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Research article

Evaluation of effectiveness of pest des petits ruminants vaccine in Northern Tanzania

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Abstract

After the incursion of Peste des Petits ruminants (PPR) in Tanzania in 2008, Ministry of Livestock and Fisheries Development (MLDF) in collaboration with development partners started to control the disease by vaccination of sheep and goats through the Vaccination for Control of Neglected Animal Diseases in Africa (VACNADA) project. Vaccination was carried out in Northern and Lake Zones, where Tanzania borders Kenya, the known entry point for the disease in East Africa. A cross sectional epidemiological study was carried out in the Tarime district to evaluate the effectiveness of PPR control by vaccination implemented in Tanzania. A total of 360 serum samples, 180 pre-vaccination and 180 post-vaccination of sheep and goats were randomly retrieved from lake zone. Retrieved serum samples were serologically analyzed using a monoclonal antibody-based competitive enzyme-linked immunosorbent assay (c-ELISA) to assess the seroprevalence of PPR before and after vaccination. There was a statistically significant difference in seroconversion between pre- and post-vaccination samples. The pre-vaccination and post-vaccination seroprevalence of PPR in sheep and goats from nine representative villages were found to be 3.3% and 71.3% respectively ($P<0.0001$). Mean change in seroconversion rates across villages was found to be 67.8% (range 45 to 80%). Significantly higher acquisition of antibodies following vaccination suggests positive response that could be protective for sheep and goats against PPR. Efforts should be made to upscale vaccination coverage as well as carrying out further studies to evaluate the role of PPR vaccination in protection against this disease in small ruminants.

Keywords: PPR vaccine; effectiveness; competitive ELISA; Tanzania

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Introduction

Peste des petits ruminants (PPR) is a highly contagious and economically important viral disease of domestic and wild small ruminants (Rahman et al., 2011). It is caused by a PPR virus (PPRV), classified in the genus *Morbillivirus* within the family *Paramyxoviridae* (Gibbs et al., 1979). PPRV mainly cause disease in sheep and goats, but it can also cause subclinical infection in cattle with the development of a

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cross-neutralizing and cross-protective humoral response against rinderpest (Diop et al., 2005). PPR was first described in Côte D'Ivoire by Gargadennec and Lalanne in 1942 in Africa, since then it has been spreading to other African countries north of the Sahara and south of the equator including Tanzania (Diallo, 1990; Swai, et al., 2009). PPR virus transmission requires close contact between susceptible and infected animals in the febrile stage (Taylor, 1984). Clinically, the disease is characterized by high fever, catarrhal ocular, mucopurulent nasal discharges and erosive stomatitis in early stages followed by severe enteritis and pneumonia (Ularamu et al., 2012). Morbidity and mortality rates are lower in endemic areas and in adult animals compared to non endemic and young animals, where morbidity may be as high as 100% and mortality may be greater than 90%, especially amongst animals under six months of age (Kulu et al., 1994). The presence of PPR in the northern Tanzania was confirmed in 2008 (Swai et al., 2009). Having the disease in northern Tanzania posed a risk of spread to other parts of the country. Moreover the spread of disease from Tanzania to the 15-nations of the Southern African Development Community (SADC) could potentially devastate the livelihoods and food security of millions of small-scale livestock keepers and agro-pastoralists (Banyard et al., 2010). Following PPR outbreak in Tanzania, the Ministry of Livestock Development and Fisheries got support for vaccination of PPR through Vaccination for Control of Neglected Animal Diseases in Africa (VACNADA) project. Vaccinations were in regions neighboring Kenya, where the disease was reported first in East Africa and this included districts in the Northern zone (Kiteto, Simanjiro, Longido, Meru, Arusha DC, Monduli Ngorongoro and Siha Districts) and the lake zone (Tarime, Rorya, Bunda and Serengeti). VACNADA was implemented by the African Union-Interafrican Bureau for Animal Resources (AU-IBAR) in partnership with the Global Alliance for Livestock Veterinary Medicines (GALVmed), the African Union-Pan African Veterinary Vaccine Centre (AU-PANVAC) and the French Centre for International Cooperation in Agronomic Research for Development (CIRAD). The project was funded by the European Union Food Facility with the overall aim to enhance food security through reducing the impact of animal disease by increasing access to and use of quality vaccines.

