Variability of resistance in Black Bengal goats naturally infected with *Haemonchus contortus*

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Abstract A total 290 Black Bengal goats (6 buck, 109 doe and 175 kids born from 11 sires) were studied to evaluate the variability of resistance in Black Bengal goats naturally infected with *Haemonchus contortus*. The variability of resistance in Black Bengal goat was studied for both genetic and non-genetic factors like village, sex, age dam, sire, dam resistance group and offspring resistance group. Male kids have slightly higher resistance than female kids although it was not significant. Resistance of kids was increased as age increases and kid population showed significantly different resistance status among the offspring resistant groups. The doe population showed significantly different LEPC as per the resistance group in all the collections. The present study found that the resistance of kids under sire were varied significantly and observed that the kids under sire 1, 6–8 were significantly more resistant than the kids of the sire 2, 5 and 11 in 3rd collection and it is also noticed that maternal genetic effect has a very little impact on resistance of kids. Males (buck) were most resistant and the kids were least

resistant and the resistance of dam was in between the male and kids population.

Keywords *Haemonchus contortus* · Black Bengal goats · Variability of resistance and genetic and non-genetic factors

Introduction

Among the gastrointestinal nematodes infecting the small ruminants, *Haemonchus contortus* is a major problem in goat production in India. Current control practices rely heavily upon the frequent use of anthelmintics which leads to the development of resistance to the anthelmintics (Pandey and Sivaraj 1994). Internal parasites become increasingly more resistance to dewormers and given the emergence of multiple drug resistance parasites (Kaplan 2004). As a result, gastrointestinal nematodes adversely affected the production potential of goat in tropical and subtropical areas, leading to countless death and insidious economic losses in livestock sector (Al-Quaisy et al. 1987). The increasing prevalence of anthelmintics resistance during the recent years and also great concern about drug residues in the food chain have necessitated the search for an effective alternative strategy to control roundworm (especially *H. contortus*). This can be resolved by utilizing principle of breeding for genetic resistance which is a component of integrated parasite management (IPM) programmes (Woolaston and Windon 2001; Bishop et al. 2004). Albers (1987) reported that resistance to *H. contortus* was moderately heritable, indicating that selection and breeding goat for increased resistance is possible. Therefore shifting to resistant variety or designing cross breeding programmes involving resistant goat breeds are thus most promising application in

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combating nematode infection. In view of the above facts, the present work has been undertaken on Black Bengal goat to study the variability of resistance in Black Bengal goat naturally infected with *H. contortus*.

Materials and methods

The research work was carried out on Black Bengal goats maintained at the village Ganguria, Ayeshpur & Doulipur in Nadia district, West Bengal under AICRP on goat, Black Bengal Field Unit, WBUAFS, Kolkata. A total of 290 Black Bengal goats (6 buck, 109 doe and 175 kids born from 11 sires) were studied to evaluate the variability of resistance in Black Bengal goat naturally infected with *H. contortus*. At the beginning of the experiment initial surveys were done to know the types of parasites present in the flock. Then all the selected animals were dewormed first simultaneously by 2.26 % oxyfendazole orally @ 2.5 ml per 15 kg b.wt. and Ivermectin s/c @ 1 ml/50 kg b.wt. After 3 weeks of deworming all the kids along with their sire and dams were evaluated at 1 month interval for consecutively 3 months for their parasitic egg loads. Faecal samples were collected in 30-ml wide-mouthed plastic vials from each animal at 1 month interval for evaluation of *H. contortus* resistance/susceptibility. A part of the individual faecal samples was examined qualitatively for the presence of nematode eggs by using standard salt flotation technique and the remaining part of samples were subjected to quantitative faecal examination by modified McMaster's technique for determining the eggs per gram (EPG) of faeces.

The data for EPG have been tested for normalcy and then transformed to $\log_{10}(\text{EPG} + 75)$ LEPG for best fitted to normalize the data. The dam and kids were classified into three resistance groups based on their log EPG value. Animals with log EPG value below 2.0 are in resistant group 1 (resistant), animals with log EPG value 2.0–2.2 are in resistant group 2 (susceptible) and animals with log EPG value above 2.2 are in resistant group 3 (highly susceptible). To study the effect of age the kids have been grouped according to their age as

group-I (up to 3 months), group-II (3–6 months), group-III (6–9 months) and group-IV (above 9 months). Villages are represented like Ganguria (1), Ayeshpur (2) and Doulipur (3). Analysis of the arranged data has been made in SPSS (10) following Snedecor and Cochran (1994).

