

Investigation of functional state of liver and endocrinal pancreas through propionate loading probe in healthy cows and those ill with ketosis

R. Đoković, Snežana Bošković-Bogošavljević, M. Petrović
Faculty of Agronomy Čačak

H. Šamanc
Faculty of Veterinary Medicine, Beograd

Abstract: The effect of sodium propionate on functional state of liver and endocrinal pancreas in healthy and ketotic dairy cows was tested. When Na-propionate solution (1.84 mol/l) i.v. was applied in the amount of 1 ml/kg of the body weight, a significant increase in glucose concentration in the blood of the healthy cows occurred at the 30th and the 60th min., (and at the 120th min. of the testing, whereas only at the 8th min. did such an increase occur in cows ill with ketosis. Significantly lower concentrations of glucose in the blood in ketotic cows compared to the healthy ones after the application of propionate solution, i.e. after 30, 120, 240 and 60 min. of the testing denote that functional ability of the liver was weakened to synthesize glucose from propionate in ketotic dairy cows. During the i.v. injection of Na-propionate solution a marked insulin level increase was ascertained two hours after the injection in relation to the initial value in healthy dairy cattle, whereas in ketotic cows, such an increase occurred after 120, 240 and 480 min. of the medicine injection.

The concentration of insulin in healthy and ketotic cows was observed to be approximately the same at the commencement of the experiment, while 480 min. after the injection of sodium propionate in ketotic dairy cows, the level of insulin was noticeably raised in comparison to that of the healthy cows. This occurred due to a comparatively great sensitivity of beta-cells of endocrinal pancreas in ketotic cows to Na-propionate.

Key words: cow, insulin, liver, ketosis, sodium propionate

Introduction

Propionate loading probe was used in order to examine the functioning of liver. Namely, propionate was considered a basic precursor for synthesis of glucose with ruminants, and liver represents a major organ for gluconeogenesis and metabolism of propionate (Elliott 1980, Grohn 1985, Brockman, 1990). Grohn (1985) established that i.v. application of Na-propionate solution resulted in a significant increase in concentration of glucose in the blood with healthy cows, unlike the ketotic ones.

Bruss et al. (1986) achieved similar results with ketotic and fasted dairy cattle. These facts pointed to the decreased functional ability of hepatocyte to synthesize glucose in ketotic and fasted cows in relation to the healthy ones. Besides examining the functional ability of the liver cells, through propionate loading test, the endocrine pancreas functional ability can also be examined. In other words, some data indicated that after i.v. application of propionate solution a marked insulin concentration increase in the blood of the ruminants occurred, which was considered an immediate effect of propionate on the insulin synthesis and liberating from beta-cells of endocrine pancreas (Johnston et al. 1982, Peters and Elliot, 1984, Peters et al., 1983, Gross et al., Sano et al., 1993)

These studies were aimed at testing the functional state of liver and endocrine pancreas through propionate loading test i.v. in healthy as well as in ketotic cows.

Material and Methods

Two groups of the cows from Holstein herd aged 7-10 days were chosen for the test. In one group there were healthy cows ($n = 10$) and those with clinical signs of ketosis ($n = 10$) were in the other one. To carry out the experiment, Na-propionate solution in the amount of 1.84 mol/l was used. It was applied to jugular vein intravenously in 1ml/kg of the body weight. Blood samples were taken by jugular vein needle biopsy at the following intervals of time: just before propionate solution application (zero time) and after 8, 30, 60, 120, 240 and 480 minutes, respectively.

Enzymatic specific method of Dextrosis sticks was used to determine glucose concentrations in blood serum, and RIA method (INEP), Zemun, for insulin concentration of insulin. Statistical processing of the data obtained was done by the analysis of two-factorial analysis at the Biostatistics Department of the Faculty of Medicine in Belgrade.

