



## Gastrointestinal parasites of horses (*Equus caballus* Linnaeus, 1758) and risk factors associated with equine coccidiosis in Kwara and Niger States, Nigeria

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### Abstract

About two-third of the parasitic infections in animals are believed to occur in the gastrointestinal tract. Coccidiosis is an important disease of horses and it is responsible for a great economic setback worldwide. This study was designed to determine the species diversity and prevalence of gastrointestinal parasites of horses and the risk factors associated with *Eimeria* infections in horses in Kwara and Niger States, North Central Nigeria. Faecal samples were collected from 105 horses in Kwara and Niger States. Simple floatation and formalin-ethyl acetate concentration techniques were used as diagnostic techniques. An overall prevalence of 62.86% (66/105) was recorded. Eleven gastrointestinal parasites comprising of 7 nematodes, 2 trematodes, 1 protozoan and 1 cestode were detected. *Strongylus* spp. (33.33%; 35/105) and *Eimeria* spp. (28.57%; 30/105) were the most prevalent. Forty-six (43.81%) of the sampled population had multiple gastrointestinal parasites infection. Body condition score, presence/ absence of diarrhoea and horse ownership were significantly association with the occurrence of *Eimeria* infection. This appears to be the first report on gastrointestinal parasites of horses in Kwara and Niger States of Nigeria. The high prevalence reported in this study calls for horse owners to improve on the veterinary medical attention given to their horses as gastrointestinal parasitism is a major cause of economic loss in equine husbandry. The curtailing of gastrointestinal parasitism will improve production, reproduction and performance of horses in the study areas.

**Keywords:** *Eimeria* spp.; Gastrointestinal parasites; Horses; North Central Nigeria; Risk factors

### Introduction

The world equine population is estimated to be about 124 million (Alemayehu & Etaferahu, 2013), with over

60% of all horses been found in developing countries (Mayaki, 2017) where they are used for diverse

purposes. Horse (*Equus caballus*) has long been domesticated by man and since then it has been a loyal friend and a trusted partner in man's day to day life. Horses play a vital role in many aspects of human life, either as livestock pets or companion animals (Bulgaru & Tudor, 2016; Ola-Fadunsin *et al.*, 2018). Horses are known to be of importance to man in many ways, which includes working activities such as police service, pleasure riding, polo games, ceremonies, crowd control, entertainment, agriculture and research. Also, meat, milk, hide, bones, blood, hooves and pharmaceuticals are other important products derived from horses (Abiola *et al.*, 2016; Ola-Fadunsin *et al.*, 2018). Horses are associated with royalty and some special traditional festivals in some parts of Nigeria (Ehizibolo *et al.*, 2012; Ola-Fadunsin *et al.*, 2018).

Equines are generally considered as hardy and resistant animals. Despite this belief, they do suffer from a number of diseases (Takele & Nibret, 2013) including parasitism which causes a major impact on their production in the tropics including Nigeria (Regassa & Yimer, 2013; Ola-Fadunsin *et al.*, 2018). Equines harbor many species of parasites in their gastrointestinal tract, as it provides a suitable environment for their survival and proliferation (Regassa & Yimer, 2013; Umar *et al.*, 2013). Parasites such as protozoa, trematodes, cestodes and nematodes are generally seen in apparently healthy horses (Wosu & Udobi, 2014). *Eimeria leuckarti*, *Eimeria solipedum* and *Eimeria uniungulata* are the *Eimeria* spp. known to affect horses (Effat *et al.*, 2014; Taylor *et al.*, 2016). Gastrointestinal parasitism is usually associated with signs such as weakness, emaciation, restlessness, unthriftiness, diarrhea, anaemia and sometimes intestinal obstruction or perforation (Umar *et al.*, 2013) depending on the species and number of parasites present, the age, nutritional and immune status of the horse (Mezgebu *et al.*, 2013; Belete & Derso, 2015).

A proper understanding of the epidemiology of a disease-causing agent is a prerequisite for the rational design of effective preventive and control programme against the disease. Although studies on gastrointestinal parasites of horses have been carried out in some States in North Central Nigeria, none has been conducted in Kwara and Niger States to the best of our knowledge. Therefore, this study was carried out to elucidate the species diversity and prevalence of gastrointestinal parasites of horses and the risk factors associated with *Eimeria* infections in horses in the study areas.

## Materials and Methods

### Study area and population

The study was carried out in Ilorin (Kwara State), Bida and Kainji (Niger State) all in North Central Nigeria. Kwara State occupies an area of 35,705 Km<sup>2</sup> and lies between 8°05'–10°15'N and 2°73'–6°13'E, while Niger State occupies an area of 68,925 Km<sup>2</sup> and lies between 10°0'N and 6°0'E (NBS, 2016). The study population was recruited from institutional stables (Government Establishments, Agricultural Colleges and Security Agencies) and non-institutional stables (traditional and private).

