The Journal of Animal & Plant Sciences, 27(5): 2017, Page: 1522-1527
ISSN: 1018-7081

PESTE DES PETITS RUMINANTS IN ALGERIA: VIRAL CIRCULATION OF PPRV BETWEEN 2012 AND 2015

R. Baazizi[1], D. Khelef[1] and T. Hussain[*2]

[1]National Veterinary Higher School, ENSV/BP 161 Hacène Badi, El- Harrach, Algiers, Algeria
[2]Department of Molecular Biology, Virtual University of Pakistan, Lahore
[*]Corresponding author's email: tanveer.hussain@vu.edu.pk

ABSTRACT

Following the detection of lineage IV peste des petits ruminants virus (PPRV) circulation in Tunisia and Morocco in 2008, investigations were regularly executed in farms and livestock markets of Algeria, mainly in western and eastern part bordering Morocco and Tunisia, respectively. A sero-surveillance undertaken in early 2011 confirmed serologically positive cases in the Sahara desert region. Consequently a national sero-survey of PPR involving all the 48 administrative districts of Algeria was conducted in February 2012, from 13/02/2012 to 23/02/2012. A total of 3396 samples from 202 livestock herds spread over 48 administrative districts (Wilayas) of Algeria were collected for this purpose. Serum samples were tested for the presence of antibodies to PPRV following the competitive ELISA protocol (cELISA). The laboratory investigation revealed a very high rate (68.8%) of serologic prevalence of PPR at national level. It also showed the spatial variability of the prevalence between different regions in the country; the highest infection rates (86.8%) were registered at the west region bordering Morocco while the lowest (51.4%) was observed in the north. This rate also varied from old animals (22.9%) to young animals (13.5%) and from goats (23.9%) to sheep (17.1%) and from females (21.8%) to males (14.1%). The PPRV circulation is proven towards this survey but none vaccination program was applied. It is in this purpose that a sero-survey was lead in 2015 where 1286 animals were sampled (1085 sheep and 201 goats), 315 were positive with a global seroprevalence of (24.5%). The seroprevalence calculated in sheep is (24%) and (26%) in goats. This lead to implement the strategy to fight PPR as the veterinary services decided in 2013 that vaccination will be extended to other districts based on the results of the serological survey and changes in health status.

Keywords: Peste des Petits Ruminants, morbillivirus, seroprevalence, sheep, goat, Algeria**.**

INTRODUCTION

Peste des petits ruminants (PPR), also named pseudo-peste bovine is a highly contagious viral disease, mainly infecting small ruminants. In 1942 the PPR was first reported in West African Cote d'Ivoire in 1942 (Kock *et al*., 2015) and was spread during the eighties to East Africa, Middle East and Asia. It is now spreading to North African countries as Morocco, Tunisia and Algeria where outbreaks were occurred (Baron *et al*., 2011; Parida *et al*., 2016) possibly due to the movement of animals from Egypt, Sudan and Middle East (Banyard *et al*., 2010). The disease was reported in Algeria in 2012. The mortality rate range between 10 to 90% and the morbidity between 10 to 80% (Waret-Szkuta *et al*., 2008). PPR is a notifiable disease and should be reported to the World Organization for animal health (OIE).

The virus, peste des petits ruminants (PPRV) is the cause of PPR that belongs to the family *Paramyxoviridae*, genus *Morbillivirus*. The incubation period of PPR is typically 4–6 days although it may range from between 3 and 10 days. During the acute stage of disease, animals show pyrexia (up to 41 °C) that may last for 3 to 5 days and that can be accompanied by depression, anorexia and dryness of the muzzle. Watery nasal and lachrymal discharges gradually become mucopurulent with excessive salivation. Erosive lesions formed in the oral cavity may become necrotic. In later stages of the disease, animals develop diarrhea and coughing with laboured, abdominal breathing. Disease may last for 14 days before recovery from infection or lead to earlier death (Parida *et al*., 2016; Parida *et al*., 2015)

Four phylogenic lineages of PPRV were identified in different geographic regions of the world. The lineages I and II were reported in Africa while the lineage III was reported in Africa, the Middle East and South India. It was not reported in India since 1992 (OIE, 2008). In Asia, only the lineage IV was mainly circulating (Kwiatek *et al*., 2011, Kumar *et al*., 2014). However, the outbreak of PPR in Morocco in 2008 confirmed the circulation of lineage IV in Africa (Albina *et al*., 2013; Khalafalla *et al*., 2010).

