EVALUATION OF THE MILK PRODUCTION AND SOMATIC CELL COUNT OF LITHUANIAN PUREBRED AND CROSSBRED DAIRY COWS

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Abstract. The research was carried out on a total of 2023 Lithuanian dairy cows on 9 dairy farms. The milk yield, milk composition (milk fat and protein) and SCC (somatic cell count) were evaluated of purebred (n=567) and crossbred (n=1456) cows of different dairy cattle breeds. Analysis of milk composition and SCC was made during control milking. The objectives of this research were to compare milk yield, milk composition and SCC between purebred and crossbred cows of Lithuanian dairy cattle populations, to determine breed combinations of crossbred cows, which are with the best traits. The highest milk yield (P<0.001) and SCC were estimated in purebred HO (Holstein) breed cows. The highest milk yield of cows of Lithuanian Black and White population was estimated in crossbred Lithuanian Black and White and Swedish Black and White (LB&WxSB&W) cows and the lowest milk yield and SCC were estimated in crossbred Holstein and Dutch Black & White (HOxDB&W) cows. The highest milk yield of Lithuanian Red and Red and White population was estimated in crossbred Simmental and Red Holstein (DSIxHOR) cows and the lowest SCC was estimated in crossbred Angler and Red Holstein (ANxHOR) cows. The highest milk yield (8041.45±235.62 kg) and the lowest SCC (202.67±40.08 kg) were estimated in crossbred cows of Lithuanian Black and White cattle population (P<0.001). The lowest milk yield (in average 7820.79±167.42 kg) was estimated in purebred cows and the highest SCC (in average 497.16±101.18 thousand/ml) was estimated in crossbred cows between different populations of Lithuanian cattle (P<0.001). Significant differences were not estimated for the different purebred and crossbred cows' milk composition traits. It is recommended to use crossbreeding in cows of Lithuanian dairy cattle populations raised in industrial dairy farms.

Keywords: cows, breed, milk yield, somatic cell count, purebred, crossbred

Introduction

Crossbreeding of dairy cattle has become more popular and potentially can give rise to economic gains on higher milk yield produced by cows or crossbred cows can adjust to the environment and prosper in the herd (Cassell, 2009, Kellogg et al. 2009). The main reason for avoidance of crossbreeding in dairy cattle has been the fear of lower production of crossbreds compared with pure Holstein cows (Weigel and Barlass, 2003). Production traits are the major source of income from a dairy cow. Milk yield and somatic cell count (SCC) are important factors affecting dairy farm's profitability. Milk yield and SCC play a key role to monitor milk quality (Cinar et al. 2015). The Holstein is the world leader in milk production, and crossing Holstein dams to other breeds of sire is not expected to surpass the Holstein (Schaeffer et al., 2011). Level of Holstein in cows was associated with SCC (P<0.01) but not with milk yield (P=0.27). Cows with a high Holstein fraction tended to produce more milk but they also had higher SCC. (Jattawa et al., 2012). The Holstein cows and cows with high Holstein fractions would need more intensive care and management (feeding, housing, milking and health care) than cows with lower Holstein fractions (Koonawootrittriron et al., 2009; Boonkum et al., 2011; Jattawa et al., 2012).

Walsh et al. (2008) reported that crossbreds had similar milk, fat, and protein production to pure Holstein cows. Petraškienė et al. (2013) estimated significant differences for milk yield, fat and protein (kg) (P<0.001), but the yield of recalculated milk was higher in purebred cows compared to all crossbred cows (P<0.001).

Significant differences were found for milk yield kg, fat kg and protein kg (P<0.001). Also the yield of recalculated milk was higher in purebred cows comparing with all crossbred cows; and the differences were statistically significant (P<0.001). Crossbreeding of dairy cattle may be used if the goals are not only production of milk but also improvement of fertility, wellness and longevity Petraškienė et al. (2013). The Lithuanian Black and White breed has a meaningful amount of Holstein-Friesian content, which could reduce heterosis in crosses with HO. Mäki-Tanila (2007) indicated heterosis increases as the genetic distance between breeds becomes greater.