### Sample collection

About five grams of faecal samples were collected from 105 horses of both sexes and different age categories between March and October, 2018. Samples were collected immediately after defecation into clean and sterile polyethene bags and the collected samples were labeled accordingly and placed in cool boxes. The samples were immediately transported to the Parasitology Laboratory of the Faculty of Veterinary Medicine, University of Ilorin, Nigeria for further processing.

### Laboratory analysis

Faecal samples were processed using the simple floatation and the formalin-ethyl acetate concentration techniques. The flotation technique was carried out as described by Soulsby (1982). Briefly, 2 grams of each faecal sample were placed in universal bottles and mixed with little quantities of saturated sodium chloride solution. This mixture was then sieved into a test tube. Afterward, the filtrate was filled to the brim (forming a meniscus) with more of the saturated sodium chloride solution and a clean cover slip was gently placed on top of the test tube whereby avoiding spillage. The cover slip was left for about 20 minutes; afterwards, the cover slip (having the harvested eggs) was placed on a clean glass slide for microscopic examination.

The formalin-ethyl acetate concentration technique was carried out as described by Cheesbrough (2009). Briefly, about 2 grams of each faeces were dissolved in 10% formalin and sieved in to a plastic test tube to the 7 ml mark and allowed to stand for few minutes. Three (3) ml of ethyl acetate were added. The tube was closed, vigorously shaken by hand for 1 min and centrifuged at 3000rpm for 5 min. The debris plug was loosened and the top three layers were discarded. Iodine stain preparation was made with the sediment and the entire sediment was examined on a clean glass slide and covered with a clean cover slip. All the

processed samples were examined using 10X and 40X objective lenses.

#### Identification of *Eimeria* oocyst and helminth eggs

The oocysts and eggs from the processing methods mentioned above were identified using the keys as described by Soulsby (1982) and Taylor *et al.* (2016).

#### Determination of positivity

Samples that were positive in one or both of the tests carried out were considered positive for the gastrointestinal parasite(s) detected.

#### Data collection

Information on the potential risk factors were recorded during sample collection by using a well-structured, interviewer-administered questionnaire containing open-ended and closed ended questions. The sex and presence or absence of diarrhoea were determined by observation. The body condition scores (poor, moderate and good) were estimated based on the published guideline as documented by the National Equine Welfare Council (2009).

#### Statistical analysis

Data were initially entered in Microsoft office Excel version 2010 for the determination of absolute frequencies and percentages (%). Chi-square (Univariable model) test for discrete variables at 95% confidence interval at  $P < 0.05$  was used to determine the associations of potential risk factors with the presence/ absence of *Eimeria* oocysts. The Statistical Package for the Social Sciences (SPSS, Chicago, Illinois, USA) for windows version 22.0 was used for all analysis. A  $P$ -value  $< 0.05$  was considered statistically significant in all the analyses.

