Effects of Experimental *Haemonchus contortus* Infection on Red Blood Cells and White Blood Cells of Growing Goats

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**ABSTRACT**: A uniform group of 12 upgraded growing goats aged between 6.0 and 7.5 months were used in this study. They were divided into three groups of T₁, T₂ and T₃. Four animals were randomly allocated to each group. They were infected orally with three levels (0 larva, 5,000 larvae and 10,000 larvae) of infective *Haemonchus contortus* larvae. Before infection, all animals were housed in individual pens with concrete floors. They were provided with a uniform management. Total red blood cells (RBC) and total white blood cells (WBC) were measured by hemacytometric method. Results showed significant interaction effect of *H. contortus* infection and duration of infection on red blood cell counts. The RBC counts of animals in treatment groups 2 and 3 showed significantly lower values over the control group from the second fortnight to the end of the study. The overall mean RBC values of groups 1, 2 and 3 were 11.73, 9.70 and 9.12 million/mm³ blood, respectively. *H. contortus* infection did not significantly influence the total leukocyte counts. Worm infection and duration of infection interaction was also absent on WBC counts. However, the time or duration of infection significantly influenced the WBC counts. Fecal egg counts showed patent infections in the infected animals which also indicated by postmortem worm counts.

(Key words: Experimental Infection, *Haemonchus contortus*, Growing Goat, Red Blood Cell, White Blood Cell)

INTRODUCTION

*Haemonchus contortus* is commonly known as stomach worm of ruminants. In tropical countries, it is the predominant internal parasite of sheep and goats. The main feature of *H. contortus* infection is anemia. Both adult and the fourth larval stages of this parasites in sheep suck blood and cause hemorrhage into the abomasum. Thus, it is of major economic significance to the sheep and goat industries in the hot and humid areas of the world.

The anemia produced by blood sucking activities of *H. contortus* is similar to that resulted in periodic bleeding (Fourie, 1931 cited by Evans et al., 1963). The parasite reduced the productivity of sheep and goats in the less developed countries (Devendra, 1981).

Investigations of the pathogenesis of haemonchosis have generally made only over a relatively short period of infection, usually during the acute phase of the disease. As a result, there is little information regarding the process of chronic infection. In order to determine the chronic effect of *H. contortus* on the cellular components of blood of growing goats, it is necessary to determine the effect of different levels of infections over a sufficiently long period, hence, this study was done.

MATERIALS AND METHODS

A uniform group of 12 worm-free upgraded growing goats aged between 6.0 and 7.5 months were randomly allocated into treatment groups T₁, T₂ and T₃. They were housed in individual pens on concrete floor. Strict cleanliness and hygienic measures were adopted to ensure that adventitious infections with nematode parasites did not occur. All animals were fed uniform concentrate mixture at equivalent to 1% of their liveweight. The concentrate feed was compounded using copra meal (50.5%), tricalcium phosphate (1.7%), rice bran (29.5%), molasses (15.2%), urea (1.0%), salt (1.0%), limestone (1.0%) and vitamin-mineral (0.1%). Napier grass (*Pennisetum purpureum*) and Guinea grass (* Panicum maximum*) were

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offered *ad libitum* to satisfy the dry matter requirement of the animals.

*H. contortus* infective larvae were obtained by culturing the feces of kids harboring monospecific infections of the parasite. Each animal in the treated groups T₁, T₂, and T₃ was fed orally with a single dose of 0, 5,000 and 10,000 *H. contortus* infective larvae in 10 ml physiological saline solution, respectively.

About 5 ml blood was collected from the jugular vein of each animal at fortnightly intervals. Blood samples were treated with oxalates anticoagulant to prevent blood clotting. Total red blood cell (RBC) and total white blood cell (WBC) were determined by hemacytometric method (Bauer et al., 1974; Coles, 1980). At fortnightly intervals, fecal samples were collected directly from the rectum of each animal and the number of eggs per gram (EPG) of feces was determined following a modified method used by Gordon and Whitlock (1939). Four grams of feces were mixed with 60 ml saturated sodium chloride (NaCl) solution. A portion of the fecal suspension was examined using a McMaster's slide. The EPG of feces was calculated by adding the egg counts of two chambers which was multiplied by 50 to represent the EPG. A split-plot-in-time analysis of variance was used to test for differences between different levels of larval infections, time periods and larval infection by period interaction. Comparison based on the least significant difference at \( p = 0.05 \) was made between the means of T₁, T₂, and T₃ at each time period.