Results and Discussion

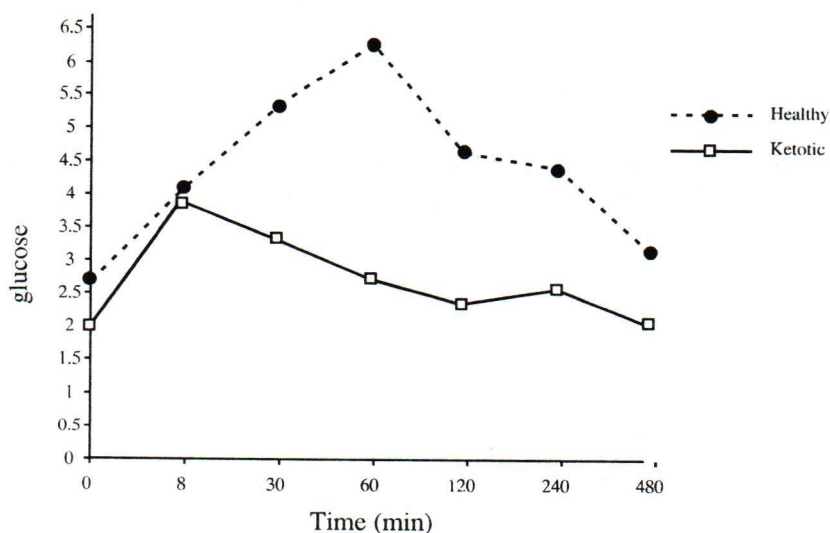
The results on testing the concentration of glucose in blood before and after intravenous Na-propionate solution application are shown in Tab.1 and Fig.1.

Table 1. Concentration of Glucose in Blood Serum (mmol/l) in Healthy and Ketotic Cows and Statistical Significance of Mean values:

	1	2	3	4	5	6	7		
	0	8	30	60	120	240	480	p<0.05	p<0.01
A	2.67	4.01	5.25	6.22	4.59	4.32	3.11	1:5; 2:4; 3:7;	1:3.4; 4:7
B	1.94	3.81	3.26	2.70	2.35	2.60	2.08	1:2; 2:7	
p<0.05			A : B		A : B	A : B			
p<0.01				A : B					

key: A- healthy cows; B-ketotic cows

Fig. 1 Concentration of gluivil in blood serum in healthy (mmol/l) and ketotic cows before and after Na-propionate solution application



Glucose concentration in blood serum of the healthy cows amounted to 2.67 ± 0.29 mmol/l whereas in ketotic cows, it was lower, i.e. 1.94 ± 0.30 mmol/l. After Na-propionate solution intravenous injecting, the glucose blood serum level markedly increased after 30, 60 and 120 min. of examining the healthy cows, whereas immediately after 8 min. lapsed, it occurred with ketotic cows. Significantly higher concentrations of glucose were found to exist in the blood of

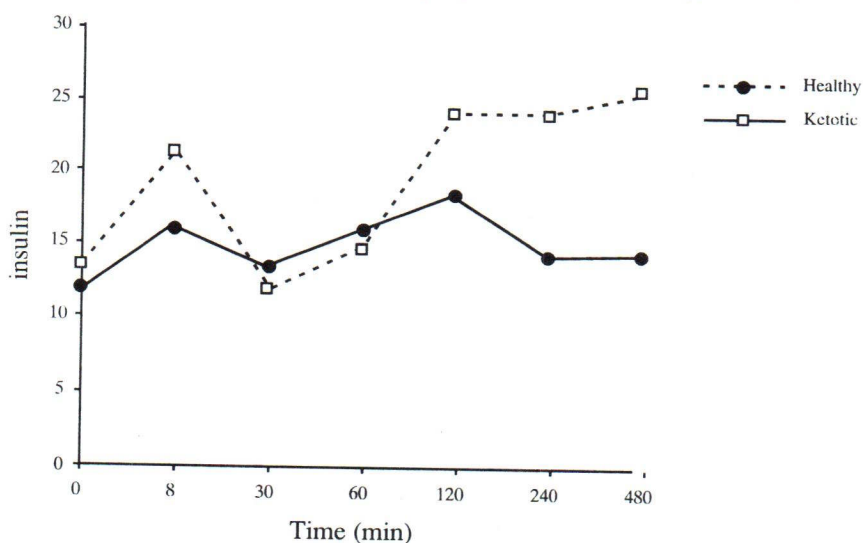
the healthy cows in relation to ketotic ones, ie. after 30, 60, 120 and 240 min. respectively. The results obtained are in agreement with the data of B r u s s (1986) and G r o h n (1985) denoting lowered liver ability to synthesize glucose from propionate in the case of dairy cows ill with ketosis. The results of examining insulin concentration in blood serum in healthy and ketotic cows before and after i.v. Na-propionate solution application are given in Table 2. and Fig. 2.

