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Effect of Glycerol and Propylene Glycol Supplementation on Metabolic Parameters and Production Performance in Periparturient Period of Dairy Cows

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Abstract: The aim of this study was to evaluate of two short-term methods of feeding with glycerin and propylene glycol that were fed to Holstein-Friesian cows directly per os or top dressing with TMR. The study included both lipid-carbohydrate transformations, selected enzymes activity and milk yield. To the experiment 50 multiparous cows were included. The cows were divided on 5 group\s: Group I (n = 10); control group that received standard TMR, Group II (n = 10); receiving 300 mL day^{-1} of glycerin per os, Group III (n = 10); receiving 300 mL day^{-1} of glycol, Group IV (n = 10); receiving 300 mL day^{-1} of glycerin top dressed with TMR dose and Group V (n = 10); receiving 300 mL day^{-1} of propylene glycol also top dressed with TMR. The preparation were feed from 1 week before parturition to 5th day postpartum. Blood samples were taken 1 week before parturition and 5 and 28 days postpartum. Biochemical analyses were executed with use of Pentra 400 analyzer of Horriba ABX. The condition of cows, milk yield and milk composition were also estimated. No significant effect of glucogenic compound kind on milk yield and composition was affirmed. Propylene glycol and glycerin caused the limitation of BHBA growth at 5th day after parturition. In the control group, this increase was significant ($p<0.01$). At the day of finish the feeding of preparation, the highest glucose concentration was affirmed in group that received glycerin (Group II and IV). In the control group the lipolysis was more intensified (1.35 mmol L^{-1}). Total bilirubin concentration in blood increased after parturition however, at groups that received the preparation per os and glycerin to TMR dose this growth was not as significant as at control cows ($p<0.01$) to 11.36 μmol L^{-1}. The similar tendencies were observed in AST and GGT activity.

Key words: Cows, transition period, propylene glycol, glycerin, blood metabolic profile, Poland

INTRODUCTION

In periparturient period and at the beginning of lactation, the sudden increase of demand on energy and nutrition compounds which are essential for foetus development, colostrum and milk production with simultaneous hormonal changes are observed (Bell, 1995; Goff, 2009). Decrease of Dry Matter (DM) taking at cows carry out 31% in term from 21-1 days ante partum (Hayirli *et al.*, 2003). Energy deficiency and/or decreased feed intake during the periparturient period result in increased lipolysis of deposited fat and release of Non-esterified Fatty Acids (NEFA) in the blood (Goff, 2009; Grummer, 2008). An excessive increase of NEFA concentration leads to the accumulation of Triacylglycerols (TAG) in liver and significant increase of ketonic compounds production (Studer *et al.*, 1993; Rukkwasmsuk *et al.*, 2005; Goff, 2009).

Propylene Glycol (PG) is a glucogenic precursor that is rapidly absorbed from the rumen for gluconeogenesis in the liver that has been used for many years for both treatment and prevention of ketosis in cow. Propylene glycol caused increase of glucose level and lowering of β-hydroxybutyrate Acid (BHBA) and NEFA concentration in blood of cows (Grummer *et al.*, 1994; Christensen *et al.*, 1997; Butler *et al.*, 2006; Rizos *et al.*, 2008). The antilipolityc effect of PG is particularly emphasized (Grummer, 2008).

PG affects metabolism of the cows by 2 modes of action increased supply of L-lactate and propionate to gluconeogenesis and insulin resistance of peripheral tissues that induced by increased concentrations of PG and propanol as well as a decreased ratio of ketogenic to glucogenic metabolites in arterial blood plasma (Kristensen and Raun, 2007). The growth of interest of glycerin use in animal feeding result from development of

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biodiesel production. Goff and Horst (2001) reported that the oral administration of glycerol was effective procedure in prevention of ketosis during periparturient period. The positive effect on energy status of cows was also affirmed by Chung *et al.* (2007). Glycerol that fed during 1st 2 weeks after parturition (per os) caused the lowering of glucagon, NEFA and BHBA with simultaneously glycolysis (Osman *et al.*, 2008).

