



***Peste-des-petits-ruminants* in goats: Sero-epidemiological study in middle Indo-Gangetic plains**

PANKAJ KUMAR¹, BIDYA SHANKAR SINHA², RAMA KRISHNA ROY³,
RASHMI REKHA KUMARI⁴ and ABHAY KUMAR⁵

ICAR Research Complex for Eastern Region, P O B V College, Patna, Bihar 800 014 India

Received: 2 September 2016; Accepted: 19 September 2016

ABSTRACT

Bihar state is situated in the middle of Indo-Gangetic plains of India and located between 24°–27° N latitude and 82°–88° E longitude with a total geographical area of 94.2 thousand sq. km. It possesses 7.63% of India's total goat population which is the fifth largest among states of India. PPR has become endemic and reported from most states of India by various researchers. A systematic three years study on sero-epidemiology of PPR in goats was carried out in nine districts covering all the four agro-climatic zones of Bihar. Random samples (769) were collected from unvaccinated goats of all gender, breeds with more than 3 months of age. Samples were tested using Mab c-ELISA following standard protocol provided. The overall circulating PPR virus (PPRV) antibody was 34.50% (apparent prevalence) and 39.04% (corrected prevalence). The PPRV antibody in goats of Zone 2 was significantly higher compared to Zone 1. Amongst different breeds, the circulating PPRV antibody was significantly higher in Sirohi breed compared to Black Bengal and nonsignificantly higher to other breeds of the goat. Binary logistic regression of PPR with gender indicated a significantly higher probability of PPRV antibody in female goats compared to male goats. The odds ratio was high with respect to the occurrence of PPR and physiological state (age) and the difference was significantly higher in adult goats compared to kids. The present finding is helpful in planning effective disease management program for PPR in Indo-Gangetic plains.

Key words: Bihar, Goat, PPR, Sero-epidemiology

Goat plague or *Peste-des-petits-ruminants* (PPR) is the most important devastating viral disease causing huge economic losses to goat farmers. Bihar state is situated in the middle of Indo-Gangetic plains of India. Bihar has 7.63% of India's total goat population. Sero-epidemiological studies were attempted and reported from most parts of the country (Balamurugan *et al.* 2014, Devi *et al.* 2016), however, no systematic study of goat plague based on sero-prevalence of PPR in Bihar state has been reported. Thus, the present study was undertaken with the objective to assess the sero-prevalence of PPRV antibody in randomly selected goats of mid Indo-Gangetic plains of Bihar.

MATERIALS AND METHODS

Study area: Bihar state is divided into four agro-climatic zones viz. 1, 2, 3A and 3B. A total of 9 districts were

Present address: ¹Scientist-Veterinary Medicine (pankaj.kumar1@icar.gov.in), Division of Livestock and Fisheries Management. ²SMS-Animal Science (bidyashankarsinha@rediffmail.com), KVK, Ariari. ³Programme Coordinator (dramakrishnaroy@gmail.com), KVK, Sipaya. ⁴Assistant Professor (rrkvet@gmail.com), Bihar Veterinary College, Patna. ⁵Head and Principal Scientist (akumar1904@rediffmail.com), Division of Socio-economics and Extension.

randomly selected for the study covering all the agro-climatic zones of the state viz. Sitamarhi and Vaishali in zone 1; Purnea and Katihar in zone 2; Patna, Gaya, and Jehanabad in zone 3B and Sheikhpura and Lakhisarai in zone 3A. The study was carried out for 3 years from Feb 2013 to Jan 2016 with the help of various KVKs i.e. Jehanabad, Gaya, Buxar, Sheikhpura and Lakhisarai.

Animal: Goats of all age, breed, and sex were taken randomly from the selected districts of Bihar in all the four agro-climatic zones including institute farm goats. Most goats under study were Black Bengal and its type, Sirohi and non-descript. Data were collected through pretested schedule developed for the study. Blood samples were collected from kids (3–6 months) and adults. None of the survey area was covered for PPR vaccination in goats. Blood samples were collected and immediately harvested for serum. Serum samples after proper identification were stored in cryovials at –20°C till further analysis. A total of 769 random samples were collected.

