Finfinnee Zuria, Special Zone Oromia Regional State, Ethiopia, were randomly chosen as the study's animals. Individual farmers owned the animals, which they packed to make money and used for domestic purposes. Regardless of age or sex, samples were taken at random from donkeys that were either sub clinically or clinically ill.

2.3. Study Design

A cross sectional study was conducted from November 2016-April 2017 in and around Holeta town, finfinne Zuria, Special Zone Oromia Regional State, Ethiopia to determine the prevalence rate and the major Gastro Intestinal parasite of donkey. Samples were collected randomly and each examined animals were registered in prepared data collection format.

2.4. Sample Size Determination

The sample size for this study was calculated by [36] with a 95% confidence level, a 5% precision, and a 50% predicted prevalence.

$$n=\frac{1.962Pexp\ (1\text{-}Pexp)}{d2}=\frac{1.962\ 0.5(1\text{-}0.5)}{0.052}=384$$

Where, Pexp = expected prevalence; d= absolute precision; n=sample size. Accordingly, a total of 384 donkeys were used in this study. Hence, accordingly, total of 384 donkeys were used for this study.

2.5. Age and Body Condition Estimation

During sample collection various potential risk factors including; sex, and age, deworming status and body condition score were recorded. The age of donkeys was determined by dentition using the given standard [10] and body condition scores were also being estimated based on the published guideline NEWC [26]. Donkeys were grouped into three age categories less than 3 years of age were classed as young; those in range of 4 to 8 years grouped as adult and those above 9 years were classified as old.

2.6. Sample Collection and Examination

Fecal samples were collected directly from the rectum into universal bottle using sterile disposable gloves. Each sample were labeled with necessary information and immediately transported to Holeta animal health research center parasitology laboratory. These samples were processed within 48 hours. It was kept in refrigerator at 4°C if immediate processing was not possible. Sedimentation, floatation techniques and bearman techniques were used to identify the eggs in feces and presence of parasite larvae after examined microscopically by 10x and 40x by following their procedures. Identification of the eggs was made on the basis of their morphology [31].

2.6.1. Faecal Sample Examination

For the purpose of identifying larvae and determining whether parasite eggs were present, various qualitative and quantitative faecal examination techniques were used. The sedimentation and floatation technique was used to conduct a qualitative feces examination. Fecal samples were cultivated, and the larvae were retrieved using the Baer man apparatus technique for parasite identification down to the species level. Then, using a lower power microscope (10X objectives) and an oil emersion microscope (100X objectives), the larvae were recognized based on the number of gut cells and the relative size and form of their tails [19]. The study's floating medium was a supersaturated solution of salty sodium chloride that was made in a lab. For the aforementioned parasitological techniques, we followed the instructions provided by [38].

2.6.2. Fecal Culture

As the eggs of parasite species have much in common, it is difficult to make identification based on the kind of eggs, so for identification of such parasites to species level faecal samples were cultured and the larvae were recovered using Baermann apparatus technique. Identification of larvae (L3) was based on the shape and gut cells, relative size of sheath tail and shape of tail of larvae [41].

2.7. Data Analysis

All of the row data that had been obtained was entered into a Microsoft Excel spreadsheet and coded. The statistical analysis was done with the aid of SPSS version 20. Prevalence was calculated using a percentage. The degree of connection between risk variables and the prevalence of gastrointestinal parasites was also determined using chi-square. A difference was considered significant in the study when the p-value was less than 0.05 and the confidence level was maintained at 95%.

3. Results

3.1. Coproscopical Examination

During the study period, from a total 384 donkey (348 male and 36 female) samples examined an overall GIT parasite prevalence of 95.3% was found. The parasites encountered with their respective overall prevalence rates in the study area include: Strongyle spp. (74.7%), Oxrus equi (15.1%), Parascaris equorum spps (8.1%), Faciola spp(19%), Gastrodiscus spp. (18.5%), Strongyliodes spp. (3.6%), Trichonema spp. (62.8%) and Anoplocephala spp. (3.1%) (Table 1).

