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EFFECT OF ADDING FIBROLYTIC ENZYMES TO PERIPARTURIENT AND EARLY LACTATION DAIRY COW DIETS ON PRODUCTION PARAMETERS

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Abstract

The aim of the study was to determine the degree to which complete diets (TMR) supplemented with fibrolytic enzymes given to periparturient dairy cows affect feed intake and conversion, milk yield and chemical composition, and metabolic and reproductive parameters. The experiment was conducted from 3 weeks before calving to 10 weeks of lactation using 18 Polish Red-and-White Holstein-Friesian cows assigned to two equal groups of 9 animals per group. Cows from the control group (C) received a diet without the enzyme preparation. The experimental group (E) received the identical diet supplemented (15 g/day) with Fibrozyme™ preparation containing a blend of active xylanase and cellulase. The preparation was added daily to the concentrate found in TMR, in which the basal wet roughage of maize silage and wilted grass silage was supplemented with brewers' grains, meadow hay, barley straw and ensiled maize grain. With a slightly higher (P>0.05) dry matter intake in cows from group E compared to group K, the former group also showed a tendency towards about 7–13.5% higher milk yield and slightly higher crude protein and casein content (by about 0.15 percentage units on average), with no clear effect on the other milk components. Compared to group K, cows from group E showed a tendency towards better feed and nutrient conversion per kg milk production, especially during the first three weeks postcalving. In cows from group E the blood metabolic profile tended to improve, with reduced β-hydroxybutyric acid levels, lower AspAT activity and improved reproductive parameters.

Key words: dairy cows, fibrolytic enzymes, milk yield and composition, blood metabolites, fertility indices

The periparturient period is a critical period in the nutrition of dairy cows where disturbed fermentation processes in the rumen and energy deficit occur (Stevenson, 2001). Feeding periparturient cows diets with large amounts of high starch concentrates with insufficient intake of roughages may lead to an excessive decline in the pH of ruminal fluid, the incidence of metabolic disorders, decreased reproductive function, and udder and claw diseases (Drackley, 1999). This is due to increased requirement of nutrients needed for fetal and placental development and postpartum milk synthesis, with reduced feed intake capacity (Ingvartsen and Andersen, 2000). A considerable role in reducing the negative energy balance of cows is played by ap-

petite stimulation, proper ration formulation (Strzetelski et al., 2008), and the use of feed supplements that stabilize rumen fermentation during early lactation, when large amounts of concentrates have to be fed (Nowak et al., 2003). An important role in this regard, especially in increasing the digestibility of structural carbohydrates and thus contributing to the provision of energy requirements in lactating dairy cows, and in regulating rumen digestion can be played by a new generation of feed additives, including exogenous fibrolytic enzymes (Beauchemin et al., 1999; Bowman et al., 2002; Nowak et al., 2003). In an age of growing ecological awareness, their use in animal nutrition does not raise so many doubts as the use of synthetic feed additives (Beuchemin et al., 1999).

In general, research on the use of fibrolytic enzymes in the feeding of high-yielding Holstein-Friesian (HF) cows with a daily milk yield of 45–55 kg in the first lactation period concluded that they usually have a favourable effect on feed conversion and production results (Sutton et al., 2003). It was decided to determine if the use of a similar enzyme composite (composed of cellulase and xylanase) in the feeding of Polish Red-and-White Holstein-Friesian (PRW-HF) cows with a lower milk production potential (30–35 kg milk/day) will deliver similar production results.

The aim of the study was to determine if feeding PRW-HF cows during the last three weeks before calving and in the initial lactation period (days 1 to 70) with TMR diets supplemented with enzyme preparation containing active xylanase and cellulose, will positively affect feed intake and conversion, as well as production, metabolic and reproductive parameters.