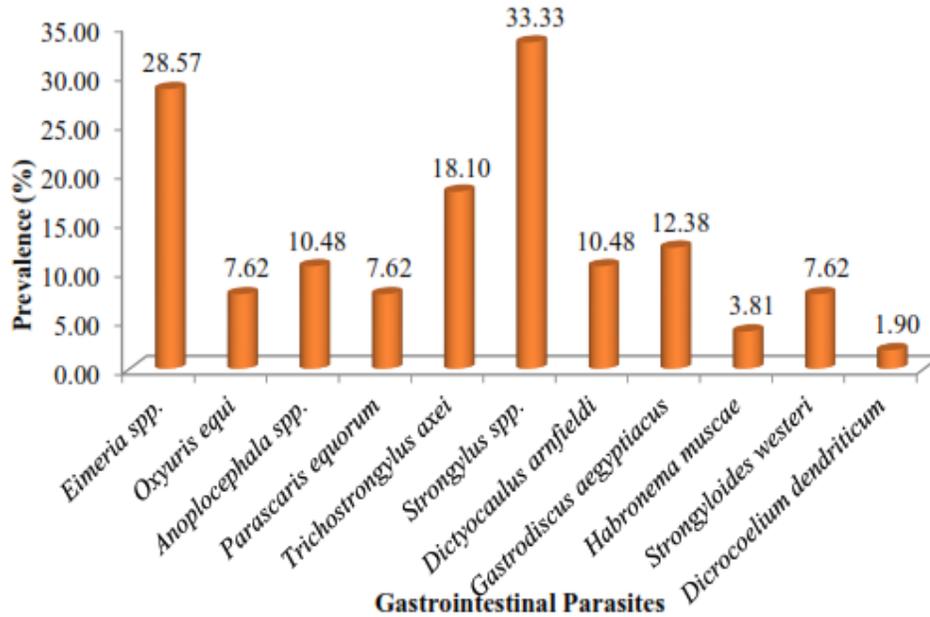
#### Results

There was no significant association between the potential risk factors and the prevalence of helminth infection. Of the total 105 horses sampled, 66 (62.86%) were positive for gastrointestinal parasite(s) infection. Eleven gastrointestinal parasites were detected in this study comprising of 7 nematodes (*Oxyuris equi*, *Parascaris equorum*, *Trichostrongylus axei*, *Strongylus* spp., *Dictyocaulus arnfieldi*, *Habronema muscae* and *Strongyloides westeri*); 2 trematodes (*Gastrodiscus aegyptiacus* and *Dicrocoelium dendriticum*); 1 protozoan (*Eimeria* spp.) and 1 cestode (*Anoplocephala* spp.). *Strongylus*

spp. was the most prevalent GI parasite infecting 35 (33.33%) of the total sampled population, while *Eimeria* spp. was the next representing 28.57% of the sampled population. *Habronema muscae* and *Dicrocoelium dendriticum* were the least prevalent GI parasites representing 3.81% and 1.90% of the sampled population respectively (Figure 1).

The infection patterns of gastrointestinal parasites of horses in North Central Nigeria were presented in tables 1 to 6. Twenty (19.05%) out of the 105 sampled horses were infected with one GI parasite, with *Strongylus* spp. and *Eimeria* spp. being the most prevalent in this category (Table 1). In the two GI parasites infection category, *Eimeria* spp. + *Strongylus* spp. was the most prevalent (Table 2). A total of 9.52% of the sampled population was concurrently infected with three GI parasites, with *Eimeria* spp. + *Strongylus* spp. + *Dictyocaulus arnfieldi* being the most prevalent (Table 3). Five of the 105 sampled horses representing 4.76% were having four GI parasites co-infection (Table 4). The infection pattern of *Eimeria* spp. + *Trichostrongylus axei* + *Strongylus* spp. + *Dictyocaulus arnfieldi* + *Strongyloides westeri* was the most prevalent in the five GI parasites co-infection category (Table 5). Of the sampled horses, two (1.90%) were infected with six GI parasites co-infection (Table 6).

The prevalence of *Eimeria* infections among horses increased with age. Females were 1.96 times more likely to be infected compared to their male counterparts. Horses with poor body condition score were 2.78 times more likely to be infected with *Eimeria* spp. compared to horses with moderate body condition score, while horse with good body condition score were 3.57 times less likely to be infected with *Eimeria* spp. compared to horses with poor body condition score. Horses with diarrhoea were 4.12 times more likely to be infected with *Eimeria* infections compared to horses that are not diarrhoeic. There was a higher tendency (7.76) of coccidiosis among horses raised in institutional stables than those raised in non-institutional stables. There was no significant difference in the prevalence of equine coccidiosis among the sampled States, although the prevalence was higher in Niger State compared to Kwara State. The association between body condition score, presence/ absence of diarrhoea and horse ownership with the prevalence of equine coccidiosis was statistically significant ( $P < 0.05$ ) (Table 7).



**Figure 1:** Total prevalence (%) of gastrointestinal parasites of horses in Kwara and Niger States, North central Nigeria

**Table 1:** Prevalence of single gastrointestinal parasite infection among horses in Kwara and Niger States, North Central Nigeria (n=105)

Gastrointestinal parasite infection	Number (%)	95% CI
<i>Eimeria</i> spp.	4 (20.00)	6.70; 41.49
<i>Oxyuris equi</i>	1 (5.00)	0.25; 22.28
<i>Anoplocephala</i> spp.	1 (5.00)	0.25; 22.28
<i>Parascaris equorum</i>	2 (10.00)	1.71; 29.29
<i>Trichostrongylus axei</i>	1 (5.00)	0.25; 22.28
<i>Strongylus</i> spp.	6 (30.00)	13.16; 52.28
<i>Gastrodiscus aegyptiacus</i>	3 (15.00)	3.96; 35.61
<i>Habronema muscae</i>	1 (5.00)	0.25; 22.28
<i>Dicrocoelium dendriticum</i>	1 (5.00)	0.25; 22.28
<b>Total</b>	<b>20 (19.05)</b>	<b>12.38; 27.40</b>

**Discussion**

The overall prevalence of 62.86% reported in our study is lower than of previous studies conducted in Nigeria, where 70.8% and 76.1% prevalences were reported by Umar *et al.* (2013) and Wosu & Udobi (2014) in their respective studies conducted in Kaduna and Abuja. Lower prevalence of 60.80% has been reported in Ethiopia (Regassa & Yimer, 2013) and 28.57% in Romania (Bulgaru & Tudor, 2016), while higher prevalences of 80.95% and 84.76% had been reported in Ethiopia (Mezgebu *et al.*, 2013) and Nepal (Oli & Subedi, 2018) respectively. The differences in the prevalence could be attributed to the season of sampling, climatic and environmental differences, management practice, level of stable hygiene, breeding-related conditions, diagnostic

technique carried out and nutritional and immune status of the studied horses.