Others research that glycerin was fed to TMR (DeFrain *et al.*, 2004; Bodarski *et al.*, 2005) or to the drink water (Osborne *et al.*, 2009), also show on a lack of antiketogenic effect of its. Rumen microbes adapt to glycerol feeding as the rates of glycerol disappearance from rumen fluid are more rapid after 7 days of glycerol feeding to donor animals used as a source of rumen-fluid (Kijora *et al.*, 1998). The increase of propionate content together with the lowering of acetate to propionate ratio in rumen content was observed when the increasing glycerin doses were given per os to steers (Wanga *et al.*, 2009). The significant increase ($p<0.01$) of propionate in rumen was affirmed that the glycerin was used on mineral support (zeolite). However, there were no glucogenic effect (Farkasova *et al.*, 2008). The different forms of glycol and glycerin (powder, liquid) that were used in early presented research can have an effect on an effectiveness of both compounds action. The aim of this study was to evaluate of two short-term methods of feeding with glycerin and propylene glycol that was fed to Polish Holstein-Friesian cows directly per os or top dressing with TMR. The study included both lipid-carbohydrate transformations, selected enzymes activity and milk yield.

MATERIALS AND METHODS

The experiment was executed in dairy cows farm that included 360 cows of Polish Holstein-Friesian breed with an average annual milk yield was 8650 kg. In periparturient period the animals were kept in the same environmental conditions. Nutrition doses were done regarding to DLG standards. Feeding was based on TMR (Total Mixed Ration) doses calculated according to DLG system. Two feeding doses were used; prepartum period (2-3 weeks a.p.) and lactating cows (Table 1). There were no interference in used dose composition in these research. Used glucogenic precursors (propylene glycol and glycerin) were the differentiating factors in an individual experimental groups.

To the experiment, 50 multiparous cows were included that were 1 week before expected labour term. Animals were clinically health, 4-7 years old. They were divided into 5 group by analog method, regarding lactation order:

Table 1: Ingredient and chemical composition of the prepartum and postpartum diets

Items (kg day^{-1})	Prepartum	Postpartum
Corn silage	16.00	24.00
Partially wilted lucerne silage	6.00	12.00
Pressesd pulp silage	6.00	-
Fresh spent grain	3.00	6.00
Breeder mash	3.00	5.00
Extracted soybean meal	1.20	2.00
Corn grain silage	1.50	3.00
Protected fat	-	0.25
Wheat straw	1.00	1.00
Dry cow premix[1]	0.12	-
Lactation premix[1]	-	0.15
Forage chalk	-	0.05
Acid sodium carbonate	-	0.15
Nutritive value		
Dry matter (kg day^{-1})	12.70	22.80
NEL (MJ day^{-1})	97.80	161.90
nBO (g day^{-1})	2235.00	4016.00
Calcium (g day^{-1})	60.62	200.40
Phosphorus (g day^{-1})	23.51	109.90
Sodium (g day^{-1})	7.06	28.97
Magnesium (g day^{-1})	19.29	63.67

[1]Commercial premixes containing trace minerals and vitamins-M32 ADE Premium (prepartum) and Blattin Bio-mix (lactation), Blattin Polska

Group I (n = 10); control group that received standard TMR dose, Group II (n = 10); receiving 300 mL day^{-1} of glycerin per os, Group III (n = 10); receiving 300 mL day^{-1} of glycol, Group IV (n = 10); receiving 300 mL day^{-1} of glycerin top dressed with TMR dose and Group V (n = 10) receiving 300 mL day^{-1} of propylene glycol also top dressed with TMR. The animals received propylene glycol (99.9% content of 1, 2-propandiol, Blattin Poland) and glycerin (99,7% content of 1, 2, 3-propantriol, Over Poland), once daily in liquid from during the morning feeding. After TMR feeding the preparations (Group IV and V) were precisely top dressed. The preparations were fed 1 week before expected labour term (4.8-3.7 days) and continued to 5th day after it.

