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Dairy cattle crossbreeding and milk production

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Abstract: *Dairy cattle crossbreeding and milk production.* The aim of this study is to compare the results of milk performance of purebred Polish Holstein-Friesian (PHF) cows and their crossbreeds (PHF × SRB). Data for the analysis originated from the Polish Federation of Dairy Cattle Breeder and Producers – cows reports. The results indicate a positive influence of the breed on milk composition: fat, protein and dry matter content and somatic cell count. Purebred Polish Holstein-Friesian (PHF) cows had significantly higher ($P \leq 0.05$) milk yield for both the 100 and 305 milking days. The milk production of crossbreeds cows is lower by 15.89%, at 100 days of lactation, and by 34.57% in the full lactation than PHF.

Key words: crossbreeding, milk production, milk composition

INTRODUCTION

High production of HF is due to the systematic and consistent genetic improvement towards milk production as well as wide use in AI of dairy bull semen only the most genetically outstanding males. Unfortunately, besides significant improvement of cows' milk yield, the use of small number of bulls was a "bottle neck" of the breeding program which to decrease heterozygosity and in consequence increase the inbreeding level and caused inbreeding depression in many countries (Kania-Gierdziewicz 2006). Inbreeding depression caused health problems, deteriorating both the production and reproduction results and increased frequency of the lethal genes.

The genetic tool which can be used to limit inbreeding and to improve the low inheritable functional traits is crossbreeding (Sørensen 2007). That is why for last several years, an increase interest of dairy farmers to implement this method has been observed (Heins 2007). Besides the inbreeding limitation this method produces beneficial heterosis effect, which is due to favorable combination of genes. The heterosis effect is growing as the genetic distance between crossed breeds increases. According to Hansen et al. (2005), the effect of heterosis for production traits can be as high as 6.5%, while for fertility, health and survival may be as high as 10%. An additional advantage of crossbreeding is the acceleration of genetic improvement (Cassell 2007).

The most advanced research in this area were carried out in the United States, where as reported by Hansen et al. (2005), in 2004 the level of inbreeding was average at 5%, and increasing rate at 0.1% per annum. Many countries has reached a critical level of inbreeding amounting to 6.25%, and in Canada, according to Schaeffer and Burnside (2011) the level of inbreeding ranged from 6–7%. Ac-

cording to the same authors, an increase of 1% inbreeding can cause about 200 kg drop in milk production.

The availability AI had a very large impact on breeders who could use bull semen of many different breeds. In Poland, the most common breeds used for crossbreeding are: Simmental (SM), Montbéliarde (MO), Jersey (JE), Brown Swiss (BS), Swedish Red (SRB), Norwegian Red (NR), Danish Red (RDM) and Normande (NO). The use of these breeds is possible due to the wide range of companies operating on the Polish semen market. Among these breeds more and more popular are two Scandinavian breeds: Scandinavian Red (SRB) and Norwegian Red (NR). This is mainly due genetic ability of these breed for improvement of the health and reproductive traits.

The aim of this study is to compare the results of milk performance of purebred Polish Holstein-Friesian (PHF) cows and their crossbreeds (PHF × SRB).

MATERIAL AND METHODS

Experiment was carried out at the Experimental Farm of Warsaw University of Life Sciences – SGGW at Wilanów. The research material consisted of 50 cows. The cows were divided into two groups. The experimental group consisted of 25 PHF × SRB crossbreeds (MM), and 25 pure PHF in the control group. All selected primiparous were at the same stage of lactation.

Data including information on milk performance, chemical composition of milk: fat, protein and dry matter content and somatic cell count originated from test day records and cow-heifers record.

Statistical analyzes of data were performed using one way ANOVA. Statistical analysis was performed using the program Statgraphics 15.2.11.0. The obtained results were presented in the tables and charts. The F-test was used to assess whether the expected values of a quantitative variable within several pre-defined groups differ from each other.

