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PASSIVE SURVEILLANCE AND RISK ANALYSIS OF GASTROINTESTINAL PARASITISM IN EQUINE POPULATION OF FAISALABAD METROPOLITAN, PAKISTAN

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ABSTRACT

A total of 3456 faecal samples of equines brought to the mobile clinic of the department of clinical medicine and surgery, University of Agriculture, Faisalabad, screened for gastrointestinal tract (GIT) parasitism using standard protocols. Information regarding possible risk factors was also collected with clinical observations on a predesigned questionnaire. A total of 45.1% (1562/3456) equines were recorded positive for GIT parasites in the study population. Younger, thinner, females, draught purpose animals and donkeys were found more prone to GIT parasitic infection, with highest rate of infection during summer. The results of this study will contribute towards the climatographic and quantitative distribution of GIT parasitism in equine population of Metropolitan city, Faisalabad, Pakistan.

Key words: Epidemiology, Equine Faisalabad, Quantitative distribution, Gastrointestinal tract parasitism.

INTRODUCTION

Equines have gathered much attention predominantly as draught animals round the globe. In some parts of the world, they are also used as source of meat, leather and other related products. The use of equines (horse, donkey, and mule) in rural and urban areas of Pakistan is increasing rapidly due to high energy crises and prices of fuel. According to the socio-economic survey, 1.5 million Pakistani natives are dependent on draught equines for their livelihood and agriculture. Traditionally, the use of equines varies between racing, endurance, pleasure-riding and as religious animal.

Gastrointestinal tract (GIT) parasitism is one of the major health issues in equines worldwide (Morris *et al.* 2004; Roberson, 2009; Egan *et al.* 2010) as well as in Pakistan (Saeed *et al.* 2010; Goraya *et al.* 2013). Equine GIT parasitism cause anorexia, inadequacy in performance, mechanical obstruction of GIT passage, compression of organs, weight loss, blood loss, debility and toxemia with varying effects (Ryu *et al.* 2004). GIT parasites can directly or indirectly facilitate the entry and settlement of other microbial pathogens like bacteria and viruses (Love *et al.* 1999). In addition, diagnosis of the pathogenic GIT helminths during pre-patent period is still challenging (Andersen *et al.* 2013). Resultantly, GIT parasites impose serious economic impact on poor farmers/ equine-cart owners in terms of reduced productivity and cost of treatment. Authorities spent several million dollars annually to control the GIT parasites, but all in vain (Mbafor *et al.* 2012; Andersen *et al.* 2013; Stratford *et al.* 2014).

Faisalabad (the hub of textiles) is the third largest city of Pakistan and the second largest industrial city of the Punjab. Equines have gained enormous significance in the metropolitan Faisalabad due to their use as the cheapest source of the logistics of raw materials to machinery and products to the industrial markets. In such a situation, the significance of equine health perspectives is increased manifolds. Parasitic infections of equines have not been addressed appropriately except a recent report, which briefly described the clinical epidemiology of different ailments including those of parasitic origin in selected equine population of three districts including that of Faisalabad (Goraya *et al.* 2013). However, the information specifically on the GIT parasitism and its associated risk factors has not been extensively detailed as required. Hence, this study was planned with the following objectives: (a) determination of prevalence of GIT parasites in the selected equine population of the metropolitan Faisalabad and (b) determination of risk factors including age, sex, breed, body scoring, physical parameters, and health conditions, statistically associated with the distribution of GIT parasitism in equines.

MATERIALS AND METHODS

Study Site: The study was conducted from September 2013 to the August 2014 in metropolitan Faisalabad (30–35° to 31–47°N latitude and 72–01° to 73–40°E), Punjab,

Pakistan. The extreme conditions rise above 50°C in summer, and fall below 5°C in winter.

