



## RESEARCH PAPER

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## Comparative study of endo-parasites in captive hog deer (*Axis Porcinus*)

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### Abstract

This study was carried out to observe the prevalence of parasitic infection in 86 Hog Deer (*Axis porcinus*) kept at Jallo Wildlife Park, Lahore Safari Park and Lahore Zoo, Pakistan. The fresh fecal samples of each Hog Deer (*A. porcinus*) were collected from the respective Wildlife Parks of Lahore and were brought to the Research Laboratory of the Department of Zoology, Wildlife and Fisheries, GC University, Faisalabad for analysis. Fecal egg count and identification of each endo-parasite was determined by Modified MC Master Technique. The egg per gram (E P G) of fecal matter was calculated to check the relative abundance of endo-parasites. It was investigated that 90.90% male and female Hog Deer (*A. porcinus*) of Lahore Zoo were mostly susceptible to endo-parasites followed by Lahore Safari Park (87.5%) and Jallo Wildlife Park (83.92%). Overall infestation of endo-parasites in Hog Deer (*A. porcinus*) at three Wildlife Parks was found to be 86.04%. Mixed infection of endo-parasites was noted in majority of the Hog Deer (*A. porcinus*) at three different localities. The prevalence of seven different gastro-intestinal endo-parasite namely *Paramphistomum cervi* (31.39%), *Moniezia expansa* (39.53%), *Moniezia benedeni* (6.98%), *Strongyloides papillosus* (82.55%), *Trichuris globulosa* (74.41%), *Trichostrongylus spp.* (81.39%) and *Haemonchus contortus* (32.55%) was recorded at three different localities. *Strongyloides papillosus*, *Trichuris globulosa*, *Trichostrongylus spp.* and *Haemonchus contortus* were common in Hog Deer (*A. porcinus*) at three different captive localities. Conclusively, high prevalence of endo-parasites was determined from the current study indicating life threats and economical loss of natural number of live stock.

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## Introduction

Hog Deer (*Axis porcinus*) is one of the least studied wildlife fauna in Pakistan. It belongs to order *Artiodactyla* and family *Cervidae*. It is a small deer having short delicate legs and bulky heavy body with dark olive brown colouration. Hog Deer (*A. porcinus*) is economically important due to its meat, skin and antlers for which they are hunted and farmed. Deer's skin is used for making of shoes, boots and gloves. Antlers are used into button and knife handles (Kanungo *et al.*, 2010). The byproducts of deer such as antlers and velvet can be used for oriental medicine. Cervids also make the popular exhibitions and are found in Zoos throughout the world (Fowler, 1986).

Depending on the regions and environments, Hog Deer (*A. porcinus*) tends to become more nocturnal and solitary due to hunting pressure. This wild animal has been declared as endangered specie (IUCN, 1993). The habitat of Hog Deer (*A. porcinus*) consists of moist grasslands associated with rivers (Biswas and Mathur, 2000). It is known to have reached to highest densities in flood plain grasslands (Odden *et al.*, 2005). In areas of no anthropogenic pressure and undisturbed ecosystems, its highest calculated life span is 20 years. Young fawns are paler sandy-yellow in color. Hog Deer (*A. porcinus*) are solitary animals and are not found in large herds. When alarmed they make a whistling vocalization and warning bark (Rao and Acharjyo, 1984).

In Pakistan Hog Deer (*A. porcinus*) is confined to the riverine forest in the plains, particularly where there are extensive areas of dense grass. It is not found in the Himalayan foothill zone of Pakistan which is the species favoured habitat. The bulk of the population now survives in the Indus river forest reserves of Sindh, with small population around the Indus mouth, twelve miles north of Hyderabad in the Rajhari forest reserve and the KethiShahu forest reserve twenty miles North of Sukkur. South of Hyderabad, riverine forest such as the khirsar which contain a large population of Hog Deer (*A. porcinus*) are now drying out due to control of the Indus river floods (Roberts, 1997). It is also present in the Protected Areas of Chashma Barrage Wildlife

Sanctuary while it has been significantly reduced in number in Head Islam/Chak Kotora Game Reserve. Reports further revealed its potential presence in Lal Suhanra National Park. Taunsa Barrage Wildlife Sanctuary and possibly Rasool Wildlife Sanctuary are regarded as better potential habitats for Hog Deer (Whale, 1996).

