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Susceptibility pattern of Jamunapari and Sirohi goats to natural infection with *Haemonchus contortus* in semi-arid region of India

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The resistance to parasitic diseases in animals is a heritable trait. The resistant animals harbored fewer parasites than susceptible animals and allowed a progressive reduction in the contamination of the pastures (Windon 1990). Studies compared different breeds for their ability to resist internal nematode infections and indicated variations between breeds (Wanyangu 1997, Mugambi *et al.* 1997, Rout *et al.* 2002, Baker *et al*. 2003, Gruner *et al.* 2003, Nimbkar *et al.* 2003). Genetic variation for resistance or tolerance (resilience) to gastrointestinal nematode parasites occur in sheep and goats (Gray *et al.* 1995, Woolaston and Baker 1996, Chauhan *et al*. 2003, Burke *et al*. 2004, Behnke *et al*. 2011, Chiejina and Behnke 2011). There were few studies in goats as compared to sheep. Saanen goats were reported to be more resistant than East African Galla goats (Preston and Allonby 1978). Similarly Small East African, West African Dwarf, Thai native, Philippine native, and Boer were found more resistant than other breeds (Barger 1989, Baker *et al.* 1992, 1995, Saithanoo 1996, Pralomkarn *et al.* 1997, Suba *et al.* 2000, Rout *et al.* 2002). The Anglo-Nubian goats seem to be less susceptible to *H. contortus* infection than the Caninde, and Bhuj breed being intermediate (Costa *et al.* 2000). Barbari and Jakhrana were found with resistance to GI nematodes (Rout *et al*. 2002, Nimisha *et al.* 2010). The objective of present work was to study the natural infections of Jamunapari and Sirohi goats with gastrointestinal nematodes, predominantly *Haemonchus contortus* and to identify the factors affecting them in semi arid region of India. The study carries relevance to address the GI nematode problem in Indian scenario with wide geographical and environmental variations.

Location of study: Data were collected from kids and adults of both Jamunapari and Sirohi goats, maintained at the Central Institute for Research on Goats (CIRG), Makhdoom, Farah, Mathura, India. The climate of study area is tropical (semi arid) with the variation in temperature from 28 to 42°C in summer (April–July) and 6 to 24°C in winter (November–February). The annual rainfall is about 750mm with major precipitation during the months from June to Sept.

Flock description and management: Jamunapari flock was maintained at the CIRG since 1982 while Sirohi flock was maintained since 1985. The animals were housed in groups in different sheds according to their breed, age, sex and physiological states and health status. All the animals were reared under semi-intensive system of management with 6 h grazing and were supplemented with (@ 250–300 g/day) concentrate mixtures. The kids were maintained on milk and mesh feed before weaning (up to 3 month of age). After weaning, they were allowed for grazing to nearby pasture areas for a very short period of about 2h up to 6 months of age. Usually kidding in flocks took place during Oct-Nov and March-April. Deworming was carried out twice annually i.e. in the pre-monsoon season (May-June) and in the post-monsoon (Sep-Oct).

Parasitological examination: The faecal samples were collected randomly (per rectum) from different groups of animals on monthly basis and intensity of infection was estimated by the modified McMaster Technique (MAFF 1977). Faecal cultures were set from pooled faecal samples to assess the generic composition of nematode species prevalent in flock. Samples (1858: 715 kids and 1143 adults of both breeds) were collected from 2006 to 2008. Out of 715 kids in this experimental design, 547 were from Jamunapari and 168 were from Sirohi goats. The number of kids were distributed in different age categories viz. 0–3 months (m), >3-6m, >6–9m, >9–12m. Out of 1143 adult goats, there were 602 Jamunapari and 541 Sirohi goats.

Statistical analysis: Data of faecal egg count for kids and adults were analyzed separately according to breed, age, sex, and season of collection by least square analysis for fitting constants (Harvey 1990). The non-genetic factors like type of birth, season, year and type of birth (single or multiple)

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were considered only for analysis of kids. Sampling was done on monthly basis, however, for the convenience of analysis, data were grouped in 3 seasons i.e. summer, rainy and winter. Data on pregnant and lactating does were excluded from this data set.

To normalize the FECs, data were subjected to log transformation by adding 100 ($\log_e$ (FEC+100)) as this transformation was found the most appropriative for this data set. The results were back transformed by taking anti-logarithms the least squares means (LSM), subtracting 100 and presented as geometric means (GFEC). Analysis of data was made using a mixed model least-squares for fitting constants (Harvey 1990) including all main and interactions effects:

$Y_{ijklmnpx} = \mu + B_i + C_k + A_l + Y_p + (B \times C)_{ik} + (B \times A)_{il} + e_{ijklmnpx}$ (for kids)

$Y_{ijkx} = \mu + B_i + C_k + S_j + (B \times C)_{ik} + e_{ijkx}$ (for adult)

where,

$Y_{ijkx}/Y_{ijklmnpx}$, is the record of the x^{th} animal; μ, overall mean; B_i, fixed effect of i^{th} breed (j = 1, 2); C_k, fixed effect of k^{th} season of collection (k = 1, 2, 3); A_l, fixed effect of l^{th} age of animals (l = 0–3, >3-6, >6-9, >9-12 months); S_j, fixed effect of j^{th} sex (j= 1, 2); Y_p, fixed effect of p^{th} year of birth (p = 1, 2, 3); $(B \times C)_{ik}$, interaction effect between i^{th} breed and k^{th} season of collection; $(B \times A)_{il}$, interaction effect between i^{th} breed and l^{th} age of animal; $e_{ijkx}/e_{ijklmnpx}$, random error associated with observation with mean 0 (zero) and variance Δ^2 e.

