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EVALUATION OF THE MILK FAT TO PROTEIN RATIO AND FERTILITY TRAITS IN LATVIAN BROWN AND HOLSTEIN DAIRY COWS

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ABSTRACT

Test-day (TD) records of milk productivity traits and fat to protein ratio (FPR) in the first and second lactation phases of Latvian Brown (LB) and Holstein Black and White (HF) cows as well as the effect of FPR on fertility traits in early lactating cows were analysed. HF and LB cows were kept under indoor housing system. Animals had *ad libitum* access to total mixed rations. The LB cows demonstrated a higher fat content in milk (4.26%) than HF cows (4.03%). The average FPR during the investigations was 1.25 for LB cows and 1.17 for HF cows. The percentage of TD records from cows with an optimal FPR (1.1–1.5) was 56.8% in days in milk (DIM) from 6 to 210, and 48.2% at the beginning of lactation (DIM 6–30). Cows on DIM from 6 to 90 with optimal FPR had a lower number of milking days (–22.8 days MD), shorter calving interval (–30.3 days CI), and less days open (–20.5 days DO). The differences in fertility traits between cows with optimal and low-high FPR (<1.1 and >1.5) of TD records were not significant.

Key words: dairy cows / breeds / milk / fat protein ratio / fertility / Latvia

1 INTRODUCTION

In Latvia, two dairy cattle breeds, LB and HF, are selected for milk production. The LB is a Latvian native breed. During the last years it has become very popular to use European cow breeds, such as Danish Red, Holstein Red-and-White, and Swedish Red, for artificial insemination (AI) of the Latvian Brown cows. Average milk yield per cow during the last five years has increased from 4897 kg in 2007 to 5602 kg in 2011 for LB cows, and from 5692 kg to 6868 kg for HF cows. The high-producing LB and HF cows have a 12000–13000 kg and 16000–17000 kg milk yield per standard lactation. The farmers are motivated to improve the feeding of cows and develop total mixed rations (TMR), as well as monitor the herd nutritional status.

The milk FPR can be used as an indicator to evaluate nutritional problems and energy deficit in lactating dairy cattle. Negative energy balance (EB) can be associated with increased milk fat content due to adipose tissue mobilisation and decreased milk fat content due to a shortage of glucose for milk protein synthesis in the udder (De Vries and Veerkamp, 2000). Buttchereit *et al.* (2010) have found that FPR was the greatest in the initial lactation period when energy deficit was most pronounced. When a single measurement of FPR is used to predict EB, the first test-day measure would be the most appropriate (Mäntysaari and Mäntysaari, 2010).

The measurement of EB is very cost-intensive; however, FPR of milk is an easily measurable trait and can be obtained from routine milk perfomance testing (Buttchereit *et al.*, 2010). Several studies indicate that the optimal FPR varies between 1–1.25, whereas Duffield (2000) sets 1.33 as a high margin (cited in Eicher, 2004) and Richardt (2004) proposes the optimal range of FPR is 1.1–1.5. Doing research on Holstein cows, Čejna and Chládek (2005) have indicated that the optimum FPR was between 1.2 and 1.4.

FPR greater than 1.5 is considered a risk factor for metabolic problems such as ketosis. When inversion of

