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Epidemiology of Parasitic Infection among Working Donkeys in Qubaish Locality, Western Kurdufan State of Sudan

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Abstract **Background**: Parasitic diseases are an important cause of morbidity and mortality in donkeys. Effort must be given to control and prevention of parasitic disease transmission within a facility and among animal populations. Therefore, the aim of the present study was to assess the epidemiology of parasitic infection among working donkeys in Qubaish locality, Western Kurdufan State of Sudan. **Methodology**: This is a retrospective cross sectional study conducted in Western Sudan to assess the epidemiologic burden of parasitic infections among donkeys. The study included 200 working donkeys. **Results:** The most frequently detected parasite was Strongylus spp representing 30/62 (48%) followed by mixed infection, Cyathostomes, Dictyocaulus arnfieldi, Oxyuris equi, parascaris equorum, constituting 15/62(24.2%), 13/62(21%), 2/62(3.2%), 1/62(1.6%), 1/62(1.6%), respectively. **Conclusion**: Strongylus and Cyathostomes helminthes were prevalent among working donkeys in West Kurdufan State, Sudan, which necessitate for urgent effective control measures including treatment, prevention and drug resistant testing.

Keywords: *donkeys, parasitic infection, Sudan, Qubaish, Kurdufan*

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1. Introduction

Gastrointestinal nematode infections constitute a threat to the health and welfare of donkeys worldwide [1]. These parasites can be responsible for considerable morbidity and mortality in horses [2,3] and may have negative effects on performance and productivity in donkeys [4,5].

There are over 85 % of equids in developing countries where they are usually used for goods transporting, pack, cart, ridding, and traction in agricultural activities [6]. Studies conducted in Ethiopia and Mexico estimate the prevalence of endo-parasite infections at over 90 % in horses [7,8,9], and over 80 % in donkeys [10,11].

The most commonly identified parasites worldwide include: *Strongyle*, Cyathostomes, *Triodontophorus* species, *Strongyloides westeri*, *Parascaris equorum*, *Dictyocaulus arnfieldi*, *Oxyuris equi*, *Gastrodiscus* and *Fasciola* species [11,12].

Although the use of donkeys is considered as backwardness, yet in Sudan the use of donkey as a means of transport is common, particularly in remote states. In Sudan, the donkey population was estimated at 7.5 million in 2009 [13]. A study from Sudan reported that, the overall prevalence with helminth parasites was 24.6%. 5% of the horses and 35.5% of the donkeys examined were proved to harbor gastro-intestinal nematodes [14]. However, most of the reports from Sudan in this context were from Khartoum or Dar Four state with a lack of literature from West Kurdufan State.

The state of West Kurdufan, located in the south western part of the region of Kurdufan in Sudan and between latitude 11° - 20°N longitude 32°. 22″ - 30°. 27″ E. The southern part is heavy rainfall and vegetation and tree and heavy clay soils , and the northern part is a medium-range rain and light to prevail and sandy soil (soil Al Quoz) in this side of the state as an area of 111 373 km² [15]. Since, most of population of West Kurdufan are mainly depend on farming and livestock, donkeys represent the prime mean of transportations, cultivation, and serving of all requirements of agricultural and livestock activities in the area. Therefore, donkey is an essential animal in every day western Kurdufan man activities. This indicates the strong financial and health impact of these animal among the population.

Therefore, the aim of the present study was to assess the epidemiology of parasitic infection among working donkeys in Qubaish locality, Western Kurdufan State of Sudan.

2. Materials and Methods

This is a retrospective cross sectional study conducted in Western Sudan mainly in Western part of the state of Western Kurdufan. The study included 200 working donkeys. A fecal sample was collected from each animal and immediately investigated by microscope for the presence of parasites. A purposeful questionnaire was used to obtain animal related demographical data from each animal's owner. Data obtained included: locality, animal age, animal sex, donkey type, body condition, Fecal consistency, Feeding type, Feeding method, Feeding habits & water, Housing, Bedding, Disposal of manure, Presence of helminth, Use of anti-helminthic, Response, Source of anti-helminthic, Presence of other infections, vegetation in (wet, cool and hot months), Work intensity, Type of work, Donkeys users and the place where it used.