The objectives of this research were to compare milk yield, milk composition and SCC between purebred and crossbred cows of Lithuanian dairy cattle populations, to determine breed combinations of crossbred cows, which are with the best traits

Material and methods

The research was carried out on a total of 2023 Lithuanian dairy cows on 9 dairy farms. In all farms cows were kept under similar conditions and were fed the same nutritionally balanced diets. Dairy cows were selected by cow's (mother – M) and sire's (father – F) breeds – MxF.

The milk yield (kg) and somatic cell count (SCC, thousand/ml) were evaluated of purebred and crossbred cows of different dairy cattle breeds:

1. purebred: Lithuanian Black and White cows (LB&W; n=91), Lithuanian red (LR; n=15), Holstein (HO; n=402), Red Holstein (HOR; n=28), Ayrshire (AY; n=31).
2. crossbred:

- Lithuanian Black and White cattle population: Holstein and Lithuanian Black & White (HOxLB&W; n=24), Holstein and Dutch Black & White (HOxDB&W; n=14), Lithuanian Black&White and Holstein (LB&WxHO; n=583), Lithuanian Black & White and Swedish Black & White cows (LB&WxSB&W; n=14), German Black & White and Holstein (GB&WxHO; n=46), German Black & White and Lithuanian Black & White (GB&WxLB&W; n=14).
- Lithuanian Red and Red and White cattle population: Ayrshire and Swedish Red (AYxSR; n=17), Ayrshire and Red Holstein (AYxHOR; n=14), Angler and Red Holstein (ANxHOR; n=11), Lithuanian Red and Ayrshire (LRxAY; n=80), Lithuanian Red and Angler (LRxAN; n=10), Lithuanian Red and Jersey (LRxJE; n=46), Lithuanian Red and dairy Simmental (LRxDSI; n=20), Lithuanian Red and Swedish Red (LRxSR; n=68), Lithuanian Red and Red Holstein (LRxHOR; n=274).
- The different Lithuanian cattle populations: Holstein and Swedish Red (HOxSR; n=27), Holstein and Red Holstein (HOxHOR; n=19), Lithuanian Black & White and Swedish Red (LB&WxSR; n=49), Lithuanian Black & White and Red Holstein (LB&WxHOR; n=12), Lithuanian Red and Holstein (LRxHO; n=85), Lithuanian Red and Lithuanian Black & White (LRxLB&W; n=10), Lithuanian Red and Swedish Black & White (LRxSB&W; n=19) breeds of cows.

Analysis of milk composition and SCC was made during control milking. Milk analyses were carried out in a Milk Composition and Quality Research Laboratory of State enterprise „Pieno tyrimai".

SCC was measured using "Somascop MK2" device ("Delta Instruments", the Netherlands). Fat, protein content in milk was estimated by "Lactoscope 550" (Holland). With "Lactoscope 550" was measured the absorption of the specific wave length of medial infrared rays of each component (fat, protein). The amount of these milk ingredients was calculated according to the amount of energy absorbed.

Descriptive statistic (mean ± standard error), reliability value (P) were calculated by using R 2.1.0" package (http://www.r-project.org/). Data analysis was conducted having performed the statistical significance by the method of variance analysis (ANOVA). The results considered to be reliable under $P \leq 0.05$.

Results

Our results of Lithuanian Black and White cattle population of purebred cows (Fig. 1) showed that the highest milk yield and SCC were estimated in purebred HO breed cows. Milk yield of these cows was 13.45 % higher than purebred LB&W ($P<0.001$) and SCC in purebred LB&W cows was 9.26 % less than purebred HO ($P>0.05$).