Parasitism is a huge problem of livestock which lowers the productivity. It is also very important in case of wild animals when kept in captivity. There are different factors like feeding, environmental conditions and animal management as well as the staff dealing with the animals in captivity can be a source of parasite transmission with food, working tools, cloths, shoes and hands etc. Parasites can also be transmitted to animals themselves when they are moved from one place to another without proper sanitation and treatment of diseased animals. Another way of transmission is when different species are kept together. In wild conditions, animals have some natural resistance against parasitic diseases or live in a balanced condition but in captivity as the environmental and living condition changes which will influence the animal's behavior and ecology. The risk of having a parasitic disease might also increase (Atanaskova *et al.*, 2011).

Parasitic diseases make up one of the major management problems causing mortality and morbidity in wild animals in captivity (Rao and Acharjyo, 1984). Infection with helminthes is a major health issue in captive and wild deer (Goossens *et al.*, 2005). Studies and different literature on the captive animals in European zoos reflect that helminthes are the most abundant and frequently occurring endo-parasites in captive animals than any other parasite. Protozoones come after the nematodes according to the frequency of report. *Cryptosporidium*, *Giardia* and *Eimeria spp.* are the parasites which develop without intermediate hosts and directly influence on gastro-intestinal tract of definite host (Pencheva, 2013).

Parasites cause a multitude of problems for wildlife

and although it often appears that wild life have adapted, to the presence of parasites, they have not adapted to the adverse effects of parasitism (Bliss, 2009). Incomplete information on diseases and parasites of zoo animals is a major limiting factor in zoological gardens. Investigations into endo-parasitic fauna are important for the study of the prevalence, geographical distribution, systematic and biology of parasites. The parasitic burden and its relationship with the host have been successfully exploited by modern scientists in the control of wildlife pests and predators in our forests and agricultural system. Endoparasitic studies of fellow deer in game-park in south Moravia shows that most of the endo-parasites are reputed for their abundance and have great impact in maintaining the stability of various ecosystems. Mostly, the endo-parasitic infection was recorded to be highest in autumn months (Borkovcova *et al.*, 2013).

Disease monitoring in wild animals has presently become necessary component of games management. The presence of endo-parasites in an animal's body particularly in young animals, leads to health worsening declined condition, reduced body, weight gains and reproductive disorders. Furthermore the parasite affects the quality of animal products (meat, skin, and antlers), as compared to domestic animals, the losses of which are measurable and documentable. The nature, prevalence and intensity of worm infestation may vary with the age of animals. Young animals have often been reported to have higher rates of worm infection and burden (Komoin *et al.*, 1999). This may be due to better immune status of the host because of repeated exposure to worm infection in older age. A difference in the species involved in the young and old animals has also been reported. A higher rate of nematode infection and worm burden has been observed in female hosts compared with the males). The ruminants are heavily infected by a variety of helminths of high economical significance. Two species of helminthes were recorded in black buck from domesticated and wild ruminants in cholistan desert of Pakistan. Most of the recorded helminthes were nematodes. *Haemonchus contortus*

and *Trichostrongylus spp.* were frequently recorded from the ruminants (Farooq *et al.*, 2012).