Results and discussion

Variability of resistance in Black Bengal doe

The present study revealed that there is a significant variation of resistance of doe among different the three villages in 1st collection in contrast to 2nd and 3rd collection, which did not show any variation. The average LEPG of doe were 1.9967 ± 0.017 , 1.9840 ± 0.022 and 1.9865 ± 0.028 respectively for village-1–3. It has been examined that there was no significant variation in average resistance in different villages. The average LEPG of Doe in resistance group-1–3 were 1.9295 ± 0.005 , 1.9294 ± 0.005 and 2.3033 ± 0.021 respectively (Table 1).

Variability of resistance in Black Bengal kids

The present investigation was carried out to evaluate the effect of various factors i.e. village (1,2,3), sex (male, female), age (1,2,3,4), resistance group (R1, R2 and R3), Dam resistance group (DR-1–3) and sire on variability of resistance in Black Bengal kids infected with *H. contortus* on the basis of LEPG values in kids. The LEPG of kids were 2.135 ± 0.023 , 2.136 ± 0.021 and 2.094 ± 0.022 in village-1 for the three collections respectively, the corresponding values for village-2 and 3 were 2.081 ± 0.024 , 2.106 ± 0.022 , 2.193 ± 0.023 and 2.016 ± 0.022 , 2.112 ± 0.028 , 2.113 ± 0.030 respectively. The average LEPG values for village-1–3 were 2.122 ± 0.009 , 2.128 ± 0.010 and 2.111 ± 0.013 respectively (Table 2). The present study noticed that village had significant effect on LEPG during natural infection of *H. contortus* in kids and kids of village-3 were more resistant as compared to village-1 and 2. The average LEPG have been

Table 1 Least squares means ($\pm$ S.E) of LEPG in Black Bengal doe for village and resistance group

	No. of obs.	LEPG			Avg. LEPG
		1st collection	2nd collection	3rd collection	
Village-1	57	$2.0429 \pm 0.027^{\text{n}}$	1.9786 ± 0.025	1.9635 ± 0.019	1.9967 ± 0.017
Village-2	35	$1.9277 \pm 0.014^{\text{m}}$	1.9794 ± 0.031	2.0386 ± 0.037	1.9840 ± 0.022
Village-3	17	$1.9573 \pm 0.022^{\text{m,n}}$	1.9984 ± 0.047	2.0062 ± 0.043	1.9865 ± 0.028
DR-1	81	$1.9383 \pm 0.010^{\text{a}}$	$1.9141 \pm 0.008^{\text{a}}$	$1.9284 \pm 0.009^{\text{a}}$	$1.9295 \pm 0.005^{\text{a}}$
DR-2	16	$1.9384 \pm 0.010^{\text{a}}$	$1.9140 \pm 0.008^{\text{a}}$	$1.9283 \pm 0.009^{\text{a}}$	$1.9294 \pm 0.005^{\text{a}}$
DR-3	12	$2.2271 \pm 0.088^{\text{c}}$	$2.4185 \pm 0.062^{\text{c}}$	$2.2656 \pm 0.072^{\text{c}}$	$2.3033 \pm 0.021^{\text{c}}$
Overall	109	1.9925 ± 0.016	1.9819 ± 0.017	1.9941 ± 0.017	1.9910 ± 0.012

* Mean $\pm$ S.E (column wise) values bearing common superscripts do not differ significantly from each other ($P < 0.05$)

