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Evaluation of animal performance, feed intake, and economic losses in sheep experimentally infected with *Trypanosoma vivax*

Avaliação do desempenho animal, consumo de alimento e perdas econômicas em ovinos infectados experimentalmente por *Trypanosoma vivax*

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Abstract

Trypanosoma vivax is a protozoan originating from the African continent, which, although it has not yet been able to complete its biological cycle in South America, due to the absence of the tsetse fly, can still cause death in ruminants. The objective of this study was to verify the effects of *T. vivax* on the measurements and indices in sheep that characterize animal performance, as well as on economic losses in meat animals. Twenty intact adult male sheep were used for this study, all of approximately the same ages and weights, reared in confinement, and subjected to the same management and diet, which was balanced and supplemented with adequate minerals. The animals were divided into two groups: the control group (CG) and the infected group (IG), which was inoculated intravenously with 1.3 x 10^5 trypomastigotes of *T. vivax*. Feed intake was verified daily, whereas the feed conversion (FC), feed efficiency index (FEI), and weight gain were obtained weekly. Total weight gain (TWG) was determined after 70 days post-infection. The economic loss was calculated by subtracting the value obtained (IG) from the expected value (CG), and the difference was expressed as a percentage. A randomized block design was used to isolate the effect of the initial weight. The means were compared by the Student "t" test at 5%. Of the 10 infected animals, one died from the parasitism, yielding a rate much lower than that observed in natural outbreaks. The groups presented similar feed intakes throughout the experimental period; however, the TWG of the infected group was significantly lower (50.7%) than that of the CG. Similarly, the daily weight gain (DWG), feed conversion (FC), and feed efficiency index (FEI) of the IG were significantly lower than those of the CG. In addition, the worst rates of FC and FEI coincided with parasitemia peaks and recurrences, probably due to immunological demand and tissue repair. The abdominal circumference of the infected animals was statistically lower than that of the CG, which may be directly related to fat mobilization, in addition to the possible negative effect on the digestive capacity. The economic losses due to weight alone were 24.07% and could reach 31.66% of the herd value due to animal death. Infection with *T. vivax* negatively affected animal performance indices, even when the animals were well nourished. *Trypanosoma vivax* in sheep destined for slaughter caused economic losses of 31.66% due to the decrease in performance and the death rate in the infected group.
Key words: Trypanosomiasis. Feed conversion. Economic impact. Weight gain.

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Resumo

O *Trypanosoma vivax* é um protozoário originário do Continente Africano que mesmo não completando seu ciclo biológico na América do Sul, devido à ausência da mosca tsé-tsé, pode levar ruminantes a óbito. O presente trabalho teve por objetivo verificar, em ovinos infectados, os efeitos do *T. vivax* em medidas e índices que caracterizam o desempenho animal, bem como perdas econômicas em animais de abate. Para tanto foram utilizados vinte ovinos adultos, machos, inteiros com idade e peso aproximados, criados em confinamento, submetidos ao mesmo manejo e alimentação, sendo esta balanceada e suplementada com minerais adequados. Os animais foram divididos em dois grupos: o grupo controle (GC) e o grupo infectado (GI) que foi alcançado pela inoculação endovenosa de 1,3 x 10^5 tripomastigotas de *T. vivax*. O consumo de ração foi verificado diariamente, enquanto a conversão alimentar (CA), o índice de eficiência alimentar (IEA) e o ganho de peso foram obtidos semanalmente. O ganho de peso total (GPT) foi obtido ao final de 70 dias pós-infecção. A perda econômica foi obtida subtraindo do valor esperado (GC) do valor obtido (GI), e a diferença exposta em porcentagem. O delineamento utilizado foi o de blocos casualizados, para isolar o efeito do peso inicial, foi aplicado o teste “t” de Student a 5% para comparação de médias. A taxa de letalidade do *T. vivax* em ambiente experimental controlado foi de 10%, taxa muito inferior ao verificado em surtos naturais. Quanto ao consumo de ração, os grupos apresentaram consumo idêntico durante todo o período, todavia, o GPT do grupo infectado foi significativamente inferior, 50,7% menor quando comparado ao GC. Do mesmo modo, o ganho de peso diário (GPD), conversão alimentar (CA) e o índice de eficiência alimentar (IEA) do GI foram significantemente inferiores ao GC. Além disso, os piores índices de CA e IEA coincidiram com os picos parasitêmicos e recidivas, provavelmente pela demanda imunológica, e de reparos teciduais. A circunferência abdominal dos animais infectados foi estatisticamente inferior ao GC, o que pode estar relacionado diretamente à mobilização de gordura, além de possível efeito negativo na capacidade digestiva. As perdas econômicas apenas sobre o peso foram de 24,07%, podendo alcançar 31,66% do valor do lote na ocorrência de óbito. A infecção por *T. vivax* afetou negativamente os índices de desempenho animal, ainda que bem nutridos. O *T. vivax* em ovinos destinados ao abate causou perdas econômicas de 31,66%, devido à diminuição do desempenho e a taxa de óbito verificado no grupo infectado.