2.1. Sample Collection and Microscopic Examination

Faecal and blood samples were collected randomly during wet, dry cool and dry hot seasons from Qubaish locality, Western Cordovan State of Sudan, for the diagnosis of *helminths* and evaluation the anaemic status in working donkeys of different sexes and ages.

2.2. Faecal Samples Collection and Examination

Total of (200) fresh faecal samples (during wet, dry cool and dry hot seasons) were collected randomly for the diagnosis of *helminths* in working donkeys of different sexes and ages. Faecal materials were taken directly from the rectum and placed in faecal sample containers (airtight containers) and labeled. The faecal samples were then transferred to the Parasitology Laboratory, Faculty of Veterinary Medicine, West Kurdufan University. Faeces were gross examined for morphological changes, odor and color. Modified McMaster slide technique was used to count egg per gram faeces to assess the worm burden.

The severity of infection as obtained from the number of eggs per gram of faeces was determined according to [16] as following:

500 eggs/gram of faeces = mild infection

800 – 1000 eggs/gram of faeces = moderate infection

1500 – 2000 eggs/gram of faeces = severe infection

2.3. Techniques Used For Egg Count and Identification

3 grams of faeces were taken from each collected fresh sample and mixed with 42 ml of fecal flotation solution Sodium Chloride (400 g NaCl in 1 litre H20 = specific gravity 1.2 [17]) then the faecal mixture was poured through tea strainer (sieve). The solution was removed from the strainer as much as possible by pressing on the material. The strained material was poured into a 15ml centrifuge tube and centrifuged at 1,500 rpm for 2 minutes. With a *pipette* or syringe, both of the chambers in the McMaster slide were loaded with the strained solution. The slide was allowed to sit for a few minutes for the flotation process. Then using a microscope the slides were red, focusing on the top layer so that the grid lines are in focus, the counts for each type of parasite egg were recorded in both chambers inside the gridlines (using the battlement method). After reading, the slide was washed thoroughly to be ready for the second use. The number of eggs per gram of feces was calculated as follows:

Each grid counts the eggs in 0.15 ml. So the total number of eggs counted was found in 0.3 ml. So, we used 3 g of feces, we convert this back to 45 ml because the original set up was 42 ml of solution + 3 g of feces = 45. Therefore, the number of eggs that found in the chambers was multiplied by 100. Then divided by 2 to convert the number into eggs per one gram of feces (Or just the number of eggs in the two chambers multiplied by 50).

2.4. Blood Samples

A total of (100) blood samples were taken. 5 ml of blood were withdrawn from the jugular vein using sterile syringes. The blood was immediately transferred to heparinized containers, and put in cold container. The samples were then transferred to the Parasitology Laboratory Faculty of Veterinary Medicine, West Kurdufan University for hematological examinations.

2.5. Packed Cell Volume Determination

Blood were taken from the heparinized containers (brought from the field) in a heparinized capillary tube to determine packed cell volume (PCV). The vacant end was sealed with sealant. The capillary tube was centrifuged at 1500 rpm for 5 minutes then the value of PCV was determined using a microhaematocrite reader [18]. The anemic statuses of the donkeys were evaluated using Pack Cell Volume (PCV).

2.6. Ethical Consent

The proposal of present study was approved by the Faculty Research Board Committee, Faculty of Veterinary Medicine, Sudan University for Science and Technology. Moreover, the sample obtained from each animal by none invasive method.

2.7. Data Analysis

Data were collected and arranged in standard master sheet then entered a computer software statistical package for social studies (SPSS) (SPSS version 16). Frequencies and Chi Squair test were obtained. P value less than 0.05 was considered as statistically significant.