Also, differences in the environment-host interaction, environment-parasitic interaction and host-parasite interaction (Radostitis *et al.*, 2000; Belete & Derso, 2015) may have contributed to the varying prevalence rates.

We detected eleven different GI parasites in our study as against the fewer numbers detected in previous studies conducted in Nigeria (Ehizibolo *et al.*, 2012; Umar *et al.*, 2013; Wosu & Udobi 2014). The higher number detected could be attributed to the better sensitivity of the formalin-ethyl acetate concentration technique used in this study, which the preferred method for the detection of GI

**Table 2:** Prevalence of two gastrointestinal parasites co-infection among horses in Kwara and Niger States, North Central Nigeria (n=105)

Gastrointestinal parasites infection	Number (%)	95% CI
<i>Eimeria</i> spp. + <i>Anoplocephala</i> spp.	1 (3.85)	0.19; 17.54
<i>Eimeria</i> spp. + <i>Parascaris equorum</i>	1 (3.85)	0.19; 17.54
<i>Eimeria</i> spp. + <i>Trichostrongylus axei</i>	1 (3.85)	0.19; 17.54
<i>Eimeria</i> spp. + <i>Strongylus</i> spp.	4 (15.38)	5.09; 33.06
<i>Eimeria</i> spp. + <i>Dictyocaulus arnfieldi</i>	2 (7.69)	1.31; 23.16
<i>Eimeria</i> spp. + <i>Gastrodiscus aegyptiacus</i>	3 (11.54)	3.02; 28.27
<i>Eimeria</i> spp. + <i>Habronema muscae</i>	1 (3.85)	0.19; 17.54
<i>Eimeria</i> spp. + <i>Strongyloides westeri</i>	1 (3.85)	0.19; 17.54
<i>Oxyuris equi</i> + <i>Anoplocephala</i> spp.	1 (3.85)	0.19; 17.54
<i>Oxyuris equi</i> + <i>Strongylus</i> spp.	1 (3.85)	0.19; 17.54
<i>Anoplocephala</i> spp. + <i>Parascaris equorum</i>	1 (3.85)	0.19; 17.54
<i>Anoplocephala</i> spp. + <i>Gastrodiscus aegyptiacus</i>	1 (3.85)	0.19; 17.54
<i>Parascaris equorum</i> + <i>Strongylus</i> spp.	1 (3.85)	0.19; 17.54
<i>Trichostrongylus axei</i> + <i>Strongylus</i> spp.	6 (23.08)	9.92; 41.95
<i>Strongylus</i> spp. + <i>Strongyloides westeri</i>	1 (3.85)	0.19; 17.54
Total	26 (24.76)	17.22; 33.68

**Table 3:** Prevalence of three gastrointestinal parasites co-infection among horses in Kwara and Niger States, North Central Nigeria (n=105)

Gastrointestinal parasites infection	Number (%)	95% CI
<i>Eimeria</i> spp. + <i>Anoplocephala</i> spp. + <i>Dictyocaulus arnfieldi</i>	1 (10.00)	0.50; 40.35
<i>Eimeria</i> spp. + <i>Trichostrongylus axei</i> + <i>Strongylus</i> spp.	1 (10.00)	0.50; 40.35
<i>Eimeria</i> spp. + <i>Strongylus</i> spp. + <i>Dictyocaulus arnfieldi</i>	2 (20.00)	3.50; 51.95
<i>Oxyuris equi</i> + <i>Trichostrongylus axei</i> + <i>Strongylus</i> spp.	1 (10.00)	0.50; 40.35
<i>Oxyuris equi</i> + <i>Strongylus</i> spp. + <i>Dictyocaulus arnfieldi</i>	1 (10.00)	0.50; 40.35
<i>Oxyuris equi</i> + <i>Strongylus</i> spp. + <i>Gastrodiscus aegyptiacus</i>	1 (10.00)	0.50; 40.35
<i>Anoplocephala</i> spp. + <i>Trichostrongylus axei</i> + <i>Strongylus</i> spp.	1 (10.00)	0.50; 40.35
<i>Strongylus</i> spp. + <i>Dictyocaulus arnfieldi</i> + <i>Dicrocoelium dendriticum</i>	1 (10.00)	0.50; 40.35
<i>Strongylus</i> spp. + <i>Habronema muscae</i> + <i>Strongyloides westeri</i>	1 (10.00)	0.50; 40.35
Total	10 (9.52)	4.94; 16.32

