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ORIGINAL RESEARCH

Effect of high plane of nutrition on the performance of *Haemonchus contortus* infected kids

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Abstract

Aim: To determine the effect of severity of *Haemonchus contortus* infection on performance and economics of raising kids fed on two respective plane of nutrition.

Materials and Methods: The feeding trial was conducted for 120 days with non-descript female kids (3-5 months age). The kids were randomly allocated into two dietary treatments having normal protein normal energy (NPNE) and high protein medium energy (HPME) using conventional feedstuffs (crushed maize, ground nut cake, berseem hay and chaffed paddy straw), fortified with mineral mixture (1%), salt (0.5%) and vitamin premix (@ $20gq^{-1}$ feed), each treatment having three levels of *H. contortus* infection (W_0, W_{500} and W_{2000}) in a 2x3 factorial design. The study was undertaken to ascertain the performance and economics of raising kids fed on higher plane of nutrition.

Results: The total dry matter intake (DMI: kg) was 41.18, 39.56 and 41.11 in W0, W_{500} and W_{2000} in group HPME; whereas in NPNE the DMI was 39.66, 38.03 and 35.95 kg in the respective infection levels. The highest body weight gain was obtained in HPME than NPNE from 1st to 16th week of experiment. The infected kids at NPNE gained at a slower rate as compared to the kids maintained at HPME. The mean percentage of monocytes, lymphocytes and neutrophils fluctuated in different ways throughout the experiment without any significant difference and these cells were not followed any specific trend. However, significantly higher ($P<0.05$) eosinophils count was recorded in W_{500} and W_{2000} of HPME fed kids as compared to W_{500} and W_{2000} of NPNE fed kids. In the present study the maximum benefit could be obtained by feeding of HPME diet with W_{500} infection as compared to other treatments.

Conclusions: The cost of raising kids per kg meat was worked out to be the most economical at high plane of nutrition even with the heavy *H. contortus* infection.

Keywords: economics, *Haemonchus contortus* infection; kids, performance, plane of nutrition

Introduction

The recurring losses in productivity and profit due to *Haemonchus contortus* infection are a common problem for small ruminants' production in the most part of the world [1-7]. This condition becomes worse in the malnourished animals. This shows a significant relationship between nutrition and infection. Enhanced nutrition can affect the ability of the host to cope with the consequences of parasitism and to tolerate or overcome parasitism [8-12]. Many workers [13-15] have demonstrated that parasitic infestation adversely reduced DMI in small ruminants and that was improved by high quality feed supplementation [16]. Similarly, highly metabolizable protein diets have been shown to increase resistance of lambs against *H. contortus* [17]. Well-fed animals can withstand the harmful effects of GI parasitism, can remain reasonably productive and may require less anthelmintic treatments when compared with undernourished animals [18,19]. On high plane of nutrition, animals do not have to repartition protein from productive functions such as muscle, bone and wool growth towards repair functions of the GI tract, plasma and blood replacement [8]. A more recent update of the implications and interactions of nutrients and parasites in small ruminants have been discussed by Jackson [20], Athanasiadou *et al*. [21], as well as with an emphasis in goats by Hoste *et al*. [22].

However, this field of investigation is still unexplored which needs to be exploited for the better health of the animals. Therefore this field has been considered to be a recent trend to find out a suitable performance index of parasitized animals. It would provide a proficient indication to develop a novel feed formula for the animals in accordance with intensity of parasitic infections. Keeping this in view, the present study was planned to ascertain the effect of severity of *H. contortus* infection on performance and economics of raising kids fed on high plane of nutrition.

Materials and Methods

Twenty four non-descript goat kids (3-5 months) were randomly allocated into six equal groups. Two diets normal protein normal energy (NPNE) and high protein medium energy (HPME) were fed to kids

Table-1. Differential leucocytes count (%) of kids fed on different diets with *H. contortus*