Material and methods

Experimental design, feeding and management of animals

A total of 18 Polish Red-and-White Holstein-Friesian cows were studied from 3 weeks before calving to 10 weeks of lactation. Animals were assigned to two equal groups of 9 animals per group according to body weight, lactation number, percentage of HF Red genes, milk yield for 305- and 100-day lactation, and expected calving date. The mean HF inheritance in the feeding groups was 87.5% (67.5–97.5%). The experimental animals were chosen from a herd of about 200 cows with a milk yield of 6000–7000 kg/cow for a standard (305-day) lactation. The control group (C) received a diet without the feed additive, and the experimental group (E) received the identical diet supplemented (15 g/day) with FibrozymeTM enzyme preparation containing a blend of active xylanase and cellulase. The enzyme preparation was added daily to the concentrate found in complete diet (TMR).

Depending on the experimental period (last three weeks before expected calving or 10 weeks after calving), cows received complete diets (TMR) differing in the percentage of roughage and concentrate (Table 1). Ration composition was determined according to IZ-INRA standards (2001) using INRAtion ver. 3.23 software (2006). The precalving diet was formulated to meet daily nutrient requirement and feed intake capacity of multiparous 9-month-pregnant cows weighing 650 kg (with adjustment for each 100 kg change in body weight), increased by additional requirement for fetal

and placental growth and the mammary gland. The post-calving diet (1–70 days of lactation) was formulated to meet maintenance and production requirements of a cow weighing 600 kg and yielding 30 kg milk/day with 3.9% fat and 3.2% protein. Cows were fed individually twice daily, and the amount of feed (TMR) intake and feed refusals were recorded. During the experiment, animals were kept in a herd of dry and fresh cows. Tie-up stalls were bedded with straw and equipped with automatic drinkers, milking installation and trough partitions to allow for individual feeding.

Table 1. Daily rations for cows

Feed	Experimental period			
	dry period (last 3 weeks before calving)		lactation (1 to 10 weeks)	
	Amount of feed (kg/day)			
	TMR I		TMR II	
	SM	proportion in TMR DM (%)	SM	proportion in TMR DM (%)
Maize silage	3.5	26.76	6.8	32.12
Ensiled maize grain	1.2	9.17	2.4	11.34
Wilted grass silage	1.8	13.76	3.5	16.53
Barley straw	2.1	16.05		
Meadow hay	0.5	3.82	0.3	1.42
Fresh brewers' grains	1.0	7.65	1.9	8.97
Concentrate*	2.98	22.78	6.27	29.62
Total	13.08	100.0	21.17	100.0

*Concentrate diet contained (%): ground wheat 27, ground barley 18, ground triticale 9, soybean meal 18, rapeseed meal 10, rapeseed expeller 10, ground limestone 4, mineral-vitamin premix 4.

Measurements, chemical analyses and statistical calculations

During the experiment, chemical composition and intake of feeds, cows' body weight and condition, milk yield and composition, blood components and reproductive parameters were determined.

Feed intake (TMR) was evaluated based on weighing (over 2–3 successive days) the amount of feed ration and feed refusals. This was done in the third and last week before calving and in the first, fifth and tenth week after calving. Basic chemical composition of the feeds was determined using the standard procedure (AOAC, 1995), and ADF and NDF fibre fractions in roughages according to Goering and Van Soest (1970). pH of silages was determined using an Elwro N 5170 potentiometer. Except lactic acid, volatile fatty acid (VFA) analyses in silages were performed with gas chromatography (Varian 3400, column CP-WAX 58, 25 m, 0.53 mm, 1.0 micron, FID detection, 260°C, range 11, helium as carrier gas, 6 ml/min, injector temperature 200°C), using an 8200 CX autosampler. Lactic acid was determined by high-performance liquid chromatography (HPLC) after centrifugation of water filtrates with 24% metaphosphoric acid using a Shimadzu chromatograph (column Nucleosil 250/4 – C 18, detector UV-Vis SPP-6 AV and autosampler SIL-10 AX). Analysis time for determination of VFA content was 17 min and sample injection volume was 1.0 µl.