Palavras-chave: Tripanossomíase. Conversão alimentar. Impacto econômico. Ganho de peso.

Introduction

Trypanosoma vivax has broad epidemiological and economic importance in several countries of the world, as it can trigger the most severe form of trypanosomiasis and contribute to losses in ruminant herds. In South America, the parasite has adapted to mechanical transmission by hematophagous dipterans, such as *Stomoxys spp.* and insects of the Tabanidae family (DÁVILA; SILVA, 2000). In Brazil, trypanosomiasis from *T. vivax* has already been reported in several states, and the expansion of trypanosomiasis throughout the country may have been favored by the movement of bovine herds (LINHARES et al., 2006).

Trypanosomiasis from *T. vivax* affects ruminant productivity, usually due to organic changes such as reproductive and metabolic problems, and this parasite is considered the main limiting factor for cattle production in Africa (BATISTA et al., 2008). These problems are due, among other factors, to the range of vectors, susceptible hosts, and the immunodeficiency of the animals, as well as to malnutrition in these herds (GARCIA et al., 2006). In addition, the presence of other diseases can aggravate the general state of the animals, leading to death.

Because alterations in health can be reflected in body changes, measurements that show these changes are necessary. Body measurements are important for estimating the productive potential and commercial capability of the herd (OLIVEIRA, 2007). In addition, measurements such as body length, thoracic perimeter, height of the withers, and height of the croup may indicate, for example, the digestive and respiratory capacity of the animals, as well as productive characteristics such as carcass yield (SANTANA et al., 2001). Knowledge of these measurements may be useful, for example, in the estimation of carcass losses and economic impacts in herds of ruminants infected with hemoparasites such as *T. vivax*.

According to Abrão et al. (2009), losses due to infection with *T. vivax* in Latin America are not yet estimated; however, in dairy herds, outbreaks are associated with significant economic losses, mainly due to the mortality of adult animals, abortions, and a reduction in milk production.

Because the majority of the Brazilian sheep herd (approximately 57.24%) is located in the Northeast region and, more importantly, because sheep production plays an important role in the socioeconomic development of this region, direct studies are needed that quantify the effects of *T. vivax* on the performance of sheep in the region. Therefore, the present study aimed to evaluate exclusively the effects of trypanosomiasis by *T. vivax* on feed intake and performance of sheep through indices and body measurements, as well as to estimate the possible economic losses caused by the disease in an experimental environment.

Materials and Methods

The experiment was conducted at the Center for Studies and Research in Small Ruminants of the Federal Rural University of the Semiarid Region of Brazil (Universidade Federal Rural do Semi-Árido – UFERSA), located in the municipality of Mossoró, Rio Grande do Norte state (RN), Brazil.

Twenty intact male sheep of undefined breeds, each with an approximate age of 360 days and average weight of 20 ± 2 kg, were used for this study. The experimental animals underwent a quarantine period where they were subjected to clinical, hematological, serological, and parasitic evaluation, and when their health was verified, they were distributed into two well-screened pens where they were kept for another 15 days to adapt to the environment and management. The groups, designated as the infected group (IG) and the control group (CG), were allocated into the respective pens, being randomly sorted according to similar initial weight. All sheep were raised in an intensive management system and were subjected to the same type of management and feed during the experiment.

