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Relationships between production traits and the parity of Polish Holstein-Friesian cows

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Abstract: *Relationships between production traits and the parity of Polish Holstein-Friesian cows.* The objectives of the study was to describe the relationships between milk urea, protein, fat concentrations and the age of Polish Holstein-Friesian cows. The experiment was carried out at the research dairy farm of the Warsaw University of Life Sciences – SGGW (WULS). From a herd of 320 Polish Holstein-Friesian cows maintained in a free-stall dairy shed 50 cows were selected. Parity had significant effect on the shaping the concentration of the production traits. The highest content of protein, 3.87%, was found in milk of cows during 3rd and subsequent lactations in the 10th collecting (above 271 day of lactation). The fat content ranged at the herd level from 3.18 to 4.89 %, the highest level has been recorded in milk of cows during 3rd and subsequent lactations, in the 10th collecting (above 271 day of lactation). The urea content ranged at the herd level from 183 to 267 mg/l. Milk production traits varies significantly with the age of cows. Hence, researchers should consider monitoring for this variable as potential cofounder when exploring the relationship between urea, protein, fat content in milk and nutritional management for meeting the production requirements of cows.

Key words: cow, parity, protein, fat, urea

INTRODUCTION

The gross composition of cow's milk is variable, because many factors influence the end product. These variations can be related to genetics and environment parameters. The milk composition also varies within the cows from milking to milking and with the intensification of production, stage of lactation, disease and age of the cows (Nałęcz-Tarwacka 2006, Januś 2008, Kuczyńska 2011, Puppel et al. 2012).

Concentration of urea in milk is also variable from herd to herd and within cows. The variation in milk urea concentrations indicates a wide variation in protein, energy and water intake (Minakowski 2006). The proper formulation of cows diet requires to appropriately balance diets for rumen digestion and absorption of needed nutrients for maintenance of body tissue and production of milk. Hof et al. (1997) reported that regular measurement of milk urea N in bulk samples can be used to monitor N losses from rumen fermentation.

The cow production depends not only on its genetic and physiological characteristics but also on the quantity and quality of nutrients to its intermediary metabolism. Production traits are the result of the voluntary intake and the nutrient density of feed intake (Piłat

2006). The INRA system distinguishes the various parts of proteins which are finally digested in the intestine, i.e. PDIA (Protein Digestible in the Intestine from dietary origin), microbial protein allowed by available fermentable N (PDIMN) and microbial protein allowed by available fermentable energy (PDIME). The sum of PDIA + PDIMN, and the sum of PDIA + PDIME gives PDIN and PDIE values of a feed (Kowalski et al. 2008). Balancing a cows basal diet with the appropriate supplementary feeds is achieved when PDIN and PDIE values are equal (+/–50 g) and meet the production requirements (Kida 2003).

The objectives of this study was to describe the relationships between milk urea, protein, fat concentrations and the parity of Polish Holstein-Friesian cows during lactation.

MATERIAL AND METHODS

The experiment was carried out at the research dairy farm of the Warsaw University of Life Sciences – SGGW (WULS). From a herd of 320 Polish Holstein-Friesian cows maintained in a free-stall dairy shed 50 cows were selected taking into consideration: stage of lactation (8 ±14 days) and parity (1^{st}, 2^{nd}, 3^{rd} and subsequent lactations).

During the experimental period cows feeding ration was based on the total mixed ration (TMR) diet provided *ad libitum*, formulated using the INRA system. Representative TMR samples were analyzed for dry matter, crude protein, ash, ether extract, acid detergent fiber, neutral detergent fiber. Chemical composition of the treatment diets is presented in the Table 1.

TABLE 1. Ingredient and chemical composition of the TMR diet

Composition	TMR diet
Ingredient (kg/day)	
Maize silage	25.000
Alfaalfa silage	9.400
Corn silage	3.700
Concentrate	5.200
Straw	1.000
Concentrate (kg)	
Hydropalm – by pass oil	0.600
Pasture ground chalk	0.150
$NaHCO_3$	0.125
BetaLac – premix	0.130
NaCl	0.050
Rapeseed meal	2.230
Soya meal	2.300
Grain meal	1.300
Rumex	0.005
$Ca_3(PO_4)_2$	0.050
Chemical composition	
DM (%)	57.500
Crude protein (% of DM)	18.500
Acid detergent fiber (% of DM)	19.000
Neutral detergent fiber (% of DM)	28.500
Ash (% of DM)	5.000
Ether extract (% of DM)	4.500
Ca (% of DM)	0.700
P (% of DM)	0.500
Total (ULF)	19.500
Total (PDIE) (g)	1860
Total (PDIN) (g)	1835

Sampling

Representative milk samples were collected from each cow during milking by means of a milk meter in the milking parlor. Milk samples were taken individually from each cow 10 times during the experiment at monthly intervals (10 collecting from each cow). The samples were collected at following stages of lactation: first: 8–30; second: 31–60; third: 61–90; fourth: 91–120; fifth: 121–150; sixth: 151–180; seventh: 181–210; eighth: 211–240; ninth: 241–270 and tenth: above 271 day of lactation.

