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Effect of Booroola fecundity (FeCB) gene on litter size and scope for use in restoration of Nilagiri sheep from threatened status. Efeito do gene Booroola fecundity (FeCB) no escopo e tamanho da ninhada para uso na restauração de ovelhas Nilagiri de status ameaçado

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Abstract

The Nilagiri breed native to Nilgiri hills of Tamil Nadu is one of the fine wool breeds of India, which is now primarily reared for mutton. The population size has now declined to the threatened status. The presence of FecB mutation, which increases fecundity, has been confirmed recently in Nilagiri breed. To find out the scope for utilizing this mutation in the breeding programme to restore the population from threatened status, evaluation of effect of this mutation on litter traits was carried out. Litter sizes were compared between non-carrier wild type (++) and carrier (B+) ewes. The litter size at birth was 1.23 ± 0.05 and 1.44 ± 0.06, respectively. The litter size at weaning was 1.14 ± 0.07 and 1.34 ± 0.07, respectively. The litter size at birth and litter size at weaning were significantly higher among carrier animals. These results indicate scope for utilising the FecB mutation to improve prolificacy in the Nilagiri breed.
Keywords: Nilagiri sheep, FecB mutation, threatened, titter size, prolificacy

Resumo

A raça Nilagiri, nativa das colinas Nilgiri de Tamil Nadu, é uma das raças de lã fina da Índia, que agora é criada principalmente para carne. O tamanho da população agora caiu para o status de ameaçada. A presença da mutação FecB, que aumenta a fecundidade, foi confirmada recentemente na raça Nilagiri. Para descobrir o escopo da utilização dessa mutação no programa de melhoramento para restaurar a população do status de ameaça, foi realizada uma avaliação do efeito dessa mutação nas características da ninhada. Os tamanhos das ninhadas foram comparados entre ovelhas não portadoras do tipo selvagem (++) e portadoras (B +). O tamanho da ninhada ao nascimento foi de 1,23 ± 0,05 e 1,44 ± 0,06, respectivamente. O tamanho da ninhada no desmame foi de 1,14 ± 0,07 e 1,34 ± 0,07, respectivamente. O tamanho da ninhada ao nascer e o tamanho da ninhada ao desmame foram significativamente maiores entre os animais portadores. Estes resultados indicam espaço para a utilização da mutação FecB para melhorar a prolificidade na raça Nilagiri.
Palavras-chave: Ovinos Nilagiri, mutação FecB, ameaçada, tamanho da ninhada, prolificidade

Introduction

The Nilagiri sheep, native to the Nilgiri hills of Tamil Nadu, is adapted over centuries to the unique conditions of climate and topography prevailing in the hilly region. Nilagiri sheep are maintained for mutton and fine wool production and is known for its better prolificacy. However, as the demand for wool in the state is less and selling price of wool does not even match the cost of shearing, the focus has changed to mutton production alone. The population of Nilagiri breed is 'threatened' and hence the periodical assessment of reproductive and fitness traits is of paramount importance in the conservation point of view.

The mutations that increase ovulation rate have been discovered in the *BMPR-1B* gene also known as Booroola fecundity gene (FecB), BMP15 and GDF9 genes. The main source of income from rearing of these animals is from sale of surplus male lambs and hence improvement in reproduction and fitness traits are very essential.

The presence of FecB mutation in the Nilagiri breed has been confirmed recently (Sudhakar, 2013) and evaluation of effect of this gene on reproduction traits is important. In Nilagiri 12.03% of the ewes produce multiple births, of which 11.68% and 0.35% are twins and triplets, respectively and the age at first lambing is about 876 days (Chaudhari, 2016). Nilagiri breed seems to have high twinning rate next to Garole and Kendrapada sheep among the Indian sheep breeds. Detection of FecB mutation in Nilagiri sheep puts the breed at seventh position (Booroola Merino, Garole, Javanese, Hu, Small tailed Han and Kendrapada sheep) in the order of breeds known to carry the mutation, which has large effect on litter size (Sudhakar et al., 2013). The present study was undertaken to estimate the effect of FecB gene on litter traits in Nilagiri sheep.