An isonutritive diet was formulated in order to promote maintenance and to achieve a significant weight gain (growth/finishing). This diet comprised Tifton hay (*Cynodon dactylon*)-based roughage, corn (*Zea mays L.*), and soy (*Glycine max L.*)-based concentrate, formulated to contain 18% crude protein, with adequate mineral supplementation for sheep and water supplied *ad libitum*. The quantity of roughage was adjusted daily based on the leftovers from the previous day (10% of the total offered), and the concentrate was adjusted in proportion to 2.0% of the live body weight. Feeding was done at predetermined times: 7:00 am and 3:30 pm.

All management was performed in adherence to the appropriate standards, aiming at minimal discomfort and respecting peculiar aspects of the ovine species. All procedures performed on the animals were carried out strictly according to the standards of the Brazilian School of Animal Experimentation (Colégio Brasileiro de Experimentação Animal – COBEA) and the *National Institute of Health Guide for Care and Use of Laboratory Animals*.

The sheep in the infected group (IG) were inoculated intravenously with a *T. vivax* strain isolated from small ruminants during an outbreak that occurred in the State of Paraiba (BATISTA et al., 2009); the strain isolates had been frozen in liquid nitrogen at –170ºC. A total of 0.5 mL of blood containing approximately 1.3 x 10^5 trypomastigotes of *T. vivax*, estimated according to the method of Brener (1961), was injected per animal. Determination of parasitemia was conducted throughout the whole experiment, and for both groups, 0.5 mL of blood was drawn daily from the jugular of each animal for the direct calculation of parasitemia.

Concentrate intake was monitored by calculating the average weekly consumption, obtained from the sum of the amount of feed offered daily to the experimental groups. Through this monitoring, consumption from the trough was easy to control. The weekly feed was weighed (using a semi-analytical balance with a precision of 0.01 grams), and the leftovers were subtracted (when present) and divided by seven (7). The animals were weighed weekly starting on the first experimental day (Wi, initial weight) for 70 days, until the final weight (Wf) was reached. Feed intake was calculated per week, using the sum of daily consumption divided by 7 days. Total weight gain (TWG) was calculated using the formula TWG = Wf – Wi, whereas daily weight gain (DWG) was obtained as follows: DWG = TWG / (total of days in the experiment). In turn, the feed conversion rate (FC) and the feed efficiency index (FEI) were calculated using the formulas FC = average consumption per animal (kg) / live weight gain/animal (kg) and FEI = [live weight gain per animal (kg) / unit of feed offered (kg)] x 100, respectively.

The body measurements were obtained by means of tape measures (girth measurement and lengths) and a hypometer (to measure heights). These measurements were taken from the animals, at the appropriate locations, at the beginning of the experiment (35th day post-infection) and on the last day of the experiment (70 days after infection), and were expressed in centimeters. The body measurements were obtained using an average of three measurements according to the methodology of Oliveira (2007):

Body Length (BL) – measured from the tip of the shoulder to the tip of the ischium, in the longitudinal direction;

Croup length (LenCro) – measured from the tip of the ilium to the tip of the ischium;

Thoracic circumference (CirTho) – performed at the withers, with the measuring tape passing under the armpits, as light pressure was applied;

Abdominal circumference (CirAb) – measured with a tape measure in the middle of the abdomen, passing over the umbilical scar, as light pressure was applied, with the reading performed at the height of the lumbar vertebrae;

Height at the withers (HeiWi) – measured from the withers to the ground, at an angle 90º;

Height of the Croup (HeiCr) – measured from the sacral vertebrae to the ground, at an angle of 90º;

Width of the Breast (WidBr) – measured from extremity to extremity of each scapula at its most lateral part (proximal to the scapulohumeral joints); and

Width of the Croup (WidCr) – obtained by measuring from extremity to extremity of each bone base, such as the ilium, trochanters and ischium.

