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Epidemiology of *Eimeria* and associated risk factors in goats of district Toba Tek Singh, Pakistan

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Coccidiosis is one of the most ubiquitous and economically important diseases of goats (Foreyt 1990). The high mortality rates and lowered productivity due to poor growth, together with costs of anticoccidials and disinfection, are all factors causing losses by coccidiosis in domestic animals (Cornelius1980). The disease is more serious in 4–6-month old kids and also when animals of any age are kept in unhygienic and overcrowded houses or in heavily stocked paddocks. A higher intensity of infection is found in wet season as compared to dry season (Kusiluka *et al.*1998). Unsanitary and overcrowded conditions also favour the rapid transmission and development of environmental contamination and coccidial infection rates in animals (Soulsby 2006). Goat coccidiosis have been reported in Pakistan (Ahmed 1992, Asif *et al.* 2008) but detailed study has not been carried out to determine the prevalence and seasonal trend of infection in different management and husbandry systems which are pre-requisites for the development of control programmes to minimize the losses inferred by goat coccidiosis. Hence, present study was conducted to determine prevalence of *Eimeria* in goats of district Toba Tek Singh, Pakistan, and determine association of possible risk factors (age, breed, sex, season, feeding system, watering system, type of floor, herd size) with prevalence of *Eimeria*.

Study area confined to district T.T.Singh which is located in central Punjab between 30°33' to 31°2' degree north latitudes and 72°08' to 72°48' degree longitudes. The district comprises of three tehsils (Gojra, Kamalia and T.T.Singh) and 82 union councils (UC). T.T.Singh has an average goat population of 0.50 million. Based on two stage cluster random sampling, the number of primary units (UC) and elementary units (animals) was sampled using following formulae as given by Thrusfield (2008). Selection of primary units to be sampled was done using map grid method and 486 animals were examined in the present survey.

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A questionnaire was developed for collecting necessary information from farmers regarding associated risk factors using closed ended (dichotomous and multiple choice) questions (Thrusfield 2008). Information regarding following determinants were collected through questionnaire. Animals were divided into 2 age categories, viz. adults and young-stock. The age range of adult and young-stock was > 6 months and <6 months respectively. Beetle, Teddy, Dera Din Pannah and Desi breeds were studied. Both sexes were sampled during study. Season wise prevalence was noted separately. The seasons in Pakistan are cold season (December to March), hot season (April to June), rainy season (July to September), and post- rainy season (October and November).

Data regarding meteorological parameters i.e. monthly average temperature, relative humidity and rain fall have been collected from Meteorological Cell, Department of Crop Physiology, University of Agriculture, Faisalabad.

Type of feeding system (grazing/ ground feeding/ trough feeding), housing system (open/ close), floor pattern (non-cemented/ partially cemented), watering system (tap water/ pond) and herd size (larger/ smaller) were observed in present study. Herds having more than 50 animals were declared as larger herds where as herds with less than this were considered as smaller.

A total of 486 faecal samples were collected. Faecal samples (5g) were collected directly from rectum or immediately after defecation in a wide mouth plastic bottle and preserved in 10% formalin (Zajac and Conboy 2006). Collecting bottles were labeled properly. Faecal samples were analyzed using floatation technique with saturated Sodium chloride solution as floatation solution for the presence of oocyst. The procedure was adopted as described by Zajac and Conboy (2006). Quantitative fecal examination was performed by McMaster technique to determine the number of oocysts per gram of feces (OPG) as per MAFF (1986). Identification of *Eimeria* species was based on the morphological features of the oocysts (size, shape, color, and texture of oocyst wall, presence or absence of micropyle, polar cap) with the aid of taxonomic keys (Iqbal *et al.* 2006,

Soulsby 2006).

Logistic analysis was carried out by using logit model including all variables in the model with backward elimination procedure. Factors with paired characteristics were analyzed using Odd's Ratio (OR) and Mantel-Haenszel (M.H.) Chi-square. Hosmer-Lemeshow goodness-of-fit test indicated that model fits well. All the analyses were carried out using SAS software package (1998) at 95% confidence level.

The prevalence was calculated for all data by using the following formula:

$$\text{Prevalence (\%)} = \frac{\text{Number of infected individuals (n)}}{\text{Total number of sampled individuals (N)}} \times 100$$

Overall prevalence of *Eimeria* was 55.76% (271/486). Five species of *Eimeria* were identified during coprological examination. *E. ninakohlyakimovae* was the commonest of the identified species (53.14%), followed in order *E. arloingi, E. alijevi, E. caprina and E.hirci* with prevalence of 47.97, 33.58, 28.04 and 21.77% respectively. Species of *Eimeria* identified in present survey are documented in Pakistan (Ahmed 1992). *E. ninakohlyakimovae* was reported as the most prevalent specie by many researchers in various countries (Abo-Shehada and Abo-Farieha 2003, Ruiz *et al.* 2006). Oocyst count elevation in rainy season (Fig. 1) is in line with seasonal dynamics of *Eimeria* reported by Kusiluka *et al.* (1998). Generally kids have high mean OPG than adults. Seasonal elevation in OPG was more apparent in kids. The observation that kids excreted higher number of oocysts compared to adults was reported by Ruiz *et al.* (2006).

