GENETIC RESISTANCE TO GASTROINTESTINAL NEMATODE PARASITES IN SOME INDIGENOUS BREEDS OF SHEEP AND GOATS IN EAST AFRICA.

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SUMMARY

Research in Kenya has confirmed that Red Maasai sheep are more resistant to gastrointestinal parasites than Dorper sheep and has shown that Small East African goats are more resistant than Galla goats. There is no difference in resistance between the Menz and Horro sheep breeds in Ethiopia. Heritability estimates in 8-month-old lambs in Kenya were 0.18 ± .08 for logarithm transformed faecal egg counts (FEC), but higher in the susceptible Dorper-sired lambs (0.35 ± .16) than in the resistant Red Maasai-sired lambs (0.06 ± .07). In Ethiopia the heritability for log FEC in 3-month-old lambs at weaning was 0.14 ± .05, with a lower heritability in the better adapted Menz lambs (0.09 ± .05) than in the Horro lambs (0.23 ± .09).

INTRODUCTION

Gastrointesinal (GI) nematode parasites occur in all livestock species world-wide, but are a particularly serious disease constraint in sheep and goats in the tropics. Current control methods rely on drug treatments with anthelmintics or controlled grazing to reduce pasture contamination. In many parts of the developing world in the tropics these control methods are limited by the communal grazing of livestock, the high costs of anthelmintics, their unavailability, and the increasing frequency of anthelmintic resistance in the target worm populations. A potential alternative means of control is the use of genetically resistant livestock (Gray *et al.* 1995; Woolaston and Baker 1996). This paper reports studies undertaken by ILRI in Kenya and Ethiopia which comprehensively characterise both between- and within-breed genetic resistance to GI worms in some indigenous breeds of sheep and goats.

MATERIALS AND METHODS

Kenya. This study was undertaken at Diani Estate of Baobab Farm Ltd., 20 km south of Mombasa in the sub-humid coastal region of Kenya, where the predominant GI parasites are *Haemonchus contortus* and *Trichostrongylus spp.* Sheep (Red Maasai (R), Dorper (D) and their crosses) and goats (Galla (G) and Small East African (SEA)) have been evaluated at this site between 1991 and 1997. A total of 76 different rams (42 D and 34 R) and 35 bucks (18 G and 17 SEA) were used.

Ethiopia. This study was undertaken at ILRI's research site at Debre Berhan in the highlands of Ethiopia (altitude of 2,900 m). The predominant GI parasites are species of *Longistrongylus* and *Trichostrongylus*. The Menz (42 rams; indigenous to the Debre Berhan region) and Horro

(41 rams; indigenous to the Bako region - 1680 m in altitude) sheep breeds have been evaluated between 1992 and 1997, with experimental lambings taking place in both the wet (July) and the dry (November) seasons.

Experimental protocol. The same experimental protocol to assess resistance to GI parasites was used at both sites for both sheep and goats as described in detail by Baker *et al.* (1994). Briefly, all lambs and kids had live weight (LWT), FEC and blood packed cell volume (PCV) recorded at 1, 2 and 3 months of age and were then treated with an anthelmintic at weaning (about 3 months of age). They were then grazed on pasture until a monitor group of about 40-50 lambs or kids, which were sampled every week, reached an average FEC of about 1500-2000 eggs per gram (epg) for lambs and 1000-1500 epg for kids. When this threshold mean FEC was reached all animals in the grazing group were weighed and FEC and PCV recorded on two consecutive days. Then all lambs or kids were drenched and the procedure repeated until they reached about a year of age. The ewes and does had LWT, PCV and FEC recorded six times during the reproductive cycle: at mating, three months after mating, two weeks before lambing and one, two and three months after lambing.

Statistical analysis. The breed effects reported in this paper for lambs or kids were derived from least squares analysis of variance fitting, when significant, main effects for year of birth, season of birth (Debre Berhan analysis only), breed, sex, type of birth/type of rearing, age of dam, age of lamb or kid as a linear covariate and any significant interactions. Heritabilities were estimated by Restricted Maximum Likelihood (REML) using an animal model (Johnson and Thompson 1995). Breed effects for ewes and does were derived from analyses of variance fitting breed, year of birth, season of birth (Debre Berhan analyses), physiological status (lactating, non-lactating), ewe age and any significant interactions. Faecal egg counts were logarithm transformed ($\log_{10}$ (FEC+25)) to normalise the variance.

RESULTS AND DISCUSSION

Breed effects: Lambs and kids. Differences between the sheep and goat breeds evaluated in Kenya and the sheep breeds evaluated in Ethiopia for both resistance to GI parasites (as assessed by FEC and PCV) and production (LWT and mortality) are shown in Table 1. The research in coastal Kenya confirms previous studies in the semi-arid region of Kenya (Preston and Allonby 1978, 1979) that Red Maasai lambs are more resistant to GI parasites than Dorper lambs as shown by their significantly higher PCV (ability to control anaemia), lower FEC (lower worm burden) and lower lamb mortality. The sheep experiment in Kenya also includes four crossbred genotypes (DxR, RxD, Dx(RxD), Rx(RxD)) and there is an additive genetic breed effect for both PCV and FEC indicating that crossbred genotypes with a higher proportion of Red Maasai blood are more resistant (Baker *et al.* 1994), but no evidence for heterosis for either PCV or FEC. The SEA kids are more resistant than the Galla kids as seen by their lower FEC post-weaning but there is no breed difference for PCV. In Ethiopia there is no difference in resistance to GI parasites between the Menz and Horro breeds as reflected by FEC. While PCV is a useful indicator of resistance when *Haemonchus contortus* is the predominant GI parasite, this is not the case in this highland site in Ethiopia. While the Menz lambs have a significantly higher PCV than Horro lambs this is not related to their resistance

to endoparasites and might be an adaptation of this breed to higher altitude. The Menz lambs have a significantly lower mortality than Horro lambs both pre- and post-weaning possibly reflecting their better adaptation to the high altitude environment.

