Saudi Journal of Biological Sciences (2011) **18**, 299–303

King Saud University

Saudi Journal of Biological Sciences

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ORIGINAL ARTICLE

Prevalence of non-strongyle gastrointestinal parasites of horses in Riyadh region of Saudi Arabia

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Received 4 October 2010; revised 31 January 2011; accepted 12 February 2011
Available online 17 February 2011

KEYWORDS

Horse parasites;
Strongyle;
Necropsy;
Gastrointestinal tract;
Riyadh region;
Saudi Arabia

Abstract This study aimed to provide recent data on the occurrence of non-strongyle intestinal parasite infestation in horses in the Riyadh region of Saudi Arabia as a basis for developing parasite control strategies. We conducted necropsy for 45 horses from September 2006 to November 2007 in the Riyadh region, Saudi Arabia. 39 out of 45 horses were infected with intestinal parasites with an infestation rate of 86.6%. Infestations with seven nematode species and two species of *Gasterophilus* larva were found. The most prevalent parasites were *Strongyloides westeri* (64.4%) and *Parascaris equorum* (28.8%) followed by *Habronema muscae* (22.2%). *Trichostrongylus axei* and *Oxyuris equi* were less common at (11.1%) and (8.8%), respectively. *Habronema megastoma* and *Setaria equine* were found in two horses only (4.4%). *Gasterophilus intestinalis* larvae were recovered from 39 horses (86.6%) and *Gasterophilus nasalis* larvae were found in 17 horses (37.7%). Season had a significant effect on the prevalence of *P. equorum* and *G. nasalis,* while age of horses had a significant effect only on the prevalence of *P. equorum*. The husbandry in Saudi Arabia appears to be conductive to parasites transmitted in stables or by insects rather than in pasture.

1. Introduction

The gastrointestinal tract of horses provides a target site for many internal parasites species, such as *Parascaris equorum, Habronema* spp., *Gasterophilus* spp., and tapeworms. These parasites have the potential to cause serious diseased conditions in horses including diarrhoea, emaciation, colic, anaemia, haemorrhage and death (Mfitilodze and Hutchinson, 1989; Gawor, 1995). Several studies have been conducted on horse parasites in many countries, such as USA (Reinemeyer et al., 1984; Lyons et al., 1987), UK (Ogbourne, 1976), Europe (Pecheur et al., 1979; Gawor, 1995) and Australia (Dunsmore and Jue Sue, 1985; Mfitilodze and Hutchinson, 1989; Bucknell

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Peer review under responsibility of King Saud University.
doi:10.1016/j.sjbs.2011.02.001

Production and hosting by Elsevier

et al., 1995; Boxell et al., 2004), but not in Saudi Arabia. According to estimates by the Saudi Ministry of Agriculture, Saudi Arabia, the number of horses in Saudi Arabia in 2008 exceeded 22,000 and more than 500 horses were imported annually from UAE, USA and European countries (Ministry of Agriculture, 2008).

Furthermore, tonnes of veterinary anthelmintics and vaccines were reported to be imported annually to Saudi Arabia (Ministry of Agriculture, 2008) indicating significant usage. The main objectives of the present study were to investigate the rate of infestation of non-strongyle gastrointestinal parasites in horses in the Riyadh region of Saudi Arabia.

2. Materials and methods

2.1. Necropsies and parasite identification

From September 2006 to August 2007, 45 gastrointestinal tracts of recently dead horses of both sexes (29 male, 16 female), varying in ages (from 2 to 17 years with mean age of 12 years) were necropsied and examined for internal parasites at necropsy at the National Agriculture and Animal Resources Research Centre, Ministry of Agriculture, Saudi Arabia (Table 1). Background information, such as the date of death and necropsy slaughter, sex, age, geographic source of the horses and

Table 1 Number of horses, which are obtained from different geographical areas, of Riyadh region during the study source of horses, sex, age, season and date of necropsy slaughter.