Monoclonal antibody (MAB) based competitive enzyme linked immunosorbent assay (c-ELISA): Sero-epidemiology of PPRV circulating antibody was done by measuring the titre by MAB based c-ELISA kits procured from Indian Veterinary Research Institute, Mukteswar using the method described by Singh *et al.* (2004). The specificity (98.4%)

and sensitivity (92.4%) of the MAb based c-ELISA has been reported to be high compared to the virus neutralisation assay (Singh *et al.* 2014). Optical density was measured by ELISA reader (ECIL micro scan MS5608A) at 492 nm wavelength. All the samples were tested in duplicate as per the standard protocol.

Statistical analysis: Apparent prevalence and corrected prevalence was calculated using formula used by Balamurugan *et al.* (2011). Results obtained from MAb based c-ELISA test were statistically analysed for testing the significance by analysis of variance and odds ratio of age, gender, zones and breeds of goat using binary logistic regression model.

RESULTS AND DISCUSSION

Sero-surveillance and risk assessment is an initial step towards effective control and eradication of PPR in small ruminants in any developing regions like middle Indo-Gangetic plains of Bihar. In the present study which was conducted in all the four agro-climatic zones of the middle Indo-Gangetic plains, the sero-epidemiology of circulating PPRV antibody in 769 random selected goats using MAb based c-ELISA tests indicated 34.50% apparent prevalence and 39.04% corrected prevalence. The mean negative control I (%) was 14.70 ± 0.79 and below 25% is required for validation. The optical densities of MAb control (C_m) were also within the optimal range required for test validation with mean of 0.55 ± 0.019 . The high prevalence (%) of PPRV antibody in Bihar implies contagious nature of the disease and its high morbidity. The present finding corroborates the earlier reports of high PPRV circulating antibody in goats as reported in surveillance study in neighbouring states of Uttar Pradesh (44.12%) and West Bengal (80.00%) (Balamurugan *et al.* 2011). Extensive study comprising 52 districts in five states of Andhra Pradesh, Gujarat, Jammu and Kashmir, Maharashtra and Rajasthan reported that 38.54% of sampled goats were positive for PPRV antibodies (Balamurugan *et al.* 2014).

However, in the North-Eastern states of India, lower trends of sero-prevalence of PPRV were reported. In Asom, the sero-prevalence of PPR in goats was 27.28% (Devi *et al.* 2016).

An attempt has been made to understand possible role of these variables in presence of PPRV antibody in goats of Bihar. The categorical prevalence (%) of PPRV antibody in agro-climatic zone districts, gender and physiological state is depicted in Table 1. Highest prevalence (%) of circulating PPRV antibody was observed in agro-climatic zone 2 of Bihar. The PPRV antibody in goats of was significantly higher ($P=0.048$) in zone 2 compared to zone 1 and non-significantly higher from zone 3A ($P=0.246$) and 3B ($P=0.296$). Agro-climatic zone 2 is located north-east of Bihar having nine districts including Katihar and Purnea which shares borders with Jharkhand and West Bengal. Both these districts have comparatively higher population density of goats ($100-150/\text{km}^2$) compared to other districts of Bihar. Inter-state migration of goats for sale or purchase might be responsible for higher percentage of positivity for PPRV antibody. Other possible reasons might be attributed to less sample size, difference in climatic conditions and higher rainfall in this zone. The present finding corroborates that high rainfall contributes to spread of PPR (Saeed *et al.* 2010).

The prevalence (%) of PPRV antibody in the four agro-climatic zones among different breeds of goats is represented in Table 2. Amongst different breeds, the circulating PPRV antibody was significantly ($P=0.030$) higher in Sirohi breed (52.46 ± 13.61) compared to Black Bengal (33.33 ± 2.34) and non-significantly ($P=0.196$) higher to other non-descript breeds (37.35 ± 3.61) of goat. The present findings may be attributed to difference in sample size of breeds and possible purchase of Sirohi breeds from state of Rajasthan and western Uttar Pradesh. Moreover, higher sero-prevalence of PPRV (64.39%) was reported from breeding tracts of Sirohi (Balamurugan *et al.* 2011). In present study, PPRV antibody was non-significantly

Table 1. Agro-climatic zone-wise sero-prevalence (%) of PPR antibody in goats of middle Indo-Gangetic plains of Bihar