The economic losses were calculated by considering the values of the control group as the expected value (EV) and those of the infected group as the observed values (OV). To obtain the difference in absolute value between the groups, the following formula was used: EV – OV. The percentage value was then calculated using the following formula: [(EV-OV)/EV]*100. The economic losses were calculated based on the average sheep weight at slaughter, average purchase value of each sheep, herd value, and estimates (considering the deaths recorded during the experimental period and minimum treatment cost). To ensure that percentages were as small as possible, with positive variations only, certain aspects were not included. These aspects included diagnostic expenses, losses due to herd rejection, condemnation of parts of the carcass found to be improper, losses from prolonged treatment (and/or relapses), treatment of secondary diseases or even the costs to reverse weakness in affected animals, and bad reputation among other breeders.

When normality in the distribution and homoscedasticity were found, analysis of variance and the F test at 5% were performed, and the means were compared by the Student "t" test at a level of 5% probability. The experimental design used was a randomized block design, the blocks being formed according to the initial weight gradient for the animals. The following statistical model was used:

$$Y_{ijk} = \mu \text{ x } A_i \text{ x } B_j \text{ x } e_{ijk},$$

where

Yijk = observation of j, referring to group i;

μ = general constant;

Ai = effect of infection i, i = 1.2;

Bj = block effect by weight j, j = 1,2,3,4,5; and

eijk = random error associated with each observation Yijk.

Analyses of weight gain, feed intake, and feed conversion were performed. The computational resource used was the Statistical Analysis System-SAS (1999) statistical program.

Results and Discussion

Throughout the experiment, only the infected animals manifested clinical abnormalities such as fever, enlargement of the lymph nodes, pale mucous membrane, nasal discharge, mild diarrhea, apathy, and reduction in the rate of weight gain. In addition to these signs, one animal from the infected group showed progressive weakness, depression, anorexia, weight loss, severe orchitis, decubitus, ataxia, and subsequent death.

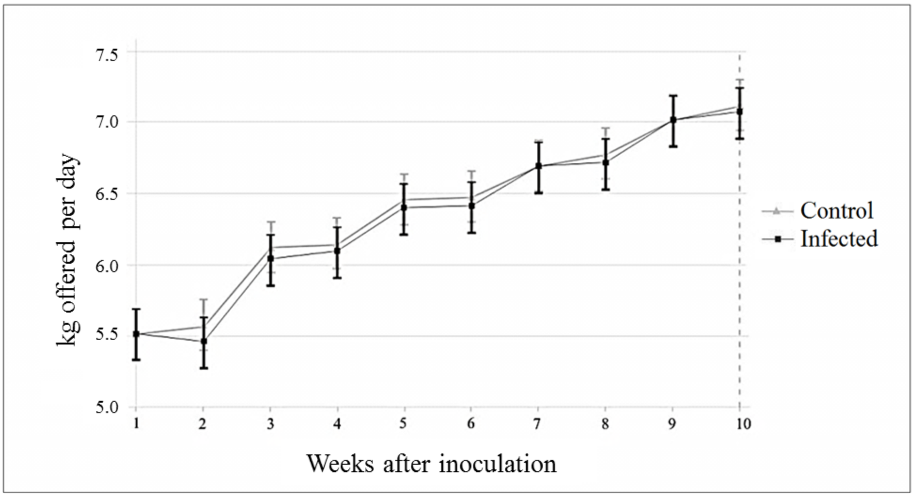
The symptomatology described agrees with that found by Almeida et al. (2010). However, anorexia, wheezing, signs of fatigue after exertion, and weight loss were only observed in the sheep that subsequently died. The symptomatic profile of the group did not indicate the severity after the peak in parasitemia, which agrees with a previous report by Batista et al. (2006), who studied four sheep experimentally infected with a freshly obtained strain from a natural outbreak in Paraiba. However, the animal that died in the current study had symptoms similar to those described by the mentioned authors.

Using cattle as a reference, trypanosomiasis presents itself as a chronic disease, with high morbidity and low lethality, dependent on the strain that is infecting the animal (BORGES, 2014). Even without pathognomonic signs, the symptoms presented (progressive weight loss, debilitation, anemia, among others) associated with high morbidity make this a serious economic problem for cattle production. Abrão et al. (2009), in a study with cattle, found a lethality of 30.43% in a herd of 235 animals. The author states that even when the cattle were treated with a more effective drug against *T. vivax* (diminazene aceturate), the treatment was not effective enough to eliminate the disease from the herd or to prevent new animals from becoming infected.