Analysis of all the hypothesized risk factors and chi-square analysis revealed that age, sex, breed, season, housing system, floor, watering system and herd size were the factors significantly associated (P<0.05) with *Eimeria* infection. *Eimeria* was observed in all age groups. Kids had significantly higher prevalence than adults (Table 1, 2; Fig. 3). Higher prevalence in kids in comparison to adults was reported by Abo-Shehada and Abo-Farieha (2003). Trend to shed more oocysts in kids may be due to low immunity. The

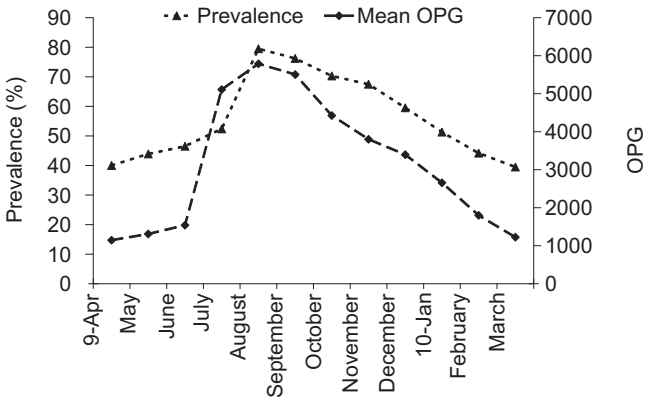

Fig. 1. Month-wise prevalence and mean OPG of *Eimeria*

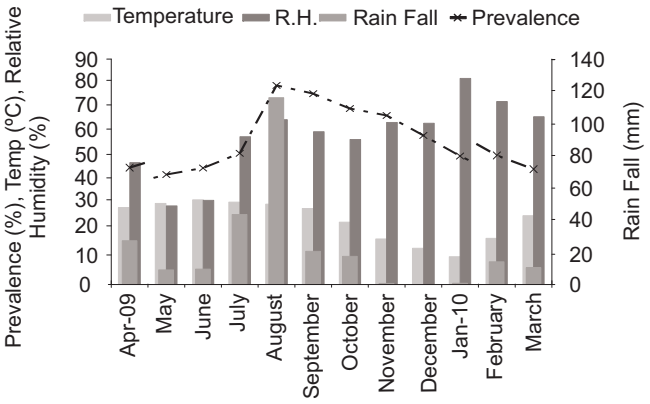

Fig. 2. Association of meteorological parameters with risk of *Eimeria* in goats of district T.T. Singh

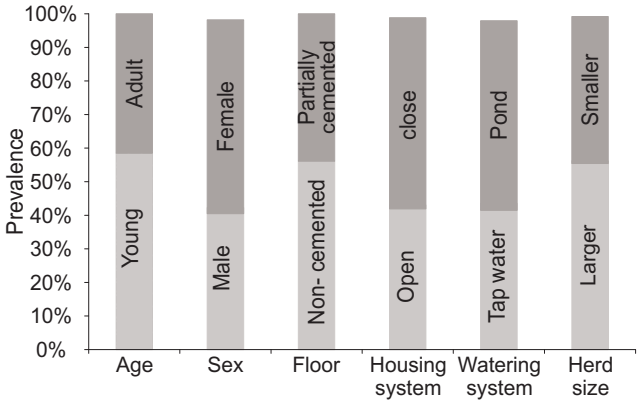

Fig. 3. Association of various risk factors with *Eimeria*

adults may have acquired immunity over periods of time and may therefore suppress *Eimeria* infections. *Eimeria* infection was found more prevalent in females as compared to males (Table 1, 2; Fig. 3). Among goat breeds highest prevalence was observed in Beetle while 51.43% of Desi, 50.79% of Dera Din Panah and 48.54% of Teddy goats were found infected with *Eimeria*. Varied breed susceptibility to *Eimeria* infection in goats has also been observed by Kusiluka *et al.*

Table 1. Multivariate logistic regression analysis of associated factors with risk of *Eimeria* infection in goat

Term	Odds ratio	C.I.	P- value
Month	1.136	1.072–1.205	0.000
Age	0.462	0.306–0.696	0.000
Sex	0.566	0.366–0.877	0.011
Breed	0.794	0.649–0.971	0.024
Floor	0.402	0.258–0.626	0.000
Housing system	2.527	1.609–3.969	0.000
Watering system	1.713	1.140–2.575	0.010
Herd size	1.493	1.000–2.227	0.050
Body condition	0.652	0.437–0.974	0.037

Hosmer-lemeshow goodness-of-fit test: P= 0.543

Table 2. Mantel-Haenszel chi-square analysis of all hypothesized risk factors with *Eimeria* infection in goat