Source of horses	Sex	Age	Season	Date of slaughter
Al-Jandiriyah	Male	4	Autumn	7 September 2006
Al-Jandiriyah	Female	2		11 September 2006
Al-Jandiriyah	Male	17		21 September 2006
Al-Kharj	Male	7		3 October 2006
Al-Jandiriyah	Male	3		11 October 2006
Al-Kharj	Male	8		1 October 2006
Al-Jandiriyah	Female	11		27 October 2006
Al-Jandiriyah	Female	2		7 November 2006
Al-Jandiriyah	Male	5		9 November 2006
Al-Hair	Male	5		17 November 2006
Al-Muzahimiyah	Male	7		21 November 2006
Rumah	Male	8		30 November 2006
Al-Hair	Female	3	Winter	9 December 2006
Al-Kharj	Female	3		14 December 2006
Al-Jandiriyah	Male	2		22 December 2006
Al-Muzahimiyah	Female	5		28 December 2006
Al-Jandiriyah	Male	11		4 January 2007
Al-Jandiriyah	Male	2		19 January 2007
Dirab	Male	4		22 January 2007
Al-Jandiriyah	Female	4		5 February 2007
Al-Kharj	Male	5		8 February 2007
Al-Jandiriyah	Female	3		16 February 2007
Dirab	Female	5		23 February 2007
Al-Jandiriyah	Male	3	Spring	2 March 2007
Al-Jandiriyah	Female	7		11 March 2007
Thadig	Male	9		16 March 2007
Al-Hair	Male	11		21 March 2007
Al-Jandiriyah	Female	3		7 April 2007
Al-Jandiriyah	Male	8		18 April 2007
Al-Kharj	Male	15		29 April 2007
Al-Jandiriyah	Female	12		11 May 2007
Rumah	Male	5		15 May 2007
Al-Muzahimiyah	Female	9		22 May 2007
Al-Jandiriyah	Male	6		27 May 2007
Dirab	Female	8	Summer	6 June 2007
Al-Kharj	Male	2		13 June 2007
Al-Kharj	Male	6		22 June 2007
Thadig	Female	7		4 July 2007
Al-Hair	Female	8		15July 2007
Al-Jandiriyah	Male	10		19 July 2007
Dirab	Male	9		24 July 2007
Al-Jandiriyah	Male	13		6 August 2007
Al-Jandiriyah	Male	15		13 August 2007
Al-Kharj	Male	8		21 August 2007
Al-Jandiriyah	Male	11		29 August 2007

physical conditions were recorded where ever possible. No information was available on the anthelmintics treatment of the horses. Necropsy procedures for the identified recovering parasites followed according to methods previously described by studies such as Ogbourne (1976) and Reinemeyer et al. (1984). The gastrointestinal tract (GIT) was divided into five parts or compartments: stomach, small intestine, caecum, ventral colon and dorsal colon. Each part was ligated to avoid mixing and processed separately. After opening longitudinally, each part was then examined and washed by a stream of water. Large worms were collected directly into 70% ethanol. GIT contents were washed into a large container (~100 L), a 10% aliquot was removed and fixed in a 70% ethanol solution. Then 10% aliquot was examined for parasites present and the total numbers of parasites were calculated from the numbers found in the aliquots ten times plus the numbers of parasites that were collected directly. Parasites were cleared with lactophenol on a glass slide and identified under a light microscope by using the keys of Lichtenfels et al. (2008) and the photographs of Bowman (2003).

2.2. Climatological data

The seasons were defined as follows, summer: June, July and August; autumn: September; October and November; winter: December, January and February and spring: March, April and May. Mean monthly minimum and maximum temperatures, mean rainfall and relative humidity for Riyadh region was obtained from the Presidency of Meteorology and Environment (PME), Saudi Arabian Government website (http://www.pme.gov.sa). Riyadh region has very hot summer approaching 50 °C. The average high temperature in July is 45 °C. Winters are cold with windy nights. The overall climate is arid, receiving very little rainfall of 21.4 mm with relative humidity ranging from 10% to 47% throughout the year. Riyadh region is also known to have many dust storms.

2.3. Statistical analysis

Data analyses were performed using the Statistical Package for Social Sciences (SPSS) (16.0, 2008) for windows software and for subsequent calculations. Because of the wide ranges in the total numbers of worms and large variances data were transformed using the formula (log 10 (value) + 10). The influence of seasons and horse age on mean prevalence counts was compared using the subprogram Post Hoc Test, One-way 'ANOVA' with the *F*-statistic for a test of significant *P* value ($p < 0.05$). Means were re-transformed (10^(value) − 10) to obtain the geometric mean for all results.

3. Results

Of the 45 horses examined, 39 horses (86.6%) were infected at least with one internal parasitic species. The individual preva-

Table 2 Rate of infestation with non-strongyle intestinal parasites, mean of intensity and range of non-strongyle intestinal parasites in the 45 necropsied horses at necropsy in Riyadh region of Saudi Arabia during this study parasites, infected horses (45), infestation rate%, mean intensity, and range.