Body weight and body condition score (BCS) on a 5-point scale were evaluated 7 days before expected parturition and at 7, 35 and 70 days of lactation. The trial period was preceded by the determination of cows' body weight, which was accounted for when formulating the diet for a 3-week precalving period. Animals were weighed at the same time in the morning, prior to feeding. Body condition was estimated independently by 2 or 3 evaluators in accordance with DEFA recommendations (2001). The mean of individual scores served as the ultimate score.

Cows were milked twice daily and the amount of milk drawn from every cow was determined daily using TRU-TEST milk meters. Representative samples of milk (means from two milkings) were collected every two weeks to determine its chemical composition. Milk samples were preserved with 2-bromo-2-nitro-1,3-propanediol (GROPOL), cooled and stored until analysis in a freezer (–20°) for about two weeks. The fat, crude protein, casein, lactose and urea content of milk was determined using a Milko-Scan FT 120 (Foss Electric).

Blood for analyses was collected from all animals 7 days before and 10 days after parturition. Tubes with full blood were stored at room temperature for 1 h, after which serum was extracted into 1.5 ml Eppendorf tubes and frozen. After thawing, serum was analysed for free fatty acids (FFA), β-hydroxy butyric acid (BHBA), glucose, urea, albumins and aspartate aminotransferase (AspAT). FFA and BHBA content was determined by the enzymatic-colorimetric method using a Cobas-Bio automatic analyser (ROCHE) at 37°C and a wavelength of 550 nm for FFA and 340 nm for BHBA. FFA were determined using standard reagents: WAKO Chemicals USA, WKT C test Kit and ACS-ACOD method, while BHBA was determined using RANDOX, RANBUT, Cobas MIRA and HANT-PROD Warsaw reagents. The level of glucose, urea, albumins and AspAT was determined by dry colorimetric technique using a KODAK analyser (VITROS 250 Chemistry).

Fertility indices of the cows were determined based on insemination index (services per conception), conception rate (pregnancy rate after first insemination) and calving-to-conception interval (days). The ease of parturition was scored on a 3-point scale: spontaneous (no assistance), intermediate (moderate assistance) and complicated (veterinary assistance).

Statistical calculations were performed by one-way analysis of variance (ANOVA) using SAS package (1999/2001), and significance of differences between the groups was determined using Fisher's test.

Results

The nutrient content of roughages and concentrates and their nutritive value (Table 2) corresponded to parameters characterizing feeds of average quality. In particular periods of the experiment, daily feed (TMR) and nutrient intake were similar ($P>0.05$) in both groups of cows (Table 3). However, cows from group E, especially during the first three weeks of lactation, showed a tendency towards slightly greater intake of dry matter (DM), energy (UFL) and protein (CP, PDIN and PDIE) compared to the control group (C).

Table 2. Chemical composition and nutritive value of the feeds

Feed	Dry matter (%)	Content in DM (%)							Content per kg feed DM		
		ash	crude protein	ether extract	crude fibre	N-free extractives	ADF	NDF	UFL	PDIN (g)	PDIE (g)
Maize silage	29.20	4.48	8.59	3.97	19.83	63.17	29.90	41.61	0.83	52	65
Wilted grass silage	37.50	11.00	12.15	3.92	29.36	43.57	38.24	53.12	0.72	73	61
Ensiled maize grain	58.10	1.26	8.20	4.61	2.38	83.55	2.54	8.46	1.22	56	67
Meadow hay	85.20	9.23	9.11	1.78	34.19	45.69	39.50	35.75	0.66	59	71
Barley straw	87.70	5.61	4.46	2.06	44.34	43.53	54.16	80.35	0.42	22	44
Brewers' grains	23.63	4.25	27.84	8.35	16.06	43.50			0.84	206	179
Wheat	86.54	1.80	12.75	1.51	2.62	81.32			1.14	73	98
Soybean meal	89.54	8.01	53.47	1.59	3.76	33.17			1.22	393	272
Rapeseed meal	88.63	6.78	35.32	10.41	12.99	34.50			0.93	245	154
Rapeseed cake	89.30	6.84	34.96	10.60	13.41	34.19			1.07	227	147
Barley	88.19	2.87	10.40	3.47	7.94	75.33			1.12	70	100
Triticale	85.96	1.98	10.10	1.58	2.56	83.78			1.15	66	94
Concentrate	88.24	10.3	16.42	1.34	3.13	66.16			1.09	156	131
TMR I ("dry")	52.64	7.47	14.29	3.64	19.81	53.39	25.20	44.50	0.67	74	75
TMR II ("lactation")	41.52	7.57	17.05	4.02	17.45	59.93	23.55	38.56	0.85	98	93