**Table 4:** Prevalence of four gastrointestinal parasites co-infection among horses in Kwara and Niger States, North Central Nigeria (n=105)

Gastrointestinal parasites infection	Number (%)	95% CI
<i>Eimeria</i> spp. + <i>Oxyuris equi</i> + <i>Anoplocephala</i> spp. + <i>Parascaris equorum</i>	1 (20.00)	1.00; 66.56
<i>Eimeria</i> spp. + <i>Anoplocephala</i> spp. + <i>Trichostrongylus axei</i> + <i>Strongylus</i> spp.	1 (20.00)	1.00; 66.56
<i>Eimeria</i> spp. + <i>Parascaris equorum</i> + <i>Trichostrongylus axei</i> + <i>Gastrodiscus aegyptiacus</i>	1 (20.00)	1.00; 66.56
<i>Eimeria</i> spp. + <i>Trichostrongylus axei</i> + <i>Strongylus</i> spp. + <i>Strongyloides westeri</i>	1 (20.00)	1.00; 66.56
<i>Trichostrongylus axei</i> + <i>Strongylus</i> spp. + <i>Gastrodiscus aegyptiacus</i> + <i>Strongyloides westeri</i>	1 (20.00)	1.00; 66.56
Total	5 (4.76)	1.77; 10.24

**Table 5:** Prevalence of five gastrointestinal parasites co-infection among horses in Kwara and Niger States, North Central Nigeria (n=105)

Gastrointestinal parasites infection	Number (%)	95% CI
<i>Eimeria</i> spp. + <i>Anoplocephala</i> spp. + <i>Trichostrongylus axei</i> + <i>Dictyocaulus arnfieldi</i> + <i>Gastrodiscus aegyptiacus</i>	1 (33.33)	1.67; 86.80
<i>Eimeria</i> spp. + <i>Trichostrongylus axei</i> + <i>Strongylus</i> spp. + <i>Dictyocaulus arnfieldi</i> + <i>Strongyloides westeri</i>	2 (66.67)	13.2; 98.33
Total	3 (2.86)	0.73; 7.58

**Table 6:** Prevalence of six gastrointestinal parasites co-infection among horses in Kwara and Niger States, North Central Nigeria (n=105)

Gastrointestinal parasites infection	Number (%)	95% CI
<i>Eimeria</i> spp. + <i>Strongylus</i> spp. + <i>Dictyocaulus arnfieldi</i> + <i>Gastrodiscus aegyptiacus</i> + <i>Habronema muscae</i> + <i>Strongyloides westeri</i>	1 (50.00)	2.50; 97.50
<i>Oxyuris equi</i> + <i>Anoplocephala</i> spp. + <i>Parascaris equorum</i> + <i>Trichostrongylus axei</i> + <i>Strongylus</i> spp. + <i>Gastrodiscus aegyptiacus</i>	1 (50.00)	2.50; 97.50
Total	2 (1.90)	0.32; 6.15

**Table 7:** Prevalence and risk factors associated with *Eimeria* infections among horses in Kwara and Niger States, North Central Nigeria

Risk Factors	<i>Eimeria</i> + (%)	<i>Eimeria</i> – (%)	OR	95% CI	P value
Age					
Young (<4 years) <sup>a</sup>	1 (11.11)	8 (88.89)	1.00		
Adult (>4 - <15 years)	27 (29.35)	65 (70.65)	3.29	0.49 – 76.92	0.27
Aged (> 15 years)	2 (50.00)	2 (50.00)	6.52	0.35 – 26.19	0.22
Sex					
Male <sup>a</sup>	27 (27.55)	71 (72.45)	1.00		
Female	3 (42.86)	4 (57.14)	1.96	0.35 – 10.07	0.41
Body condition score					
Poor <sup>a</sup>	13 (46.43)	15 (53.57)	1.00		
Moderate	11 (23.91)	35 (76.09)	0.36	0.13 – 0.99	0.04 <sup>b</sup>
Good	6 (19.35)	25 (80.65)	0.28	0.08 – 0.90	0.03 <sup>b</sup>
Diarrhoea					
Absent <sup>a</sup>	20 (22.99)	67 (77.01)	1.00		
Present	10 (55.56)	8 (44.44)	4.12	1.42 – 12.33	0.01 <sup>b</sup>
Ownership					
Non- institutional <sup>a</sup>	2 (6.90)	27 (93.10)	1.00		
Institutional	28 (36.84)	48 (63.16)	7.76	1.96 – 51.67	<0.01 <sup>b</sup>
States					
Kwara <sup>a</sup>	16 (27.12)	43 (72.88)	1.00		
Niger	14 (30.43)	32 (69.57)	1.17	0.49 – 2.78	0.71

OR=Odds Ratio, CI=Confidence Interval

<sup>a</sup> Reference category<sup>b</sup> Significant

parasites in many laboratories in most parts of the world (Truant *et al.*, 1981; Lier *et al.*, 2009) as the technique separates parasites from fats and faecal debris.

