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Cross Sectional Study

Evaluating the Effect of Delthamethrine on the Prevalence of Trypanosomiasis in Two Districts of Buno Bedelle Zone, Ethiopia

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ABSTRACT

Introduction

Trypanosomosis is a bottleneck on the livelihood of farmers in the study area and the Ethiopian government has been using 0.4% Delthamethrine impregnated targets and 1% pour-on to reduce the impact of this disease on food security. However, there was no information on the effect of this chemical on the prevalence of Trypanosomiasis.

Objective

The aim of the study was to evaluate the effect of Deltamethrine in controlling trypanosomiasis.

Methods

Cross-sectional study was conducted on cattle of two districts of Buno Bedele Zone in April 2020 and 2022. Paired samples "*t*" test statistic was used to summarize data by using statistical package for the social sciences (SPSS) statistics version 21. The approach followed to complete the study was implementing a pre-intervention phase to know the status of trypanosoma before using a chemical in April 2020 and an intervention phase using deltamethrine chemical on cattle at a rate of 1 mL/10 kg body weight and 0.4% Delthamethrine impregnated targets from October 2021 to March 2022. The post-intervention was done in April 2022 to evaluate the prevalence difference.

Results

Out of 576 cattle during pre-intervention 159 (27.60%) cattle were positive with a mean packed cell volume (PCV) of 20.68%. During post-intervention out of 576 cattle, 27 (4.70%) cattle were positive with a mean PCV of 26.10%. For the study, there was strong evidence at a 95% confidence interval (t=3.035, p<0.05). Delthamethrine chemical application reduces the prevalence of the trypanosoma parasite by ten estimated mean. Also, there was strong evidence at a 95% confidence interval (t=-84.66, p<0.05) that Delthamethrine chemical application increased the PCV of cattle by five estimated mean.

Conclusion

In both districts, there was strong evidence that deltamethrin chemical application reduces the prevalence of trypanosome parasites. Deltamethrin chemical application increased cattle's PCV, which showed that an intervention was encouraging to suppress trypanosomosis and should be continually implemented to keep the intervention difference.

Keywords

Cross-sectional; Ethiopia; Delthamethrine; Packed cell volume, Pour-on, Prevalence of trypanosomosis, "*t*" test.

INTRODUCTION

Trypanosomosis is an important livestock disease of the African continent and a big challenge for cattle health and economic-performance in sub-Sahara Africa.[1] It reduces milk and meat production and income.[2] It indirectly impairs land use by reducing the draft power, productivity of oxen. Because of the risk of this disease, farmers keep away from productive tsetse-fly-infested lands, which might very important to fill higher food in thend inthe current steady growing human population of sub-Sahara Africa.[3] It is predictable to cause three million deaths of cattle yearly and direct economic loss of US$ 1-1.2 billion in cattle production. Accounting for indirect, economic losses, sub-Sahara Africa might lose up to 4.75 billion of gross domestic product (GDP) per year.[3] In sub-Sahara

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Africa livestock production is responsible for forty percent of total farmers' income across all livestock production systems.[1]

Ethiopia is one of these countries that have been being challenged by trypanosomosis and about 14 million heads of cattle are exposed to the risk of trypanosomosis. It is not only the production loses of animals recovering from the disease but the huge economic impact caused by the disease is that it has led to thousands of hectors of land unfit for settlement and cultivation. In addition, some drugs are applied to treat diseased animals, which are costly and drug resistance is becoming a big challenge. It causes direct and indirect losses and is one of the most considerable and costly diseases in Ethiopia hindering the effort made for food adequacy.[4]

To overcome the impact of this disease, institutions like Food and Agriculture Organization (FAO), work together with the African Union by providing technical and financial support to eradicate the disease and spent a significant amount of financial and non-financial resources, however, trypanosomosis remains a threat to sub-Sahara Africa.[5] Various tsetse fly and trypanosomosis controlling techniques have been used in the past years.[6,7] Treating sick animals using trypanocide is one of the most commonly used approaches.[8,9] Preventive actions that target the tsetse fly vector itself are broadly used in different communities. These actions include: clearing the habitat of the tsetse fly, using baited targets, sequential aerosol technique (SAT), ground spraying, insecticide-treated cattle (ITC) and sterile insect technique (SIT).[6,10]

Despite the main successes of using these approaches, with few exceptions, sub-Sahara Africa has not still been able to control trypanosomosis.[11] Implementers of the control techniques on the ground and African livestock policymakers face several challenges.[12] Drug resistance is one of the challenges facing livestock producers.[13] Low quality and counterfeit drugs further worsen the problem of resistance to trypanocides.[6,14] The financial sustainability of some of the techniques (e.g., aerial or ground spraying, SAT and SIT) has been questioned.[6] Clearing forests and vegetation, killing game animals, and pesticide spraying are not environmentally friendly.[9]

In Buno Bedelle zone Borecha and Dabo Hana districts trypanosomosis is endemic due to high tsetse infestation. In these areas to minimize the impact of this disease on the livelihood of poor farmers application of the delthamethrine chemical has been implemented. Accordingly, 0.4% impregnated targets and 1% pour-on formulation to control tsetse and trypanosomosis was carried out in two selected districts. So the objective of this study was to measure the prevalence of the trypanosoma parasite difference after the intervention was done using the delthamethrine chemical.