Parameters	Periods (Weeks)	Infection			SEM	Diets		SEM
		W_0	W_{500}	W_{2000}		NPNE	HPME	
Monocytes	3rd	2.25	2.62	2.75	0.60	2.67	2.42	0.49
	4th	1.25	1.37	1.25	0.39	1.17	1.42	0.32
	5th	1.50	1.62	1.25	0.40	1.17	1.75	0.32
	6th	1.87	1.50	2.00	0.34	1.50	2.08	0.28
	7th	1.62	2.25	2.50	0.25	2.00	2.25	0.20
	8th	2.12	2.25	2.25	0.49	1.92	2.50	0.40
Lymphocytes	3rd	61.50	57.37	56.50	1.88	59.08	57.83	1.53
	4th	60.87	55.12	55.87	1.82	57.75	56.83	1.48
	5th	59.75	52.25	57.50	2.52	58.83	54.17	2.05
	6th	57.75	54.75	53.25	2.32	57.67	52.83	1.89
	7th	53.00	55.25	50.00	1.62	52.83	52.67	1.32
	8th	59.75	54.87	51.12	2.11	55.92	54.58	1.30
Neutrophils	3rd	34.75	28.87	26.87	1.65	30.08	30.25	1.34
	4th	36.37	35.00	32.00	2.24	35.00	33.92	1.83
	5th	38.00	35.37	32.12	2.48	35.00	35.33	2.03
	6th	40.87	36.75	36.00	1.91	37.42	38.33	1.56
	7th	43.50	38.25	39.00	1.59	42.25	38.25	1.30
	8th	37.25	34.12	38.75	1.84	38.25	35.17	1.50
Eosinophils	3rd	1.50^{a}	11.12^{b}	13.87^{c}	0.83	8.17	9.50	0.68
	4th	1.50^{a}	8.50^{b}	10.87^{c}	0.52	6.08^{A}	7.83^{B}	0.42
	5th	0.75^{a}	10.75^{b}	9.12^{c}	0.63	4.92^{A}	8.83^{B}	0.51
	6th	0.75^{a}	8.87^{b}	8.75^{c}	0.66	4.50^{A}	7.75^{B}	0.54
	7th	0.62^{a}	8.75^{b}	8.25^{c}	0.68	4.17^{A}	7.58^{B}	0.55
	8th	0.87^{a}	8.75^{b}	8.12^{c}	0.51	3.92^{A}	7.92^{B}	0.41

a b c & A B: Means with different superscripts differ significantly (P<0.05)

having three levels of *H. contortus* infection (W_0, W_{500}, W_{2000}) in a 2x3 factorial design [23] for experimental period of 120 days.

The NPNE diet contained berseem hay and chopped rice straw as source of roughage in the ratio of 60:40 and crushed maize @ 100g/d/kid as source of concentrate ingredient. However, the HPME diet contained berseem hay and chopped rice straw in the ratio of 90:10 and crushed maize and groundnut cake (50:50) as concentrate. The diets were supplemented with mineral mixture (1%), salt (0.5%) and vitamin premix (20g/q feed). The diets were formulated on the basis of DCP and TDN requirement of kids for maintenance and growth as per NRC [24]. The formulated diets contained 7% DCP and 57.3% TDN in NPNE while 13.15% DCP and 62.5% TDN in HPME.

All the kids were kept under uniform managemental conditions by housing them in a well-ventilated shed with facilities for individual feeding. All kids were dewormed and vaccinated according to standard protocol before the start of experiment. The feeding trial was lasted for 120 days. Daily record of feed intake was done. All kids were weighed weekly at three consecutive days during the entire experiment. Daily gain in body weight of kids was determined by subtracting the initial body weight from the final body weight. The blood samples were collected from all kids after giving three weeks of infection. The collection was done at weekly interval till the 8th week post infection. Blood smears were prepared immediately after blood collection. It was stained with Leishman's stain. Thereafter counting was done for Neutrophils, Basophils, Eosinophils and lymphocytes.

Ethical Consideration:

Permission of the Institutional Animal Ethics Committee was taken prior to start of the experimental study.

Results and Discussion

The average dry matter intake (gd^{-1}) of entire feeding trial at weekly interval in various groups has been presented in Fig1. The difference between NPNE and HPME was found to be significant at 2nd week. The same trend maintained till the end of the experiment except on 5th week. Significantly (P<0.05) higher DMI was reported in HPME than that of in NPNE. No significant difference was observed between different level of infection (W_0, W_{500} and W_{2000}) at varying levels of nutrition (NPNE and HPME) before the administration of *H. contortus* infection. However, it was statistically significant after 5th week post infection and till the end of experiment. The highest DMI was obtained in W_0 kids followed by W_{500} and lowest in W_{2000} kids. The DMI in W_{2000} kids of NPNE group was found to be drastically reduced at 3rd week post infection on ward as compared to W_{2000} kids of HPME. As the period of infection increased the DMI was also increased but in W_{2000} and W_{500} kids it was not increased as that of kids without infection.

