TRADITION AND MODERNITY IN VETERINARY MEDICINE, 2021, vol. 6, No 2(11): 3–8

INFLUENCE OF MILK PROTEIN GENOTYPES ON MILK YIELD FOR THE CONTROL DAY IN BROWN CATTLE

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ABSTRACT

The aim of the present study was to determine the influence of milk protein genotypes on milk yield for a control day in Brown cattle.

The analysis included 155 animals kept in 4 herds in different regions of the country, regardless of their parity and lactation days. The analyzes were based on the hypothesis that the variation in milk yield for the control day was caused by genetic and environmental factors.

The factors of parity and herd – year – season, as well as the genetic factors CSN3 and LGB, have a highly reliable influence on the average daily milk yield for a control day.

The animals with the BH genotype of CSN3 have the highest average daily milk yield – 24.30 kg, followed by those with AB – 18.87 kg. Heterozygous animals with different genotypes of milk proteins are characterized by close values f daily milk yield for the control day.

Key words: milk yield, factors, genotype, Brown cattle.

Introduction

Brown cattle breed is the second most spread dairy breed worldwide after the Holstein. It is perhaps the oldest of all dairy breeds. Many historians affirm that the Brown Swiss cattle breed originated in valleys and mountain slopes of Switzerland about 4000 years BC. Today, beautiful Brown cattle are spread at a global scale. According to the Brown Swiss Cattle Breeders' Association of the USA, the current world population amounts to about 6 million cattle. Nowadays, the breed in our country is developing at the background of general trends in cattle husbandry due to its valuable economic traits and competitiveness.

The average annual milk yield from Brown cattle in Wisconsin is 18,800 pounds of milk with fat content of 4.1% and protein content 3.37% /WDATCP, 2010/. Brown Swiss cattle produce daily by 9% less milk than Holsteins, however, their milk has higher protein content, casein content and titratable acidity, considerably shorted milk coagulation time, firmer curd, and produced cheese has a saturated yellow colour (De Marchi et al., 2008; Mistry et al., 2002).

Şahin et al., (2014) have investigated variation components and genetic parameters of first lactation milk yield (milk yield, 305-day yield, lactation duration and dry period duration) along with some fertility traits (calving interval, duration of pregnancy and number of inseminations) in Brown Swiss cattle in Turkey.

The effect on milk yield, milk composition and fatty acid profile from the introduction of genes from the American brown cattle population in less productive Swiss farms was investigated by Stergiadis et al., (2018).

Sulimova et al., (2007) outlined that alleles A and B of CSN3 were of practical significance, as allele B was associated with commercially valuable milk parameters (milk protein content and milk yield), as well as with improved profitability from cheese production. Robitaille et al., (2002); Caroli et al., (2004); Rachagani and Gupta (2008) and Mota et al., (2020) also confirmed that genetic variants of milk proteins had a beneficial effect on milk production traits, cheesemaking properties and milk nutritional value.

Doğan and Kaygisiz (1999) reported that cows from the BB genotype of CSN_2 had both the shortest lactation period and lowest 305-day milk yield.

Ozdemir and Dogru (2004); Ozdemir et al. (2018) indicated that αs_1-Cn had a substantial effect on milk yiled and milk butter in Hosletin cows, whereas in Brown cattle, no positive effect on the same traits has been demonstrated. In the view of authors, cows from the BC genotype had higher 305-day milk yield and higher amount of butterfat. The principal effect of β-Lg genotypes in Brown Swiss and Holstein cows was on milk fat content, daily milk yield, and butterfat content, but not on 305-day milk yield (Ozdemir and Doğru, 2007).

The aim of the present investigation was to evaluate the effect of genetic and environmental factors on test-day milk yield in Brown cattle.

Materials and methods

Experimental design and animals

The analysis comprised 155 animals reared in 4 herds from different regions of the country, regardless of lactation number and days in lactation. Records of animals' origin were obtained from pedigree books. ***Farm 1 – Stara Zagora region.*** Cows were housed in free stalls, with individual resting boxes. Feeding was based on corn silage and compound feed, milking was performed twice daily in a herringbone milking parlour. After milking, cows were let to walk in fenced pastures.

Farms 2, 3 and 4 – Sliven region, Sliven municipality. Cows were reared in tie-stalls. Feeding was based on corn silage, hay and compound feed, and milking was performed twice, through a central milking pipeline. After milking, cows were let to walk in fenced pastures.

For evaluation of effects of different milk protein genotypes in Brown cattle, data from PCR-RFLP analysis of polymorphisms of 155 animals performed by the University of Padova, were used. Test-day milk yields (in kg) were determined by milk meters.

Statistical analysis design

The analysis of experimental data was based on main principles allowing for unbiased assessment of studied variables. To this end, working models including as many as possible data from analyses were designed.