Blood samples were taken from *V. jungularis* externa at the morning hours before TMR feeding at the day that the experiment was begun (1 week a.p.) at the day that the experiment was finished (5 days p.p.) as well as in 4th week of lactation. In aim of serum obtainment the blood samples were centrifuged during 15 min •3000 g^{-1} next the samples were frozen (-20°C). The laboratory analyses were done with use of Pentra 400 biochemical analyser (Horiba ABX Diagnosis, France). In the blood serum the follow factors were marked:

- β-hydroxybutyrate Acid (BHBA), Nonesterified Fatty Acids (NEFA) by enzymatic method with use of Randox reagents, Ireland (RANBUT, Cat. No. RB1007 and NEFA Cat. No. FA 115)
- Glucose by Oxydase Method with use of HORIBA ABX reagents (Glucosa PAP, Cat. No. A11A016979)

- Triacylglycerols (TAG), total cholesterol by Enzymatic Methods , HORRIBA ABX reagents (TAG, Cat No. A11A01640 and Cholesterol, Cat. No. A11A01634)
- Asparginian aminotransferase (AST), Alanine aminotransferase (ALT) and β-glutamylotransferase (GGT) enzymes activity by Kinetic Method (HORRIBA ABX reagents, AST Cat. No. A11A01629, ALT Cat. No. AA1A01627, GGT Cat. No. A11A01630)
- Total bilirubin concentration by Colorimetric Method, HORIBA ABX (Total bilirubin Cat. No. A11A01639)
- Total protein and albumin by Colometric Method, HORIBA ABX (Total protein, Cat. No. A11A01639 and albumin Cat. No. A11A01664)

Condition of cows was estimated by BCS Method (1-5-point scale in 0.25 point interval) 1 week before parturition and in 1 and 4 weeks of lactation. From 7-100 days of lactation the weekly milk yield was recorded. The data about milk chemical composition (fat, protein, lactose) of was carried on results of the monthly milk yield, control. Basic statistical parameters of results (mean, standard deviation) in individual groups were carried out using Microsoft Excel XP software. The significance of differences between the experimental factors was determined by Duncan's test using Statgraphics Ver. 5.0 software.

RESULTS AND DISCUSSION

There were no statistic differences in milk yield and lactose content between groups during the 1st 100 days of lactation (Table 2). Fat content in milk of cows that received glycerin top dressed with TMR (Group IV) was significantly higher ($p<0.05$) in comparison to Group III (PG per os). In milk of Group III, the lowest content of protein (3.10%) was noted, however in control group, it was higher ($p<0.05$). No statistic effect of powder glycerin on milk yield and composition was showed by Chung *et al.* (2007). In these research, the higher milk yield (52 vs. 46 kg day^{-1}) and the lower fat content (4.0 vs. 4.37%) were noted in groups that glycerin was fed. Bodarski *et al.* (2005) feeding with glycerin (300 or 500 kg day^{-1}) from 3 weeks a.p. to 70 days p.p., affirmed in 1st 10 weeks of lactation the significant growth ($p<0.01$) of milk yield and total protein ($p<0.05$). It suggested potential benefit of dry glycerin he subsequent milk production. However, DeFrain *et al.* (2004) reported tendencies for lower milk fat yield and MUN when glycerol was fed. Osborne *et al.* (2009) supplemented in drinking water 20 g L^{-1} of glycerin reported no difference in milk yield and components. Similarly, the short-tem feeding wit PG in periparturient period did not influence on milk yield and composition (Studer *et al.*, 1993; Pickett *et al.*, 2003; Chung *et al.*, 2009). Supplementation PG in transition period contributed to improvement of colostrum composition as well as to higher milk yield (Kupczynski *et al.*, 2005).

