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Prevalence and Risk Factors Assessment of Porcine Coccidiosis in Rajasthan, India

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Abstract

A cross sectional study was conducted for coproprevalence and associated risk factors for coccidiosis in pigs from 7 districts representing 6 agroclimatic zones of Rajasthan. A total of 769 faecal samples (371 stray and 398 farm animals) were collected during September, 2017 – August, 2018. An overall prevalence rate of 40.18 % was recorded for coccidiosis in pigs with mixed infections of two or more species of Eimeria with a significantly higher (P<0.01) infection rate in stray pigs (68.73%) in comparison to farm animals (22.11%). Quantitative analysis revealed severe infection of Eimeria sp. on the basis of oocyst per gram of faeces ranging from 4200-438700 with an average of 33675±21390.52 and of Isospora suis ranging from 11000-22100 with an average of 16550±5550.834. Microscopic examination of sporulated oocysts revealed the presence of Isospora suis and six morphotypes of Eimeria viz., E. debliecki, E. neodebliecki, E. suis, E. porci, E. perminuta, E. scabra.

Keywords: Coccidiosis, Eimeria, Pigs, Prevalence, Rajasthan, Risk Factors

Introduction

Porcine coccidiosis is caused by protozoan parasites that multiply inside the intestinal tract of host. There are three types, *Eimeria*, *Isospora* and *Crytosporidia* (Soulsby, 1986). *Isospora suis* reproduces in enterocytes of the small intestine of pigs. Pig farming is approaching fast to establish as an income generating activity for small-scale farmers, especially in developing countries like India. Pigs provide cost effective provision of protein/meat and manure for fertilizing the soil, particularly for farmers that practice mixed farming. However, swine could carry many intestinal parasites which would hinder its growth, leading to significant economic losses to the livestock industries and farming communities (Geresu *et al.*, 2015).

Although, coccidian infections are asymptomatic but dehydration, wasting, poor growth, sloppy diarrhea, even fatalities may be seen and faeces may occasionally be tinged with blood that have negative impact on growth rate of pigs (Ruprah, 1985; Tsunda *et al*., 2013; Laha *et al.*, 2017). Coccidial infections generally receive little attention and are often overlooked because clinical symptoms are rarely apparent. The protozoa lead to loss of production mainly from retarded growth, delayed fertility, reduced productivity, high morbidity (Kumsa and Kifle, 2014; Okorafor *et al.*, 2014; Jufare *et al.*, 2015). Other constraints include poor husbandry skills and general poverty and lack of a viable market chain for pigs (Chenais *et al*., 2017). The prevalence of coccidiosis in pigs has been reported worldwide by various workers *viz.* Daugschies *et al.* (2004), Tsunda *et al*. (2013), Junhui *et al.* (2015) and Chilundo *et al.* (2017) and very limited reports have been documented in India (Laha *et al*., 2014; Kaur *et al.* 2017; Singh *et al.* 2017). As per best of our knowledge, this is a pioneer study from the state of Rajasthan. Therefore, the present study was conducted to generate epizootiological data and to minimize losses in terms of prophylaxis measures and strategic control of disease.

Material and Methods

The present study was conducted for a period of one year from September 2017 to August 2018 including all three seasons (winter, summer and rainy) to determine the prevalence of coccidiosis in the swine population under field conditions at six agroclimatic zones of Rajasthan state.

Study Area

Rajasthan is located at 27.0238° North latitude, 74.2179° East longitude and 309 m above the sea level on the western side of the country. Present work has been carried out in six zones out of the 10 agro-climatic zones comprising Semi-Arid Eastern Plain, Flood Prone Eastern Plain, Internal Drainage Dry, Hyper Arid Partial Irrigated, Transitional Plain of Luni Basin and Humid South Eastern Zones. These regions are encircled with wide variations in soil texture with average rainfall of 100-1000 mm and temperature ranging between 4°C to 48°C (D.O.A., Govt. of Rajasthan, 2018-19).

Collection of Samples

A total of 769 faecal samples were collected randomly from both free ranging pigs (371) and farm pigs (398) from 7 districts of different agro-climatic zones of Rajasthan *viz*. Humid south eastern zone: (Kota), Hyper arid partial irrigated zone: (Bikaner), Semi-Arid Eastern Plain: (Jaipur), Flood Prone Eastern Plain: (Alwar, Dholpur), Internal Drainage Dry: (Sikar) and Transitional Plain of Luni Basin: (Kota). Collection of samples was done seasonally from September 2017 to August 2018. Information regarding management, water consumption, deworming status, species, age, sex and location was collected as per developed questionnaire. The samples were placed in properly labeled sterile polythene bags, kept in a cool transport box and brought to the laboratory for further examination.