MATERIALS AND METHODS

Study Area

The study was conducted in April 2020 and 2022 in Borecha and Dabo Hana districts of Buno Bedelle zone, Oromia regional state of Ethiopia. Buno Bedelle zone is located in the western part of Ethiopia and is bounded on the south by Ilubabor zone, on the north by the East Wollega zone, on the west by again Ilubaborzone, and the East Jimma zone (Figure 1).

Borecha district is located about 464 km west of Addis Ababa at an altitude between 1400-2100 meters above sea level. The districttown of, Yanfa lies between 08°14' N latitude and E 36°35' E longitude with a temperature range of 15-21 °C. It receives rainfall ranging from 1300-2000 mm. The livestock population of the district is estimated to be 249786 cattle, 35321 sheep, 37895 goats and 8,417 equines. The study was done in three peasant associations, namely Danaba, Nataro and Markafo with a cattle population of 19740, 11230, and 8533 respectively. In these three kebele Danaba, Nataro, and Markefo 119 L, 122 L and 130 L of 1% delthamethrine was respectively applied to cattle in 2021 (66 cattle per 1 L of 1% delthamethrine). Also, 4,50 targets were deployed in three kebel of Borecha district.[15]

Dabo Hana district is located about 510 km west of Addis Ababa at an altitude between 1600-2200 meters above sea level. district town, Kone lies between 08°41' N latitude and 36°17' E longitude with a temperature range of 18-24 °C. It gains rainfall ranging from 1200-1800 mm. The livestock population of the district is estimated to be 78,576 cattle, 22,428 sheep, 25,516 goats, and 9,966 equines. The study was done in three peasant associations namely Dhidessa, Loko, and Lilo Sato with cattle populations of 3512, 2717, and 29,300 respectively. In these three kebele Didessa, Loko and Lilo Sato 79 L, 134 L and 111 L of 1% delthamethrine were respectively applied to cattle in 2021(66 cattle per 1 L of 1% delthamethrine). Also, 900 targets were deployed in three kebele of the Dabo Hana district.[15]

Study Populations

The study population was bovines from six kebele's of two districts. The farming system of cattle in the study areas was extensive mixed crop-livestock production system. The assessment of prevalence of trypanosomosis was done in 2020 (pre-intervention) and 2022 (post intervention). The intervention phase was done in 2021 by Deltamethrine (0.4% impregnated targets and 1% pour-on formulation) to control tsetse and trypanosomosis. Post-intervention trypanosomosis prevalence (monitoring) was done after intervention in 2022 to estimate prevalence difference due to the application of delthamethrine and targets on control of trypanosomosis.

Study Design, Sample Size and Sampling

The study was conducted to estimate the prevalence difference of trypanosomosis using a cross-sectional study design and a simple random sampling technique was used to select the sampling unit.[16] Sample sizes from the two districts were 576 cattle which was a large sample size.[17]

Methodology

Monitoring of trypanosome infections: Blood was collected from the ear-vein *via* heparinized capillary tubes, centrifuged at 8000 for 5-minutes, and examined for the presence of trypanosomes using

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the phase-contrast, buffy-coat technique and its packed red cell volume.[18] Packed-redcell volume (PCV) was then considered and the buffy coat method was functional: thin smears were done with buffy coats and examined for trypanosome detection with a microscope (40×10).Trypanosome species were recognized morphologically. During the assessment period, positive animals to the buffy coat method were treated with diminazene aceturate 7mg/kg.[19]

Packed cell volume: Haemoparasites affect the volume of cells by haemolysis which results in anaemia. Therefore, PCV will help to analyze the concentration of blood cells in the animals' bodies.[19]

Data Management and Analysis

All the data obtained from the field was recorded in the record sheet format and later entered into the computer and managed using Microsoft Excel worksheet and paired samples "*t*" test statistic was used to summarize data by using statistical package for social sciences (SPSS) Statistics version 21. Prevalence was defined as the number of bovines found positive for one or more trypanosomes from the sample population which was representative of the study population.

RESULTS

Assessments during pre-intervention were done in both districts of six kebele and 576 cattle were sampled with a total prevalence of 27.60%. The most common species of trypanosoma was *trypanosoma congolense* (12.67%) followed by *T. vivax* (8.70%), mixed infections (5.60%) of (*T. congolense*, *T. vivax* and *T. brucei*) and (5.20%) *T. brucei* (Table 1).