Nematodes were the most numerous and prevalent GI parasites detected in our study with *Strongylus* spp. being the most prevalent among all. Nematodes have been reported to be the most numerous, prevalent, common and most diverse group of GI helminth of horses (Belete & Derso, 2015; Bulgaru & Tudor, 2016).

The fact that *Strongylus* spp. was the most prevalent parasite in our study concurs with reports from previous researchers in Nigeria (Ehizibolo *et al.*, 2012; Umar *et al.*, 2013; Wosu & Udobi, 2014), Pakistan (Khan *et al.*, 2017) and Nepal (Oli & Subedi, 2018). The high prevalence of nematodes (*Strongylus* spp.) recorded may be due to the direct life cycle of this group of helminths where an intermediate host is not

required, thereby making infection easier and completion of lifecycle faster. *Strongylus edentatus*, *Strongylus vulgaris* and *Strongylus equinus* are the *Strongylus* species known to infect horses and they are worldwide in distribution. *Strongylus equinus* is known to be the relatively least prevalent and least abundant among the other members of the genus (Taylor *et al.*, 2016). *Eimeria* species has been reported to be the most important GI protozoan that affects horses within Nigeria (Useh *et al.*, 2005; Ehizibolo *et al.*, 2012) and outside Nigeria (Belete & Derso, 2015; Oli & Subedi, 2018).

The high prevalence of multiple gastrointestinal parasites infection we recorded is expected as horses are known to harbour several species of parasites at any given time (Ehizibolo *et al.*, 2012; Wannas *et al.*, 2012; Umar *et al.*, 2013; Samuel *et al.*, 2015). The multiple gastrointestinal parasite infection reported might be attributed to the animal grazing preference,

favourable climatic conditions and rate of environmental contamination with viable helminth eggs and sporulated oocysts at a particular time, which to a great extent can determine the establishment of mixed infection (Ola-Fadunsin *et al.*, 2019).

Contrary to expected outcome that foals and young horses are more susceptible to *Eimeria* infections compared to adult horses (Effat *et al.*, 2014; Gülegen *et al.*, 2016; Taylor *et al.*, 2016; Dubey & Bauer, 2018), we observed that the prevalence of *Eimeria* infections increased with age. Our finding may be attributed to the reduced medical attention given to adult horses as it pertains to *Eimeria* infection treatment, because it is erroneously believed by horse owners that adult horses are resistant to the infection. Adult animals are not totally resistant to infection, as a result, small numbers of parasites manage to complete their life cycle and usually cause no detectable harm with the adult animals serving as a means of contaminating the environment (Taylor *et al.*, 2016).

There was no bias in the infection of *Eimeria* spp. among sex as both genders were significantly infected, although female showed a higher prevalence compared to male. Similar finding has been documented by Gülegen *et al.* (2016) where they reported no significant differences in the prevalence of *Eimeria* infections between genders. The higher prevalence recorded in female horses could be attributed to stress associated with gestation, parturition and lactation.

Body condition score is a reliable sign of parasitic burden and can serve as a useful indicator to identify horses that require a immediate attention against gastrointestinal parasitic infections (Ehizibolo *et al.*, 2012; Worku & Afera, 2012; Tesfu *et al.*, 2014; Samuel *et al.*, 2015). In line with this, we observed that horses with poor body condition score were more prone to coccidiosis than horses with better body condition score. Our findings may be attributed to the coccidial activities in their gastrointestinal tracts depriving them of adequate absorption and assimilation of digested nutrients resulting in emaciation and cachexia. On the other hand, poor nutrition may affect the immune status of horses making it easier for them to succumb to *Eimeria* infection.

We observed that horses with diarrhoea were more prone to coccidiosis than those without diarrhoea. Intermittent diarrhoea is the major clinical sign associated with equine coccidiosis (Taylor *et al.*, 2016) as this clinical sign (diarrhoea) can be due to the pathogenesis of *Eimeria* spp. where it erodes the epithelia layer of the intestine. Also, other factors

(such as nutrition, management, health status of the horses, etc) can lead to diarrhoea in horses and this may negatively affect the immune status, making them prone to Eimeriosis. Long duration of diarrhoea will result to emaciation and cachexia which translates to poor body condition score.