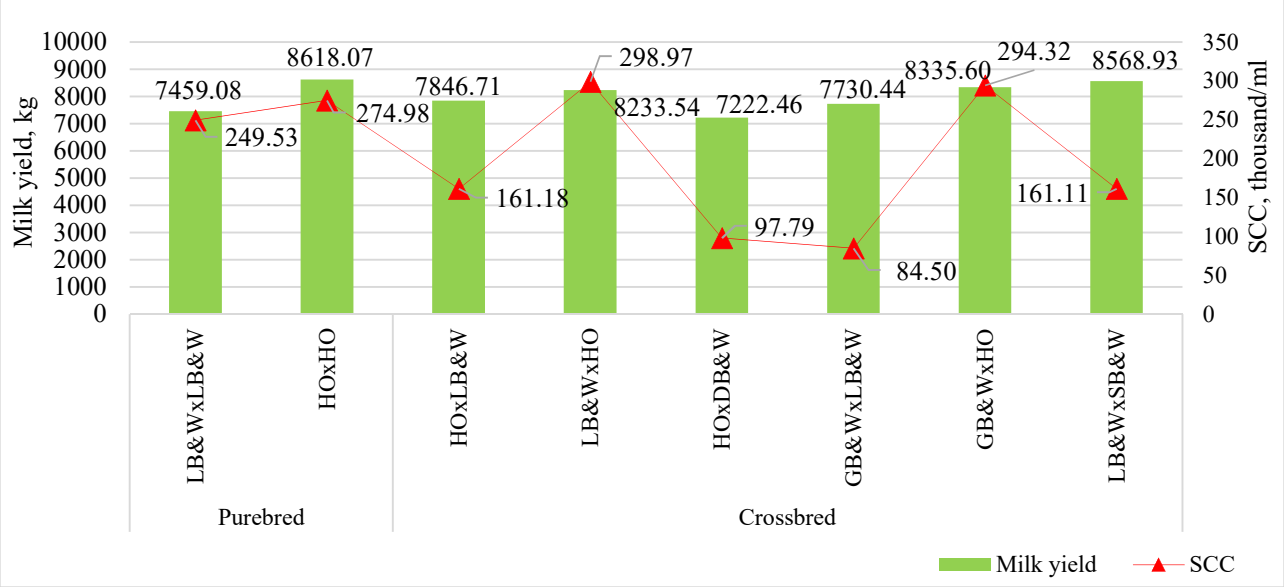

Fig. 1. **Average of milk yield and SCC in milk of purebred and crossbred cows of Lithuanian Black and White cattle population**

The crossbred cattle of Lithuanian Black and White cattle population showed, that the highest milk yield was estimated in crossbred LB&WxSB&W cows, but it was 0.57 % less than in purebred HO breed cows. Milk yield of crossbred LB&WxSB&W cows was 2.72 – 15.71 % higher than of other crossbred cows (P<0.005).

The lowest SCC was estimated in a cross of HOxDB&W cows. Crossbred cows had lower SCC than purebreds (P<0.05), except crosses of LB&WxHO and GB&WxHO (P>0.05) breeds cows.

The evaluation of purebred cow's milk composition traits (Fig. 2) didn't showed the significant difference between these indicators.

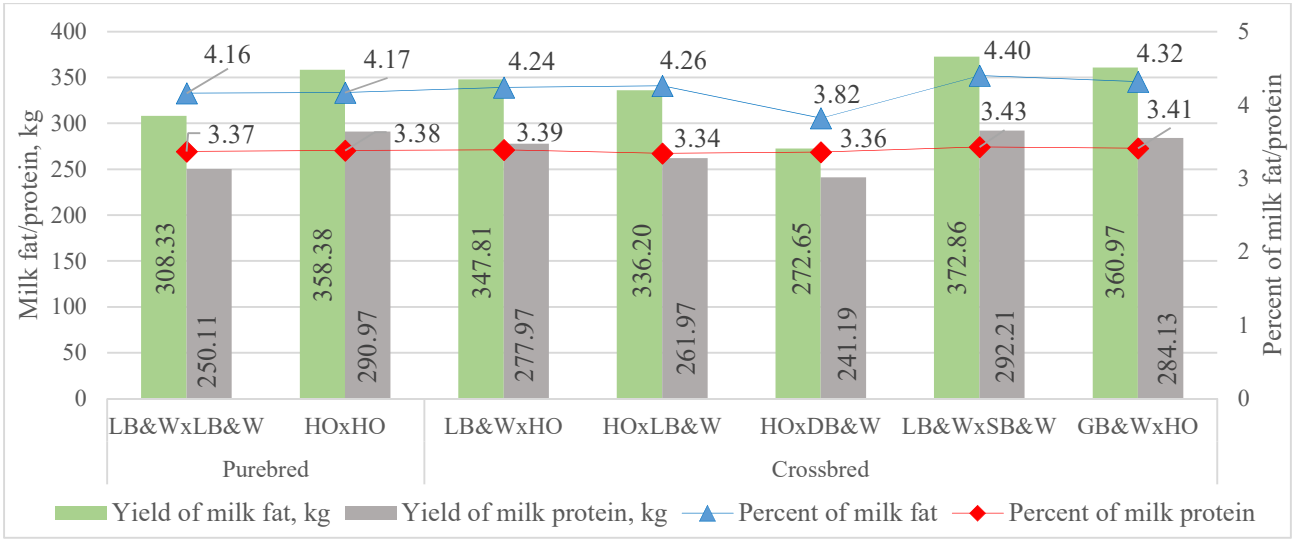

Fig. 2. **Average of milk fat and protein of purebred and crossbred cows of Lithuanian Black and White cattle population**

