Performance of Growing Goats Experimentally Infected with Stomach Worm (*Haemonchus contortus*)

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ABSTRACT : A uniform group of 12 upgrade grower goats of 6.0-7.5 months old were used in this study. They were equally divided into three groups of T_1, T_2 and T_3 and were infected orally with three levels (0, 5,000 and 10,000 larvae) of infective *Haemonchus contortus* larvae. Before infection, all animals were housed in individual pens with concrete floor. They were provided with a uniform management. Comparison of body weight changes of infected and uninfected grower goats were done using weekly body weights. There was significant ($p < 0.01$) interaction between the effect of stomach worm infection and duration of infection on body weight. The infected groups (2 and 3) weighed significantly ($p < 0.05$) less than the control group from week 18 to 21. The animals of control group gained an average of 2.85 kg with 18.75 g average daily gain (ADG) in 152 days, which were significantly higher than those of animals in the infected groups. There was significant effect of *H. contortus* infection on the preslaughter weights of grower goats. The hot carcass weights of the infected goats were significantly lower than the uninfected group. No significant difference in dressing percentage of infected and uninfected groups was observed.

(**Key Words**: Growth, Grower, Goat, Stomach Worm, Experimental Infection)

INTRODUCTION

The nematode parasite *Haemonchus contortus* is a predominant gastro-intestinal parasite of goats in the hot-humid areas of the world. Despite earlier indications that this parasite could cause substantial losses (Albers et al., 1989), no work has been done to quantify these production losses especially in terms of body weight and dressing percentage.

The infection with *H. contortus* in sheep prevented the rearing of young sheep in Australia until the introduction of the anthelmintic carbon tetrachloride (Clunies-Ross, 1932). Reports of a number of studies have been published on the performance of pasture-grazing sheep predominantly infected with *H. contortus*. The liveweight gains of Merino weaners increased by around 100% when dewormed every four weeks as compared with similar animals that were dewormed only to avert death (Johnstone et al., 1979).

A number of studies have been published on the pathophysiological, hematological, parasitological and immunological aspects of monospecific *H. contortus* infections in small ruminants. However, no attempt was made to evaluate the effect of *H. contortus* infection on body weight and dressing percentage of goats. In order to determine the chronic effect of *H. contortus* on the performance of grower goats, it is necessary to determine the effect of different levels of infections over a sufficiently long period, hence, this study was conducted.

MATERIALS AND METHODS

A uniform group of 12 worm-free upgrade grower goats aged between 6.0 and 7.5 months was used in the study. The animals were randomly allocated into three treatment groups: T_1 = 0 infection (control), T_2 = 5,000 infective *Haemonchus contortus* larvae and T_3 = 10,000 infective *Haemonchus contortus* larvae.

Each animal in the treated groups was fed orally with a single dose of the prescribed level of infective larvae in 10 ml physiological saline solution. The animals were fed uniform concentrate mixture at equivalent to 1% of their body weight. The mixed 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%),

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limestone (1.0%) and vitamin-mineral (0.1%). Napier grass (*Pennisetum perpureum*) and Guinea grass (*Panicum maximum*) were offered *ad libitum* to satisfy the dry matter requirement of the animals. The animals were housed in individual pens with concrete floor. Strict cleanliness and hygienic measures were adopted to ensure that adventitious infections with nematode parasites did not occur.

Haemonchus contortus infective larvae were obtained by culturing the faeces of kids harboring monospecific infections of the parasite. Counts of the parasite eggs in the faeces of all goats were determined before the experimental infection and thereafter at two weeks intervals by modified method of Gordon and Whitlock (1939). The number of eggs within two ruled areas of McMaster's slide was counted and the number was multiplied by 50 to represent the EPG of faeces.

Body weights were taken weekly for 21 weeks and prior to the slaughter of the animals. The weight of the eviscerated carcass was recorded for all treatment groups. Immediately after slaughter, the animals were skinned and the head, lower limbs and all viscera were removed. The dressed carcass including kidneys and liver were weighed. Postmortem worm counts of the abomasum of all animals were made using a standard method.

A split-plot-in-time analysis of variance was used to test for differences between different levels of larval infection, time periods and larval infection by period interaction. Comparisons based on the least significant difference at $P = 0.05$ were done between the means of T_1, T_2 and T_3 at each time period.