Post-intervention assessment after application of chemical was done in the same kebele and herd. Accordingly, the most common species of trypanosoma were *trypanosoma congolense* (2.6%) followed by *T. vivax* (2.1%) and no mixed infections (Table 2). The prevalence of trypanosoma species was reduced after intervention (Table 2). The overall differences in prevalence between pre and post-intervention of delthamethrine chemical application showed a positive association of the chemical with trypanosoma species ($p<0.05$, Table 3) and negative associations with the increased PCV of cattle after intervention ($p<0.05$, Table 4).

The overall mean PCV was increased from pre-intervention

Table 1. *Pre-intervention Prevalence and Mean PCV*

	Pre-intervention Prevalence					Total	Mean PCV
District	No. Animals	*T. congolense*	*T. vivax*	*T. brucei*	Mixed		
Dabo Hana	288	46	28	17	21	95	21.19
Boracha	288	27	22	13	11	64	20.16
Total	576	73	50	30	32	159	20.68
Prevalence		12.67%	8.70%	5.20%	5.60%	27.60%	

Table 2. *Pre-intervention Prevalence and Mean PCV*

	Pre-intervention Prevalence					Total	Mean PCV
District	No. Animals	*T. congolense*	*T. vivax*	*T. brucei*	Mixed		
Dabo Hana	288	9	1	0	0	10	26.48
Boracha	288	6	11	0	0	18	25.67
Total	576	15	12	0	0	27	26.1
Prevalence		2.6%	2.1%	0.0%	0.0%	4.7%	

Table 3. *Prevalence Paired Differences*

	Paired Differences					t	Df	Sig. (2-tailed)
	Mean	Standar Deviation	Standar Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
pre–post	10.07	7.42	3.32	0.85	19.29	3.035	4	0.039

Table 4. *Packed-cell Volume Paired Differences*

	Paired Differences					t	Df	Sig. (2-tailed)
	Mean	Standar Deviation	Standar Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
pre–post	-5.40	0.11	0.064	-5.681	-5.132	-84.66	2	0.000

(20.68%) to 26.10% (post-intervention) the significance of the mean difference between interventions showed an association of delthamethrine chemical with PCV (p<0.05, Table 4). From this research, there was strong evidence at a 95% confidence interval (t=3.035, p<0.05) that delthamethrine chemical application reducesthe prevalence of trypanosoma parasite by ten estimated mean (Table 3). Also there was strong evidence at a 95% confidence interval (t=-84.66, p<0.05) that delthamethrine chemical application increasedthe PCV of cattle by five estimated means (Table 4).

DISCUSSION

It has been interesting to evaluate the effect of the delthamethrine chemical on trypanosoma parasite control since it was endemic and has been considered a bottleneck on the livelihood of poor farmers. Ethiopian government has been using this chemical to suppress the impact of this disease and bait techniques has been consideredto be environmentally more friendly.[20] That was the major thrust in the recently launched project 'Farming in Tsetse Control Areas of East Africa (FITCA)', which is sponsored by the European Union (EU). The aim of this study was to assess the prevalence difference in both districts 1% or 20% delthamethrine chemical was positively associated with trypanosoma parasites (p<0.05).

In study areas after chemical application *via* 0.4% impregnated targets and 1% pour-on prevalence and PCA difference was assessed and significantly associated with trypanosomosis (p< 0.05) in agreement with studies[21,22] that showed Deltamethrine has successfully controlled bovine trypanosomosis in different parts of Africa. Also in agreement with a study of Gimonneau et al[23] that showed Trypanosomosis prevalence was significantly reduced and PCV of the treated cattle increased significantly.

In all study areas prevalence of *T. congolense*, *T. vivax*, *T. brucei* and mixed infections (*T. congolense*, *T. vivax* and *T. brucei*) were reduced after intervention (p<0.05) that in agreement with studies.[21,23] This study indicated deltamethrine chemical was effective in killing biological flies (tsetse fly) that intermediate host to trypanosoma parasitessince the prevalence was reduced after an intervention. The prevalence difference between districts could be dose, either chemical applied to animal or not, the number of targets deployed, sites of target deployed, a number of animals treated with chemical "pour on" and so on.

CONCLUSION

In both districts, there wasstrong evidence at a 95% confidence interval (t=3.035, p<0.05) that delthamethrine chemical application reducesthe prevalence of trypanosoma parasite by ten estimated mean. Also, there was strong evidence at a 95% confidence interval (t=-84.66, p<0.05) delthamethrine chemical application increased PCV of cattle by five estimated mean that showed an intervention was encouraging to suppress Trypanosomosis and should be continually implemented to keep the intervention difference.

STUDY LIMITATIONS

Due to the long time between pre and post-intervention studies, there was some cattle dynamism from one kebele to other.

ETHICS APPROVAL

A local ethics committee ruled that no official ethics approval was required to carry out this study. Before conducting the study, informed permission was obtained from the owners of the cattle used in this study.

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