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FAT-TO-PROTEIN RATIO: EVALUATION OF METABOLIC DISORDERS AND MILK YIELD

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ABSTRACT

The aim of the paper was to evaluate the occurrence of metabolic disorder based on the fat-to-protein ratio and the effect of fat-to-protein ratio on the milk yield. In total, 680 records of test day (from 3 to 150 days) of 188 cows originating from 4 farms in west part of Slovakia between years 2013 and 2016 were collected to perform the study. The statistical analyses were carried out by SAS software. The highest prevalence of ketosis risk (19.08 %) was found in first month after calving, while the frequency of acidosis risk increased gradually from the start (10.53 %) to the middle of lactation (26.60 %). In the analysed group of cows the average milk yield at level 35.83 kg day^{-1} was found. The selected effect of herd, parity, year, calving season, days in milk and fat-to-protein ratio explained 55.67 % of the milk yield variability. Due to the effect of fat-to-protein ratio the decrease of milk yield 1.2 kg day^{-1} was observed. Based on the results the fat-to-protein ration can be regarded as good estimator of metabolic disorders occurrence.

Key words: cattle, dairy cows, test day, fat-to-protein ratio, milk yield, metabolic disorders

1 INTRODUCTION

The problems of negative energy balance (NEB), disproportional energy metabolism (fatty liver, ketosis, subacute, acute ruminal acidosis), disturbed mineral utilization and perturbed immune function are common in transition cows (Esposito *et al.*, 2014). Duffield *et al.* (2009) reported that poor adaptive response to the onset of lactation can lead to the problems of clinical diseases and impaired milk production.

Subacute ruminal acidosis (SARA) is characterized by depressed rumen pH for several hours per day due to accumulation of volatile fatty acids and insufficient rumen buffering (Plaizier *et al.*, 2009). SARA is a prevalent metabolic disorder that has been found in high-producing dairy herds, mainly due to the feeding excessively fermentable diets (Gao and Oba, 2014).

Subclinical ketosis (SCK) is a major dairy cow metabolic disorder caused by strong dietary negative energy balance around calving. A certain degree of negative energy balance is expected in cows in late gestation and early lactation (Duffield *et al.*, 2009). Berge and Vertenten (2014) observed high prevalence of ketosis in fresh cows. Currently, the lactational prevalence of SCK in Europe is estimated to be at 25 % (Raboisson *et al.*, 2014).

The aim of this study was to analyse the occurrence of metabolic disorders using the fat-to protein ratio and estimate the impact of fat-to-protein ratio on the milk yield in dairy cows.

2 MATHERIALS AND METHODS

In total 188 dairy cows from 4 farms in west part of Slovakia were included into the study. The records of test day of milk yield of cows between 3 and 150 days in milk (DIM) were collected in period 2013 to 2016. The risk of metabolic disorders prevalence based on the fat-to-

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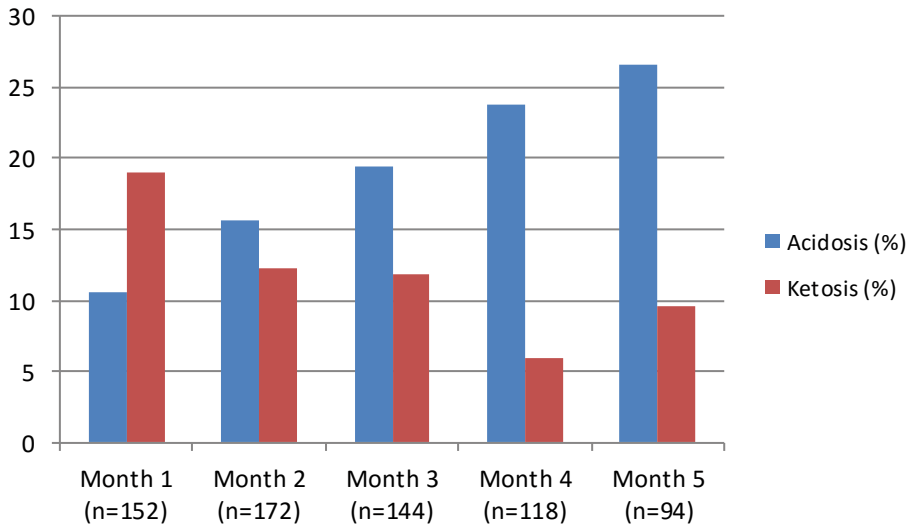

Figure 1: *The prevalence of acidosis and ketosis over the 5 months of lactation (150 days in milk); n – number of observations*

protein ratio (F/P ratio) was indicated according to the methodology of Gantner (2015) and the F/P ratio was divided into the groups:

K when F/P ≥ 1.5 meaning ketosis risk,

N when F/P 1.0 – 1.5 meaning normal conditions,

A when F/P < 1.0 meaning acidosis risk.

The effect of F/P ratio on milk yield was analysed with using general linear model (GLM) procedure incorporated in SAS software (SAS Institute, 2009). In the GLM model were included fixed effects of year, calving season, parity, herd and the random effects of F/P ratio and days in milk. For statistical analyses calving season was grouped as spring (March to May), summer (June to August), autumn (September to November) or winter (December to February). The parity of cows was divided into groups of first parity, second parity and third or higher parity.

