Immune Profile of Enterotoxaemia in Sheep – A Field Study

Abstract

Enterotoxaemia is one of the economically important epidemic diseases of sheep caused due to the absorption of epsilon toxin released by Clostridium perfringens type D. Several factors have been cited as predisposing to the occurrence of pulpy kidney disease, with the most important including sudden dietary changes and a reduction in intestinal transit of ingested food.

Two measures are emphasized as being of great importance in the prophylaxis against enterotoxemia: vaccination of all animals and adequate nutritional management. Every year vaccination of sheep is being carried out extensively in Andhra Pradesh in pre-monsoon season to prevent the disease occurrence. In the present study, to evaluate the duration of immunity after vaccination under field conditions, Indirect ELISA kits were prepared, validated and used to detect the protective antibody levels in sheep vaccinated against ET.

Keywords: Immune; Disease; Vaccination

Introduction

Enterotoxaemia is one of the economically important epidemic diseases of sheep caused due to the absorption of epsilon toxin released by Clostridium perfringens type D. Several factors have been cited as predisposing to the occurrence of pulpy kidney disease, with the most important including sudden dietary changes and a reduction in intestinal transit of ingested food [1].

Materials and Methods

Selection of districts for the study

Based on the number of OBR’s reported during the past five years, Nellore, Prakasham, West Godavari, Krishna, Kurnool, Chittoor, Nizamabad and Mahabubnagar districts of Andhra Pradesh were selected. Two villages from each district were identified to collect sera samples periodically.

Vaccination

Vaccinations were carried out for the sheep of the above districts in the months of May and June with Enterotoxaemia vaccine (Brew No. 1, 2, 3, 4, 5, 6 and 7 with a mouse Minimum Lethal Dose (MLD) ranging from 5,000-8,000) produced at VBRI with fermentor technology in new cGMP vaccine production facility. The efficacy of the vaccine was evaluated experimentally in the Standardization of Biological Products (SDBP) Division, Rajendranagar before sending to the field institutions. All the batches were safe, sterile and found to produce not less than 5.0 IU of epsilon antitoxin per ml.

Collection of sera samples

Five sera samples were collected from each of the identified villages of the selected districts from same sheep at 0, 90, 135, 180, 225 and 270 days post vaccination and transported to VBRI in cold chain. The samples were preserved at -20°C until use.

Preparation of indirect ELISA kits

Antigen (Pure epsilon prototoxin) for ELISA was prepared, concentrated and purified as per the method described by Pavan Kumar et al. Briefly, 18 hours old C. Perfringens type D culture grown in thioglycolate broth was centrifuged at 10,000 rpm for 30 min. The supernatant containing epsilon prototoxin was concentrated by precipitating with Ammonium Sulphate. Ammonium Sulphate was removed by dialyzing in distilled water over night at +4°C. The crude toxin was purified by Ion exchange Chromatography using DEAE Cellulose column. Purified toxin was used as the antigen in indirect ELISA to increase the sensitivity and specificity of the test [2]. The eluted fractions having highest optical density at 280 nm were pooled together, MLD was determined in mice and stored at -20°C in aliquots until use.
Serum with antibody levels 0.01 IU/ml and 20 IU/ml were used as negative and positive controls in the test, which showed the OD values of 0.09-0.1 and 0.9-1.1 respectively.

**Cut-off determination**

As 0.2 IU of epsilon anti-toxin per ml and above gives protection against ET at field level. It is possible to determine the cut-off value separating positive from negative sera. The sera samples showing 20-50 percent positivity (PP) values were subjected to toxin neutralization test. One ml of each (pooled) sera sample was mixed with 30 MLD of epsilon toxin and kept at room temperature for half an hour because, sera containing one IU anti-toxin per ml will be able to neutralize 150 mouse MLD of toxin. Five mice weighing not less than 18g are each given 0.2 ml of mixture intra-venously and the control mouse each were given with 0.2 ml of 30 MLD of epsilon toxin and normal saline mixture. The test was repeated for 3 times to get consistent results.