Parasites	Infected horses (45)	Infection rate (%)	Mean intensity	Range
Parascaris equorum	13	28.8	13	7–42
Strongyloides westeri	29	64.4	89	140–453
Oxyuris equi	4	8.8	104	280–445
Trichostrongylus axei	5	11.1	123	210–621
Habronema muscae	10	22.2	42	14–245
Habronema megastoma	2	4.4	8	6–17
Setaria equina	2	4.4	11	7–23
Gastrophilus intestinalis	39	86.6	67	17–490
Gasterophilus nasalis	17	37.7	14	22–91

Table 3 Statistical analysis of effect of the seasonal effect on the prevalence of infestation of non-strongyle gastrointestinal parasites from the 45 necropsied horses at necropsy in different seasons from Riyadh region, Saudi Arabia.

Non-strongyle species	No of infected horses per season				Statistical analysis				
	S	A	W	Sp	Log M	SE	GM	F	Sig
Parascaris equorum[*]	1	0	10	2	1.740	0.2231	55	4.34	0.007
Strongyloides westeri	4	7	11	7	2.346	0.2435	222	1.838	0.26
Oxyuris equi	0	1	1	2	1.322	0.1651	21	2.708	0.231
Trichostrongylus axei	0	1	1	3	1.342	0.1401	22	0.919	0.46
Habronema muscae	4	2	1	3	1.546	0.1761	35.2	1.483	0.23
Habronema megastoma	1	0	1	0	1.145	0.1722	14	0.871	0.43
Setaria equina	0	1	1	0	1.046	0.1021	11.2	0.318	0.812
Gastrophilus intestinalis	14	9	6	10	2.730	0.2663	537.5	3.431	0.63
**Gasterophilus nasalis*	2	1	12	2	1.476	0.1123	30	6.33	0.01

S = summer, A = autumn, W = winter, Sp = spring, Log M = logmetric mean, SE = standard error, GM = geometric mean, F = *F*-test, Sig = significance.
The mean difference is significant at the 0.05 level.
[*] Significant value.

Table 4 Statistical analysis of the effect of horse age on the prevalence of infestation of non-strongyle gastrointestinal parasites from the 45 necropsied horses at necropsy in different seasons from Riyadh region, Saudi Arabia.

Non-strongyle species	No of infected horses per age group				Statistical analysis				
	0 < 2	3–5	6–8	9 >	Log M	SE	GM	F	Sig
Parascaris equorum[*]	11	2	0	0	1.1760	0.1241	15	4.671	0.007
Strongyloides westeri	9	13	5	2	2.1701	0.2311	207	1.623	0.24
Oxyuris equi	1	2	1	0	1.322	0.2371	21	2.721	0.282
Trichostrongylus axei	0	1	1	3	1.230	0.1330	17	0.923	0.472
Habronema muscae	2	3	4	1	1.442	0.1772	27.6	0.483	0.382
Habronema megastoma	0	0	1	1	1.120	0.1735	13.2	0.633	0.440
Setaria equina	0	1	1	0	0.920	0.1181	8.3	0.413	0.914
Gastrophilus intestinalis	8	9	9	13	2.620	0.2813	417	2.331	0.821
Gasterophilus nasalis	4	3	3	7	1.520	0.1562	33.1	1.351	0.243

S = summer, A = autumn, W = winter, Sp = spring, Log M = logmetric mean, SE = standard error, GM = geometric mean, F = *F*-test, Sig = significance.
The mean difference is significant at the 0.05 level.
[*] Significant value.

lence and mean intensity of parasite in the 45 horses at necropsy are shown in Table 2. Nine gastrointestinal parasites were found in this study. These included 7 nematode species; *Strongyloides westeri, Trichostrongylus axei, P. equorum, Habronema muscae, Habronema megastoma, Oxyuris equi* and *Setaria equine*. Also, *Gasterophilus intestinalis* and *Gasterophilus nasalis* were the only botfly species found with prevalence of 86.6% and 34%, respectively. In addition, *P. equorum* only infected horses less than 5 years of age. Tapeworms were not found in this study.

3.1. Effect of season on prevalence of horses parasites

Significant seasonal differences in prevalence ($p < 0.05$) were shown only by *G. nasalis* and *P. equorum*. These species had highest prevalence during the winter season (Table 3).

3.2. Effect of horse age on prevalence of horse parasites

Significant differences were only shown by *P. equorum* that was not recovered from horses older than 5 years. General characteristic of the rest of the species was that the prevalence was higher in horses over 9 years of age (Table 4).

