

Association between PrP genotypes and selected growth traits of Hungarian Merino and German Mutton Merino rams (Short Communication)

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Abstract

In sheep, susceptibility to scrapie is associated with the prion protein (PrP) gene polymorphism. In this study the association between selected growth traits (daily weight gain from birth to weaning and in farm fattening performance test, as well as body weight at one and two years) and PrP genotypes ARR/ARR, ARR/XXX and XXX/XXX (XXX representing AHQ, ARQ, ARH or VRQ) has been investigated in Hungarian Merino ($n=286$) and German Mutton Merino ($n=215$) rams. No significant association was found among the studied growth traits and the PrP genotypes in the Hungarian Merino breed. In case of a group of German Mutton Merino rams lamb daily gain was significantly ($P \leq 0.05$) – but in a small extent – associated with PrP genotype, which influenced the daily gain values by 9.6%.

Keywords: prion protein (PrP) genotypes, growth traits, sheep, Merino

Zusammenfassung

Beziehungen zwischen PrP Genotypen und einigen Wachstumsmerkmalen von Ungarischen und Deutschen Merinoböcken (Kurzmitteilung)

Beim Schaf ist das Vorkommen von Scrapie verbunden mit dem Prion-Protein (PrP) Genpolymorphismus. In vorliegendem Beitrag werden die Beziehungen zwischen ausgewählten Wachstumsmerkmalen, wie der täglichen Zunahme von Geburt bis zum Absetzen, der Gewichtszunahme während eines 40-tägigen Stichprobentestes sowie dem Körpergewicht im Alter von einem bzw. zwei Jahren und den PrP Genotypen ARR/ARR, ARR/XXX und XXX/XXX (XXX repräsentiert AHQ, ARQ, ARH oder VRQ) untersucht. Erfasst wurden Böcke der Ungarischen Merino ($n=286$) und Deutschen Merino ($n=215$) Schafe. Bei den Ungarischen Merinoböcken konnten keine signifikanten Beziehungen zwischen den erfassten Wachstumsmerkmalen und den PrP Genotypen nachgewiesen werden. Bei den deutschen Merinobocklämmern aus Importen war die tägliche Zunahme geringfügig aber signifikant mit den PrP Genotypen verbunden.

Schlüsselwörter: Prion Protein (PrP) Genotypen, Wachstumsmerkmale, Schaf, Merino

Introduction

Scrapie is a fatal, infectious, neurodegenerative disease of sheep and goats (PRUSINER 1991, DRÖGEMÜLLER *et al.* 2001). In sheep a well defined polymorphism of the PrP gene has been demonstrated at codons 136 (A to V), 154 (R to H), 171 (Q to R,H) determining five allelic variants (ARR, AHQ, ARQ, ARH and VRQ) which can be related to scrapie susceptibility or resistance (WISNIEWSKA *et al.* 2006).

According to Commission Regulation (EC) No. 100/2003, using genotype information, each member country should carry out breeding programmes to increase the frequency of the ARR allele and to reduce that of those alleles which are associated with increased disease risk. This selection might result in changes of certain production and/or reproduction traits, and might induce strong selection pressure on ovine chromosome 13.

Several studies have been carried out to estimate the possible influence of the individual PrP genotypes on various quality and production traits. PROPOKOVÁ *et al.* (2002), DE VRIES *et al.* (2004), GERNAND *et al.* (2005) and CASELLAS *et al.* (2007) conducted studies for some selected growth traits and could not demonstrate significant PrP genotype effects. BRANDSMA *et al.* (2004) demonstrated small negative, significant genotype effect on 135 days body weight. A simulation has also focused on possible genetic loss interval if selection is starting for the ARR variant (WING-YOUNG *et al.* 2007).

The aim of the study was to estimate the relationship of PrP genotypes with production traits (daily weight gain from 1 to 135 days, on farm fattening performance from 150 to 185 days, as well as body weight at 1 and 2 years) in the Hungarian Merino and German Mutton Merino breeds.

Material and methods

Animals

501 rams – 286 Hungarian Merinos (HM) and 215 German Mutton Merinos (GMM) – from 98 breeding herds were included in the study. Among German Mutton Merino rams import and home bred rams were used, as well. Rams were selected for the analysis since they can easily spread favourable characteristics of the selected growth traits on the population, and because the Hungarian scrapie breeding programme primarily focuses on the genotyping of rams. Rams included in this study were born between the years of 1993 and 2005.

The first data set included production data (available in the herd books of the Hungarian Sheepbreeders' Association): lamb daily gain from birth to weaning (between 60-80 days) (g/day), and in the 40 days long farm fattening performance test after weaning (g/day) as well as body weights (kg) at 1 and 2 years of age, respectively. The second data set included the PrP genotypes (genotyping was performed at the Research Institute for Animal Breeding and Nutrition, Herceghalom, Hungary).

PrP genotyping

The DNA isolation was done from whole blood. In the first PCR reaction 266 bp part of PrP gene was amplified. After purification the amplified fragment was used as a template in

the second reaction containing primers with various lengths (40-60 mers, designed right beside the SNP sites responsible for prion genotypes in question) and labeled ddNTPs. Finally, the genotype assessment of the one-base elongated primers were based on capillary-electrophoretic separation on ABIPrism 310 Genetic Analyzer (Applied Biosystems, USA) followed by the application of Genotyper and Microsoft Excel softwares. This method was detailed and described elsewhere (ZSOLNAI *et al.* 2003).