Zone	Districts	Male (n=213)		Female (n=556)		Apparent prevalence (%)	Corrected prevalence (%)	Zone prevalence (%)
		Kid (n=42)	Adult (n=171)	Kid (n=63)	Adult (n=493)			
1	Vaishali(n=96)	0.00(n=8)	22.22(n=27)	10.00(n=10)	37.25(n=51)	27.08	29.81	28.19 ^a
	Sitamarhi (n=53)	0.00(n=3)	30.43(n=23)	0.00(n=4)	39.13(n=23)	30.19	33.23	
2	Purnea(n=43)	0.00(n=2)	40.00(n=10)	0.00(n=4)	62.96(n=27)	48.84	53.77	46.27 ^b
	Katihar(n=24)	0.00	60.00(n=5)	0.00(n=2)	41.18(n=17)	41.67	45.87	
3A	Patna(n=196)	5.88(n=17)	38.46(n=65)	4.35(n=23)	48.35(n=91)	36.22	39.87	35.25 ^{ab}
	Jehanabad(n=97)	0.00(n=3)	30.77(n=13)	11.11(n=9)	34.72(n=72)	30.93	34.05	
	Gaya(n=90)	20.00(n=5)	30.00(n=10)	22.22(n=9)	42.42(n=66)	37.78	41.59	
3B	Lakhisarai(n=74)	0.00	50.00(n=10)	0.00	28.13(n=64)	31.08	34.21	35.53 ^{ab}
	Sheikhpura(n=96)	0.00(n=4)	37.50(n=8)	50.00(n=2)	36.59(n=82)	35.42	38.99	
Total		2.22±2.22	37.71±3.83	10.85±5.50	41.19±3.29	34.50±2.24	39.04±2.47	36.31±3.72
Confidence interval at 95%		-2.22 to 7.35	28.88 to 46.53	-1.82 to 25.53	33.60 to 48.78	30.30 to 40.63	35.56 to 44.73	24.44 to 48.18

Values with different superscript differ significantly ($P<0.05$) and values in parenthesis indicate sample size.

Table 2. Breed-wise prevalence (%) of PPRV antibody in goats of middle Indo-Gangetic plains of Bihar

Zone	Districts	Black Bengal type (n=389)	Sirohi (n=59)	Others (n=321)
1	Vaishali (n=96)	29.73 (n=37)	0.00 (n=2)	26.32 (n=57)
	Sitamarhi (n=53)	26.92 (n=26)	-	33.33 (n=27)
2	Purnea (n=43)	42.11 (n=19)	66.67 (n=3)	52.38 (n=21)
	Katihar (n=24)	46.15 (n=13)	-	36.36 (n=11)
3A	Patna (n=196)	25.21 (n=119)	44.44 (n=27)	58.00 (n=50)
	Jehanabad (n=97)	29.27 (n=41)	40.00 (n=15)	29.27 (n=41)
	Gaya (n=90)	36.11 (n=36)	63.64 (n=11)	32.56 (n=43)
3B	Lakhisarai (n=74)	30.56 (n=36)	100.00 (n=1)	29.73 (n=37)
	Sheikhpura (n=96)	33.87 (n=62)	-	38.24 (n=34)
Total		33.33± 2.34 ^a	52.46± 13.61 ^b	37.35± 3.61 ^{ab}
Confidence interval at 95%		27.93 to 38.71	17.47 to 87.45	29.03 to 45.68

Values with different superscript differ significantly ($P < 0.05$) and values in parenthesis indicates samples size.

lower ($P = 0.249$) in Black Bengal goats compared to other non-descript type.

The results of binary logistic regression of PPR with different variables studied is depicted in Table 3. The odds ratio of PPR and gender was 0.684 indicating significantly ($P = 0.048$) higher probability of PPRV antibody in female goats compared to male goats. The present finding is attributed to greater chance of survival of female goats compared to male goats which included castrated goats as well. Male castrated goats are generally consumed for meat

Table 3. Binary logistic regression of PPR sero-positivity and zone, breed, gender and age

Log regression of PPR with	B	SE	Z	Sig.	Odds ratio Exp (B)
Gender	-0.381	0.193	-1.97	0.048*	0.684
Age	2.17	0.387	5.61	0.000*	8.750
Black Bengal breed	-.3302023	.166406	-1.98	0.047*	0.719
Sirohi breed	0.768	0.326	2.35	0.019*	2.155
Other breeds	Omitted				
Zone 1	-0.248	0.226		0.272	0.780
Zone 2	0.470	0.281	1.67	0.094	1.600
Zone 3B	-0.217	0.205	-1.06	0.290	0.805
Zone 3A	Omitted				
Constant	-2.366	.400	-5.92	.000	0.094