Table 3. Mean daily intake of feed and nutrients

Item	Groups		SEM	P
	K	E		
Before calving (21–1 days):				
TMR (kg)	32.6	33.7	2.84	0.25
Dry matter (kg)	13.6	14.1	1.19	0.25
Crude protein (g)	1943.4	2014.9	149.62	0.25
PDIN[1] (g)	1006.4	1043.4	99.77	0.25
PDIE[2] (g)	1020.0	1057.5	99.77	0.25
UFL[3]	9.11	9.45	0.91	0.25
After calving (days):				
1–21:				
TMR (kg)	50.7	52.6	2.65	0.15
DM (kg)	20.8	21.6	1.09	0.15
CP (g)	3546.4	3682.8	159.71	0.15
PDIN (g)	2038.4	2116.8	106.55	0.15
PDIE (g)	1934.4	2008.8	101.12	0.15
UFL	17.7	18.4	0.90	0.15
22–70:				
TMR (kg)	52.8	53.2	1.02	0.47
DM (kg)	21.7	22.0	0.56	0.20
CP (g)	3699.8	3751.0	81.90	0.20
PDIN (g)	2126.6	2156.0	54.64	0.20
PDIE (g)	2018.1	2046.0	51.86	0.20
UFL	18.4	18.7	0.46	0.20
1–70:				
TMR (kg)	51.7	52.9	2.20	0.19
DM (kg)	21.3	21.8	0.90	0.19
CP (g)	3631.6	3716.9	132.49	0.19
PDIN (g)	2087.4	2136.4	88.39	0.19
PDIE (g)	1980.9	2027.4	83.89	0.19
UFL	18.1	18.5	0.75	0.19

[1] Protein digested in the small intestine depending on the amount of nitrogen substrates degraded in the rumen.
[2] Protein digested in the small intestine depending on the amount of energy from feed.
[3] Feed unit for milk production (1 UFL – 1700 kcal net energy).

Body weight and body condition of the cows at 7 days before expected calving and on particular days (7, 35 and 70) of different experimental periods (1–21, 22–70 and 1–70 days of lactation) did not differ significantly (P>0.05) between the groups (Table 4). Compared to 7 days before expected calving, average body weight of the cows at 7, 30 and 70 days after calving was lower by 10%, 15.4% and 14% in the control group (C) and by 10.5%, 15.4% and 13.4% in group E, respectively. A similar tendency was also found for body condition score (BCS), which was 0.47, 0.49 and 0.46 points lower in group C and 0.47, 0.53 and 0.43 points lower in group E at 7, 30 and 70 days after calving, respectively.

Milk yield during the whole 10-week period of the experiment (1 to 70 days of lactation) averaged 2107 kg of milk (30.1 kg/day) containing 3.92% fat, 3.36% protein and 4.79% lactose (Table 4). Although no statistically significant (P>0.05) differences in milk productivity were found between the groups, cows from group E achieved higher daily milk yield (by an average of 13.7 and 7%, respectively) both in the first three weeks of lactation and in the whole 10-week lactation period compared to cows

from the control group (C). Cows from group E were characterized by higher mean daily milk yield in particular weeks of lactation, higher maximum milk production at peak lactation and better lactation persistency compared to animals from group C (Figure 1). The milk of cows from group E also contained more crude protein and casein (by about 0.15 percentage units) and significantly ($P<0.05$) less urea (172.1 mg/l in group E vs. 208.9 mg/l in group C). In different periods of the analysed lactation, no statistically significant ($P>0.05$) differences were found between the groups in complete diet (TMR) and nutrient intake per kg of milk produced (Table 4), although lower numerical values for the analysed parameters were observed for cows from group E.

