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EVALUATION OF MILK YIELD AND MILKING CHARACTERISTICS OF DIFFERENT GENOTYPES DURING LACTATION IN ORGANIC FARMS

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ABSTRACT

Dairy cattle on organic farms are still selected on the basis of information from conventional systems. Productivity of cows differs between organic and conventional herds, therefore, the ability of cows to adapt to an organic production environment has been questioned. The aim of this study was to investigate the milk yield and milk ability traits during lactation of Lithuanian black & white and Holstein cows with different genotypes in organic farm. The research was carried out in organic farm in 2020 with dairy cows (n=364) of different genotype of Lithuanian black and white cattle population. The milk yield (MY), milking speed (MS), highest milk flow (HMF), milking time (MT) were evaluated. Investigated traits were measured with DeLaval electronic milk meters, "Apro Windows" software. All records were between five and 305 days of lactation. The statistical analysis of data was performed using the SPSS 20.0 (SPSS Inc., Chicago, IL, USA) software package. A probability of less than 0.05 was considered significant ($P<0.05$). We observed that a highest MY and HMF in organic farm was detected in cows with a genotype of Lithuanian Black and White breed (LB&W, LB&WxH and LB&WxHxLB&W) during all stages of lactation. MT of these cows during the first two stages of lactation was longer, compared to cows of other genotypes. We estimated that of all fixed effects the biggest influence on MY, MS, MT was by stage of lactation ($P<0.001$); a genotype showed a highest impact on MT($P<0.001$) and MY($P<0.01$).

Keywords: *genotype, milk yield, milk flow, milking time.*

INTRODUCTION

The global debate on climate change and environmental issues on sustainable food production systems, development of adapted to different farming conditions, (Ahlman, 2010; Röös *et al*., 2018), and the need for healthy products on the

market, owners of dairy farms are increasingly choosing organic farming. Productivity of cows differs between organic and conventional herds, therefore, the ability of cows to adapt to an organic production environment has been questioned. (Pryce *et al*., 2004, Ahlman, 2010). Dairy cattle on organic farms are still selected on the basis of information from conventional systems (Algers *et al*., 2009; Ahlman, 2010; Ahlman *et al*., 2011 m.; Horn *et al*., 2012, Rodríguez-Bermúdez *et al*., 2019). The ability of high-yielding cow breeds to adapt to the organic environment, which is often associated with lower energy and protein content in feed and limited use of antibiotics, can be difficult task (Verhoog *et al*., 2004, Nauta *et al*., 2006a). Not only the productivity of cows but also their functional characteristics are important in cattle breeding (Ahlman *et al*., 2014).

Holstein cattle have been used for many decades for the breeding of other dairy cattle in order to increase milk production. Schaeffer et al. (2011) Studies in a conventional dairy farm have shown that crossbred cows in Canada produce less milk than purebred Holstein. Dairy herds in Europe and North America were selected for high milk production under intensive farming conditions. Even under optimal management conditions, selection for increase of milk yield has reduced dairy cattle health and reproductive efficiency worldwide (Brotherstone and Goddard, 2005; Oltenacu and Broom, 2010). This raised doubts are these high-cost genotypes, are suitable for organic farming systems (Nauta *et al*.,2006b; Horn *et al*., 2012).

The effect of the stage of lactation on milking characteristics was analysed by Sandrucci et al. (2007), who estimated significantly higher average milk flow rate in Holstein dairy cows in the first half of lactation - up to 150 days.

The aim of this study was to investigate the milk yield and milking characteristics during lactation (different stage of lactation) of Lithuanian black & white and Holstein cows with different genotypes in organic farm.

MATERIALS AND METHODS

The research was carried out in organic farm in 2020 with dairy cows (n=364) of different genotype of Lithuanian black and white cattle population.

The milk yield (MY), milking speed (MS), highest milk flow (HMF), milking time (MT) were evaluated. The milking characteristics and milk yield of dairy cows were measured with DeLaval electronic milk meters installed on milking sites; the data was processed with DeLaval "Apro Windows" software. All records were between five and 305 days of lactation, with average 2.14±0.245 lactation. All cow's had two milk-recording events per test day (morning and evening).