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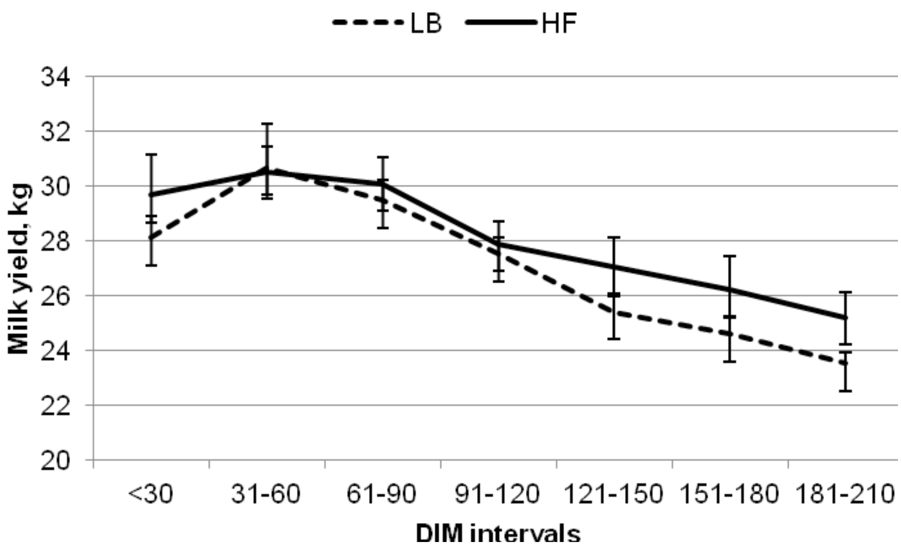

Figure 1: *Average daily milk yield (in kg) of LB and HF cows in the first and second lactation phase*

the milk FPR occurs (ratio<1), the herd is considered at risk of subacute ruminal acidosis (Eicher, 2004).

The aim of our study was to evaluate the influence of FPR on the cows' reproduction traits in Latvian Brown and Holstein dairy cows kept in the TMR feeding system.

2 MATERIAL AND METHODS

The data of the first and second lactation of Holstein and Latvian Brown cows with calving years from 2008 to 2009 were collected monthly from the dairy herd of the Study and research farm „Vecauce" of the Latvia University of Agriculture. HF and LB cows were kept under indoor housing system. Animals had *ad libitum* access to total mixed rations. The diet was calculated to net energy for lactation and protein for cows with average milk yield of about 30 kg. The ration consisted of grass and corn silage, barley and corn flour, and rape meal supplemented with minerals.

During the investigations, 1029 TD milk samples of 31 HF and 129 LB cows were analysed for fat (%), protein (%), FPR, lactose (%), milk urea (mg/dl), and SCS. Milk samples were collected from evening and morning milking once per month (A4 method). Milk samples were analysed in an accredited milk quality laboratory SIA „Piensaimnieku Laboratorija" with FOSS instrument Combi Foss FC.

Records from 6 to 210 DIM of the milk with a 1.5–9% fat content and a 1–7% protein content were included

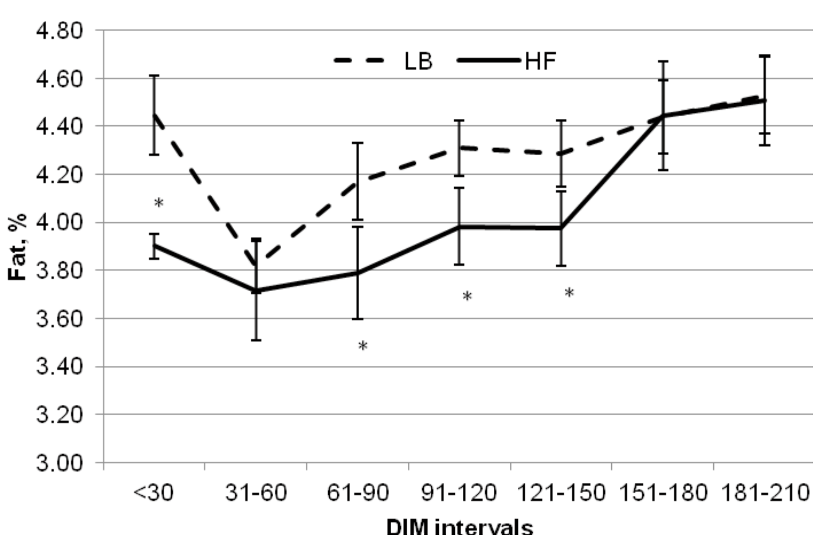

Figure 2: *Average fat content (in %) in milk of LB and HF cows in the first and second lactation phase*