Livestock is an important sector of agriculture in Algeria. It is mainly comprised of sheep, goats, cattle and camels. The livestock is playing a major role in the socioeconomic development of millions of rural families. Algeria has one of the largest livestock populations with

about 28111773 sheep and 5013950 goats heads of PPR susceptible animals.

Following the detection of lineage IV PPRV circulation in Tunisia and Morocco in 2008, surveys were regularly conducted in farms and livestock markets in Algeria, mainly in western and eastern part bordering Morocco and Tunisia, respectively. A number of sera were found positive during an investigation conducted in the Sahara desert region of the country in early 2011. However, signs of the clinical disease were not found and the RT-PCR results were also negative. The director of the Algerian Veterinary Services in March 2011 officially notified the World Organization for Animal Health (OIE) about PPR serologically confirmed cases in five provinces of Algeria, even though samples tested negative by reverse transcription–polymerase chain reaction (RT-PCR) and no clinical signs were observed.

In March 2012, the re-occurrence of PPR was notified to the OIE. Three outbreaks, with clinical cases, were reported in Ghardaïa region. Three focies are reported in 659 susceptible animals, 19 cases of clinical signs and the RT-PCR was positive. The event was resolved one month later. Additional serological investigations in several parts of the country were being implemented.

Reoccurrence of the disease was again notified to the OIE in January 2013 from the same region of Ghardaïa with four clinical disease outbreaks: from four farms 32 small ruminants were affected out of 251 susceptible animals, nine animals died and the others were given treatment. However, De Nardi and colleagues (De Nardi *et al*., 2012) reported lineage IV PPRV circulation in Algeria analyzing the samples collected during 2010 outbreak. The main objective of this study was to determine the seroprevalence of PPRV infection in small ruminants in 2012 also to determine the regional distribution and circulation of PPRV in Algeria and the evolution of the situation three years after (2015).

MATERIALS AND METHODS

Study area and Data collection: The survey covered all the regions of the country and animals were sampled randomly for serologic screening for PPR, from the districts veterinary services listing. The 70 blood samples were gathered (sensitive to the disease) by species and by district wherever possible (Fig. 1). The sampling was made as showed in Table 1. For each herd selected, a survey questionnaire was completed. The information collected through the questionnaire was about the geographic location, the herd size, the number of animals, the characteristics of the livestock (species and their number) the mobility (sedentary or nomad), the type of livestock (intensive or extensive), the market target (milk or meat) and sanitary antecedent (introduction of new and sensitive animals, their origin, presence of clinical signs etc.). A database was created on animal's age, sex, species, type of livestock; geographic location, animal movement etc., and clinical signs were also recorded wherever available. For the survey undertaken in 2015, the animals were sampled randomly according to the age and sex. In this survey, we were interested by the evolution of PPR seroprevalence in Algeria in sheep and goats.

Sampling: In February 2012, a transverse survey was conducted on the small ruminants (sheep and goats) suspected of PPRV infection involving all the 48 districts (Wilayas) in Algeria through the district veterinary services (Fig.1). The 3396 blood samples were collected (610 goats and 2786 sheep) from a total of 202 livestock herds, with a mean of 70 samples by administrative district. The age of the animal was determined both by reading the dental table of the animal and by farmer's told birth date. The animals were divided in two groups, each according to their age and sex. Animals up to one year of age were considered as young and animal ≥ 1 year of age were considered as adult. The serum was separated and stored at -20^{o} C until tested.