Table 1. Average weekly body weight (kg) of grower goats with different levels of stomach worm (*Haemonchus contortus*)

Week (w)	Body Weight		
	Treatment (T)		
	T_1 (0 larva)[1/]	T_2 (5,000 larvae)[1/]	T_3 (10,000 larvae)[1/]
W 1	13.48 kA	13.70 d-gA	13.45 cdA
W 2	13.95 jA	13.68 d-gA	14.90 a-dA
W 3	14.05 ijA	13.68 d-gA	13.48 bcdA
W 4	14.50 ghiA	13.75 c-gA	13.43 dA
W 5	14.65 e-hA	13.78 b-gA	13.55 a-dA
W 6	14.60 fghA	13.75 c-gA	13.60 a-dA
W 7	14.83 e-hA	13.63 efgA	13.65 a-dA
W 8	14.98 efgA	13.60 fgA	13.68 a-dA
W 9	14.38 hijA	13.50 gA	13.43 dA
W10	14.90 e-hA	13.63 efgA	13.55 a-dA
W11	14.90 e-hA	13.63 efgA	13.65 a-dA
W12	15.13 defA	13.70 d-gA	13.70 a-dA
W13	15.18 deA	13.83 a-gA	13.70 a-dA
W14	15.55 cdA	13.88 a-gA	13.78 a-dA
W15	15.68 cA	13.93 a-gA	13.88 a-dA
W16	16.03 bcA	14.10 a-fA	14.00 abcA
W17	16.33 abA	14.15 a-eA	13.93 a-dB
W18	16.53 aA	14.18 a-dB	13.93 a-dB
W19	16.60 aA	14.28 abcB	14.05 aB
W20	16.63 aA	14.30 abB	14.03 abB
W21	16.65 aA	14.35 aB	14.08 aB

[1/] Average of four replications. Means in the same column with a common small letter, and in a row with similar capital letter are not significantly ($p > 0.05$) different.

RESULTS AND DISCUSSION

Body weight

Comparison of liveweight changes of infected and uninfected grower goats were presented in table 1. Statistical analysis of the results showed significant ($p < 0.01$) interaction effect of stomach worm burden and duration of infection on body weight. There was no significant difference in the body weights of goats of different treatment groups from the 1st to 16th week postinfection. On the 17th week, the goats in the treatment group 3 registered significantly ($p < 0.05$) lighter body weight than the goats in other treatment groups. The infected groups (T_2 and T_3) weighed significantly ($p < 0.05$) lower than the goats in other treatment groups. The infected differences in body weight changes between the infected and uninfected control goats were observed in the last four and five weeks for treatment groups 2 and 3, respectively.

A summary of body weight gain is presented in table 2. There was no significant ($p > 0.05$) difference in the initial body weight of goats allocated to the different treatment groups. At the end of experiment, the animals in control group (T_1) gained an average of 2.85 kg or an average daily gain (ADG) of 18.75 g for the 152-day study period. These were significantly heavier than those of animals in the infected groups.

Parasitic burden

The average egg per gram (EPG) of faeces was presented in table 3. Analysis of variance of this variable indicated significant ($p < 0.01$) interaction effect of stomach worm, *Haemonchus contortus* and duration of infection. Within treatment, significant differences were found in different sampling periods. The faecal egg counts of group 2 animals were higher at sixth, seventh and

Table 2. Summary of body weight gain of grower goats as affected by different levels of stomach worm (*Haemonchus contortus*)

Treatment	Initial Weight[1/] (kg)	Final Weight[1/] (kg)	Total Gain[1/] (kg)	Total Depression (kg)	% Depression	Average Daily Gain[2/] (g)
T_1 (0 larva)	13.80[a]	16.65[a]	2.85[a]	0.00[b]	0.00[b]	18.75[a]
T_2 (5,000 larvae)	13.73[a]	14.35[b]	0.63[b]	2.23[a]	78.00[a]	4.11[b]
T_3 (10,000 larvae)	13.38[a]	14.08[b]	0.71[b]	2.15[a]	75.00[a]	4.64[b]

[1/] Average of four replications.
[2/] Average of 152 days, weight gain. In a column, means with a similar letter are not significantly ($p > 0.05$) different.

Table 3. Average fortnightly faecal egg per gram (EPG) of faeces of grower goats as affected by stomach worm (*Haemonchus contortus*)

	EPG of Faeces			
Time (F)	Treatment (T)			
	T_1 (0 larvae)[1/]	T_2 (5,000 larvae)[1/]	T_3 (10,000 larvae)[1/]	F - Mean
F 2	0.00 aC	487.50 fB	775.00 fA	420.83
F 3	0.00 aB	962.50 dA	975.00 eA	645.83
F 4	0.00 aB	987.50 dA	950.00 efA	645.83
F 5	0.00 aB	1,350.00 bcA	1,275.00 cdA	875.00
F 6	0.00 aB	1,775.00 aA	1,612.50 abA	1,129.17
F 7	0.00 aB	1,862.50 aA	1,900.00 aA	1,254.17
F 8	0.00 aB	1,600.00 abA	1,900.00 aA	1,166.67
F 9	0.00 aB	1,200.00 cdA	1,350.00 bcA	850.00
F10	0.00 aC	1,175.00 cdB	1,537.50 acA	904.17
F11	0.00 aC	662.50 eB	1,212.50 deA	625.00
	T - Mean 0.00	1,206.25	1,348.75	851.67

[1/] Average of four replications. Means in the same column with a common small letter and in a row with similar capital letter are not significantly ($p > 0.05$) different.

eighth fortnight postinfection. Animals of treatment group 3 registered significantly higher values at sixth, seventh, eighth and tenth fortnight postinfection.