Tab. 2 Concentration of Insulin in Blood Serum (mIU/l) in Healthy and Ketotic Dairy Cattle and Statistical Significance of Mean Values

	1	2	3	4	5	6	7		
	0	8	30	60	120	240	480	p<0.05	p<0.01
A	12.06	16.0	13.4	16.0	18.7	14.4	14.42	1:5	
		8	0	8	6	2			
B	13.40	21.4	12.0	14.7	24.1	24.1	25.46	1:2; 2:3; 4:6	1:5, 6, 7; 4:5:7
		4	6	4	2	2			
p<							A : B		
p<									
0.01									

A - healthy cows B - ketotic cows

Fig. 2 Concentration of Insulin in Blood Serum (mIU/l) of Healthy and Ketotic Cows before and after i.v. Na-propionate Solution Application



Insulin concentration in blood serum of the healthy cows was recorded to be 12.06 ± 4.02 mIU/l. However, it proved somewhat higher in ketotic cows, i.e. 13.40 ± 2.86 mIU/l. After i.v. propionate application, markedly higher values in healthy cows were detected at the 120th min. of the experiment, i.e. after 8, 120, 240 and 480 min. the ketotic cows. Besides, only at 480th min. of the probe, considerably higher insulin concentration occurred in ketotic cows in relation to the healthy ones. The results obtained led to the conclusion about Na-propionate to directly influence the insulin synthesis together with its liberating from beta cells of endocrinal pancreas. Prominently higher insulin peaks in ketotic cows in relation to the healthy ones over the testing indicated that beta cells functioning was ensured. Moreover, it was raised in the event of the ketotic cows.

From Fig. 2 it can be seen that insulin is increasing in blood over two stages after propionate solution has been applied. The first insulin concentration increment was found to be a consequence of a direct effect of propionate, while the other was due to the glucose higher concentration in the blood, which was synthesized from the propionate in liver through gluconeogenesis.

Conclusion

- Na-propionate solution (1.84 mol/l) applied i.v. in the amount of 1ml/kg of the body weight induces a significant glucose concentration increase in the blood after 30, 60 and 120 min. of the investigation with healthy cows, yet such an increase appeared only at the 8th min. of testing the cows ill with ketosis. Markedly lower concentrations of glucose in the blood of ketotic cows in relation to the healthy ones were observed after the propionate solution had been applied after 30, 120, 240 and 60 min. of the investigation, which pointed at reduced functional ability of the liver to synthesize glucose from propionate in the ketotic dairy cattle.

- In the course of intravenous Na-propionate solution injection, a marked insulin level increase was detected in healthy cows after 120 min. in relation to the initial value whereas in cows ill with ketosis such an insulin level increase occurred after 120, 240 and 480min. of applying the medicine.

- The concentration of insulin of either healthy or ketotic cows proved to be approximately equal at the beginning of the probe, while 480min. after Na-propionate solution application in ketotic cows, the insulin level was noticeably higher in relation to the healthy, which was obviously a sign of higher sensitivity of endocrinal pancreas beta cells in the ketotic cows to Na-propionate.

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ISPITIVANJE FUNKCIONALNOG STANJA JETRE I ENDOKRINO PANKREASA TESTOM OPTEREĆENJA PROPIONATOM KOD ZDRAVIH KRAVA I KRAVA OBOLELIH OD KETOZE

- originalni naučni rad -

Radojica Đoković, Snežana Bošković-Bogosavljević, Milun Petrović
Agronomski fakultet, Čačak

Horea Šamanc
Veterinarski fakultet, Beograd

Rezime

Za ovo ispitivanje izabrane su iz Holštajn zapata dve grupe krava i to od 7-10 dana posle telenja.

Davanje rastvora Na-propionata (1.84 mol/l) i.v. u količini od 1ml/kg telesne mase izaziva značajno povećanje koncentracije glukoze u krvi i to u 30., 60.($v<0.01$) i 120. minutu ($v<0.05$) ispitivanja kod zdravih krava, a samo u 8. minutu kod krava obolelih od ketoze.

Značajno niže koncentracije glukoze u krvi kod ketoznih krava u odnosu na zdrave krave nakon aplikacije rastvora propionata i to u 30., 120., 240. ($v<0.05$) i 60. ($v<0.01$) minutu ispitivanja ukazuju na smanjenu funkcionalnu sposobnost jetre da sintetiše glukozu iz propionata kod krava obolelih od ketoze. Kod i.v. ubrizgavanja rastvora Na-propionata utvrđeno je značajno povećanje nivoa insulina kod zdravih krava u 120. minutu u odnosu na početnu vrednost a kod krava obolelih od ketoze, značajno povećanje nivoa insulina pojavilo se u 120., 240. i u 480. minutu nakon davanja preparata. Koncentracija insulina kod zdravih i ketoznih krava na početku oglada je približno ista, a 480. minuta posle davanja rastvora Na-propionata kod ketoznih krava nivo insulina se značajno povećao u odnosu na zdrave krave što ukazuje na veću osetljivost beta-ćelija endokrinog pankreasa ketoznih krava na Na-propionat.