

International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
 ISSN Online: 2617-4707
 NAAS Rating (2026): 5.29
 IJABR 2026; 10(6): 348-352
www.biochemjournal.com
 Received: 28-04-2026
 Accepted: 30-05-2026

Elaiyaraja Govindaraj
 Assistant Professor,
 Department of Veterinary
 Microbiology, Veterinary
 College and Research Institute,
 TANUVAS, Salem, Tamil
 Nadu, India

K Shoba
 Professor and Head,
 Department of Veterinary
 Microbiology, Madras
 Veterinary College,
 TANUVAS, Chennai, Tamil
 Nadu, India

V Sankar
 Assistant Professor, Macheri
 Sheep Research Station,
 Pottaneri, TANUVAS, Salem,
 Tamil Nadu, India

V Jeichitra
 Professor, Department of
 Animal Genetics and Breeding,
 Madras Veterinary College,
 TANUVAS, Chennai, Tamil
 Nadu, India

M Manobhavan
 Assistant Professor,
 Department of Animal
 Nutrition, Madras Veterinary
 College, TANUVAS, Chennai,
 Tamil Nadu, India

R Ranjini
 MVSc Research Scholar,
 Department of Veterinary
 Microbiology, Madras
 Veterinary College,
 TANUVAS, Chennai, Tamil
 Nadu, India

Corresponding Author:
Elaiyaraja Govindaraj
 Assistant Professor,
 Department of Veterinary
 Microbiology, Veterinary
 College and Research Institute,
 TANUVAS, Salem, Tamil
 Nadu, India

Effective vaccination strategies for intensive rearing lambs and kids against PPR

Elaiyaraja Govindaraj, K Shoba, V Sankar, V Jeichitra, M Manobhavan and R Ranjini

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i6d.8641>

Abstract

Peste des petits ruminants is a highly contagious viral disease of small ruminants, characterized by fever, anorexia, conjunctivitis, nasal discharge, dyspnoea, pneumonia, erosive stomatitis and gastroenteritis. The PPR is caused by small ruminant morbillivirus. Currently, the effective vaccination of offspring against SRMV is achieved by covering up the window of susceptibility period by considering the waning of maternal antibody titre in the serum of offspring. So, the present study was devised to estimate the decay of maternal antibody titre in serum of intensive rearing lambs and kids born to vaccinated Sheep and Goat at Mecheri Sheep Research Station, Pottaneri and Sheep & Goat section of Post Graduate Research Institute on Animals Sciences, Kattupakkam. The serum samples from lambs and kids were collected in monthly interval upto 5th month of age under three categories. i.e., the category I, II and III consist of each 100 serum samples of lambs and kids born to 2 months, 6 months and 12 months post vaccinated dam respectively. Later, these samples were processed to estimate the protective antibody titre against SRMV by cELISA kit method. Results showed that, only 10% of offspring in category I were susceptible to SRMV infection at 3rd month of age whereas these susceptibility rate was 60 and 100% in the category II and III respectively at 3rd month of age. So, this study suggested that the effective vaccination of offspring born to dam vaccinated during advance pregnancy should be early in the 4th month of age. The most critical recommendation based on the data of category II and III, the offspring born to the dam that are not vaccinated during advance stage pregnancy should be vaccinated early in the 3rd month of age itself to cover up the window of susceptibility period.

Keywords: Small ruminant morbillivirus, lambs and kids, competitive ELISA, maternal antibody, vaccination time

