Electronic Journal of Polish Agricultural Universities is the very first Polish scientific journal published exclusively on the Internet, founded on January 1, 1998 by the following agricultural universities and higher schools of agriculture: University of Technology and Agriculture of Bydgoszcz, Agricultural University of Cracow, Agricultural University of Lublin, Agricultural University of Poznan, Higher School of Agriculture and Teacher Training Siedlce, Agricultural University of Szczecin, and Agricultural University of Wroclaw.

ELECTRONIC JOURNAL OF POLISH AGRICULTURAL UNIVERSITIES

2001
Volume 4
Issue 2
Series ANIMAL HUSBANDRY

KUPCZYŃSKI R., CHUDOBA-DROZDOWSKA B. 2001. DEVELOPMENT OF SELECTED BLOOD BIOCHEMICAL PARAMETERS IN COWS DURING TRANSITION PERIOD AFTER APPLICATION OF COL PRESS SUPPLEMENT **Electronic Journal of Polish Agricultural Universities**, Animal Husbandry, Volume 4, Issue 2.
Available Online http://www.ejpau.media.pl

DEVELOPMENT OF SELECTED BLOOD BIOCHEMICAL PARAMETERS IN COWS DURING TRANSITION PERIOD AFTER APPLICATION OF COL PRESS SUPPLEMENT

Robert Kupczyński, Bożena Chudoba–Drozdowska
Department of Animal Hygiene and Livestock Environment, Agricultural University of Wrocław, Poland

ABSTRACT

The studies were carried out on 20 dairy cows assigned to two groups depending on their blood serum content of ketonic compounds. The cows of group I, which had subclinical ketosis, were administered Col press supplement to feed ration, whereas the cows of group II were the control group. Col press was applied from

seven days before expected parturition through four weeks postpartum. In the blood serum of all the animals, the following were determined: level of ketonic compounds, glucose, total protein and its fractions, activity of enzymes (AST, ALT, ALP and GTP) and concentration of macroelements (Ca, P inorganic, Mg, Na, K and Cl). ABB parameters were analysed in whole blood. The blood tests were done four weeks before expected parturition, and one week and four weeks after parturition. Application of Col press for cows, as a ketosis preventive measure, resulted in only temporary decrease in blood serum ketonic compounds concentration, however the supplement positively influenced the formation of ABB parameters, which consisted in quick compensation of metabolic acidosis. Col press also contributed to an increase in blood serum magnesium concentration and to an increased milk yield of the cows, by 136.8 kg of milk and 273 kg FCM, compared to the control group.

Key words: cows, ketosis, acid–base balance, biochemical parameters of blood, feed supplements

INTRODUCTION

Ketosis belongs to the most significant and the most common metabolism disorders in cows [2, 9, 13, 45]. Clinical form of this disease is quite seldom, while in a range of cases it proceeds in its subclinical form, resulting in considerable economical loss [2, 13, 24]. Many studies have indicated that dairy cow ketosis is observed in various countries with incidence from a few percent to as much as about 40% [1, 2, 13, 15, 24]. A serious problem in herds of high–yielding cows has been imposed by spontaneous ketosis, which occurs in cow's peak lactation. In Poland, Filar [13] studied cows in the region of Lublin and found subclinical or clinical ketosis in 32.1 and 42.8% of cows in the 3rd and 4th week of lactation. The lowest incidence level of subclinical ketosis, i.e. 16.6%, was observed by Zieliński [49]. Rajala–Schultz *et al*. [36], who studied a large number of cows, observed that milk yield of the cows affected by subclinical ketosis decreased by 3.0 to 5.3 kg per day, and their lactation yield was lower by 353.4 kg of milk, compared to healthy animals.

Energy deficiency of feed ration, which occurs during the final stage of gestation and in the beginning of lactation, especially in high–yielding cows, results from reduced feed intake. This imposes a serious threat of spontaneous ketosis, also the syndrome of fatty liver in the peak lactation, i.e. in 3–5 weeks postpartum [2, 13, 14, 17, 29]. Alimentary ketosis is etiologically different, being caused by insufficiently nutritive or mono–diet feeding, or by ketogenic feeds [13, 23].

Besides carbohydrate and lipid metabolism disorders, which lead to ketosis, also the disorders of acid–base balance occur with considerable frequency in herds of cows [8, 15, 26]. For example, Markusfeld [32], who studied a large number of cows, recorded acidosis in an average of 29.1% of cows.

Metabolic disorders occurring in cows negatively influence their reproductive functions, yield and composition of milk and the healthiness of their offspring [8, 15, 20, 22, 34].

Over the last years, many authors have suggested application of various supplements that would prevent or lower the risk of spontaneous ketosis. These are glucoplastic and antiketogenic compounds, which also increase the level of dry matter intake of feeds, e.g. propylene glycol, sodium propionate or niacin [7, 11, 12, 45, 47]. These compounds are included in a range of preparations, which are recommended for administration from 3–1 weeks of preparturient period until a few weeks after calving. The compounds also stimulate milk yield and improve the fertility indices. In order to prevent acid–base balance disorders in the form of acidosis, application of various buffers is recommended, which aim at pH balancing of the animal's rumen [3, 4, 19, 41, 42, 46]. The compounds that have been applied

include sodium bicarbonate, potassium bicarbonate, calcium bicarbonate, sodium chloride, potassium chloride as well as magnesium compounds. Good results in this respect have also been achieved by administration of natural feed supplements, e.g. dolomite [48], bentonite [10] and brown coal [26]. However, prior determination of metabolic profile indices of the cow's organism is an important element of the usefulness assessment of the supplement or premix.

The aim of the study was to determine the effect of Col press preparation on the following indices: level of selected parameters of carbohydrate and protein metabolisms, level of acid–base balance (ABB) and electrolyte parameters, activity of selected blood enzymes and milk yield of cows.