3. Results

This study investigated the presence of parasitic infections in 200 working donkeys, their ages ranging from 3 to 15 years with a mean age of 8 years old. Out of the 200 animals, 180/200(90%) were males and 20/200 (10%) were females. Out of the 200 animals, parasitic infections were detected in 62/200(31%) and the remaining 138(69%) were not proved to be infected. Out of the 62 infected animals, 31/62(50%), their owners were found to think that their animals were infected. The most frequently detected parasite was *Strongylus spp* representing 30/62(48%) followed by mixed infection, Trichonema (Cyathostomes), *Dictyocaulus arnfieldi, Oxyuris equi*,, *parascaris equorum*, constituting 15/62 (24.2%), 13/62 (21%), 2/62(3.2%), 1/62(1.6%), 1/62(1.6%), respectively as indicated in Figure 1.

With regard to the distribution of the parasites with age, the age was available for only 31 of the infected cases. The majority of infections were found among age group 6-9 years followed by age groups 10-12 and 13+ years representing 20/31(66.7%), 8/31(25.8%) and 3/31(10%) respectively. *Strongylus* was more common among age group 6-9 years followed by age group 13+ years constituting 4/7(57%) and 2/7(28.6%) correspondingly. Cyathostomes were more frequent in age group 6-9 years followed by age range 10-12 years representing 7/12(58.3%) and 4/12(33.3%) in this order. Mixed infections were more frequent in age group 6-9 years followed by age range 10-12 years representing8/10(80%) and 2/10(20%) in this order, as indicated in Table 1, Figure 2.

For male animals, the majority were found with *Strongylus spp* infection followed by Cyathostomes and mixed infection constitution 27/55(49%), 12/55(22%) and 12/55(22%), respectively. For female animals, the majority were found with *Strongylus spp* infection followed by mixed infection constitution 3/7(43%) and 3/7(43%), respectively, as indicated in Table 1, Figure 2.