The Hog Deer (*A. porcinus*) is one of the least studied species in Pakistan and no documented proof is available on its recent records. Considering the economic significance of endo-parasites in Hog Deer (*A. porcinus*) kept at Jallo Wildlife Park, Lahore Safari Park and Lahore Zoo, Lahore, Punjab, respectively. The present work was carried out to know the mean and prevalence of egg per gram (EPG) of endo-parasites and diversity of endo-parasites identified in the fecal samples of immature/ adult male and female Hog Deer (*A. porcinus*), captive at Jallo Wildlife Park, Lahore Zoo and Lahore Safari Park.

#### Materials and methods

This study was carried out for a period of seven months from March, 2013 to September, 2013 in three captive areas viz., Jallo Wildlife Park, Lahore Safari Park and Lahore Zoo, Lahore, Punjab. The three captive areas were selected due to the availability of Hog Deer (*A. porcinus*) existing in Pakistan. Fecal samples of about 86 Hog Deer (*A. porcinus*) including adult male and female were collected randomly and examined for the comparative study of endo-parasites. The number of Hog Deer (*A. porcinus*) in three different localities in Lahore district is shown in Table 1.

#### Location

The study area (three captive wildlife parks) is situated in Lahore district, a capital city of Punjab province in Pakistan. Lahore is situated in central Punjab at latitude 31.32'59 N, longitude 74.20'37 E. Jallo Wildlife Park was established in 1978. It is public recreation and wildlife site spread over an area of 456 acres (185 ha). It is about 28 km East to Lahore city in Wagha Town, Lahore, near the Indian border. About 43 acres (17 ha) has been allocated as a breeding centre for wildlife.

Lahore safari park is also called Woodland Wildlife Park. It is wildlife as well as safari park located on Raiwind road about 30 km from Lahore Zoo in

Allama Iqbal Town, Lahore. It was established in 1982 and spread over 242 acres (98 ha). 80 acres (32 ha) has been allocated for wildlife. This park is recently renamed as Lahore Safari Zoo.

Lahore Zoo is one of the largest zoo in South Asia. It is thought of the third or fourth oldest zoo in the world. It was established in 1872. Lahore Zoo is spread over 25(10 ha) acres and is located on Mall Road of Lahore city besides the Jinnah garden in the Data Gunj BukshTown, Lahore city.

The study area has four seasons with long and extremely hot summer, dry cold winter, a monsoon and dust storms. During the month of May, June and July weather is extreme when the temperature ranges from 40-48 °C (104-118°F).

#### *Experimental Procedure*

Fresh fecal samples were collected directly from the Hog Deer (*A. porcinus*) of three captive areas. There fecal samples were placed in separated clean polythene bags having tag number, sex, age of animal and date of collection of fecal matter. Each fecal sample was brought to the Research Laboratory of Department of Zoology, Wildlife and Fisheries GC University, Faisalabad to check the presence of eggs of endo-parasites.

The fecal samples were analyzed by applying the modified MC Master Technique through Whitlock chamber method, by using saturated sodium chloride solution. Precisely 2 gram fecal samples were weighed on electronic weight balance and kept into beaker of 200 ml. In order to soften the fecal matter, 2.5 ml tap water was added into the beaker containing fecal sample. Then 45.5 ml of saturated sodium chloride solution was added as floatation solution. After thorough mixing, solution was strained with the help of tea strainer and filled in whitlock chamber. After 2-3 minutes, helminthes eggs began to float due to low specific gravity. Refined samples were examined under light microscope at 10 x. Eggs were identified with the help of available keys to diagnose eggs (Soulsby, 1982).

#### *Egg per Gram Calculations*

Prevalence of endoparasites in eggs per gram (EPG) was determined following Soulsby (1982). The number of eggs per gram (EPG) of faeces was calculated by multiplying the number of eggs by 50 as:

$$EPG = (16 + 24) \times 50^* = 2000 / 2 = 1000$$

The images of endo-parasites were taken by Olympus B x 40 microscope under the 400 x. The data was analyzed statistically by following Thrusfield (2005).