Table 4. Cows' body weight and body condition, milk yield and chemical composition, and feed conversion per kg milk

Item	Groups		SEM	P
	K	E		
Body weight (kg):				
before calving (day 7)	691.2	687.2	35.60	0.70
after calving (days):				
7	623.3	615.2	76.76	0.30
30	585.0	581.2	26.28	0.56
70	594.2	595.3	29.13	0.94
Body condition score (BCS, pts):				
before calving (day 7)	3.46	3.48	0.15	0.75
after calving (days):				
7	2.99	3.01	0.16	0.54
30	2.97	2.99	0.15	0.56
70	3.00	3.05	0.13	0.64
Milk yield (kg):				
total from 1 to 70 days	2033.3	2181.2	240.7	0.21
daily by period (days):				
1–21	26.0	29.6	3.99	0.08
22–70	30.3	31.8	3.69	0.41
1–70	29.1	31.2	3.44	0.21
Content of components in milk (%):				
solids	12.07	12.63	1.20	0.61
fat	3.91	3.93	0.16	0.86
protein	3.28	3.44	0.20	0.13
casein	2.67	2.82	0.18	0.10
lactose	4.80	4.78	0.11	0.72
urea (mg/l)	208.9a	172.1b	34.17	0.04
Feed conversion per kg milk by period (days):				
1–21				
TMR (kg)	1.95	1.77	0.50	0.07
dry matter (kg)	0.80	0.73	0.21	0.07
crude protein (g)	136.4	124.4	30.11	0.07
PDI (g)	74.4	67.9	19.06	0.07
UFL	0.68	0.62	0.17	0.07
1–70				
TMR (kg)	1.78	1.70	0.20	0.32
dry matter (kg)	0.73	0.70	0.08	0.36
crude protein (g)	124.8	119.1	11.97	0.35
PDI (g)	68.1	65.0	7.58	0.35
UFL	0.62	0.59	0.07	0.31

a, b – $P<0.05$.

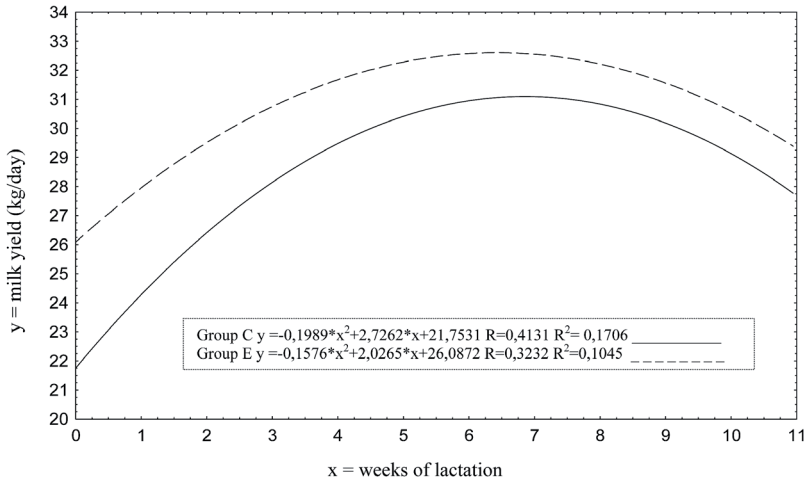

Figure 1. Changes in mean daily milk yield of cows per week of 70-day lactation (mean daily milk yields calculated according to the formula: y = a * x2 + b * x + c; a, b, c – coefficients)