Table 2: Milk yield and composition in 1st 100 days of lactation (mean±standard deviation)

Groups	Milk yield (kg day^{-1})	Fat (%)	Protein (%)	Lactose (%)
I	35.04±7.140	3.79±0.62	3.23±0.17*	4.86±0.14
II	33.39±6.020	3.76±0.60	3.24±0.29	5.02±0.15
III	35.56±6.800	3.64±0.59*	3.10±0.19*	4.76±0.16
IV	35.19±8.110	3.94±0.45*	3.28±0.23	4.95±0.34
V	32.33±10.92	3.73±0.54	3.12±0.17	4.70±0.17

I: Control, II: Glycerin per os, III: Propylene glycol per os, IV: Glycerin top dressed with TMR, V: Propylene glycol top dressed with TMR. Preparations were fed from 7 days antepartum to 7 days postpartum; *Significant differences between groups at $p<0.05$

Before parturition the condition of cows was noted as a high (Table 3). To the 4th week after parturition, decrease of cows' condition was affirmed at all the groups ($p<0.01$). About 1 week after parturition, the decrease of condition was significant ($p<0.01$) in group I and II. In 4 weeks of lactation, the highest condition was showed in groups receiving top dressed to TMR dose (Group IV and V). The affirmed decrease of condition at the beginning of lactation can be recognized as physiologic ones in this milk yield level. Feeding with glycerin added to TMR (DeFrain *et al.*, 2004; Chung *et al.*, 2007) or to drinking water (Osborne *et al.*, 2009), no influence on condition of cows was showed.

Propylene glycol feeding per os also did not have an influence on cows' condition (Studer *et al.*, 1993; Miyoshi *et al.*, 2001). In present research, PG fed in both form as well as glycerin fed top dressed with TMR caused pace decrease of condition's loss after parturition. Mean values for serum lipid-carbohydrate parameters are shown in Table 4. At the finish day of preparation's feeding, the lowering of glucose concentration at all the groups was affirmed ($p<0.01$). The highest concentration of this parameter was noted in groups that the glycerin was fed (Group II and IV) however, the lowest ones was affirmed in control group and in group receiving top dressed PG (Table 4).

Table 3: Estimation of cows condition by BCS Method (points), mean±standard deviation

	Estimation term		
Groups	1 week a.p.	1 week p.p.	4 weeks p.p.
I	3.75±0.12[aA]	3.40±0.19[a]	3.24±0.38[A]
II	3.73±0.16[aA]	3.42±0.24[a]	3.21±0.29[A]
III	3.68±0.18[A]	3.34±0.23*	3.38±0.27[A]
IV	3.78±0.18[A]	3.54±0.20	3.36±0.23[A]
V	3.77±0.14[A]	3.62±0.13*	3.45±0.20[A]

I: Control, II: Glycerin per os, III: Propylene glycol per os, IV: Glycerin top dressed with TMR, V: Propylene glycol top dressed with TMR. Preparations were fed from 7 days antepartum to 7 days postpartum; [a]Significant differences between estimate terms at $p<0.05$; [A]Significant differences between estimate terms at $p<0.01$; *Significant differences between groups at $p<0.05$

Table 4: Metabolites concentration in serum of dairy cows (mean±standard deviation)

