Observations on the effects of concurrent natural bovine Trypanosoma and Fasciola infections in Kone area, western Ethiopia

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SUMMARY

A study was carried out to assess the effects of concurrent Trypanosoma congolense and Fasciola infections in an endemic area in western Ethiopia. A total of 32 zebu cattle, confirmed positive for trypanosomososis and fasciolosis, were divided into 4 groups of equal number and received either isometamidium, or triclabendazole, or both, or none. Intensity of parasitaemia, faecal faecal egg output (epg), packed cell volume (PCV), differential eosinophil count and live weight gains were monitored weekly for a period of ten weeks. The results indicated that the initial parasitaemia due to natural infection with T. congolense ranged from 2+ to 4+ score in all treatment groups. Parasitaemia in Group I and II declined to zero level at week 3 post-treatment with isometamidium. Animals in Group III and IV (without isometamidium treatment) continued with fluctuating parasitaemia throughout the study period. Faecal examination showed a mean Fasciola egg ranging from 103 to 145 in all the groups prior to treatment with triclabendazole. One week after treatment, animals ceased excreting Fasciola eggs while non-treated subjects continued to do so with an overall mean epg count of 130 ± 11.68 and 148 ± 8.71 for Group II and IV, respectively. Assessment of mean PCV values of different treatment groups indicated 37.04 % and 26.81 % improvement in Group I and II, respectively. Differential count results indicated a significantly higher eosinophil number in Fasciola positive animals (Group II and IV) than in Group I and III regardless of absence or presence of trypanosomie infection. The results also indicated the presence of higher overall mean body weight gain in Group I and II (trypanosomie negative animals) than their Group III and IV counterparts, irrespective of the presence or absence of Fasciola infection. The present study strongly suggests that concurrent infection due to Trypanosomie and Fasciola infection is the most harmful form of parasitism in the study area, warranting for due considerations for the control of these diseases.

KEY-WORDS : Trypanosomosis - Fasciolosis - Bos indicus - concurrent infection - Ethiopia.

RÉSUMÉ

Observations des effets de l’infection naturelle simultanée des bovins par Trypanosoma et Fasciola dans une région de Kone dans l’ouest de l’Ethiopie. Par Z. MATHEWOS, A. GETACHEW et J. YILMA.

Une étude fut menée pour évaluer les effets de l’infection simultanée par Trypanosoma et Fasciola dans une zone d’endémie dans l’ouest de l’Ethiopie. Trente deux bovins zébu, confirmés positifs pour la trypanosomose et la fasciolose, furent divisés en 4 groupes de nombre égal d’animaux auxquels furent administrés respectivement de l’isometamidium, du triclabendazole, les deux traitements ou aucun traitement. La parasitémie, le comptage coproscopique des œufs de douve (epg), l’hématocritie, le comptage différentiel des éosinophiles et le gain en poids vif furent enregistrés chaque semaine pendant une période de dix semaines. Les résultats montrent que la parasitémie initiale causée par l’infection naturelle avec T. congolense variant entre le score 2+ et 4+ dans tous les groupes avec traitement. La parasitémie dans les groupes I et II baissa jusqu’au niveau zéro à la troisième semaine après traitement avec de l’isometamidium. Les animaux des groupes III et IV sans traitement avec de l’isometamidium ont gardé une parasitémie variable pendant toute la période d’étude. L’examen des fèces a montré un comptage fécal moyen (epg) de Fasciola variant entre 103 et 145 dans tous les groupes antérieurement au traitement avec le triclabendazole. Une semaine après traitement les animaux ont cessé d’excréter les œufs de Fasciola alors que les animaux non traités continuaient l’excrétion avec un comptage epg moyen total de 130 + 11.68 et de 148 + 8.71 pour les groupes II et IV respectivement. Les valeurs moyennes de l’hématocritie des différents groupes traités indiquent une amélioration de 37.04 % et 26.81 % pour les groupes I et II respectivement. Cependant, les animaux des groupes III et IV montrèrent une chute de 24,1 % et 42.63 % respective-ment. Le comptage différentiel indiqua un nombre significativement supérieur d’éosinophiles chez les animaux positifs pour Fasciola par rapport au nombre d’animaux négatifs, sans considérer l’absence ou la présence d’infection trypanosomienne. Les résultats indiquèrent également un gain moyen général en poids vif supérieur pour les animaux des groupes I et II (sans trypanosomose) par rapport aux animaux des groupes III et IV (avec trypanosomose) sans tenir compte de l’infection par Fasciola. Cette étude suggère fortement que l’infection simultanée par trypanosomie et fasciolose est la forme de parasitisme la plus nuisible dans la zone d’étude et qu’une attention appropriée devrait être portée à toute tentative de contrôle de ces deux maladies.