1. Introduction

Peste des petits ruminants (PPR) is a highly contagious viral disease and characterized by fever, anorexia, conjunctivitis, nasal discharge, dyspnoea, pneumonia, erosive stomatitis and gastroenteritis (Sen *et al.*, 2010) [15]. The PPR viral disease is caused by small ruminant morbillivirus (SRMV) belonging to the *Morbillivirus* genus under the family *Paramyxoviridae* (Gibbs *et al.*, 1979) [11]. Further, the lineage IV of SRMV is mainly endemic in Middle East and Asia (Banyard *et al.*, 2010) [4] among four distinct lineages (Shaila *et al.*, 1996; Dhar *et al.*, 2002) [16, 9]. Currently, the vaccination is the only mainstay tool to control the spread of SRMV by producing long-lasting protective immunity. The vaccination of dam during pregnancy helps in efficient transfer of passive maternal antibody to offspring through colostrum thereby protects lambs and kids against SRMV during its early life. Moreover, the age at which the offspring can effectively be immunized is proportional to the amount of maternal antibody acquired from the dam (Bodjo *et al.*, 2006) [6]. In the offspring, there is a window of susceptibility (WOS) period from several days to weeks in which the maternal antibodies recede to a low level to allow a vaccine to work, and also increase the chance of contract of disease (Vono *et al.*, 2019) [22]. Further, the earlier findings recommended the optimum time for vaccination in offspring was at 4th month of age (MOA) based on the decay maternal antibody level (Balamurugan *et al.*, 2012d) [3]. Interestingly, besides considering the maternal antibody level in offspring, the time of vaccination in dam is also an influential factor in determining the optimum vaccination time in offspring.

So, the present study was devised to estimate the decay of maternal antibody titre in serum of dams and offspring in monthly interval under three categories and thereby the optimum vaccination time would be determined to eradicate SRMV infection from the susceptible populations by covering up the WOS period.

2. Materials and Methods

2.1. Experimental animal

A total of 50 dam (each 25 sheep and goat) and 66 offsprings (each 33 lambs and kids) reared intensively at Mecheri Sheep Research Station, Pottaneri, Salem and Sheep & Goat section, Post Graduate Research Institute for Animal Sciences, Kattupakkam and University research farm, Madhavaram, Chennai were used in this study. All the 50 dams were vaccinated with live attenuated PPR vaccine (Raksha-PPR, Indian Immunological Limited) at different lifetime.

2.2. Experimental design

The 60 offsprings were grouped (20 in each group) into three categories based on the interval between dam's vaccination and delivery of lamb/kid i.e. the category I, II and III are the offspring born to 2, 6 and 12 months post vaccinated dam respectively. Further, 6 offsprings born to the unvaccinated dam were used as control animals.

2.3. Sampling

The whole blood samples were collected from the dam and its offspring in vacutainer tube (Table 1) and allowed to ooze-out the serum. Then, the serum samples were separated as per the standard procedures and same were tested to measure the percent inhibition value thereby to ascertain the protective maternal antibody titre against SRMV as described in cELISA kit method. The test sera samples showing more than 40 percent inhibition (PI) of mean OD values of the monoclonal antibody control (Cm) wells were taken as positive for PPR antibodies and protective against SRMV provided other control wells fall within the range as per standard values (Singh *et al.*, 2004)^[20].

2.4. Statistical analysis

Antibody titre data was summarized as geometric mean titres with 95% confidence intervals. The protective antibody titre was assessed using Kaplan-Meier survival analysis and the survival curves among the different category of animals were compared using the Log-rank (Mantel-Cox) test. Pairwise comparisons between groups were also performed using Log-rank (Mantel-Cox) test. All the statistical analyses were performed using GraphPad prism statistical software version 5.01, (GraphPad, San Diego, California, USA).

3. Results

3.1. Antibody titre as Percent Inhibition (PI) value in serum samples of dam

Results showed that all the 50 dam animals maintained the protective antibody titre above the threshold PI value 40% and the Geometric mean ranged between 52 to 73% against SRMV till 5th Month of post lambing/kidding (MOL/K) as shown in Figure 1.

3.2. Antibody titre as PI value in serum samples of lambs and kids

Based on the Geometric mean of percent inhibition values of antibody against SRMV, the protective threshold value

was maintained as 49 to 74% till third month of age (MOA) in category I followed by 48 to 64% till second MOA in category II and only 45% till first MOA in category III. Thereafter, the protective antibody titre in all three categories started declining progressively below the threshold value. Further, the PI value in control group was below the 40% threshold value in all the study interval period (Figure 2).