The higher percent of milk fat and protein were estimated in purebred HO cow's milk. The percent of milk fat and protein was 0.01 %, milk fat yield – 50.05 kg and milk protein yield – 40.86 kg higher than purebred LB&W cows (P<0.001).

The best milk composition traits were estimated in a milk of LB&WxSB&W crossbred cows. Milk fat percentage of these cows was higher from 1.82 % to 13.18 % (P<0.005-0.025), the milk fat yield - from 3.19 % to 26.88 % (P<0.001–0.005), milk protein percentage – from 0.58 % to 2.62 % (P>0.05) and the milk protein yield - from 2.77 % to 17.46 % (P<0.001) compared to the other crossbred cows.

Our results of purebred cows of Lithuanian Red and Red and White population (Fig. 3) showed, that the highest milk yield and lowest SCC were estimated in purebred HOR breed cows.

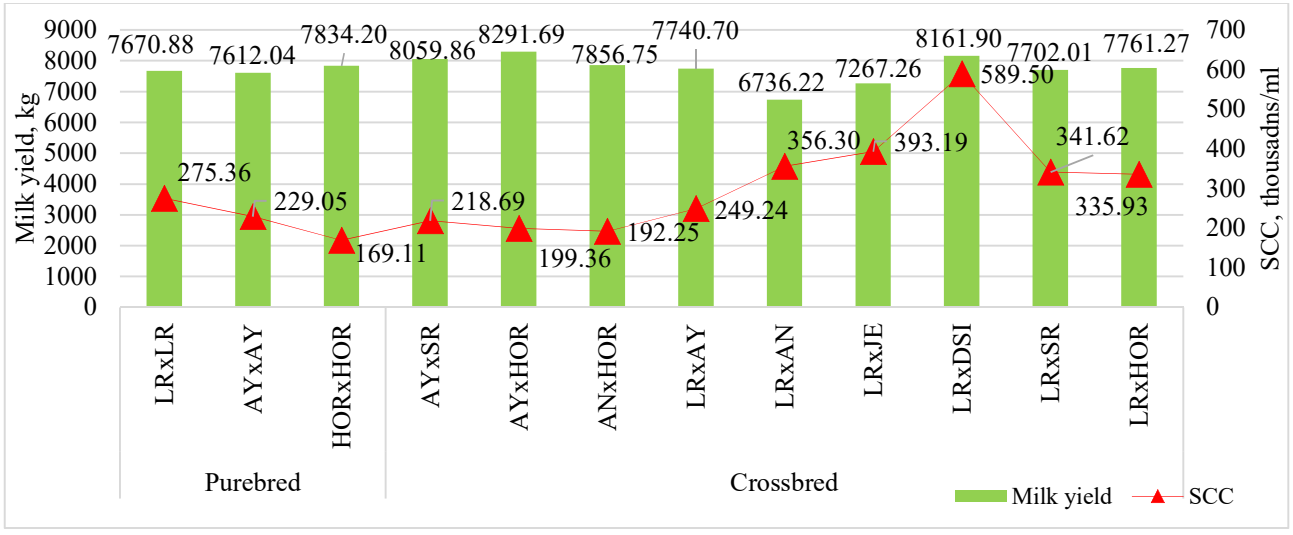

Fig. 3. **Average of milk yield and SCC in milk of purebred and crossbred cows of Lithuanian Red and Red and White cattle population**

Milk yield of these cows was 2.09 % higher than LR, 2.84 % – than AY (P>0.05) and SCC 38.59 % lower than LR, 26.17 % – than AY (P>0.05) cows. The lowest milk yield estimated in purebred AY cows and higher SCC - in purebred LR cows.