MATERIALS AND METHODS

The studies were carried out on 20 clinically healthy BW x HF dairy cows housed in confinement system in the same space. The cows were 4–8 years of age and of similar body weight. The feeding was based on whole year's monodiet in TMR feeding system. Feed rations were formulated according to actual nutritive value of the feeds, basing on their chemical composition and conversions, in accordance with ruminant feeding system INRA'88 [21]. Diet composition on the days of both commencement and completion of the studies is presented in Table 1.

One month before parturition, all the cows included in the experiment were clinically examined and their body condition scoring (BCS) was evaluated. The cows were classified at 3.75 points on average. Blood was collected on the commencement of the experiment, in the morning, (series I), in which the following were determined:

- Blood serum biochemical parameters: total protein (TP) with burette method; protein fractions with agarose gel electrophoresis in CORMAY DIAGNOSTICS chamber using DS.–2 (CORMAY) densitometer for fraction reading; glucose with enzymatic method using Analco kit, ketonic compounds concentration (acetone and aceto–acetic acid) through reaction with sodium nitroprusside[18].
- Acid–base balance (ABB) parameters were determined in arterial blood. The blood, collected from the middle coccygean artery (*arteria coccygea mediana*), was cooled to about 4–6°C. Within 2–4 hours after the blood collection, ABB was determined with Astrup's method, using a CORNING–464 instrument. The following parameters were determined: pH, oxygen pressure (pO_2), carbon dioxide pressure (pCO_2), hydrocarbons concentration (HCO_3^-), base excess (BE), total carbon dioxide content (CO_2T), percent haemoglobin oxygen saturation (sO_2), non–respiratory to respiratory component ratio (HCO_3^-/ pCO_2).
- Blood serum enzymes activity: asparagine aminotransferase (AST) and alanine aminotransferase (ALT), using kinetic method with NADH and Tris buffer; alkaline phosphatase (ALP) using kinetic method with p–nitrophenylphosphate and diethylamine (DEA) buffer; γ–glutamyltranspeptidase (GTP) using kinetic method with γ–glutamyl–p–nitroanilide and glycylglycine. Activity of all the enzymes was evaluated at 37°C using bioMerieux kit.
- Blood serum macroelements concentration: Ca, P inorganic and Mg by means of calorimetric method on UV–VIS spectrophotometer (bioMerieux), with use of ALPHA Diagnostics kit; Na, K and Cl with ion–selective electrodes (ISE) by means of an EasyEyte instrument.

Table 1. Composition of feed rations for cows and their nutritive value

Ration composition	Dry cows (9th month of pregnancy) – beginning of the experiment [kg]		First lactation stage (35 litres of milk) – end of the experiment [kg]	
Maize silage			30	
Rye silage	28			
Sunflower silage	13			
Lucerne silage (3 aftermath)			10	
Brewer's grains			5.5	
Fodder yeast			6	
Concentrate mash (R257)			6	
Dry sugar beet pulp			1	
Mineral supplement (Lax 2)			0.1	
Mineral supplement (Spokowit)	0.1			
Col press	0.8		0.8	
	Ration content*	Dietary needs	Ration content*	Dietary needs
Energy – JPM	7.2	7.6	22.4	20.4
BTJN [g]	521	600	2343	2075
BTJE [g]	473	600	2219	2075
JWK	14.6	15.5 (ZPP)	15.7	17.9 (ZPP)
Ca [g]	56.1	61	213	166
P [g]	39.2	35	120.1	86

*** Without Col press contents in feed ration**

Basing on the results of the laboratory analyses, the cows were assigned to two groups, according to the concentration of ketonic compounds in their blood serum. Group I consisted of the cows that had the ketonic compounds concentration higher than 861 µmol·dm^3, which indicated subclinical ketosis, while group II consisted of the cows of lower ketonic compounds concentration than the applied criterion, thus being free of ketosis. The cows of the group I were fed with addition of 800 g per day per head of Col press (registration no. PR pp–4121–c–283/97). General composition of the supplement is presented in Table 2. Group II was the control group. Col pres was administered according to the manufacturer's recommendation, i.e. from 7 days before expected parturition until 4 weeks after calving. In order to assess the effect of the applied supplement on the organisms, all the blood analyses were repeated in the following periods:

- in about 7 days during the postparturient period (series II of analyses),
- four weeks after parturition – completion of Col press administration (series III).

Table 2. The content of components of Col press (per 1 kg)

Components					
Raw protein	6.8%	Manganese	520 mg	Vitamin B_2	30 mg
Raw fat	1.4%	Copper	200 mg	Vitamin B_6	25 mg
Raw fibre	7.0%	Cobalt	3 mg	Vitamin B_{12}	250 mcg
Ash	37.0%	Iodine	16 mg	Nicotinic acid	2150 mg
Calcium	2.8%	Selenium	6.5	Pantothenic acid	70 mg
Phosphorus	1.0%	Vitamin A	100 000 units	Folic acid	3 mg
Magnesium	3.5%	Vitamin D_3	10 000 units	Propylene glycol*	
Sodium	2.5%	Vitamin E	500 mg	Sodium carbonate*	
Zinc	1500 mg	Vitamin B_1	20 mg	Sodium formate*	

*** Quantity not stated by the manufacturer**

Additionally, performance indices were analysed, i.e. milk yield (converted to 305–day lactation and FCM yield), lactation milk fat and protein content (in kg and %) after application of the supplement. These data were taken from the performance evaluation of the cows carried out in the Regional Animal Breeding Station (OSHZ) in Wroclaw.

The results of the laboratory test and performance evaluation were statistically analysed for means, standard deviations and significance of differences between groups and series of analyses (Duncan test) using Statgraphics ver. 5.0 software.