			Postpartum	
Items	Groups	Prepartum	5 days	28 days
Glucose (mmol L^{-1})	I	3.47±0.16^{*AB}	2.49±0.35$^{(*)**A}$	2.57±0.35^{B}
	II	3.65±0.34^{AB}	2.94±0.43$^{(*)**A}$	2.45±0.40^{B}
	III	3.20±0.83^{*AB}	2.69±0.45^{A}	2.61±0.36^{B}
	IV	3.60±0.52^{A}	2.74±0.54^{aA}	2.95±0.45^{a}
	V	3.02±0.32^{*A}	2.49±1.12^{**A}	2.52±0.58
BHBA (mmol L^{-1})	I	0.35±0.15^{A}	1.15±0.27^{AB}	0.57±0.20^{B}
	II	0.27±0.19	0.81±0.41	0.63±0.31
	III	0.29±0.11	0.65±0.40	0.41±0.29
	IV	0.35±0.16	0.73±0.35	0.50±0.29
	V	0.41±0.19	0.70±0.31	0.67±0.31
NEFA (mmol L^{-1})	I	0.35±0.26^{A}	1.35±0.59^{*A}	0.68±0.23
	II	0.34±0.12^{A}	1.16±0.66^{*A}	0.81±0.24
	III	0.39±0.15^{A}	0.97±0.32^{aA}	0.62±0.34^{a}
	IV	0.37±0.19^{a}	0.81±0.28^{*a}	0.72±0.28
	V	0.30±0.12^{AB}	0.99±0.41^{A}	1.14±0.38^{B}
TAG (mmol L^{-1})	I	0.19±0.04	0.10±0.09	0.09±0.02
	II	0.16±0.04	0.14±0.13	0.13±0.04
	III	0.23±0.24	0.17±0.09	0.13±0.08
	IV	0.20±0.06^{A}	0.08±0.05^{A}	0.12±0.06
	V	0.19±0.06	0.15±0.13	0.11±0.01
Cholesterol (mmol L^{-1})	I	3.01±0.50^{aA}	1.95±0.51^{AB}	4.34±0.85^{aB}
	II	2.92±0.48	2.48±0.84^{*a}	3.56±0.84^{a}
	III	2.77±1.20	2.52±0.71^{*A}	4.08±1.01^{A}
	IV	3.13±0.34^{aA}	1.53±0.24^{*AB}	3.95±0.69^{aB}
	V	3.07±0.58^{AB}	1.68±0.48^{AC}	3.70±0.72^{BC}

I: Control, II: Glycerin per os, III: Propylene glycol per os, IV: Glycerin top dressed with TMR, V: Propylene glycol top dressed with TMR. Preparations were fed from 7 days antepartum to 7 days postpartum ^{a}Significant differences between estimate terms at $p<0.05$, $^{A-C}$Significant differences between estimate terms at $p<0.01$; *Significant differences between groups at $p<0.05$

In 4th week of lactation, presented hesitant of glucose content did not have a relationship with earlier feeding with the preparations. The increase of BHBA ($p<0.01$) content in blood of control cows at 5 days after parturition was affirmed. Concentration of BHBA in blood serum on level of 1200 µmol L^{-1} (Enjalbert *et al*., 2001) or 1400 µmol L^{-1} (Duffield *et al*., 2003) is consider as a limiting value between healthy cows and cows with subclinical ketosis. At all the animals that received the preparations these vales did not exceed. It is possible to suppose that the all forms of glucogenic precursors feeding limited the BHBA production.

Beginning lactation had a significant influence ($p<0.01$) on lipolise intensification what was marked by the increase of NEFA at 5 days p.p. The highest increase of NEFA concentration was noted in control group (1.35 mmol L^{-1}) and in group receiving glycerin per os (1.16 mmol L^{-1}), respectively. There was no intensified lipolise in 4 weeks of lactation except Group V. In Group IV at 5 days after parturition content of TAG tended to be lower significantly ($p<0.01$). Total cholesterol level in blood serum of control cows significantly decreased ($p<0.01$) and next in 4 weeks of lactation increased ($p<0.01$). The similar changes were visible in Group IV and V. Feeding with both preparations per os limited degreases cholesterol in 5 days after parturition (Table 4). The glucogenic effect of glycerol was affirmed in research of Goff and Horst (2001) and Osborne *et al*. (2009). Use of glycerin in powder forms in transition period resulted in an improvement of energy the status underlined higher concentration of plasma glucose, lower concentrations of plasma BHBA and lower concentrations of urine ketones (Chung *et al*., 2007). Glycerol administration (1 week postpartum) also decreased plasma glucagon and NEFA on days 1, 7 and 13 and plasma BHBA on day 1 postpartum relative the saline group (Osman *et al*., 2008). It was affirmed in these research that the more profitable effect on metabolism had an associative use of glucagon injection (s.c.) and glycerol. Farkasova *et al*. (2008) showed on moderate antilipolitic and glucoplastic effect of glycerol (300 g of Ketoglyc powder day^{-1}). DeFrain *et al*. (2004) and Bodarski *et al*. (2005) did not affirm the significant influence of feeding with glycerin on metabolic transitions at the beginning of lactation.