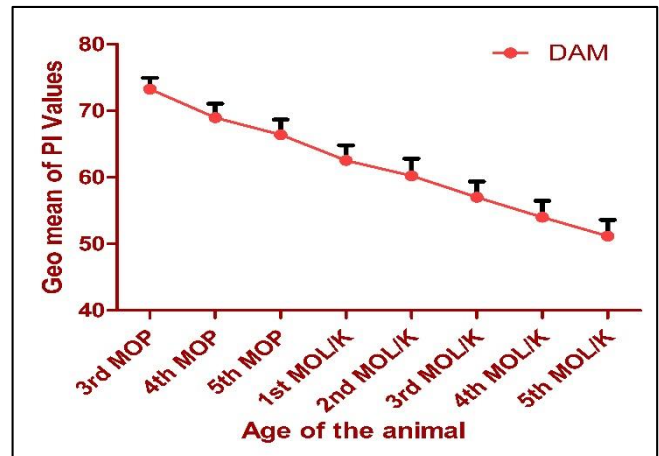


Fig 1: Antibody kinetics of Dams from 3rd month of pregnancy to 5th month of lambing/kidding based on geometric mean of PI values

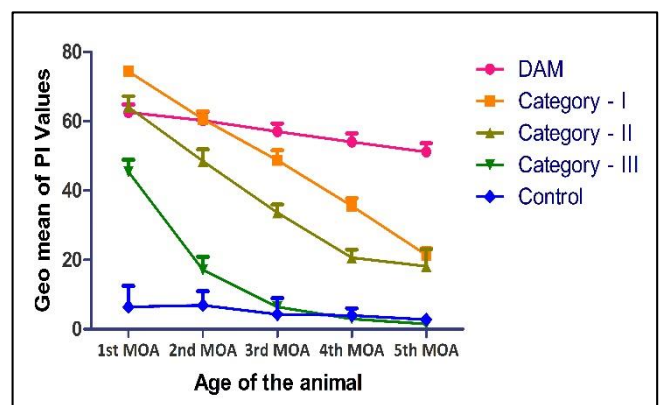


Fig 2: Antibody kinetics of lambs and Kids from 1st to 5th month of age based on geometric mean of PI values

3.3. Protection rate of lambs and kids against SRMV

The protection rate was assessed based on threshold percent inhibition value at 40% in all three categories of animals (Table 2, Figure 3)

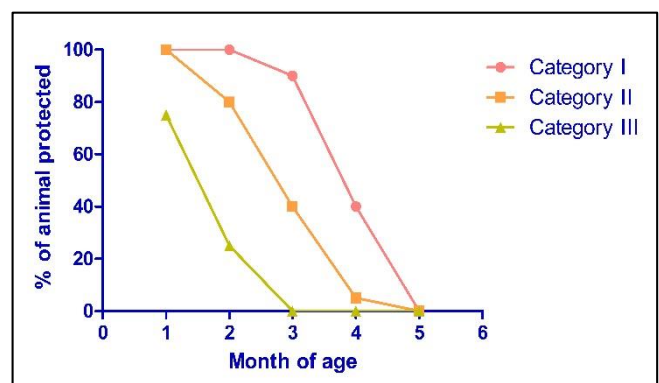


Fig 3: Protection rate of lambs and kids from 1st to 5th month of age

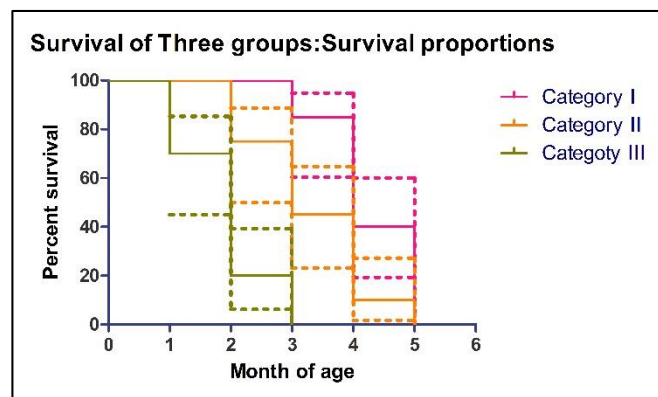


Fig 4: Kaplan-Meier curves showing the probability of maintaining protective maternal antibody titres in three categories of animals