MOTS-CLÉS : Trypanosomose - Fasciolose - Bos indicus - infection simultanée - Ethiopie.
Introduction

Cyclically transmitted bovine trypanosomosis, caused by Trypanosoma congoense, T. vivax and T. brucei, is one of the major diseases in South and Southwestern Ethiopia [4]. Apart from causing clinical diseases, which leads to high mortality and poor productivity, trypanosomosis also renders large areas of Ethiopia totally unsuitable for cattle based agriculture. Therefore, the disease represents a major obstacle not only for increased food production, but also to the agricultural and socioeconomic development endeavors of the communities in tsetse infested areas [26].

Fasciolosis, especially the chronic form, is the common and one of the major anaemia causing helminth infections in the tropic [28]. In Ethiopia, infections both due to F. hepatica, the temperate species, and F. gigantica, its tropical counterpart, occur in different agroecological zones [12, 31]. The disease causes considerable economic loss through mortality, organ condemnation at meat inspection, reduced productivity (weight gain, milk yield and traction power) and lowered resistance to other concurrent infections [7, 22].

In cattle infected either by Trypanosomae and/or Fasciola spp, anaemia is a well-recognized and inevitable consequence. In tsetse infested areas, anaemia is mainly attributed to Trypanosoma infections [19]. However, helminthes like Fasciola are equally potent and highly prevalent anaemia-causing pathogens [17]. An important phenomenon, which is still a subject of discussion in the context of trypanosomosis and fasciolosis, is immune-suppression. Laboratory experiments have shown that T. brucei infection superimposed on a Nippostrogylus brasiliensis infection in rat, resulted in an abolished self-cure response and enhanced pathogenicity of the latter [27]. A reduced prepatent period and increased pathogenicity of Haemonchus contortus infection superimposed on primary T. congoense infection is also reported [16]. Despite its frequent occurrence under field conditions in the tropics, however, information with regard to concurrent Trypanosoma and Fasciola infections in cattle, is scanty. The present experiment was, therefore, designed to assess the effects, on certain clinical parameters, of these two common anaemia-causing diseases of cattle in Kone settlement area, Western Ethiopia.

Materials and methods

THE STUDY AREA

The study was carried out in the Lower Didessa Valley, at Kone Settlement area, Western Ethiopia. The area is located some 510 km West of Addis Ababa, the capital, 9.0°N-36.5°E, at an altitude range between 1100 m and 1400 m a.s.l. Geographically, the area is classified as humid zone and as having a climate of atypical tropical rain forest. The annual rainfall varies between 1200 mm and 1600 mm, 85 % of the precipitation occurring between May and October, while the remaining is an intermittent shower from February through April. The annual mean of minimum and maximum air temperature varies from 9.3 to 14.5 °C and 26.1 to 33.4 °C, respectively (Regional Meteorology Services, 1997).

Generally, the area lies within the tsetse belt zone [17] and among the regions where high annual risk of fasciolosis was forecasted for most part of the year [31]. The lively hood of the inhabitants of the area is based of crop-livestock farming where animal power plays a crucial role.

Experimental animals and management

By way of purposive sampling techniques, based on approximate uniformity in estimated body weights, age, Packed Cell Volume (PCV) levels, confirmation of the presence of natural concurrent Trypanosoma and Fasciola infections with apparent similarity in intensity of infection, 32 adult local Zebu cattle (Bos indicus) were selected.

All experimental animals were kept under traditional village management in which they were allowed daytime grazing on natural pastures and watered from rivers on regular basis. Animals are kept in open-air barns built near individual house holds and supplemented with crop residues provided early in the morning and late in the afternoon, prior and after grazing, respectively.