Table 1. *Overall prevalence of GIT parasites of donkeys by coproscopical examination.*

Parasite	Number of positive animals	Prevalence (%)
Strongylesspp	287	74.7
Oxyrusequi	58	15.1
Parascarisequorum	31	8.1
Strongyloidespp	14	3.6
Faciolaspp	73	19
Gastrodiscusspp	71	18.5
Anoplocephalaspp	12	3.1
Trichonemaspp	241	62.8

3.2. Baerman's Technique Examinations

By using the Baerman approach to identify L3 GI parasites from coprocultured feces, it was discovered that Trichonema spp., *Strongylus vulgaris*, *Strongylus edentatus*, and *Triodonthophorus tenuicollis* predominated over the other GI parasites (Table 2).

Table 2. *Species of GI parasites identified from coprocultured faeces.*

Species of parasite	Number positive	Prevalence (%)
Strongyle vulgaris	199	51.8
Strongyle edentates	135	35.3
Strongyle equines	101	26.3
Tricostrongylusaxie	18	4.7
Strongyliodwesteri	14	3.6
Triodonthophorustencollis	116	30.2
Trichonemaspp	241	62.8
Gastrodiscusaegypticus	71	18.5

Table 3. *Concurrent infection rate of GI parasites.*

Concurrent infection	Number positive	Percentage (%)
One species	46	12
Two species	108	28.1
Three species	212	55.2

Assessment of concurrent infection status indicated the existence of higher rate of infection 212 (55.2%) by three or more species of parasites than infection by two 108 (28.1%) parasite species and a single 46 (12%) parasite species (Table 3).

3.3. Analysis of Risk Factors

Analysis of different risk factors showed occurrence of significant association of age, body condition score and deworming status ($P < 0.05$) and non-significant association of sex of the animal with GI parasite infection (Table 6).

Association of BCS with larvoscopic exanimation revealed highest and lowest prevalence of 58.8%, and 28.4%, for Strongylus vulgaris and Triodontophorus tenuicollis with other parasite spps found being in between this two extremes in donkeys with poor body condition score. In moderate, ideal and good body condition scored animals the highest and lowest prevalence rates of Trichostrongylus axei (61.1%) and Strongyliod westeri (35.7%), Strongyliodwesteri (7.1%) and Strongylus vulgaris (0.5%), Triodontophorustenuicollis (35.3%) and Trichonema spp (32.2%) There was statistically significant difference ($P < 0.05$) in prevalence of Strongyliod westeri (Table 4).

Table 4. *Prevalence of GIT parasites of donkeys between the body condition scores.*

Species of parasite	BCS				X^2	P-Value
	Poor (%)	Moderate (%)	Ideal (%)	Fat (%)		
Strongylus vulgaris	117 (58.8)	81 (40.7)	1 (0.5)	0	2.526	0.471
Strongylus edentates	77 (57.0)	58 (43.0)	0	0	1.097	0.778
Strongylus.equines	55 (54.5)	46 (45.5)	0	0	1.183	0.757
Strongyliodes westeri	8 (57.1)	5 (35.7)	1 (7.1)	0	26.622	0.000
Parascaris equorum	18 (58.1)	13 (41.9)	0	0	0.184	0.980
Triodontophorus tenuicollis	33 (28.4)	42 (36.2)	0	41 (35.3)	14.904	0.684
Gastrodiscus aegypticus	36 (50.7)	34 (47.9)	1 (1.4)	0	5.856	0.119
Anoplocephala spp	6 (50)	6 (50)	0	0	0.338	0.953
Trichonema spp	69 (28.9)	92 (38.2)	0	80 (32.2)	46.29	0.245
Trichostrongylus axei	7 (38.9)	11 (61.1)	0	0	2.738	0.434

The prevalence of GIT parasites among age category revealed Parascaris equerum (83.9%) as highest and Oxyuris equi, Strongylus edentates, Strongyliod westeri, Anoplocephala spp. and Trichostrongylus axei were the least (0%) in young. In adult, Anoplocephala spp (75%) highly prevalent and Parascaris equerum(16.1%)was the lowest. In old age groups, Oxyuris equi (63.2%) and Parascaris equerum (0%) highest and lowest respectively. There was statistically significance ($P <0.05$) in prevalence of Parascaris equerum and Strongylus vulgaris (Table 5).