#### **Results**

Table 1 shows the total number of 86 Hog deer (*A. porcinus*) captive at three different localities namely Jallo Wildlife Park, Lahore Zoo and Lahore Safari Park in Lahore district. In Jallo Wildlife Park a total of 56 out of which male adult (17), immature (5) and female adult (27) and immature (7) Hog deer (*A. porcinus*) were captive. In Lahore Zoo a total of 22 out of which male adult (6), immature (2) and female adult (11) and immature (3) Hog deer (*A. porcinus*) were captive. In Lahore Safari Park, a total 8 out of which male adult (3) and female adult (4) and immature (1) Hog deer (*A. porcinus*) were captive. There was no male immature Hog Deer (*A. porcinus*) present in Lahore Safari Park. Table 2 shows the comparison between localities and endo-parasites identified in the fecal samples of Hog Deer (*A. porcinus*). All the three localities namely Jallo Wildlife Park, Lahore Zoo and Lahore Safari Park showed highly significant variations in the presence of endo-parasites in the fecal sample of Hog Deer (*A. porcinus*) ( $P < 0.01$ ). Similarly the number of endo-parasites identified in the selected localities, where Hog Deer (*A. porcinus*) captive were significantly different ( $P < 0.05$ ).

Table 3 shows the total number and percentage prevalence of examined and infected Hog Deer at three different localities. In Jallo Wildlife Park 47 infected male and female Hog Deer were recorded which represent 83.92% prevalence. Similarly, in Lahore Zoo 20 infected animals shows the 90.90 % prevalence and 7 infected animals at Lahore Safari

Park gives the 87.55 % prevalence. Of the total 86 Hog Deer (*A. porcinus*) 74 (86.04%) were determined to be affected with endo-parasites.

Table 4 shows the over all prevalence (%) of endo-parasites at three captive localities. Endo-parasitic species, *Strongyloides papillosus* (82.55%), *Trichostrongylus spp.*(81.39%) and *Trichuris globulosa* (74.41%) has shown maximum prevalence followed by *Haemonchus contortus* (32.55%), *Paramphistomum cervi*(31.39%) and *Moniezia benedeni* (6.98%), respectively.

Table 5 shows significant differences in the mean number of endo-parasites in the fecal samples of Hog Deer (*A. porcinus*) captive at Jallo Wildlife Park, Lahore Zoo and Lahore Safari Park ( $P < 0.05$ ). Highest number of endo-parasites were recorded from the

Hog Deer (*A. porcinus*) captive at Jallo Wildlife Park ( $27.29 \pm 3.85$ ) followed by Lahore Zoo ( $9.57 \pm 1.54$ ) and Lahore Safari Park ( $5.71 \pm 0.73$ ), respectively. A total number of seven species of endo-parasites namely *Paramphistomum cervi*, *Moniezia expansa*, *Moniezia benedeni*, *Strongyloides papillosus*, *Trichuris globulosa*, *Trichostrongylus spp.* and *Haemonchus contortus* were identified from the fecal samples of Hog Deer (*A. porcinus*) captive at Jallo Wildlife Park, Lahore Zoo and Lahore Safari Park. The most dominant endo-parasitic species were *Strongyloides papillosus* ( $23.67 \pm 3.65$ ), *Trichostrongylus spp.* ( $23.33 \pm 4.33$ ) and *Trichuris globulosa* ( $21.33 \pm 3.23$ ) followed by *Moniezia expansa* ( $10.67 \pm 1.30$ ), *Haemonchus contortus* ( $9.33 \pm 1.03$ ), *Paramphistomum cervi* ( $9.00 \pm 1.03$ ) and *Moniezia benedeni* ( $2.00 \pm 0.32$ ).

