



Full length article

Lactation curve and milk quality of goats experimentally infected with *Trypanosoma vivax*



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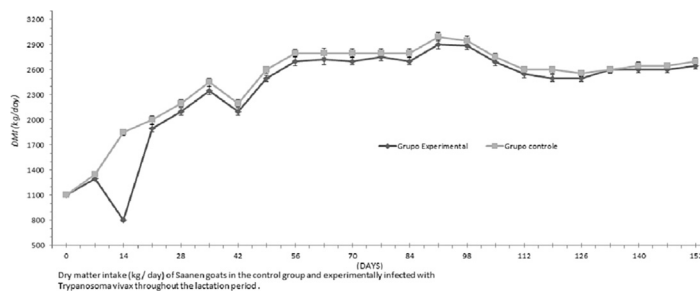
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HIGHLIGHTS

- Trypanosomiasis affected the persistency of lactation, being lower in goats infected.
- *Trypanosoma vivax* infection decreased the physicochemical properties of milk.
- Experimentally infected goats, present unusual lactation curves with lower production.
- Infected goats present unusual lactation curves, with modified milk quality.

GRAPHICAL ABSTRACT



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ABSTRACT

The present study aimed to evaluate the effects of *Trypanosoma vivax* infection on the shape of the lactation curve and the milk quality of dairy goats experimentally infected with *T. vivax*. In total, twenty Saanen goats, aged 26–30 months and the same number of calving (two calvings), were divided into two experimental groups: an infected group, consisting of ten goats intravenously infected with 0.5 ml of blood containing approximately 1.25×10^5 trypomastigotes of *T. vivax* and ten uninfected animals as the control group. Clinical tests and hematocrit, parasitemia, and serum biochemistry evaluations were performed on all of the goats. Milk production was measured daily for 152 days by hand milking the goats and weighing the milk. Every seven days, physicochemical analyses were performed to evaluate the milk. Wood's nonlinear model was used to analyze the lactation curve parameters. The infected goats had high levels of parasitemia and hyperthermia, significantly reduced hematocrit, serum total protein, albumin, and glucose levels and increased cholesterol and urea concentrations. Wood's model indicated that the milk production of goats in the infected group declined sharply over a short period of time and produced a flattened yield curve and significant difference ($P < 0.05$) in the rate of increase of peak milk production, rate of decrease of milk production after the peak, day of peak milk production, and maximum peak milk production compared with that of the control group. Trypanosomiasis also affected the persistency of lactation, which was significantly reduced in goats in the infected group. In addition, the physico-chemical properties of the milk, including the fat content, defatted dry extracts (DDE) and

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protein content, decreased significantly ($P < 0.05$) in the goats in the infected group compared with those in the control group. The *T. vivax*-infected goats showed reduction in milk production, persistence of lactation, and fat levels, the defatted dry extract (DDE) content, and protein, changing the quality of milk.
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1. Introduction

Trypanosoma vivax is a pathogenic hemoparasite that has a negative impact on health and productivity of domestic ruminants in African countries, especially in regions occupied by the biological vector, the tsetse fly (Gutierrez et al., 2006). Adaptation by mechanical transmission through bloodsucking *Stomoxys* spp. and *Tabanus* spp. associated with the animals' shift from endemic to non-endemic areas has contributed to the expansion of *T. vivax* to other regions of the world, such as South America, Central America, and the Caribbean (Silva et al., 2002).

The occurrence of trypanosomiasis by *T. vivax* is becoming increasingly frequent in various states of Brazil (Batista et al., 2007; Cadioli et al., 2012; Cuglovici et al., 2010; Galiza et al., 2011; Pimentel et al., 2012). The disease presents different epidemiological situations in different regions of Brazil. The North and the Pantanal of Mato Grosso can be considered areas of enzootic stability for trypanosomiasis, where the disease is often benign, and infected animals are asymptomatic with very low morbidity and mortality (Desquesnes, 2004). In non-endemic areas, such as the semi-arid region of Northeast Brazil, outbreaks occur most frequently during the rainy season, when there is an increase in vector populations. Outbreaks described in cattle herds, sheep, and goats in the region are reported as having high mortality, abortions, heat repetition, anestrus, neonatal deaths, and drastic reduction of milk production (Batista et al., 2008, 2011; Galiza et al., 2011; Rodrigues et al., 2013).