RESULTS AND DISCUSSION

On the commencement of the studies, increased concentration of blood serum ketonic compounds (1491.25 µmol·dm^{-3} on average) was observed in 10 cows, which indicated subclinical ketosis (group I). The remaining cows, whose mean blood serum ketonic compounds level was 709.46 µmol·dm^{-3}, were considered healthy (group II). The administration of Col press resulted in temporary decrease in blood serum ketonic compounds during postparturient period by 185.97 µmol·dm^{-3}, however the level increased again to 1656.56 µmol·dm^{-3} on the day of the completion of the studies, exceeding the initial value by 165.31 µmol·dm^{-3}. In the group II of cows (control), a steady, statistically highly significant ($p \leq 0.05$) increase in ketonic compounds was observed, which reached 1742.66 µmol·dm^{-3} and was by 1033.20 µmol·dm^{-3} higher than the initial value (Table 3).

Table 3. Mean values of biochemical parameters in blood serum of cows

Group		Glucose [mmol·dm^{-3}]	Ketonic compounds [μmol·dm^{-3}]	Total protein [g·dm^{-3}]	Albumins [g·dm^{-3}]	Globulins [g·dm^{-3}]		
						α	β	γ
Series I								
I	x̄	**2.38**	**1491.25^{A}**	**74.6^{a}**	**35.2**	**8.5^{AB}**	**5.6**	**25.3**
	SD	0.22	271.08	5.87	2.58	1.27	1.00	5.13
II	x̄	**2.50**	**709.46^{AB}**	**72.0^{b}**	**34.1**	**9.4^{CD}**	**5.4**	**23.1^{a}**
	SD	0.35	155.04	6.59	3.19	0.92	0.77	3.40
Series II								
I	x̄	**2.47**	**1305.28**	**83.0^{ac}**	**36.0**	**11.9^{A}**	**5.9**	**29.3**
	SD	0.31	573.93	4.74	4.78	0.55	0.85	5.71
II	x̄	**2.49**	**1045.25^{BC}**	**75.3^{c}**	**32.5**	**11.7^{C}**	**5.4**	**25.7**
	SD	0.33	533.24	6.29	2.68	1.04	0.83	4.70
Series III								
I	x̄	**2.37**	**1656.56**	**78.1**	**35.2**	**10.9^{B}**	**5.4**	**26.7**
	SD	0.32	587.94	7.32	4.17	1.26	1.06	5.37
II	x̄	**2.28**	**1742.66^{C}**	**79.2^{b}**	**32.6**	**10.9^{D}**	**6.0**	**29.8^{a}**
	SD	0.19	722.73	7.55	4.53	0.81	0.47	10.65

$^{a, b}$ – differences significant at p≤0.05.
$^{A, B, C, D}$ – differences significant at p≤0.01.

Filar *et al.* [12], who applied Boviketozin for cows with subclinical or clinical form of ketosis, obtained a decrease in blood concentration of ketonic compounds and free fatty acids as well as complete disappearance of ketonic compounds from urine. Also Tyler *et al.* [47], who administered propylene glycol, dextrose and insulin to clinical ketosis affected cows, observed a decrease in urine ketonic compounds. The efficacy of propylene glycol in ketosis prevention has been confirmed by Studer *et al.* [45], Gerloff [14] and other authors [7]. Similar efficacy in ketosis treatment was achieved with application of niacin, administered independently [11] or in combination with propylene glycol [38]. Such effect was not achieved in this study as a result of Col press application, despite the fact that it contains both propylene glycol and niacin. Optimum feed rations during so–called transition period and appropriate feeding system management reduce the necessity of application of the mentioned supplements [2, 38].

Blood serum glucose level of both groups on the analyses commencement ranged between 2.38 mmol·dm^{-3} for group I, i.e. the cows with subclinical ketosis, and 2.50 mmol·dm^{-3} for group II, i.e. the control animals, and fell within the limits of standard values [33]. Dufva *et al.* [11] and Skrzypek *et al.* [43, 44] point to decreased glucose level in blood serum of the cows with ketosis symptoms. Also Filar *et al.* [12], who examined such cows, observed very low levels of glucose, especially in the case of clinical ketosis. During the second series of the studies, a slight increase in blood serum glucose was observed in the cows that received Col press (Table 3). This effect may be associated with the administration of Col press. Increased blood serum glucose concentrations during application of propylene glycol were observed by

Studer *et al.* [45] and Filar *et al.* [12]. In our studies, systematic decrease in glucose level was observed in control group, to 2.28 mmol·dm^{-3} on the day of completion of the study.

Total protein level in blood serum was rather stable in both groups on the commencement of analyses, and ranged between 72 g·dm^{-3} in group II and 74.5 g·dm^{-3} in group I. On the 7th day after parturition, statistically highly significant ($p \leq 0.01$) increase in total protein content was observed in group I, to 83.0 g·dm^{-3}, while in group II it increased to 75.3 g·dm^{-3}. During the last series of analyses, further increase in blood serum total protein was observed in the cows of group II ($p \leq 0.05$), whereas in group I, its decrease was observed and the values for both groups became nearly the same (Table 3). Similar changes to those in total protein content were throughout the experiment observed in the levels of blood serum γ–globulins of both groups, which increased gradually in group II, while in group I, after temporary increase, decreased again. Such changes were not observed in the remaining protein fractions, whose changes were similar in both groups of cows throughout the experiment (Table 3).

Blood serum total protein content is one of the indices of nitrogen metabolism [25]. Excessive supply of protein in feed ration results in liver overload and energy use associated with the processes of ammonia deactivation [29]. The increase in blood serum protein level in our studies was distinct only in the second series of analyses in the cows of group I, however a slight increasing trend was visible throughout the experiment in both groups of cows. The condition of mild hyperproteinaemia in the first month of lactation belongs to regular adaptation reactions, resulting from its nearing to the peak [23, 26]. There is little data in the available literature on the evaluation of the levels of total protein and its fractions in the course of cow ketosis. However, there are reports [35], in which no influence of subclinical ketosis on total protein content was observed. Jonkisz [23] points to the possibilities of application of protein in energetic metabolism, as the majority of amino acids may be used in the process of gluoneogenesis. The author also observed a decrease in albumin level in alimentary ketosis. In our studies this was not confirmed.