3 RESULTS AND DISCUSSION

Overall, 680 records of test day (3 to 150 days in milk) of 188 dairy cows from 4 farms were analysed. All 4 herds were fed by total mixed ratio (TMR). Evaluated cows were divided into the groups according to first parity (n = 42), second parity (n = 59) and third or higher parity (n = 88), and the same animal could be also observed at different parity. The average milk production of cows across all herds was 35.83 ± 11.17 kg day^{-1} with average 68.18 ± 40.38 days in milk and average parity 2.23 ± 0.8. Within the analysed group of cows higher proportion for acidosis risk was found. The frequency of ketosis risk was 12.21 %, while the acidosis risk reached frequency at level 18.24 %. Compared to our results Buttcheriet *et al.* (2012) reported for dairy cows lower proportion of metabolic disorders at level 9.7 %.

Figure 1 shows the prevalence of acidosis and ketosis over 5 months of lactation. The highest observed prevalence of ketosis risk (19.08 %) in first month after calving is in accordance with study of Gantner (2015), who reported that the highest ketosis risk was determined in early lactation (till 60th day), while the lowest frequency was after the 180th day. In addition, Berge and Vertenten (2014) found that the average herd prevalence of ketosis in fresh cows 1 to 3 week post-calving was 41 %, whereas only 1.6 % of the cows were diagnosed with clinical ketosis within 35 days postpartum.

The frequency of acidosis risk within analysed cows increased gradually from the start to the middle of lactation (Fig. 1). Gao and Oba (2014) reported that the risk of SARA is greater for early- and mid-lactation cows compared with late lactation cows mainly due to feeding highly fermentable diets and greater feed intake.

Our results indicated that the higher prevalence of ketosis can be associated with quick increase of milk production in early lactation. The intake of dry matter and energy is lower than cows´ requirements what result to negative energy balance (NEB) and production of ketones (acetoacetic acid, acetone and β-hydroxybutyrate) in blood (Esposito *et al.*, 2014). The lower levels of ketosis were found mainly in herds fed with total mixed ratio (TMR) or feeding forage and concentrate in comparison to the herd fed with partial mixed ratio (PMR) (Berge and Vertenten, 2014). Oetzel (2007) reported that the occurrence of ketosis is uncommon in TMR-fed herds be-

Table 1: *Final model for milk yield*

Parameter	Estimate	Standard Error	*p*-value
Intercept	38.312	5.126	< 0.0001
Herd 1	−8.957	1.614	< 0.0001
Herd 2	−4.702	1.451	0.0013
Herd 3	2.320	1.505	0.1239
Herd 4	Referent	.	.
Parity 1	−5.753	1.073	< 0.0001
Parity 2	1.294	0.862	0.134
Parity 3	Referent	.	.
Year 2013	−5.703	4.732	0.2287
Year 2014	−3.603	4.616	0.4354
Year 2015	2.281	4.634	0.6227
Year 2016	Referent	.	.
Calving season 1	2.565	1.734	0.1398
Calving season 2	4.742	1.755	0.0071
Calving season 3	3.532	1.588	0.0265
Calving season 4	Referent	.	.
Days in milk	0.029	0.013	0.0279
F/P ratio	−1.200	1.365	0.3796

cause TMR feeding allows for higher energy intakes with less risk for ruminal acidosis.

The impact of fat-to-protein ratio was also tested in relation to the milk production using GLM model. Except the F/P ratio six other fixed effects were included in the statistical analysis. Based on the selected model we were able to describe the variability of milk yield in analysed group of cows on 55.67 %. All of the selected effects had statistically significant impact ($P < 0.05$) on milk yield variation, except F/P ratio. Main influence on milk yield was observed for effects of herd ($P < 0.001$), year of calving ($P < 0.001$) and calving season ($P < 0.001$). However, the results indicated that due to the effect of F/P ratio the milk production decreased by 1.2 kg day^{-1}.

The effect of F/P ratio has been reported for dairy cattle in several studies (Toni *et al.*, 2011, Buttchereit *et al.*, 2012, Zink *et al.*, 2014). Buttcheriet *et al.* (2012) reported that fat-to-protein ratio (F/P ratio) and body condition score are potential variables to describe how well cows can adapt to the challenge of early lactation. The increase of F/P ratio in the early lactation was also significantly associated with increase of risk of being culled from the herd (Toni *et al.*, 2011). Moreover, the F/P ratio is a valuable indicator of negative energy balance in postpartum cows and might be helpful in selecting concerning metabolic or other disorders (Zink *et al.*, 2014).

4 CONCLUSION

Within analysed group of cows higher proportion for acidosis risk was found. The frequency of ketosis risk was 12.21 %, while the acidosis risk reached proportion at level 18.24 %. The highest prevalence of ketosis risk was observed in first month after calving, while the frequency of acidosis risk increased from the start to the middle of lactation. In addition, the results indicated that the higher prevalence of ketosis has been associated with quick increase of milk production in early lactation. Except F/P ratio each of selected fixed effects included in GLM model significantly affected the milk production. But the results indicated that the F/P ratio have negative impact of milk yield and reflect the risk of subclincal ketosis or subacute ruminal acidosis. Therefore, the evaluation of F/P ratio can be regarded as the non-invasive and cheap method of metabolic disorders prediction to eliminate its negative effect on milk yield.

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