Materials and Methods

Study site, design and sampling

This study was carried out using serum samples collected from 9 villages of Tarime District. The sera were collected between 2010 (before vaccination) and 2011 (after vaccination), and stored at the Lake Zone Veterinary Laboratory.

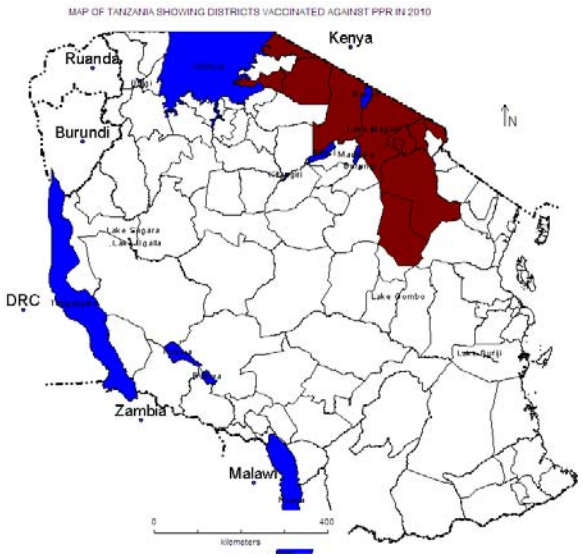

Fig. 1: Map of Tanzania showing areas covered by VACNADA Project

A cross-sectional epidemiological study was conducted. The sample size was estimated using estimated prevalence of 95% and the formula is according to Pfeiffer (1999). $n = Z^2 P (1-P)/ d^2$ where n = required sample size, z = 1.96 (95% confidence level significance level), p = expected prevalence (95%), (1-p) = probability of having no disease, d= precision level or allowable error (5%) and the design effect of 10%. A total of 360 serum samples were randomly retrieved from a serum bank at the Lake Zone Veterinary laboratory, 180 of which were sampled prior to vaccination while the remaining 180 sera were collected after vaccination against PPRV. The samples came from 9 villages and from each 20 pre-vaccination and 20 post-vaccination sera were selected for laboratory analysis.

Laboratory analysis of serum samples

Detection of antibodies to PPRV was done using competitive enzyme linked immunosorbent assay (cELISA) to establish seroprevalence of PPR. The test is based on the competition between the anti-PPR monoclonal antibody and antibodies in the serum sample binding to the PPR antigen. The presence of antibodies to PPRV in the serum sample will block reactivity of the monoclonal antibody resulting in the reduction in expected colour following the addition of enzyme labelled anti-mouse conjugate and substrate or chromogen solution. The assay was performed according to the general principle of cELISA as previously described (Anderson et al., 1991; Anderson and McKay, 1994).

Data analysis

Data were entered into Excel program and subsequently imported into SPSS for statistical analysis using IBM SPSS version 21 analysis software. Frequency of positivity was compared before and after vaccination for each village as well as overall throughout the study area. Tables and graphs were used to summarize data. Paired sample t-test was used to determine whether seroconversion rates before and after vaccination was significant. P value less than 0.05 was considered statistically significant.

Results

Serological results for samples collected before and after vaccination

Of the 180 pre-vaccination samples analyzed only 6 (3.3%) were found positive for PPR antibodies. On the other hand, 128 (71.1% seroprevalence) out of 180 post vaccination serum samples were seropositive (Table 1). The lowest seroconversion rate before vaccination was found to be zero percent with the highest being 20%, while the lowest and highest seroconversion rates after vaccination were 65% and 100% respectively. This difference was found to be statistically significant (P<0.00001). The changes in seroconversion rates in pre- and post-vaccination samples are summarized in Table 2.

