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# EFFECT OF EXPERIMENTAL INFECTION OF *HAEMONCHUS CONTORTUS IN* LACTATING RED SOKOTO AND SAHELIAN GOATS

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## SUMMARY

**This study was carried out to compare the resistance of Red Sokoto and Sahelian breeds of goats to experimental *Haemonchus contortus* infection and to measure the impact of the infection on milk yield, average weight gain, packed cell volume, serum proteins. Gravid goats in their last trimester of pregnancy were divided into two groups. Group one was given no infection while group two was given low infection dose (75$L_3$/kg liveweight) for each breed. The faecal egg count showed significant difference between breed at the low infection level, Sahelian had a higher epg of 984.3±583.15 (P<0.05) than the red Sokoto goats with an epg of 172.1±653.80. The Packed Cell Volume (PCV) was not statistically (P>0.05) different for breed. The total protein concentration was significantly affected by breed with the Sahelian recording a higher concentration of total protein (65.9±3.67g/lt) than the Red Sokoto goats (62.1±4.31g/lt). The Sahelian goats had significantly (P<0.05) higher albumin concentrations (34.1±2.68g/lt) than the Red Sokoto goats (32.5±3.19), There was however no statistical difference (P>0.05), between breeds for mean weight, average daily gain, milk yield and globulin concentrations in both breeds. The red Sokoto showed a relative tolerance to *H. contortus* on the basis of lower egg count, comparable packed cell volume, but due to the fact that the red Sokoto were suckling twin kids this tolerance or resilience was not beneficial in terms of milk yield and average daily gains. On the other hand the Sahelian had higher faecal egg count; they were able to withstand the infection evident by higher average daily gain, milk yield and total protein concentrations.**

**KEY WORDS:** Goats, Lactating, Breed, Experimental, *Haemonchus contortus*

## INTRODUCTION

The Red Sokoto (Maradi) is the most important breed that is widely distributed in northern Nigeria (Makun *et al.*, 2005) and is estimated to be about half of the total goat population in the country. It inhabits the sub humid and semi-Arid regions of the country, while the Sahelian is sparsely distributed along the semi-arid and arid regions of Nigeria, but most abundant in the republic of Niger, a boundary country to Nigeria (Shaib *et al.*, 1996).

Helminth infections are important factors that influence dairy production world-wide (Silvestre *et al.*, 2000). Gross *et al.* 1999 reviewed 80 experiments in dairy cow and reported that in about 80% of the experiments, there was an increase in milk production and milk fat following anthelmintic treatment. In earlier studies, dairy goats had shown that not only do helminths affect milk production, but helminthiasis has profound effect on high-producing and first lactating goats by making them less resistant and resilient to nematode infection when compared to *does* with low level

of milk production (Charteir *et al.*, 2000, Hoste *et al.*, 2005).

Etter *et al.* (2000) reported that the differences in response to infection in dairy goats, was dependent on both nutritional and generic factors. They reported that the differences between the high-producers (HP) and low-producers (LP) during parasitic challenge becomes evident at the beginning of lactation when the requirement by the HP may not be met by the routine ration, therefore requiring supplementation. Hoste and Charteir (1993) and Charteir and Hoste (1997) showed that when challenged with nematode, the HP goats excreted more faecal eggs in comparison with the LP goats, but when dietary protein was included in their diets, the HP goats exhibited lower egg output (Hoste *et al.*, 2006). Also the periparturient rise (Sargison *et al.*, 2007) in faecal egg count observed during late pregnancy and early lactation might also be attributable to lowered maternal immunity during these physiological stages of the animal (Chauchan *et al.*, 2003; Papadopoulos *et al.*, 2003; Knox *et al.*, 2006).

The objective of the study was to evaluate the comparative resistance and/or resilience of Red Sokoto and Sahelian goats to experimental infection of *H. contortus* during lactation.

## MATERIALS AND METHODS

The study was conducted in September 2006 at the National Animal Production Research Institute, (NAPRI), Shika, Ahmadu Bello University, Zaria, Nigeria. Shika is situated in the Northern Guinea Savannah zone between latitudes 11° and 12° N, and between longitudes 7° and 8° E; at an altitude of 650m; with a mean annual rainfall of 1150mm. The climate of the site is sub humid; rainfall is well distributed during the rainy season between May and October, with about 70% of the rain occurring during the months of July and August Barje *et al.* (2007). The average temperature and humidity during the wet season are 24.7°c and 72% respectively. The early dry season commences from October with a period of cold dry weather known as harmattan lasting until February. This is followed by the hot weather when temperatures fluctuate during the day (14-34°C) and relative humidity is between 10-20%.