Table 1. Least squares means by breed for live weight (LWT kg), mortality (%), PCV (%) and the anti-log of logarithm FEC (ALFEC, epg).

Traits	Lambs-Kenya[A]		Kids-Kenya[A]		Lambs-Ethiopia[A]	
	R.M.	Dorper	S.E.A.	Galla	Menz	Horro
At weaning (3 mo)						
No.	182	226	283	145	1714	1131
LWT	10.1[a]	11.2[b]	7.6[a]	9.8[b]	8.0[a]	9.0[b]
Pre-wng mortality	10.3[a]	30.0[b]	20.6[a]	25.4[a]	21.5[a]	30.3[b]
PCV	27.4[a]	23.5[b]	27.0[a]	27.2[a]	35.7[a]	34.6[b]
ALFEC	1175[a]	1412[b]	282[a]	363[a]	91[a]	117[a]
As vlgs(10-12 mo)						
No.	134	112	246	126	985	397
LWT	18.4[a]	19.7[b]	15.5[a]	18.5[b]	15.7[a]	17.4[b]
Post-wng mortality	18.4[a]	39.2[b]	13.1[a]	13.2[a]	25.0[a]	51.9[b]
PCV	26.6[a]	23.4[b]	26.3[a]	26.4[a]	31.0[a]	28.5[b]
ALFEC	1500[a]	2203[b]	807[a]	1476[b]	309[a]	288[a]

[A] Means with different superscripts are significantly different (P<0.05).

Table 2. Least squares means by breed for resistance and reproduction in ewes and does at the two experimental sites.

Traits	Ewes-Kenya		Does-Kenya		Ewes-Ethiopia	
	R.M.	Dorper	S.E.A.	Galla	Menz	Horro
No. ewes/does	166	315	121	114	637	668
LWT (kg)	26.2[a]	30.1[b]	27.7[a]	35.3[b]	25.5[a]	29.0[b]
PCV(%)	26.0[a]	24.2[b]	27.6[a]	25.7[b]	32.0[a]	30.0[b]
ALFEC(epg)	362[a]	496[b]	204[a]	372[b]	234[a]	251[a]
No. matings	431	422	360	380	1322	1201
Preg. rate (%)	77.3[a]	68.2[b]	72.8[a]	49.8[b]	86.6[a]	84.8[a]
Prolificacy (%)	102.0[a]	101.9[a]	133.2[a]	116.6[b]	118.0[a]	122.0[a]
PW/FM (%)[A]	61.1[a]	33.5[b]	74.6[a]	41.9[b]	91.0[a]	82.0[b]

[A] Progeny weaned/Female mated

Breed effects: Ewes and Does. Breed effects for live weight, resistance to GI parasites (FEC and PCV) and some measures of reproductive performance are shown in Table 2. In the Kenyan study Red Maasai ewes are more resistant to GI worms than Dorper ewes and SEA does are more resistant than Galla does as indicated by their higher PCV and lower FEC. In the

does this breed difference was particularly marked over the peri-parturient period. In addition, in both species the resistant breed has a superior reproductive performance to the susceptible breed and this superiority is most marked in the sheep and goats in Kenya. In Ethiopia, there is no significant difference between the breeds in resistance to GI worms in the ewes, but the Menz sheep have a higher reproductive rate than the Horro.

Heritabilities. In the lambs in Kenya there is no evidence of significant heritabilities for resistance to GI worms (as assessed by logarithm transformed FEC (LFEC) and PCV) in 3-month old lambs at weaning, but significant additive direct heritability (h^2a) estimates are found for LFEC (0.09 ± .03) and PCV (0.11 ± .05) in 6-month old lambs (repeated measures analyses using the first 3 records post-weaning). When the lambs are 8 months of age the heritability (h^2a) for LFEC is 0.18 ± .08 in all lambs, but higher in the susceptible Dorper-sired lambs (0.35 ± .16) than in the resistant Red Maasai-sired lambs (0.06 ± .07). The low heritability for FEC in Red Maasai-sired lambs suggests that after many centuries of natural selection under endoparasite challenge that some of the important genes for resistance have been fixed in Red Maasai sheep. In the Ethiopian study, where there has been less intense natural selection for resistance, there is a significant heritability for LFEC (0.14 ± .05) in 3-month old lambs in contrast to the low, non-significant estimate in weaner lambs in Kenya (0.01 ± .04). As in Kenya there are different heritabilities for LFEC in the two breeds being studied in Ethiopia with the better adapted Menz lambs having a lower heritability for LFEC at weaning (0.09 ± .05) than the Horro lambs (0.23 ± .09). There is a low heritability for LFEC (0.01 ± .02) in yearling sheep in Ethiopia which may be due to to the high post-weaning mortality (Table 1) and to the low levels of endoparasite challenge post-weaning at this site. In both Kenya and Ethiopia additive maternal heritability estimates are not significant for LFEC or PCV at any sampling of the lambs between birth and the yearling stage. In 5-month old kids in Kenya heritabilities (h^2a) are 0.11 ± .07 for PCV and 0.10 ± .06 for LFEC. Heritabilities (h^2a) for post-weaning mortalities in lambs in both Kenya (0.09 ± .05) and Ethiopia (0.12 ± .05) are significant and higher than estimates reported in non-tropical sheep breeds.

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