THE STUDY PROTOCOL

Experimental animals were randomly divided into four treatment groups, consisting eight animals each, and designated as Group I, II, III and IV (Table I).

Group I. Animals in this group were treated once with Isometamidium chloride hydrochloride (Trypamidium/Samorin, Rhone Merieux, France) at a dose rate 1 mg/kg, IM, as 2 % solution. In addition, they were treated with Trichlabendazole (Fascinex®, CIBA Geify, Switzerland) at a dose of 12 mg/kg, per os. This group served as an overall positive control.

Group II. Animals in this group received a single dose of Isometamidium chloride hydrochloride alone and served as Fasciola positive and Trypanosome negative group.

Group III. Animals in this group received a single dose of Trichlabendazole alone and served as Trypanosome positive and Fasciola negative group.

Group IV. Animals in this group received no treatment and served as an overall positive control.

After these initial treatments, a two weeks acclimation was allowed and all treated animals were subjected to reexamination to ascertain their clearance from the corresponding infections against which they were treated. Ten animals that experienced relapse after Isometamidium hydrochloride treatments were again treated with Diminazine acetate (Berenil®, Hoechst, Germany) at a dose rate of 7 mg/kg IM to definitely clear relapsed infection.

The experiment lasted for ten consecutive weeks and at the term of the study all experimental animals received Diminazine and Trichlabendazole treatments to clear all Trypanosome and Fasciola infections.
MEASURED PARAMETERS

All experimental animals were sampled and measurements performed at trial initiation and weekly then after for ten consecutive weeks.

— Parasitaemia: All centrifuged samples in capillary tubes used for PCV level determination were subsequently used for measuring the weekly levels of Trypanosoma parasitaemia in all treatment groups. Each microhematocrit tube was cut 1 cm above and 1 mm below the buffy coat layer. The content then expressed on clean slide, examined under a 40 x objective microscope by the buffy coat method [20] and intensity of infection was graded from 0 to 6 as per the standard scores described by PARIS et al., [24].

— Faecal Egg Output: Fresh faecal samples were collected directly from the rectum of all experimental animals during the weekly sampling occasions. Specimens were transported to the laboratory in screw cap bottles under airtight conditions, Fasciola egg per gram of faeces (epg) was determined employing the standard McMaster technique with saturated Zinc Sulphate solution as a floating medium [18].

— Packed Cell Volume (PCV): Animals were bled from the marginal ear veins into paired heparinized microhemacrit capillary tubes up to three-quarter of its capacity. Immediately after collection, the lower end of each tube was sealed with creastaseal (Hawaksly, England), centrifuged at 1200 rpm for five minutes. PCV level was read from a microhematocrit reader and values are expressed in percentage [26]. Mean PCV improvement (MPI) between initial and final measurements was computed for all treatment groups using the following formula.

\[
\text{MPI} = \frac{PCV_f - PCV_i}{PCV_i} \times 100
\]

Where : PCV_i and PCV_f are group mean measurements of PCV for week-0 and week-10, respectively.

— Differential Eosinophil Count: During all sampling occasions, thin blood smears were prepared, stained with May Grunwald Giemsa stain and differential leukocyte counts performed [8]. This involves counting and classifying of 200 leukocytes using battlement method. For the purpose of this study, the proportional percentage of eosinophil count was only considered.

Body Weight Gain: The weights of individual animals was estimated weekly using a ‘weigh band’ as per the procedure described by BRANTN and SALISBURY [5].

Statistical Analysis: The experimental design is a two-by-two factorial arrangement with eight replications. Some of the data generated from the present study were subjected to angular (PCV and Differential Eosinophil counts) and square root transformations (epg) as suggested by SNEDECOR and COCHRAN [25]. The transformed data sets were then depicted using the analysis of variance statistics. Inter-group comparison of parasitaemia levels and body weight measurements was carried out. 95 % probability level (p < 0.05) was considered statistically significant.