Genotype has been estimated according to a records of cows with complete 3 ancestor's generations pedigree information estimated from the data base of State Enterprise Agricultural Information and Rural Business Center. Cows of different genotypes were investigated. Breed of cow: Lithuanian Black and White (LB&W), (n=174) and Holstein (H) (n=190). Genotypes: mother breed x father breed: Holstein x Holstein (HxH), (n=140) and Lithuanian Black and White x Holstein (LB&WxH), (n=125); mother breed x father breed x mother's father breed:

Holstein x Holstein x Holstein (HxHxH), (n=106), Holstein x Holstein x Lithuanian Black and White (HxHxLB&W), (n=18), Lithuanian Black and White x Holstein x Holstein (LB&WxHxH), (n=65), Lithuanian Black and White x Holstein x Lithuanian Black and White (LB&WxHxLB&W), (n=18). Differences in the number of cows between groups were due to an unknown breed of father or mother father.

Lactation of cows was divided into stages: stage 1st - early period - up to 100 days. During this period, the amount of milk increases rapidly from three to six weeks after calving. At this stage, the cow should be re-fertilized. Stage 2 - mid-lactation - 100-200 days. In mid-lactation, the goal is to maintain the maximum amount of milk for as long as possible, because cows are already pregnant and some of the nutrients are used by the body for the needs of the fetus. Stage 3 - late period - 200 to 305 days, when the lactation of the cow is coming to an end.

Statistical characteristics of the sample (n) – arithmetic mean (M), standard error (SE), P – value (P) – were calculated using the SPSS 20.0 (SPSS Inc., Chicago, IL, USA) software package. Data analysis was performed by using Student-t and Chi-Square statistical significance tests. The impact of single factor (genotype, stage of lactation, milk yield) on milking characteristics was evaluated using Post Hoc - Tukey test. The differences were considered as significant at $P<0.05$.

Data of cows were analysed by using a linear model of ANOVA:

$Y_{ij}=\mu+G_i+L_j+ + GL_{ij} +e_{ij}$

Where: Yij=dependent variables (MY, MS, HMF, MT); μ=general mean, Gi – genotypes of cows (8 genotypes: LB&W, H, HxH, LB&WxH, HxHxH, HxHxLB&W, LB&WxHxH, LB&WxHxLB&W), Lj – lactation stage (1st - early period - up to 100 days, 2 - mid-lactation - 100-200 days,3 - late period - 200 to 305 days), eij - residual error.

RESULTS AND DISCUSSION

Organic farmers have realized that many of the traditional commercial cow breeds are not well adapted to organic farm situations and a stronger constitution is needed for cows that can perform well in an ecological environment to achieve acceptable longevity and productivity.

Therefore, the researchers are investigating the current diversity of organic dairy breeds to identify the cow breeds and their genotypes that would best meet the goals of breeding in organic herds. Choosing a breed it is recommended to take into account the ability of the animals adapt to local conditions, their viability and their resistance to disease, however, most dairy farms that have transitioned to ecosystems maintain the same high-productivity cow breeds such as Holstein (Peeters and Wezel, 2017).The analysis of milk yield and milking characteristics of Lithuanian Black and White (LB&W) and Holstein (H) cows of different genotypes showed, that high-yielding cow breeds are kept on the farm, which need to adapt to the environment, which are often associated with lower energy and protein levels in feed and limited use of antibiotics, can be challenging. In

investigated organic farm purebred Holstein cows accounted for 52.2% (2=58.78, df = 1, P<0.001).

Milking characteristics of dairy cows are very important economic indicators that determine health of cow's udder and milk cost. The scientific literature focuses on production characteristics and animal health, and research on cow milking characteristics in organic farm is still scarce. Juozaitienė *et al*. (2016) found that cows with a higher degree of Holstein breed had higher milk yield in conventional dairy farms, which resulted in higher milk flow, but in our research, cows with LB&W breed blood had the highest milk yield and higher milk flow (Figure 1).

The results show, that the highest milk yield of all genotypes of cows was estimated in all stages of lactation. The milk yield of LB&W cows' was 4.34% (P<0.05), milking speed – 3.24% and high milk flow - 5.98% (P>0.05) higher compared to genotype of H cows' in organic farm on first stage of lactation (Figure 1).