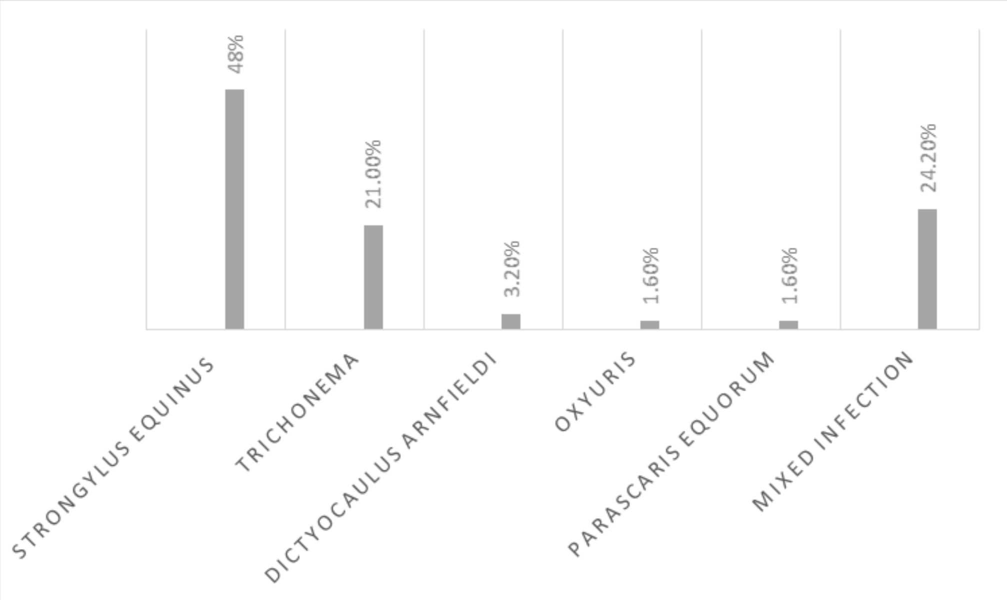

Figure 1. Description of the study subjects by different parasites

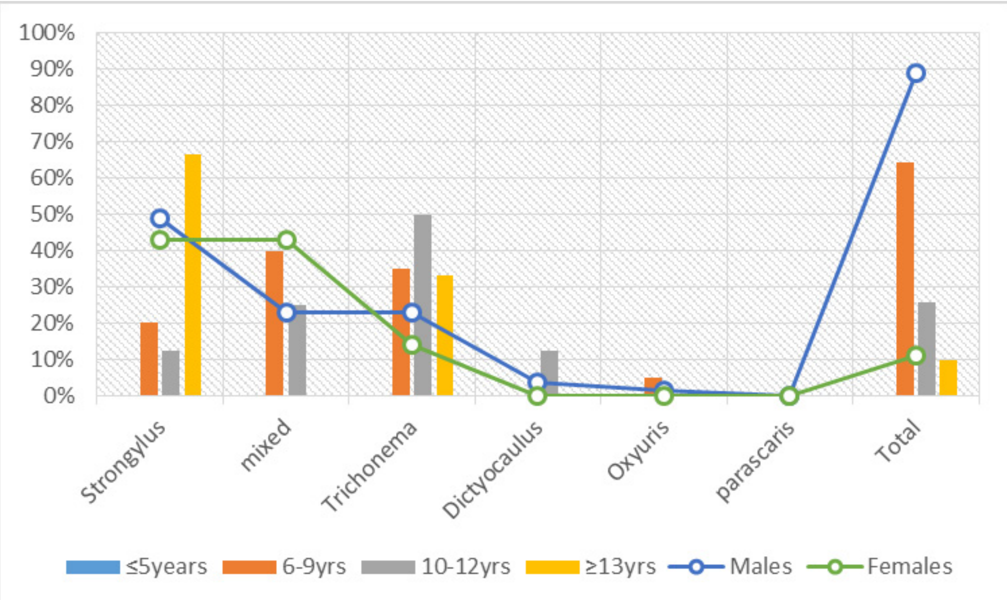

Figure 2. Description of the parasites by age and sex

Table 1. Distribution of the parasites by age and sex

Variable	Category	*Strongylus*	mixed	*Trichonema*	*Dictyocaulus*	*Oxyuris*	*parascaris*	Total
Age								
	≤5years	0	0	0	0	0	0	0
	6-9yrs	4	8	7	0	1	0	20
	10-12yrs	1	2	4	1	0	0	8
	≥13yrs	2	0	1	0	0	0	3
	Total	7	10	12	1	1	0	31
Sex								
	Males	27	12	12	2	1	0	55
	Females	3	3	1	0	0	0	7
	Total	30	15	13	2	1	0	62

With regard to the distribution of the infected animals by the intensity of infection, mild, moderate and severe parasitic infections were categorized in 29 (47%), 5(8%) and 28 (45%) of the animals, respectively. Most of the mild infections were identified *Strongylus* followed by Cyathostomes representing 15(52%) and 9(15%) correspondingly. Most of the moderate infections were identified mixed infection followed by Cyathostomes representing 4(80%) and 1(20%) correspondingly. Most of the severe infections were identified *Strongylus* followed by mixed infection representing 15(54%) and 8(29%) correspondingly, as indicated in Table 2, Figure 3.

Table 3 summarized the distribution of the parasites by animal's owner interference. With regard to the animal's owner observation of the presence of warms, the variable was only answered by 31 of the infected animal's owners of whom 11/31(35%) answered yes and the remaining 20/31(65%) answered no. With regard to the animal's owner use of anti-helminthes drug, the variable was only answered by 31 of the infected animal's owners of whom 15/31(48%) answered yes and the remaining 16/31(52%) answered no. with regard to the treatment response, 10 animals were completely cured and 6 indicated no change. With regard to the source of treatment, 10 had obtained it from pharmacy, 2 from clinic and one from friend, as shown in Table 3.

Moreover, about 45% of the infected animals were found with packed cell volume (PCV) values less than the reference values.