RESULTS AND DISCUSSION

Figure 1 shows the lactation curve of PHF and crossbreed (MM). The pure breed PHF characterized by 20.74% ($p \leq 0.05$) higher average daily milk production in each month during the first lactation. Similar trend was observed by Heins et al. (2006a), but in their experiment, the differences in milk production between PHF and crossbreeds were much smaller. According to the results presented in Figure 1, MM cows reached the peak of the production at the second month of lactation compared to PHF which characterized by the highest daily yield at third month of lactation. At this stage of the lactation PHF still produced over 16.5% more milk than MM primiparous. Well balanced lactation curve of both breeds indicated that feeding ratio of this cows well balanced.

Figure 2 shows the milk fat concentration changes during the first 10 months lactation. The fat content was significantly ($p \leq 0.05$) higher (on average by 11.96%) in milk of MM cows than PHF ones over the first 8 month of the lactation. Nevertheless, PHF milk at ninth month of lactation characterized by

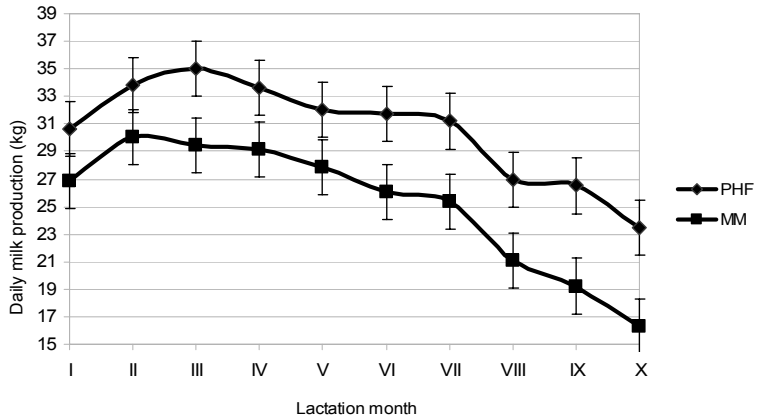

FIGURE 1. Lactation curve for pure PHF and MM

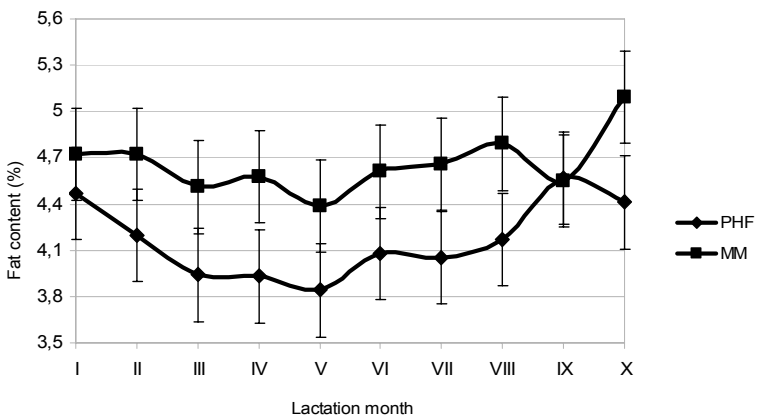

FIGURE 2. Milk fat content changes in milk of PHF and MM cows during the lactation

a higher fat content than MM ones. This could be due to the changes in cows feeding technology or/and feed quality. The average PHF cow at the end of the lactation (last 2 months of the lactation) produced over 8 kg of milk a day less than MM one what could explain significant increase in fat concentration as both milk and fat are negatively correlated. Moreover, lower milk production of MM cows resulted in quicker decision to move them to last feeding group where feeding ration s mainly based on roughage. Elevated concentration of feeding fibre had than direct effect on increased fat concentration in milk through higher production of octanes which are main precursors of milk fat.

Changes in milk protein content of PHF and MM cows during the lactation are presented in Figure 3. MM cows characterized by 9.13% higher protein content than PHF. The differences proved to be statistically significant ($P \leq 0.05$). A similar trend were observed by Petraškienër et al. (2013) who indicated technological suitability of MM milk for cheese production.