3.4. Comparison of duration of protective maternal antibody titres among three categories of animals using Kaplan-Meier survival analysis

Kaplan-Meier analysis revealed significant difference in the duration of protective antibody titres among the three category of animals (Long-rank test: $\chi^2=27.53$, $df = 2$, $P = < 0.0001$). Animals in category I maintained the longer duration of protective immunity (4 months), followed by category II-3 months and category III-2 months (Table 3 & Figure 4). Pairwise comparisons also demonstrated that category I animals maintained the protective antibody titres significantly longer than category II and III (Table 4).

4. Discussion

Peste des petits ruminants is an acute contagious viral disease and considered as an endemic disease among small ruminants in India (Singh, 2011; Singh *et al.*, 2004a; Singh and Prasad, 2008; FAO, O. 2015) [18, 19, 17, 10] and it is most severe in less than one year age animals (Constable *et al.*, 2017) [8]. Hence, the protection of offspring against SRMV during the early life depends on the availability of maternally acquired immunity through colostrum. Moreover, the maternal antibodies influence the optimal time of vaccination in young animals. In the present study, experimental animals have been categorized into three and the serum samples of offspring and dam were tested by cELISA kit method. The results revealed that all the vaccinated dams maintained the protectiveness against SRMV beyond 365 days. This long lasting response is due to regular vaccination of animals at farm and our results were in accordance with earlier report that the flock mean titre remained above the protection threshold 12 months post

vaccination (Awa *et al.*, 2002) [2] and longer than two years in sheep and goat (Tatar and Kabakli *et al.*, 2006) [21].

In the category-I, all the offsprings maintained above the threshold PI value till 2nd MOA and even 90% in the 3rd MOA. This extended protectiveness in offspring support the effective transfer of maternal antibody from the dam (vaccinated during pregnancy). Our result coincide with earlier report that 80% of 3-4 month old offspring born to dam vaccinated during pregnancy were maintained the PPR virus antibodies (Bidjeh *et al.*, 1999) [5]. Similarly, vaccination of dam/adult before parturition or during pregnancy helps for efficient transfer of maternal immunity to their offspring (Hammami *et al.*, 2018; Cinicola *et al.*, 2021; Lagousi *et al.*, 2022) [12, 7, 13].

In the category-II, all the lambs and kids maintained above the threshold PI value only in the 1st MOA. Thereafter, only 80% and 40% of offspring maintained the protectiveness in the 2nd and 3rd MOA respectively. It might be due to inadequate transfer of maternal immunity. This result was in accordance with Bodjo *et al.*, (2006) [6] were 70% and 95% of lambs became negative for maternal antibody against SRMV at day 75 and 90 after birth. So, the results suggesting that the 60% lambs and kids born to 6 months post vaccinated dam are vulnerable to SRMV infection even in the 3rd MOA itself.

In the category-III, only 75% of offsprings maintained the protectiveness till 1st MOA and drastically reduced to 25% in the 2nd MOA. Thereafter, all the offspring failed to maintain the threshold value and become susceptible to SRMV infection. Though the dam maintained the protectiveness beyond one year, the transfer of maternal antibody to young animals was poor and it might be due to the offsprings born one year after the dam's vaccination. Similarly, Alamerew *et al.*, (2026) [1] reported that the highest seropositivity rate was observed in the ≤ 30 day age group, whereas the lowest was recorded in the 61-90 day age group of offsprings. Our results also in accordance with Markus *et al.*, (2019) [14] reported that more than 80% of the kids had lost its maternal immunity by 10 weeks (2.5 months) of age. So, the result suggested that 75% lambs and kids born to 12 month post vaccinated dam were vulnerable to SRMV infection even in the 2nd MOA itself.