**RESULTS AND DISCUSSION**

The average eggs per gram (EPG) of feces are presented in figure 1. In the first fortnight postinfection, no worm egg was found in any animals in the three treatment groups. From the second fortnight, animals in the infected groups (2 and 3) showed the presence of eggs of *H. contortus* in their feces. The fecal egg counts of animals in group 2 were higher at 6th, 7th and 8th fortnight postinfection. Animals in treatment group 3 showed significantly higher values at 6th, 7th, 8th and 10th fortnight. The EPG of feces gradually increased up to 8th fortnight postinfection and then the number changed irregularly up to the end of the experiment. Occasionally, some fecal samples of the control and infected groups showed very few nematode eggs other than *H. contortus*. The animals in infected groups showed significantly higher number of *H. contortus* on postmortem examination at the end of the experiment. However, animals in the control group did not show any worm in the abomasum and duodenum at postmortem examination.

![Graph showing average fortnightly fecal egg per gram (EPG) of feces as affected by different levels of stomach worm (*Haemonchus contortus*).](image)

**Figure 1.** Average fortnightly fecal egg per gram (EPG) of feces as affected by different levels of stomach worm (*Haemonchus contortus*).

**Red blood cell**

Table 1 shows the mean fortnightly RBC values of goats infected with different levels of stomach worm. The analysis of variance of this variable indicated significant (\( p < 0.01 \)) interaction effect of *H. contortus* infection and duration of infection on red blood cell values. The noninfected goats showed no significant (\( p > 0.05 \)) fortnightly variation in RBC except on fortnight 7 when RBC showed significantly (\( p < 0.01 \)) lower values from the preceeding fortnights and on fortnight 11, when RBC was significantly (\( p < 0.05 \)) lower than the second fortnight. From the second to the last sampling RBC values of animals in treatment group 2 were significantly (\( p < 0.01 \)) lower than that of fortnight 1 postinfection. Similar trend was observed for animals in treatment group 3. In the first fortnight postinfection no significant (\( p > 0.05 \)) difference was found in erythrocyte counts of goats in all the three treatment groups. From the second fortnight, RBC counts of goats in treatment groups 2 and 3 were significantly (\( p < 0.01 \)) lower than those of the animals in the control group. Nevertheless, the interaction effect was not significant (\( p > 0.05 \)) on RBC values.
between the animals in treatment groups 2 and 3 for most of the sampling periods. During the 4th and 11th fortnight, the mean RBC values of goats infected with 10,000 stomach worm larvae were significantly (p < 0.05) lower than those infected with 5,000 larvae. Although, goats in treatment 3 received a larger dose of \textit{H. contortus} larvae, the resulting infection did not produce greater severity. On the average, results indicated significant (p < 0.01) interaction effect \textit{H. contortus} infection and duration of infection reduced the number of circulating erythrocytes.

<table>
<thead>
<tr>
<th>Table 1. Average fortnightly RBC values of growing goats as affected by different levels of stomach worm (\textit{Haemonchus contortus})</th>
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<tbody>
<tr>
<td></td>
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<tr>
<td>Red blood cells (million/mm$^3$)</td>
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<td>Time (F)</td>
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<tr>
<td>T$_1$ (0 larva)$^1$</td>
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<td>T$_2$ (5000 larvae)$^1$</td>
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<td>T$_3$ (10000 larvae)$^1$</td>
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<td>F-Mean</td>
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<tr>
<td>F1 12.03$^{abA}$</td>
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<tr>
<td>11.67$^{aA}$</td>
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<tr>
<td>11.62$^{aA}$</td>
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<tr>
<td>11.77</td>
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<tr>
<td>F2 12.59$^{aA}$</td>
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<tr>
<td>10.28$^{bB}$</td>
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<tr>
<td>9.65$^{bB}$</td>
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<td>10.84</td>
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<td>F3 11.97$^{bA}$</td>
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<td>9.41$^{bcB}$</td>
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<td>10.44</td>
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<td>F4 11.69$^{caA}$</td>
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<tr>
<td>8.57$^{cC}$</td>
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<tr>
<td>9.98</td>
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<tr>
<td>F5 11.79$^{caA}$</td>
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<td>9.16$^{deB}$</td>
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<td>8.62$^{deB}$</td>
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<td>F6 12.02$^{caA}$</td>
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<td>8.62$^{bcB}$</td>
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<td>9.97</td>
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<td>8.52$^{bcB}$</td>
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<td>9.86</td>
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<td>9.40$^{bcB}$</td>
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<td>9.04$^{bcB}$</td>
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<td>10.06</td>
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<td>F10 11.75$^{deA}$</td>
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<td>9.33$^{bcB}$</td>
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<tr>
<td>8.52$^{bcB}$</td>
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<td>9.81</td>
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<tr>
<td>F11 11.20$^{deA}$</td>
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<td>8.70$^{bcB}$</td>
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<td>9.87</td>
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<td>T-Mean 11.73</td>
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<td>9.12</td>
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<tr>
<td>10.18</td>
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</table>

$^1$Average of four replications. In a column, means with a common small letter, and in a row with similar capital letter are not significantly (p > 0.01) different.