However, significant ($p < 0.01$) differences between treatment groups 2 and 3 were found only during fortnight, 2, 10 and 11. In the first fortnight postinfection, no worm egg was found in any group of the experimental goats. From the second fortnight, animals of the infected groups started showing eggs of *Haemonchus* in their faeces. Occasionally, some faecal samples of the control and infected groups showed very few nematode eggs other than *Haemonchus*.

Egg production by the worms followed a similar pattern in both groups of infected animals. The EPG of faeces gradually increased up to 8th fortnight postinfection and then the number changed irregularly through the end of the experiment. Following patency stage, parasite egg counts reached a maximum of 1,862.5 and 1,900 EPG of faeces for groups 2 and 3, respectively, during the 7th fortnight postinfection. The EPG values reached their post patency minimum levels in the last fortnight. No worm was found in the abomasum and duodenum at postmortem examination in uninfected control goats. Sample examination of the intestine of the goats of 3 treatments did not show any presence of the worm.

Various studies also showed large effects of helminth on body weight changes (Durie and Elek, 1966; Keith, 1968). The average interaction effect of infection and duration of infection on grower goats were not very pronounced even in group 3 which received higher level of larval doses. There was no mortality in any group of experimental animals during the study period. This could

be attributed to the amount of damage caused by the parasites were not adequate to cause death of the infected animals. The interaction effect of infection and duration of infection on liveweight change was relatively small. This finding was consistent with the work of Albers et al. (1989) which showed similar trend during the first two weeks postinfection in lambs affected by *Haemonchus contortus*. During this time, blood loss from the host animals was relatively minimal (Albers and LeJambre, 1983) but a progressive increase of detrimental interaction effect of infection and duration of infection was noted thereafter. Albers et al. (1989) reported that the weekly depression of liveweight change/gain was highest during the fifth week postinfection with *H. contortus* in lambs. The animals in treatment groups 2 and 3 gained 0.63 and 0.71 kg, respectively, during the 21-week-study period. On the other hand, animals of the control group gained 2.85 kg during the same period. This finding was partially consistent with the results obtained by Pradhan and Johnstone (1972) where body weights of lambs with daily dosing with *H. contortus* fell rapidly from 29 kg to 24.80 kg in 80 days. In this study, there was a slight increase in the average body weight of infected goats. This might be because the number of larvae (5,000 and 10,000) used was not sufficient to depress the liveweight but was probably enough to inhibit the normal growth of the grower goats. The effect of *H. contortus* on growth of the hosts must have continued for at least some more weeks after the infection. Muller (1964) reported that the effects of worm infection could persist up to a year and that infected animals did not regain the body weight loss even if the infection was terminated. This continued effect might have been offset by some compensatory growth or refilling of the abomasal wall within the first four weeks after experimental infection. However, in this study, the interaction effect persisted throughout the duration of the experiment.

Thus, it was clear that the timing of the effect of *H. contortus* infection on liveweight change of grower goats was associated with the worm burden of both immature blood sucking form and mature form. The latent effects of the blood sucking worm had continued for a considerable period of time and without anthelmintic treatment, the animals suffered for a longer time. The discrepancy in liveweight changes between the infected and uninfected groups was more apparent just before the termination of the experiment as similar to Pradhan and Johnstone (1972).

Growth performance

The generally poor growth performance of even the uninfected animals (control) could be attributed to the type of ration fed to the grower goats. Possibly, better growth could have been obtained if the ration was supplemented with more protein or minerals. Weir et al. (1948) obtained similar result in lambs infected with *H. contortus*. In their study, even the uninfected animals did not grow well on a basal ration. They obtained the best growth when the ration was supplemented with both protein and minerals.

The quantitative relationship between anemia and liveweight gain was discussed by Albers and his associates (1990). In their earlier experiments, the liveweight gains were depressed by 24-65% in lambs while infected with a single dose of 11,000 larvae as compared with the control over an eight to nine-week period (Albers et al., 1984). In the present experiment, the larval dose of infected group 3 was almost the same as that used by Albers et al. (1990), while larval doses in group 2 was almost half of that in the previous study. The quantitative depression in liveweight change in this study was consistent with the findings of Albers et al. (1989), where the depression amounted to 1.29 kg or 38% of the total weight gain of uninfected lambs. In this study, a depression of 2.15-2.23 or 75-78% of the total gain of the uninfected goats was observed.