Table 5. *The relative prevalence of GIT parasites among age category.*

Species of parasite	No of positive in each age category (%)			X^2	P-Value
	Young (%)	Adult (%)	Old (%)		
Strongylus vulgaris	5 (2.5)	129 (64.8)	65 (32.7)	0.385	0.032
Strongylus edentates	0	86 (63.7)	49 (36.3)	5.322	0.070
Stronglus equines	2 (2)	67 (66.3)	32 (31.7)	0.59	0.971
Stronyliodes westeri	0	10 (71.4)	4 (28.6)	0.455	0.796
Oxyurisequi	0	37 (63.8)	21 (63.2)	1.729	0.421
Parascarisequerum	26 (83.9)	5 (16.1)	0	44.678	0.000
Triodontophorus tencollis	1 (0.9)	75 (64.7)	40 (34.5)	1.393	0.498
Fasciola spp	2 (2.7)	50 (68.2)	21 (28.8)	0.718	0.698
Anoplocephalaspp	0	9 (75)	3 (25)	0.651	0.722
Cythostomespp	3 (1.2)	162 (67.2)	76 (31.5)	2.731	0.255
Gastrodiscusaegypicus	1 (1.4)	41 (57.7)	29 (40.8)	2.804	0.246
Trichostrongylusaxei	0	12 (66.7)	6 (33.3)	0.407	0.818

Sex wise prevalence of the parasitic prevalence showed highest and lowest of prevalence of Parascaris equorum (16.1%) and Anoplocephala spp. (0%) in females; and Anoplocephala spps (100%) and Trichostrongylus axei (83.3%) in males respectively (Table 6).

Table 6. *The relative prevalence of GIT parasites among the sex category.*

Species of Parasites	Sex			X^2-Value	P-Value
	Female (%)	Male (%)			
Strongylus vulgaris	199	20 (10.1)	179 (89.9)	0.221	0.638
Strongylus edentates	135	17 (12.6)	118 (87.4)	2.530	0.111
Strongylusequines	101	13 (12.9)	88 (87.1)	1.967	0.160
Strongyliodwesteri	14	2 (14.3)	12 (85.7)	0.411	0.521
Parascarisequorum	31	5 (16.1)	26 (83.9)	1.806	0.178
Triodontophorustenuicollis	116	10 (8.6)	106 (91.4)	0.111	0.739
Gastrodiscusaegypticus	71	5 (7)	66 (93)	0.556	0.455
Anoplocephala spps	12	0	12 (100)	1.278	0.258
Trichonema spps	241	20 (8.3)	221 (91.7)	0.884	0.348
Trichostrongylusaxei	18	3 (8.3)	15 (83.3)	1.179	0.277

The prevalence of GIT parasites among non-dewormed donkeys revealed high prevalence of Strongyliodes westeri and Anoplocephala spps. (100%) and low prevalence of Trichostrongylus axei (94.4%). In dewormed donkeys Trichostrongylus axei (5.6%) was highest and Strongyliod westeri and Anoplocephala spps (0%) were the lowest. There was statistically significance ($P < 0.05$) in prevalence of Triodontophorus tenuicollis and Trichonema spp (Table 7).