Antibodies against PPRV were detected in a few samples from only three villages before vaccination and these villages were Bisarwi (5%), Kibasuka (5%) and Weigita (20%). However, after vaccination, more samples from all villages had seroconverted and the differences in the degree of seroconversion before and after vaccination was clear (Fig. 2). The change in seroconversion rates was slightly variable among villages (Table 2 and Fig. 3), but nonetheless significant in all villages individually or collectively (Fig. 3 and 4).

Discussion

In this study, serological investigation found that 3.3% of pre-vaccinated sheep and goat serum samples had seroconverted. The observed seroprevalence suggests that animals were either incubating the disease or vaccinated animals were introduced in the area, as the disease was first confirmed in Tanzania in 2008 (Swai et al., 2009). But since animals were dying with PPR, clinical signs may suggest that the seroconversion was due to PPR infection. Moreover, sheep and goat vaccination against PPR had already been done in some areas of the Northern Zone in 2009; hence unregulated migration of livestock keepers might have contributed to the PPR vaccinated animals from other parts of the country into the study area.

Table 1: Pre- and post-vaccination PPR Seroprevalence in 360 serum samples collected from sheep and goats in nine villages of the Tarime district in Tanzania (2010-2011)

District	Ward	Village	Pre-vaccination		Post-vaccination	
			No. Analyzed	(%) Positive	No. Analyzed	(%) Positive
Tarime	Kibasuka	Weigita	20	4(20.0)	20	13(65.0)
		Kibasuka	20	1(5.0)	20	14(70.0)
	Kentare	Mogabiri	20	0(-)	20	16(80.0)
	Komaswa	Nyamirambaro	20	0(-)	20	16(80.0)
		Surubu	20	0(-)	20	13(65.0)
	Manga	Bisarwi	20	1(5.0)	20	14(70.0)
		Kembwi	20	0(-)	20	13(65.0)
	Matongo	Matongo	20	0(-)	20	16(80.0)
	Nyarero	Nyarero	20	0(-)	20	13(65.0)
Total			180	6(3.3)	180	128(71.1)

Table 2: Change in seroprevalence of PPRV antibodies before and after vaccination of sheep and goats in nine villages in Tarime District in Tanzania (2010-2011)

District	Ward	Village	N	Seroconversion rates (%)		
				Prevaccination	Postvaccination	Change
Tarime	Kibasuka	Weigita	20	20	65	45
		Kibasuka	20	5	70	65
	Kentare	Mogabiri	20	0	80	80
	Komaswa	Nyamirambaro	20	0	80	80
		Surubu	20	0	65	65
	Manga	Bisarwi	20	5	70	65
		Kembwi	20	0	65	65
	Matongo	Matongo	20	0	80	80
	Nyarero	Nyarero	20	0	65	65
Average				3.3	71.1	67.8

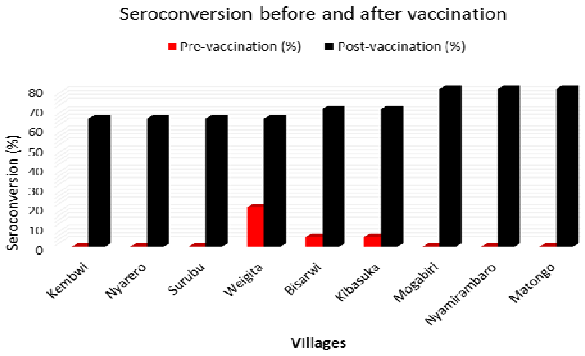

Fig. 2: Seroconversion rates before and after vaccination against PPR. Note clear differences in seroconversion rate for each village