**Experimental animals and design**

Animals were housed a week after parturition and infected. Five *does* of Red Sokoto and five does of Sahelian breed weighing approximately 20kg were infected with low dose of *H. contortus* larvae. Equal numbers of does of the same breeds were not infected and served as control. Animals in group 1 were the controls, and they had no larva infection while those in group 2 had 75 larvae ($L_3$) per kg live weight given as trickle infection 3times per week for 3 weeks. The range of infection was between 3825 to 6000 infective $L_3$ per week per animal (Romjali *et al.* 1996, Wallace *et al.* 1996). Water and mineral salts were supplied *ad libitum*.

Prior to the experiment, animals were checked for helminths and treated accordingly. The kids were allowed to suckle the dam to obtain colostrum for one week prior to infection of their dams with *H. contortus* larvae, but continued suckling their dams throughout the experiment. The health management of the goats in NAPRI comprises of an annual immunization with pestes des petit (PPR) vaccine purchased from the Nigerian Veterinary Research Institute Vom, ( which is about 200km southwest of Zaria) weekly dipping to control ectoparasites and strategic deworming to reduce helminth burden. The feed consisted of *Digitaria simutsii* hay and concentrate, which included maize (26.1%); wheat offal (27.8%); cottonseed cake (43.1%); bone meal (2%); and salt (1%) and the goats were fed individually at 4% of their body weight.

**Larval culture**

Infective larvae of *H. contortus* were produced from female worms obtained from abomasums

purchased from small ruminant slaughter slabs in 3 market districts in Zaria town. Abomasums were transported to the laboratory in a cooler, and then washed immediately, and then worms were gently crushed to rupture the uteri to release their eggs. Eggs were cultured at 28°C in damp heat-sterilized bovine faeces for 7 days. The harvested larvae were counted and stored in water at 4°C. Thereafter goats were dosed according to their treatment group before flushing with water (Makun *et. al.* 2008).

**Parasitological techniques**

From time of infection, goats were weighed each week for 10 weeks. Faecal samples were collected from the rectum of individual goat for faecal egg count (FEC) using modified McMaster technique (Whitlock, 1948). Blood samples with anticoagulant (EDTA) were collected by jugular venipuncture. Packed cell volume was determined by the microhaemotocrit method (Benjamin, 1978), while the serum was harvested from clotted blood and total serum proteins were determined by the bieuret method using standard Boehring diagnostic kit described by Nnadi *et. al.* (2007). The serum albumin fraction was determined by the Bromocresol green methods (Weichselbaum, 1946) of the Boechringer standard diagnostic kit. Globulin fraction was estimated by difference between the total protein and albumin fractions (Nnadi *et al.*, 2007).

**Milk Collection**

Milk was collected twice a week to determine the yield and analysed for chemical composition. Kids were allowed to suckle their dams, except on the days prior to milk collection, where they were separated from their dams 12hour prior to milking.

**Data analysis**

Analysis was made of the weight changes and milk off take. The differences in faecal egg count, PCV, total protein, albumin and globulin concentration between the breeds were analyzed by repeated measures of variance using the general linear model procedure of SAS (2000) package.

## RESULTS

**Weight change**

The results of the mean bodyweight of the does are presented in Table I. There was no significant weight difference between breed of the goats. Amongst the breed, the Red Sokoto had the higher mean weight of 26.0 and 25.0kg for control and low infection groups, while the Sahelian had a mean weight of 22.4 and 25.5 for the control and low infection groups respectively. The average daily gains for the Sahelian were 37.8 and 24.5g/day was higher than that of the Red Sokoto with 26.8 and 15.2g/day for the control and low infection groups respectively.

