Study Number: IND/SUI/14/038

FIELD TRIAL REPORT

EFFICACY AND SAFETY STUDY OF RECOMBINANT PORCINE CYSTICERCOSIS VACCINE (TSOL 18 VACCINE) IN PIGS

Trial Conducted by

Postgraduate Research Institute in Animal Sciences, TANUVAS
Kattupakkam, Kancheepuram, Tamil Nadu- 603203

For

Indian Immunologicals Limited
Rakshapuram, Gachibowli,
Hyderabad-32, Telangana, India

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STUDY SUMMARY

Study Title:

Efficacy and safety study of recombinant porcine cysticercosis vaccine (TSOL 18 vaccine) in pigs.

Study Objective:

The primary objective of the study is to determine the efficacy and safety of recombinant porcine cysticercosis vaccine (TSOL18 vaccine), produced as a GMP batch suitable for commercial use, in the prevention of cysticercosis caused by *Taenia solium* in Pigs. Efficacy will be determined by serum IgG antibody responses as determined by specific ELISA. Safety will be determined by clinical observations including rectal temperatures and injection site observations.

Test Vaccine:

Recombinant porcine cysticercosis vaccine (TSOL18 vaccine) produced by Indian Immunologicals Limited, Hyderabad.

Study Center:

Postgraduate Research Institute in Animal Sciences
Tamil Nadu Veterinary and Animal Sciences University,
Kattupakkam, Kancheepuram district
Tamil Nadu- 603203, India.

Conducted For:

Indian Immunologicals Limited
Rakshapuram, Gachibowli,
Hyderabad-32, Telangana, India.

Principal Investigator:

Dr. M. Murugan, Ph.D
Associate Professor
Postgraduate Research Institute in Animal Sciences
Tamil Nadu Veterinary and Animal Sciences University
Kattupakkam, Kancheepuram district
Tamil Nadu 603203, India.

DECLARATION BY THE INVESTIGATOR

This study was conducted in accordance with the ethical principles as per Good Clinical Practice guidelines and Ethical Guidelines for Biomedical Research on animal subjects as per International Cooperation on Harmonization (Veterinary) (VICH) and Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA).

Principal Investigator

Section Head (PBU)
PGRIAS, Kattupakkam - 603 203

Dr. M. Murugan
Associate Professor
Postgraduate Research Institute in Animal Sciences
Tamil Nadu Veterinary and Animal Sciences University
Kattupakkam, Kancheepuram district
Tamil Nadu 603203, India.

Study Dates:

Start date: 09 April 2015

End date: 27 June 2015

ABBREVIATIONS

%	Percent
µg	Microgram
^{0}C	Degree centigrade
AE	Adverse Event
DCF	Data Capture Form
DPV	Day Post Vaccination
ELISA	Enzyme Linked Immuno Sorbent Assay
GMT	Geometric Mean Titre
GST	Glutathione-S-transferase
i-ELISA	Indirect Enzyme Linked Immuno Sorbent Assay
IgG	Immunoglobulin G
IIL	Indian Immunologicals Limited
IM	Intramuscular
IU	International Unit
MBP	Maltose binding protein
mL	Milli litre
OIE	Office International des Epizooties
PBST	Phosphate Buffered Saline with Tween® 20
q.s.	Quantum sufficit
SAE	Serious Adverse Event
TMB	Tetramethylbenzidine

INTRODUCTION

Taenia solium is a taeniid cestode parasite which causes taeniasis in humans and cysticercosis in humans and pigs. Cysticercosis in humans is caused by infection with the cysticerci, the larval stage of this tapeworm parasite. The cysticerci infection has a propensity to occur in the brain and other nervous tissue, and the resultant disease, neurocysticercosis, is an important cause of human morbidity and mortality (Gemmell *et al.*, 1983). Neurocysticercosis is a zoonotic disease which is widespread in the developing world and most prevalent in many Latin American, African and Asian countries.