Although \textit{H. contortus} produces disease principally by sucking the blood of its host, the peripheral blood picture might be varied under different conditions. Gibson (1954) reported the causes of lower erythrocyte counts in \textit{H. contortus} infection in sheep. He concluded that the anemia was purely the result of a failure in the production of erythrocytes by the erythroblastic tissues and the normal destruction of the red blood cells resulted in a gradual decrease in the total number of erythrocytes in blood. In this study, the lower red blood cell counts in the infected animals might be due to the above stated causes.

Whitlock (1950) reported that both microcytic hyperchromic and leptomorphemic anemia could be produced in sheep with a predominant infection of \textit{H. contortus}. The controlling factor found by him was the dietary source of materials essential to blood formation. The red blood cell count of infected animals did not differ significantly from the noninfected ones (control) during the first fortnight postinfection. This was because the worms were in the developmental stages during this time. At this period some immature worms could start sucking blood, but the amount of blood lost through this process was too small to be reflected in the peripheral blood picture. From the second to eleventh fortnight, the infected animals registered significantly lower RBC values than their noninfected counterparts. Nevertheless, the RBC values were not very low. This might be because of the moderate level infections. The number of worms present in the abomasum may not be sufficient to produce very low RBC counts as well as apparent anemia.

The results also suggested that there were clinical signs of infection in the growing goats that received a single dose of 5,000 or 10,000 larvae but the physical manifestations were not very distinct. These findings were consistent with the reports of Pradhan and Johnstone (1972), who found a latent infection among weaner lambs that received a weekly dose of 3,500 larvae for 11 weeks. In the present work, the RBC values of uninfected animals showed practically less variations throughout the sampling periods. These variation might be due to management, environment and counting error factors. The load of worms was found to be less pathogenic in the grower goats because only single dose of infection was used. Pradhan and Johnstone (1972) noted that the pathogenicity was higher when the lambs were infected daily with a small number of larvae than when the same number of larvae was given in one dose at weekly intervals.

**White blood cell**

The average fortnightly WBC values of goats infected with different doses of stomach worm larvae are presented in table 2. \textit{H. contortus} larval dosing did not significantly (p > 0.05) influence the leukocyte counts of growing goats. Worm infection and duration of infection interaction was also absent. However, the influence of the duration or time of infection was found to be significant (p < 0.01). On the average, the fortnightly mean WBC counts irrespective of treatment were significantly lower during fortnights 5, 7, 9, 10 and 11 compared to the rest of the sampling periods. This could be attributed to the very low response of WBC after infection. Some support for this finding came from the results of Gallagher (1963) who reported no significant difference in WBC count in sheep infected with small stomach worm, \textit{Trichostronglus}...
colubriformis larvae. This finding is also consistent with the results of the work of Leland et al. (1960) where the total leukocyte counts remained within normal limits in sheep infected with small stomach worm, T. axei. However, they found a pronounced increase in total WBC counts during extreme pathogenic stage. In their study, they used 750,000 larvae which was higher than those used in the present investigation. Infection with H. contortus did not alter the circulating white blood cell picture and the disease did not reach any extreme situation. Certainly, the significant changes that were found could be attributed to other environmental factors.

Table 2. Average fortnightly WBC values of growing goats as affected by different levels of stomach worm (Haemonchus contortus)

<table>
<thead>
<tr>
<th>Time (F)</th>
<th>T1 (0 larva)</th>
<th>T2 (5000 larvae)</th>
<th>T3 (10000 larvae)</th>
<th>F-Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>10.30</td>
<td>10.28</td>
<td>10.54</td>
<td>10.37bc</td>
</tr>
<tr>
<td>F2</td>
<td>10.64</td>
<td>10.74</td>
<td>10.19</td>
<td>10.52bc</td>
</tr>
<tr>
<td>F3</td>
<td>10.85</td>
<td>10.31</td>
<td>10.51</td>
<td>10.56bc</td>
</tr>
<tr>
<td>F4</td>
<td>10.03</td>
<td>10.85</td>
<td>10.66</td>
<td>10.51bc</td>
</tr>
<tr>
<td>F5</td>
<td>8.85</td>
<td>10.09</td>
<td>9.24</td>
<td>9.39bc</td>
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<td>F6</td>
<td>9.68</td>
<td>10.59</td>
<td>9.81</td>
<td>10.03bc</td>
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<td>9.89</td>
<td>9.10</td>
<td>9.04bc</td>
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<tr>
<td>F9</td>
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<td>9.33</td>
<td>9.20</td>
<td>9.28bc</td>
</tr>
<tr>
<td>F10</td>
<td>9.16</td>
<td>9.19</td>
<td>9.48</td>
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</tr>
<tr>
<td>F11</td>
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<td>9.21</td>
<td>9.00</td>
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<tr>
<td>T-Mean</td>
<td>9.60</td>
<td>10.04</td>
<td>9.79</td>
<td>9.81</td>
</tr>
</tbody>
</table>

1 Average of four replications. In a column, means with a common letter, and in a row with similar capital letter are not significantly (p > 0.05) different.

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REFERENCES