4. Discussion

Previous studies on horse parasites in Saudi Arabia are restricted to the collections of external parasites (Al-Khalifa et al., 1983). This is the first study in Saudi Arabia that recorded species of non-strongyle intestinal parasitic infestation described in horses in Saudi Arabia infected with the species of non-strongyle intestinal parasites typically to those recorded in horses worldwide. Because the number of the sample size was moderate (45 horses) and sampling techniques used in various studies described below differed, rigorous comparisons of the rates of parasite infestation were limited. Nevertheless, results in the present study appear to differ from other studies in USA, Europe and Australia. The infestation rates fell into several patterns. Some parasites such as *S. westeri* and *P. equorum* were common. In contrast, other parasites were present at low prevalence and some were absent such as tapeworms.

S. westeri were found in the small intestine of 29 horses (64.8%). Compared with reports from other regions this represents a high level of infestation. For example, infestation rates were 4% in 50 Polish horses (Gawor, 1995), 6% of 57 horses in northern Queensland, Australia (Mfitilodze and Hutchinson, 1989) or absent (Reinemeyer et al., 1984; Bucknell et al., 1995). The high rate of *S. westeri* infestation in the sample of Saudi horses may be due to lack of treatment of horses and poor hygiene measures in stables.

All of the horses infected with *P. equorum* were less than 5 years of age (28.8%), but they carried low worm burdens. The proportion of infected horses in the present study is similar to that recorded by Reinemeyer et al. (1984) (18%) and Gawor (1995) (26%). *P. equorum* is principally a parasite of young horses < 5 years of age (Drudge and Lyons, 1966). Dunsmore and Jue Sue (1985) and Mfitilodze and Hutchinson (1989) also found *P. equorum* in horses up to the age of 5 year old, while Bucknell et al. (1995) found this parasite exclusively in horses less than 2 years of age. Also, higher prevalence of *P. equorum* in winter season in this study suggests that its transmission may be administered by climatic conditions, and particularly that the infective eggs may be susceptible to aridity (Mfitilodze and Hutchinson, 1989).

The rate of *O. equi* (8.8%) infestation falls within the range reported in previous studies. Levels reported by Mfitilodze and Hutchinson (1989) (26%), Torbert et al. (1986) (56.8%) and Gawor (1995) (36%) were higher than those reported by Reinemeyer et al. (1984) (11%), Bucknell et al. (1995) (7%) and Boxell et al. (2004). The low prevalence of *O. equi* in the present study may have been due to the predilection of *O. equi* for young and stabled horses where transmission is enhanced (Arundel, 1985).

Horses typically become infected by *T. axei* when they graze pasture in common with ruminants. El-Azazy (1995) reported that (7.3%) of Saudi Arabian sheep were infected with *T. axei*. The prevalence of *T. axei* (11%) in horses in the present study was similar to that found in horses from NSW, Australia (17%) (Brockwell et al., 1998). However, it was less than that found by Bucknell et al. (1995) (51%) in a Victorian study in Australia where climatic and grazing conditions may predispose to it.

H. muscae and *H. megastoma* were found only in stomach of horses. Differences in their proportion might be because these parasites are transmitted by flies, their presence tends to be seasonal, being more prevalent in the summer months. Infestation rates vary from summer 71% (Reinemeyer et al., 1984) to winter 13% (Bucknell et al., 1995) in different regions.

S. equina has been reported from horses before in studies by Gawor (1995) (8%) and Mfitilodze and Hutchinson (1989) (2%), but the low infestation rates in the present study (4.4%) suggest it is a rare infestation.

Larvae of *G. intestinalis* were found in the stomach of 39 horses (prevalence 86.6%). It was similar to that previously recorded which is in accord with previous studies on the prevalence of this species in many countries or parts of the world such as in USA by Reinemeyer et al. (1984) (71%), Australia by Bucknell et al. (1995) (81%) and Europe by Gawor (1995) (40%). The prevalence of *G. nasalis* in the present study was similar to the most previous studies (Reinemeyer et al., 1984; Dunsmore and Jue Sue, 1985; Mfitilodze and Hutchinson, 1989; Bucknell et al., 1995).

A striking pattern revealed in this study is the relatively low rate of infestation by parasites that are transmitted via pasture due to the limited area for grazing and poor pasture available in the desert climate. Saudi horses are typically fed grains and green and dry grass. Further, the short life cycle and harsh climate probably limit the transmission of these parasite species. Neither *Anoplocephala perfoliata* nor *Anoplocephala magna* or their eggs were found in horses in this study. These parasites are also transmitted on pasture. Nevertheless, the presence of some species of Anoplocephalidae in sheep, cattle and camels in Saudi Arabia indicate that transmission of tapeworms can occur in this climate (Kasim and Al-Shawa, 1984; Nasher, 1993; Omer and Al-Sagair, 2005).

Acknowledgements

We thank the National Agriculture and Animal Resources Research Centre, Ministry of Agriculture in Saudi Arabia for the technical support of this investigation.

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