Sampled Animals: The equine keepers selected (randomly) for the study were informed about the importance of the study, and asked to present their equines on specific visit dates and places of mobile clinic (Department of Clinical Medicine and Surgery, University of Agriculture Faisalabad, Punjab, Pakistan). In order to acquire the required information, a pre-designed questionnaire containing open-ended and closed-ended (dichotomous or multiple choice) questions was prepared and refined through informal and formal testing procedures (Thrusfield, 2007).

Sample Collection: A total of 3456 faecal samples were collected randomly from equines. Under strict sanitation, samples were placed in screw tight vials and shipped to the Department of Parasitology, University of Agriculture, Faisalabad, Punjab, Pakistan for further processing.

Parasitological Techniques: After macroscopic examination, the faecal samples were subjected to microscopic examination through qualitative and quantitative methods, using concentration techniques and McMaster egg counting technique, respectively. Egg/oocysts of parasites were identified using standard parasitological keys (Soulsby, 1982). Faecal culture of positive samples was carried out for identification of larvae (L3), based on specific morphological traits (Urquhart, 1996).

Statistical Analysis: Prevalence of GIT parasites was analyzed through multiple logistic regression. Odds ratio, using statistical software (WinPepi 11.23) at 95% confidence level, were used for determination of any positive or negative statistical association of the determinants influencing epidemiology of GIT parasites in equine population of the study (Schork and Remington, 2010).

RESULTS

The prevalence of various GIT parasitic infections in equines was recorded 45.1%, with range of 1–95 eggs per gram of faeces. Among helminths, the abundance of nematodes was found the highest followed in order by those of cestodes and trematodes. Overall prevalence of different protozoa species was recorded as 10.8%. Monthly variation was ranging from 22.5% to 74.6% in months of January and August, respectively. The predominantly found species were: *Parascaris (P.) equorum* (34.60%), *Anoplocephala (A.)* spp. (17.90%), *Strongyles (S.)* spp. (14.90%), *Dictyocaulus (D.) arnfieldi* (6.50%), *Eimeria leuckarti* (5.10%), *Giardia* spp. (5.70%), *Oxyuris (O.) equi* (5.50%), *Strogyloides (St.) westeri* (4.90%), *Draschia (Dr.) megastoma* (4.00%), *Gastrodiscus aegyptiacus* (3.20%), *Habronema* spp. (0.96%). A total of 3.77% equines were found suffering from mixed infections of the mentioned parasites.

Donkeys, females, younger and draught purpose animals were found most susceptible to GIT parasitism among the equine population of metropolitan Faisalabad. Health status and body scoring of equines were found having inverse statistical association with the abundance of GIT parasitism. Although, severity of GIT parasitism was higher in animals which were not having a history of de-worming; however, a handsome number of dewormed subjects were also found positive for GIT parasites (Table 1.).

Table 1. Statistical association of different host and agent related determinants with gastro-intestinal parasitism in the equine population of metropolitan Faisalabad, Punjab, Pakistan

Sr. No	Determinants	Levels	Equine Screened	Positive	Prevalence (%)	95% CI*.		Odds Ratio	p-Value
						LL*	UL*		
1	Age	0-5 years	799	727	21.0	19.66	22.40	4.10	0.000
		6-15 years	1505	334	9.6	8.64	10.64	-	-
		>15 years	1152	501	14.4	13.25	15.63	1.96	0.000
2	Sex	Male	2137	657	26.1	24.64	27.60	-	-
		Female	1319	905	19.1	17.80	20.45	2.23	0.000
3	Purpose of equine keeping	BKC*	845	358	42.37	9.36	11.42	2.40	0.042
		BKP*	280	116	41.43	2.73	3.95	2.35	0.053
		TPC*	814	335	41.15	8.64	10.64	2.33	0.041
		TGC*	675	386	57.19	10.08	12.21	3.24	0.005
		Recreational	607	240	39.54	5.60	7.26	2.24	0.058
		Ceremonial	201	121	56.81	3.29	4.61	3.41	0.004
		Ethical	34	6	27.27	0.08	0.42	-	-
4	Body scoring	Very poor	1333	867	25.0	23.56	26.48	36.42	0.000
		Poor	878	425	12.2	11.14	13.35	27.11	0.000