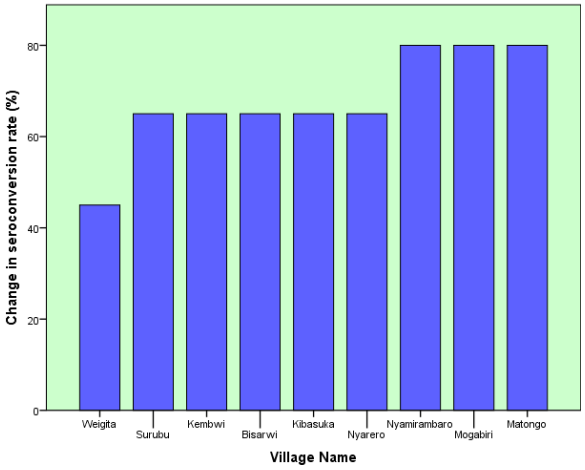

Fig. 3: Change in seroconversion rates in pre- and post-vaccination serum samples from Tarime District. The lowest change was observed in samples from Weigita (45%) while the highest change was 80% in Nyamirambaro, Mogabiri and Matongo villages

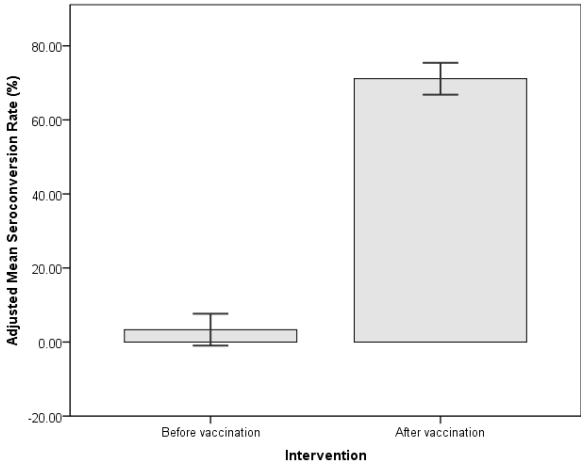

Fig. 4: Error Bar charts depicting significant difference in proportion of responders to PPRV before and after vaccination

Likewise, serosurveillance on post vaccinated animals found that 71.1% (range 65-80%) of animals seroconverted. Acquisition of antibodies against PPRV following vaccination gives an indication that vaccinated animals had responded to the vaccine and hence were probably protected against PPRV. The average seroconversion rate of 71% is very close to the recommended minimum of 75-80% herd immunity required to control rinderpest, which is related to PPR (Rossiter and James, 1989). A study in Nigeria reported that, the tissue culture rinderpest vaccine was used to provide protection against PPR until recently when the homologous PPR vaccine was developed by Diallo through attenuation of Nig 75/1 PPRV strain (Luka et al., 2011). The results of this study tally with the findings from Pakistan, where a seroconversion rate of 71% was reported (Muhammad et al., 2011). The level of PPRV sero-positivity by PPR vaccine found in this study has been reported to confer protection for up to three years, however, the immunogenicity of PPR vaccine has been reported to vary considerably (Diallo et al., 2007). Same type of PPR vaccine developed by Diallo (2004) was used in vaccination of sheep and goats in Tarime District. However, due to an increase in sheep and goat population within a short period, the proportion of unprotected sheep and goats is likely to increase with time thereby disrupting herd immunity. Therefore, there is a need to follow-up vaccination rounds for full protection of newly susceptible species. Significantly higher post-vaccination acquisition of antibodies reported in this study suggests positive response that could be protective to sheep and goats against PPR. Efforts should be made to upscale vaccination coverage as well as carrying out further studies to evaluate the role of PPR vaccination in protection against this disease in small ruminants.

The study was not able to establish the relationship between the disease and animal species, age or sex of sheep and goats because analyzed samples were retrieved from the Mwanza VIC serum bank and this information was not recorded during the sampling process. This observation underscores importance of applying standard operating procedures whenever samples are being collected in the field. Field veterinarians from private and public sectors need to be equipped with sampling skills so that specimens and samples collected have all necessary information for future analyses.

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