Evaluation of Kumaon hill goats for resistance to natural infection with gastrointestinal nematodes

K. V. Subramani · M. Sankar · A. Prasad · G. R. Gowane · A. K. Sharma ·
A. K. Zahid · B. C. Saravanan · Vikram Khobra · Subhash Chandra

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Abstract The present study deals with the investigation of different degrees of genetic resistance/resilience of Uttarakhand hill goats to natural infection with gastrointestinal nematodes in order to introduce into breeding schemes. Animals were naturally infected with *Haemonchus contortus*, *Teladorsagia circumcincta*, *Oesophagostomum* spp. and *Trichostrongylus* spp. Faecal egg counts (FEC) were carried out every month for a period of 1 year and blood samples were collected every third month for the determination of indicator traits such as FEC, packed cell volume (PCV) and haemoglobin (Hb). The mean egg per gram (EPG), PCV and Hb were $1,579.6 \pm 346$, 35.12 ± 1.1 and 8.7 ± 0.2 , respectively. The goats were divided into three groups (<800, 801–2,000 and >2,000) based on EPG. The EPG showed a negative correlation with both Hb and PCV ($P < 0.01$). Therefore, it was concluded that the Hb and PCV value would decrease, if EPG increases.

Keywords Goat · Gastrointestinal nematode · EPG Hb · PCV · Resistance

Introduction

The grazing animals are commonly exposed to gastrointestinal nematodes infections, which causes lowered productivity, mortality, and high economic losses among livestock. The strongyle spp. viz., *Haemonchus contortus*, *Trichostrongylus columbriformis* and *Oesophagostomum columbianum* are common in small ruminants in India (Annual report GIP 2010). The projected losses due to strongyle infection in goats in Madhya Pradesh were Rs. 657 million, while it was Rs. 73 million in Meghalaya (Annual report on GIP, 2011). The control of nematode infections in livestock relies mainly on the usage of anthelmintic agents and (or) by proper management of grazing practices (Barger 1996, 1999). The continuous use of anthelmintics leads to high frequency of resistance (Waller 1997) among parasites. The controlled grazing is impractical in developing countries like India due to non availability and fragmented pasture land. Alternatively, simple and cheap method of reducing the effects of nematode infection is the characterization and utilization of host genetic variation for resistance. The genetic variation in domestic animals lead to variation in resistance to gastrointestinal nematodes (Gray et al. 1995; Axford et al. 1999) and resistance known to follow polygenic inheritance i.e. inheritance of a phenotypic character (trait) that is attributable to two or more genes which can be measured quantitatively.

Resistance refers to the ability of host to suppress the establishment or development of parasites, while resilience is the ability of host to survive and be productive in the face of parasitic challenge (Woolaston and Baker 1996). The degree of resistance was assessed by measuring faecal egg count (FEC) and resilience by packed cell volume (PCV) and haemoglobin (Hb). There are no published estimates of heritability for resistance or resilience to GI

K. V. Subramani · M. Sankar (✉) · G. R. Gowane ·
A. K. Sharma · V. Khobra
Temperate Animal Husbandry Division, Indian Veterinary
Research Institute, Mukteshwar, India
e-mail: drsankarm@gmail.com

A. Prasad · G. R. Gowane · B. C. Saravanan · S. Chandra
Division of Parasitology, Indian Veterinary Research Institute,
Bareilly, India

G. R. Gowane · A. K. Zahid
Division of Microbiology, CoVsc, SKUAST-K, Srinagar, India

nematodes in goats of temperate regions of Uttarakhand, India.

Materials and methods

The experimental goats (6–9 months of age) used in the study were belongs to Indian Veterinary Research Institute, Mukteshwar. The study area (Mukteshwar, Nainital, Uttarakhand) is located in the temperate Himalayan region of India at 29°28'20"N, 79°38'52"E, and at 2,171 m (7,123 feet) above the mean sea level (msl).

Sixty animals were selected for the study. The faecal samples were collected into plastic bags directly from the rectum at monthly intervals for a period of 1 year and the egg per gram (EPG) was estimated according to modified McMasters method (MAFF 1977). The positive samples were pooled and subjected to copro-culture to obtain third stage infective larva. The larvae were identified as per the morphological keys given by Soulsby (1965, 1982).

The blood samples (5 ml) were collected aseptically from the jugular vein into plastic containers with anticoagulant (0.1 % EDTA). Hb was estimated by Sahli's acid haematin method as described by Balasubramaniam and Malathi (1992). Briefly, 200 µl of blood was mixed with 0.1 N HCl drop by drop and kept for 5 min. The colour was adjusted to the standard colour of haemoglobinometer by adding 0.1 N HCl. The column was red by comparing the colour of calibrated tube with the reference tube. Haematocrit estimation was done by Wintrobe method (Coles 1980). Briefly, Wintrobe tube was filled slowly with blood up to the mark "10". The tube was centrifuged at 3,000 rpm for 10 min and the reading was taken at the top of packed erythrocytes immediately adjacent to the buffy coat.

Repeatability of FEC, PCV and Hb were estimated over time. Pearson's correlation (r) was obtained for blood parameters (Hb and PCV) with EPG from local hill breed using the formula:

$$\rho_{X,Y} = \frac{\text{Cov}(X,Y)}{\sigma_X \sigma_Y} = \frac{E[(X - \mu_x)(Y - \mu_y)]}{\sigma_X \sigma_Y}$$

where, $\rho_{X,Y}$ = Pearson correlation, X = Haemoglobin or PCV, Y = EPG, E = expected value, estimates were tested for significance at 5 % level.

Results and discussion

The Uttarakhand hill goats were evolved from long term natural and artificial selections. The goats exhibited extensive adaptability to temperate climate, relatively rapid growth and ability of resistance to certain diseases and are

also important in meat, hair, skin and dairy resources for the local people.