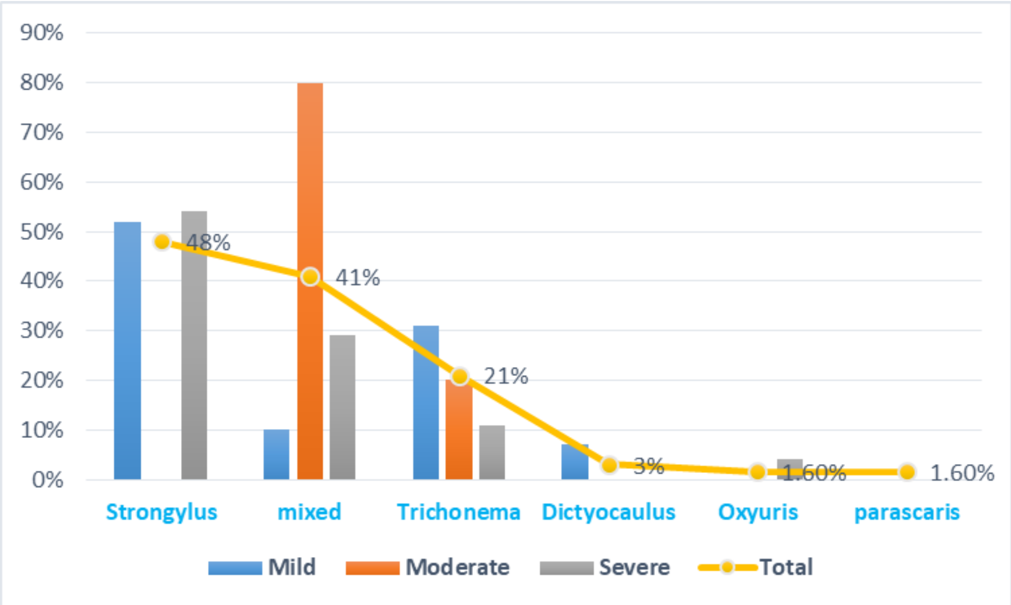

Figure 3. Description of the infected animals by the intensity of infection

Table 2. Distribution of the infected animals by the intensity of infection

Variable	*Strongylus*	mixed	*Trichonema*	*Dictyocaulus*	*Oxyuris*	*parascaris*	Total
Mild	**15**	**3**	**9**	**2**	**0**	**0**	**29**
Moderate	**0**	**4**	**1**	**0**	**0**	**0**	**5**
Severe	**15**	**8**	**3**	**0**	**1**	**1**	**28**
Total	**30**	**15**	**13**	**2**	**1**	**1**	**62**

Table 3. Distribution of the parasites by animal's owner interference

Variable	Category	*Strongylus*	mixed	*Trichonema*	*Dictyocaulus*	*Oxyuris*	*parascaris*	Total
The owner observed the presence of warms								
	Yes	**2**	**3**	**5**	**1**	**0**	**0**	**11**
	No	**5**	**7**	**5**	**0**	**1**	**0**	**20**
	Total	**7**	**10**	**10**	**1**	**1**	**0**	**31**
The owner used the anti-helminthes drug								
	Yes	**5**	**3**	**6**	**1**	**0**	**0**	**15**
	No	**3**	**6**	**6**	**0**	**1**	**0**	**16**
	Total	**8**	**9**	**12**	**1**	**1**	**0**	**31**
Treatment Response								
	Cured	**2**	**3**	**5**	**0**	**0**	**0**	**10**
	No change	**3**	**0**	**1**	**1**	**1**	**0**	**6**
	Total	**5**	**3**	**6**	**1**	**1**	**0**	**16**
Treatment Source								
	Pharmacy	**3**	**1**	**5**	**0**	**1**	**0**	**10**
	Clinic	**1**	**2**	**0**	**0**	**0**	**0**	**2**
	Friend	**1**	**0**	**0**	**0**	**0**	**0**	**1**
	Total	**5**	**3**	**5**	**0**	**1**	**0**	**13**

4. Discussion

West Kurdufan is one of the 18 Wilayat or provinces of Sudan. In 2006 it had an area of 111,373 km² and an estimated population of approximately 1,320,405 [19]. Qubaish is one of the cities in western part of the state. The majority of the population in this state depend on their living agriculture and/or Animal husbandry. Therefore, donkey has a major impact on their everyday activity as a source of transportation. Due to the closer relationship between donkey and human in these areas, the infectious health consequences may influence each other. However, in the current study assessed the epidemiology of parasitic infection among working donkeys in Qubish locality, Western Kurdufan State of Sudan.

To the best of our knowledge this is first report about the epidemiology of parasitic infections among donkeys from this area. In the present study spectrum rage of helminths when identified with variable infection intensity.