Considering the values of acid–base balance parameters, it was observed that on the day of analyses commencement the parameters slightly changed towards balanced metabolic acidosis, which was demonstrated with low carbon dioxide pressure (pCO_2, 4.24 kPa) along with low concentration of hydrocarbons (HCO_3^- 20.1 mmol·dm^{-3}) and with deficiency in buffer bases (BE – 2.4 mmol·dm^{-3}). Col press in cow feeds resulted in statistically highly significant ($p \leq 0.01$) increase of those parameters, which led to acid–base balance as soon as after two weeks from its application (second series). The balance remained until the completion of the studies. In the cows of group II (control), relatively standard level of gasometric blood parameter persisted throughout the period of the analyses (Table 4).

Table 4. Mean values of acid–base balance parameters in blood of cows

Group		pH	pO_2	pCO_2	HCO_3^- act.	BE	sO_2 [%]	CO_2 T [mmol·dm^{-3}]	$\frac{HCO_3^- \text{ act.}}{pCO_2}$
			[kPa]		[mmol·dm^{-3}]				
Series I									
I	$\bar{x}$	**7.383^{AB}**	**10.47**	**4.24^{ABC}**	**20.1^{ABC}**	**–2.4^{ABa}**	**90.3^{a}**	**22.3^{ABC}**	**20.98**
	SD	0.031	2.33	0.91	5.20	5.55	3.36	5.40	2.49
II	$\bar{x}$	**7.441^{A}**	**12.64**	**5.33^{A}**	**26.3^{A}**	**2.3^{a}**	**89.9**	**27.4^{A}**	**21.92**
	SD	0.021	3.60	0.75	2.87	2.75	8.93	3.02	1.12

Series II									
I	$\bar{x}$	**7.442^{B}**	**10.13^{a}**	**5.63^{B}**	**27.9^{B}**	**4.0^{A}**	**83.8^{ab}**	**29.1^{B}**	**22.21**
	SD	0.067	4.22	0.83	3.83	4.39	19.60	3.89	3.29
II	$\bar{x}$	**7.442**	**13.65^{a}**	**5.37**	**26.8**	**2.8**	**95.3^{b}**	**28.0**	**22.00**
	SD	0.036	1.65	0.49	3.74	4.20	6.35	3.84	1.85
Series III									
I	$\bar{x}$	**7.410**	**11.27**	**5.89^{Ca}**	**28.1^{Ca}**	**3.2^{B}**	**91.7**	**28.6^{C}**	**21.17**
	SD	0.026	2.74	0.31	2.40	2.43	14.46	2.18	1.79
II	$\bar{x}$	**7.441**	**13.92**	**4.98^{a}**	**24.2^{a}**	**0.2**	**96.7**	**25.2**	**21.86**
	SD	0.039	5.26	1.04	4.03	3.58	2.63	4.01	2.07

$^{a, b}$ – differences significant at p≤0.05.
$^{A, B, C}$ – differences significant at p≤0.01.

Adult cattle organism is characterised by a condition of mild alkalosis, which depends on the kind of feed and individual traits [20, 26, 28]. In reference literature [16], information can be found that deal with the differences between the gasometric parameters of arterial and venal blood. In our studies arterial blood was used. Positive influence of Col press on ABB may have been a result of sodium carbonate, which is a component of the preparation. In numerous studies [4, 37, 42, 46] it was demonstrated that administration of acid sodium bicarbonate to feed might effectively eliminate the symptoms of acidosis. Similar, buffering effect was achieved using $NaHCO_3$ and MgO together [3, 19]. Natural supplements, e.g. dolomite [48], bentonite [10], brown coal and Humobentofet supplement, the latter containing among others brown coal [26], also have positive effect on ABB in dairy cows.

Activity of the cow blood serum enzymes, i.e. AST, ALT, ALP and GTP, as analysed on the commencement of the studies, fell within the limits considered as proper for adult cattle [33].

During the first series of the analyses, the activity of AST changed between 62.8 U/L in group II of the cows and 67.0 U/L in group I, and remained on this similar level throughout the study period (Table 5). The ALT activity in group I decreased during the second series of the analyses from the initial value of 21.8 U/L to 17.8 U/L, to rise again to 23.4 U/L. In group II of the cows, both the pattern of the changes and ALT activity were similar (Table 5). The activity of aminotransferases (AST and ALT) is commonly determined within metabolic profiles of cows [28, 31, 34, 39, 40]. Similar levels to those obtained in this study were reported by other authors [26, 31]. Lechowski [28] stated that high activity of indicatory enzymes in cows with metabolic ketosis suggest liver damage characteristic to degeneration and/or necrosis. Nicpoń and Jonkisz [34] represent the same opinion, and they observed distinctly increased level of tramsaminases both for acidosis and alkalosis. Most of researchers [5, 28, 40] have related the activity of these enzymes to the physiological state of the animal. Increased activity of indicatory enzymes, especially AST, was observed in cows after parturition [5, 27] as well as during the initial period of lactation [31, 39].

Table 5. Mean activity of enzymes in blood serum of cows

Group		AST	ALT	ALP	GTP
		[U/L]			
Series I					
I	$\bar{x}$	**67.0**	**21.8**	**107.0^{a}**	**17.4**
	SD	16.51	7.74	18.93	3.21
II	$\bar{x}$	**62.8**	**20.7**	**75.5^{a}**	**21.4^{a}**
	SD	14.98	10.25	23.35	4.73
Series II					
I	$\bar{x}$	**67.7**	**17.8**	**111.3^{Ab}**	**22.3**
	SD	22.48	3.38	38.74	4.20
II	$\bar{x}$	**63.2**	**19.5**	**67.2^{A}**	**22.7^{b}**
	SD	13.90	9.00	33.07	4.71
Series III					
I	$\bar{x}$	**67.4**	**23.4**	**85.1^{b}**	**24.6**
	SD	8.58	6.42	16.63	5.70
II	$\bar{x}$	**62.0**	**21.3**	**66.1**	**29.8^{ab}**
	SD	16.48	5.79	23.80	14.66

$^{a, b}$ – differences significant at p≤0.05.
^{A} – differences significant at p≤0.01.