The result of our research in crossbred cattle of Lithuanian Red and Red and White population shows the highest milk yield was estimated in crossbred AYxHOR cows. Milk yield of these cows was 1.57 – 18.76 % (P<0.025) higher than other crossbred cows. The lowest milk yield was estimated in crossbred LRxAN cows.

The lowest SCC was estimated in crossbred ANxHOR cows. Milk yield of these cows was 3.57 - 72.97 % (P>0.05) less than other crossbred cows. The highest SCC was estimated in crossbred LRxDSI cows.

By the evaluation of milk composition traits of crossbred cows of Lithuanian Red and Red White cattle population (Fig. 4), we estimated that the milk protein percentage of purebred LR cows was 1.97 % higher than HOR (P<0.025) and 0.56 % – than AY cow's (P>0.05), the milk protein yield 1.97 % higher than HOR and 0.29 % – than AY cow's (P>0.05). Milk fat percentage of purebred LR cows was 7.54 % higher than purebred HOR (P<0.001) and 0.44 % – than AY cow's (P>0.05); the milk fat yield of purebred LR cows was 13.97 % higher than purebred 0.29 % – than HOR and 5.87 % – than AY cow's (P>0.05).

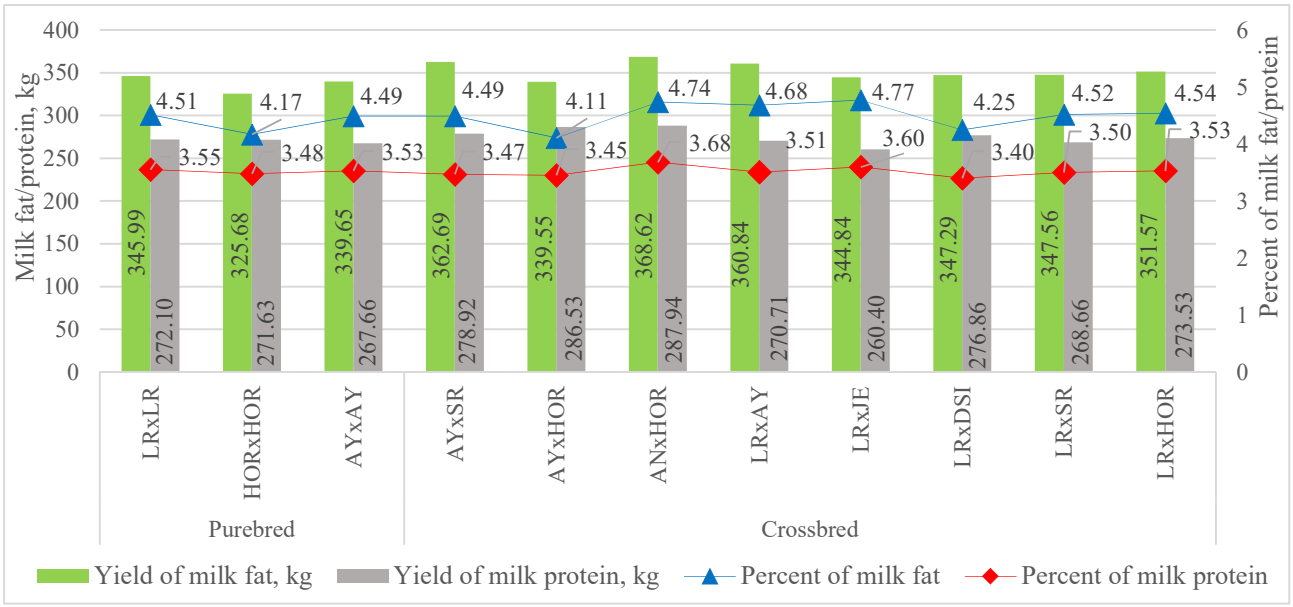

Fig. 4. **Average of milk fat and protein of purebred and crossbred cows of Lithuanian Red and Red and White cattle population**