Therefore, the effective vaccination time could be determined based on the magnitude and persistence of antibody titres, the proportion of animals maintaining protective titres over time, and the median duration of protection estimated from kaplan-meier survival analysis.

Table 1: Experimental design and sample details

Animals/Samples	Dam	Category I		Category II		Category III		Unvaccinated control
		Lambs	Kids	Lambs	Kids	Lambs	Kids	
No. of animals	50	10	10	10	10	10	10	6
No. of interval in months	8	5						
No.of samples	400	100		100		100		30
Total number of samples	730							

Table 2: Percentage of animals maintained above/below the threshold PI value (40%) in all three category of animals

Age of the animal in month	Above the 40%-Protective			Below the 40%-Non protective		
	I	II	III	I	II	III
1	100	100	75	0	0	25
2	100	80	25	0	20	75
3	90	40	0	10	60	100
4	40	5	0	60	95	100
5	0	0	0	100	100	100

Table 3: Comparison of duration of protective antibody titres among different category of animals using Kaplan-Meier survival analysis

Comparison	χ^2	df	P-value
Overall comparison (CI vs CII vs CIII)	27.53	2	< 0.0001

Table 4: Pairwise comparison of Kaplan-Meier protection curves (Log-rank (Mantel-Cox) Test)

Groups compared	χ^2	P-value	Result
CI vs CII	8.756	0.0031	Significant
CI vs CIII	36.24	< 0.0001	Significant
CII vs CIII	17.97	< 0.0001	Significant

5. Conclusion

PPR is considered as a major constraint with a case fatality rate as high as 100% among small ruminant production. The young animals should be covered by vaccination against SRMV disease when the maternal antibody levels goes below the threshold PI value 40%. Therefore, the offsprings born to the dam vaccinated during pregnancy can be vaccinated early in the 4th month of age, whereas the offspring born to the one year before vaccinated dam became vulnerable to SRMV infection soon after birth. Hence, these offsprings should be vaccinated as early as in the 2nd month of age itself. Similarly, the offspring born to the dam vaccinated six month before lambing/kidding should be vaccinated early in third month of age to cover up the period of window of susceptibility against SRMV infection and to maintain at least 80% population with effective protective immunity to eliminate the SRMV virus circulation in the country.

6. Declaration Conflict of Interest

On behalf of all author declare that no conflict of interest with the publication

7. Ethics Statement

The animals used in this study were in accordance with the ethics of the TANUVAS institutional animal ethics committee (IAEC).

8. Acknowledgement

I gratefully acknowledge and thankful to the TANUVAS University for funding and support during entire study period.