**TABLE I: Weight changes (kg) and ADG (g/day) of Lactating Red Sokoto and Sahelian goats experimentally infected with *H. contortus***

| Week PI | Red Sokoto | | | | Sahelian | | | |
|---|---|---|---|---|---|---|---|---|
| | $0L_3$/kg | diff | $75L_3$/kg | diff | $0L_3$/kg | diff | $75L_3$/kg | diff |
| 0 | 25.3 | | 28.4 | | 20.9 | | 27.1 | |
| 1 | 25.3 | 0 | 28.2 | -0.2 | 21 | 0.1 | 27.3 | -0.2 |
| 2 | 25.5 | 0.2 | 29.9 | 1.5 | 23.9 | 3 | 27.0 | -0.1 |
| 3 | 25.2 | -0.1 | 30.2 | 1.8 | 23.6 | 2.7 | 24.5 | -2.6 |
| 4 | 25.4 | 0.1 | 29.3 | 0.9 | 22.2 | 1.3 | 27.3 | 0.2 |
| 5 | 25.9 | 0.6 | 29.5 | 1.1 | 22.5 | 1.6 | 24.9 | -2.2 |
| 6 | 26.7 | 1.4 | 29.9 | 1.5 | 22.9 | 2 | 25.0 | -2.1 |
| 7 | 26.4 | 1.1 | 29.0 | 0.6 | 21.9 | 1 | 27.1 | 0 |
| 8 | 26.6 | 1.3 | 29.7 | 1.4 | 22.6 | 1.7 | 25.9 | -1.2 |
| 9 | 26.6 | 1.3 | 29.2 | 0.8 | 22.7 | 1.8 | 26.3 | -0.8 |
| 10 | 25.3 | 0 | 29.5 | 1.1 | 23.3 | 2.4 | 25.7 | -1.4 |
| X | 26.0 | | 25.0 | | 22.4 | | 25.5 | |
| SEM | 6.67 | | 5.97 | | 6.67 | | 5.97 | |
| ADG | 26.8 | | 15.2 | | 37.8 | | 24.5 | |

**Faecal egg count**

There was significant difference ($P<0.05$) in the faecal egg count between breed (Table II). The faecal egg count was influenced by the Infection levels only ($P<0.05$); the log transformed epg for goats on the low infection level had the higher count of 1.9±0.33 and 1.6±0.32 eggs per gram for the Sahelian and Red Sokoto breeds.

**Milk yield and composition**

The average daily milk yield differ significantly ($P<0.05$) between the two breeds ($P<0.05$). The average daily milk for the Sahelian was 307.0±35.8mls and the Red Sokoto had 212.4±12.6. The milk yield was recorded twice weekly, following infection. There was a drop below the pre-infection level by week 1.5. The Red Sokoto demonstrated a fluctuating pattern in the milk yield post infection. The pre-infection level of production was not attained again with the exception of the sudden peak in production at week 4. The Sahelian showed a sharp drop below pre-infection level by one and a half week of infection after which there was a gradual rise to a peak of 327.8±44.9 at week five and a half. There was no difference ($P>0.05$) in the chemical composition of milk for breed or following infection.

**TABLE II: Least squares mean of epg of lactating Red Sokoto and Sahelian goats infected *H. contortus***

| Weeks PI | Red Sokoto | Sahelian |
|---|---|---|
| | $75L_3$ | $75L_3$ |
| 0 | 0 | 0 |
| 1 | 0 | 20 |
| 2 | 8 | 4180 |
| 3 | 12 | 200 |
| 4 | 16 | 3192 |
| 5 | 164 | 1192 |
| 6 | 672 | 408 |
| 7 | 268 | 1612 |
| 8 | 336 | 292 |
| 9 | 72 | 532 |
| 10 | 196 | 536 |
| X | $172.1^b$ | $984.3^a$ |
| SEM | 653.80 | 583.15 |

**Packed cell volume**

The PCV was neither influenced by breed (P>0.05) nor by Infection level (P>0.05). Both breeds showed a drop in the PCV by week 2 of infection (Table III). For the Sahelian, the initial PCV dropped by 42% while in the Red Sokoto it dropped by 33%. For both breeds the highest mean PCV after infection was attained by week 3, by which time the Sahelian had a value of 27%, and the Red Sokoto a value of 26%. These values were nonetheless lower than the pre-infection values. By the end of the experiment at week 10, the mean PCV for the Sahelian and Red Sokoto breeds were 24% and 23% respectively. These values were about 55% and 66% of their respective pre-infection values.