The most common encountered parasite was *Strongylus spp,* which represented about 49% of the infections. Many studies have shown that *Strongylus* usually affects young animals, as most horses and donkeys acquire relative immunity against the large *strongylus* as a consequence of natural infection [20]. Strongylus parasites are ubiquitous in grazing horses, and the large strongyle Strongylus vulgaris is considered the most pathogenic helminth parasite of horses. Recent investigations have suggested an association between occurrence of this parasite and usage of selective therapy based on regular fecal egg counts [21]. Strongylus vulgaris is a pathogenic helminth parasite infecting horses and was once considered to be the primary cause of colic. Migrating larvae cause ischemia and infarction of intestinal segments [22]. In areas where S. vulgaris is prevalent, non-strangulating intestinal infarction should be considered as a differential diagnosis in horses presenting with mild colic and peritonitis. Survival of non-strangulating intestinal infarction is possible in cases where surgical intervention with resection of the infarcted intestine is feasible [23]. However, Anthelmintic treatment strategies designed to control *Strongylus* have been extremely successful in reducing prevalence, morbidity, and mortality from this parasite [24].

Trichonema (Cyathostomes) was identified in 21% of the working donkeys in the present study. Several incidents of diarrhea and loss of weight occurred in adult horses due to maturation of inhibited larvae of Trichonema spp [25]. Clinical and laboratory findings are recorded from a series of 15 cases (aged one to 16 years) of sudden-onset chronic diarrhea with weight loss, progressing in many cases to emaciation and death, associated with the emergence of fourth stage cyathostome (trichoneme) larvae in large numbers through the colonic and caecal mucosae [26].

Other parasites including *Dictyocaulus arnfieldi, Oxyuris*, *parascaris equorum* were found in low proportions in this study. *Dictyocaulus arnfieldi and* its association with donkeys was reported in several studies [27,28,29].

Whilst anthelminthic resistance of small strongyles is well documented, anthelmintic failures against infections with *Oxyuris equi* have scarcely been published so far [30]. Drug resistance in equine gastro-intestinal parasitic nematodes has been reported throughout the world. While the focus is usually put on cyathostomins, observations of macrocylic lactone failure against *Oxyuris equi* have accumulated over the last decade [31]. Suppressive anthelmintic treatment strategies originally designed to control Strongylus vulgaris in horses were extremely successful in reducing morbidity and mortality from parasitic disease. Unfortunately, this strategy has inadvertently resulted in the selection of drug-resistant cyathostomes (Cyathostominea), which are now considered the principal parasitic pathogens of horses. Resistance in the cyathostomes to benzimidazole drugs is highly prevalent throughout the world, and resistance to pyrantel appears to be increasingly common. However, there are still no reports of ivermectin resistance in nematode parasites of horses despite 20 years of use. It is unknown why resistance to ivermectin has not yet emerged, but considering that ivermectin is the single most commonly used anthelmintic in horses most parasitologists agree that resistance is inevitable. The fecal egg count reduction test is considered the gold standard for clinical diagnosis of anthelmintic resistance in horses, but diagnosis is complicated by lack of an accepted standard for the performance of this test or for the analysis and interpretation of data. Presently there is very little data available on the molecular mechanisms of anthelmintic resistance in cyathostomes; beta-tubulin gene is the only anthelmintic-resistance associated gene that has been cloned [32].

Furthermore, it was observed that a high percentage of infected donkeys were found with low PCV measurements. However, there is no explanation for this from the available literature.

Despite the economic importance of donkeys in the Sudan, little data has been tired towards their diseases in general and particularly gastrointestinal parasites. The earliest recognized parasitic disease of donkeys in the Sudan was strongyle infections which have been shown to cause serious losses in affected areas [33,34]. In a recent survey Out of 92 donkeys examined for gastrointestinal parasites, 90 animals were found infected by one or more gastrointestinal parasites with an overall prevalence rate of 97.78%. The distributions of the recovered parasites in the different parts of the body were as follows: stomach, 92.4%, small intestine, 19.6%, caecum, 88%, colon, 80.4%, rectum, 73.9%, and cranial mesenteric artery, 64.1%. The parasites identified were *Habronema spp*. (40.2%), *Trichostrongylus axei* (30.4%), *Parascaris equorum* (18.5%), *Anoplocephala perfoliata* (4.35%), *Gastrodiscus aegyptiacus* (8.7%), large strongyles (84%), small strongyles (72%), and *Oxyuris equi* (1.1%) [34].