Table 5. Biochemical components of blood and fertility indices of the cows

Item	Groups		SEM	P
	K	E		
Before calving (day 7):				
FFA (mml/l)	0.36	0.35	0.30	0.98
BHBA (mml/l)	0.61	0.49	0.13	0.25
Glucose (mml/l)	3.70	3.75	0.50	0.85
Urea (mml/l)	3.24b	3.78b	0.46	0.02
Albumins (g/l)	31.0	30.0	2.55	0.28
AspAT (U/l)	98.0a	69b	27.62	0.04
After calving (day 7):				
FFA (mml/l)	0.74	0.54	0.39	0.30
BHBA (mml/l)	1.37	0.88	0.95	0.29
Glucose (mml/l)	3.59	3.07	0.75	0.16
Urea (mml/l)	3.60	3.21	1.24	0.51
Albumins (g/l)	30.0	30.0	5.04	0.85
AspAT (U/l)	124.0	96.0	29.67	0.06
Insemination index	2.44	2.22	1.37	0.73
Conception rate (%)	22.2	44.4		
Calving-to-conception interval (days)	141.0	131.1	19.87	0.31
Course of calving[1] (no. of cows):				
S	7	7		
I	2	1		
C	0	1		

[1] According to a 3-point scale: S – spontaneous (no assistance); I – intermediate (moderate assistance); C – complicated (veterinary assistance).

a, b – $P<0.05$.

The values of some biochemical components of blood and fertility indices of cows are given in Table 5. In the blood serum collected 7 days before calving, there were no significant (P>0.05) differences between the groups in energy metabolism parameters (glucose, FFA and β-HB acid) and in albumin concentration. However, during this period cows from group E showed a slightly (P>0.05) lower level of BHBA (by 0.12 units), a higher urea level (by 0.54 units) and a significantly (P<0.05) lower level of aspartate aminotransferase (AspAT) compared to cows from the control group (C). Like before calving, 7 days after calving no significant differences were found between the groups in the level of serum components. However, lower numerical values were found for cows from group E for all blood components analysed (except albumin) compared to cows from the control group (C).

In the experimental herd, no significant (P>0.05) differences were observed in fertility indices. All of the cows in both groups conceived after an average of 2.4 (1-4) inseminations. However, cows from group E demonstrated a higher pregnancy rate after first insemination and needed a lower number of inseminations to conceive compared to the control group (C). Cows from group E were also characterized by about 10-day shorter calving-to-conception interval. Most parturitions were normal and only a very small number of animals needed veterinary assistance at calving.

Discussion

The intake of feed (TMR) during the last three weeks before calving indicates that adding the enzyme preparation did not significantly increase the dry matter and nutrient intake compared to the control group. Likewise, other authors (Yang et al., 1999) observed no significant effect of supplementing enzyme preparations during the precalving period on feed intake. This shows that feed intake during this period may be largely regulated by non-feeding factors, especially the animal's metabolism and hormones (Morrison et al., 2001). Like in other research (Bowman et al., 2002), we did not observe a significant effect of giving preparturient cows the enzyme preparation on feed and nutrient intake. Feed intake by early lactation cows tended to improve in a study by Lewis et al. (1999), who used a liquid form of enzyme supplement containing about 21% NDF in dry matter.

Maintaining the optimum condition and body weight of periparturient cows determines trouble-free transition from late pregnancy to early lactation (Mulligan et al., 2006). The body condition scores in the last week before calving (3.47 pts on average) were close to the upper limit of normal BCS values (3.0–3.5 pts) specified by Contreras et al. (2004) for high-yielding Holstein-Friesian cows entering the dry period. Body condition scores for dry cows, recommended by the above authors, should result mainly from the development of fetal membranes as well as fetal and udder growth, and not from the deposition of body fat reserves. Other authors (Domecg et al., 1997) suggest that precalving cows should have BCS scores of 3.2–3.75 pts, which should not decrease by more than 0.5 points in early lactation compared to the precalving period. Like in other studies (Yang et al., 1999; Kung et al., 1999; Vicini et al., 2003),

we did not observe a significant effect of using fibrolytic enzymes on the body weight of peroparturient and early lactation cows.