**TABLE III: Changes in Packed Cell Volume ( %) of lactating Red Sokoto and Sahelian goats infected with *H. contortus***

| Week PI | Red Sokoto | | | | Sahelian | | | |
|---|---|---|---|---|---|---|---|---|
| | $0L_3$/kg | diff | $75L_3$/kg | diff | $0L_3$/kg | diff | $75L_3$/kg | diff |
| 0 | 35.6 | | 31.7 | | 38.7 | | 41.6 | |
| 1 | 35.5 | -0.1 | 31.7 | 0 | 38.5 | -0.2 | 41.6 | 0 |
| 2 | 31 | -4.6 | 26.8 | -4.9 | 25.2 | -13.2 | 23 | -18.6 |
| 3 | 28.6 | -7.0 | 26.5 | -5.2 | 31.7 | -6.7 | 25.8 | -16.8 |
| 4 | 26.3 | -9.3 | 24.8 | -6.9 | 27.8 | -10.7 | 25.6 | -16 |
| 5 | 25 | -10.6 | 24.3 | -7.4 | 27.5 | -11.2 | 26 | -15.6 |
| 6 | 24.5 | -10.1 | 20 | -11.7 | 25.2 | -13.5 | 20.8 | -20.8 |
| 7 | 25.3 | -10.3 | 24.5 | -7.2 | 24.3 | -14.4 | 20 | -21.6 |
| 8 | 26.5 | -9.1 | 23.5 | -8.2 | 26.3 | -12.7 | 25.6 | -16 |
| 9 | 23.3 | -11.3 | 20.8 | -10.9 | 23.5 | -15.2 | 23.8 | -17.8 |
| 10 | 25 | -10 | 21.8 | -9.9 | 22.8 | -15.9 | 24.4 | -17.2 |
| X | 27.1[a] | | 24.3[a] | | 27.6[a] | | 25.2[a] | |
| SEM | 5.84 | | 5.86 | | 5.86 | | 5.25 | |

**Serum proteins**

The difference in the mean value was significant for both breed and Infection dose (P<0.05). The value of 65.7±1.43g/dl for the Sahelian was significantly higher than the 62.6±0.80g/dl for the Red Sokoto goats. Likewise the control groups (65.3 and 63±1.23g/dl) had a higher mean total protein concentration than the infected group (62.9 and 62.1±1.00g/dl) for the Sahelian and red Sokoto respectively (Table IV). In both breeds, there was a drop in the total protein concentration below the pre-infection level by week 1. The pre-infection level of production was never attained until the end of the experiment. Similarly the mean albumin concentration was significantly influenced (P<0.05) by breed and infection group, the Sahelian had a higher albumin concentration (35.7±0.99g/dl) than the Red Sokoto (33.7±0.56g/dl). Both breeds showed a drop in the mean albumin concentration by week 2 post-infection (Table V).

The Sahelian suffered a drop of 30% from the initial pre-infection value while the Red Sokoto experienced a 26% drop within the same period. For both breeds the pre-infection value were never attained except for the rise observed in week 5. By the end of the experiment at week 10 the mean albumin concentration for the Sahelian and Red Sokoto were 28.8 and 28.9 g/dl representing 57 and 54% of the respective pre-infection values. However there was no significant difference (P>0.05) for both treatment and breed. There was no difference in globulin concentration, between the Sahelian (29.9±1.21g/dl) and the Red Sokoto goats (29.4±0.73g/dl). The highest mean globulin concentration was attained for both breeds at the end of the experiment in week 10. The globulin concentrations at the end of the experiment were 176 and 154% of their respective pre-infection values for the Sahelian and Red Sokoto goats.

**TABLE IV: Least squares mean of Total protein (g/dl) of lactating Red Sokoto and Sahelian goats infected with different levels of *H. contortus***