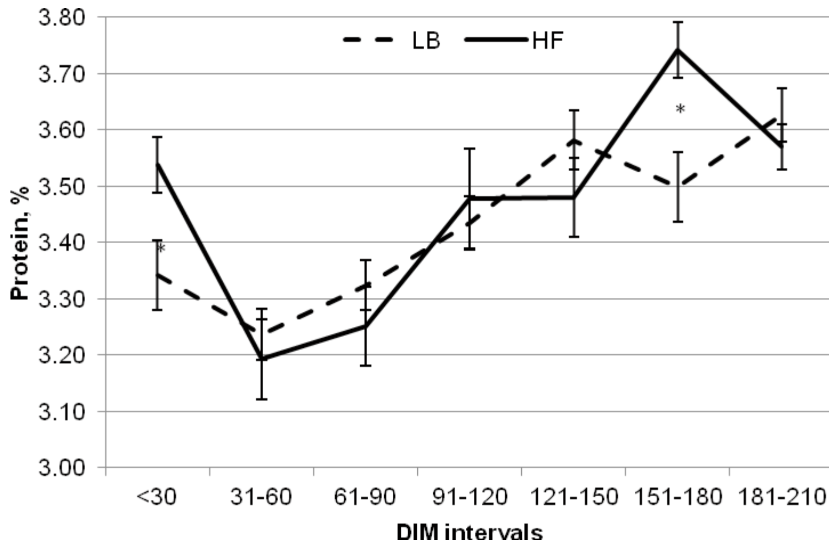

Figure 3: *Average protein content (in %) in milk of LB and HF cows in the first and second lactation phase*

in the data set. Days in milk were split into 7 intervals: till 30 DIM, and 6 intervals each with a length of 30 DIM for days from 31 to 210. The LB and HF breed cows had on average 120 and 27 TD records in each DIM interval respectively.

The investigation data were processed using the IBM SPSS Statistics 20 program.

3 RESULTS AND DISCUSSION

The LB breed cows are characterized by a lower milk yield and a higher test-day fat and protein content than Holstein cows. According to Latvian Agriculture Data Processing centre, average milk production of LB cows in 2011 was 5602 kg milk yield per standard lactation with fat content of 4.40% and protein content of 3.33%, and for HF cows – 6868 kg milk yield with fat content of 4.08% and protein content of 3.20%.

In the first phase of lactation (6–120 DIM) there were no significant differences between LB and HF cow milk yields. In the second phase of lactation (121–210 DIM), the HF breed cows produced a comparatively higher average milk yield. Figure 1 shows that both milk yield curves reach their highest peak in the same interval (31–60 DIM) when both fat and protein content curves reach their lowest point. Lactation curve for HF cow milk yield is less sloping than for the milk yield of LB cows.

Average lactation curves of LB and HF cows for fat and protein % are the inverse of the milk lactation curves

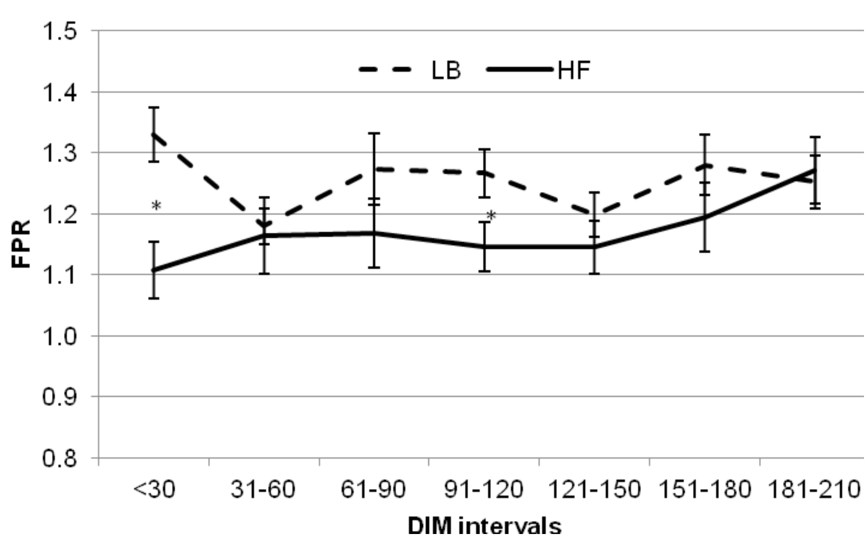

Figure 4: *FPR in milk of LB and HF cows in the first and second lactation phase*