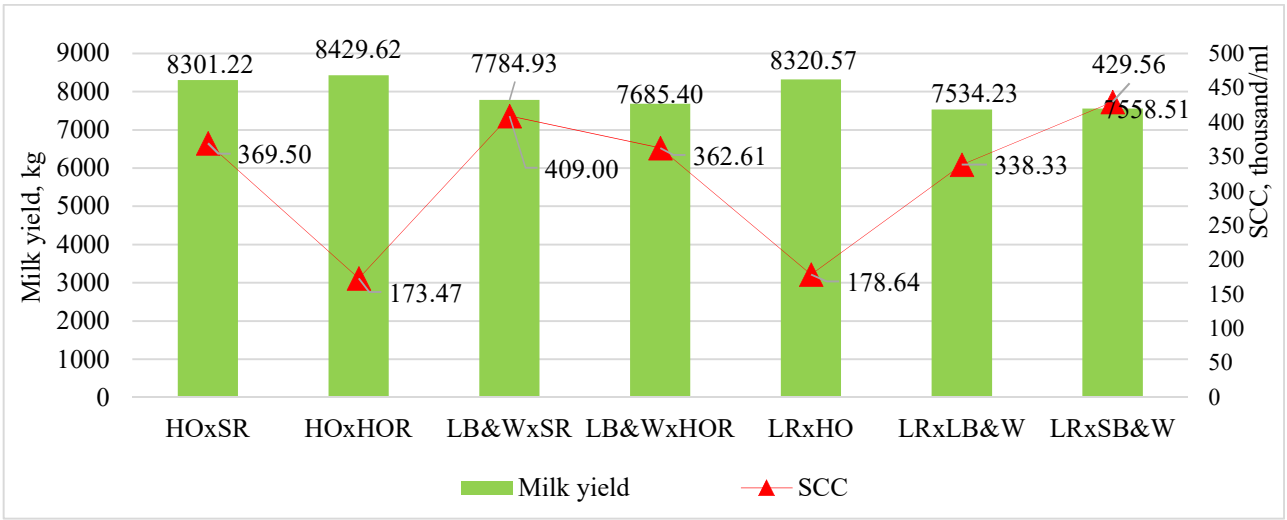

Fig. 5. **Average of milk yield and SCC in milk of crossbred cows between different populations of Lithuanian cattle**

The highest percent of milk fat was estimated in a milk of LRxJE crossbred cows and was higher from 0.63 % to 13.84 % (P<0.001–0.01) than other crossbred cow's.

The highest milk fat yield and milk protein (content percent and kg) were estimated in a milk of ANxHOR crossbred cows. The milk fat yield of these cows was higher from 1.61 % to 7.89 % (P>0.05), milk protein percentage – from 2.17 % to 7.61 % (P<0.001-0.01) and milk protein yield – from 0.49 % to 9.56 % (P<0.05) compared to the other crossbred cows.

The lowest milk fat (content percent and kg) were estimated in a crossbred AYxHOR, milk protein percentage - LRxDSI and milk protein yield - LRxJE crossbred cows.

The result of our research between both populations of Lithuanian cattle crossbred cows (Fig. 5) shows, that the highest milk yield was estimated in crossbred HOxHOR cows. Milk yield of these cows was 1.29 – 10.62 % higher than other crossbred cows (P<0.05). The lowest milk yield was estimated in crossbred LRxLB&W cows.

The lowest SCC was estimated in HOxHOR crossbred cows. SCC of these cows was 5.17 – 59.62 % lower than other crossbred cows (P>0.05). The highest SCC was estimated in LRxSB&W crossbred cows.

As presented in a figure 6 the highest milk fat percentage was estimated in LRxSB&W crossbred cows and was higher from 2.21 % to 8.39 % (P<0.05) compared to other crossbred cows. The highest milk fat yield was estimated in LRxHO crossbred cows and was higher from 1.47 % to 13.64 % (P<0.001–0.05) compared to other crossbred cows.