5. Conclusion

Strongylus and *Trichonema* (Cyathostomes) helminthes were prevalent among working donkeys in West Kurdufan State, Sudan, which necessitate for urgent effective control measures including treatment, prevention and drug resistant testing. The progressively elevated incidence of anthelmintic-resistant must be taken into account when designing worm control programs for Donkeys. Further studies in this context are important in the future.

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References

[1] Scantlebury CE, Peachey L, Hodgkinson J, et al. Participatory study of medicinal plants used in the control of gastrointestinal parasites in donkeys in Eastern Shewa and Arsi zones of Oromia region, Ethiopia. *BMC Veterinary Research*. 2013; 9:179.

[2] Love S, Murphy D, Mellor D. Pathogenicity of cyathostome infection. Vet Parasitol. 1999; 85:113-121.

[3] Matthews JB. Facing the threat of equine parasitic disease. Equine Vet J. 2011; 43:126-132.

[4] Getachew AM, Innocent G, Trawford AF, Reid SWJ, Love S. Gasterophilosis: a major cause of rectal prolapse in working donkeys in Ethiopia. Trop Anim Health Prod. 2012; 44: 757-762.

[5] Matthee S, Krecek RC, Milne SA, Boshoff M, Guthrie AJ. Impact of management interventions on helminth levels, and body and blood measurements in working donkeys in South Africa. Vet Parasitol. 2002; 107:103-113.

[6] Pritchard JC, Lindberg AC, Main DC, Whay HR. Assessment of the welfare of working horses, mules and donkeys, using health and behaviour parameters. Prev Vet Med. 2005 Jul 12; 69 (3-4): 265-83.

[7] Fikru R, Reta D, Bizunesh M. Prevalence of equine gastrointestinal parasites in western high lands of Oromia, Ethiopia. Bull Anim health prod Afr. 2005; 53:161-166.

[8] Valdez-Cruz MP, Hernandez-Gil M, Galindo-Rodriguez L, Alonso-Diza MA (2006) gastrointestinal parasites burden body condition and hematological value in equines in the humid tropical area of Mexico. In: A. person, C. Muir and M, Farrow (eds) Proceedings of the 5th International colloquium on working equines. The Future for working equines. The donkey sanctuary Sidmouth, pp. 62-72.

[9] Gebreab F (1998) Helminth parasites of working equids, The African perspective. In: proceedings of the 8th international Conference on Infectious disease of Equines, Dubai, UAF. pp. 318-324.

[10] Burden FA, Du Toit N, Hernandez-Gil M, Prado-Ortiz O, Trawford AF. Selected health and management issues facing working donkeys presented for veterinary treatment in rural Mexico: some possible risk factors and potential intervention strategies. Trop Anim Health Prod. 2010 Apr; 42(4):597-605.

[11] Getachew M, Trawford A, Feseha G, Reid SW. Gastrointestinal parasites of working donkeys of Ethiopia. Trop Anim Health Prod. 2010 Jan; 42(1):27-33.

[12] Dersema G. Epidemiological study of helminthosis in traction horses in three selected districts of the Awi zone, North West Ethiopia. Ethiop Vet J. 2006; 10(2): 37-54.

[13] Ministry of Animal Resources (MARF and Fisheries, Annual Report (2009).

[14] Adam AA, Suliman SE, Seri HI. The Prevalence and Intensity of Gastro-Intestinal helminths in Equine in North Darfur, Sudan. Journal of Agricultural and Veterinary Sciences 2013; 14(1): 102-107.

[15] West Kordofan University, The state of West Kordofan, accessed 2017. Avialable at: http://wku.edu.sd/en/index.php/west-kordufan-state/2-the-state-of-west-kordofan.html

[16] Soulsby, E. J. L (1982). Helminths, Arthropods and Protozoa of domesticated Animals. 7th edition. Bailliere Tindall. London. pp.1 – 4 and 417-475.