Table 7. *Species of parasite based on deworming status.*

Parasite species	Deworming status		X^2-value	P-value
	Non dewormed	Dewormed		
Strong ylus vulgaris	192 (96.5)	7 (3.5))	3.042	0.081
Strong ylus edentates	130 (96.3)	5 (3.7)	1.255	0.263
Strong ylus equines	99 (98)	2 (2)	3.226	0.072
Strong yliod westeri	14 (100)	0	0.841	0.359
Parascarisequorum	30 (96.8)	1 (3.2)	0.328	0.567
Triodontophorustenuicollis	114 (98.3)	2 (1.7)	4.508	0.034
Gastrodiscusaegypticus	70 (98.2)	1 (1.4)	2.778	0.096
Anoplocephalaspp	12 (100)	0	0.717	0.397
Trichonemaspp	239 (99.2)	2 (0.8)	26.936	0.000
Trichostrongylusaxei	17 (94.4)	1 (5.6)	0.987	0.987

4. Discussion

The current study revealed that a range of gastrointestinal helminthes, including nematodes, cestodes, and trematodes, were present in the donkeys from the study area. The coprological examination performed in this study using the flotation and sedimentation method revealed a 95.3% prevalence. This prevalence was in agreement with some of the earlier reports of 98.2% by [5] in Gonder, 96.9% by [18] in Dugda Bora district and 96.9% by [27] in Hawassa Town, 92.71% by [23] in Awi Zone and 93.75% by [8] in Haramaya district. But disagree with some of earlier reports of 84.4% by [16] in Hawassa, and 72.33% [35] in Tenta Woreda, 75% [17] in Dodola District. The reasons of variable results from previous reports might be due to sampling methods, use of anthelmintic in the selected and limited targeted species of parasite.

The prevalence of Strongyles spps in the present study was 74.7%. This result was higher than the earlier findings of [35] 57.2%, in Tenta woreda, [37] 57.14%, in Gonder town and [17] 33.9% in Dodola district; but it was much lower than the earlier findings of [13, 25, 39, 40] who reported prevalence of 100, 100, 100 and 98.2% in Sululta and Gefersa, Wonchi, highlands of Wollo province and Western highlands of Oromia, respectively. This may most probably be attributed to the difference in the area or due to nutritional status of the animal in the respective study area which can influence the level of immunity of the host or by deworming strategy and accessibility to veterinary clinic.

The prevalence of strongyloides spps in the present study was 3.6%. This result was lower than the earlier reports by [17] 9.4% in Dodola district, [15] 11% in central Ethiopia, and 24.5% by [30] in the incidence of helminth parasite in donkeys in Nappur. This difference may arise from variation in environmental temperature and humidity since warm and moistures favor their development.

The prevalence of Oxyrus equi in present study was 15.1%. This result was higher than the prevalence reported by [37] 4.3% in Gonder town, [35] 6.5% in Tenta Woreda, [5], who reported 3% and [15], who reported 2% in donkeys in Western highlands of Oromia; but it is lower than reports in donkeys by [27] 31.8% in Hawassa town and [39] 32.4% in Wonchi. The reason for difference in prevalence rate in different areas might be consequence of influence of climatic conditions on the dynamics of egg expulsion [20].

The prevalence of Parascaris equorum in present study was 8.1% which was in agreement with earlier finding of [35] 11.2% in Tenta Woreda. But it disagree with reports of [13], [5] and [42] who reported 43%, 17.3% and 42.8% in Western highlands of Oromia, Dugda Bora district, and highlands of Wollo provinces, respectively. These differences in prevalence might be due to the variation in the length of the study period, the season of the study period, ecology of the

study area and intervention with anthelminthic or deworming practices.

The prevalence of fasciola species in this study was 19% which was found to be higher than the earlier report by [35] 4% in Tenta Woreda, by [5] who reported 1.5% in Dugda Bora district by [17] who reported fasciola species prevalence as 3.6% in dodola district. But it was in agreement with the previous report of 17.92% by [7] in and around Bahir Dar town. The higher prevalence in the current study could be due to difference in sample size and sampling method or geographical location of the area which is comfortable for the intermediate host snail pupation.

The prevalence of Gastrodiscus spp in present study was 18.5% which was higher than reports of Astede et al. (2017) 2.5% in Mekele town, [23] 3.5% in and around Gondar, [5] 6% in Dugda Bora district, [35] 8.1% in Tenta Woreda, [33] 2% in and around Maiduguri metropolis, Borno state, Nigeria; but lower than report of [15] 30% in Ethiopia. In all cases this might be due to difference in geographical location study areas.