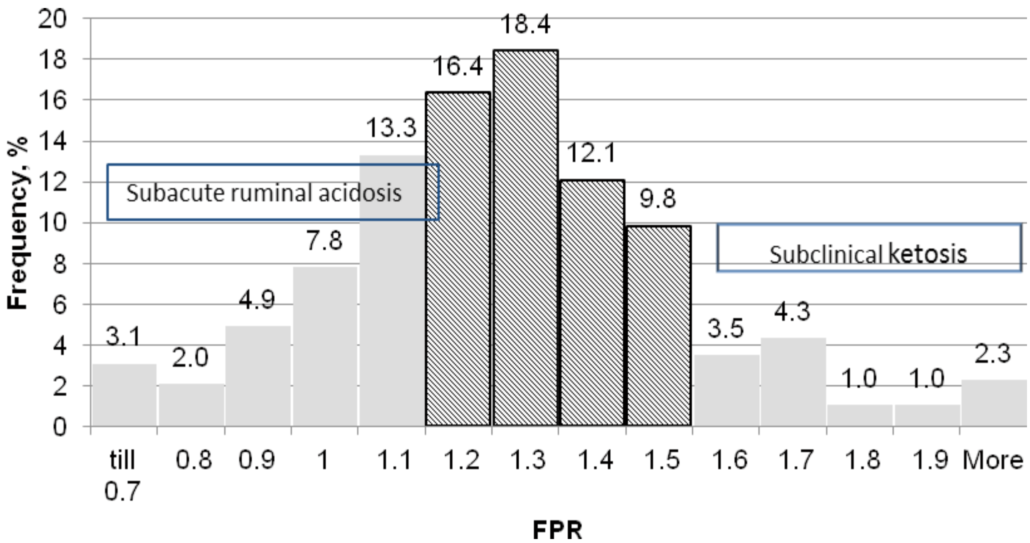

Figure 5: *Distribution of FPR in milk of LB and HF cows in the first and second lactation phase*

– the fat and protein % decreased till 50–60 DIM and then began to increase again with the increase in DIM (Figures 2 and 3). Compared to LB breed, HF cows had a lower fat content in the first 30 DIM and in 61–150 DIM ($P < 0.05$). The average protein content in the first 30 DIM was significantly higher for HF cows ($P < 0.05$), but later sharply decreased from 3.54% to 3.12% in 31–60 DIM. During the 31–150 DIM there were no differences in milk protein content between HF and LB cows.

Average test-day FPR ranged from 1.11 to 1.27 for HF cows, and from 1.16 to 1.33 for LB cows. The highest FPR for LB cows was observed in DIM from 6 to 30, and the lowest – in DIM from 31 to 60 (Fig. 4). Lactation curve for FPR of LB cows in our investigation was similar with that obtained in the research of Jamrozik and Schaeffer (2012): the largest values of FPR were on DIM immediately after calving, decrease towards the peak of lactation for milk yield, and steady but slow increase with the progression of lactation. Negussie *et al.* (2008) have estimated that in early lactation (from day 8 to 60) of Finnish Ayrshire cows, the average test-day FPR ranged from 1.3 to 1.4, and in mid-lactation (from day 60 to 150) – from 1.20 to 1.25, whereas from day 150 to day 200 the test-day FPR was relatively constant and started to increase towards the end of lactation.