The life cycle of *T. solium* involves both humans (definitive host) and pigs (intermediate host) and includes the adult stage, the egg and the larval stage. *Taenia solium* is transmitted from pigs, which harbor the larval parasites in their muscles, to humans who have adult tapeworms in their intestines. The adult parasite or tapeworm is lodged exclusively in the human intestine, it measures several meters long and is constituted by repetitive segments or proglottids. The last proglottids, which are shed with feces, contain approximately 50,000 eggs each. Pigs become infected by ingesting T. solium eggs in the feces of a person carrying the tapeworm. When a pig ingests human feces containing eggs and proglottids, eggs are released in the intestine, oncospheres (hexacanth embryos) hatch, activate, cross the intestinal wall and lodge in striated muscles, subcutaneous tissues, eyes and central nervous system, where they transform into cysticerci, which are the larval stage or metacestode (OIE report, 2014). The cysticercus is a whitish, semitransparent vesicle that has a spherical scolex inside. When a person eats rare or undercooked pork meat that contains cysticerci, the scolex protrudes, attaches to the intestinal wall and 3 to 4 months later, a new adult parasite develops.

Intestinal taeniasis is generally asymptomatic, as well as swine cysticercosis, that seemingly does not cause neurological problems to pigs. T. solium only causes disease to humans that harbor the larval stage, which occurs when T. solium eggs are ingested (Gemmell *et al.* 1983, Flisser 1988, 1994, Flisser *et al.* 1998). The clinical significance of the parasite in humans occurs particularly when cysts that are located in the central nervous system cause neurocysticercosis that leads to serious neurological disorders such as seizures and epilepsy, psychiatric disturbance, hydrocephalus, and other neurologic conditions (Schantz *et al.*, 1993; Garcia and Del Brutto, 2005; Gonzalez *et al.*, 2005).

T. solium control could be achieved by improvements in public sanitation (through health education), treatment of humans to remove the adult tapeworms, preventing pigs having access to human feces, inspection of pork meat to prevent infected material being available for consumption, or by killing the cysticerci in the intermediate host with anthelmintics (Garcia and Del Brutto, 2005; Gonzalez et al., 2001; Pawlowski et al., 2005; Sarti et al., 2000).

Although the disease has been identified as having the potential to be eradicated on a global scale (Schantz et al., 1993), limitations in the usefulness of available tools have inhibited the initiation of widespread *T. solium* control programs and those that have been undertaken to date have achieved only a temporal decrease in disease transmission (Garcia and Del Brutto, 2005). A problem for *T. solium* control is that, although the adult tapeworm in humans is readily killed by treatment of infected persons with anthelmintics, in an environment where there are many pigs infected with the parasite, new human tapeworm infections can be established and transmission of the disease can continue. Another potential control measure for *T. solium* is the treatment of infected pigs with anthelmintics to kill the muscle cysts. It also relates to the occurrence of substantial lesions in the meat of infected animals arising from the inflammatory reactions that occur in response to the anthelmintic-mediated death of cysticerci in the muscles. These lesions are not of concern for transmission of *T. solium* because the parasite is dead; however, they are unsightly and if present in significant numbers, make the meat unsuitable for sale (Sikasunge et al., 2008). Despite the availability of these potentially effective methods to interrupt the parasite's life cycle, cysticercosis and neurocysticercosis remain serious problems in many developing countries (Garcia and Del Brutto, 2005).

Vaccination has been identified as a potentially valuable new tool for prevention of *T. solium* transmission (Lightowlers, 1999). While it may be potentially possible to vaccinate the human population against *T. solium*, a less expensive option is using an effective vaccine in pigs that would remove the source of tapeworm infection in humans, breaking the parasite's life cycle and indirectly eliminating the causative agent of human neurocysticercosis (Lightowlers, 1999, 2010).