Log likelihood = -460.07306; Pseudo $R^2 = 0.0711$.

purpose at age of 1–2 years and so the opportunity of exposure is comparatively less compared to female and intact male goats. Frequent kidding and lactation in female goats is also responsible for immunocompromised state. The present finding is congruent to earlier reports of higher prevalence in female goats compared to male (Nizamani *et al.* 2015). In some studies, no significant difference was found (Mahajan *et al.* 2012). The variability in these reports might be due to variable sample size of two sexes with comparatively lesser representation of males. The odds ratio was high with respect to occurrence of PPR and age, and was significantly ($P = 0.00$) higher in adult goats compared to kids and the prevalence was 7.61% in kids of both gender. The present finding is attributed to low sample size of kids as the goat owners were reluctant. Amongst the breeds, odds ratio for the presence of PPRV antibody in Sirohi breed was 2.155 with positive Z value (2.35) indicating more than 2 fold higher probability of circulating PPRV antibody compared to other breeds. Similarly, Black Bengal goats had lower probability of circulating virus antibody compared to other breeds indicated by negative Z (-1.98) value and odd ratio of 0.719. Binary logistic regression was non-significantly different between agro-climatic zones, however, the odd ratio was high (1.600) with positive Z (1.67) value in zone 2 indicating higher probability of circulating PPRV antibody in goats of this zone compared to other zones. The high log likelihood (-460.073) validates the test applied to compare these variables.

The present finding of high circulating PPRV antibody in all the four agro-climatic zones of Bihar suggest policy maker to take up immediate control strategies for PPR in goats. Vaccination is not in practice by farmers in all the zones studied. Bihar occupies sufficient percentage of goat population and most of these goats are reared by landless, marginal and small farmers, therefore, efforts taken in control of most dreaded disease PPR will improve the livelihood of under-privileged farming community.

ACKNOWLEDGEMENT

Authors acknowledge support and cooperation of Director, ICAR- Research Complex for Eastern Region, Patna for providing necessary funds and facilities for undertaking the institute project. Support rendered by Head, Division of Livestock and Fisheries Management is also acknowledged. Support provided by Programme Coordinators of the Krishi Vigyan Kendras during survey and sampling is duly acknowledged.

REFERENCES

- Balamurugan V, Krishnamoorthy P, Raju D S N, Rajak K K, Bhanuprakash V, Pandey A B, Gajendragad M R, Prabhudas K and Rahman H. 2014. Prevalence of *Peste-des-petits-ruminants* virus antibodies in cattle, buffaloes, sheep and goats in India. *Virus Disease* 25(1): 85–90.
- Balamurugan V, Saravanan P, Sen A, Rajak K K, Bhanuprakash V, Krishnamoorthy P and Singh R K. 2011. Sero-

- epidemiological study of *Peste des petits ruminants* in sheep and goats in India between 2003 and 2009. *Revue Scientifique et Technique-OIE* **30**(3): 889.
- Devi M, Das S, Sharma K and Dutta R. 2016. Seroprevalence and molecular detection of *peste des petits ruminants* in goats of Assam. *Virus Disease* **27**(1): 91–97.
- Mahajan S, Agrawal R, Kumar M, Mohan A and Pande N. 2012. Risk of seroconversion to *peste des petits ruminants* (PPR) and its association with species, sex, age and migration. *Small Ruminant Research* **104**(1): 195–200.
- Nizamani A R, Nizamani Z A, Umrani A P, Dewani P, Vandiar M A and Soomro J G N. 2015. Prevalence of *peste des petits ruminants* virus antibodies in small ruminants in Sindh, Pakistan. *Journal of Animal and Plant Sciences* **25**(6): 1515–19.
- Saeed I K, Ali Y H, Khalfalla A I and Rahman-Mahasin E A. 2010. Current situation of *peste des petits ruminants* (PPR) in the Sudan. *Tropical Animal Health and Production* **42**: 89–93.
- Singh R P, Saravanan P, Sreenivasa B P, Singh R K and Bandyopadhyay S K. 2004. Prevalence and distribution of *peste des petits ruminants* virus infection in small ruminants in India. *Revue scientifique et technique (International Office of Epizootics)* **23**(3): 807–19.