		Moderate	800	256	7.40	6.56	8.33	17.92	0.000
		Good	333	12	0.34	0.18	0.61	2.02	0.442
		Fat	112	2	0.05	0.01	0.21	-	-
5	Equine species	Donkey	1882	928	49.31	25.32	28.30	1.27	0.001
		Horse	1083	419	38.69	11.03	13.23	-	-
		Mules	491	215	43.79	5.41	7.05	1.13	0.215
6	Deworming history	Dewormed	2021	580	16.7	15.47	17.98	2.38	0.000
		Not dewormed	1435	982	28.41	26.92	29.95	-	-
7	Seasons of study area	Summer	864	574	16.6	15.38	17.89	2.65	0.000
		Autumn	864	421	12.1	11.03	13.23	1.94	0.000
		Spring	864	350	10.1	9.11	11.15	1.61	0.000
		Winter	864	217	6.2	5.41	7.05	-	-
8	Parasite species	Nematode	3456	1121	71.7	69.40	73.93	22.42	0.000
		Cestode	3456	280	17.9	16.05	19.92	5.60	0.000
		Trematode	3456	50	3.20	2.39	4.20	-	-
		Protozoa	3456	170	10.8	9.32	12.47	3.40	0.000

Where; LL*= Lower limit, UL*= Upper limit, GI*= Gastrointestinal, CI*= Confidence interval BKC*= Brick Kline use of cart, BKP*= Brick Kline packed sadellery, TGC*= Transport of goods through cart, TPC*= Transport of people through cart.

DISCUSSION

The present study revealed an overall prevalence of 45.1% GIT parasites in metropolitan Faisalabad, Punjab, Pakistan. Earlier, prevalence of GIT parasites in equines population from different parts of the country have been reported as 53.33% (Aftab *et al.* 2005), 58.5% (Saeed *et al.* 2010) and 75% (Mahfooz *et al.* 2008). The reasons of variable results from previous reports may include: (a) sampling methods; the prevalence could be higher in purposive/passive sampling than active surveillance, (b) use of anthelmintic in the selected population; ignoring previous history of anthelmintic therapy during samples selection can provide false negative results, (c) season of surveillance; if limited to only winter season cannot provide true picture of parasitic distribution in the population, (d) limited targeted species of parasite; e.g. if focused on only one or two kinds of parasitic nematodes/trematodes/cestodes, the true cumulative worm burden cannot be attained, and (e) the expert personnel; field surveillance is sometimes relied upon the field assistants who cannot collect samples appropriately which can provide false negative/positive results.

Andersen *et al.* (2013) reviewed the major parasitic threats in the equine population worldwide including, cyathostomins, *P. equorum*, *A. perfoliata* and *S. vulgaris*. Inappropriate use of anthelmintics has also been found associated with distribution of GIT helminths in equines (Stratford *et al.* 2014). In our study, *P. equorum* (34.60%) was the most frequently found nematode in the study area which has also been reported the most frequent equine parasite elsewhere (Getachew *et al.* 2008; Getachew *et al.* 2010; Alanazi and Alyousif, 2011). However, in some parts of the world, the abundance of *P. equorum* is not frequent (Gawor, 1995; Fikru and Teshale, 2005). The probable reasons of higher prevalence among GIT parasites may include: (a) resilience, (b) joint grazing of adults with foals, and (c) season and husbandry providing favorable environment for growth of ascarids. In metropolitan Faisalabad, *Strongyles spp*. were found in 14.90% of the population which is resembling with earlier reports (Aftab *et al.* 2005; Gülbahçe and Cantoray, 1995; Arslan and Umur, 1998; Gül *et al.* 2003; Umur and Acici, 2009). Prevalence of *D. arnifieldi*, *O. equi*, *St. westeri* and *Dr. megastoma* were found in descending order which are in accordance with previous findings (Pecheur *et al.* 1979; Bucknell *et al.* 1995; Arslan and Umur, 1998; Gawor, 1995; Boxell *et al.* 2004; Saeed *et al.* 2010; Alanazi and Alyousif, 2011). In our study area, *Anoplocephala* spp. is the only reported cestode specie which is also reported earlier (Öge, 1991; Burgu, 1995a, b). The probable argument of less abundance of trematodes in our study and elsewhere (Umur and Acici, 2009) might be associated with unavailability of intermediate host for completion of their life cycles (Soulsby, 1982; Urquhart, 1996).