As no serological test is available that can differentiate animals vaccinated with homologous PPR vaccine from those who had recovered from natural PPR infection, therefore sero-survey was undertaken in 2015. Blood samples (1286) were collected (1085 sheep and 201 goats) from a total of 16 districts with a mean of 80 samples by administrative district. The serum was separated and stored at -20^{o} C until tested.

Laboratory investigation for PPRV- specific antibodies: Serum samples were examined for PPRV-specific antibody by competitive enzyme-linked immunosorbent assay as described by the c-ELISA kit used (N-protein specific c-ELISA test marketed by ID Screen®, PPR Competition. Innovative Diagnostics. Montpellier. France) at veterinarian laboratories of Algeria.

Data analysis: Epi Info software (version 3.4.1) was used for processing and data analysis. The Chi2 test with a confidence range of 95% was performed in order to compare the seroprevalence in relation to age, sex, species, type of livestock and other factors. The differences were considered as statistically significant where the probability (P) correspond to a value of ≤ 0.05 with a confidence range of 95%.

For the survey conducted in 2015, seroprevalence only was calculated.

RESULTS AND DISCUSSION

The global seroprevalence: The survey results showed the average prevalence at the national level was 68.8% in 2012. This national seroprevalence rate was relatively

high in comparison to the rate (51.34%) reported in Pakistan (Khan *et al*., 2008).

Differences were there in the prevalence among the four great regions of the country. Prevalence varied from 86.6% at the West region of the country followed by 84% at the East, while the lowest prevalence (51.4%) was recorded at the North (Table 2). However the statistical analysis showed that there is no significant difference between the regions (p-value = 0.078). The slight difference of occurrence of PPR in geographic location could be explained by the geographical characteristics of each region and the part and the nature of livestock in the region economy. In the West (86.8%) and East (84%), the agro-pastoral zone is much larger, with a high concentration of sheep and goats livestock. In addition these regions border with the neighboring countries (with no restriction in animal movement) that could be a portal of entry of the disease. Previous reports of PPRV outbreaks in Morocco and Tunisia, bordering western and eastern borders of Algeria, respectively, could also contribute to the relatively higher rate of prevalence in the West and East part of the country.

The results obtained in 2015 showed a global seroprevalence with a percentage of 24.5 %. This seroprevalence was lower comparatively to the one calculated in 2012 but is relatively closed than the results reported by authors (Khan *et al*., 2008).

This result showed that the seroprevalence decreased, comparing to the results obtained in 2012; this could be explained by the implication of an endemic situation in the country.

Three different types of farms were sampled in this study; (i) sheep, (ii) goat and (iii) mixed (both sheep and goats were reared together). The prevalence rate varied between type of farms, ranging from highest (71.5%) in mixed farms and the lowest (40.0%) in goat farms (Table 2), however they were not statistically significant.

Seroprevalence at livestock type level: There are different types of livestock in Algeria, i. e. nomadic or sedentary, under extensive or intensive rearing practice, fattening livestock etc. Analysis of the data to study the seroprevalence according to livestock type revealed highest (68.3%) prevalence in extensive livestock and lowest (53.9%) in fattening livestock (Table 3). The statistical analysis did not show any difference between livestock by type (p-value = 0.998) indicating the type of livestock does not have much impact on the occurrence of the disease.

The results for sedentary and nomad livestock, respectively (62%) and (61.5%) join those found where pastoral management systems prevail over sedentary ones (Waret-Szkuta *et al*., 2008).

At the individual level PPRV infection was lower in sheep (17.4%) as compared to goats i.e. 24.9%. A high seroprevalence in goats was also observed by other authors (Kihu *et al*. 2015; Megersa *et al*., 2011; Waret-Szkuta *et al*., 2008). The statistical analysis of the serologic survey showed that there is significant difference between species, (p-value < 0.001), making this a major risk factor to the infection (Table 4). The same result was found in other studies conducted earlier (Waret-Szkuta *et al*., 2008).The greater severity of the disease in goats may be attributed to a greater susceptibility of the goat population to infection with PPRV (Khan *et al*., 2008) and may have died from the disease, whereas sheep may have survived (Abraham *et al*., 2005).