References

1. Alamerew EA, Sibhatu D, Cherenet T, *et al.* Maternal immunity and post-vaccination sero-monitoring in small ruminants for peste des petits ruminants eradication in North Shewa, Ethiopia. *Sci Rep.* 2026;16:11275.
2. Awa DN, Ngagnou A, Teflang E, Yaya D, Njoya A. Post vaccination and colostral peste des petits ruminants antibody dynamics in research flocks of Kirdi goats and Foulbe sheep of north Cameroon. *Prev Vet Med.* 2002;55:265-271.
3. Balamurugan V, Sen A, Venkatesan G, Rajak KK, Bhanuprakash V, Singh RK. Study on passive immunity: Time of vaccination in kids born to goats vaccinated against peste des petits ruminants. *Virol Sin.* 2012;27:228-233.
4. Banyard AC, Parida S, Batten C, Oura C, Kwiatek O, Libeau G. Global distribution of peste des petits ruminants virus and prospects for improved diagnosis and control. *J Gen Virol.* 2010;91:2885-2897.
5. Bidjeh K, Diguimbaye C, Hendrikx P, Dedet V, Tchari D, Naïssingar S. Maternal immunity in young goats or sheep whose dams were vaccinated with anti-peste des petits ruminants vaccine. *Cah Agric.* 1999;8(3):219-222.
6. Bodjo SC, Couacy-Hymann E, Koffi MY, Danho T. Assessment of the duration of maternal antibodies specific to the homologous peste des petits ruminants vaccine Nigeria 75/1 in Djallonke lambs. *Biokemistri.* 2006;18:99-103.
7. Cinicola B, Conti MG, Terrin G, Sgrulletti M, Elfeky R, Carsetti R, *et al.* The protective role of maternal immunization in early life. *Front Pediatr.* 2021;9:638871.
8. Constable P, Hinchcliff KW, Done SH, Gruenberg W. *Veterinary Medicine: A Textbook of the Diseases of Cattle, Horses, Sheep, Pigs and Goats.* 11th ed. St. Louis: Elsevier; 2017.
9. Dhar P, Sreenivasa BP, Barrett T, Singh RP, Bandyopadhyay SK. A recent epidemiology of PPRV. *Vet Microbiol.* 2002;88:153-159.
10. FAO, OIE. Global Strategy for the Control and Eradication of PPR. Rome: FAO and OIE; 2015.
11. Gibbs EPJ, Taylor WP, Lawman MJP, Bryant J. Classification of peste des petits ruminants as the fourth member of the genus *Morbillivirus*. *Intervirology.* 1979;11:268-274.
12. Hammami P, Lancelot R, Domenech J, Lesnoff M. Ex-ante assessment of different vaccination-based control schedules against the peste des petits ruminants virus in sub-Saharan Africa. *PLoS One.* 2018;13(1):e0190296.
13. Lagousi T, Gkentzi D, Geropeppa M, Tsagkli P, Spoulou V. Protecting the offspring, the gift of maternal immunization: Current status and future perspectives. *Vaccines.* 2022;10(11):1953.
14. Markus TP, Adamu J, Kazeem HM, Olaolu OS, Woma TY. Assessment of peste des petits ruminants antibodies in vaccinated pregnant Kano Brown does from Nigeria and subsequent maternal immunity in their kids. *Small Rumin Res.* 2019;174:53-56.
15. Sen A, Saravanan P, Balamurugan V, Rajak KK, Sudhakar SB, Bhanuprakash V, *et al.* Vaccines against peste des petits ruminants virus. *Expert Rev Vaccines.* 2010;9(7):785-796.
16. Shaila MS, Shamaki D, Forsyth MA, Diallo A, Groatley L, Kitching RP, *et al.* Geographic distribution and epidemiology of peste des petits ruminants viruses. *Virus Res.* 1996;43:149-153.

17. Singh B, Prasad S. Modelling of economic losses due to some important disease in goats in India. *Afr Econ Res Rev*. 2008;21:297-303.
18. Singh RP. Control strategies for peste des petits ruminants in small ruminants of India. *Rev Sci Tech*. 2011;30:879-887.
19. Singh RP, Saravanan P, Sreenivasa BP, Singh RK, Bandyopadhyay SK. Prevalence and distribution of peste des petits ruminants virus infection in small ruminants in India. *Rev Sci Tech*. 2004;23:807-819.
20. Singh RP, Bandyopadhyay SK, Sreenivasa BP, Dhar P. Production and characterization of monoclonal antibodies to peste des petits ruminants virus. *Vet Res Commun*. 2004;28:623-639.
21. Tatar N, Kabaklı Ö. Detection of the duration of immunity by PPR vaccine produced in Turkey. *J Etlik Vet Microbiol*. 2006.
22. Vono M, Eberhardt CS, Auderset F, Mastelic-Gavillet B, Lemeille S, Christensen D, *et al*. Maternal antibodies inhibit neonatal and infant responses to vaccination by shaping the early-life B cell repertoire within germinal centers. *Cell Rep*. 2019;28(7):1773-1784.