Propylene glycol caused the increase of glucose level in blood as well as the lowering of BHBA and NEFA concentration (Grummer *et al*., 1994; Hoedemaker *et al*., 2004; Rizos *et al*., 2008). Grummer *et al*. (1994) indicated that plasma concentration of glucose and insulin peaked within 75 and 30 min after glycol drenching, respectively. On similar dynamic of changes in talked over parameters shows also other research (Chung *et al*., 2009; Rizos *et al*., 2008). Feeding with PG per os before parturition or in periparturient period clearly decreased TAG accumulation in liver of cows on the beginning of lactation (Studer *et al*., 1993; Rizos *et al*., 2008). PG used during restrictive nutrition of heifers was more effective that fed per os than as a part of concentrate or added to TMR (Christensen *et al*., 1997). It is likely that rapid delivery of PG to the rumen gives a greater plasma concentration of PG because of the competition intraruminal metabolism and absorption. Feeding with PG as a dry product reduced plasma BHBA concentration but top dressing PG was more efficient at reducing plasma BHBA level than incorporating PG into TMR (Chung *et al*., 2009).

Decrease of TAG concentration in blood can testify about its increase in liver with simultaneous low secretion of VLDL lipoproteins (Bremmer *et al*., 2000). PG did not have influence on TAG concentration in blood with tendency of the lowering of its content on the beginning of lactation (Mikula *et al*., 2008). In own research, the content of TAG lowered at 5 days p.p. in group receiving glycerin to the TMR. Low content of total cholesterol in blood serum was affirmed in 1 week p.p. The level of cholesterol is lowered in cows with ketosis

Table 5: Enzymes activity and total bilirubin content in blood serum (mean±standard deviation)

			Postpartum	
Items	Groups	Prepartum	5 days	28 days
AST ($U\ L^{-1}$)	I	63.99 ± 7.480^{ab}	75.82 ± 22.76^{a}	95.24 ± 10.09^{b}
	II	52.00 ± 15.27^{ab}	80.34 ± 20.12^{a}	78.94 ± 9.690^{b}
	III	79.54 ± 48.09^{a}	87.78 ± 17.07^{a}	79.21 ± 18.70
	IV	63.36 ± 10.17^{A}	80.77 ± 80.22^{A}	73.44 ± 24.15
	V	61.09 ± 6.660^{a}	67.61 ± 12.88	69.79 ± 8.150^{a}
0LT ($U\ L^{-1}$)	I	17.27 ± 4.280	17.10 ± 6.440	15.38 ± 4.550
	II	14.96 ± 7.820	15.26 ± 4.890	16.98 ± 8.660
	III	21.48 ± 4.100^{a}	18.54 ± 5.220	14.99 ± 5.560^{a}
	IV	16.82 ± 1.940	20.88 ± 13.03	15.81 ± 5.640
	V	19.80 ± 6.580	18.43 ± 4.760	16.59 ± 3.060
GGT ($U\ L^{-1}$)	I	25.85 ± 6.720^{a}	28.54 ± 8.910	38.22 ± 13.42^{a}
	II	29.75 ± 14.97	27.85 ± 8.690	26.01 ± 6.750
	III	28.03 ± 6.810	28.24 ± 7.190	24.31 ± 9.440
	IV	26.60 ± 8.070	$23.20\pm8.420^{*a}$	$39.89\pm23.040^{*a}$
	V	25.68 ± 3.040	30.52 ± 9.900*	24.44 ± 9.640*
Bilirubin ($\mu mol\ L^{-1}$)	I	4.48 ± 2.340^{A}	6.10 ± 1.310^{a}	11.36 ± 6.630^{Aa}
	II	5.06 ± 4.850^{a}	5.90 ± 2.730	8.50 ± 4.940^{a}
	III	3.96 ± 2.480	4.31 ± 2.170^{a}	7.63 ± 3.310^{a}
	IV	3.92 ± 1.480^{a}	4.72 ± 4.210	9.59 ± 2.920^{a}
	V	4.33 ± 3.110^{A}	5.99 ± 2.180	10.75 ± 4.130^{A}