Proteins contained within the parasite eggs (known as oncospheres) are known to be a source of protective antigens (Pathak and Gaur, 1990; Verastegui *et al.*, 2002). *T. solium* homologs of protective antigens for the other taneiid species have been identified and the recombinant proteins expressed in Escherichia coli. These antigens

(TSOL16, TSOL18 and TSOL45) have been produced as glutathione-S-transferase (GST) fusion proteins. In common with all other taeniid cestodes which have been investigated, oncosphere antigens of *T. solium* have been found to be a rich source of hostprotective antigens (Pathak and Gaur, 1990; Plancarte *et al.*, 1999; Verastegui *et al.*, 2002). TSOL18 has shown high efficacy as vaccine in preventing pig infections with *T. solium* in experimental trials in Mexico, Cameroon, Peru and Honduras inducing 99.3–100% protection against an experimental challenge infection with *T. solium* eggs in pigs (Flisser *et al.*, 2004; Gonzalez *et al.*, 2005; Lightowlers, 2006).

The recombinant antigen TSOL18 developed by the University of Melbourne has been shown to be most effective in protecting pigs against *T. solium* infection.

TSOL18 vaccine in combination with mineral oil adjuvant has been produced by Indian Immunologicals Limited (IIL) by adopting a novel procedure using Pichia expression. The vaccine has been proven to be highly immunogenic when used. The vaccine is given in two doses (150µg TSOL18 /dose) as primary and booster vaccination, 3-4 weeks apart.

Earlier studies on Efficacy and Safety of TSOL 18 vaccine:

An efficacy study conducted in Peru revealed that the vaccinated animals which were given two doses of *Pichia* TSOL18 + Montanide ISA 206V adjuvant vaccine developed adequate titres (≥ 500) of TSOL18-specific IgG.
It was found highly effective in the prevention of *T. solium* cysts and substantially reduced the burden of *T. solium* infection in pigs by >94% compared with control animals. The results confirm that two doses of TSOL18 vaccine given three weeks apart are safe and effective.

In an immunogenicity study conducted at University of Zaragoza, Spain, TSOL18 vaccine produced in *Pichia* (150 µg/dose) with Montanide ISA 206V adjuvant was found immunogenic that provided marked and persistent anti-TSOL18-specific IgG serum responses (titres ≥ 500) in 90 % of pigs from approximately 10 weeks of age, following two administrations, three weeks apart.

Efficacy and Safety Study of TSOL 18 vaccine conducted at PGRIAS, Kattupakkam, Tamil Nadu, India:

The present study was undertaken at Post Graduate Research Institute in Animal Sciences, Tamil Nadu Veterinary and Animal Sciences University, Kattupakkam, Tamil Nadu, India to determine the efficacy and safety of recombinant porcine cysticercosis vaccine (TSOL18 vaccine) produced by IIL, in the prevention of cysticercosis caused by *Taenia solium* in pigs.

Study Objective:

The primary objective of the study is to determine the efficacy and safety of recombinant porcine cysticercosis vaccine (TSOL18 vaccine), produced as a GMP batch suitable for commercial use, in the prevention of cysticercosis caused by *Taenia solium* in Pigs. Efficacy will be determined by serum IgG antibody responses as determined by specific ELISA. Safety will be determined by clinical observations including rectal temperatures and injection site observations.

MATERIALS AND METHODS

Animal species:	Pig
Number:	80 pigs
Body weight range:	Approximate initial weight >10 kg
Age group:	At least 2 months of age and not older than 2 years. 40 pigs of 2-4 months of age and 40 animals of over 4 months of age upto 2 years.
Gender:	Males (including castrates) & females.
Physiological status:	Healthy animals which were serologically negative (serum TSOL 18 antibody titre<500) for porcine cysticercosis.
Identification:	Each animal was identified with two ear tags, each with unique identification.
Selection criteria:	According to the inclusion/exclusion criteria of the clinical trial protocol.

Study outline:

The present study was undertaken to evaluate the efficacy and safety of recombinant porcine cysticercosis vaccine (TSOL18 vaccine) containing mineral oil adjuvant, compared with a control treatment (mineral oil adjuvant).

The experimental unit was the individual animal. According to randomization plan, animals were allocated randomly to treatment groups T1 (Adjuvant Control group) and T2 (TSOL 18 vaccine group) on the basis of similar breed, sex, age and estimated body weight. Pens contained different numbers of animals. Within a specific pen approximately half the animals that met the inclusion criteria and for which none of the exclusion criteria applied, were randomly allocated to T1 and approximately half the animals were randomly allocated to T2. Within a pen, all treatments were administered on the same day.