Our results can be explained by a higher affinity of the virus for the caprine species versus the ovine species in contrast with the results obtained by other authors who observed a higher affinity of the virus for the ovine species versus the caprine species (Intisar *et al*., 2010; Khan *et al*., 2008; Nizamani *et al*., 2015).

The study undertaken in 2015 showed a seroprevalence of 24% in sheep and 26% in goats. Our results showed that goats are more sensitive than sheep as reported by several authors and joins the previous results

Seroprevalence according to the age: Our study indicated a relationship between the animal's age and PPR prevalence as well. In both the species relatively higher prevalence in adult animals compared to the young animals was observed (Table 4). Statistically, the animal's age represented an important risk factor, for both sheep and goats (p-value = 0.000). According to Waret-Szkuta *et al* (2008), the oldest animals are more at risk to contract the disease than the young, where animals aged over three years; they are more sensitive to PPRV and presented a high seroprevalence than the younger animals. Some authors are also reported that infection rates in sheep and goats rise with age (Özkul *et al*., 2002) while Kihu *et al*. (2015) reported that both middle age and adult sheep were less likely to be seropositive against PPRV compared to younger. However, our study did not precise the exact age of animal concerned in the survey.

Seroprevalence by sex: The analysis to study the effect of sex on the prevalence of the disease revealed a higher prevalence in females compared to the males (Table 4). The statistical analysis have not shown any significant difference for the goats (p-value = 0.134), while in case of sheep, sex could be considered as a major risk factor (p-value = 0.000).

In the overall results, the seroprevalence for females was higher than to males respectively 26% (541/2084) and 14.3% (188/1312). This result corroborate with a previous results reported by other authors (Waret-Szkuta *et al* 2008., Khan *et al*.,2008., Nizamani *et al*., 2015., Megersa *et al*., 2011). This higher rate of PPR could be due to the fact that females are maintained for a longer period of time as compared to

males in order to promote production practices, which many indirectly account for the high prevalence of antibodies to PPRV in female animals (Khan *et al*., 2008).

In contrast, any significant difference has not been observed in the prevalence between males and females by other authors (Kihu *et al*., 2015).

According to the field questionnaire of the survey the mortality rate was 3.5% for goats while for sheep it was null, which signifies that goats are more sensitive to the disease than sheep. Our result also agrees with the report in other studies that showed that there is a difference in the virulence of the PPRV between goats and sheep (Truong *et al*., 2014) or that the PPRV prefers goat over sheep when both of these natural hosts are reared contiguously (Balamurugan *et al*., 2012).

According to the field questionnaire of the survey, the animal did not have any clinical sign of the disease during the survey in these areas. At the same time a PPR outbreak was signaled at Ghardaïa. The movement of the animals in this nomadic region may have created opportunities for contact between infected and naïve animals which could be the explanation of this high prevalence in these areas. The seropositivity to PPR increased with introduction of new animals in flocks and communal grazing of animals (Mbyuzi *et al*., 2014).

Considering that there was no PPR vaccination program in Algeria and detection of PPRV-specific antibodies in sheep and goat in this study indicated the circulation of the virus which may have gone un-noticed in the previous years.

Table 1. Sampling strategy for the serosurveillance in Algeria (2012).

Size of the herd	No. sampled
100	25
150	26
200	27
250	28
300-500	28
500- 1000	29
≥1000	30