Coprological Examination

Faecal samples were examined by qualitative faecal assays (direct smear and floatation techniques) as per standard protocols for detection of coccidian oocysts. The coccidian parasites were identified on basis of the morphological features of oocysts. Quantitative faecal examination was done by standard McMaster's technique to calculate the oocysts per gram (OPG) of faeces (Soulsby, 1982).

Sporulation of Oocysts

Faecal samples positive for coccidian oocysts were mixed with 2.5% potassium dichromate in petri dishes and kept in an incubator at 27 °C for sporulation. The dimensions of the oocysts were recorded and species were identified as per available literature according to their size with the help of micrometric analysis using micrometer (ERMA, Tokyo) and morphological characteristics of the sporulated oocysts (shape, color, and texture of oocyst wall, presence or absence of micropyle, polar cap, and time of sporulation) with the aid of taxonomic keys (Soulsby, 1986; Taylor *et al.*, 2006).

Statistical Analysis

All data analyses were performed by using statistical software program (SPSS for Windows, Version 20.0, USA). Association between the prevalence of coccidial infection with various factors (season, district and animal type) was carried out by Chi square ($\chi 2$) test. Variables with significant association at $P \leq 0.05$ (two-side) were subjected to the multivariate binary logistic regression model. The results were each expressed as logistic regression coefficient (B), wald test, Standard error (S.E.), P value and odds ratio (OR) with a 95 % confidence interval (CI 95%).

Result and Discussion

Overall Prevalence

Out of 769 faecal samples from pigs, 343 were found positive with an overall prevalence of 40.18% for coccidiosis (Table 1) which is in agreement to the findings of Eijck and Borgsteede (2005), Matsubayashi *et al.* (2009) and Tsunda *et al*. (2013) from other countries of the world and Laha *et al.* (2017) from India. In contrast to this, higher prevalence rates were reported by other workers *viz.* Laha *et al.* (2014) and Singh *et al.* (2017) from India and lower prevalence rates have been documented by Kaur *et al*. (2017) from India and various workers from world *viz*. Tiwari *et al*. (2009), Weka and Ikeh (2009), Kagira *et al.* (2010), Junhui *et al.* (2015) and Chilundo *et al.* (2017). The variations in the above findings could be due to differences in the managemental practices, change in the geographical locations, local ecological factors (humidity, temperature, rainfall, soils), sample size, breed, age, sex, plane of nutrition, stress, vegetation, grazing pattern, rearing and husbandry measures, animal health extension services, anthelmintic therapy, genetic resistance, stocking rate and immunity status of animals (Kumar *et al.*, 2002; Jufare *et al.*, 2015). However, the degree of prevalence and infection intensities indicating a need for intensified hygiene and tactical control (Daugschies *et al.*, 2004).

Table 1: Overall prevalence of protozoan parasites in swine in six agro-climatic zones of Rajasthan

		Examined	Coccidian (%)
Animal type	Stray	371	221 (59.57)
	Farm	398	88 (22.11)
χ^2 Value			112.088**
Season	Winter	311	99 (31.83)
	Summer	201	20 (9.95)
	Rainy	257	190 (73.93)
χ^2 Value			207.23**
District	Alwar	78	22 (28.21)
	Jaipur	85	54 (63.53)
	Sikar	148	23 (15.54)
	Dholpur	50	0
	Pali	75	9 (12)
	Bikaner	96	15 (15.63)
	Kota	237	186 (78.48)
χ^2 Value			288.40**
Total		769	309 (40.18)

Seasonal Dynamics

Season wise prevalence was recorded uppermost during the rainy season (73.93%) followed by winter (31.83%) and summer (9.95%) with a statistically highly significant difference ($p<0.01$) (Table 1). Multivariate binary logistic regression for coccidiosis indicated a negative association in summer season and positive association in rainy season indiacting that the pigs had more chances of acquiring infection during rainy season (OR: 6.75; B: 1.91) and were reported to be at lower risk during summer (OR: 0.247; B: -1.40) as compared to winter season (Table 3). The findings are in close agreement to the studies of Tsunda *et al*. (2013). Higher prevalence in rainy season may be due to the fact that moist and warm environment and environmental factors such as higher humidity, rainfall, temperature and climate is conducive for coccidian transmission (Manya *et al*., 2008; Tsunda *et al*., 2013; Kouam *et al*., 2018). Also, various workers have suggested that reduced immunity in rainy season may also be responsible for the higher incidence of coccidiosis during monsoon (Murleedharan, 2005; Gupta *et al*., 2015).