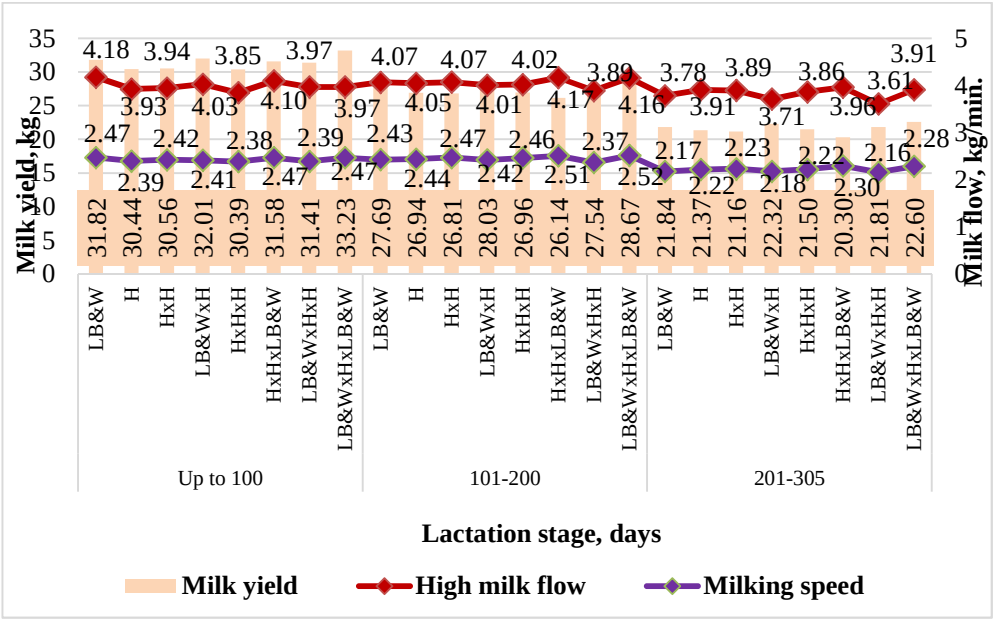

Figure 1. Average of daily milk yield and milk flow of cows during lactation.

The milk yield on the second and on the last stage of lactation of LB&W cows was 2.71% and 2.15% higher than of purebred H cows', but milking speed of H cows' were not significant (0.41% and 2.25% higher compared to LB&W cows). The high milk flow of LB&W cows on the second stage of lactation was 0.49% higher, but on the last stage of lactation - 3.33% lower than of H cows'.

The purebred Holstein cows produced 4.53% (HxH) and 5.06% (HxHxH) lower milk yield; high milk flow - 2.23% (HxH) and 4.47% (HxHxH) lower than a crossbred LB&WxH; while the milking speed of genotype HxH cows was was 0.41% higher, and genotype HxHxH cows was 1.25% lower than genotype

LB&WxH, and these results also were not statistically significant (P>0.05). Juozaitiene *et al*. (2016) studies with different genotypes of cows, reveals that cows with a higher Holstein breed degree had a higher milk yield, which leads to a greater milk flow.

Statistical analysis of various genotypes of crossbred cows shows that the higher milk yield was estimated in genotypes with higher LB&W breed blood, but had no significant effects (P>0.05).

The daily milking time of the first and second stages of lactation depended on the milk yield (Figure 2). The milking time of cows with higher milking yield was longer. On the last stage of lactation cows with more LB&W blood in their genotype, milk yield was higher, and a shorter milking time compared to purebred H (P>0.05).

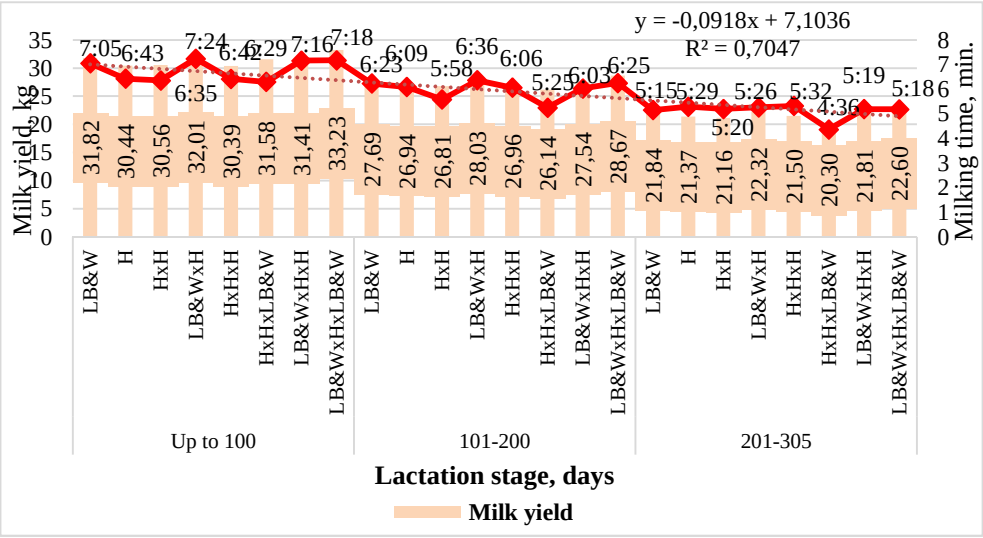

Figure 2. Average of daily milk yield and daily milk time of cows during lactation.