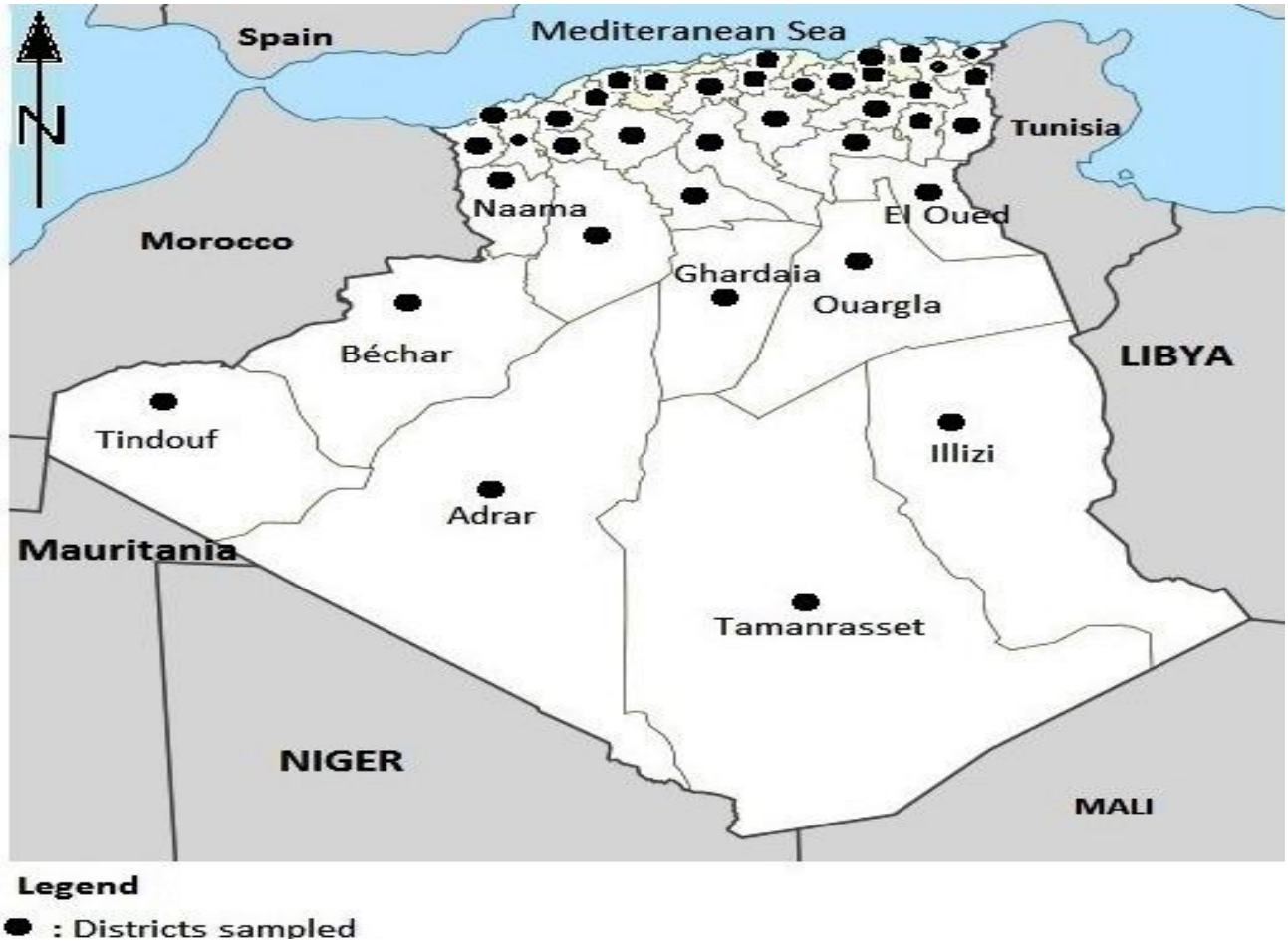

Figure 1. Map of Algeria showing sampled districts.

Table 2. Seroprevalence according to region and type of livestock in Algeria.

	No. of Livestock	No. of positives livestock	Prevalence (%)	p-value
Region				0,078
North	72	37	51.4	
East	50	42	84.0	
West	53	46	86.8	
South	27	14	51.8	
Type of livestock				0,63
Sheep	104	72	69.2	
Goat	10	04	40.0	
Mixed	88	63	71.5	
Total	202	139	68.8	

Table 3. Seroprevalence according to demographic type in Algeria.