In general, epidemiology of parasitic diseases has been found associated with various intrinsic (age, sex, host specie, and body scoring) and extrinsic factors (season, sampling methods, drug administered, parasite species and purpose of keeping) which are well established earlier (Demir *et al.* 1995; Franscico *et al.* 2009; Khan *et al.* 2010; Khan *et al.* 2011; Getachew *et al.* 2010; Umar *et al.* 2013; Stratford *et al.* 2014). In equines, the present study provides probably the first attempt to correlate these factors with the distribution of infections in Pakistan. Donkeys fall into the sphere of affordability of many low income farmers dwelling in Faisalabad, Punjab, Pakistan. Among different species of equines, the highest prevalence of GIT parasites is observed in

donkeys followed by horses and mules which might be due to feeding stress, ignored health care and over-loading stress (Singh *et al.* 2002). Among other possible determinants, variables reports are available on the association of parasitic burden with the age group. The probable argument of higher abundance in younger and older animals may include: (a) poor immune status of animals, (b) mixed grazing, (c) use of ineffective drugs, and (d) administration of lower dose of anthelmintics. However, the reports supporting GIT parasites among different age categories (young, adults and older) are also available (Bucknell *et al.* 1995; Urquhart, 1996; Mahfooz *et al.* 2008; Dunsmore and Jue, 1985). Association of sex with the prevalence of GIT parasitism is controversial as it is statistically associated with GIT parasitism (Sotiraki *et al.* 2010) while on the other hand no statistical association has also found (Saeed *et al.* 2010). The arguments of higher occurrence in females (Soulsby, 1982; Urquhart, 1996) may include estrus cycle and lactation stress. Impact of seasonal variations on gastrointestinal fauna of equids is well-documented in different climatic regions of the world (Mushi *et al.* 2003; Yoseph *et al.* 2005; Nielsen *et al.* 2007). In our study, summer was the most risky season the calendar year for abundance of GIT parasitism. Presumably, variations in humidity and temperature directly influence the hatching of parasitic eggs and growth of intermediate hosts (if any). Higher infection of GIT parasites in draught animals might be due to their poor immune status, stress of working in the harsh environment and ignored feeding status (Kornas *et al.* 2010). Variation in the susceptibility of equines with reference to husbandry practices is also reported (Fritzen *et al.* 2010) which might also be associated with the higher prevalence of GIT parasitism in draught equines.

The positive tests of routinely dewormed animals in our study point out the possibility of the development of multiple drug resistance due to administration of less efficacious drugs and under dosing (Slocombe *et al.* 2007). Reports are available on the establishment of worm infection in the treated equines under the controlled conditions confirming the development of resistance (Boersema *et al.* 1991; Craven *et al.* 1998; Kaplan *et al.* 2004; Slocombe *et al.* 2007; Lyons *et al.* 2011). This issue warrants the community for further research to identify the potential determinants facilitating the development of resistance.

In crux, GIT parasitism is prevalent in equine population of metropolitan Faisalabad, Punjab, Pakistan where younger, female, draught animals with poor body score are more susceptible to nematodes during summer season. However, equine owners and farmers of the studied area in specific, and Pakistan in general are recommended to take short term measures. These include: preventive therapy before summer, setting good standards of sanitation on stables, pay more attention towards the more susceptible categories of equids, and selecting the best effective anthelmintic with an appropriate dose to reduce the threats of development of anthelmintic resistance. In addition, there is a need to execute a wide-scaled awareness campaign for sustainable parasitic management in the equine population of Pakistan. The scientific community should utilize the molecular biology tools for taxonomy, early diagnosis of infection and identification of alternate receptors for anthelmintics. Specifically in Pakistan, periodic screening the best effective anthelmintic compound among available ones through the controlled experiments in the local microclimate is direly needed.