Materials and Methods

The data (FecB genotyping data and reproduction data) on Nilagiri sheep reared at Sheep Breeding Station, Sandynallah, The Nilgiris were utilized for the present study. The climate is generally cool with the temperature ranging from subzero levels in the winters to 24.2 ºC in the summer. The ewes are first put to breeding at 18 months of age. The ewes are either hand mated or inseminated with freshly collected semen from nominated rams with a ram:ewe ratio of 1:20. Two breeding seasons are followed in a year. Each breeding season consists of 55 to 60 days. Male and female animals were selected for breeding based on 6 months body weight.

The FecB genotyping was carried out in Nilagiri sheep by forced PCR-RFLP technique (Sudhakar et al., 2013). The FecB genotyping work was done at the Department of Animal Genetics and Breeding, Madras Veterinary College and Molecular Genetics laboratory, Department of Animal Genetics and Breeding, Veterinary College and Research Institute, Namakkal, Tamil Nadu Veterinary and Animal Sciences University.

The traits studied were number of lambs born alive per ewe lambing, number of lambs weaned per ewe lambing, total lambs born per ewe over lifetime, total lambs weaned per ewe over lifetime.

Statistical analysis

The gene and genotypic frequencies of the population were studied as proportions. The effect of FecB genotype on number of lambs born alive per ewe lambing and number of lambs weaned per ewe lambing was studied using a general linear model by including genotype and season of breeding as fixed effect.

Results and Discussion

A total of 164 individuals of Nilagiri sheep were analyzed for FecB mutation, out of which only two were homozygous (BB), 53 heterozygous (B+) and 109 non-carriers (++). In Nilagiri, a proportion of 0.323 were found carrier for FecB mutation and frequency of allele was 0.174 (Table 1).

Table 1. Gene and genotype frequencies at FecB locus in Nilagiri sheep

Sl. No.	Particulars	Frequency	
1.	Genotype	$FecB^{++}$	0.665
		$FecB^{B+}$	0.323
		$FecB^{BB}$	0.012
2.	Allele	$FecB^{+}$	0.826
		$FecB^{B}$	0.174

The effect of FecB mutation on litter size was determined in Nilagiri breed of sheep. Least-squares means for number of lambs born alive per ewe lambing, number of lambs weaned per ewe lambing, total lambs born per ewe over lifetime, total lambs weaned per ewe over lifetime for Nilagiri sheep are presented in Tables 2 and Table 3. The mean number of lambs born alive per ewe lambing for Nilagiri sheep in homozygous wild (++) and heterozygous mutant (B+) groups were 1.23 ± 0.05 and 1.44 ± 0.06. The mean number of lambs weaned per ewe lambing for Nilagiri sheep in homozygous wild (++) and heterozygous mutant (B+) groups were 1.14 ± 0.07 and 1.34 ± 0.07 respectively.

Table 2. Effect of FecB mutation on lambs born and lambs weaned in Nilagiri sheep

Details	NLBAEL		NLWEL	
	N	Mean ± S.E	N	Mean ± S.E
Nilagiri				
(++)	125	1.23 ± 0.05	125	1.14 ± 0.07
(B+)	69	1.44 ± 0.06	69	1.34 ± 0.07

NLBAEL = Number of lambs born alive per ewe lambing; NLWEL= Number of lambs weaned per ewe lambing; N= Number of observations; S.E. = Standard error

The mean number of lambs born per ewe over lifetime for Nilagiri sheep in homozygous wild (++) and heterozygous mutant (B+) groups were 4.86 ± 0.63 and 5.73 ± 0.70. The mean number of lambs weaned per ewe over lifetime for Nilagiri sheep in homozygous wild (++) and heterozygous mutant (B+) groups were 3.21 ± 0.48 and 4.30 ± 0.58, respectively.