**Table 1.** Number of Hog Deer (*Axis porcinus*) in three different captive localities.

Sr No.	Location	Adult Male	Immature Male	Total Male	Adult Female	Immature Female	Total Female	Grand Total (Male & Female)
1	Jallo Wildlife Park	17	5	22	27	7	34	56
2	Lahore Zoo	6	2	8	11	3	14	22
3	Lahore Safari Park	3	0	3	4	1	5	8
Total		26	7	33	35	9	53	86

**Table 2.** Analysis of variance showing comparison between localities and endo-parasites in Hog Deer (*A. porcinus*).

Source of variation	Degrees of freedom	Sum of squares	Mean squares	F-value
Localities	2	1852.667	926.333	15.73**
Parasite	6	1307.905	217.984	3.70*
Error	12	706.667	58.889	
Total	20	3867.238		

\* = Significant ( $P < 0.05$ ); \*\* = Highly significant ( $P < 0.01$ ).

Table 6 shows the prevalence (%) comparison between localities and endo-parasites identified in the fecal samples of Hog Deer (*A. porcinus*). All the three localities namely Jallo wildlife Park, Lahore Zoo and Lahore Safari Park showed non-significant variations in the presence of endo-parasites in the fecal sample of Hog Deer (*A. porcinus*) ( $P > 0.05$ ). The number of endo-parasites identified in the fecal samples of Hog Deer from above mentioned localities were

significantly different ( $P < 0.05$ ).

Table 7 shows that the mean number of endo-parasites in fecal samples of Hog Deer from Jallo Wildlife Park and Lahore Zoo were similar ( $P > 0.05$ ), while these differ significantly in fecal samples of Hog Deer from Lahore Safari Park ( $P < 0.05$ ). Highest number of endo-parasites were recorded from the Hog Deer (*A. porcinus*) captive at Lahore Safari Park

(71.43 ±7.10) followed by Jallo wildlife Park (49.23±4.40) and Lahore Zoo (43.51±5.08). A total number of seven species of endo-parasites namely *Paramphistomum cervi*, *Moniezia expansa*, *Moniezia benedeni*, *Strongyloides papillosus*, *Trichuris globulosa*, *Trichostrongylus spp.* and *Haemonchus contortus* were identified from the fecal samples of Hog Deer (*A. porcinus*) captive at Jallo wildlife Park, Lahore Zoo and Lahore Safari Park. The most dominant prevalence (%) of endo-parasitic species was *Strongyloides papillosus*

(88.31±6.26), *Trichostrongylus spp.*(87.72±6.73) and *Trichuris globulosa* (72.51±5.59) followed by *Moniezia expansa* (48.81±5.89) *Paramphistomum cervi* (41.07±4.40), *Haemonchus contortus* (41.07±8.93), and *Moniezia benedeni* ( 3.57 ± 3.57 ). There was no difference in the mean egg per gram of endo-parasites of *Strongyloides papillosus*, *Trichuris globulosa*, *Trichostrongylus spp* ( $P>0.05$ ) while these differed significantly from *Paramphistomum cervi*, *Moniezia expansa*, *Haemonchus contortus* and *Moniezia benedeni* ( $P<0.05$ ; Table 7).

**Table 3.** Number and percentage(%) of infected Hog Deer (*A. porcinus*) in three different captive localities.

Sr No.	Location	Hog Deer examined (M)	Hog Deer Infected (M)	Hog Deer examined (F)	Hog Deer Infected (F)	Hog Deer Total examined (M&F)	Hog Deer Total infected (Infected %)
1	Jallo Wildlife Park	22	22	34	25	56	47 (83.92 %)
2	Lahore Zoo	8	7	14	13	22	20 (90.9 %)
3	Lahore Safari Park	3	2	5	5	8	7 (87.5 %)
Total		33	31	53	43	86	74 (86.04 %)

(Male=M; Female=F).