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REFERENCES

Aftab, J., M.S. Khan, K. Pervez, M. Avais, and J.A. Khan (2005). Prevalence and chemotherapy of ecto-an d endoparasites in rangers horses at Lahore. Pakistan. Int. J. Agri. Biol. 7: 5.

Alanazi, A.D., and M.S. Alyousif (2011). Prevalence of non-strongyle gastrointestinal parasites of horses in Riyadh region of Saudi Arabia. Saudi. J. Biol. Sci. 18: 299–303.

Andersen, U.V., D.K. Howe, S.N. Olsen, and M.K. Nielsen (2013). Recent advances in diagnosing pathogenic equine gastrointestinal helminths: The challenge of prepatent detection. Vet. Parasitol. 192: 1–9.

Arslan, M.O., and S. Umur (1998). The helminth and Eimeria (Protozoa) species in horse and donkey in Kars province of Turkey. T. Parazitol. Derg. 22: 180–184.

Boersema, J.H., F.H. Borgsteede, M. Eysker, T.E. Elema, C.P. Gaasenbeek, and W.P. Van-der-Burg (1991). The prevalence of anthelmintic resistance of horse strongyles in the Netherlands. Vet. Q. 13: 209–217.

Boxell, A.C., K.T. Gibson, R.P. Hobbs, and R.A.C.Thompson (2004). Occurrence of gastrointestinal parasites in horses in metropolitan Perth, Western. Australia. Aust. Vet. J. 82: 91–95.

Bucknell, D.G., R.B. Gasser, and I. Beveridge (1995). The prevalence and epidemiology of gastrointestinal parasites of horses in Victoria. Australia. Int. J. Parasitol. 25: 711–724.

Burgu, A., A. Doğanay, H. Öge, O. Sarımehmetoğlu, and E. Ayaz (1995a). Helminth species found in

donkeys, Ankara Üniversity. Vet. Fak. Derg. 42: 207–215.

Burgu, A., S. Öge, A. Doğanay, C. Pişkin, and H. Öge (1995b). Helminth species found in horses, Ankara Üniversity. Vet. Fak. Derg. 42: 193–205.

Craven, J., H. Bjorn, S.A. Henriksen, P. Nansen, M. Larsen, and S. Lendal (1998). Survey of anthelmintic resistance on Danish horse farms using 5 different methods of calculating faecal egg count reduction. Equine. Vet. J. 30: 289–293.

Demir, S., R. Tınar, L. Aydın, V.Y. Çırak, and R. Ergül (1995). Prevalence of helminth species according to faecal examination in equids in Bursa. T. Parazitol. Derg. 19: 124–131.

Dunsmore, J.D., and S.L.P. Jue (1985). Prevalence and epidemiology of the major gastrointestinal parasites of horses in Perth Western. Australia. Equine. Vet. J. 17: 208–213.

Egan, C.E., T.J. Snelling, and N.R. McEwan (2010). The onset of ciliated populations in new born foals. Acta. Protozool. 49: 145–147.

Fikru, R., and B. Teshale (2005). Prevalence of equine gastrointestinal parasites in western highlands of Oromia. Ethiopia. B. Anim. Health. Pro. Africa. 53: 161–166.

Franscico, I., M. Arias, F.J. Cortinas, R. Francisco, E. Mochales, V. Dacal, J.L. Suárez, J. Uriarte, P. Morrondo, R. Sáanchez-Andrade, P. Díez-Banos, and A. Paz-Silva (2009). Intrinsic factors influencing the infection by helminth parasites in horses under an oceanic climate area (NW Spain). J. Parasitol. Res. (5 doi:10.1155/2009/616173).