Table 3. Effect of FecB mutation on lifetime traits in Nilagiri sheep

Details	TLBE		TLWE	
	N	Mean ± S.E	N	Mean ± S.E
Nilagiri				
(++)	43	4.86 ± 0.63	43	3.21 ± 0.48
(B+)	22	5.73 ± 0.70	22	4.30 ± 0.58

TLBE= Total lambs born per ewe over lifetime; TLWE= Total lambs weaned per ewe over lifetime; N= Number of observations; S.E. = Standard error

The FecB mutation of the BMPR1B gene is reported to be positively associated with ovulation rate and increased litter size. In India, the FecB mutation has been identified in Garole (Ghalsasi and Nimbkar, 1993), Kendrapada (Kumar et al., 2008) and Nilagiri sheep (Sudhakar, 2013). The highly significant effects of genotype for FecB mutation on litter size at birth in Nilagiri sheep are similar to the earlier reports in different breeds of sheep (Piper and Bindon, 1982; Davis et al., 1982; Gootwine et al., 1995; Safari, 2005; Kumar et al., 2006, 2008). Carrying one copy of the B allele increases prolificacy by 0.21 (Table 1.) in Nilagiri sheep.

Ewes with $FecB^{B+}$ genotype had weaned a greater number of lambs than those of homozygous wild type. The highly significant effect of $FecB^{B}$ allele on litter size at weaning in the present study agrees with the results of (Kumar et al., 2006) in Garole x Malpura, (Walkden-Brown et al., 2007) in Booroola Merino x Merino backcross sheep.

Carrying one copy of B allele increases weaning rate of 0.20 (number of lambs weaned per ewe lambing) in Nilagiri sheep. B+ ewes manifest higher prolificacy and weaning rate than the ++ genotype, indicating the positive effect of 'B' allele on prolificacy. Moreover, the sustainability of increased prolificacy of 0.20 until weaning shows better pre-weaning survivability in these heterozygous animals. Animals with BB genotype were not available with data on traits studied and thus the effect of homozygous FecB genotype could not be ascertained. One of the reasons for non-availability could be the higher proportion of culling and disposal of animals born as twins and triplets due to the lower body weight.

The result is in agreement with the findings reported earlier in Garole x Malpura halfbred sheep by (Mishra et al., 2008; Kumar et al., 2008) in Garole x Muzzafarnagri sheep; (Banerjee et al., 2008) in Booroola Merino x Awassi and Booroola Merino x Assaf sheep by (Gootwine et al., 2008), in Indonesian thin tail sheep reported by (Inounu and Priyanti, 2009), in Booroola Merino x French Merinos d'Arles sheep by (Teyssier et al., 1998), in Chinese breeds of sheep (Hu, Small Tail Han, Cele, Duolong and Chinese Merino strain) reported by (Hua and Yang, 2009) and in Booroola Merino x Merino backcross sheep reported by (Walkden-Brown et al., 2007).

The FecB genotype significantly affected number of lambs born per ewe over lifetime and number of lambs weaned per ewe over lifetime (Table 2). It was found that carrying one copy of the B allele increases number of lambs born per ewe over lifetime and number of lambs weaned per ewe over lifetime by 0.87 and 1.09 respectively in Nilagiri sheep.

Conclusion

In the present study, the effect of fecundity Booroola gene (FecB gene) on litter traits in Nilagiri breed of sheep has been confirmed. Results of this study indicate that presence of FecB mutation is likely to induce manageable and desirable increase in litter size in Nilagiri sheep. The Nilagiri sheep has been reported as the third most prolific sheep breed of India after the Garole and Kendrapada sheep. Use of this mutation can be used to improve prolificacy, which could ensure *in-situ* conservation of Nilagiri sheep and also restoration from threatened status. Appropriate breeding programs utilising the FecB mutation could be formulated for the purpose. Further screening in larger populations will throw light on the effect of homozygous genotype of the gene on these traits.

Conflicts of interest

The authors declare they have no conflicts of interest.

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