The analyses were based on the hypothesis that variations in test-day milk yields were provoked by genetic and environmental factors – individual, lactation number, sire, herd, year and season of production, milk proteins polymorphism. A mixed linear model was applied for unbiased assessment of abovementioned traits:

$$Y_{ijklmnopq} = HYM_i + PL_j + Sire_k + CSN1_l + CSN2_m + CSN3_n + LGB_o + e_{ij\kappa lmnop}$$

where: $Y_{ijklmnop}$ – p^{th} observation of a trait;

HYM_i – fixed effect of i^{th} herd-year-month;

PL_j – fixed effect of j^{th} lactation;

$Sire_k$ – random effect of the sire;

$CSN1_l$ – fixed effect of l^{th} CSN1 genotype;

$CSN2_m$ – fixed effect of m^{th} CSN2 genotype;

$CSN3_n$ – fixed effect of n^{th} CSN3 genotype;

LGB_o – fixed effect of o^{th} LGB genotype;

$e_{ijklmnop}$ – random effect of unobserved factors.

The analysis of data was done with statistical software Pest (Groeneveld) and SYSTAT 13.

Results and discussion

Table 1 presents variance components and respective levels of statistical significance related to effects of various factors on daily milk yield. All studied genetic and environmental factors had a highly statistically significant effect, except for CSN_1S_1 and CSN_2 which were irrelevant. Similar conclusions were also made by Ozdemir and Dogru (2004); Ozdemir et al. (2018), finding out that αs_1-Cn had a pronounced effect on milk yield and butterfat yield only in Holstein cows, whereas no positive effect was detected on Brown Swiss cattle. CSN_3 and LGB demonstrated a substantial influence on milk yields. Ozdemir and Doğru (2007) reported that the main effect of β-Lg genotypes in Brown Swiss and Holstein cattle were on milk fat content, daily milk yield and butterfat yield, but not on 305-day milk yield.

The obtained results for the effect of genetic polymorphisms of casein were similar to previously reported results. Sulimova et al., (2007) affirmed that alleles A and B of CSN_3 were of practical significance, as allele B was associated with commercially valuable milk traits (milk protein and fat contents), as well as with improved profitability from milk processing into cheese.

Cak and Yilmaz, (2014) demonstrated that the effects of lactation number, calving year and calving season in Brown Swiss cattle in Turkey on lactation milk yield and 305-day milk yield were highly significant (P<0.001).

Table 1: F – values and levels of statistical significance related to effect of various factors on test-day milk yield

Factor \ Trait	Milk yield, kg
Parity/Lactation number	13.364***
Herd-year-season	7.528***
Sire	5.326***
CSN_1S_1	1.074
CSN_2	1.160
CSN_3	8.508***
LGB	12.078***