The level of feeding in different periods of the production cycle affects metabolic processes, and milk yield and chemical composition (Borkowska et al., 2006). The milk yield values obtained for cows receiving fibrolytic enzymes confirm, to a certain degree, the findings of other authors (Beauchemin et al., 1999; Sutton et al., 2003), who reported that their use in precalving and early lactation cows increases their milk productivity. The higher milk yield of cows from group E could result from the increased ruminal nutrient degradation and better total tract nutrient digestion (Bowman et al., 2002). Probably, this has also contributed to better and more efficient conversion of feed to production during the milk production period, without the need to mobilize the body's fat stores (Kung et al., 2000). The productivity of cows is also affected to a considerable extent by the amount of enzyme preparation used (Yang et al., 1999) and the enzyme ratio in the enzyme complex (Kung et al., 2000). These authors suggest that excessive amounts of the supplement in the diet may block the enzyme and substrate binding site and hinder rumen bacteria, or release antinutritional factors that reduce the microbiological digestibility of the feed. Some authors (Sutton et al., 2003) indicate that adding an aqueous solution of enzyme supplement to roughage directly before feeding produced better results than when used during ensiling or when given directly in the rumen in the form of an aqueous solution. The favourable production results of Holstein-Friesian cows given an aqueous solution of fibrolytic enzymes at 1.25 or 2.0 litres per ton of complete diet (TMR) was not confirmed by Vicini et al. (2003).

The increase in the milk yield of cows receiving diets with fibrolytic enzymes, observed in some studies (Sutton et al., 2003), can be attributed to their effect on ruminal metabolism and, to a smaller degree, to their effect on feed intake and conversion. The increase in the milk yield of cows from group E (by 13% in the first three weeks of lactation and by about 7% during the 10-week period after calving) could be due to the increased amount of nutrients needed for udder milk synthesis, derived from the increased degradation and better nutrient conversion in the rumen (Nowak et al., 2003).

Although the effect of fibrolytic enzyme supplement on percentage of milk components is not consistent, some authors (Beauchemin et al., 1999) observed a tendency for milk protein to increase without clear effects on the content of fat and other components. This is also supported by our study, which showed that the use of enzyme supplement in cow diets has a beneficial effect on increasing milk protein and casein, without changing the content of milk fat and other components in milk. This can be attributed to changes in the rumen fermentation processes under the influence of the enzymes, reflected in decreased milk and serum urea concentrations of the cows after calving. This is indicative of more efficient synthesis of microbiological protein, lower strain on the liver caused by ammonia detoxication, and lower energy loss (Nowak et al., 2003). The urea (172–209 mg/l) and protein (3.28–3.44%) content of milk obtained in the present trial are within the range recommended for these components (Borkowska et al., 2006). This also shows that the diet was properly formulated in terms of energy and protein.

Based on the results obtained, it cannot be determined if the enzyme preparation added to TMR diets for periparturient dairy cows improves nutrient utilization. The tendency towards better nutrient conversion per kg milk in cows from group E compared to the control (C) cows, shown especially during the first three weeks of lactation, was mainly due to the higher milk yield of the cows from group E (Yang et al., 1999; Bowman et al., 2002).

Three serum parameters are needed to assess the cow's energy condition: glucose, free fatty acids (FFA) and β-hydroxybutyric acid (β-HB). The serum glucose levels (within the physiologically normal range) observed in the cows before and after calving with close to optimum body condition may be evidence that the cows' energy requirement has been met and they have been properly prepared for lactation (Strzetelski et al., 2008). The lower serum levels of BHBA and AspAT, found in group E compared to group C 7 days after calving are evidence of the lower energy deficit of the cows receiving fibrolytic enzymes. Serum urea levels in pre- and postparturient cows shows that both the supply of ruminally degraded protein (Chládek, 2002) and the energy supply for bacteria that digest structural carbohydrates with the participation of fibrolytic enzymes were appropriate (Nowak et al., 2003). The serum albumin and AspAT levels, observed in the cows after calving, were also within the physiologically normal range, which shows normal liver function and appropriate supply of amino acids in the diet (Reader, 2003).