**Table 4.** Prevalence (%) of endo-parasites identified in fecal samples of Hog Deer (*A. porcinus*).

Sr. No.	Endo-parasite eggs identified	Total samples of Hog Deer examined	No. of infected Hog Deer	Hog Prevalence (%) of endoparasites
1	<i>Paramphistomum cervi</i>	86	27	31.39 %
2	<i>Moniezia expansa</i>	86	34	39.53 %
3	<i>Moniezia benideni</i>	86	6	6.98 %
4	<i>Strongyloides papillosus</i>	86	71	82.55 %
5	<i>Trichuris globulosa</i>	86	64	74.41 %
6	<i>Trichostrongylus spp.</i>	86	70	81.39 %
7	<i>Haemonchus contortus</i>	86	28	32.55 %

Table 8 shows that number of endo-parasitic species recorded in the fecal sample of Hog Deer (*A. porcinus*) from Jallo Wildlife Park, Lahore Zoo and Lahore Safari Park were 7, 4 and 6, respectively. Where as total number of endo-parasites in these experimental localities were 191, 67 and 40, respectively. Maximum number of endo-parasites identified in the fecal samples of Hog Deer (*A. porcinus*) were 44, 19 and 8, respectively captive at Jallo Wildlife park Lahore Zoo and Lahore Safari Park. According to Burger Parker diversity index, the fecal sample of Hog Deer (*A. porcinus*) captive at Lahore Safari Park had most diverse endo-parasites species (5.0) followed by fecal sample of Hog Deer at Jallo Wildlife Park (4.34) and the fecal sample at

Lahore Zoo (3.57).

#### Discussion

Total 86 fecal samples of Hog Deer (*A. porcinus*) including adult male and female, immature male and female were collected and examined for the comparative study of endo-parasites The combined data of all the three captive localities showed that *stronglyoides papillosus* (82.55%) *Trichostrongylus spp* (81.39%) and *Trichuris globolusa* (74.41%) has shown maximum prevalence followed by *Haemonchus contortus* (32.55%), *paramphistomum cervi* (31.39%) and *Moniezia benedeni* (6.98%), respectively (Table 4).

**Table 5.** DMR-test showing locality and endo-parasite (Mean±SE) in Hog Deer (*A. porcinus*) at different localities.

Localities	Mean±SE	Parasite	Mean±SE
Jallo Wildlife Park	27.29 ± 3.85 A	<i>Paramphistomum cervi</i>	9.00 ± 1.06 B
Lahore Zoo	9.57 ± 1.54 B	<i>Moniezia aexpansa</i>	10.67 ± 1.30 B
Lahore Safari Park	5.71 ± 0.73 C	<i>Moniezia benideni</i>	2.00 ± 0.32 C
		<i>Strongyloides papillosus</i>	23.67 ± 3.65 A
		<i>Trichuris globulosa</i>	21.33 ± 3.23 A
		<i>Trichostrongylus spp.</i>	23.33 ± 4.33 A
		<i>Haemonchus contortus</i>	9.33 ± 1.03 B

Means sharing similar letter in a column are statistically non-significant ( $P > 0.05$ ).

**Table 6.** Analysis of variance showing prevalence (%) comparison between Localities and Endo-parasites in Hog Deer (*A. porcinus*).

Source of variation	Degrees of freedom	Sum of squares	Mean squares	F-value
Localities	2	3045.31	1522.658	2.57NS
Endo-parasites	6	16672.343	2778.724	4.70*
Error	12	7084.143	590.345	
Total	20	26801.804		

NS = Non-significant ( $P > 0.05$ ); \* = Significant ( $P < 0.05$ ).

Of the total 86 Hog Deer (*A. porcinus*) 74 (86.04%) were determined to be affected with endo-parasites and reflects conformity with the earlier report by Cisek *et al.* (2003), Santin-Duran *et al.* (2004),

Farooq *et al.* (2012) and Pencheva (2013). It is evident from these results that all captive Hog Deer (*A. porcinus*) were highly susceptible to gastrointestinal nematodiasis.