It is important to emphasize that natural conditions reflect unfavorably on the recovery of animals in naturally occurring outbreaks, sometimes aggravating the condition of the animals. However, the experimental conditions, to which the animals of the present study were subjected, favorably influenced the results, by softening the effects of the infection, which can be supported by the decrease in the weight gained by the animals. This shows that an effective nutritional and sanitary management protocol can reduce herd losses in sheep infected with *T. vivax*, even though these measures demand higher expenses. However, even when studied under controlled conditions in the experimental environment, trypanosomiasis lethality in the sheep studied was 10%, a considerable percentage because the most virulent form of *T. vivax* has not yet been observed in herds outside of the African continent; in the absence of the biological vector, this disease manifests itself in its mildest form.

Throughout the experiment, no significant changes were observed in feed intake ($P > 0.05$), as seen in Figure 1. However, feed consumption was interrupted in the animals that died due to severe apathy and to being positioned in lateral decubitus one day before death. The weekly average of feed intake also did not show a significant difference ($P > 0.05$).

Figure 1. Average weekly values for feed intake (kg) of intact adult male sheep of undefined breed from the group experimentally infected with *T. vivax* and the control group during the experimental period in Mossoró, RN, Brazil.

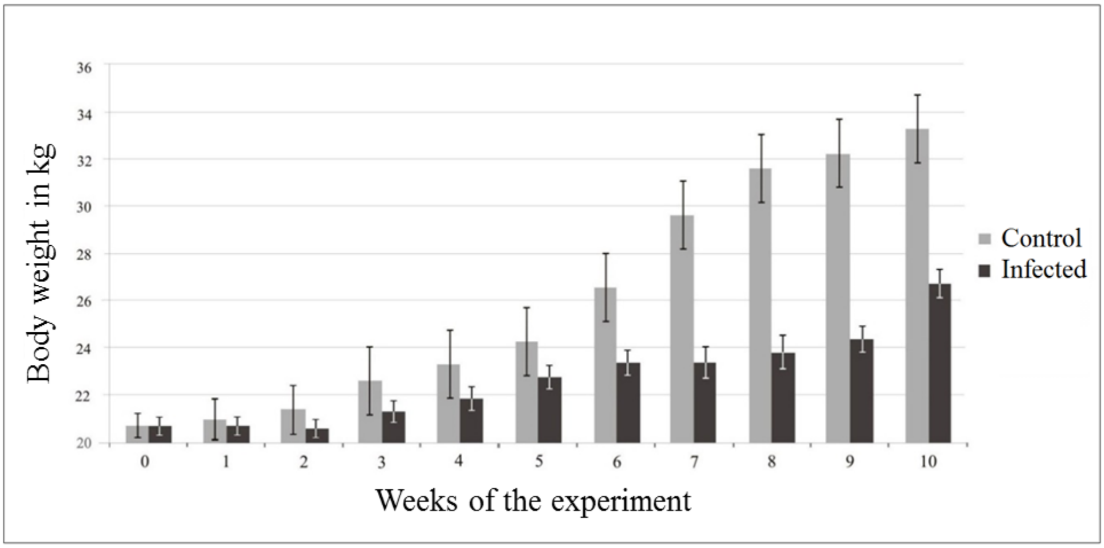


The statistically similar feed intake in both groups ($P > 0.05$) is probably due to the high nutritive value (protein/energy/digestibility) of the feed offered, which is associated with the palatability as well as the abundant supply of forage offered in the pens. In addition, because the sheep in this experiment were previously healthy, normal appetite was present in the studied groups. According to Moraes (2001) and Almeida et al. (2010), during the course of trypanosomiasis, oscillations in parasitemia and even episodes of aparasitemia that may be related to the host's immune response and antigenic variation of glycoproteins are commonly observed (NANTULYA, 1990; CROSS, 2003, CADIOLI, 2005).