Selection of Animals:

Animal were selected and enrolled based on the inclusion and exclusion criteria of the study. Animals those qualified the following inclusion and exclusion criteria were enrolled in the study.

Inclusion Criteria:

- Healthy animals
- Amenable to handling
- Animals those were weaned for a minimum of 2 weeks before enrollment
- Animals those were at least 2 months of age and not knowingly older than 2 years
- Serologically negative for porcine cysticercosis
- All routine vaccinations and medications completed at the beginning of the study and at least 3 weeks prior to day 0 (day of vaccine or adjuvant control administration)
- Animals were moved to the study site for at least one month prior to selection
- Animals which were always kept indoors and not been allowed to roam free
- No possibility of contact with human faeces

Exclusion Criteria:

- Unhealthy, injured and/or under-weight animals
- All animals with hernias
- Any animal with an unacceptable growth rate
- Serologically positive animals for Porcine Cysticercosis in the acclimatization period.

Animal Groups and Treatments:

In all, 80 seronegative Large White Yorkshire pigs which were 2 months of age up to 2 years were enrolled for the trial. The grouping and treatments were as follows:

• Treatment-1 (Adjuvant Control group) contained 40 animals, 20 in the age group of 2-4 months and another 20 animals above 4 months up to 2 years. One ml dose of Adjuvant control was administered by intramuscular route.

• Treatment-2 (Vaccine group) contained 40 animals, 20 in the age group of 2-4 months and another 20 animals above 4 months up to 2 years. One ml dose of TSOL18 vaccine was administered by intramuscular route.

The injection site for administration of the vaccine or control product was approximately 5-10 cm ventral to the dorsal surface of the neck and 5-10 cm posterior to the base of the ear, according to the size of pig, in the left side by using a fresh syringe and needle for each pig.

Treatment group	Treatment	Dosage regimen & Route	Treatment Administration on Study Days	Post Vaccination Observation Period	Total Number of Animals
T1	Adjuvant Control	1 ml; IM	0, 21	28 Days	40
T2	Porcine cysticercosis vaccine (TSOL 18 vaccine)	1 ml; IM	0, 21	28 Days	40

Test vaccine details:

Name: Recombinant porcine cysticercosis vaccine (TSOL18 vaccine) (Test Vaccine) manufactured by Indian Immunologicals Limited (IIL)

Composition:

Taenia solium oncosphere antigen (TSOL 18)	150µg
Thiomersal	0.01%
Phosphate buffer	q.s
Mineral oil used as adjuvant	

Indications:	For the active immunization of pigs against porcine cysticercosis
Storage and transport:	The vaccine was stored and transported between 2°C and 8°C.

Control product details:

Name:	Adjuvant control	
Composition:	Mineral oil used as adjuvant	
	Thiomersal	0.01%
	Phosphate buffer	q.s

Study procedure:

All the experimental animals were identified with double tagging with each tag bearing unique identification number. Before the scheduled vaccine or adjuvant control administration to the animals, they were acclimatized for a period of 1 month. No immunosuppressant drugs like glucocorticoids and antibiotics etc. were used during the study period. Animals were allocated to different pens in groups according to randomization plan. The randomization plan was based on randomized block design considering pen as a block and the pigs in the pens were ranked as per sex, age and body weights and the pigs were randomly allocated to treatment groups, T1 and T2. The animals were confined to pens and strictly prevented from roaming outside their pens during acclimatization and study period. Feeding, watering and management were followed as per the standard farm management practices. A balanced diet in adequate quantities was provided and clean drinking water was made available to the animals at all times.