Results

T. CONGOLENSE PARASITAEMIA

Initially the parasitaemia in all experimental groups were in the range of ‘2+’ to ‘4+’ score. After treatment, two distinct parasitaemia evolution patterns were clearly observed between animals that were treated with trypanocidal drugs (Group I and II) and the untreated ones (Group III and IV) (Fig. 1). The parasitaemia in Group I and II declined to zero level at week-3 post treatment, but that of Group III and IV continued to fluctuate between ‘1+’ and ‘3+’ up to the end of the study.

FAECAL EGG OUTPUT

The mean Fasciola epg of Group I, II, III and IV prior to trial initiation were 122, 136.5, 103 and 145, respectively. Egg excretion ceased in animals of Group I and III a week after receiving treatment with Triclabendazol. But animals in Group II and IV continued to shed Fasciola eggs throughout the study period. Although the mean egg output for Group IV animals (148.0 epg) was slightly higher than Group II animals (130 epg.), there was no statistically discernable difference between them (P > 0.05) (Table II).

PACKED CELL VOLUME (PCV)

The mean PCV evolution pattern for the different experimental groups prior and after the initiation of the study per-

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**Table I.** — Repartition of experimental animals and description of treatment administration.

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of Animals</th>
<th>Isometamidium chloride (1\text{mg/kg (IM)})</th>
<th>Triclabendazole (12\text{mg/kg (per os)})</th>
<th>Diminazine aceturate*</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>8</td>
<td>(+)</td>
<td>(+)</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>8</td>
<td>(+)</td>
<td>(-)</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>8</td>
<td>(-)</td>
<td>(+)</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>8</td>
<td>(-)</td>
<td>(-)</td>
<td></td>
</tr>
</tbody>
</table>

* A single dose of diminazine aceturate was administered to 3 and 7 animals during the first and second week, respectively, after isometamidium treatment.
iod are shown in Fig. 2. The results indicated that the mean PCV levels of Groups I and II were improved by 37.04% and 26.81%, respectively. However, in Groups III and IV, a decline of 24.10% and 42.63% was noted during the ten weeks monitoring period.

Analysis of the results revealed that the changes in mean PCV levels over the study period of Groups I and II were significantly higher (p < 0.01) than those in Group III and IV, respectively (Fig. 3). Similarly, significantly greater results were also obtained between Group II and III. Conversely, no statistically significant differences in PCV evolution were obtained between Group I and II, and also between Group III and IV. On the other hand, Trypanosome negative animals (Group I and II pooled) showed a significantly greater mean PCV than the Trypanosome positive animals (Group III and IV pooled). Comparison of mean PCV changes in Fasciola negative (Group I and III pooled) and Fasciola positive

### TABLE II. Mean faecal fluke egg output (epg) of study animals before and during the study period.

<table>
<thead>
<tr>
<th>Week</th>
<th>Group I</th>
<th>Group II</th>
<th>Group III</th>
<th>Group IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>122±26.0</td>
<td>136.5±216.5</td>
<td>103±9.0</td>
<td>145±15.0</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>140</td>
<td>0</td>
<td>154</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>125</td>
<td>0</td>
<td>126</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>162</td>
<td>0</td>
<td>169</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>125</td>
<td>0</td>
<td>184</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>110</td>
<td>0</td>
<td>110</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>160</td>
<td>0</td>
<td>127</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>131</td>
<td>0</td>
<td>181</td>
</tr>
<tr>
<td>8</td>
<td>0</td>
<td>71</td>
<td>0</td>
<td>142</td>
</tr>
<tr>
<td>9</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>171</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>176</td>
<td>0</td>
<td>116</td>
</tr>
<tr>
<td>Mean</td>
<td>0</td>
<td>130±11.68</td>
<td>0</td>
<td>148±8.71</td>
</tr>
</tbody>
</table>

Fig. 1. — Mean weekly parasitaemia scores of Trypanosome infection in four groups of experimental animals.
(Group II and IV pooled) animals, irrespective of the presence or absence of Trypanosome infection, revealed no statistically depicted difference.