The majority of faecal cultures were containing the larvae of *T. circumcincta* (32 %), *B. trigonocephalum* (29 %), *H. contortus* (18 %), *Trichostrongylus* spp. (12 %) and *Oesophagostomum* spp. (9 %) in winter (December–March). However, in April–July, *H. contortus* (48 %), *T. circumcincta* (23 %) and *Trichostrongylus* spp. (14 %) were predominant with less number of *Oesophagostomum* spp. (10 %) and *B. trigonocephalum* (5 %). The *H. contortus* (56 %) was predominant in rest of the season followed by *Trichostrongylus* spp. (18 %), *Oesophagostomum* spp. (13 %), *T. circumcincta* (11 %) and *B. trigonocephalum* (2 %). In a similar study, nine species of gastrointestinal nematodes viz., *H. contortus*, *B. trigonocephalum*, *Chabertia ovina*, *T. circumcincta*, *Nematodirus spathiger*, *Trichostrongylus* spp., *O. columbianum*, *Trichuris ovis* and *Marshallagia marshalli* were reported by Tariq et al. (2010) in the goats of Kashmir valley, where similar climate conditions are prevailing.

EPG, Hb and PCV were taken as phenotypic parameters in the study as they were found to be reliable phenotypic markers and correlates of high responsiveness to infection (Behnke et al. 2006). The mean EPG, PCV and Hb of hill goats were $1,579.6 \pm 346$, 35.12 ± 1.1 and 8.7 ± 0.2 , respectively. The local goats had more Hb and PCV than the normal which might be due to adoptability of the local goats well in local environmental conditions. Similar opinion was expressed by Charon (2004) who observed significant resistance/tolerance in "unimproved" breeds of sheep to parasites as compared to the "improved" breeds.

There are no reports available to set phenotypic markers for goats. In the present study, we developed the basic phenotypic criteria for estimating the resistance/resilience in local hill goats. The animals were divided into three groups based on EPG values (<800, 801–2000 and >2000) studied over a period of 2 years (Table 1). FEC is viewed as a parameter most directly reflecting parasitological status of the sheep, and in young animal, can be well correlated with the burden of adult nematodes (Douch et al. 1995, 1996).

The average EPG, PCV and Hb were 500, 38.4 and 10.15, respectively in low EPG group, 1,304, 36.2 and 8.8, respectively in medium EPG group whereas it was 2,894, 31 and 7.3, respectively in high EPG groups. The percentage of low, medium and high EPG animals in the population were 30.5, 40.67 and 32.2, respectively. The EPG showed a negative correlation (Pearson correlation) with both Hb and PCV (Tables 2, 3) which was highly significant ($P < 0.01$). Our results are on line with the observations of Vanimisetti et al. (2004), Behnke et al. (2006) and Yadav et al. (2006) in ewes and lambs. In lambs, heritabilities were 0.39 for PCV and 0.10 for FEC across all measurement. Selection for resistance to *H. contortus* is therefore possible which should not adversely

Table 1 Animals were showing low EPG (<800), medium EPG and high EPG, consistently

Sl. No.	Low EPG			Medium EPG			High EPG		
	EPG	PCV	Hb (%)	EPG	PCV	Hb (%)	EPG	PCV	Hb (%)
1	600	39	11	1,100	38	9	2,600	31	8
2	700	39	10.5	1,100	38	11	2,200	32	9
3	600	39	10	1,000	35	8.5	3,800	31	7
4	700	38	10	2,000	33	8	2,700	32	7.5
5	0	39	11	900	38	10	2,800	32	8.5
6	800	37	10	1,600	37	8.5	3,200	30	7.5
7	800	38	8	1,200	38	9	3,400	29	7
8	400	39	10	900	39	9.5	2,400	32	7
9	800	37	9	1,100	38	10	2,200	33	8
10	100	39	12	1,900	35	8	3,100	28	6.5
11	700	37	10	1,000	36	9	2,200	34	8
12	700	36	9	1,000	35	8	4,200	26	6
13	200	43	11.5	1,200	38	9.5	2,500	30	7
14	100	38	10	1,900	34	7.5	2,700	32	7
15	400	38	10	1,400	35	8.5	3,300	31	7
16	500	38	9.5	1,100	35	8.5	2,500	34	7.5
17	400	39	11	1,400	36	7.5	3,900	29	6
18	500	38	10	2,000	34	9.5	2,400	32	6.5
19				900	36	8	2,900	31	7.5
20				900	37	9			
21				1,300	38	9.5			
22				1,500	37	9			
23				1,600	33	8			
Average	500 ± 61	38.4 ± 0.34	10.15 ± 0.22	1,304 ± 77	36.2 ± 0.37	8.8 ± 0.18	2,894 ± 137	31 ± 0.45	7.3 ± 0.18

Table 2 Correlations between EPG and Hb

	EPG	Hb
EPG		
Pearson correlation	1	−.845**
Sig. (2-tailed)		.000
N	59	59
Hb		
Pearson correlation	−.845**	1
Sig. (2-tailed)	.000	
N	59	59

** Correlation is significant at the 0.01 level (2-tailed)

affect the growth of lambs and fertility of ewes in the production environment (Vanimisetti et al. 2004) reported in the study. Therefore, it was concluded that if EPG count increases, the Hb and PCV value would decrease, or, otherwise.

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Table 3 Correlations between EPG and PCV

	EPG	PCV
EPG		
Pearson correlation	1	−.926**
Sig. (2-tailed)		.000
N	59	59
PCV		
Pearson correlation	−.926**	1
Sig. (2-tailed)	.000	
N	59	59

** Correlation is significant at the 0.01 level (2-tailed)

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