The animal selection and enrollment of experimental pigs was done on -15 day as per the study plan mentioned in the protocol. From day -13 of the trial, the animals were subjected to general health observations (GHO) daily and clinical examinations (on days 0, 1, 3, 7, 14, 21, 22, 24, 28, 35 and 49). This data was recorded in respective Data Capture Forms (DCFs), as per the protocol of the study. Restrictions were imposed on the access to the study information by blinding the personnel involved in clinical examinations and laboratory ELISA assays, whereas personnel dispensing and administering the IVP and CP were exempted from blinding. The non-blinded persons were barred from participation in any study procedures, except those involved in random allocation of animals to treatment groups and treatment administration.

One day before primary vaccination (day -1), blood specimens for serum were collected from all the study animals. The serum thus obtained was analyzed for TSOL specific antibody titre using indirect ELISA method.

At day 0, the Treatment-1 animals were administered with adjuvant control dose through intramuscular route and Treatment-2 animals were administered vaccine 1ml dose of TSOL18.

On day 21, the Treatment 1 and 2 animals were administered with Adjuvant Control and TSOL18 vaccine booster dose, respectively, through intramuscular route.

All the animals were monitored for local and systemic reactions following vaccination and during the follow-up period. Blood sampling was done on -30, -1, 20, and 35 DPV and analyzed by indirect ELISA for antibody response.

Log of activities of TSOL 18 vaccine study:

Study day	Activity
Prior to selection	Identification of each animal by two ear tags, with unique identification number
-30	Blood collection for screening of Porcine cysticercosis antibodies titre estimation using indirect ELISA
-15 to -13	1. Clinical examination of each individual pig by a veterinarian. 2. Selection of animals according to inclusion and exclusion criteria 3. Animal enrollment in study: Recording approximate age, breed, sex and estimated initial body weight of each animal. 4. Daily general health observations for each individual pig on the day after enrolment and continued for duration of the study except on days when clinical observations were made.
-14 to -5	Randomisation and allocation to treatment groups.
-1	Blood collection for antibody titre estimation using indirect ELISA
0	1. Administration of treatment (TSOL18 vaccine or Adjuvant control), according to random treatment allocation plan, intramuscularly in the neck. 2. Clinical observations, injection site observations, recording rectal temperatures, 1 -3 hours before and 4 to 8 h after treatment

	administration.
1, 3, 7, 14	Clinical observations Injection site observations Rectal temperatures
20	Blood collection for antibody titre estimation using indirect ELISA
21	1. Administration of booster dose (TSOL18 vaccine or Adjuvant control), according to random treatment allocation plan, intramuscularly in the neck. 2. Clinical observations, injection site observations, recording rectal temperatures, 1 -3 hours before and 4 to 8 h after treatment administration.
22, 24, 28. 35, 49	Clinical observations Injection site observations Rectal temperatures
35	Blood collection for antibody titre estimation using indirect ELISA
49	End of study
All days	General health observations were performed on all days of the study period.

Post-vaccination Evaluations:

Efficacy evaluation:

Efficacy study was done to determine the antibody response to porcine cysticercosis vaccine (TSOL18 vaccine) administered through intramuscular route at different intervals. The sera samples collected from the experimental pigs after administration of primary and booster doses were properly labelled and stored at -20^{0}C until further testing. The sera samples were analyzed by indirect enzyme linked immunosorbent assay (i-ELISA) for the characterization of antibody responses induced by TSOL 18 vaccine.

Indirect enzyme-linked immunosorbent assay (i-ELISA):

TSOL18-specific antibody titres were determined using enzyme-linked immunosorbent assay as per Assana *et al.* (2010) using purified TSOL18-MBP as antigen. ELISA plates (Nunc, maxisorp, cat.No. 442404) were coated overnight at 4^{0}C with TSOL18-MBP antigen in carbonate buffer (pH 9.6, 100 µl/well). The plates were washed thrice with phosphate-buffered saline containing 0.05% Tween 20 (PBST) and blocked by incubation with 200µl/well of blocking buffer (1% Sodium caseinate in PBST) for 1 h at

37^{0}C. Plates were emptied and washed thrice with PBST. The serum samples were diluted to 1:20 in blocking buffer and incubated at 2-8^{0}C for 2 hrs. 50µl of test serum samples serially diluted in blocking buffer were added and incubated at 37^{0}C for 1 hour after which the plates were washed thrice with PBST and incubated with 50µl/well of rabbit anti-porcine IgG HRPO conjugate (1 in 8000 in blocking buffer) at 37^{0}C for 1 hour. Then the plates were washed thrice with PBST and two times with distilled water. Chromogen/substrate solution (TMB and H_2O_2) was added (100 µl/well) and incubated at 37^{0}C for 30 min. in dark. The reaction was stopped by addition of 50 µl/well of 1.25N H_2SO_4 solution to each well. Optical densities (OD) were measured at 450 nm using a microplate reader.