The initial and final body weight (kg), total body weight gain (kg) and body weight gain (gd^{-1}) at weekly interval during the entire experiment (120 days) were presented in Table-2 and Fig-2. Difference in body weight gain (P<0.05) between NPNE and HPME kids was started early in the experiment but it was only pronounced after 3rd week post infection. It was noted that the differences of weight gain between NPNE and HPME fed kids were statistically significant at the time of zero infection. Within NPNE, the differences in

Table-2. Least square means for different parameters of kids fed on diets at varying level of *H. contortus* infection

Parameters	NPNE			HPME		
	W_0	W_{500}	W_{2000}	W_0	W_{500}	W_{2000}
Initial body weight (kg)	11.04	11.06	11.05	11.03	11.04	11.06
Final body weight (kg)	14.72^{bA}	13.48^{aA}	12.64^{aA}	15.80^{bB}	14.56^{aB}	13.73^{aB}
Total DMI (kg)	39.66^{A}	38.03^{A}	35.95^{A}	41.18^{B}	39.56^{B}	41.11^{B}
Cost of feed (Rs/kg)						
Concentrate	12.10	12.10	12.10	12.30	12.30	12.30
Roughage	2.20	2.20	2.20	3.00	3.00	3.00
Total cost (Rs)	194.17	190.59	186.01	223.98	219.12	223.77
Total body weight gain(kg)	3.68^{cA}	2.42^{bA}	1.59^{aA}	4.77^{cB}	3.52^{bB}	2.67^{aB}
Total cost of meat (Rs)	368^{cA}	242^{bA}	159^{aA}	477^{cB}	352^{bB}	267^{aB}
Feeding cost/ Kg meat (Rs)	52.76^{aA}	78.76^{bA}	117.00^{cA}	46.95^{aB}	62.25^{bB}	83.81^{cB}
Profit / loss (Rs)	172.83^{cA}	51.41^{bA}	-27.01^{aA}	253.02^{cB}	132.88^{bB}	43.23^{aB}
Cost of dewormer (Rs)	—	11.90	23.80	—	11.9	11.9
Total expenditure (Rs) (Feed + dewormer cost)	173.83^{aA}	202.49^{bA}	209.81^{bA}	253.02^{bB}	231.02^{aB}	235.67^{aB}
Net profit / loss (Rs)	173.83	39.51^{bA}	-50.81^{aA}	253.02^{cB}	120.98^{bB}	31.33^{aB}

Cost of meat was considered at the local market price of Rs 100 / kg.
a b c & A B: Means with different superscripts differ significantly (P<0.05)

Fig. 1 Dry matter intake by kids at different periods with varying level of *H. contortus* infection

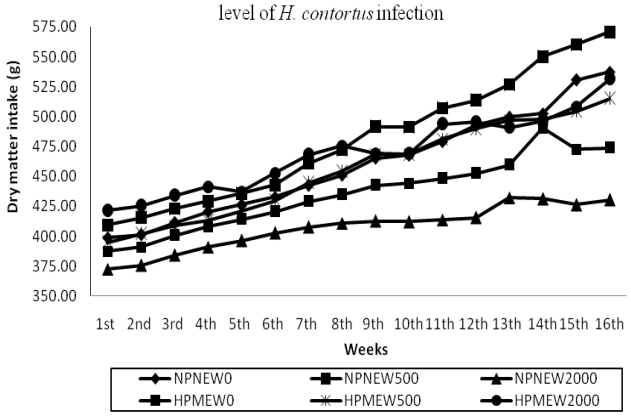
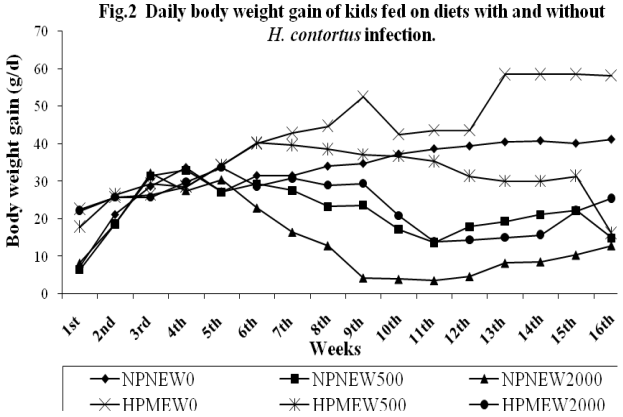


Fig.2 Daily body weight gain of kids fed on diets with and without *H. contortus* infection.



body weight gain due to W_{500} and W_{2000} infections were more. However, within HPME these differences were not so large. This was due to compensatory growth of kids because of HPME diet. The daily body weight gain was found to be highest in W_0 followed by W_{500} and W_{2000}. The interaction between diets and infection differ significantly (P<0.05) only after 5th week post infection.