It was observed that horses raised in institutional stables were much more prone to coccidiosis compared to those raised in non-institutional stables. This may be attributed to the fact that most of the horses raised in institutional stables were kept on soiled floors which encourages the sporulation of *Eimeria* oocysts. Animal coccidiosis represents a major disease problem in all parts of the world where intensive rearing is practiced (Reid, 1978; Jatau, 2014; Taylor *et al.*, 2016).

The non-significant difference in the prevalence of equine coccidiosis between Kwara and Niger States can be explained by the fact that both States have common boundary which favours the spread of diseases including coccidiosis. Anyway, the low prevalence recorded in Kwara State could be associated with the presence of the Veterinary Teaching Hospital (that provides prompt and adequate veterinary medical care) in Ilorin the capital of Kwara State.

In conclusion, the overall prevalence and number of gastrointestinal parasites of horses revealed in this study showed that gastrointestinal parasitism is of great concern in the study area. Diverse groups of gastrointestinal parasites (protozoan, nematodes, trematodes and cestodes) were detected among horses in the study area with *Strongylus* spp., *Eimeria* spp. and *Trichostrongylus axei* being the most prevalent. Gastrointestinal parasite infections occurred more as mixed infections. The occurrence of equine coccidiosis depends on the body condition score of the horse, presence/ absence of diarrhoea and horse ownership. The presence of these parasites will impact negatively on the overall wellbeing of this animal species. There is need for horse owners to improve on the veterinary medical attention given to their horses irrespective of the age categories and the sexes.

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#### **Conflict of Interest**

The authors declare no conflict of interest among them.

## References

- Abiola OJ, Olaogun SC, Emedoh OM & Olalekan TJ (2016). A retrospective study of ruminant cases presented between 1996 and 2005 at the Veterinary Teaching Hospital, University of Ibadan, Ibadan Nigeria. *International Journal of Livestock Research*, **6**(7): 16-23.
- Alemayehu R & Etaferahu Y (2013). Gastrointestinal parasites of equine in South Wollo Zone, North Eastern Ethiopia. *Global Veterinaria*, **11**(6): 824-830.
- Belete S & Derso S (2015). Prevalence of major gastrointestinal parasites of horses in and around Mekelle (Quiha and Wukro). *World Journal of Animal Science Research*, **3**(3): 1-10.
- Bulgaru A & Tudor P (2016). The prevalence of helminth parasites in horses raised in modern conditions. *Scientific Works Series C Veterinary Medicine*, **61**(2): 271-274.
- Cheesbrough M (2009). *District Laboratory Practice in Tropical Countries*. Second edition. Cambridge University Press, Cambridge, UK. Pp 195-198.
- Dubey JP & Bauer C (2018). A review of *Eimeria* infections in horses and other equids. *Veterinary Parasitology*, **256**: 58-70.
- Effat KG, Amin A, Sajede GS & Hamid RA (2014). *Eimeria leuckarti* (Flesch, 1883; Reichenow, 1940) from worker horses and donkeys of Shahrekord, Iran. *International Journal of Advanced Biological and Biomedical Research*, **2**(6): 1980-1984.
- Ehizibolo DO, Kamani J, Ehizibolo PO, Egbu KO, Dogo GI & Salami-Shinaba JO (2012). Prevalence and significance of parasites of horses in some states of Northern Nigeria. *Journal of Equine Science*, **23**(1): 1-4.
- Gülegen E, Girisgin O, Girisgin AO & Cirak VY (2016). *Eimeria leuckarti* infections in sport horses in Northwest Turkey, **129**(1-2): 52-55.
- Jatau ID (2014). Prevalence, identification and genetic diversity of *Eimeria* species in commercial poultry farms in Zaria and environs, Kaduna State, Nigeria. PhD dissertation. Ahmadu Bello University, Zaria, Nigeria. Pp 11.
- Khan A, Rizwan M, Samad A, Bugti FS, Khan MA, Achakzai SK, Naeem M, Sanya H, Akhtar W, Ashraf S, Irum N & Shakoor G (2017). Epidemiological prevalence and role of risk factors in the major gastrointestinal parasites in the working equines. *Indo American Journal of Pharmaceutical Sciences*, **4**(10): 3923-3927.
- Lier T, Simonsen GS, Wang T, Lu D, Haukland HH, Vennervald BJ & Johansen MV (2009). Low Sensitivity of the formol-ethyl acetate sedimentation concentration technique in low-intensity *Schistosoma japonicum* infections. *PLoS Neglected Tropical Diseases*, doi:10.1371/journal.pntd.0000386.
- Mayaki AM (2017). Retrospective study of equine cases at the Veterinary Teaching Hospital, Usmanu Danfodiyo University, Sokoto, Nigeria (2001-2015). *Nigeria Veterinary Journal*, **38**(3): 208-214.
- Mezgebu T, Tefesi K & Tamiru F (2013). Prevalence of gastro-intestinal parasites of horses and donkeys in and around Gondar town, Ethiopia. *Open Journal of Veterinary Medicine*, **3**(6): 267-272.
- National Bureau of Statistics (NBS) (2016). Annual Abstract of Statistics. Federal Republic of Nigeria. Pp 3.
- National Equine Welfare Council (2009). *Equine Industry Welfare Guidelines Compendium for Horses, Ponies and Donkeys*. Third edition. <http://www.newc.co.uk>.
- Ola-Fadunsin SD, Ganiyu IA, Hussain K & Rabiun M (2018). Occurrence of parasitic diseases of horses in Osun State, Nigeria: A retrospective evaluation. *Alexandria Journal of Veterinary Sciences*, **56**(1):175-181.
- Ola-Fadunsin SD, Ganiyu IA, Rabiun M, Hussain K, Sanda IM, Musa SA, Uwabujo IP & Furo NA (2019). Epidemiology of gastrointestinal parasites of different avian species in Ilorin, North Central, Nigeria. *Journal of Advanced Veterinary and Animal Research*, **6**(1): 108-116.
- Oli N & Subedi JR (2018). Prevalence of gastrointestinal parasites of horse (*equus caballus* Linnaeus, 1758) in seven village development committee of Rukum district, Nepal. *Journal of Institute of Science and Technology*, **22**(2): 70-75.
- Radostitis OM, Gay CC, Blood DC & Hinchcliff KW (2000). *Veterinary Medicine: A Textbook of Diseases of Cattle, Sheep, Pigs, Goats and Horses*. Tenth edition. W.B. Saunders Company, Philadelphia. Pp 1339-1352.