DIFFERENTIAL EOSINOPHIL COUNT:

Mean eosinophil counts of 5.66 %, 10.16 %, 6.38 % and 8.09 % were recorded for Groups I, II, III and IV, respectively (Table III). The differences between Group I and II, Group II and III, and I and IV were statistically significant. Regardless of the presence or absence of Trypanosome infection, significantly higher counts were obtained in Fasciola positive subjects (Group II and IV pooled) than their negative counterparts (Group I and III pooled). The differences in evolution of eosinophil count among the other possible treatment group combinations were found to be insignificant.

BODY WEIGHT MEASUREMENTS

The mean daily body weight changes (BWC) of the four treatment-Groups are listed in Table III. Animals in Group I and II gained 333.4 and 270 g/d, respectively whereas animals in Group III and IV invariably lost 346.8 and 359.6g/d, respectively, during the ten weeks monitoring period. The mean daily weight gain was significantly higher (p < 0.01) both in Group I and II animals than that of Group III and IV animals both of which actually lost body weight (Table IV).

Although the mean daily weight gain of Group I was higher than Group II, the difference was not statistically significant (p > 0.05). Similarly the higher body weight loss recorded for Group IV as compared to Group III was found to be statistically insignificant. The over all mean body weight gain of Group I and II animals together in one hand (Trypanosome negative) was significantly higher (p < 0.01) than Group III and IV (Trypanosome positive) animals irrespective of Fasciola infection. Conversely, no significant difference was obtained in the pooled body weight changes of Fasciola negative animals (Group I and III together) and Fasciola positive animals (Group II and IV together) regardless of Trypanosome infection.

Discussion

The major findings of the present study strongly suggest that concurrent infection due to Trypanosome and Fasciola is the most harmful form of parasitosis in animals within the study area. This observation basically agrees with the results of KAUFMANN et al. [16] and DWINGER et al. [9] who disclosed an increased pathogenicity when helminthosis is superimposed on Trypanosome infections. Another observation, which is consistent with the present findings, is HENDY’s [13], that showed higher improvement in PCV levels and body weight gains in goats receiving antihelmin-
tic treatment and trypanocidal prophylaxis under traditional management in Southern Tanzania and attributed the effects to the additive effect of both treatments.

Statistical analysis revealed that there were no interactions between trypanocidal and flukicidal treatments, but were of additive and independent in nature, as reflected on all measured parameters. In addition, the presence or absence of one of them did not affect the responses from either of the treatments given. This finding agrees with the previously observation made by HENDY [13].

On the other hand, mono-infection with *Trypanosome* spp. has significant effect on both PCV level and body weight gain as compared with the effects of mono-infection with *Fasciola*. Analysis of the obtained results suggest that the pathologic effects of concurrent infections due to *Trypanosome* and *Fasciola* spp. were predominantly influen-

![Graph](image)

**Fig. 3.** Relative improvement in mean packed cell volume (PCV) levels of animals belonging to four treatment groups during the ten weeks study period.

<table>
<thead>
<tr>
<th>Infection Types</th>
<th>Fasciolosis</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trypanosomosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Status</td>
<td>Positive</td>
<td>Negative</td>
</tr>
<tr>
<td>Positive</td>
<td>8.09±2.89</td>
<td>6.38±3.57b</td>
</tr>
<tr>
<td>Negative</td>
<td>10.16±2.98a</td>
<td>5.66±1.82b</td>
</tr>
<tr>
<td>Overall</td>
<td>9.12±2.62A</td>
<td>6.03±2.76B</td>
</tr>
</tbody>
</table>

* Figures with different letters across columns and rows (a, b, A, B) differ significantly (p < 0.05)

**Table III.** Mean eosinophil differential count (%) by infection type and interactions*.
ced by the Trypanosome infection. This observation further imply the relative advantage and value of using trypanocidal drugs or other alternative trypanosomosis control measures for the improvement of cattle productivity in the study area.