Associated determinants	Variables	Prevalence	Mantel-Haenszel chi-square (P-value)
Age	Young	67.34% (134/199)	16.7146 (<.0001)
	Adult	47.74% (137/287)	
Sex	Male	44.28% (62/140)	10.4763 (0.0012)
	Female	60.40% (209/346)	
Breed	Beetle	62.61% (139/222)	4.9911 (0.0255)
	Teddy	48.54% (50/103)	
	Dera Din Panah	50.79% (64/126)	
	Desi	51.43% (18/35)	
Feeding system	Grazing	36.58% (30/82)	1.1813 (0.2771)
	Ground	66.67% (140/210)	
	Trough	52.57% (102/194)	
Floor	Non-cemented	62.30% (157/252)	11.3884 (0.0007)
	Partially cemented	48.72% (114/234)	
Housing system	Open	49.11% (138/281)	10.6799 (0.0011)
	Close	64.88% (133/205)	
Watering system	Tap water	49.04% (128/261)	11.5044 (0.0007)
	Pond	63.55% (143/225)	
Herd size	Larger	62.60% (154/246)	9.4294 (0.0021)
	Smaller	48.75% (117/240)	
Body condition	Poor	67.19% (170/253)	3.2847 (0.0699)
	Good	43.35% (101/233)	

(1998) who recorded higher *Eimeria* infection in crossbred goats as compared to indigenous ones. Peak prevalence was observed in August (79.49%) while least number of animals (39.47%) were found infected with *Eimeria* in March. This could be attributed to wet, hot and humid climate which is ideal for development and transmission of coccidial infection (Taylor *et al.* 2007). Higher prevalence was recorded during rainy (69.35%) and post-rainy seasons (68.88%) as compared to cold (48.61%) and hot seasons (43.47%). A relationship between high rain fall; temperature; relative humidity and occurrence of *Eimeria* is shown in Fig.2.

A strong association (P<0.05) was observed between housing system and risk of *Eimeria* infection. Higher *Eimeria* prevalence was recorded in animals reared under closed type of housing system as compared to open type (Table 1, 2; Fig. 3). O'Callaghan (1989) observed higher prevalence of *Eimeria* in domesticated goats as compared to feral goats which supports higher prevalence of *Eimeria* in close housing system. Statistically different rate of prevalence was found in two floor types. Multivariate logistic regression analysis and chi-square analysis of watering system with the intensity of infection revealed that there was a highly significant association between these two. Significantly higher infection rate was observed in goats watered at pond compared to those given tap water (Table 1, 2; Fig.3). This favours the recommendations described by Radostits *et al.* (2009) and McKellar (2008) that watering devices should be clean and protected from faecal contamination. *Eimeria* infection was more prevalent (P<0.05) in non-cemented floor type compared to partially cemented floor (Table 1, 2; Fig. 3). Prevalence of *Eimeria* was strongly predisposed by the herd size (P<0.05). Higher prevalence was observed in larger herds as compared to smaller ones (Table 1, 2; Fig.3). Poor sanitation and overcrowded conditions may have resulted in the development of higher level of infection in non-cemented floor, close housing system and large herds (Soulsby 2006) due to greater contamination. Crowding of animals concentrates the hosts and parasites within a restricted area. Although prevalence of *Eimeria* in goat fed under 3 feeding systems were different being lowest in grazing goats followed in order by trough and ground feeding goats but statistically insignificant association was found with P=0.277. Moreover, *Eimeria* infection in poor body condition animals was a bit higher than animals with good body condition (Table 3) but there was a statistically nonsignificant association between body condition of animals and risk of *Eimeria* infection.

In conclusion, the results of current research showed age, gender, breed, season and management-related variations in Eimeriosis. Managemental practices, such as improvement in hygienic situation in housing, feeding and watering system may beneficial to reduce the infection to levels compatible with maximum production. Special attention should be given towards hygiene of kids and females prior to rainy season.

SUMMARY

Of the total 486 faecal samples examined for *Eimeria*, 271 (55.76%) were found infected with 5 species of *Eimeria*. Amongst the identified species of *Eimeria*, *E. ninakohlyakimovae* was the commonest one (53.14%) followed in order by *E. arloingi, E. alijevi, E. caprina and E.hirci* with prevalence of 47.97, 33.58, 28.04 and 21.77% respectively. Peak prevalence was observed in August. Wet

season was found favourable for *Eimeria*. Kids had significantly higher prevalence of *Eimeria* than adults while higher prevalence of *Eimeria* was observed in female goats. Beetle breed were found at highest risk of *Eimeria* followed in order by Desi, Dera Din Panah and Teddy breeds of goats. Among management and husbandry practices; watering system, housing system, floor type and herd size strongly influenced the prevalence of *Eimeria*. Coccidiosis was more prevalent in close housing system, non-cemented floor type, pond watered animals and larger herds as compared to open housing system, partially cemented floor type, tap watered animals and smaller herds respectively. Feeding system and body condition of animals were not found risk factors influencing prevalence of *Eimeria*.

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