**ELISA**

A total number of 480 samples were screened for protective antibodies against enterotoxaemia by indirect ELISA in duplicate. Antigen and test sera were used at 1:100 dilution in the test. Commercially available Anti-sheep IgG conjugated with Horseradish Peroxidase (Sigma cat. No A3415) was used in 1:10,000 dilution to detect sheep immunoglobulins. 3,3',5,5'-Tetramethyl Benzidine (Sigma cat. No T2885) at 0.01% was used in 1:10,000 dilution to detect sheep immunoglobulins. The reaction was stopped with 1 M H₂SO₄ (Qualigens 29995) and the colour development was measured at 450 nm.

Percent Positivity (PP) was calculated by using the following formula:

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\text{PP} \% = \frac{\text{Mean OD value of positive control sample} - \text{Mean OD value of Test sample}}{\text{X 100}}
\]

Mean OD value of positive control sample - Mean OD value of Negative sample

**Results and Discussion**

PP value of 30% and above which is corresponding to 0.2 IU epsilon antitoxin/ml was adopted as the minimum protective threshold, as 0.2 IU antitoxin/ml and above gives protection against ET at field level [3]. Hence, in the present study sera samples showing the PP value of 30% and above (Table 1) were considered to have the protective antibody levels.

Based on the results it is observed that, on 0 day of vaccination 10.8% of animals showed protective antibody levels (Tables 2 and 3). There was 100% seroconversion in all the districts with an average PP value of 74.98% by 90 days post vaccination (PV). Gradual decline of PP value from 74.98% on 90 days PV to 42.55% on 270 days PV is observed and the percent animals showing protective level of antibodies also declined from 100% on 90 days PV to 81% on 270 days PV. The findings are in contrary with the observations [4] where the protective antibodies remained for 3 months only. The variation may be due to the vaccine produced at VBRI is improved and tested as per the new IP standards which is able to produce not less than 5.0 IU of epsilon antitoxin per ml and hence, the protective levels are continued till the end of the study period.

At the same time, the protective levels of antibodies are present only in 81% animals by 270 days PV. The recommended schedule for ET vaccination is 3-4 weeks prior to lambing to the ewes, at the age of 4-6 weeks and booster dose within 4 weeks after first dose to the lambs and yearly vaccination to the adults [5]. In the present study, vaccination was carried out to all sheep during the months of May and June and there was no booster dose administered even to the lambs. Hence, the immunity might have lost early in case of lambs and also the immune response to any vaccine depends on the individual, age, breed and various managemental practices.

Basing on the above results, annual vaccination of sheep is recommended as the protective levels were maintained up to 9 months in 81% of animals. The remaining 3 months period i.e., from March to May is generally dry period and the availability

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**Table 1** Determination of cut-off PP value.

| PP value of sera samples | Control | 20% | 25% | 30% | 35% | 40% | 45% | 50% |
|-------------------------|--------|-----|-----|-----|-----|-----|-----|-----|
| No. of mice alive       |        |     |     |     |     |     |     |     |
| (Inoculated 5 mice/group in all tests) | Test I | 0   | 0   | 2   | 5   | 5   | 5   | 5   |
|                         | Test II| 0   | 0   | 1   | 5   | 5   | 5   | 5   |
|                         | Test III| 0  | 0   | 2   | 5   | 5   | 5   | 5   |

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**Table 2** Mean PP values of indirect ELISA.