In contrast to the above findings, KAUFMANN et al. [16] reported a greater body weight loss in animals infected only with Haemonchus contortus than animals infected only with T. congolense. They proposed that N’Dama cattle which are said to be naturally resistant to trypanosomosis seemed to cope quite well with H. contortus or T. congolense infections alone and chemotherapy rapidly restore blood values to normal in mono-infected animals. However, the present study revealed that mono-infections with Trypanosomes in East African Zebu, which are highly susceptible to trypanosomosis, have no significant difference to dual infections with Trypanosome and Fasciola. Similarly, there was no significant difference between the effects of treatment with both trypanocidal and flukicidal drugs, and that of trypanocidal treatment alone. The relatively lower pathogenecity of fasciolosis among untreated groups and lower response to flukicidal drugs in treated groups may be explained by the efficiency of tolerance to chronic infections by adult cattle. FRASER et al. [11] stated that reduction of migration and activity of juvenile flukes through the liver parenchyma is associated with hepatic fibrosis, which inhibit intra-parenchymal migration, and calcified cholangitis, which deters flucks in their haematophgic activities, both of these lesion-associated phenomena help cattle to resist chronic fasciolo-sis. Besides, the fact that liver possesses considerable functional reserve and regenerating capacity help animals to survive without any significant impairment of hepatic functions even until two-third of the organ is damaged [6].

The post-treatment clearance of parasitaemia in animals of Group II and indicated that Isometamidium chloride is a highly effective trypanocidal drug in cattle when used as a prophylactic or therapeutic agent against sensitive populations. Conversely, the persistance of parasitaemia in animals (Group III and IV), which did not receive isometamidium demonstrated that cattle cannot survive without trypanocidal therapy in endemic areas, and if left untreated all could die of the disease.

A significant difference (p < 0.05) in eosinophil differential (EDF) counts between Fasciola positive (Group II and IV together) and Fasciola negative (Group I and III together) animals was observed in this study. This finding is a confirmation of the fact that marked eosinophilia is often associated with helminthiosis involving excessive tissue migration like fasciolosis as described by FRASER et al. [11]. On the other hand, relatively lower mean EDF counts were obtained in Trypanosome positive subjects (Group III and IV) as compared with their negative counterparts (Group I and II). Similarly, NAYLOR [21] has reported that a decreased eosinophil count in Trypanosome infected cattle.

Although higher mean epg counts were obtained in animals concurrently infected by both parasites (Group IV), its difference from the counts in animals with mono-infection (Group II) was not statistically significant. A previous study carried out to assess the effects of concurrent T. congolense and H. contortus infections in N’Dama cattle showed that a significant rise in egg output in animals harbouring both infections, and attributed the finding to the immuno-suppressive effect of T. congolense infection [16].

With regard to body weight, a daily gin of 333.4 g and 270 g observed in Group I and II animals, respectively, was considerable when viewed with losses of 346.8 g and 359.6 g per day in Group III and IV animals, respectively. The improvements in body weight indubitadly reveal the value of trypanocidal therapy in endemic trypanosomosis areas. Body weight loss is one of the prominent clinical signs observed in Trypanosome infected animals. Previous studies have indicated that cattle infected with T. congolense show signs of endocrine dysfunction expressed in terms of low levels of pituitary and target endocrine gland hormones. ABEBE and ELEY [1] have reported the presence of asymptomatic hypothyroidism manifested by low level of T4 in T. congolense infected Boran cattle. Furthermore, they have observed low

<table>
<thead>
<tr>
<th>Infection Types</th>
<th>Fasciolosis</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status</td>
<td>Positive</td>
<td>Negative</td>
</tr>
<tr>
<td>Positive</td>
<td>(-356±83.1a)</td>
<td>(-346±130a)</td>
</tr>
<tr>
<td>Negative</td>
<td>270±101.1b</td>
<td>333.4±86.6b</td>
</tr>
</tbody>
</table>

* Figures with different letters across columns and rows (a, b, A, B) differ significantly (p < 0.05)

Table IV. — Mean daily live body weight gain (g) by infection type and interactions*.
responsiveness of the pituitary gland towards exogenous CRF and insulin administration in Trypanosoma infected compared to control animals [2, 3]. Low levels of T₄ in particular could result in defective energy metabolism of the host. It is known that plasma concentrations of thyroid hormone correlate positively with energy intake [1]. Reduced feed and impaired efficiency of feed conversion have been implicated to be the main cause for growth failure in pigs infected with T. suis [15]. TNF (cachectin) is produced during trypanosomosis and inhibit secretion of growth hormones [29] and thyroid-stimulating hormone (TSH) [23].

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