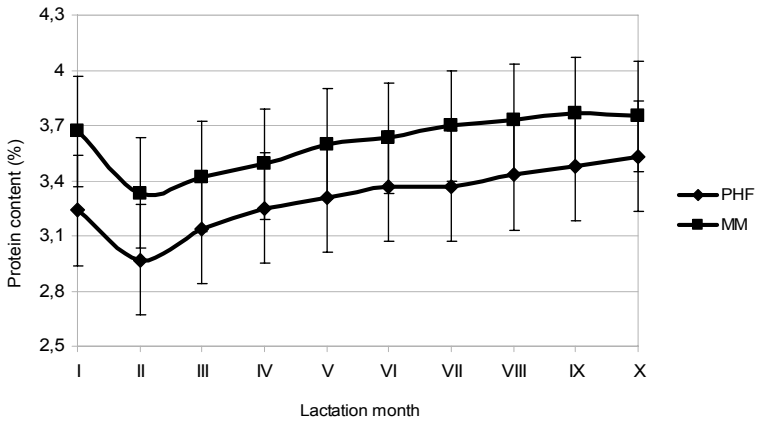

FIGURE 3. Milk protein content changes in milk of PHF and MM cows during the lactation

As the result of higher protein and fat concentration in crossbreed's milk, also the dry matter content in milk of MM cows was significantly ($P \leq 0.05$) higher (by average of 5.57%) – Figure 4. Osten-Sacken (2008), also reported the higher dry matter content in the milk of MM in his study. High dry matter content in milk positively correlated cheese yield, because of its better brevity, texture, cohesiveness, color and viscosity (Siemianowski et al. 2013). The increase of dry matter content at the ninth month of lactation in PHF milk and its slight brake down in MM was probably caused by nutritional reasons.

Figure 5 shows the sinusoidal changes of SCC in milk of both breed in 10 months of lactation. It was observed that the SCC in milk of MM cows was lower by an average of 28.31% when compared to pure PHF. The same trend was observed in the study Osten-Sacken (2008), Begley et al. (2009), Heins and Hansen (2012). It can be concluded that MM primiparous were less prone to mastitis.

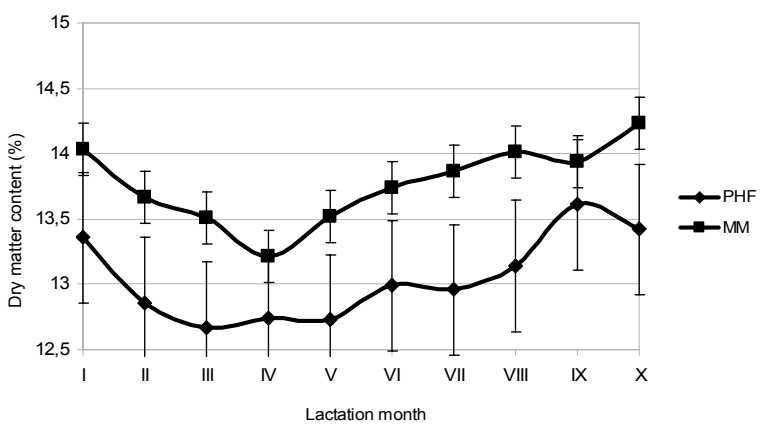

FIGURE 4. Changes in milk dry matter content of PHF and MM cows during the lactation

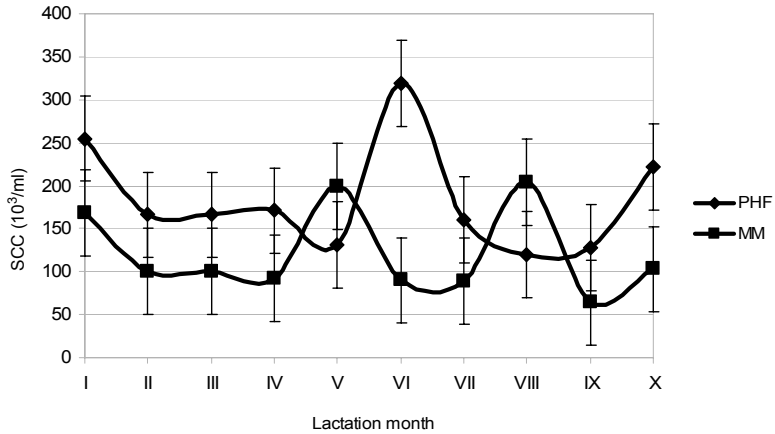

FIGURE 5. Changes in the somatic cell count (SCC) in milk of PHF and MM cows during lactation