Fritzen, B., K. Rohn, T. Schnieder, and H. Samson (2010). Endoparasite control management on horse farms lessons from worm prevalence and questionnaire data. Equine. Vet. J. 42: 79–83.

Gawor, J.J. (1995). The prevalence and abundance of internal parasites in working horses autopsied in Poland. Vet. Parasitol. 58: 99–108.

Getachew, A.M., A.F. Trawford, G. Feseha, and S.W.J. Reid (2010). Gastrointestinal parasites of working donkeys in Ethiopia. Trop. Anim. Health. Pro. 42: 27–33.

Getachew, A.M., G. Feseha, A.F. Trawford, and S.W.J. Reid (2008). A survey of seasonal patterns in strongyle faecal worm egg counts of working equids of the central mid-lands and low-lands, Ethiopia. Trop. Anim. Health. Pro. 40: 637–642.

Goraya, K., Z. Iqbal, M.S. Sajid, G. Muhammad, Q.U. Ain, and M. Saleem (2013). Diversity of flora used for cure of equine diseases in selected peri-urban areas of Punjab, Pakistan. J. Ethnobiol. Ethnomed. 9: 70.

Gül, A., S. Değer, and E. Ayaz (2003). The prevalences of helminth species according to faecal examination in equids in different cities in Turkey. Turk. J. Vet. Anim. Sci. 27: 195–199.

Gülbahçe, S., and R. Cantoray (1995). Epidemiology of equine parasites in Kenya. Proc. of the 9th National Parasitology Congress. Antalya, 177.

Kaplan, R.M., T.R. Klei, E.T. Lyons, G. Lester, C.H. Courtney, D.D. French, S.C. Tolliver, A.C. Vidyashankar, and Y. Zhao (2004). Prevalence of anthelmintic resistant cyathostomes on horse farms. J Anim. Vet. Med. Assoc. 225: 903–910.

Khan, M.N., M.S. Sajid, M.K. Khan, Z. Iqbal, and A. Hussain (2010). Gastrointestinal helminthiasis: Prevalence and associated determinants in domestic ruminants of district Toba Tek Singh Punjab Pakistan. Parasitol. Res. 107: 787–794.

Khan, M.N., T. Rehman, Z. Iqbal, M.S. Sajid, M. Ahmad, and M. Riaz (2011). Prevalence and associated risk factors of Eimeria in sheep of Punjab Pakistan. World Acad. Sci. Eng. Tech. 80: 1329–1334.

Kornas, S., J. Cabaret, M. Skalska, and B. Nowosad (2010). Horse infection with intestinal helminths in relation to age, sex, access to grass and farm System Poland. Vet. Parasitol. 174: 285–291.

Love, S., D. Murphy, and D. Mellor (1999). Pathogenicity of cyathostome infection. Vet. Parasitol. 85: 113–121.

Lyons, E.T., S.C. Tolliver, and S.S. Collins (2011). Reduced activity of moxidectin and ivermectin on small strongyles in young horses on a farm (BC) in Central Kentucky in two field tests with notes on variable counts of eggs per gram of faeces (EPGs). Parasitol. Res, 108: 1315–1319.

Mahfooz, A., M.Z. Masood, A. Yousaf, N. Akhtar, and M.A. Zafar (2008). Prevalence and anthelmintic efficacy of abamectin against gastrointestinal parasites in horses. Pak. Vet. J. 28: 76–78.

Mbafor, F.L., P.V. Khan, W.P. Joshua, and J. Tchoumboue (2012). Prevalence and intensity of gastrointestinal helminths in horses in the Sudano-Guinean climate zone of Cameroon. Trop. Parasitol. 2: 45–48.

Morris, C., A.F. Trawford, E. Svendsen (2004). Donkey: hero or villain of the parasite world? Past, present and future. Vet. Parasitol. 125: 43–58.