- Regassa A & Yimer E (2013). Gastrointestinal parasites of equine in South Wollo Zone, North Eastern Ethiopia. *Global Veterinaria*, **11**(6): 824-830.
- Reid WM (1978). Coccidiosis. In: *Diseases of Poultry*, (MS Hofstad, BW Calnek, CF Helmboldt, WM Reid & HW Yoder Jr, editors) seventh, USA, Iowa State University Press, Ames, Iowa, USA. Pp 784-805.
- Samuel E, Ashenafi A, Natnael M & Shiret B (2015). Prevalence of gastrointestinal nematode parasitic infections of horses and donkeys in and around Kombolcha town. *American-Eurasian Journal of Scientific Research*, **10**(4): 228-234.
- Soulsby E JL (1982). *Helminths, Arthropods and Protozoa of Domestic Animals*. Seventh edition. Bailliere Tindall Publishers, London. Pp 136-778.
- Takele B & Nibret E (2013). Prevalence of gastrointestinal helminthes of donkeys and mules in and around Bahir Dar, Ethiopia. *Ethiopian Veterinary Journal*, **17**(1): 13-30.
- Taylor, M.A., Coop R.L. and Wall, R.L. (2016). *Veterinary Parasitology*. Fourth edition. Wiley Blackwell Publishing Limited, Oxford, UK. Pp 283-285, 531-532.
- Tesfu N, Asrade B, Abebe R & Kasaye S (2014). Prevalence and risk factors of gastrointestinal nematode parasites of horse and donkeys in Hawassa town, Ethiopia. *Journal of Veterinary Science and Technology*, **5**(5): 210-213.
- Truant AL, Elliott SH, Kelly MT & Smith JH (1981). Comparison of formalin-ethyl ether sedimentation, formalin-ethyl acetate sedimentation and zinc sulfate flotation techniques for detection of intestinal parasites. *Journal of Clinical Microbiology*, **13**(5): 882-884.
- Umar YA, Maikaje DB, Garba UM & Alhassan MAF (2013). Prevalence of gastro-intestinal parasites in horses used for Cadets training in Nigeria. *Journal of Veterinary Advances*, **3**(2): 43-48.
- Useh NM, Oladele SB, Ibrahim NDG, Nok AJ & Esievo KA (2005). Prevalence of equine diseases in the Northern Guinea Savannah of Zaria, Nigeria. *Journal of Equine Science*, **16**(1): 27-28.
- Wannas HY, Dawood KA & Gassem GA (2012). Prevalence of gastro-intestinal parasites of horses and donkeys in Al Diwanayah Governorate. *Al Qadisiya Journal of Veterinary Medical Science*, **11**(1): 147-155.
- Worku S & Afera B (2012). Prevalence of equine nematodes in and around Kombolcha South Wollo, Ethiopia. *Revista Electronica de Veterinari*, **13**(9): 1-13.
- Wosu MI & Udobi SO (2014). Prevalence of Gastrointestinal helminths of horses (*Equus caballus*) in the southern guinea savannah zone of Northern Nigeria. *Journal of Veterinary Advances*, **4**(4): 499-502.