[17] William, J. F. (2001). Veterinary Parasitology (Reference Manual). Fifth edition. Blackwell publishing. 2121 State Avenue, Ames Iowa 50014. www.blackwellprofcssional.com. Pp 1-13.

[18] Abebew, D., Endebu, B., Gizachew, A. (2011). Status of parasitism in donkeys of project and control areas in central region of Ethiopia: a comparative study. Ethiop. Vet. J., 2011, 15 (2), 45-55.

[19] West Kurdufan. Available at: https://en.wikipedia.org/wiki/West_Kurdufan

[20] Duncan JL, Pirie HM. The pathogenesis of single experimental infections with Strongylus vulgaris in foals. Res Vet Sci. 1975; 18:82-93.

[21] Nielsen MK, Olsen SN, Lyons ET, Monrad J, Thamsborg SM. Real-time PCR evaluation of Strongylus vulgaris in horses on farms in Denmark and Central Kentucky. Vet Parasitol. 2012 Dec 21; 190(3-4): 461-6.

[22] Nielsen MK, Jacobsen S, Olsen SN, Bousquet E, Pihl T. Nonstrangulating intestinal infarction associated with Strongylus vulgaris in referred Danish equine cases. Equine Vet J. 2016 May; 48(3): 376-9.

[23] Pihl TH, Nielsen MK, Olsen SN, Leifsson PS, Jacobsen S. Nonstrangulating intestinal infarctions associated with Strongylus vulgaris: Clinical presentation and treatment outcomes of 30 horses (2008-2016). Equine Vet J. 2017 Nov 7.

[24] Kaplan RM. Anthelmintic resistance in nematodes of horses. Vet Res. 2002; 33: 491–507.

[25] Chiejina SN, Mason JA. Immature stages of Trichonema spp as a cause of diarrhoea in adult horses in spring. Vet Rec. 1977 Apr 23; 100(17): 360-1.

[26] Giles CJ, Urquhart KA, Longstaffe JA. Larval cyathostomiasis (immature trichonema-induced enteropathy): a report of 15 clinical cases. Equine Vet J. 1985 May; 17(3):196-201.

[27] Clayton HM, Neave RM. Efficacy of mebendazole against Dictyocaulus arnfieldi in the donkey. Vet Rec. 1979 Jun 23; 104(25): 571-2.

[28] El-Seify MA, Harfoush MA, El-Shahawy IS. Biological aspects on Dictyocaulus arnfieldi. J Egypt Soc Parasitol. 2010 Aug; 40(2): 395-400.

[29] Veneziano V, Di Loria A, Masucci R, Di Palo R, Brianti E, Gokbulut C. Efficacy of eprinomectin pour-on against Dictyocaulus arnfieldi infection in donkeys (Equus asinus). Vet J. 2011 Dec; 190(3): 414-5.

[30] Wolf D, Hermosilla C, Taubert A. Oxyuris equi: lack of efficacy in treatment with macrocyclic lactones. Vet Parasitol. 2014 Mar 17; 201(1-2):163-8.

[31] Sallé G, Cortet J, Koch C, Gascogne T, Reigner F, Cabaret J. Ivermectin failure in the control of Oxyuris equi in a herd of ponies in France. Vet Parasitol. 2016 Oct 15; 229: 73-75.

[32] Kaplan RM. Anthelmintic resistance in nematodes of horses. Vet Res. 2002 Sep-Oct; 33(5):491-507.

[33] El Dirdiri I, Abu Damir H, and Wahbi AA, “Disease incidence in donkeys (Equus asinus asinus) with emphasis on Strongyle infection,” Acta Veterinaria Belgrade, vol. 36, pp. 313-320, 1986.

[34] Nakayima Jesca, Kabasa William, Aleper Daniel, and Okidi Duke, “Prevalence of endo-parasites in donkeys and camels in Karamoja sub-region, North-eastern Uganda,” Journal of Veterinary Medicine and Animal Health, vol. 9, no. 1, pp. 11-15, 2017.