Management Wise Analysis

Management wise analysis revealed higher prevalence of coccidiosis in unorganized stray animals (68.73%) than farm animals with organized management system (22.11%) with a statistically highly significant difference ($p<0.01$) (Table 1). Multivariate binary logistic regression for coccidiosis indicated a negative association in farm animals i.e. odds ratio of infection decreased by 0.188 in farm animals when compared with stray animals (Table 3). The higher prevalence found in scavenging pigs than farm animals could be attributed to poor management practices as majority of pigs are reared by tribal people under backyard condition without proper introduction of scientific management like housing, feeding and deworming practices (Nganga *et al*., 2008). Also, their free access to potentially contaminated areas is an important risk for persistence of these parasites in India (Chawhan *et al*., 2014; Kaur *et al*., 2017). Moreover, underfed animals have every possibility to suffer from nutritional deficiency which is a predisposing factor for parasitic infections. Besides this, untreated animals remain a potential source of infection for newborn as well as for other animals, however, study of immune status of animal is very essential for executing future parasite control programme (Borkotoky *et al*., 2014). Husbandry practices of delayed manure and bedding removal and poor hygienic conditions (poor cleaning, wet bedding) in combination with stress increase the infection pressure to a stage of higher level of infection (Joachim and Schwarz, 2015).

District Wise Prevalence

A highly significant difference ($p<0.01$) was reported among the different districts with maximum prevalence in Kota (78.48%) followed by Jaipur (63.53%), Alwar (28.21%), Bikaner (15.63%), Sikar (15.54%), Pali (12%) and no infection reported in Dholpur distict (Table 1). The variations regarding prevalence may be due to the differences in agro-ecology, managemental practices, sampling methods and time of sampling in the various areas (Roepstorff *et al*., 1998; Gupta *et al*., 2015).

Zone Wise Prevalence

As far as zonal distribution is concerned, this is a pioneer study on the prevalence of coccidiosis in swine population of the state and a highly significant difference ($p<0.01$) was reported among six agro-climatic zones with highest prevalence in Humid south eastern zone (78.48%) (Table 2).

Table 2: Zone wise prevalence of protozoan parasites in swine in six agro-climatic zones of Rajasthan

		Examined	**Coccidian (%)**
Zone	Flood prone eastern plain	128	31 (24.22)
	Semi arid eastern	85	54 63.53
	Internal drainage dry zone	148	23 (15.54)
	Hyper arid partial irrigated	96	15 (15.63)
	Transitional plain of luni basin	75	9 (12)
	Humid south eastern	237	186 (78.48)
χ^2 Value			278.32**

Similarly, Monika *et al*. (2017) reported a highly significant difference in the district wise prevalence rate in dairy animals of Semi-arid eastern plain zone of Rajasthan while, a non-significant difference in the prevalence of coccidiosis in the dairy animals observed by Renwal *et al*. (2017) and Choudhary *et al*. (2018) from this state. High prevalence of coccidian infection in humid south eastern zone may be attributed to the fact that this part receives maximum rainfall in Rajasthan especially during monsoon (D.O.A., 2019), leading to favorable conditions in terms of temperature and moisture for growth and perpetuation of coccidia. Lower infection rates in other zones may be due to the fact that these areas are comparatively drier and hot which leads to the desiccation of the oocysts and hence make the conditions unfavourable for the growth and development of coccidia (D.O.A., 2019).

Severity of Infection

Quantitative analysis based on the estimation of oocysts per gram (OPG) of faeces revealed severe infection of *Eimeria* sp. ranging from 4200-438700 with an average of 33675±21390.52. *Isospora suis* ranged from 11000-22100 with an average of 16550±5550.834 which is congruent to the findings of Lai *et al*. (2011) and unlike to the findings of Karamon *et al.* (2007), Dey *et al*. (2014) and Kouam *et al*. (2018). Variations in range of OPG of faeces may be due to the differences in the susceptibility of animals to coccidiosis depending on genetic predisposition, innate or adaptive immunity, stress level, hygiene conditions, management system, breeding of animals, study design and methods as well as on climate of different geographical regions (Hayat *et al.*, 1994; Yu *et al.*, 2011; Monika *et al.*, 2017).