The pathogenicity of isolated *T. vivax* outbreaks that occurred in the semiarid Brazilian Northeast was confirmed in a study by Silva et al. (2013) through the experimental reproduction of the disease in pregnant ewes. The animals were infected with 1.25×10^5 parasites and presented fever, anemia, weight loss, abortion, and agalactia, with consequent starvation for five days after birth.

Milk quality is defined by its physico-chemical properties and microbiological parameters, and milk properties are characterized by the content of protein, fat, lactose, minerals, and vitamin, which are influenced by udder health, feeding, management, genetics, lactation stage, and animal stress (Santos and Fonseca, 2007). Goat herds are primarily concentrated in the northeast region of Brazil, and account for approximately 91.4% of the 9.164000 existing heads (IBGE, 2009), which correspond to 1.1% of the total herds worldwide.

According to the Food and Agriculture Organization of the United Nations, Brazil ranks 19th worldwide in goat milk production, and among the countries on the American continents, Brazil's goat milk production is the highest (FAO, 2008). Goat breeding for milk production in northeastern Brazil has generated employment opportunities and income in rural sectors and had a high social and economic impact on the region's growth; in addition, 10,000 L of goat milk are produced daily in northeastern Brazil, corresponding to 45.4% of the national production (Costa, 2005).

The drastic reduction in milk production is an important manifestation of trypanosomiasis by *T. vivax*, and may provide economic loss in the dairy farm, directly affecting the producers and industry. Considering the economic impact of trypanosomiasis on milk production in dairy goats in Northeast Brazil, this study aimed to evaluate the effect of experimental *T. vivax* infection on the shape of the lactation curve and milk quality in dairy goats

experimentally infected with *T. vivax*.

2. Materials and methods

2.1. Experimental groups composition

The experimental groups were composed of 20 Saanen goats, females, aged 26–30 months, with average body weights of 56.26 ± 5.23 kg, all in the second lactation. The animals were properly housed in individual cages, in the goat sector of the Federal Rural University of the Semi-Arid (UFERSA), Mossoro, Rio Grande do Norte. Approximately 21 days prior to inoculation of *T. vivax*, all animals were submitted to clinical, hematological, parasitological, and preliminary tests by ELISA for detection of anti-IgG antibodies to *T. vivax* by indirect immunofluorescence (IIF) according to the methodology developed by Silva et al. (2002).

The goats proven clinically healthy and serologically negative for the anti-*T. vivax* (IFAT) research were randomly distributed into two groups: the infected group, consisting of 10 *T. vivax*-infected goats (goats from 1 to 10), and the control group of ten non-infected goats (goats from 11 to 20).

2.2. Food management and evaluation of feed intake

All animals were submitted to identical handling conditions and fed a diet consisting of 40% forage and 60% concentrate. The forage was composed of Tifton 85 (*Cynodon* spp.) And the concentrate was composed of 62% ground corn, 17% soybean meal, 10% cottonseed meal, 5% wheat bran, 4% complex vitamins and 2% limestone, containing 25% crude protein, 40.1% neutral detergent fiber, 18.3% acid detergent fiber, 3.2% ether extract, 3.11% metabolizable energy (Mcal/kg DM), mineral salt, and water. The balance of the ration was based on physiological needs of goats during the lactation phase according to the recommendations of NRC (1981). We conducted the assessment of total daily feed intake, recording the initial weight of feed provided to animals and subtracting the weight of residues of the feeders.

2.3. Preparation of inoculum and experimental infection with *Trypanosoma vivax*

The strain of *T. vivax* used for experimental infection of goats was obtained from a natural outbreak of infected sheep in the city of Sao Jose do Rio do Peixe, Paraíba. Blood samples collected from sheep were preserved in ethanol (v/v) for DNA preparations which were tested using a sensitive PCR assay (TviCATL-PCR) specific for *T. vivax* and amplifying a ~177 bp fragment of the multicopy Cathepsin L-like gene (Cortez et al., 2009). On the fifth day after the delivery date, each animal in the experimental group was inoculated intravenously with 0.5 ml of blood containing 1.25×10^5 trypomastigotes of *T. vivax*, which was estimated based on the method described by Batista et al. (2007).

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