Mushi, E.Z., M.G. Binta, R.G. Chabo, and L. Monnafela (2003). Seasonal fluctuation of parasitic infestation in donkeys (*Equus asinus*) in Oodi village, Kgatleng District, Botswana. J. South. Afr. Vet. Assoc. 74: 24–26.

Nielsen, M.K., R.M. Kaplan, S.M. Thamsborg, J. Monrad, and S.N. Olsen (2007). Climatic influences on development and survival of free living stages of equine strongyles: implications for worm control strategies and managing

anthelmintic resistance. Vet. J. 174: 23–32.

Öge, H. (1991). General status of helminth infections in horses according to faecal examinations. PhD thesis, Ankara University, Ankara, Turkey.

Pecheur, M., G. Detry-Pouplard, G. Gerin, and R. Tinar (1979). Les helminths parasites du systeme digestifde poneys abattus en Beigique. Ann. Med. Vet. 123: 103–108.

Roberson, N. (2009). Prevalence of gastrointestinal nematode parasites of equine in and around Asella. DVM thesis. Oromia Regional State Mekelle University, FVM Mekelle, Ethiopia.

Ryu, S.H., J.D. Jang, U.B. Bak, C.W. Lee, H.J. Youn, and Y.L. Lee (2004). Gastrointestinal impaction by *Parascaris equorum* in a thoroughbred foal in Jeju, Korea. J. Vet. Sci. 5: 181–182.

Saeed, K., Z. Qadir, K. Ashraf, and N. Ahmad (2010). Role of intrinsic and extrinsic epidemiological factors on strongylosis in horses. J. Anim. Plant. Sci. 20: 277–280.

Schork, M.A., and R.D. Remington (2010). Statistics with applications to the biological and health sciences. 3rd Ed. Lexington KY; USA.

Singh, B., H. Ram, P.S. Banerjee, R. Garg, and C.L. Yadav (2002). Epidemiological aspects of gastrointestinal parasites of equines in Uttaranchal and Uttar Pradesh, Ind J. Ani. Sci. 72: 861–862.

Slocombe, J.O., R.V. Gannes, and M.C. Lake (2007). Macrocyclic lactone resistant *Parascaris equorum* on stud farms in Canada and effectiveness of fenbendazole and pyrantel pamoate. Vet. Parasitol. 145: 371–376.

Sotiraki, S.T., Badouvas A.G. & Himonas A.C. 2010. A survey on the prevalence of internal parasites of equines in Macedonia and Thessalia Greece. J. Equ. Vet. Sci. 550–552.

Soulsby, E.J.L. (1982). Helminths, Arthropods and Protozoa of Domesticated Animals. 7th Ed. Bailllere Tindall; London (UK).

Stratford, C.H., H.E. Lester, E.R. Morgan, K.J. Pickles, V. Relf, B.C. McGorum, and J.B. Matthews (2014). A questionnaire study of equine gastrointestinal parasite control in Scotland. Equine. Vet. J. 46: 25–31.

Thrusfield M. (2007). Veterinary Epidemiology. 3rd Ed. Blackwell Science; London (UK).

Umar, Y.A., B.D. Maikaje, U.M. Garba, and M.A.F. Al-hassan (2013). Prevalence of gastrointestinal parasites in horses used for cadets training in Nigeria. J. Vet. Adv. 3: 43–48.

Umur, S., and M. Acici (2009). A survey on helminth infections of equines in the Central Black Sea region Turkey. Turk. J. Vet. Anim. Sci. 33: 373–378.

Urquhart, G.M., J. Armour, J.L. Duncan, A.M. Dunn, and F.W. Jennings (1996). Veterinary Parasitology. 2nd Ed. Blackwell Science Ltd; London (UK).

Yoseph, S., D.G. Smith, A. Mengistu, F. Teklu, T. Firew, and Y. Betere (2005). Seasonal variation in the parasite burden and body condition of working donkeys in East Shewa and West Shewa regions of Ethiopia. Trop. Anim. Health. Pro. 1: 35–45.