Initial ALP activity in cow blood serum was rather high, ranging between 75.5 U/L in group II and 107.0 U/L in the cows of group I, where it exceeded the reference values [33]. This group of cows was diagnosed to have subclinical acidosis. Throughout the study period, blood serum ALP activity considerably decreased in both groups, especially in group I, i.e. by 21.9 U/L, whereas by only 9.4 U/L in group II (Table 5). Reports can be found in reference literature on increased ALP activity in acidosis–affected cows [28, 34], which was also confirmed in this study (group I). The decrease in the activity of this enzyme in this particular group of cows may have resulted from stabilising effect of feed–supplemented Col press on liver metabolism.

Other trends were observed in GTP activity in the blood serum of both groups of cows, which increased during the study period from 17.4 U/L to 24.6 U/L in group I, and from 21.4 U/L to 29.8 U/L in group II (Table 5). Blood serum GTP activity in cows is highly liver–specific, its changes are observable in the course of lipid metabolism disturbances and they reflect the progress of fatty liver [5, 13, 29]. Filar [13] stated that with the GTP activity increase beyond 30 U/L, a damage of liver structures occurs. It has also been demonstrated [5] that increased activity of the enzyme in the high–yielding dairy cows appears both after parturition and in the peak lactation. Our studies confirmed those observations, and an analysis of GTP in group I may allow a statement that Col press supplement reduced the increase of the activity as compared to the control group.

Average calcium and inorganic phosphorus concentration in blood serum of both groups displayed similar changes, reaching the minimum on the 7th day after parturition. Average blood serum level of calcium was slightly lower in group I (2.02 mmol·dm^{-3}) during this period than in group II (2.09 mmol·dm^{-3}). What draws attention is low inorganic phosphorus observed in both groups during the 1st and the 2nd series of the study (Table 6). Despite the decreased level of calcium and inorganic phosphorus, no postparturient paresis was observed in any of the studied cows, which proceeds with distinct hypocalcaemia and hypophosphataemia. Tyler *et al.* [47] report that low level of blood serum calcium is observed in cows with ketosis. It was not confirmed in our studies, probably due to the fact that the observed ketosis was in its subclinical form.

Table 6. Mean content of macroelements in blood serum of cows

Group		Ca	P inorg.	Mg	Na	K	Cl
		[mmol·dm^{-3}]					
Series I							
I	$\bar{x}$	**2.44^{a}**	**1.53^{ab}**	**0.85^{a}**	**141.0^{Aab}**	**4.05^{a}**	**99.3^{a}**
	SD	0.47	0.33	0.21	2.58	0.27	16.13
II	$\bar{x}$	**2.34**	**1.47^{c}**	**0.86**	**137.9^{a}**	**4.04**	**100.3**
	SD	0.40	0.37	0.21	1.87	0.19	2.70
Series II							
I	$\bar{x}$	**2.02^{a}**	**1.17^{Aa}**	**0.96**	**137.8^{b}**	**3.75^{ab}**	**91.4^{Aa}**
	SD	0.17	0.17	0.22	2.45	0.42	3.99
II	$\bar{x}$	**2.09**	**1.09^{Bc}**	**0.93**	**137.1**	**3.91**	**105.4^{Ab}**
	SD	0.26	0.21	0.08	2.37	0.26	7.36
Series III							
I	$\bar{x}$	**2.27**	**1.89^{Ab}**	**1.03^{a}**	**136.3^{A}**	**4.02^{b}**	**92.3**
	SD	0.26	0.46	0.13	1.87	0.13	4.22
II	$\bar{x}$	**2.39**	**1.76^{B}**	**0.92**	**137.3**	**3.95**	**95.7^{b}**
	SD	0.54	0.31	0.16	4.47	0.26	5.93

$^{a, b}$ – differences significant at p≤0.05.
$^{A, B}$ – differences significant at p≤0.01.

Initial magnesium concentration in blood serum on the day of the study commencement was very similar in both groups. Over the period of the experiment, its level increased to 1.03 mmol·dm^{-3} in the cows receiving Col press, which may have been an effect of the element being included in the composition of the supplement (Table 6). Reports can be found that mineral and mineral–vitamin mixtures as well as mineral buffer supplements improve the supply of macroelements [30, 37].

Initial blood serum level of sodium was slightly higher (141.0 mmol·dm^{-3}) in group I in comparison with the cows of group II (137.9 mmol·dm^{-3}), whereas the concentrations of potassium and chlorine were similar in both groups (Table 6.). As the experiment proceeded, statistically highly significant (p≤0.01) decrease in blood serum sodium level of group I was

observed with parallel decrease in chlorine level ($p \leq 0.05$). Also blood serum chlorine concentration in group II decreased, while sodium concentration remained at the same level as in the series I. Blood serum concentration of potassium decreased on the 7th day after parturition in both groups, when its increase was observed again, especially in group I ($p \leq 0.05$). The levels of the electrolytes, despite the observed changes, fell within the reference limits [33], however it is difficult to associate them with the Col press application. In reference literature [47], there is a report about an increase in sodium and chlorine content in the blood serum of ketosis–affected cows. Our studies confirmed those observations only in the 1st series of analyses, for the blood serum level of sodium in the cows with subclinical form of ketosis.

Average milk yield for lactation after Col press application was higher in the experimental group (group I), compared with the control group (Figs. 1, 2 and 3). This advantage was especially applicable for quantitative milk yield (by 136.8 kg), FCM yield (by 273 kg) and fat yield (by 14.6 kg), although these differences were statistically insignificant.