Regarding the weekly weight gain (Figure 2), a significant difference ($P < 0.05$) existed with regard to weight gain between the infected and control groups. From the sixth week on, the infected group presented impaired weight gain ($P < 0.05$) relative to the control group.

The statistically verified reduction in weekly weight gain ($P < 0.05$) from the sixth week to the tenth week shows that the effect of the infection is not restricted to the acute phase only, where the peak of parasitemia as well as the greatest reduction in the hematocrit occurs. Instead, an effect also occurs in the chronic phase, with a possible cumulative effect, which resulted in a weight loss for the IG of 24% by the end of the experiment. This percentage resembles the maintenance value observed by Vertegen and Zwart (1991), who evaluated the effect of *T. vivax* infection on energy metabolism and nitrogen balance in goats and found that the energy requirement for maintenance increased by 25% after infection. According to these authors, the increase was associated with a negative nitrogen balance, serum urea increase, urinary creatinine excretion, reduction in nitrogen retention, and greater weight loss in the group of infected animals.

Figure 2. Comparison of the weekly averages for weight gain (in kg) and standard deviation in adult male sheep of an undefined breed from the group experimentally infected with *T. vivax* and the control group, during the experimental period in Mossoró, RN, Brazil.



As shown in Table 1, the initial live weight (LWI) did not present a significant difference (P > 0.05) between the groups, in view of the selection and composition of the standardized groups. However, in relation to live weight at slaughter (LWS), total weight gain (TWG), daily weight gain (DWG), feed conversion (FC), and feed efficiency index (FEI), the infected group presented a reduction in performance when compared to the CG. When TWG was observed as a percentage, the IG notably gained 49.3% weight relative to the CG under the same conditions and in the same period.

Feed conversion (FC) differed statistically (P < 0.05) when the two groups were compared; therefore, a considerable increase was observed for the IG. When the feed conversion was considered over the course of the experiment (Figure 3), the FC was highest during the peaks of parasitemia in the infected animals.

For the feed efficiency index (FEI), calculated from the FC, a decline (P < 0.05) in efficiency is present when a peak in parasitemia occurs and when parasite recurrences are observed in the sixth week to the eighth week. From the eighth week on, low efficiency was noted but with a tendency toward recovery. This recovery by the IG can be observed in the last week (P > 0.05), when the feed efficiencies of both groups are statistically equal.