Milk analysis

Gross milk composition, i.e. fat, protein, and urea content, were determined by automated infrared analysis (FTIR) with a Milkoscan FT-120 instrument (FOSS Electric, Hillerød, Denmark).

Statistical analyses

The data obtained were analyzed statistically using analysis of variance (least squares) by means of the SPSS 21 packet software.

The model used for analyzed milk samples was

$$Y_{ijk} = \mu + A_i + B_j + (A_i \times B_j) + e_{ij}$$

where:
Y_{ijk} – dependent variable;
μ – general mean;
A_i – parity effect (1, 2, 3 ,4);
B_j – stage of lactation effect;
$(A_i \times B_j)$ – interaction between parity and stage of lactation;
e_{ij} – standard error.

RESULTS AND DISCUSSION

Parity had significant effect on the shaping the concentration of the protein in cow's milk. The content of this constituents ranged during lactation at the herd level from 2.95 to 3.87%. The highest content of protein, 3.87%, was found in milk of cows during 3rd lactation in the 10th collecting (above 271st day of lactation, Fig. 1). The overall mean for protein (Table 2) content were similar to the value obtained by Gnyp et al. (2006). Chalupa (1984), reported, that supplemental protein can increase milk yield by providing more amino acids, by increasing available energy, and by altering efficiency of utilization of absorbed nutrients.

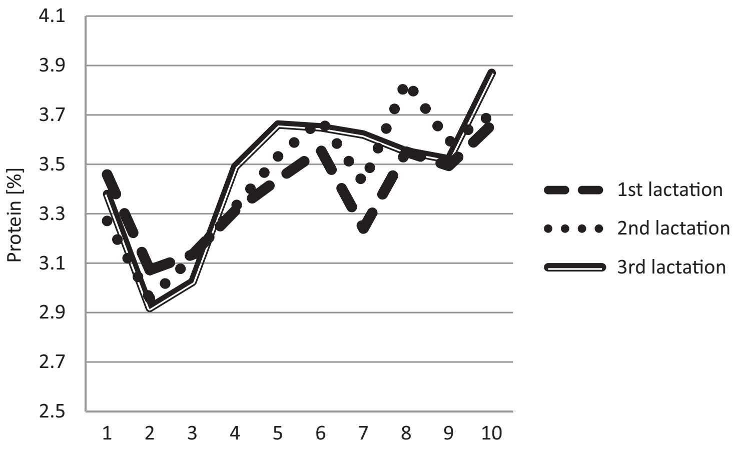

FIGURE 1. Relationships between concentration of protein and the parity of Polish Holstein-Friesian cows

TABLE 2. Relationships between production traits and the parity of Polish Holstein-Friesian cows

Parameter	Parity	LSM	SEM
Protein (%)	1st lactation	3.39[ab]	0.194
	2nd lactation	3.44[b]	0.276
	3rd and subsequent lactations	3.47[a]	0.293
	average for the entire herd	3.44	0.251
Fat (%)	1st lactation	3.88[Ab]	0.497
	2nd lactation	4.12[bc]	0.368
	3rd and subsequent lactations	4.42[Ac]	0.653
	average for the entire herd	4.14	0.550
Fat: protein ratio (-)	1st lactation	1.14[Ab]	0.115
	2nd lactation	1.20[bc]	0.103
	3rd and subsequent lactations	1.27[Ac]	0.182
	average for the entire herd	1.20	0.170
Urea (mg/l)	1st lactation	183[ABC]	8.584
	2nd lactation	267[A]	6.611
	3rd and subsequent lactations	264[B]	11.562
	average for the entire herd	243	11.341

LSM – last square mean; SEM – standard error of the mean; values in the column marked with the same letters differ significantly [A,B,C] at $P \leq 0.01$, [a,b,c] at $P \leq 0.05$.

The fat content ranged at the herd level from 3.18 to 4.89%. The highest content of fat, 4.89%, was found in milk of cows during 3rd and subsequent lactations; in the 10th collecting – above 271st day of lactation (Fig. 2).