I: Control, II: Glycerin per os, III: Propylene glycol per os, IV: Glycerin top dressed with TMR, V: Propylene glycol top dressed with TMR. Preparations were fed from 7 days antepartum to 7 days postpartum; [a, b]Significant differences between estimate terms at $p<0.05$; [A]Significant differences between estimate terms at $p<0.01$; *Significant differences between groups at $p<0.05$

(Djokovic *et al*., 2007). The similar low cholesterol and triglycerides concentration was showed in cows with fatty liver disease. In own research, feeding with preparations per os limited the decrease of cholesterol level at 5 days postpartum.

The increase of AST activity p.p. in group receiving the preparations per os was affirmed (Table 5). The significant increase ($p<0.01$) was noted in IV group at 5 days after parturition. The highest ALT activity was affirmed at control cows in 28 days p.p. However, the reference values did not exceed (Meyer and Harvey, 1998). Despite some hesitates during research period, there was not a relationship of AST activity with fed preparations. At the day of research end, the increase tendency of GGT activity was noted at control group as well as at cow that were fed with PG top dress with TMR. The reference values of 20-48 $U\ L^{-1}$ did not exceed (Meyer and Harwey, 1998). In blood serum of control cows the bilirubin concentration increase ($p<0.01$) at 28 days p.p. to 11.36 $\mu mol\ L^{-1}$. There was no significant increase of bilirubin concentration at all experimental groups at 5 days p.p. The bilirubin concentration as 8.61-6.31 $\mu mol\ L^{-1}$ in 2 and 4 weeks p.p., respectively was affirmed when developing fatty liver was observed (Lubojacka *et al*., 2005).

In own research, the high bilirubin concentration in 28 days p.p. can prove about liver dysfunction (Group I and V). Use of PG in form of powder in periparturient period caused the lowering of AST activity in blood (Mikula *et al*., 2008). The positive effect on AST and GGT activity level was noted during long-term feeding with PG to cows.

In other research, the supplementation of PG fed together with concentrate did not have an influence on AST and GLDH activity (Hoedemaker *et al*., 2004). In research of Chung *et al*. (2007) and Osborne *et al*. (2009), no enzymes activity were marked.

CONCLUSION

It can be said after results that there was no significant effect of kind of glucoplastic compound as well as method of its feeding to cows onto milk yield and compound.

PG fed in both form as well as glycerin add top dress with TMR reduced the pace of cows' condition loss after parturition. Propylene glycol and glycerin caused the limitation of BHBA at 5 days p.p. without regard on kind of feeding, however at control group growth of its was significant ($p<0.01$). At the day of the end of feeding preparations, the highest glucose concentration was affirmed in blood of cows that received the glycerin (Group II and IV). In control group, lipolysis was the most intensified (1.35 $mmol\ L^{-1}$).

Glycerin that fed per os caused the intensified lipolysis in the smallest level, what confirm the faster loss of condition (1.16 $mmol\ L^{-1}$). Total bilirubin concentration in blood raised after parturition, however at groups that the preparations were fed per os as well as the glycerin top dress with TMR this growth was not as clear ($p<0.01$) as at control ones (11.36 $\mu mol\ L^{-1}$). The similar tendency was observed in AST and GGT activity. The study conducted point that more profitable effect on productivity and metabolic changes was observed in the case of propylene glycol application per os while with an addition of preparation to TMR glycerol was more benificial.

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