Fig. 1. Mean milk yield after application of Col press converted to 305-day lactation and 4% fat content (FCM)

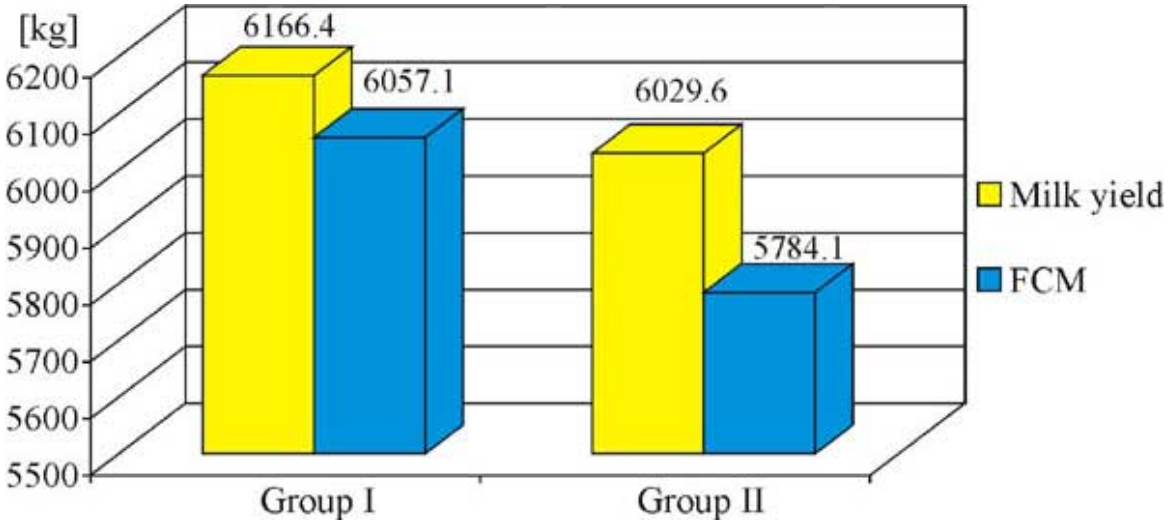


Fig. 2. Mean fat and protein yield after application of Col press

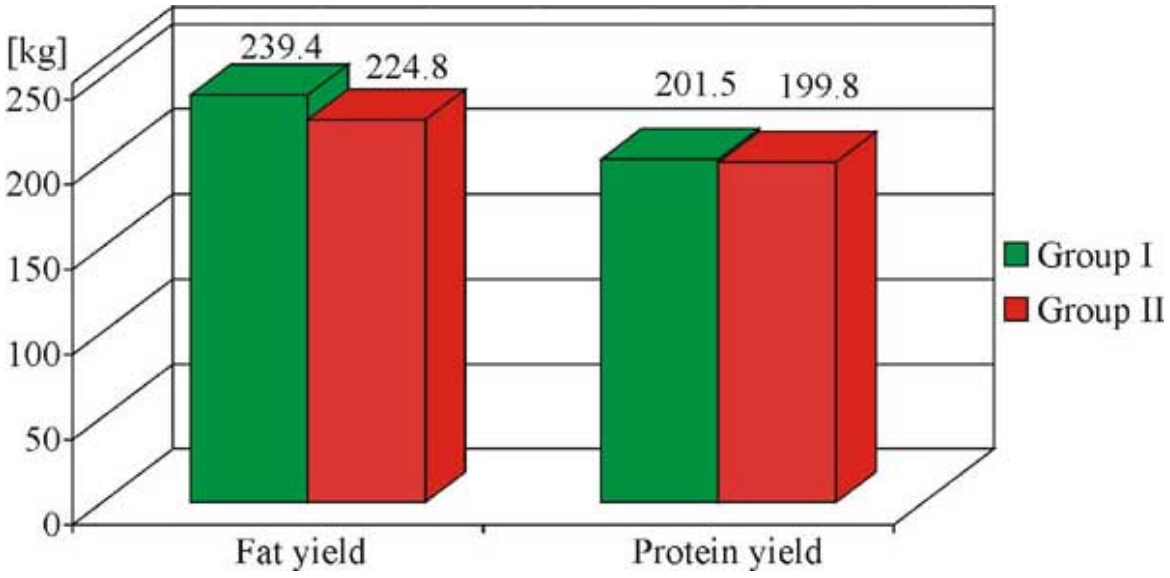
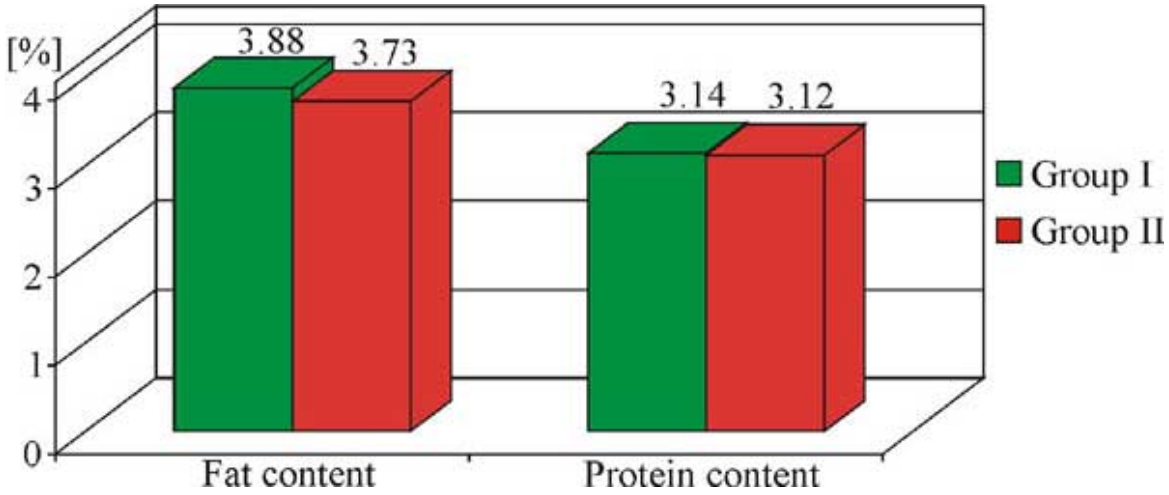


Fig. 3. Mean fat and protein content after application of Col press



There has been a range of investigations [19, 26, 37] that point to the positive effect of buffer supplements on milk yield. The results of this study confirm those observations, which should be explained with positive effect of Col press on ABB parameters, as well as with the additional supply of energy and proteins to the high–yielding cows. The effect may also be due to the supplementation with macro– and microelements and vitamins in right proportions (Table 2). Some authors however [6, 42] did not observe such effects after application of mineral mixtures or buffer supplements.