Table 2 Least squares means ($\pm$ S.E) of LEPG in Black Bengal kids

	No. of obs.	LEPG			Avg. LEPG
		1st collection	2nd collection	3rd collection	
Village-1	104	2.135 $\pm$ 0.023	2.136 $\pm$ 0.021	2.094 $\pm$ 0.022 ^a	2.122 $\pm$ 0.009 ^b
Village-2	50	2.081 $\pm$ 0.024	2.106 $\pm$ 0.022	2.193 $\pm$ 0.023 ^b	2.128 $\pm$ 0.010 ^b
Village-3	21	2.016 $\pm$ 0.031	2.112 $\pm$ 0.028	2.113 $\pm$ 0.030 ^a	2.111 $\pm$ 0.013 ^a
Male	72	2.103 $\pm$ 0.023	2.110 $\pm$ 0.021	2.134 $\pm$ 0.022	2.116 $\pm$ 0.010
Female	103	2.112 $\pm$ 0.021	2.126 $\pm$ 0.020	2.133 $\pm$ 0.021	2.124 $\pm$ 0.009
Age 1	54	2.103 $\pm$ 0.024	2.108 $\pm$ 0.022 ^{a,b}	2.153 $\pm$ 0.023 ^b	2.121 $\pm$ 0.010 ^{b,c}
Age 2	64	2.103 $\pm$ 0.023	2.131 $\pm$ 0.021 ^b	2.124 $\pm$ 0.022 ^b	2.119 $\pm$ 0.010 ^c
Age 3	46	2.105 $\pm$ 0.025	2.113 $\pm$ 0.023 ^{a,b}	2.162 $\pm$ 0.024 ^{a,b}	2.115 $\pm$ 0.011 ^b
Age 4	11	2.119 $\pm$ 0.039	2.112 $\pm$ 0.036 ^a	2.094 $\pm$ 0.038 ^a	2.113 $\pm$ 0.017 ^a
R1	134	1.927 $\pm$ 0.012 ^x	1.894 $\pm$ 0.011 ^x	1.925 $\pm$ 0.012 ^x	1.919 $\pm$ 0.005 ^x
R2	36	2.086 $\pm$ 0.021 ^y	2.022 $\pm$ 0.020 ^y	2.154 $\pm$ 0.020 ^y	2.086 $\pm$ 0.009 ^y
R3	5	2.308 $\pm$ 0.052 ^z	2.438 $\pm$ 0.048 ^z	2.321 $\pm$ 0.050 ^z	2.356 $\pm$ 0.022 ^z
Overall	175	2.107 $\pm$ 0.021	2.118 $\pm$ 0.019	2.133 $\pm$ 0.020	2.120 $\pm$ 0.009

* Mean $\pm$ S.E (column wise) values bearing common superscripts do not differ significantly from each other ($P < 0.05$)

found to be 2.116 ± 0.010 for male and 2.124 ± 0.009 for female kids (Table 2) indicating that males have slightly higher resistance than female although it was not significant. The average LEPG values for age group-1–4 were 2.121 ± 0.010 , 2.119 ± 0.010 , 2.1115 ± 0.011 and 2.113 ± 0.017 respectively, which were significantly different and suggests that resistance of kids was increased as age increases. The average LEPG were 1.919 ± 0.005 , 2.086 ± 0.009 and 2.356 ± 0.022 respectively for R1, R2 and R3, the values being significantly different from each other. The LEPG values of kid as per their dam resistance groups-1–3 were 1.9783 ± 0.013 , 1.9675 ± 0.016 and 2.0026 ± 0.045 respectively in 1st collection, 1.9516 ± 0.013 , 1.9080 ± 0.010 and 1.9836 ± 0.053 in 2nd collection and in the 3rd collection the corresponding values were 1.9826 ± 0.013 , 1.9733 ± 0.026 and 2.0088 ± 0.061 . The average LEPG of kids were 1.9703 ± 0.010 , 1.9491 ± 0.012 and 1.9960 ± 0.034 respectively for dam resistance group-1–3. The LEPG for kids under different sires in 1st and 2nd collection are almost similar and there were no significant difference as shown in Table 3. The average LEPG of kid showed significant differences under different sires (Table 3).

Discussion

The resistance status of Black Bengal goat infected with *H. contortus* was found to be <2.0 (1.995 ± 0.005). The average LEPG in adult male, doe and kids were 1.8750 ± 0.000 , 1.9910 ± 0.012 and 2.120 ± 0.009 respectively. Adult males has lowest average LEPG and the kid has highest average LEPG which implies that the males were most resistant and the kids were least resistant, the

resistance of dam group is in between the male and kids population.