Interpretation of results:

1. Samples are considered seropositive/seroprotective, if the titres are ≥500
2. Titres were calculated as the reciprocal of the highest dilution at which the sera had an OD of ≥1.0.
3. Titre values of serum samples were calculated by four parameter curve fitting using the statistical software, Sigmaplot 12.5.

Safety monitoring:

Safety evaluation included monitoring of all the experimental animals for safety issues during the entire study period. Rectal temperatures, clinical observations and injection site observations and general health observations were recorded in the respective Data Capture Forms (DCF) as per study schedule.

RESULTS

Efficacy Evaluation:

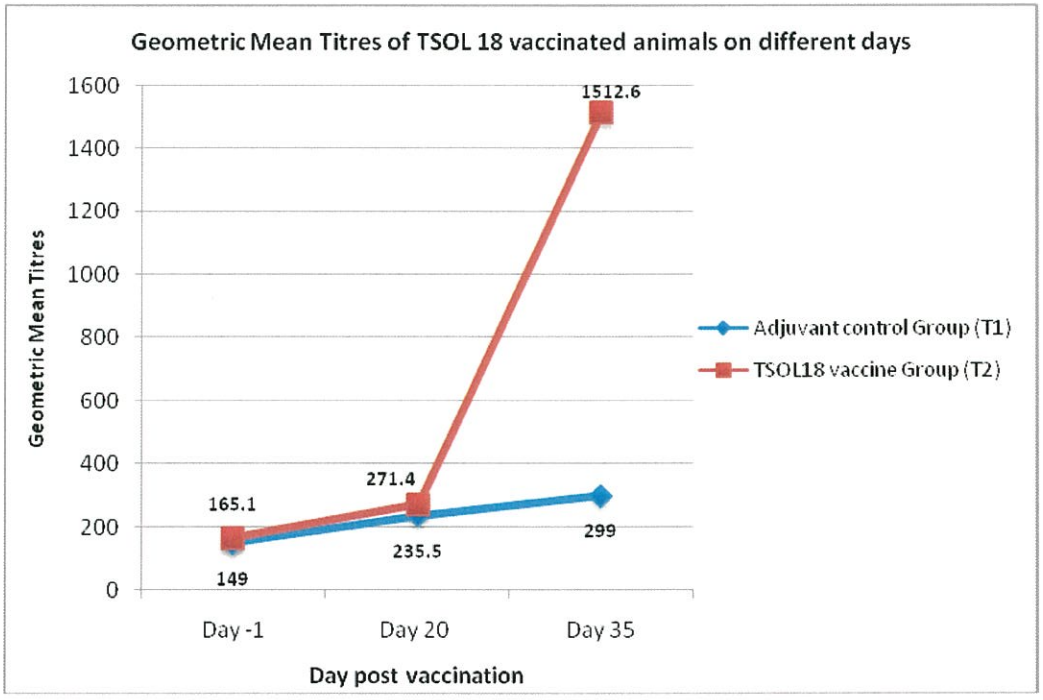
Efficacy of the recombinant porcine cysticercosis vaccine (TSOL 18 vaccine) in pigs was studied by the immune response to the vaccine by indirect ELISA. The immune response revealed geometric mean TSOL18 antibody titres of 165.1, 271.4, and 1512.6 on -1, 20 and 35 DPV respectively. In the efficacy evaluation, the geometric mean TSOL18 antibody titres in vaccinated animals showed increase by 20 DPV and reached peak by 35 DPV, following booster dose administration on 21 DPV.