Table 3: Multivariate binary logistic regression for coccidiosis in swine in six agro-climatic zones of Rajasthan

	Parameter	Logistic regression coefficient (B)	S.E.	Wald test	P value	Odds ratio
Animal group	Farm	-1.673	0.161	107.91	0	0.188
	Constant	0.399	0.106	14.175	0	1.49
District	Sikar			212.137	0	
	Alwar	0.628	0.345	3.323	0.068	1.874
	Bikaner	0.006	0.361	0	0.986	1.006
	Dholpur	-19.51	5684.144	0	0.997	0
	Jaipur	2.197	0.319	47.526	0	9.001
	Kota	3.063	0.279	120.926	0	21.399
	Pali	-0.3	0.422	0.505	0.477	0.741
	Constant	-1.693	0.227	55.667	0	0.184
Season	Winter			176.931	0	
	Rainy	1.91	0.189	101.702	0	6.754
	Summer	-1.396	0.266	27.625	0	0.247
	Constant	-0.806	0.123	43.145	0	0.447

Identification of Morphotypes

Faecal samples with high coccidial infection were subjected to sporulation and identification was done on the basis of micrometric analysis and other morphological characters *viz*. no. of sporocysts as well as sporozoites, thickness of oocysts wall, presence/absence of micropyle, micropylar cap, etc. It revealed the presence of *Isospora suis* (8.88%) and six morphotypes of *Eimeria viz. E. debliecki* (20%), *E. neodebliecki* (18.88%), *E. suis* (15.55%), *E. porci* (14.44%), *E. perminuta* (12.22%) and *E. scabra* (10%) (Table 4 and Figure1). Several species of *Eimeria* and *Isospora suis* have been identified from pigs by several other workers around the world (Soulsby, 1982; Urquhart *et al.*, 1992; Eysker *et al.*, 1994; Mundt *et al*., 2005; Canon-Franco *et al*., 2012) as well as from India (Ruprah, 1985; Laha *et al*., 2014; Kaur *et al.*, 2017 and Singh *et al*., 2017). Higher infection of *Eimeria* sp. and lower infection of *Isospora suis* was congruent to the findings of Tsunda *et al*. (2013) and Laha *et al*. (2014). Contrary to this, higher infection of *Isospora suis* and lower infection of *Eimeria* sp. was reported by Karamon *et al*. (2007).

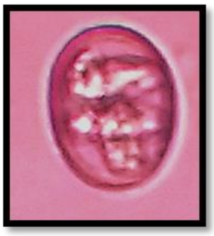
Table 4: Mean measurements (µm) of sporulated coccidian oocysts of swine (Mean±S.E.)

Coccidia	Length (Mean ± S.E.)	Width (Mean ± S.E.)	Shape	Salient features
Eimeria porci	20.03±0.34	14.27±0.12	Ovoid	Rough wall with indistinct micropyle
	(18.2-21.7)	(14-15.4)		
E. perminuta	12.98±0.35	10.95±0.13	Subspherical	Rough wall with no micropyle or oocysts residuum
	(11.2-14.7)	(10.5-11.55)		
E. debliecki	24.69±0.09	18.03±0.42	Ovoid to ellipsoidal	smooth wall with indistinct micropyle
	(23.8-25.2)	(15.4-20.3)		
E. neodebliecki	19.04±0.44	14.99±0.36	Ellipsoidal	Micropyle, oocystic residuum present.
	(17.5-21.7)	(13.3-18.2)		
E. suis	15.18±0.40	13.05±0.39	Ellipsoidal to subspherical	Thick outer wall with no micropyle
	(13.3-17.5)	(11.2-15.4)		
E. scabra	28.77±0.84	19.44±0.62	Ovoid to subspherical	Very thick wall with a visible micropyle
	(25.2-31.5)	(17.5-21)		
Isospora. suis	21.22±0.27	20.52±0.59	Subspherical	Smooth wall without micropyle
	(20.3-22.4)	(17.5-22.05)		

A: *Isospora suis*

B: *E. suis*

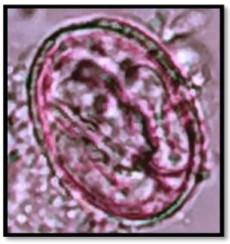
C: *E. deblecki*



D: *E. neodeblecki*

E: *E. perminuta*

F: *E. porci*



G: *E. scraba*

Figure 1: Photomicrograph of oocysts of Coccidia (×40)

Conclusion

The findings of the study indicated mild to high infection of coccidiosis in a considerable portion of pig population of the state and baseline data generated would be of immense help for developing effective control strategies.

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Conflict of Interests

There is no conflict of interest.

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