Roseby and Leng (1974) observed similar results in sheep infected with *Trichostrongylus colubriformis* larvae. Their study had shown that the body weight changes significantly such that the control sheep gained 6 g liveweight per day, whereas the infected sheep lost 12 g daily. In the present work, the control group registered an ADG of 18.75 g, while the infected ones, groups 2 and 3, however, gained 4.11 and 4.64 g, respectively, per day.

The threshold level of exposure that could cause reduction in liveweight gain was not clear. To quantify the threshold level for this parameter, further study was recommended. Coop et al. (1977) found that 21,000 *Ostertagia circumcincta* larvae per week significantly depressed liveweight gain in sheep. They also indicated variation in the threshold level of exposure from species to species of host and parasite, age and general body condition of the host, different management practices and different environmental conditions. Symons et al. (1981) concluded that the threshold level of exposure that could cause a reduction in liveweight gain were between 12,000 and 37,000 *Ostertagia circumcincta* larvae in lambs.

Holmes and Bremner (1971) found that sheep which received a large single infection of *Ostertagia circumcincta* showed a reduction in body water turnover that was principally associated with parasite-induced anorexia. Goats in this experiment did not show any apparent sign

of inappetite. The slower rate of growth could also be attributed to reduced abomasal protein digestion. Taylor et al. (1989) found that the high abomasal pH of calves infected with stomach worm, *Ostertagia circumcincta*, significantly reduced the abomasal protein digestion and subsequently was responsible for lower liveweight gain.

The comparison of growth performance between infected and uninfected groups of goats under the same management conditions showed that *H. contortus* had a detrimental interaction effect with duration of infection on liveweight gain. Therefore, the economic importance of the loss in this production parameter was clear. The liveweight and physical condition of goats were important characteristics for consideration if goats were to be sold, and they could also affect the reproductive performance of the flock. It was interesting to note that the levels of infection used in this experiment, which were probably often encountered under natural grazing conditions in most of the tropical countries, produced pathophysiological changes among the infected goats without acute clinical symptoms of the specific disease.

The average preslaughter age and weight, hot carcass weight, dressing percentage and postmortem parasite counts were presented in table 4. Analysis of variance of these variables showed significant ($p < 0.05$) effect of stomach worm larval dosing on the preslaughter weights of grower goats. The infected goats had significantly ($p < 0.05$) lower preslaughter weight than the uninfected ones (control). No significant ($p > 0.05$) difference was observed in the preslaughter weights of animals from the groups which received two levels of *Haemonchus contortus* larval infection. There was no significant ($p > 0.05$) difference in the hot carcass weights of animals from the infected but they were significantly ($p < 0.05$) lower than the hot carcass weights of the control animals. Statistical analysis also showed no significant ($p > 0.05$) difference in dressing percentage of infected and uninfected groups. The gross appearance of the skinned and eviscerated carcass was similar regardless of the presence or absence of worm burden.

On postmortem examination of the abomasum and duodenum of the control animals, no worm was recovered. Animals of group 3 which received higher level of larval doses demonstrated higher number of worms on postmortem than the animals of group 2 which received lower level of larval doses. However, the difference in postmortem worm counts between the groups of infected goats was not statistically significant ($p > 0.05$).

Liveweight is synonymous with meat production. Numerous experiments have proven that there was a considerable loss of liveweight when animals have been infected with helminths. Spedding (1954) has shown that over a period of 315 days postinfection, there was a carcass weight difference of 17 lbs between infected and uninfected lambs. Carcass quality measurements indicated a reduction in the amount of bone, fat and main muscles and the effects of the worm infection, which had occurred shortly after weaning, persisted up to a year. In the experiment, however, the difference in carcass weight was not so big and the infection persisted to the end of the experiment at 21 weeks postinfection.

Table 4. Average preslaughter age and weight, hot carcass weight, dressing percentages and postmortem parasite counts of grower goats as affected by different levels of stomach worm (*Haemonchus contortus*)

Treatment (T)	Preslaughter Age (month)	Preslaughter Weight (kg)	Hot Carcass Weight (kg)	Dressing Percentage	Postmortem Parasite Count
T_1 (0 larvae)[1/]	11.25_a	16.65_a	7.79_a	46.78_a	0.00_b
T_2 (5,000 larvae)[1/]	11.50_a	14.35_b	6.73_b	46.95_a	325.00_a
T_3 (10,000 larvae)[1/]	11.25_a	14.08_b	6.49_b	46.18_a	500.00_a
T - Mean	11.33	15.03	7.00	46.63	275.00

[1/]Average of four replications. Means in the same column with common letter are not significantly ($p > 0.05$) different.

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