Table shows the results of milk performance of studied cows at the first 100 days and full lactation. The milk production of MM cows is lower by 15.89%, at 100 days of lactation, and by 34.57% in the full lactation than PHF. The differences were statistically significant ($P \leq 0.05$). The large difference in milk production affected the fat yield both in 100 days and full lactation. In the first 100 day and full lactation PHF cows produced on average 4.44% and 11.98% respectively more milk fat than MM ones. Similar trend were observe in milk protein yield. Polish Holstein-Friesian cows produced 7.14 and 17.28% more proteins at 100 days and full lactation respectively ($P \leq 0.05$). Production of milk components is much lower in MM than PHF despite the large difference in milk production. Opposite results were presented by Heins et al. (2006b), who stated that the production of fat and protein by the MM is at a similar to PHF. Milk production of crossbreeds was lower, however, there were no significant differences in milk components yield, such as fat and protein between pure and crossbreeds (Heins et al. 2006a). Study of Malchiodi et al. (2014) has proved that crossbreeds had a higher content protein casein in the milk than HF. Osten-Säcken (2008) reported that SRB crossbreeds were similar in the milk production with a higher

TABLE 1. Milk performance of PHF and MM primiparous

Breed	Milking days	Milk performance									
		milk (kg)		fat (kg)		fat (%)		protein (kg)		protein (%)	
		LSM	*SE*	*LSM*	*SE*	*LSM*	*SE*	*LSM*	*SE*	*LSM*	*SE*
PHF	100	3 341^{a}	38.26	141	1.58	4.2^{a}	0.03	105	0.79	3.14^{a}	0.02
	304	9 795^{b}	75.36	402	3.26	4.12^{b}	0.04	319^{a}	3.56	3.27^{b}	0.03
MM	100	2 883^{a}	35.12	135	1.79	4.65^{a}	0.05	98	0.88	3.4^{a}	0.03
	292	7 279^{b}	69.45	359	2.89	4.67^{b}	0.03	272^{a}	2.65	3.59^{b}	0.03

a, b – $P \leq 0.05$.

dry matter content and much lower (20 to 45%) somatic cells count, as well as improved reproduction rates compared to HF. According to reports of Petraškienë et al. (2013), hybrids (SRB) had a higher content protein than HF, but much lower than the pure SRB. According to results presented in Table MM lactation was shorter than PHF, what could influenced differences in milk production. Hansen's study (2005) reported the lactation persistence of crossbreeds was similar to pure HF.

Crossbreeding PHF with SRB bulls had a positive effect of cows during the first lactation, on the milk chemical composition (content of fat, protein and dry matter) and udder health (low SCC). However pure breed PHF characterized by significant higher milk production than MM.

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Streszczenie: *Krzyżowanie bydła ras mlecznych a użytkowość mleczna.* Celem pracy jest porównanie wyników użytkowości mlecznej czystorasowych krów (PHF) oraz mieszańców międzyrasowych F1 (PHF × SR). Dane do analizy pochodziły z raportów wynikowych i kart jałówki-krowy. Uzyskane wyniki wskazują na pozytywny wpływ rasy SR na skład mleka, tj. procentową zawartość tłuszczu, białka i suchej masy oraz liczbę komórek somatycznych. Czystorasowe krowy rasy PHF charakteryzowały się istotnie wyższą statystycznie ($P \leq 0.05$) wydajnością mleka zarówno za 100 i 305 dni doju. Wydajność mleczna mieszańców za 100 dni laktacji była mniejsza o 15,89%, i 34,57% za laktację standardową niż wydajność krów rasy PHF.

Słowa kluczowe: krzyżowanie, wydajność mleczna, skład mleka

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