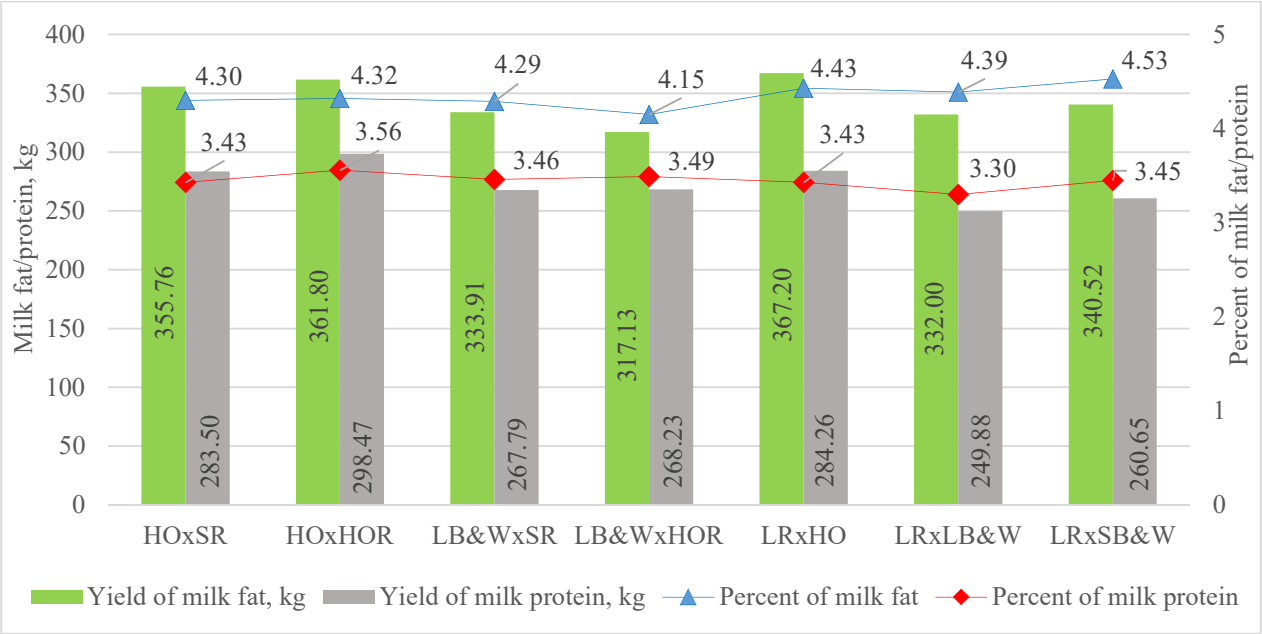

Fig. 6. **Average of milk fat and protein of crossbred cows between different populations of Lithuanian cattle**

The highest amount of milk protein (content percent and kg) was estimated in a milk of HOxHOR crossbred cows. The milk protein percentage was higher from 1.97 % to 6.46 % (P<0.005–0.05) and the milk protein yield – from 4.76 % to 16.28 % (P<0.005–0.05) compared to other crossbred cows.

The lowest amount of milk fat (content percent and kg) was estimated in a crossbred LB&WxHOR, amount of milk protein (percent and yield) – LRxLB&W breed crossbred cows.

The highest milk yield was estimated in purebred cows (on average 8038.58 kg) and lowest SCC in a milk of crossbred cows (on average 183 thousand/ml). The lowest milk yield (on average 7731 kg) and best composition of milk (on average milk fat percentage – 4,51 %; yield of milk fat – 352,87 kg, milk protein percentage – 3,52 %, yield of milk protein – 275,44 kg) was estimated in crossbred cows of Lithuanian Red and Red White cattle population.

Discussion

Crossbreeding is the most popular method of breeding used in dairy cows farms for selection traits improvement. Results of our research shows, that the highest milk yield and the lowest SCC were estimated in crossbred cows of Lithuanian Black and White cattle population (P<0.001). The lowest milk yield and the highest SCC was estimated in crossbred cows between different populations of Lithuanian cattle (P<0.001).

The highest milk yield of Lithuanian Black and White population cows was estimated in crossbred LB&WxSB&W cows and the lowest milk yield and SCC was estimated in crossbred HOxDB&W cows. The highest milk yield of Lithuanian Red and Red and White population was estimated in crossbred DSIxHOR cows and the lowest SCC was estimated in crossbred ANxHOR cows. The highest milk yield and the lowest SCC were estimated in crossbred cows of Lithuanian Black and White cattle population.