**Table 7.** DMR-test showing EPG (Mean±SE) of endo-parasites in Hog Deer (*A. porcinus*) at different localities.

Localities	Mean±SE	Endo-parasites	Mean±SE
Jallo Wildlife Park	49.23 ± 4.40 B	<i>Paramphistomum cervi</i>	41.07 ± 4.40 B
Lahore Zoo	43.51 ± 5.08 B	<i>Moniezia expansa</i>	48.81 ± 5.89 B
Lahore Safari Park	71.43 ± 7.10 A	<i>Moniezia benideni</i>	3.57 ± 0.57 C
		<i>Strongyloides papillosus</i>	88.31 ± 6.26 A
		<i>Trichuris globulosa</i>	72.51 ± 5.59 A
		<i>Trichostrongylus spp.</i>	87.72 ± 6.73 A
		<i>Haemonchus contortus</i>	41.07 ± 3.93 B

Means sharing similar letter in a column are statistically non-significant ( $P > 0.05$ ).

EPG= Egg per gram.

It appears from the results that *Haemonchus spp.* (32.55%) was found most frequently in all the three localities. More or less similar prevalence rates of *Haemonchus contortus* have been reported by Mason (1994) and Siddiqi *et al.* (2012). *Paramphistomum*

*cervi* (31.39%) remained prevalent in all the localities as supported by the previous reports of Islam *et al.* (2003). The study recorded an overall prevalence of *Strongyloides papillosus* 82.55%, *Trichuris globulosa* 74.41%, and *Trichostrongylus spp.* was

81.39%. More or less similar prevalence rate of gastro-intestinal nemotodiasis have been reported earlier by Islam *et al.*(2003), Santin-Duran *et al.*(2004), Farooq *et al.* (2012), Borkovcova *et al.*(2013) and Pencheva (2013).

The prevalence of endo-parasites by sex of animals examined indicates that males had the higher infection of endo-parasites as compared to females. The endo-parasitic infection among immature Hog Deer (*A. porcinus*) showed the higher prevalence. This might have been influenced by licking of soil of immature male Hog Deer (*A. porcinus*) and the fact that immature animals are more susceptible to

infection than the adult animals, principally because of their relative immunological incompetence which is similar with the findings of (Farooq *et al.*, 2012).

The incidence of endo-parasites in all the three localities were recorded as *Strongyloides papillosus* (82.55%), *Trichostrongylus spp* (81.39%), *Haemonchus contortus* (32.55%), *Trichuris globulosa* (74.41%). These findings corroborates with the observations of Farooq *et al.* (2012), Borkovoka *et al.* (2013) who encountered similar Helminth species. From the results of study, variations have been observed in the prevalence of endo-parasitic infection in three different localities.

**Table 8.** Endo-parasite diversity in Hog Deer (*A. porcinus*) captive at Jallo Wildlife Park, Lahore Zoo and Lahore Safari Park.

Diversity	Jallo Wildlife Park	Lahore Zoo	Lahore Safari Park	Total
Number of endo-parasites (S)	7.00	4.00	6.00	7.00
Total number of endo-parasites (N)	191.00	67.00	40.00	298.00
Maximum abundant of endo-parasites (N max)	44	19	8	71
D= (N max / N)	0.23	0.28	0.20	0.23
1/D	4.34	3.57	5.00	4.34

However infections with endo-parasites should not be neglected. Most of the Hog Deer (*A. porcinus*) observed have not shown any type of clinical signs and symptoms of diseases but still contain a sufficient number of endo-parasites.

### Conclusions

Conclusively, high prevalence of endo-parasites was determined from the current study indicating life threats and economical loss of natural number of live stock. It means that an undetermined number of wild animals had the endo-parasites without showing outward physiological signs of infection. It is zoonotically important because these animals may be serving as reservoir of hosts for some endo-parasites that are pathogenic to man. The present investigation suggests the necessity of future research to ensure the better management of Hog Deer (*A. porcinus*) population in Pakistan and to find out possible ways of reducing pressures from its potential habitats.

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