Our study disclosed that doe population showed significantly different LEPG values (Table 1) among resistance groups in all the collections as well as in average LEPG values. Various studies on goats by earlier workers reported that there exists significant variation for resistance within goat breeds (Patterson et al. 1996a, b; Morris et al. 1997; Mandonnet et al. 2001; Vagenas et al. 2000). A higher LEPG of 5.0–6.0 for adult doe had been recorded by Costa et al. (2000) in Brazil. Therefore, the classification of doe as per their resistance status i.e., resistant, susceptible and highly susceptible is justified. Chauhan et al. (2003) revealed that the FEC of kids at 9 months of age was higher than at 3 or 6 months of age. In Pakistan Rizvi et al. (1999) reported that 18.8 % prevalence of Haemonchosis in goat was significantly higher in young (53 %) than the adult goat (47 %). Gauly et al. (2006) reported that female lambs are more resistant against an experimental *H. contortus* infection compared to male lambs. Qamar et al. (2011) recorded a higher infection rate in sheep and goat below 9 months than above 9 months of age and did not show any significant difference. From the result of present study and the reports of earlier workers it can be stated that the variability of resistance to *H. contortus* exists in Black Bengal kids and there is no significant variation between two sexes.

The present study noticed that the resistances of kids under sire were varied significantly and kids under sire 1, 6–8 were significantly more resistant than the kids of the sire 2, 5 and 11 in 3rd collection. The kids under the sire 8 had lowest average LEPG and kids under the sire 5 and 11 had highest average LEPG which indicates that kids of sire 8 were highly resistant in 3rd collection. Mandonnet et al.

Table 3 Mean ($\pm$ S.E) LEPG of kids under different sires

Sires	No. of obs.	LEPG			Avg. LEPG
		1st collection	2nd collection	3rd collection	
Sire-1	11	1.9495 $\pm$ 0.027	1.8864 $\pm$ 0.011	1.9207 $\pm$ 0.018 ^a	1.9218 $\pm$ 0.017 ^{a,b}
Sire-2	16	1.9650 $\pm$ 0.028	1.9632 $\pm$ 0.059	2.1002 $\pm$ 0.053 ^{b,c}	2.0113 $\pm$ 0.037 ^{a,b,c}
Sire-3	51	2.0122 $\pm$ 0.028	1.9722 $\pm$ 0.017	1.9715 $\pm$ 0.013 ^{a,b}	1.9859 $\pm$ 0.015 ^{a,b}
Sire-4	8	1.9618 $\pm$ 0.035	1.9908 $\pm$ 0.049	1.9855 $\pm$ 0.030 ^{a,b,c}	1.9788 $\pm$ 0.026 ^{a,b}
Sire-5	10	1.9250 $\pm$ 0.020	2.0292 $\pm$ 0.114	2.1235 $\pm$ 0.104 ^c	2.0280 $\pm$ 0.061 ^{b,c}
Sire-6	36	1.9702 $\pm$ 0.019	1.9222 $\pm$ 0.014	1.9205 $\pm$ 0.011 ^a	1.9403 $\pm$ 0.010 ^{a,b}
Sire-7	12	1.9641 $\pm$ 0.024	1.9063 $\pm$ 0.016	1.9336 $\pm$ 0.024 ^a	1.9367 $\pm$ 0.019 ^{a,b}
Sire-8	3	1.9584 $\pm$ 0.041	1.8751 $\pm$ 0.000	1.8751 $\pm$ 0.000 ^a	1.9067 $\pm$ 0.013 ^a
Sire-9	9	2.0177 $\pm$ 0.042	1.9167 $\pm$ 0.020	1.9740 $\pm$ 0.028 ^{a,b}	1.9700 $\pm$ 0.025 ^{a,b}
Sire-10	15	1.9250 $\pm$ 0.016	1.9118 $\pm$ 0.022	1.9551 $\pm$ 0.036 ^{a,b}	1.9340 $\pm$ 0.017 ^{a,b}
Sire-11	4	2.0440 $\pm$ 0.090	1.9063 $\pm$ 0.031	2.3501 $\pm$ 0.160 ^d	2.1025 $\pm$ 0.075 ^c
Overall	175	1.9773 $\pm$ 0.010	1.9441 $\pm$ 0.010	1.9820 $\pm$ 0.012	1.9695 $\pm$ 0.008

* Mean $\pm$ S.E (column wise) values bearing common superscripts do not differ significantly from each other ($P < 0.05$)

(1996) recorded similar sire effect on average EPG from 6 month-old Creole kids. Mandonnet et al. (2001) also observed significant sire effect in Creole goats which corroborated with present findings. Kids did not show any significant variation among their LEPG values although their dams have significantly different LEPG, which signifies that the maternal genetic effect had a very little impact on resistance of kids after weaning. After 6 months of age the maternal effects were found to be unimportant for FEC by Mandonnet et al. (2001) in Creole goats and suggested that post-weaning genetic resistance can be evaluated on individual performances only.

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