To compare the different sub-group means, Duncan's multiple range test (DMRT) as described by Kramer (1957) was applied.

Prevalence of nematode infection: The overall prevalence rate of strongyle infection ranged from 70.75% (Jamunapari kids) to 78.00% (Sirohi kids). Out of 70.75% of Jamunapari kids, the prevalence of coccidial oocysts was 87.34% (i.e. 338/387) whereas only 35.66% kids were positive for nematode infection particularly *H. contortus*. Similarly, out of 78% of Sirohi kids, 98.47% kids were infected with coccidial oocysts, however, 35.11% were infected with *Haemonchus contortus* infection.

In adult animals, the prevalence of gastrointestinal infection in Jamunapari goats was observed as 87% (i.e. 521/602) and in Sirohi goats was 78.37% (i.e. 424/541). Out of 521 infected animals a large portion (68.14%) of goats was found infected with *H. contortus* infection and 62.96% was affected by coccidiosis infection. Similarly, out of 424 animals of Sirohi goats 50% animals infected by *H. contortus* infection and 81.60% by coccidiosis infection. Investigation showed that the major proportion of the population was less sensitive to *H. contortus* infection upto 12 months of age both in Jamunapari and Sirohi kids. The occurrence of infection was much higher in adults than kids. Results were in general agreement with the findings of Yadav *et al*. (2006) who reported that the prevalence of *H. contortus* infection was more in adults than lambs of Muzaffarnagri sheep flock of this area.

During present study, the species composition of larval cultures was not change with time and there were no significant breed differences in larval culture results. *H. contortus* was the dominant species (>95%). Other G.I. nematode species like *Oesophagostomum* (0.02%), *Strongyloides* (1.83%) were also recorded as sporadically occurring. Similarly, Swarnkar *et al.* (1996) and Garg *et al.* (2003) also reported *Haemonchus contortus* as the predominant strongyle species from semi-arid region of India.

Breed effects on faecal egg count: Jamunapari kids had significantly (P<0.01) higher GFEC with a mean of 132.76 eggs/g of faeces compared to Sirohi kids (44.03 eggs/g of faeces) (Table 1). Similarly, the adults of Jamunapari had significantly (P<0.01) higher GFEC (307.48 eggs/g) in comparison to Sirohi adults (207.97 egg/g) (Table 1). Our results demonstrated the existence of genetically determined breed differences in susceptibility for *H. contortus* infection (Rout *et al*. 2002, Chauhan *et al*. 2003).

Factors affecting faecal egg count: In both the age groups, highest intensity of *H. contortus* infection was found during rainy season followed by summer and winter, respectively. These findings were in accordance with results of Katoch *et al.* (2000), Yadav *et al.* (2006), Ram *et al.* (2007) and Sharma *et al.* (2009).

The FECs in kids were also significantly (P<0.01) influenced by the age group. Effect of interaction between breed × age on worm load of kids revealed that in both the breeds, the infection load increased as age increased (Table 1) and 9–12 m animals had highest FEC in both breeds. Chauhan *et al*. (2003), Yadav *et al.* (2006) and Mandal *et al.* (2008) also observed the significant effect of age of the animal on FEC in Jamunapari and Barbari goats and in Muzzafarnagri sheep, respectively. In the present study, the increased susceptibility with progressive age can be due to a late expression of immunity in goats. Dorney *et al.* (1995) reported that goat acquires immunity from 12 to 18 months of age. The slow build up of immunity in goats could ascribed to their habit of browsing with resultant less contact with parasites. Therefore goat might express a genetically influenced immune response at a later age than sheep (Baker *et al.* 2001, Vagenas *et al.* 2002).