	No. of livestock	No. of positives livestock	Flock Prevalence (%)	p-value
Demographic type				0.998
Extensive	41	28	68.3	
Intensive	30	18	60.0	
Fattening	13	07	53.9	
Mixed	55	34	61.8	
Sedentary	50	31	62.0	
Nomad	13	08	61.5	
Total	202	126	62.4	

Table 4. Seroprevalence according to age and sex in Algeria.

Species	Animals sampled	No. sampled	No. Positive	Pr (%)	p-value
	Adults	1542	322	20.9	0,0000
	Young	1244	162	13.02	
Sheep	males	1116	145	13.0	0,0000
	females	1670	329	19.7	
	Total	2786	484	17.4	
	Adults	377	116	30.8	0,0000
	Young	233	36	15.5	
Goats	males	196	43	22.0	0,134
	females	414	122	29.5	
	Total	610	152	24.9	

Conclusion: The results of the survey conducted in 2012 showed that circulation of PPRV in Algeria were proven with a global seroprevalence of 68.8%. The serologic prevalence was higher in goats than in sheep, within the adults than the young. It was also higher within females than the males. The 2015 survey, showed a decrease global seroprevalence of 24.5% with also a high seroprevalence in goats (26%) than in sheep (24%). Keeping in view the economic losses and threats to food security associated with PPR, it is essential to take serious measures to control and fight this disease at local, regional and national level.

Acknowledgements: The authors are thankful to the staffs of veterinary services of Algeria for providing the relevant data.

REFERENCES

Albina, E., O. Kwiatek, C. Minet, R. Lancelot, R. S. De Almeida, and G. Libeau (2013). Peste des petits ruminants. The next eradicated animal disease?. Vet. Micro. 165 (1): 38-44.

Balamurugan, V., P. Saravanan, A. Sen, K. K. Rajak, G. Venkatesan, P. Krishnamoorthy, V. Bhanuprakash and R. K. Singh (2012). Prevalence of peste des petits ruminants among

sheep and goats in India. J. Vet. Sci. 13(3): 279–285.

Banyard, A. C., S. Parida, C. Batten, C. Oura, O. Kwiatek, and G. Libeau (2010). Global distribution of peste des petits ruminants virus and prospects for improved diagnosis and control. J. Gen. Virol. 91(12): 2885–2897.

Baron M. D., S. Parida, C. A. L. Oura (2011). Peste des petits ruminants: a suitable candidate for eradication?. Vet. Rec. 169(1): 16-21.

De Nardi, M., S. M. L. Saleh, C. Batten, C. Oura, A. Di Nardo, and D. Rossi (2012). First Evidence of Peste des Petits Ruminants (PPR) Virus Circulation in Algeria (Sahrawi Territories): Outbreak Investigation and Virus Lineage Identification. Transbound. and Emer. Dis. 59(3): 214-222.

Intisar, K. S., Y. H. Ali, A. I. Khalafalla, and E. A. Rahman-Mahasin (2010). Current situation of Peste des petits ruminants (PPR) in the Sudan. Trop. Anim. Health and Prod. 42(1): 89-93.

Khalafalla, A. I., I. K. Saeed, Y. H. Ali, M. B. Abdurrahman, O. Kwiatek, G. Libeau G, A. Abu Obeidaa and Z. Abbas (2010). An outbreak of peste des petits ruminants (PPR) in camels in the Sudan. Acta Tropica. 116 (2): 161–165.

Khan, H. A., M. Siddique, M. Abubakar, M. J. Arshad, M. Hussain (2008). Prevalence and distribution of peste des petits ruminants virus infection in small ruminants. Small Rum. Res. 79(2): 152–157.

Kihu, S. M., J. M. Gachohi, E. K. Ndungu, G. C. Gitao, L. C. Bebora, N. M. John, G. G. Wairire, N. Maingi, R. G. Wahome, and R. Ireri (2015). Sero-epidemiology of Peste des petits ruminants virus infection in Turkana County, Kenya. BMC Vet. Res. 11(1): 87.