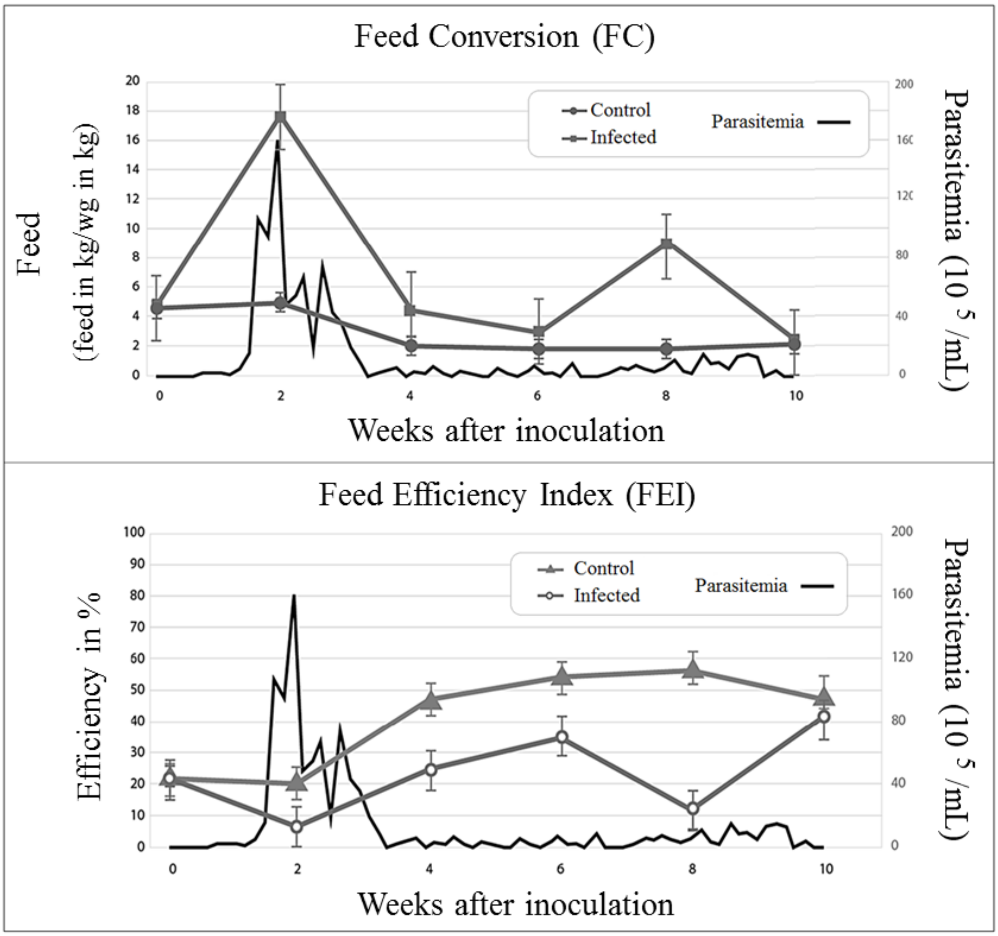
An increase in FC and a decrease in efficiency (FEI) by the infected group may be due to the high demand for nutrients for the development and maintenance of the immune response, as well as the demand for the repair of damaged tissues from the pathological changes caused by the infection (CARDIA et al., 2011). In studies by Ilemobade and Balogun (1981) on swine infected with *T. simiae,* a marked increase in FC was detected, a result attributed by the authors to the severe decrease in feed consumption (consumption of 1/3 of the normal amount). However, in the present study, no decrease in feed consumption was observed, which makes it possible to associate FC loss with other factors, such as the high-energy requirement needed to control the infection.

Table 1. Averages and coefficient of variation (CV) of the initial live weight (LWI) and live weight at slaughter (LWS), daily weight gain (DWG), total weight gain (TWG), feed conversion (FC), and the feed efficiency index (FEI) of sheep in the control group and the group infected by *T. vivax*.

Item	Groups[1]		Difference (%)*	CV (%)
	Control	Infected		
LWI (kg)	20.430 ns	20.420 ns	0.04	2.88
LWS (kg)	33.970 A	27.270 B	19.7	16.66
DWG (g/animal/day)	175.750 A	86.580 B	50.7	22.92
TWG (kg/animal)	12.300 A	6.060 B	50.7	21.05
FC (kg/kg)	2.5630 A	7.2440 B	182.6**	17.67
FEI (%)	44.820 A	23.060 B	48.5	15.18

[1] average followed by the same letters, in the same row, did not differ by Student's t test ($P < 0.05$).
ns Not significant at 5% probability.
* percentage value of the infected group in relation to the control group.
** inverse percentage value to avoid a negative number.

Figure 3. Average values of feed conversion (FC), average values with standard deviations, expressed in percentages, for the feed efficiency index (FEI), and parasitemia (10^5 trypomastigotes/mL) in adult male sheep of an undefined breed from the group experimentally infected with *T. vivax* and the control group during the experimental period in Mossoró, RN, Brazil.



As shown in table 2, a decrease (P < 0.05) in the abdominal circumference of the IG was observed relative to the CG in the zootechnical and body measurements of the studied sheep. No significant differences were observed (P > 0.05) in the other measurements.

Table 2. Averages and respective standard deviations of the body measurements of the control group and group infected by *T. vivax*.

Body Measurements	Control Group[1]			Infected Group[1]		
	Average		Deviation	Average		Deviation
Body Length	42.56	±	2.73 [ns]	41.00	±	2.20 [ns]
Thoracic Circumference	71.85	±	2.64 [ns]	68.29	±	4.71 [ns]
Flank Circumference	79.53	±	4.67 [a]	70.64	±	4.59 [b]
Back Length	39.78	±	2.55 [ns]	39.04	±	2.51 [ns]
Croup Length	14.10	±	2.24 [ns]	12.88	±	1.03 [ns]
Width of the Breast	17.05	±	1.23 [ns]	16.13	±	1.55 [ns]
Width of the Croup	16.29	±	1.27 [ns]	16.05	±	1.16 [ns]
Height of the Withers	60.28	±	3.11 [ns]	60.54	±	2.39 [ns]
Height of the Croup	62.91	±	3.46 [ns]	64.85	±	3.06 [ns]

[1] average followed by different letters on the same row differed by Student's t test (P < 0.05).
[ns] Not significant at 5% probability.