The overall mean for fat (Table 2) were similar to the value obtained by Grodzki and Brzozowski (2005) and Nogalski (2006). The higher fat content in the multiparous cow's milk could be due to more intense fat reserve mobilization

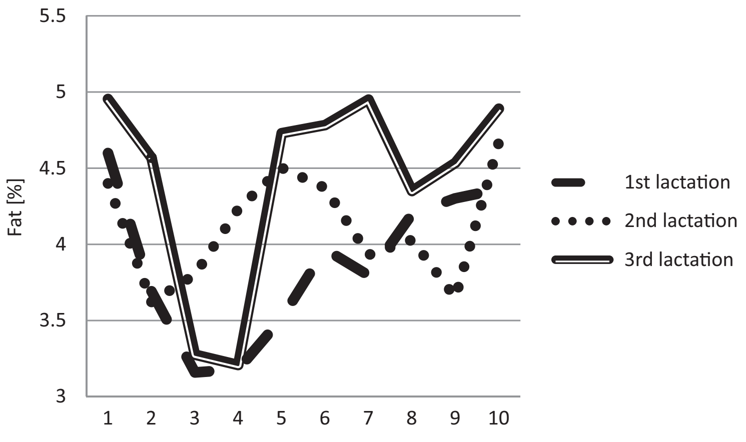

FIGURE 2. Relationships between concentration of fat and the parity of Polish Holstein-Friesian cows

in early lactation (Berry et al. 2007). In contrast Borkowska (2005) showed that the age of cows affect only milk yield. While, Litwińczuk et al. (2006) reported, that parity is associated with decrease in fat content.

The fat: protein ratio ranged at the herd level from 1.14 to 1.27. The highest ratio, 1.27 was found in milk of cows during 3rd and subsequent lactations (Table 2). The optimum fat: protein ratio is 1.2–1.4. Lower values are likely to lead to subclinical rumen acidosis which can interfere with reproductive performance of cows. The fat: protein ratio higher than 1.4 signals energy deficit and subclinical ketosis (Pogorzelska et al. 2004). Toni et al. (2011), reported that analyses of milk components in early postpartum (6–9 days in milk), particularly the ratio of fat: protein is a valuable indicator of lipomobilization and the negative energy balance status in *post partum* cows.

The urea content ranged at the herd level from 183 to 267 mg/l. The highest content of urea, 267 mg/l, was found in milk of cows during 2nd lactation (Table 2). It significantly differed from LSM in cows during 1st lactation. Godden et al. (2001) reported significant differences between lactations, also with the lowest concentrations of urea in cows in the 1st lactation. The overall mean for urea were similar to the value obtained by Sawa et al. (2010) and Slósarz (2011), who reported a mean for urea of 260 mg/l (optimal range of 250 to 270 mg/l). However, lower values were reported by other researchers. In contrast Osten-Sacken (1999) found, that the lower concentration of urea in cow's milk is associated with a lack of metabolic burden, associated with a history of lactations, and therefore the level below to 200 mg/l is satisfactory for primiparous cows. Milk urea concentration can be used as a tool to monitor protein feeding efficiency and dietary protein-energy ratio in dairy cows (Hof et al. 1997).

CONCLUSION

Milk production traits varies significantly with the age of cows. Hence, researchers should consider monitoring for this variable as potential cofounder when exploring the relationship between urea, protein, fat content in milk and nutritional management for meet the production requirements of cows.

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Streszczenie: *Kolejność laktacji krów rasy PHF jako czynnik kształtujący poziom cech użytkowych mleka w intensywnym systemie produkcji.* Celem badania było oszacowanie zależności między zawartościami białka, tłuszczu, oraz mocznika w zależności w od kolejności laktacji. Badaniami objęto 50 krów rasy polskiej holsztyńsko-fryzyjskiej. Za pomocą spektrofotometrii w podczerwieni FTIR oznaczono koncentrację poszczególnych składników mleka. W pracy wykazano zróżnicowane poziomy składników użytkowych mleka w kolejnych laktacjach. Największą zawartość białka, 3,87%, stwierdzono w mleku krów w okresie 3. laktacji, w 10. pobraniu (powyżej 271. dnia laktacji). Zawartość tłuszczu wahała

się na poziomie od 3,18 do 4,89%, najwyższy poziom wykazano w mleku krów będących w 3. laktacji, w 10. pobraniu (powyżej 271. dnia laktacji). Zawartość mocznika wahała się przedziale od 183 do 267 mg/l na poziomie stada. Cechy produkcyjne mleka różniły się znacznie w zależności od wieku krów. Sugeruje się, aby w trakcie zarządzania stadami wielkotowarowymi uwzględniać obserwację zmiennej, jaką jest wiek krów (numer laktacji), przy bilansowaniu dawek pokarmowych w poszczególnych grupach produkcyjnych.

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