CONCLUSIONS

1. Application of Col press preparation as a supplement to feed ration of cows caused only temporary decrease in ketonic compounds concentration in blood serum, however the supplement positively influenced the formation of ABB parameters, which consisted in both quick compensation of subclinical metabolic acidosis and stabilisation of acid–base balance on its constant level.
2. Activity of AST, ALT, ALP and GTP were within the scope of reference values, except for ALP in the cows that on the day of the study commencement were diagnosed to have ketosis or ABB disorders towards acidosis.
3. The supplement applied to cow feed ration did not influence the concentration of blood serum mineral elements, except for an increase in magnesium concentration.
4. An increase in lactation milk yield by 136.8 kg of milk and 273 kg FCM was observed for the cows receiving Col press supplement in comparison with the control group of cows.

REFERENCES

1. Al–Rawashdeh O. F. 1999. Prevalence of ketonemia and associations with herd size, lactation stage, parity, and postparturient diseases in Jordanian dairy cattle. Prev. Vet. Med. 31: 117–125.
2. Andersson L., 1988. Subclinical ketosis in dairy cows. Vet. Clin. North. Am. Food. Anim. Pract. 4: 233–251.
3. Bigner D.R., Goff J.P., Faust M.A., Tyler H.D., Horst R.L., 1997. Comparison of oral sodium compounds for the correction of acidosis. J. Dairy Sci. 80: 2162–2166.
4. Boerner B.J., Byers F.M F.M., Schelling G.T., Coppock C.E., Greene L.W., 1987. Trona and sodium bicarbonate in beef cattle diets: effects on pH and volatile fatty and acid concentrations. J. Anim. Sci. 65: 309–316.

5. Bronicki M., Dembinski Z., 1994. Studies on the activity of selected hepatic enzymes in dairy cows in conjunction with lipid metabolism markers. Med. Wet. 50: 268–271 [in Polish].
6. Brzoska F., Wiewiora W., Michalec J., Brzoska B., 1996. The impact of magnesium oxide and dolomite on cows milk yield, milk composition and electrolytes concentration in milk blood serum. Rocz. Nauk. Zoot. 23 (3): 71–84 [in Polish].
7. Christensen J.O., Grummer R.R, Rasmussen F.E., Bertics S.J., 1997. Effect of method of delivery of propylene glycol on plasma metabolites of feed–restricted cattle. J. Dairy Sci. 80: 563–568.
8. Correa M.T., Erb H.N., Scarlett J.M., 1993. Path analysis for seven postpartum disorders of Holstein cows. J. Dairy Sci. 76: 1305–1312.
9. Dale A., Moore, Ishler V., 1997. Managing dairy cows during the transition period: Focus on ketosis. Vet. Med. 92: 1061–1072.
10. Dembinski Z., Kosicki B., Mroz–Dembinska S., Szczesniak L., Wieckowski W., 1985. Effect of domestic production bentonite on acid–base balance in dairy cattle during periparturient period. Med. Wet. 41: 311–314 [in Polish].
11. Dufva G.S, Bartley E.E., Dayton A.D., Riddell D.O., 1983. Effect of niacin supplementation on milk production and ketosis of dairy cattle. J. Dairy Sci. 66: 2329–2336.
12. Filar J., Czerwinska E., Marczuk J., 2000. Clinical evaluation of Boviketozin preparation effectiveness in the treatment of subclinical and clinical ketosis in cows. Med. Wet. 56: 657–659 [in Polish].
13. Filar J., 1999. Disorders of hydrocarbon–lipid metabolism in ruminants. Wydaw. Akad. Rol. Lubl. [in Polish].
14. Gerloff B.J., 2000. Dry cow management for the prevention of ketosis and fatty liver in dairy cows. Vet. Clin. North. Am. Food. Anim. Pract. 16: 283–292.
15. Grohn Y.T., Eicker S.W., Ducrocq V., Hertl J.A., 1998. Effect of diseases on the culling of Holstein dairy cows in New York State. J. Dairy Sci. 81: 966–978.
16. Hejlasz Z., Nicpon J., 1977. Blood buffer systems in experimental acidosis in cows and attempts of its prevention. Pol. Arch. Wet. 20: 103–117 [in Polish].
17. Herdt T.H., 2000. Ruminant adaptation to negative energy balance. Influences on the etiology of ketosis and fatty liver. Vet. Clin. North. Am. Equine. Pract. 16: 215–230.
18. Homolka J., 1971. Clinical Biochemistry. PZWL Warszawa [in Polish].
19. Janeczek W., Chudoba–Drozdowska B., Rojkowski A., Szulc T., 1991. Development of selected blood indices levels in cows fed with various feed supplements before parturition. Zesz. Nauk. Akad. Rol. Wroc. 206 Zootech. 35: 17–31 [in Polish].
20. Janeczek W., Pogoda–Sewerniak K., Chudoba–Drozdowska B., 1996. Evaluation of relationship between levels of selected biochemical blood parameters in cows and their offspring. Zesz. Nauk. Akad. Rol. Wroc. 297, Zootech. 41: 69–78 [in Polish].
21. Jarrige J., 1993. Ruminant Feeding. Omnitech Press. PAN Jabłonna [in Polish].
22. Jonkisz P., Nicpon J., Twardon J., Monkiewicz J., 1995. Influence of ketosis in pregnant cows on health condition and ketonic bodies level in blood of calves. Med. Wet. 51: 600–601 [in Polish].
23. Jonkisz P., 1999. Influence of ketosis in pregnant cows on selected blood parameters in their neonates. Doctoral dissertation. Akad. Rol. Wroc. (unpublished) [in Polish].
24. Jordan E.R., Fourdraine R.H., 1993. Characterization of the management practices of the top milk producing herds in the country. J. Dairy Sci. 76: 3247–3256.
25. Kuleta Z., Depta A., Bronicki M., Polakowska G., Pomianowski A., 1990. Studies on metabolic disorders in production cows in selected farms in Zulawy. Part 1. Haematological and protein metabolism indices. Acta Acad. Agric. Olst. Vet. 19: 213–223 [in Polish].
26. Kupczyński R., 2000. Application of brown coal and Humobentofet as correcting agents of metabolic disease in cows. Doctoral dissertation. Akad. Rol. Wroc. (unpublished) [in Polish].
27. Kwiatkowski T., Pres J., Marcinkowski K., Sekula B., 1993. Effect of energetic supplementation of cows in perinatal period on their health condition and productivity. Med. Wet. 43: 611–616 [in Polish].
28. Lechowski R., 1993. Influence of subclinical acidosis in pregnant cows on liver condition of newborn calves – experimental and field studies. Rozpr. Monogr. SGGW Warsz. 183 [in Polish].
29. Lipiec A., Pisarski R.K., Grela E.R., 1998. Cow feeding during periparturient period. Med. Wet. 54: 296–300 [in Polish].
30. Lukaszewski W., 1984. Study on acid–base balance in cows during indoor feeding with supplementation of various mineral mixtures. Pol. Arch. Wet. 27: 50–65 [in Polish].
31. Madej E., Stec A., Filar J., 1993. Periparturient metabolic disorders in primiparous cows with genetically high milk productivity. Med. Wet. 49: 403–408. [in Polish].
32. Markusfeld O., 1987. Aciduria in the postparturient dairy cow. Br. Vet. J. 143: 119–127.
33. Meyer D.J., Harvey J.W., 1998. Veterinary Laboratory Medicine. W.B. Saunders Company. USA.