*: $p<0.05$ **: $p<0.01$ ***: $p<0.00$

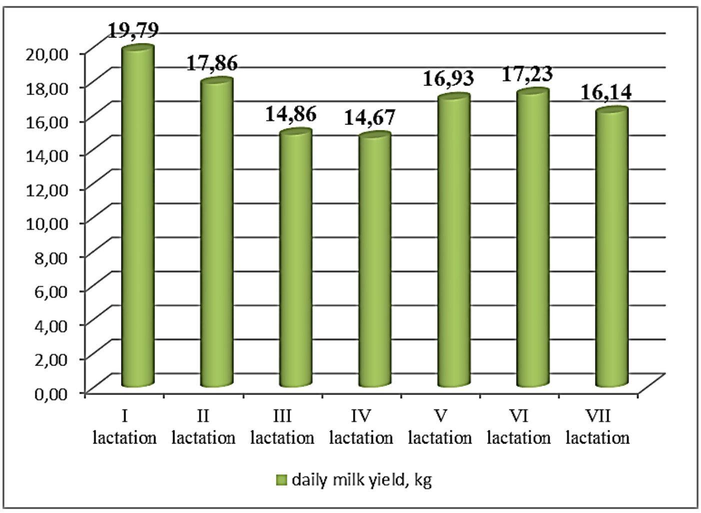


Figure 1: Daily milk yield (kg) depending on parity

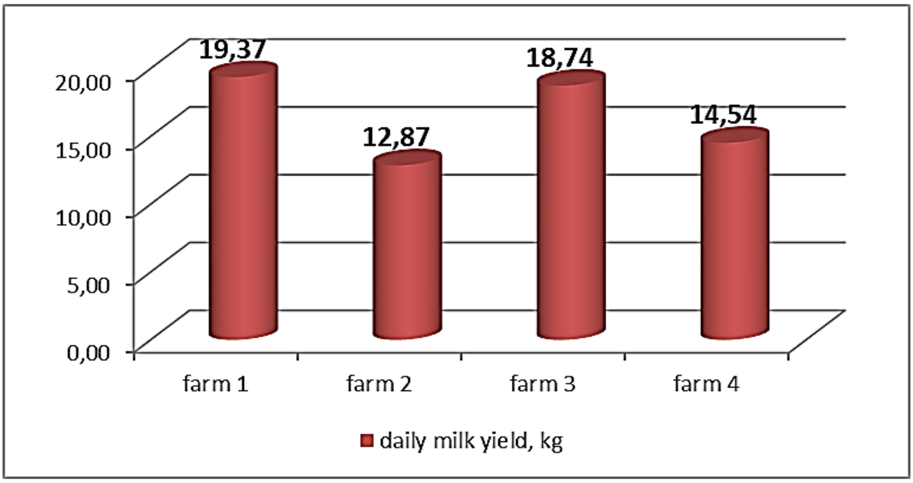
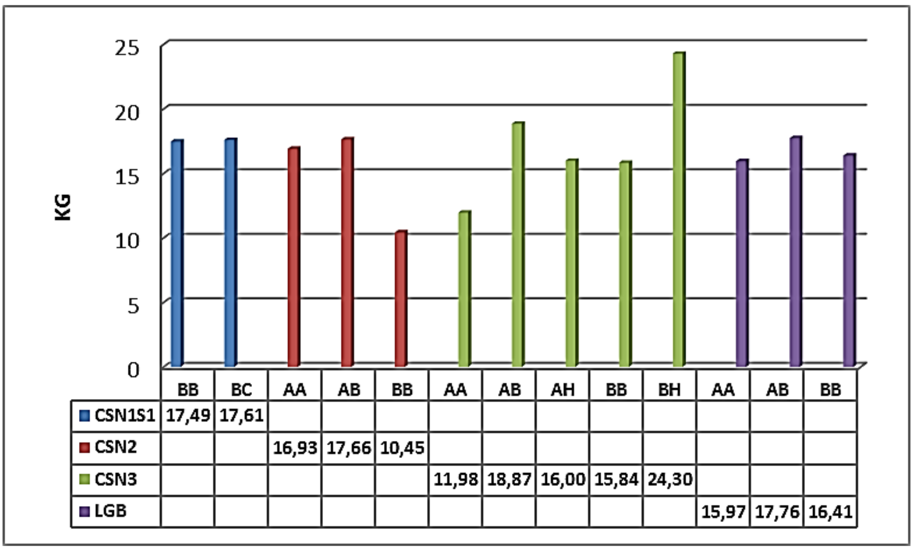


Figure 2: Average daily milk yield (kg) at the different farms

The highest milk yield was noted in cows from farm 1 – 19.37 kg, followed by those reared at farm 3 – 18.74 kg. Cows from farm 2 had the lowest test day milk yield. Comparable data were reported by Zanon et al., (2020), on the basis of analysis of 3,037 test-day records of original Brown cattle in Italy, finding out average milk yield of 18.07 kg. The researchers studied the effect of lactation number, season, lactation stage and other factors included in the statistical model.

Fig. 3 presents the average milk yield of cows from different milk protein genotypes. The highest milk yield was found out in cows from the BH genotype of CSN3 – 24.30 kg, followed by cows from the AB genotype – 18.87 kg. Heterozygous cows with various milk protein genotypes showed similar test-day milk yields. The lowest recorded yield of cows from the present study was observed in animals from the BB genotype of CSN_2 – 10.45 kg.



	BB	BC	AA	AB	BB	AA	AB	AH	BB	BH	AA	AB	BB
CSN1S1	17,49	17,61											
CSN2			16,93	17,66	10,45								
CSN3						11,98	18,87	16,00	15,84	24,30			
LGB											15,97	17,76	16,41

Figure 3: Average milk yield of different genotypes of Brown cattle

Doğan and Kaygisiz (1999) outlined that cows from the BB of CSN_2 had both the shortest lactation period, and the lowest 305-day milk yield. Comparable average milk yields were found out in cows from genotypes BB /17.49 kg/ and BC /17.61 kg/ of CSN_1S_1. In cows from the different LGB genotypes, the lowest average milk yield was observed in those from genotype AA – 15.97 kg. Cows from the BB genotype had an average milk yield of 16.41 kg, and the highest average yield was found out in cows from the AB genotype – 17.76 kg. Thus, a moderate variation of milk yields was demonstrated in cows from the different LGB genotypes.

Having investigated the effect of kappa casein genotypes on milk yield of Holstein and Swiss Brown cattle, Özdemir and Doğru (2005) found no relevant differences between the breeds. The research however provided proofs that milk fat content could be increased by using kappa casein genotype BB and milk yield could be higher by using genotype AB.

Conclusion

The factors lactation number and herd-year-season, as well as genetic factors CSN_3 and LGB, had highly statistically significant effects on test-day milk yields.

The highest test-day milk yields were established in cows at first and second lactation: 19.79 kg and 17.86 kg, respectively.

Cows reared at farm 1 and 3 demonstrated the highest milk yields, whereas those at farm 2 – the lowest one – 12.78 kg.

The highest milk yields were found out in cows from the BH genotype of CSN_3 – 24.30 kg, followed by those from the AB genotype – 18.87 kg. Heterozygous animals from various milk protein genotypes were outlined with similar test-day milk yields.

Acknowledgements

The authors acknowledge the close cooperation with renowned scientists from the University of Padova – Italy within the framework of Project DO-02-249 of the Ministry of Education and Science, with leader Prof. Jivko Krastanov.

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