The geometric mean titres (GMT) of TSOL18 vaccinated animals on different days, as evaluated through i-ELISA are presented in Table 1 and depicted in Figure 1:

Table 1: Geometric Mean Titres (GMT) of TSOL18 vaccinated animals on different days:

Treatment Group	Geometric Mean Titres (GMT) on different days		
	Day -1	Day 20	Day 35
Adjuvant control group (T1)	149	235.5	299.3
TSOL 18 vaccine group (T2)	165.1	271.4	1512.6

Figure 1: Geometric Mean Titres (GMT) in TSOL18 vaccinated animals on different days:

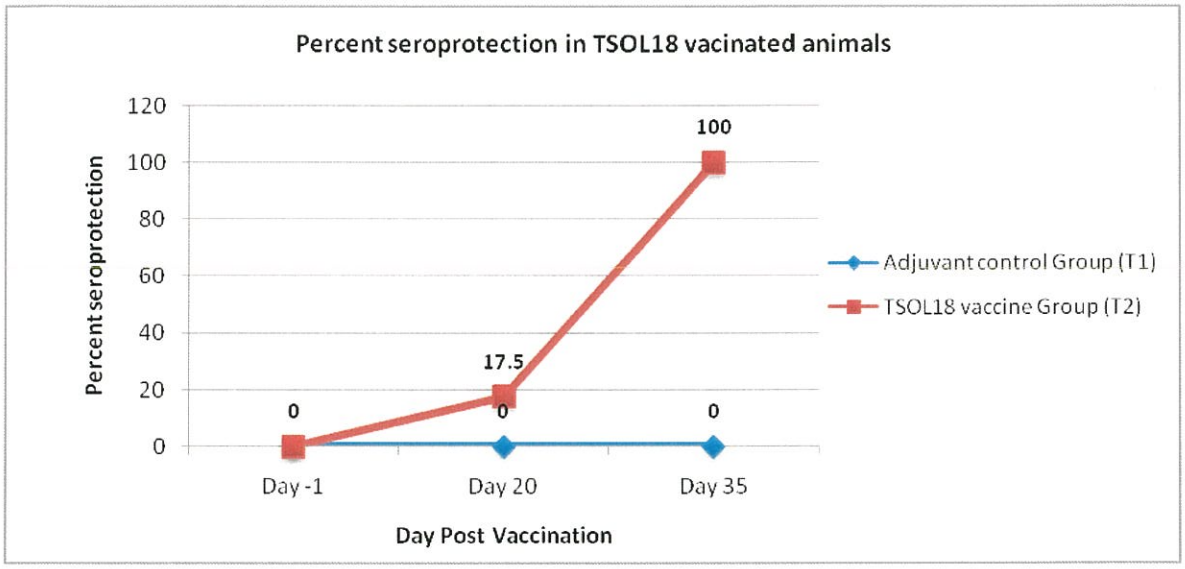


With regard to seroprotection, the percentage of the animals showing protective titres after vaccine administration was 17.50 % on 20 DPV. It further reached to 100 % on 35 DPV following the booster administration on 21 DPV. This indicates that all the vaccinated animals showed complete seroprotection on 35 DPV. The values are presented in Table 2 & Figure 2 below.

Table 2: Percent sero-protection in TSOL18 vaccinated animals on different days

Treatment Group	Percent seroprotection on different days		
	Day -1	Day 20	Day 35
Adjuvant control group (T1)	0	0	0
TSOL 18 vaccine group (T2)	0	17.50	100.0

Figure 2: Percent seroprotection in TSOL18 vaccinated animals on different days:



Safety Profiling:

Adverse Events:

The adverse events were categorized as local events and systemic events.

Local Adverse Events:

The animals were observed for local pain, swelling, rashes, skin eruption, sloughing of mucous membrane, redness at administration site, local reaction etc. Details of observations are mentioned in Table 3.

Systemic Adverse Events:

The animals were observed for systemic adverse events like fever, loss of appetite (anorexia) and restlessness which are listed in Table 3.