The average test-day FPR of HF cows in DIM from 6 to 30 was lower than in DIM from 31 to 60, which can be explained by the high (21.6) average DIM.

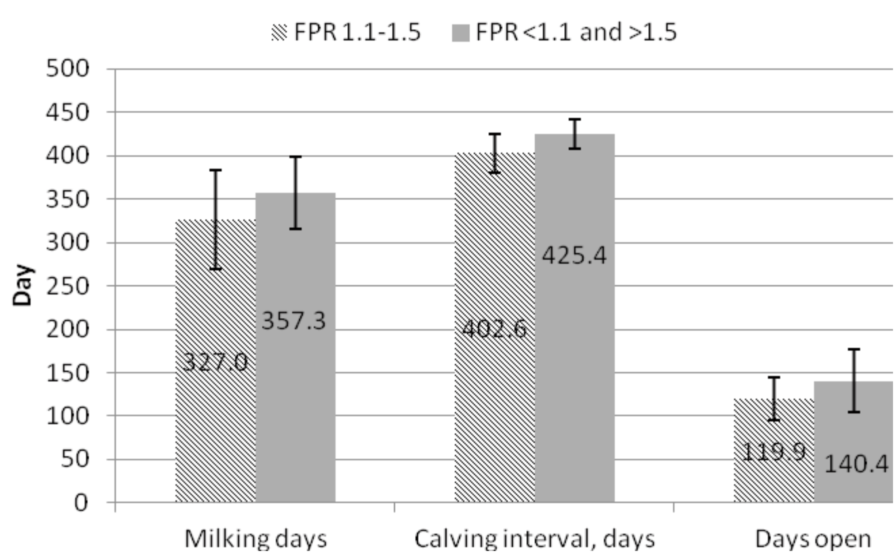

Figure 6: *Cows fertility traits according to FPR level*

A total of 30.5% of the milk recorded samples had FPR between 1.2–1.4 (Fig. 5). The number of milk samples with FPR 1.2–1.4 in the first 90 DIM constituted only 24.7–28%, and in the second phase of lactation increased up to 34.5%.

More than half (56.8%) of the recorded samples had an optimal FPR – between 1.1 and 1.5, in 31.1% of the samples FPR was lower than 1.1, and 12.1% of samples had FPR higher than 1.5. On the first test day (6–30 DIM), for 24% of cows the FPR ratio was greater than 1.5. If more than 40% of cows on the first test day have the fat to protein ratio greater than or equal to 1.5, in a true protein system, the herd may have an elevated level of subclinical ketosis (Bremmer, 2004).

Subclinical ketosis has been associated with decreased milk production, impaired reproductive performance, displaced abomasums, metritis, mastitis, and clinical ketosis (Duffield, 2000).

In the analysis of association between FPR and cows fertility traits, only TD records on DIM from 6 to 90 were included. Cows with a low-high FPR (<1.1 and >1.5) had longer DO, CI, and MD (Fig. 6). Cows with an optimal FPR had a 402.6-day CI, which is longer than the target 365-day calving interval. The differences in fertility traits between cows with an optimal and a low–high FPR of TD records were 22.8, 30.3, and 20.5 days for MD, CI, and DO respectively, and were not significant.

Negussie *et al.* (2008) have found relatively low genetic correlations between test-day FPR and fertility traits, whereas stronger genetic associations were determined between test-day FPR and days from calving to insemination and DO. Windig *et al.* (2005) in their research have observed that increased production of individual cows within high-producing herds always led to lower cow fertility.

4 CONCLUSIONS

A total of 56.8% of TD records of LB and HM cows had an optimal FPR (1.1–1.5) in DIM from 6 to 210. Cows with a low-high FPR demonstrated longer DO, CI, and MD. FPR in milk can be monitored to identify the cows subject to risk of developing subclinical ketosis as well as to improve the fertility indices in the herd. Therefore, further investigations of FPR influence on fertility traits in Latvian cow populations with a greater number of test-day records are recommended.

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