Other authors estimated similar results of Holstein crossbred cows influence on milk yield and SCC. Results of other researches as Malchiodi et al. (2011) shows, that Holstein cows did not differ (P>0.05) from crossbreds for SCC. Purebred animals produced 2.86 kg/d (P<0.01) more milk than SRxHO (Swedish Red and Holstein) and 1.61 kg/d (P<0.05) more milk than MOxSH crossbreds (Montbeliarde and Swedish Red). Heins et al. (2011) did not find differences between HO and JExHO (Jersey and Holstein) for SCC, but milk yield was lower for crossbreds than purebreds. Prendiville et al. (2009) reported that HO produced higher milk yield than JExHO at pasture. Dechow et al. (2007) reported, that BSxHO (Brown Swiss and Holstein) crosses produced less milk than HO, whereas no differences were founded for SCC. Petraškienė et al. (2013) reported that productivity performance of crossbred cows is worse than that of the purebred cows. The highest average amounts of to the milk yield (kg), fat (kg) and protein (kg) were determined in the purebred Holstein cows compared with purebred Red and crossbred cows. Petraškienė et al. (2013) reported that productivity performance of crossbred cows is worse than that of the purebred cows.

Significant differences between the milk composition traits of different purebred and crossbred cow's in our research wasn‘t estimated, suggesting that these traits are most likely dependent on the nutrition rather than on the breed of cows. In our research a percent of milk fat and protein of pure Holstein cows’ was (fat 3.02 %, protein 1.46 %) lower than crossbred HOxSR, but fat and protein (kg) of pure Holstein cows’ was (fat 2.62 kg, protein 7.47 kg) higher than crossbred HOxSR. The best milk composition traits were estimated in milk of ANxHOR crossbred cows; milk fat percent in LRxJE crossbred cow’s milk.

Other authors presented similar results. Petraškienė et al. (2013) reported that the highest average amounts of to the milk yield (kg), fat (kg) and protein (kg) were determined in the purebred Holstein cows compared with purebred Red and crossbred cows. The higher milk fat percentage they estimated in milk of crosses of Holstein cows with Danish Red (HxDR) sires and crosses of Holstein cows with Swedish Red sires (HxSR). The milk fat percentage of these cows was higher than of pure Holstein cows (2.3 % in the HxDR (P<0.01) and 2.0 % in the HxSR (P<0.05) crossbreds cows).

Malchiodi et al. (2011) results of researches showed that Holsteins produce more milk protein yield (P<0.05), but lower protein percentage (P<0.01) than Swedish Red x Holstein crossbreds and more fat (P<0.05), but lower protein percentage (P<0.001) than Montbeliarde x SH (Swedish Red x Holstein) crossbreds. Schaeffer et al. (2011) results showed, that fat and protein yields were significantly higher for crossbreds than for purebred Holsteins, except for protein yields in Jersey sired crossbreds, and fat and protein yields in Norwegian Red and Swedish Red crossbreds in second lactations, Jersey crosses surpassed in fat yield.

Heins et al. (2006) found that fat production, of Holstein cows (346 kg) were significantly higher (*P*<0.01) than Normande x Holstein (319 kg) and Montbeliarde x Holstein (334 kg) crossbred cows; however, pure Holstein cows didn’t differ from Swedish Red x Holstein (340 kg) crossbreds for fat production (P>0.05). Protein production of Holsteins were significantly higher (P<0.01) than Normande x Holstein and Montbeliarde x Holstein crossbreds, protein production of pure Holsteins surpassed the Swedish Red x Holstein crossbreds (P<0.05).

Each breed has a distinct character, unique just to this breed. One breed is distinguished by its milk production, the other - better milk composition traits. Using crossbreeding method, combining breeds with different genotypes, obtained animals has characteristic properties of both breeds, which can inherit the best qualities of both breeds or not give the desired result. Therefore, it is very important for farmers to know what breeds to use for mating in order to obtain productive and healthy cattle.

Conclusions

1. The highest milk yield and SCC were estimated in purebred HO cows. The highest milk yield of Lithuanian Black and White cattle population was estimated in crossbred LB&WxSB&W cows, in Lithuanian Red and Red and White cattle population was estimated in crossbred AYxHOR cows. The lowest SCC were estimated in crossbred cows of Lithuanian Black and White cattle population (P<0.001).
2. The best milk composition was estimated in purebred and crossbred cows of Lithuanian Red and Red White cattle population (P<0.001). The best milk composition traits were estimated in milk of ANxHOR crossbred cows; milk fat percent in LRxJE crossbred cow’s milk.
3. Significant differences between the milk composition traits of different purebred and crossbred cows in our research wasn‘t estimated, suggesting that these traits are most likely dependent on the nutrition.

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