34. Nicpon J., Jonkisz P., 1997. Influence of acid and alkaline dyspepsia in pregnant cows on health of their calves. Med. Wet. 53: 208–213 [in Polish].
35. Peneva I., Goranov K.H., 1984. Changes in the serum enzymes and clinical and clinico–biochemical indices of cows with subclinical ketosis. Vet. Med. Nauki 21: 28–36.
36. Rajala–Schultz P.J., Grohn Y.T., McCulloch C. E., 1999, Effects of milk fever, ketosis, and lameness on milk yield in dairy cows. J. Dairy Sci. 82: 288–294.
37. Ras A., Zdunczyk S., Janowski T., Studzinski T., Glazer T., 1992. Effect of Acinormin–Polfa buffering–mineral preparation on the changes in gasometric and biochemical blood indices, course of periparturient period and milk yield of cows. Acta. Acad. Agric. Tech. Olst. Vet. 20: 133–141 [in Polish].
38. Ruegsegger G.J., Schultz L.H., 1986. Use of a combination of propylene glycol and niacin for subclinical ketosis.J. Dairy Sci. 69: 1411–1415.
39. Saba L., Bis–Wencel H., 1992. Effect of mineral supplements on indices of metabolic blood profile and fertility of dairy cows. Ann. UMCS Sect. EE. 10, 41: 277–283 [in Polish].
40. Saba L., Janecki T., Wojcik S., 1982. Selected blood indices in cattle during inter–pregnancy period in the herd of decreased fertility. Med. Wet. 38: 89–91 [in Polish].
41. Safarpour M., Daniels L.B., 1988. The effects of dietary mineral buffers on plasma pH and mineral levels of Holstein steers. Nutr. Rep. Int. 37: 1289–1296.
42. Sanchez W.K., Beede D.K., Cornell J.A., 1997. Dietary mixtures of sodium bicarbonate, sodium chloride, and potassium chloride: effects on lactational performance, acid–base status, and mineral metabolism of Holstein cows. J. Dairy Sci. 80: 1207–1216.
43. Skrzypek R., Krupinski B., Zak P., 1991, Influence of acid–base balance disorders in cows on biochemical and haematological indices. Rocz. Akad. Rol. Pozn. 229: 165–171 [in Polish].
44. Skrzypek R., 1991. Influence of ketosis in cows on biochemical and haematological indices and on acid–base balance. Rocz. Akad. Rol. Pozn. 42: 147–155 [in Polish].
45. Studer V.A., Grummer R.R., Bertics S.J., Reynolds C.K., 1993. Effect of prepartum propylene glycol administration on periparturient fatty liver in dairy cows. J. Dairy Sci. 76: 2931–2939.
46. Tucker W.B., Harrison G.A., Hemken R.W., Harmon R.J., 1988. Efficacy of simulated, slow release sodium bicarbonate in stabilising ruminal milieu and acid–base status in lactating dairy cattle. J. Dairy Sci. 71: 1823–1829.
47. Tyler J.W., Dowling P.M., Spano J.S., McKnight A.L., Wolfe D.F., 1994. Severe prepartum ketosis in an obese beef cow. J. Am. Vet. Med. Assoc. 15: 1665–1667.
48. Zielinski J., 1991. Studies on effect of Dolopasz on acid–base balance in dairy cows. Med. Wet. 47: 30–31 [in Polish].
49. Zielinski J., 1988. Studies on incidence of deviations of selected biochemical indices in cows and calves in large herd farms in Leszczynskie Region. Med. Wet. 44: 229–232 [in Polish].

Submited:

Robert Kupczyński, Bożena Chudoba–Drozdowska
Department of Animal Hygiene and Livestock Environment
Agricultural University of Wrocław
Dicksteina 3, 51–631 Wrocław, Poland
misiek@ozi. ar.wroc.pl