| Weeks PI | Red Sokoto | | | | Sahelian | | | |
|---|---|---|---|---|---|---|---|---|
| | 0 $L_3$/kg | diff | 75$L_3$/kg | diff | 0$L_3$/kg | diff | 75$L_3$/kg | diff |
| 0 | 72.5 | | 65.8 | | 69.3 | 71.2 | 0 | |
| 1 | 72.3 | -0.2 | 65.5 | -0.3 | 69.4 | 1 | 71.0 | -0.2 |
| 2 | 67.7 | -4.8 | 58.3 | -7.5 | 69.3 | 0 | 54.0 | -12.2 |
| 3 | 59.3 | -13.8 | 61.7 | -4.1 | 57.5 | -11.8 | 65.5 | -5.7 |
| 4 | 64.3 | -8.2 | 54.3 | -11.5 | 61.7 | -7.6 | 68.2 | -3 |
| 5 | 57.0 | -15.5 | 61.0 | -4.8 | 64.8 | -0.5 | 72.4 | 1.2 |
| 6 | 62.3 | -10.2 | 69.8 | 4 | 66.3 | -3 | 64.0 | -7.2 |
| 7 | 58.5 | -14 | 65.5 | -0.3 | 61.8 | -7.5 | 66.8 | -4.4 |
| 8 | 63.0 | -9.5 | 65.3 | -0.5 | 65.0 | -4.3 | 65.8 | -5.4 |
| 9 | 63.0 | -9.5 | 60.0 | -5.8 | 65.0 | -4.3 | 65.8 | -5.4 |
| 10 | 63.3 | -9.2 | 60.0 | -5.8 | 71.5 | 2.2 | 66.0 | -5.2 |
| X | 63.1 [a] | | 62.1 [ab] | | 65.4 [a] | | 65.9 [a] | |
| SEM | 4.21 | | 4.31 | | 4.09 | | 3.67 | |

**TABLE V: Least squares mean of Albumin concentration (g/dl) of lactating Red Sokoto and Sahelian goats infected with Different levels of *H. contortus***

| Weeks PI | Red Sokoto | | | | Sahelian | | | |
|---|---|---|---|---|---|---|---|---|
| | 0$L_3$/kg | diff | 75$L_3$/kg | diff | 0$L_3$/kg | diff | 75$L_3$/kg | diff |
| 0 | 52.5 | | 49.7 | | 52.5 | | 49.0 | |
| 1 | 52.3 | -0.2 | 49.0 | -0.7 | 52.1 | -0.4 | 49.3 | 3 |
| 2 | 37.3 | -15.2 | 40.3 | -9.4 | 35.0 | -17.5 | 36.0 | -13 |
| 3 | 32.3 | -20.2 | 27.3 | -22.4 | 34.0 | -18.3 | 34.3 | -14.7 |
| 4 | 32.3 | -20 | 26.5 | -23.2 | 33.8 | -18.7 | 33.0 | -16 |
| 5 | 31.7 | -20.8 | 25.3 | -24.4 | 37.8 | -14.7 | 33.4 | -15.6 |
| 6 | 29.8 | -22.7 | 30.0 | -19.4 | 33.5 | -19 | 33.2 | -15.8 |
| 7 | 28.3 | -24.2 | 33.5 | -16.2 | 33.0 | -19.5 | 31.0 | -18 |
| 8 | 26.3 | -26.2 | 29.7 | -20 | 39.5 | -13 | 32.6 | -16.4 |
| 9 | 28.8 | -23.7 | 29.7 | -20 | 39.5 | -13 | 29.4 | -19.6 |
| 10 | 28.9 | 23.6 | 28.7 | -20 | 39.4 | -13.1 | 29.5 | -19.5 |
| X | 33.8 [ab] | | 32.5 [b] | | 37.2 [a] | | 34.1 [a] | |
| SEM | 3.19 | | 3.19 | | 3.13 | | 2.68 | |

## DISCUSSION

The parasitological, pathophysiological and production parameters evaluated in this study showed resistance of Red Sokoto and Sahelian goats to experimental infection with *Haemonchus contortus* helminth. The Sahelian became patent earlier than has been reported, but these animals were peri-parturient. It has been reported that peri-parturient animals usually have high egg count because of the lowered immune status; therefore it is not unlikely that the earlier epg was due to helminths other than experimental dose (Mandonnet *et al.*, 2005).