Kock, R. A., M. B. Orynbayev, K. T. Sultankulova, V. M. Strochkov, Z. D. Omarova, E. K. Shalgynbayev, N. M. Rametov, A. R. Sansyzbay and S. Parida (2011). Detection and Genetic Characterization of Lineage IV Peste Des Petits Ruminant Virus in Kazakhstan. Transbound. and Emer. Dis. 62(5): 470–479.

Kwiatek, O., Y. H. Ali, I. K. Saeed, A. I. Khalafalla, O. I. Mohamed, A. O. Ali, M. B. Abdelrahman, H. M. Osman, K. M. Taha, Z. Abbas, M. E. Harrak, Y. Lhor A. Diallo, R. Lancelot, E. Albina, and G. Libeau (2011). Asian Lineage of Peste des Petits Ruminants Virus, Africa. Emerg. Infect. Dis. 17(7): 1223.

Mbyuzi, A. O., E. V. G. Komba, S. I. Kimera , D. M. Kambarage (2014). Sero-prevalence and associated risk factors of peste des petits ruminants and contagious caprine pleuro-pneumonia in goats and sheep in the Southern Zone of Tanzania. Prevent. Vet. Med. 116(1):138–144.

Megersa, B., D. Biffa, T. Belina, E. Debela, A. Regassa, F. Abunna , T. Rufael , S.M. Stubsjøen , E. Skjerve (2011). Serological investigation of Peste des Petits Ruminants (PPR) in small ruminants managed under pastoral and agro-pastoral systems in Ethiopia. Small Rum. Res. 97(1): 134–138.

Nizamani, A. R., Z. A. Nizamani, A. P. Umrani, P. Dewani, M. A. Vandiar, J. A. Gandahi and N. M. Soomro (2015). Prevalence of Peste des petits ruminants virus antibodies in small ruminants in Sindh, Pakistan. The J. Anim. and Plant Sci. 25(6): 1515-1519.

Özkul, A., Y. Akca, F. Alkan, T. Barrett, T. Karaoglu, S. B. Dagalp, J. Anderson, K. Yesilbag, C. Cokcaliskan, A. Gencay and I. Burgu (2002). Prevalence, Distribution, and Host Range of Peste des petits ruminants virus, Turkey. Emerg. Infect. Dis. 8(7): 709.

Parida,S., M. Muniraju, E. Altan, R. Baazizi, G. Dhinakar Raj and M. Mahapatra (2016). Emergence of PPR and its threat to Europe. Small Rum. Res. 142:16–21.

Parida, S., M. Muniraju, M. Mahapatra, D. Muthuchelvan, H. Buczkowski and A. C. Banyard (2015). Peste des petits ruminants. Vet. Micro. 181(1): 90–106.

Kumar, S. K., A. Babu, G. Sundarapandian, P. Roy, A. Thangavelu, K.S. Kumar , R. Arumugam, N.D.J. Chandran, M. Muniraju, M. Mahapatra, A.C. Banyard, B.M. Manohar and S. Parida (2014). Molecular Characterisation of Lineage IV Peste Des Petits Ruminants Virus Using Multi Gene Sequence Data. Vet. Micro. 174(1): 39–49.

Truong, T., H. Boshra, C. Embury-Hyatt, C. Nfon, V. Gerdts, S. Tikoo, L. A. Babiuk, P. Kara, T. Chetty, A. Mather, D. B. Wallace and S. Babiuk (2014). Peste des Petits Ruminants Virus Tissue Tropism and Pathogenesis in Sheep and Goats following Experimental Infection. PLoS One. 9(1): e87145.

Waret-Szkuta, A., F. Roger, D. Chavernac, L. Yigezu, G. Libeau, D.U Pfeiffer and J. Guitián (2008). Peste des Petits Ruminants (PPR) in Ethiopia: Analysis of a national serological survey. BMC Vet. Res. 4(1): 34.