The 3.1% prevalence rate of Anoplocephala spp. recorded in this study was in agreement with the earlier report of [35] 2.6% in Tenta woreda, and [34] 2.2% in Kurfa Chale District, East Hararghe, but lower when compared to reports by [39], [13] and [15]. This variation could be due to the variation in environmental nature of the regions and distribution of vector mites as most of the time this parasite is common in area which is characterized by year-round moist humid conditions which tend to favor high prevalence of oribatted mites which was indicated to be true by Souls by (1982) cited by [34].

The prevalence of Cyathostomines spps n this study, 62.8%, disagreed with earlier reports of [27] 29.7% in and around Hawassa Town, [39] 23.8% in Wonchi, and [5] 18.5% in Dugda Bora District. The difference might be associated with the different in geographical location of study area and the rate of development and survival of the free-living stages of the larvae which depends on the surrounding temperature and humidity or rainfallas this parasite well develops in areas with high humidity, low temperature and high altitude areas [9].

The presence of significant difference in occurrence of Strongyliodes westeri infection ($P = 0.000$) was found in this study among the different body condition scores donkeys with highest prevalence being recorded in donkeys with poor body condition than other groups of animals in a similar risk factor. This finding was in agreement with the results of [35] 8.5% and [5] which implied that the body condition score is a good indicator of parasitic burden, which can be used by farmers to identify donkeys with immediate requirement of anthelmintic remedies.

There was no statistically significant difference ($P > 0.05$) among different age groups for GI parasite infections except P. equorum and Strongylus vulgaris. This result was in agreement with [35] and [5]. This might be due to sampling method, sample size and geographical location difference of study area.

There was no statistically significant difference ($P > 0.05$) in GIT parasite infection between sexes and this was in agreement with earlier report of [5] and [17]. But in all parasites recovered from this study higher prevalence rate was recorded in males than females. This may most probably be attributed to the less number of female animals sampled during the study.

In present study the prevalence of different GIT parasites was higher in non-dewormed donkeys than dewormed donkeys ($P < 0.05$) which was in agreement with the report of [2] and [17]. This variation might arise from slight use of animal heath extension services and access to anthelmintics treatments which reduce stress.

Identification of infective larvae of GIT parasites showed that Trichonema spp (62.8 %), S. vulgaris (51.8%) were the major larvae encountered. The prevalence of Tricostrongylus axie (4.7%) and Strongyliodes westeri (3.6%) were the least larvae encountered. This disagreed with observations of [35], [4] and [39] but agreed with report of [27] in case S. vulgaris. These differences might be due to intervention with anthelmintics, variation in management system, sample size, sampling method and the ecological and climatic differences in study areas.

5. Conclusion and Recommendation

By using both coproscopic and larvoscopic methods of investigation, the current study revealed that the study area has the highest level of GIT parasitosis with a broad variety of parasite species that endanger the health and welfare of donkeys. Among the identified parasite species, the highest relative percentage was recorded for Strongyles spps while less occurrence rate for Anaplocephala spp. followed by Strongloide spp. and Parascaris equorum. The study also indicated the existence of concurrent infection as highest prevalence infection by three and more parasite species was found. Risk factor analysis of study also showed the occurrence of significant difference in the occurrence of parasite infection among different body condition score with animals of poor body condition score being prone to the infection than other groups of animals. Over all the study clearly assessed that GIT parasitism is a challenge to the health welfare status and working capacity of donkeys in the study area.

The recommendations that followed were made in light of this conclusion.

Owners need to be educated on how to improve management practices, particularly in terms of nutrition, so that animals can maintain good physical condition and exhibit some level of resistance to GI parasite infection.

Animal health experts should educate donkey owners on how to improve the housing, feeding, and management system, as well as how to give enough food and shelter for their animals while limiting overworking and prolonged open grazing.

Broad spectrum anthelmintics should be used to implement a regular deworming regimen.

To further understand the epidemiology, pathogenicity, and

anthelmintic resistance status of the dominant parasites, more research should be done.

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