Sex of animals, season of birth and type of birth of kids were not significant (P>0.05) and therefore were removed from the model. The nonsignificant effect of sex was in agreement with the observations of Bhat *et al.* (2007) and Rout *et al.* (2002), Miller *et al.* (2006) and Sharma *et al.* (2009). Similarly, non-significant effect of birth status on FEC was also reported by Yadav *et al.* (2006) in Muzzaffaranagri sheep breed of Indian region. However, after attaining the maturity there were a significant (P<0.05) variations in FEC between two sexes (Table 1). Male were

Table 1. Least square means of log transformed faecal egg count (LFEC) and geometric mean (GFEC) following *H. contortus* infection in Jamunapari and Sirohi kids

Parameters	Kids		Adults	
	No. of observations	LFEC (GFEC**)	No. of observations	LFEC (GFEC**)
Overall	715	5.21±0.08(83.09)	1143	5.87±0.04(254.25)
Breeds of animals				
Jamunapari (Ja)	547	5.45±0.05^{a}(132.76)	602	6.01±0.05^{a}(307.48)
Sirohi (Si)	168	4.97±0.14^{b}(44.03)	541	5.73±0.06^{b}(207.97)
Sex of animals				
Male	-	-	385	5.72±0.07^{a}(204.90)
Female	-	-	758	6.03±0.05^{b}(315.72)
Sampling season				
Summer (S)	222	5.36±0.11^{a}(112.72)	395	5.78±0.07^{a}(223.76)
Rainy (R)	237	5.54±0.10^{a}(154.68)	332	6.53±0.07^{b}(585.40)
Winter (W)	256	4.74±0.14^{b}(14.43)	416	5.31±0.07^{a}(102.35)
Age of animals				
0–3 M (A_1)	144	4.89±0.12^{a}(32.95)	-	-
>3–6 M (A_2)	225	4.85±0.10^{a}(27.74)	-	-
>6-9 M (A_3)	154	5.36±0.11^{b}(112.72)	-	-
>9-12 M (A_4)	192	5.75±0.11^{c}(214.19)	-	-
Sampling year				
2006 (Y_1)	85	5.64±0.13^{a}(181.46)	-	-
2007 (Y_2)	330	4.97±0.10 ^{b}(44.03)	-	-
2008 (Y_3)	300	5.01±0.09 ^{b}(49.90)	-	-
Breed × season interaction				
Ja×Si	117	5.38±0.09^{a}(117.02)	191	6.01±0.05^{a}(307.48)
Ja×R	211	5.72±0.10^{b}(204.90)	211	6.74±0.09^{b}(745.56)
Ja×W	219	5.25±0.07^{a}(90.57)	200	5.29±0.09^{c}(98.34)
Si×S	105	5.33±0.2^{a}(106.44)	204	5.55±0.10^{c}(157.24)
Si×R	26	5.36±0.19^{a}(112.72)	121	6.31±0.12^{a}(450.04)
Si×W	37	4.22±0.28^{c}(0.00)	216	5.34±0.09^{c}(108.51)
Breed × age interaction				
Ja×A_1	118	5.28±0.08^{a}(96.37)	-	-
Ja×A_2	160	5.34±0.09^{ap}(108.51)	-	-
Ja×A_3	121	5.57±0.09^{bp}(162.43)	-	-
Ja×A_4	148	5.61±0.07^{bc}(173.14)	-	-
Si×A_1	26	4.49±0.24^{d}(0.00)	-	-
Si×A_2	65	4.35±0.18^{c}(0.00)	-	-
Si×A_3	33	5.15±0.20^{a}(72.43)	-	-
Si×A_4	44	5.89±0.21^{bc}(261.41)	-	-

Means with different superscripts in a column differ significantly (P<0.05) from each other. **units eggs/g; the mean of the $\log_e$ value is given first followed by its antilog in parentheses.

less susceptible than female due to the infection. The present finding was contrary to Romjali *et al.* (1997) who reported the average FECs of females was significantly lower than that of males. They reported greater immune responses in females than male lambs. Courteny *et al.* (1985), however, found that natural resistance of ewe lambs to *H. contortus* was higher than that of ram lambs but only after puberty.

The year of birth had significant (P<0.05) effect on FEC of animals but the interaction between breed × year of birth (YOB) was also non-significant. This may be attributed to variation in management, selection of sires and environmental conditions such as ambient temperature, humidity, rainfall etc.

Results of both analysis showed that Jamunapari goats were more susceptible to *H. contortus* infection in comparison to Sirohi goats. The difference in susceptibility was due to the relative ability of the breeds to elicit an immune response against the parasite.

Thus, study revealed that the occurrence of *H. contortus* infection was more in adults than kids in both of the flocks. Breed had significant effect for faecal egg count for both adults and kids and Jamunapari goat are more susceptible to *H. contortus* infection as compared to Sirohi goats.

SUMMARY

The susceptibility of kids (<1year) and adult goats (>1 year) against *Haemonchus contortus* infection was studied through faecal examination of naturally infected animals of Jamunapari and Sirohi breeds. For adults, All fixed effects and interaction effects were found significantly different. On the other hand, for kids, effect of breed, season of collection and year of birth on FEC was significant. The results of both study revealed that Jamunapari goats had significantly higher intensity of infection compared to Sirohi goats. For both, kids and adults, the highest FEC mean was observed in rainy season followed by summer and winter season, respectively. The interaction between breed × age was also significant for kids. Study revealed that Jamunapari goats were more susceptible to *H. contortus* infection compared to Sirohi goats. On coproculture, it was observed that in both the breeds *H. contortus* was predominant.

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