Statistical analysis

Using SPSS 14.0 software the method of univariate analysis of variance and estimated marginal means was applied to appraise the contingent correlations and relations of the PrP genotypes and growth trait data. The GLM – general linear model – model included the following effects: the three PrP genotype groups (ARR/ARR, ARR/XXX and XXX/XXX) was used as fixed effects and the growth traits (lamb growth, on farm fattening performance, 1 and 2 year weight) as dependent factors. The significance of these factors was proved by least square difference method. Correlation and regression analysis were also performed by SPSS software.

Results and discussion

The favourable ARR/ARR genotypes occurred at middle-size frequency in both breeds (about 25% in HM and 20% in GMM) (Table 1). The analysis of the means and standard deviations of examined growth traits in Hungarian Merino rams revealed no significant differences regarding the three genotype classes. However, as a general tendency, sheep with ARR/XXX genotype seemed to be superior in lamb growth, 1 and 2 year weight (Table 2).

Table 1
Genotype frequencies and number of animals
Genotypenfrequenz und Tierzahlen

Breeds	ARR/ARR	ARR/XXX	XXX/XXX
Hungarian Merino (n=286)	24.82 % (n=71)	55.59 % (n=159)	19.58 % (n=56)
German Mutton Merino (n=215)	20.00 % (n=43)	63.25 % (n=136)	16.74 % (n=36)

Table 2
Descriptive statistic of the growth traits in Hungarian Merino
PrP Genotypen und Wachstumsmerkmale ungarischer Merino

Traits	ARR/ARR		ARR/XXX		XXX/XXX		Total	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Lamb growth, g/day	373.00	83.07	376.72	72.44	358.10	67.76	372.31	74.57
Large scale fattening, g/day	348.13	67.47	347.25	76.12	355.15	52.92	348.81	69.62
1 year body weight, kg	73.83	9.71	74.45	10.24	71.39	8.76	73.72	9.87
2 year body weight, kg	88.24	13.04	90.52	11.89	89.55	14.61	89.75	12.72

SD standard deviation

Among the home bred German Mutton Merino rams we have not found significant differences between the genotypes and the investigated traits. In the import group significant differences were observable in lamb daily gain and the genotype classes. In the import group the large scale fattening data were not available, because the country

does not use it as characteristic of meat performance. Sheep not carrying the ARR allele were superior in all traits (Table 3).

Deviations from the expected genotype frequencies was only found in German Mutton Merino rams (data not shown), so two separate – a home bred and an import – subgroups were used in the calculations. Deviation from the Hardy-Weinberg equilibrium was detectable only in the home bred group (Table 4).

The difference between the observed and expected genotype frequency values proved to be significant. The possible explanation of the disequilibrium could be the selection on multiple traits at the same time.

Table 3

Descriptive statistic of the growth traits in import German Mutton Merino

PrP Genotypen und Wachstumsmerkmale deutscher Merino

Traits	ARR/ARR		ARR/XXX		XXX/XXX		Total	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Lamb growth, g/day	360.90*	50.36	374.00*	65.60	422.24*	65.61	383.14	66.57
1 year weight, kg	80.82	12.50	83.93	11.16	88.53	11.77	84.53	11.60
2 year weight, kg	107.45	14.31	105.00	13.41	116.71	15.89	108.10	14.76

SD standard deviation, * shows the significant relationship at level 0.05

Table 4

The expected (in brackets) and the observed frequencies of PrP genotypes in German mutton merino rams

Erwartete (in Klammern) und nachgewiesene PrP Genotypenfrequenz bei deutschen Merinoböcken

Breeds	Number	ARR/ARR	ARR/XXX	XXX/XXX	×2
German Mutton Merino import rams	73	15 (11)	21 (17)	36 (45)	4.077
German Mutton Merino home bred rams	142	42 (32)	70 (91)	29 (19)	12.13

Hungarian Merino and home bred German Merino populations did not show significant associations between the PrP genotypes and growth traits. Only the import group of German Mutton Merino rams not carrying ARR haplotype performed significantly ($P < 0.05$) better in case of daily gain values (Table 3.) but the interaction was found to be weak (correlation coefficient was 0.291) and the genotype was responsible for the total daily gain variance in 9.6%.

The negative association of daily gain values with ARR haplotype might be the effect of selection of the ARR allele and it might be the proof of the genetic loss, as a consequence of breeding for scrapie resistance (WING-YOUNG *et al.* 2007). This could explain why the effect was detectable among those import animals which came from a country where selection procedure has longer history than in Hungary.

Our findings are also in accordance with BRANDSMA *et al.* (2004) where small negative effect was found on 135 days weight correlated with the ARR allele.

Since the found effect of ARR haplotype on daily gain is very low and the genetic improvement is coming back in long term (WING-YOUNG *et al.* 2007), temporary stagnancy or temporary decreasing in genetic improvement is the price for having a scrapie resistant livestock in the future.

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