| S. No | Name of the District | Average PP values on days PV |
|-------|----------------------|-----------------------------|
|       |                      | 0 day | 90 | 135 | 180 | 225 | 270 |
| 1     | Nellore              | -3.7  | 73.45 | 59.9 | 57.1 | 53.2 | 34.1 |
| 2     | Prakasham            | 14.82 | 69.53 | 56.5 | 52.7 | 52.4 | 33.2 |
| 3     | WG                   | 13.08 | 60.14 | 53.5 | 52.08 | 51.0 | 35.7 |
| 4     | Krishna              | 24.09 | 79.7 | 74.1 | 62.6 | 61.7 | 45.7 |
| 5     | Kurnool              | -5.01 | 72.2 | 62.4 | 62.0 | 60.0 | 46.3 |
| 6     | Chittoor             | 5.363 | 77.97 | 75.57 | 73.4 | 66.3 | 47.6 |
| 7     | Nizamabad            | 34.31 | 79.26 | 76.5 | 70.3 | 62.7 | 46.9 |
| 8     | Mahaboobnagar        | 44.95 | 87.66 | 81.41 | 79.86 | 75.23 | 51.9 |

**Table 3** Percent animals showing protective level of antibodies.

| S. No | Name of the District | No. of samples/each collection |
|-------|----------------------|-------------------------------|
|       |                      | 0 day | 90 days | 135 days | 180 days | 225 days | 270 days |
| 1     | Nellore              | 10    | 0 | 100 | 100 | 90 | 90 | 80 |
| 2     | Prakasham            | 10    | 0 | 100 | 100 | 80 | 80 | 80 |
| 3     | WG                   | 10    | 0 | 100 | 100 | 90 | 90 | 80 |
| 4     | Krishna              | 10    | 30 | 100 | 100 | 90 | 90 | 80 |
| 5     | Kurnool              | 10    | 0 | 100 | 100 | 100 | 100 | 90 |
| 6     | Chittoor             | 10    | 0 | 100 | 100 | 100 | 100 | 80 |
| 7     | Nizamabad            | 10    | 30 | 100 | 100 | 100 | 100 | 90 |
| 8     | Mahaboobnagar        | 10    | 60 | 100 | 100 | 100 | 80 | 70 |

| Total  | 80X6=480 | 10.8 | 100 | 100 | 95 | 87.5 | 81.25 |
of lush grass pastures is very less. Since the causative bacteria proliferate in the intestine in response to ingestion of abnormally high levels of starch, sugar or protein, the disease may not occur during this period [6].

Further studies are indicated to confirm loss of immunity in lambs, effect of booster dose to lambs and vaccination to the ewes prior to lambing [7-9].

Conclusion
A field study was taken up to know the immunity profile against ET in sheep vaccinated with Enterotoxaemia vaccine in Andhra Pradesh. A total number of 480 samples collected at different intervals were tested by indirect ELISA, developed at R & D section, VBRI. This study confirmed that there is 100% seroconversion by 90 day PV and 81% of animals showed protective level of antibodies till the end of the study period i.e., 270 day PV.

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References
1 Smith MC, Sherman DM (1994) Enterotoxemia goat medicine. Lea & Febiger Pennsylvania. pp: 289-305.
2 Uzal FA, Neilsen K, Kelly WR (1997) Detection of clostridium perfringens type D epsilon antitoxin in serum of goats by competitive and indirect ELISA. Vet Microbiol 51: 223-231.
3 Hepple JR, Chodnik KS (1959) Immunisation of lambs against Clostridium welchii type D enterotoxaemia (Pulpy Kidney Disease). The Veterinary Record.
4 Pavan Kumar T, Sunitha G, Krishna Mohan AV, Hanmanth Reddy G (2008) Sero monitoring by indirect ELISA of sheep vaccinated against enterotoxaemia. Ind Vet J 85: 1253-1255.
5 Van Metre D (2010) Enterotoxemia (overeating disease) of sheep and goats. College of Veterinary Medicine and Biomedical Sciences, Clinical Sciences, Colorado State University, USA.
6 Schoenian S (2010) Vaccinating for overeating disease. University of Maryland, USA.
7 Uzal FA (1997) Studies on Enterotoxemia in goats. University of Queensland, Australia.
8 Uzal FA, Kelly WR (1999) Serum antibody responses to clostridium perfringens epsilon toxoid vaccine in goats. Anaerobe 5: 287-289.
9 Vijay M (2010) Law relating to drugs and cosmetics. Eastern Book Company, Lucknow. pp: 347-348.