The data of DLC from 3rd to 8th week post infection of kids fed on different diets are presented in Table-1. The values of monocytes, lymphocytes and neutrophils fluctuated in different ways and these cells were not followed any specific trend. These values were with in the normal physiological range. The mean percentage of monocytes was found to be maximum in HPME than that of NPNE during the entire experiment but it was found statistically non significant. The difference between dietary treatment, levels of infection and their interaction were statistically non significant. Similar observation was also reported by earlier worker [13] in *H. contortus* infected sheep. Although the eosinophils count was found statistically significant in NPNE and HPME with the various levels of infection (W_0, W_{500} and W_{2000}). The maximum eosinophils count was obtained in W_{500} and W_{2000} where kids were fed HPME diet as compared to W_{500} and W_{2000} where there kids fed NPNE diet. Earlier workers [25] also reported increased concentration of eosinophils in *Trichostrongylus. colubriformis* infected lambs supplemented with fish meal. In accordance to the earlier report [26] in *Nematodirus battus* and *H. contortus* infected sheep where high protein intake significantly increased eosinophil numbers [27]. Eosinophils have been used as selection indices for breeding sheep with an enhanced resistance to parasites [28,29]. Various workers [30,31] suggested that pro-inflammatory cytokines are linked to alterations in nutrient uptake and utilization.

The economics of raising kids with varying level of nutrition under different intensity of *H. contortus* infection have been given in Table-2. It was observed that HPME fed kids gained more body weight as compared to NPNE. It was found to be higher in control kids (W_0) than in W_{500} infected kids and least gain was recorded in W_{2000} kids. In earlier report it was found that the *H. contortus* infected kids [32] and lambs [27] gained more weight when given high protein diet than low protein diet. The depression in intake was accounted for over 60% of the difference in weight gain between *T. colubriformis* infected and control [33] while about 73% of difference in weight gain between *O. ostertagi* infected and *ad-lib* fed control calves [34]. Similar studies had shown that during infection with *H. contortus* kids [32] and sheep [35,36] offered a high

protein diet attained a more live weight gains than those offered a low protein diet. The rate of expulsion of gastrointestinal nematode parasites was related to the level of supplementation [25]. Protein supplementation had beneficial effect on both resistance and resilience of dairy goats to nematode trickle infection [37]. The faecal egg counts were lowered and eosinophil counts were higher in the animals receiving the high protein diet. Supplementation of metabolizable protein enhanced the resistance to infection from *T. colubriformis* in lambs [38]. Immunomanipulation through optimized nutrition [21,39] offers some advantage in reducing the numbers of anthelmintic treatments that animals require. Host acquired immunity is one the most important factors influencing epidemiological differences between the various gastrointestinal nematode parasites and the host plane of nutrition is a crucial element that influences its development and maintenance [5]. Therefore the result of the present study suggested that the diet fed to kids with HPME, tended to ameliorate the adverse effect of *H. contortus* infection (W_{500} and W_{2000}). The higher protein level improved daily gain in body weight in kids. The feeding cost per kg meat produced was found to be reduced due to feeding of HPME diet as compared to NPNE diet. It was worked out to be Rs. 46.95, 62.25, 83.81 per kg meat in HPME against Rs 52.76, 78.76 and 117.00 per kg meat in NPNE at three levels (W_0, W_{500} and W_{2000}) of infection respectively. The maximum benefit could be obtained by feeding of HPME diet with W_{500} infection as compared to any other level of infection either with HPME or NPNE diet. In this way there is a clear cut saving of at least Rs 16.51 per kg of meat. This might be due to the compensatory growth of kids in HPME due to supply of additional protein and energy resulting into fast recovery in such diet. The kids fed NPNE diet with W_{2000} infection required repeated deworming which increased the total cost of kid raising. However in HPME group no further deworming was done.

Conclusions

It may be concluded that the increased number of eosinophils in HPME fed kids during *H. contortus* infection may provide an index of a protective immune response of kids to *H. contortus* infection. The infected kids at the normal levels of dietary protein and energy gained at a slower rate as compared to the kids maintained at a higher level of protein and energy. The cost of raising kids per kg meat was worked out to be the most economical at high plane of nutrition even with the heavy infection.

Author's contribution

Both author contributed equally. Both author read and appproved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

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