As we can see from the data (Figure 2), the daily milking time of cows tends to decrease on average by 0.09 min with increasing of stage of lactation (R^2=0.705). Also the results show, that the highest milking time of all genotypes of cows was estimated in first stage of lactation (up to 100 days). The daily milking time of LB&W cows was 0:22 min. higher compared Holstein cows; the daily milking time of purebred Holstein -HxH-0:49 min; and HxHxH-0:41 min. (P >0.05) cows in organic farm was lower compared to genotype LB&WxH. The results of Bobić *et al*. (2014) showed that the average milking time of Holstein cows in conventional farm was slightly longer in Holstein cows (7.26 min.), compared to our results.

Statistical analysis of various genotype crossbred Lithuanian Black and White and Holstein cows shows that the milking time of genotype HxHxLB & W cows 0:49 min. higher than of genotype LB & WxHxLB & W and 0:47 min. higher than of

genotype LB & WxHxH cows, however these results also were not statistically significant (P>0.05).

Our previous research (Japertiene *et al*., 2018) related to the production and milking characteristics of Lithuanian dairy cows during the transition period from conventional to organic farms showed, that the performance of ecologically managed dairy cows differs from conventionally managed cows. During lactation the highest milk yield, milk flow and the lowest milking time were estimated when the farm was conventionally managed. The lowest milk yield and high milk flow were when transitional period was started, milking speed and milking time - when the farm was at transitional period. The cows, which produced higher milk yield, had the faster milking speed. The lowest productivity traits were, when the farm maintain the status organic.

We estimated that of all fixed effects the biggest influence on MY, MS, MT was by stage of lactation (P<0.001); a genotype showed a highest impact on MT(P<0.001) and MY(P<0.01), (Table 1). These results correspond to Strapák *et al*., (2011), were the milk flow rate was also significantly influenced by the lactation stage (P<0.01).

Table 1. Investigation of milk yield (MY), milking speed (MS), highest milk flow (HMF), milking time (MT) affecting factors influence

Source	**MY**	**MS**	**HMF**	**MT**
G_i	**0.002**	0.820	0.653	**0.000**
L_j	**0.000**	**0.000**	**0.028**	**0.000**
GL_{ij}	0.999	0.923	1.000	1.000
Model	R Squared = 0.998 (Adjusted R Squared =0.735)	R Squared = 0.995 (Adjusted R Squared = 0.461)	R Squared =0.337 (Adjusted R Squared = 0.330)	R Squared = 0.995 (Adjusted R Squared = 0.487)

The research results of Bobić *et al*. (2014) indicate that the parity significantly affected the milking characteristics and milk yield. Many studies (Strapák *et al*., 2009; Strapák *et al*., 2011; Schaeffer *et al*., 2011; Muller *et al*., 2011) with Holstein cows in conventional dairy farms showed that the milk yield of cows is related to milk flow and milking time, and a shorter milking time may negatively affect the total milk yield.

Studies with small samples have shown a trend, that crossbreds with local breeds are more adapted to organic farming, therefore, further studies with a larger sample of different breeds of cows are needed in order to determine which genotypes best suites in organic farming systems.

CONCLUSIONS

The highest milk yield in organic farm was obtained from genotypes LB&W, LB&WxH and LB&WxHxLB&W cows at all stages of lactation. The milking duration of these cows in the first two stages of lactation (1 st - up to 100, 2 nd - 100-200 days) was longer than that of cows of other genotypes. The milking

duration of the studied cows during lactation decreased along with the decreasing amount of milk.

Differences in milk flow indicators of cows with different genotypes at different stages of lactation were small, but cows with LB&W blood in the genotype had a higher milk flow.

Although most of the results of the study were not statistically reliable, but they confirmed the statements of other researchers, and it is important not only to choose the breed that best adapts to the conditions of organic farming, but also to plan the selection of pairs according to the animal genotype.

According to our results, local breeds are well-adapted and more suitable for organic farming, but further studies should be carried out in order to identify best genotypes of dairy cows for organic farming.

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