The results obtained for the course of parturition are similar to those reported in the literature for heifers from high-yielding dairy herds (Bilik et al., 2004). In our study, parturitions were mostly spontaneous or required moderate assistance, and the analysed fertility indices (insemination index, conception rate and calving-to-conception interval) were within the range considered normal for the cows of the breed studied. The lower conception rate in cows from the control group (C) could possibly be attributed to the higher urea-N content of milk from these cows, because Butler et al. (1996) demonstrated a negative relationship between milk urea level and cow fertility. It is also possible that several other environmental factors (related to oestrus detection, insemination technique and semen quality) could affect fertility indices of the cows (Stevenson, 2001). The decreased body condition of the cows, observed in our study from 7 to 70 days of lactation, fell within the normal range and probably had no effect on the number of inseminations needed to obtain pregnancy. Also our results concerning the calving-to-conception interval (131.1–141 days) are similar to the values obtained in the nucleus herds of cows of the breed studied.

In conclusion, the addition of exogenous fibrolytic enzymes (Fibrozyme™ containing active xylanase and cellulase) to the complete diets (TMR) of PRW-HF dairy cows increases milk productivity by about 7% during the periparturient and early lactation period and by as much as 13% during the first three weeks of lactation, and has a positive effect on feed conversion, especially in the first three weeks after calving. The lower serum levels of BHBA, FFA and glucose in postparturient cows receiving fibrolytic enzymes indicates the beneficial effect of this feed additive on the energy balance of early lactation cows. The use of the enzyme preparation in the periparturient and early lactation periods has no effect on changes in body weight and body

condition or fertility indices of the cows. The use of fibrolytic enzymes in practical feeding of dairy cows will be conditional on production costs, ease of use and efficiency of use under production conditions, which requires further research.

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Wpływ dodatku enzymów fibrolitycznych do dawek dla krów mlecznych w okresie okołoporodowym na wskaźniki produkcyjne

STRESZCZENIE

Celem badań było określenie, w jakim stopniu żywienie krów mlecznych w okresie okołoporodowym dawkami TMR z dodatkiem enzymów fibrolitycznych wpłynie na pobranie i wykorzystanie paszy, wydajność i skład chemiczny mleka oraz wskaźniki metaboliczne i rozrodcze. Doświadczenie przeprowadzono w okresie od 3. tygodnia przed wycieleniem do 10. tygodnia laktacji, na 18 krowach rasy PHF czb, przydzielonych do dwóch analogicznych grup (po 9 sztuk). Krowy z grupy kontrolnej (K) otrzymywały dawkę bez dodatku preparatu enzymatycznego. W grupie doświadczalnej (E) stosowano identyczną dawkę pokarmową z dodatkiem (15 g/dzień) preparatu Fibrozyme™, zawierającego kompozycję aktywnej ksylanazy i celulazy. Preparat dodawano codziennie do mieszanki treściwej wchodzącej w skład TMR, w którym podstawową paszę objętościową soczystą stanowiła kiszonka z kukurydzy i kiszonka z przewiędniętych traw, uzupełniane młótem browarnianym, sianem łąkowym, słomą jęczmienną oraz kiszonym ziarnem kukurydzy. Stwierdzono, że przy nieznacznie wyższym (P>0,05) niż w grupie K pobraniu suchej masy u krów z grupy E, w grupie tej odnotowano również tendencję do uzyskiwania wyższej (o około 7%–13,5%) wydajności mlecznej oraz nieco większej (średnio o około 0,15 jednostek procentowych) zawartości białka ogólnego i kazeiny, bez wyraźnego wpływu na pozostałe składniki mleka. W grupie E zanotowano również tendencję do lepszego w porównaniu z grupą K wykorzystania paszy i składników pokarmowych na produkcję 1 kg mleka, zwłaszcza w pierwszych trzech tygodniach po wycieleniu. U krów grupy E wykazano również tendencję do poprawy profilu metabolicznego krwi, zwłaszcza zmniejszenia poziomu kwasu β- HM i obniżenia aktywności AspAT oraz polepszenia wskaźników rozrodu.