Regarding the abdominal circumference, Mello and Schmidt (2008) affirm that this parameter indicates the ingestive capacity of the individual, presenting a high correlation with the ruminal volume. However, the reduction in abdominal circumference observed in the present study may be a result of the mobilization/metabolization of fat (either omental or subcutaneous) to meet the energy requirement. Moreover, this measurement was probably different between groups because the animals suffered a decline in superficial and omental fat.

Regarding the economic losses related to infected animals destined for slaughter (Table 3), these losses were 19.06%. Losses rose to 24.07% when only the weight of the group was considered, and the losses rose to 31.66% when death was incorporated into the losses caused by weight.

Economic losses caused by *T. vivax* have not yet been fully quantified in cattle herds or even in small ruminant herds. Studies on dairy cattle estimate losses of up to 47% in milk production for natural outbreaks (ABRÃO et al., 2009). In these cases, a higher propensity exists for death; in addition, animals seen as unsuitable for slaughter are rejected, thus imposing extra expenses on the producer in an attempt to restore the herd to a commercial profile. When slaughtered, these animals have lower yields and low market value. In an experimental environment, conditions are favorable, with water, feed, hygiene, and general management control, thus attenuating the economic losses observed in natural outbreaks, mainly by evading pathologies that aggravate the symptoms and may even be responsible for animal deaths.

Because the losses were calculated to find a minimum value, the percentage of loss of 31.66% (which includes a decline in performance and lethality of 10%) recorded in this study allows one to infer that the spread of this disease can cause losses. These losses occur during finishing, in the final weight, in the quality, and due to the poor sanitary reputation of the farm, in addition to possibly causing animal deaths. Thus, it is imperative to inspect, control, and search for ways to eradicate *T. vivax* from Brazil.

Table 3. Values, differences, and percentages of losses for the infected group relative to the control group in the average weight of the sheep at slaughter, average purchase value for each sheep, group value, and estimates after the subtraction of treatment costs and inclusion of deaths at the end of 10 weeks.

Variable	Groups*		Difference[1] BRL	%
	Control	Infected		
Average sheep weight at slaughter (kg)	33.69^{A}	27.27^{B}	32.10	19.06
Average purchase value of each sheep (BRL)[2]	179.57^{A}	136.35^{B}	43.22	24.07
Value of group of sheep (BRL)[3]	1795.68^{A}	1363.50^{B}	432.18	24.07
Estimates subtracted:				
Treatment value (BRL)[4]	1795.68^{A}	1298.25^{B}	497.43	27.70
Value of including only deaths(brl)[5]	1795.68^{A}	1227.15^{B}	568.53	31.66

* averages in the same row that are followed by the same letters did not differ from each other according to Student's t test ($P < 0.05$).
[1]calculated after subtraction (weight of the control group – the value of the infected group) x (value of kg live weight).
[2] value per kilogram (kg) of meat, paid to the producer: BRL 5.33 for finished sheep and BRL 5.00 for lean sheep, obtained from the local market of Mossoró, RN, quoted in 2014.
[3] obtained from a group of 10 sheep (corresponding to said experimental group).
[4] minimum estimated cost for treatment of a sheep BRL 21.75, restricted to only 30% of the infected herd.
[5] cost of including death in nontreated well-fed animals with one death for every 10 infected animals.

Conclusions

Experimental infection of sheep with *Trypanosoma vivax* did not affect feed consumption but negatively affected feed efficiency, feed conversion, and average weekly weight gain. Trypanosomiasis caused by *T. vivax,* in sheep destined for slaughter, caused economic losses of 31.66% due to the decrease in performance and the death rate in the infected group.

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