Table 3: Summary of Adverse Events in different Groups

Adverse Events	Adjuvant control group (T1) [N=39] n (%)		TSOL18 vaccine group (T2) [N=40] n (%)	
	Primary dose	Booster dose	Primary dose	Booster dose
Local:				
Local pain	0 (0)	0 (0)	0 (0)	0 (0)
Swelling	3 (7.7%)	2 (5.1%)	3 (7.5%)	4 (10%)
Redness at administration site	3 (7.7%)	0 (0)	0 (0)	2 (5%)
Systemic:				
Fever	0 (0)	0 (0)	0 (0)	0 (0)
Anaphylactic reactions	0 (0)	0 (0)	0 (0)	0 (0)
Loss of appetite	0 (0)	0 (0)	0 (0)	0 (0)
Restlessness	0 (0)	0 (0)	0 (0)	0 (0)
Systemic events (Diarrhea)	0 (0)	0 (0)	0 (0)	0 (0)

N – No. of animals in the study group; n- No. of animals showing AEs

Very mild swelling and redness was observed in few animals at the injection site post vaccine or adjuvant control administration. The swelling and redness subsided in 2-3 days without any medication. No other adverse events were observed in any of the study animals.

Serious Adverse Events:

There were no serious adverse events reported in the study.

DISCUSSION

The present study was conducted to evaluate the efficacy and safety of the recombinant porcine cysticercosis vaccine (TSOL 18 vaccine) in pigs 2 months and above upto 2 years of age.

The efficacy of the recombinant porcine cysticercosis vaccine (TSOL 18 vaccine) was studied by the immune response to the vaccine by indirect ELISA method. On the basis of i-ELISA, the vaccine was found to be highly immunogenic. The immune response revealed geometric mean TSOL18 antibody titres of 165.1, 271.4, and 1512.6 on -1, 20 and 35 DPV, respectively in vaccinated animals. The efficacy evaluation indicated that the geometric mean TSOL18 antibody titres increased by 20 DPV and reached maximum by 35 DPV, following administration of booster dose of TSOL 18 vaccine on 21 DPV.

With regard to seroprotection, 17.50 % of the animals were seroprotected on day 20 DPV. It showed increasing trend and 100 % of the animals were seroprotected on 35 DPV following the booster administration on 21 DPV. This indicates that all the vaccinated animals were seroprotected on 35 DPV. These findings are in agreement with the results obtained in an immunogenicity study conducted by the University of Zaragoza, Spain. The animals of approximately 10 weeks age, which received two doses of vaccine developed titres ≥500. The present study is also in agreement with the findings of another study conducted at College of Veterinary Medicine, Universidad Nacional Mayor de San Marcos, Peru. The vaccinated animals given two doses of *Pichia* TSOL18 + Montanide ISA 206V adjuvant vaccine developed adequate titres (≥500) of TSOL18-specific IgG. The results confirm that two doses of TSOL18 vaccine given three weeks apart were safe and effective.

In the safety profiling, very mild swelling and redness were observed in few animals, at the injection site post vaccine or adjuvant control treatment administration. However, the swelling and redness subsided in 2-3 days without any medication. No other adverse events were observed in any of the study animals.
Similar symptoms were observed in a safety study conducted in pigs at University of Zaragoza, Spain. Following treatment administration, there was transient mild pyrexia which resolved within 24 hours and mild injection site reactions which resolved within 7 days.

The recombinant porcine cysticercosis vaccine (TSOL 18 vaccine) produced by Indian Immunologicals Ltd. Hyderabad was found to be efficacious in stimulating good immune response in pigs as evaluated by i-ELISA and safe as only mild local reactions were observed which resolved without any medication and absence of any serious adverse events.

CONCLUSION

Base on the results obtained in the Efficacy and Safety study, it is concluded that the recombinant porcine cysticercosis vaccine (TSOL 18 vaccine) manufactured by Indian Immunologicals Ltd. is efficacious and safe and can be advocated for immunizing pigs for the prevention of cysticercosis caused by *Taenia solium.*

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