It was well established that the intensity of infection with gastrointestinal nematodes in ruminants is largely dependent on the intensity of the host immune response and ability to regulate the worm population (Cattador *et al.*,

2008). This phenomenon has been shown to be directly related to the quantity of larva ingested usually conditioned by the feeding behavior of the host. It has been earlier suggested that the ability to control parasitism by manipulation of the host immune response, varies between breeds (Abbott *et al.*, 1986). This phenomenon has also been reported by Baker *et al.* (1998), Rege *et al.* (2002) and Chiejina *et al.* (2002) who showed that there was usually breed response in the faecal egg output. Chiejina *et al.* (2002) and Fakae *et al.* (1999) showed that the West African Dwarf goat in Nigeria were able to express better immunity to local isolate of *H. contortus* compared to when the isolate was exotic. Therefore the environment and host interaction play a significant role in acquisition of immunity against a particular infection. It is only when there is a shift to an extent that the parasite overcomes the immune system that production parameters become affected.

The inability of the Red Sokoto to exhibit better weight gain and higher milk yield even though they showed resilience to the infection evident by lower FEC may be attributable to the higher production level. It has been suggested that in adult reproducing animals, the priority for response is to, maintain their body protein and survival; reproductive efforts; expression of immunity and lastly attainment of fatness (Papadopoulos *et al.*, 2007). Therefore animals that are high producer or at their peak production would be more susceptible to nematode infection with serious pathology as compared to those low producers. The Red Sokoto goats in this study were suckling twin kids as compared to the Sahelian goats that were suckling single kids, hence the demand for the survivability of the dams and sustainability of their kids outweighed the demand for attain body weight, although there was evidence in their total protein values to suggest that they had higher concentration of globulin, which is the fraction of the serum responsible for defense mechanisms. This confirms the phenomenon that, the resistant and resilient status of an animal is indirectly related to the importance of milk yield which is dependent on the nutritional requirement (Etter *et al.*, 2000). In a similar study, Barker *et al.* (1998) reported that the Small East Africa goats showed higher liveweight than the Galla goats.

The infection with *H. contortus* affects the requirement of the animal; as the goat has to respond to the challenges of milk production, as well as defense against parasitic infection. This is similar to the findings of Kyriazakis *et al.* (1996) where goats that were on high level of infection were more affected than those on the low level or control. Eknaes *et al.* (2006) reported that dairy animals usually mobilized their body reserves to sustain milk production in early lactation and that this was more pronounced in animals that were in the first lactation and especially suckling twin kids like the Red Sokoto breeds of goats in this experiment.

In studies with *Haemonchus contortus*, apart from faecal egg count and worm burden, packed cell volume has always been used as an indication of resistance or tolerance of the disease, but where the level of challenge is low; the effect on PCV is usually not noticed (Rege *et al.*, 2002). The difference observed in PCV and serum protein concentration between the infected and control goats suggested that the lowered PCV in the infected group was due to the *H. contortus* challenge and that the lack of difference between the Red Sokoto and Sahelian breeds might either have been due to the small number of experimental animals or the low level of challenge. In an earlier trial, effect of experimental *H. contortus* infection on PCV was noticed in the two breeds, and was because one of the treatment groups consisted of a higher dose of larva (Makun *et al.*, 2008)

There was no effect in the concentration of total protein in the serum, which is in agreement with the work of Kyriazakis *et al.* (1996) who showed that even after supplementation with dietary protein, there was no significant difference in the serum protein between infected and control animals. However Red Sokoto had lower mean

total protein and albumin as compared to the Sahelian. Hypoproteainaemia and hypoalbuminaemia in this trial is an indication of the pathogenesis associated with *Haemonchus contortus* infection. Low serum protein has been shown to be an indication of the adverse effect of haemonchosis. Therefore, even though the level of infection was low, the Red Sokoto showed more pathologic effect of the infection due to the higher demand of suckling twin kids as compared to the Sahelian does. It is also possible that the high protein diet may have reduced the negative effects of the infection since protein supplementation has been reported to reduce the patho-physiology of gastrointestinal parasitism. Charteir *et al.* (2000) demonstrated that goats that were fed high protein diet (25%) exhibited lower egg output, significantly higher milk yield and fat content than those goats that were fed normal level of protein (16%). Therefore the high protein level of 20.3% crude protein in this experiment as against the recommended 16% crude protein may have partially enhanced resilience of these goats.

## CONCLUSION

The Red Sokoto showed a relative resistance to the establishment of *H. contortus* on the basis of lower egg count, comparable packed cell volume, but due to the fact that the red Sokoto were suckling twin kids this tolerance was not beneficial in terms of milk yield and average daily gains.

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