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ENDOCRINE CHANGES BROUGHT ABOUT BY LOADİNG TESTS WITH ENERGY SUBSTRATES İN DAİRY CATTLE[1]

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Süt ineklerinde enerji substratları ile yükleme denemeleri sonunda meydana gelen hormonal değişiklikler

Özet: *Bu çalışmada* 18 *saat açlıktan sonra tek yumurta ikizi düvelere ve ineklere damar-içi yolla glukoz, propionat ve butirat infüzyonu yapılmıştır.*

Substratların infüzyonundan önce, infüzyon sırasında ve infüzyondan 4 *saat sonra insulin, büyüme hormonu, glukoz, serbest yağ asitleri ve β-hidroksibutirat düzeyleri ölçülmüş ve substratların hepsi metabolit ve hormonların dolaşımdaki konsantrasyonlarının geçici olarak değişmesine sebep olmuştur.*

Büyüme hormonu, insulin, glukoz, β-hidroksibutirat ve serbest yağ asitleri değerleri düve ve inekler arasında istatistik bakımından önemli değişiklikler göstermiştir.

İneklerde insulin ve glukoza olan cevaplar azaldığı halde, büyüme hormonu, serbest yağ asitleri ve β-hidroksibutirata olan cevaplar artmıştır.

Butirat verildikten sonra büyüme hormonu parametrelerinde yakın ilişki bulunmuştur.

Summary: *In this study pairs of monozygous Holstein Friesian twin heifers and cows were tested by intravenous infusion of glucose, propionate and butyrate after* 18 *hours of food withdrawal. Insulin, growth hormone,*

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glucose, free fatty acids and OH-butyrate were measured before, during and up to 4 hours after infusion of substrates.

Each substrate caused a transient change in the circulating concentrations of metabolites and hormones. The individual reaction pattern was quantified by different parameters which describe the reaction profiles. For these parameters correlations are calculated between the values of heifers and cows. Amongst them significances appeared good enough to strengthen the suggestion of possible forecasts concerning performance of cows by measuring only a few distinct metabolic parameters in young animals under the conditions of the loading test.

Introduction

Infusion of energy substrates to ascertain physiological data has a long-standing tradition in animal physiology. Intravascular and intraruminal administration of glucose and volatile fatty acids are used to determine if these substrates are involved in regulation of hormone levels. Beside this endogenous hormones and metabolites were measured and correlated to actual and potential milk yield (1). It is largely accepted that infrequent probe sampling without stimuli is not adequate for assessing production capacity in nonlactating cattle (2). Only stimuli like fasting and refeeding or infusion of substrates may cause expression of genes responsible for variation in milk production.

The experiment was designed to study the possibility of predicting the milk production capacity in heifers. Therefore we examined pattern of hormones and metabolites after substrate infusion in identical twin heifers and calculated correlations to milk yield in their first lactation. The first step was to investigate the responses of heifers and cows to infusion of substrates and then to examine relations of parameters between heifers and cows.

Material and Methods

Ten pairs of monozygous female twins (German Friesian) were used between 12 and 18 months of age and six pairs of them during the first lactation. Infusions were started at 8 a.m, after food withdrawal for 18h.

During the experiment glucose, propionate and butyrate were infused (Table 1).

Table 1: Experimental design of infusions of glucose, propionate and butyrate.

Glucose	injection 1.3 g / kg 0.75 infusion 3.0 g / kg 0.75 in 60 min.
Propionate	infusion 9.4 mmol / kg 0.75 in 20 min
Butyrate	infusion 7.2 mmol / kg 0.75 in 20 min

Figure 1. shows the procedure for the evaluation of time series by means of the growth hormone course in heifer 411 (3). First of all the median was calculated, that is the mean concentration of all values of animal. The mean of all values below the median constitutes the baseline. Then the area under the curve and the area under the

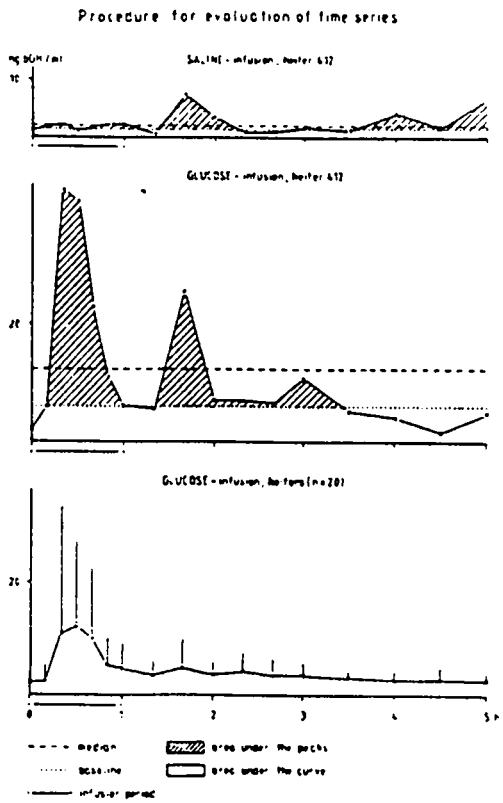

Figure 1. Procedure for evaluation of time series.
Zaman serilerini ortaya koymak için kullanılan yöntem.

peaks were determined as the area between curve and zero respectively baseline.

In a similar way it has been tried to find characteristics also for the time series of the other hormones and metabolites and to evaluate the time series of each animal under each loading test.

Results and Discussion

The results are discussed with the aid of the time series of the mean concentrations, comparing heifers and cows. The lower diagram of figure 1 is set up as an example. It shows mean concentrations with standard deviation for growth hormone values after glucose infusion in heifers.

Figure 2 combines the mean concentrations of hormones and metabolites after glucose infusion, standard deviations are omitted. Glucose concentrations are elevated up to 400 mg / dl. The decline immediately after the end of the infusion is nearly identical.

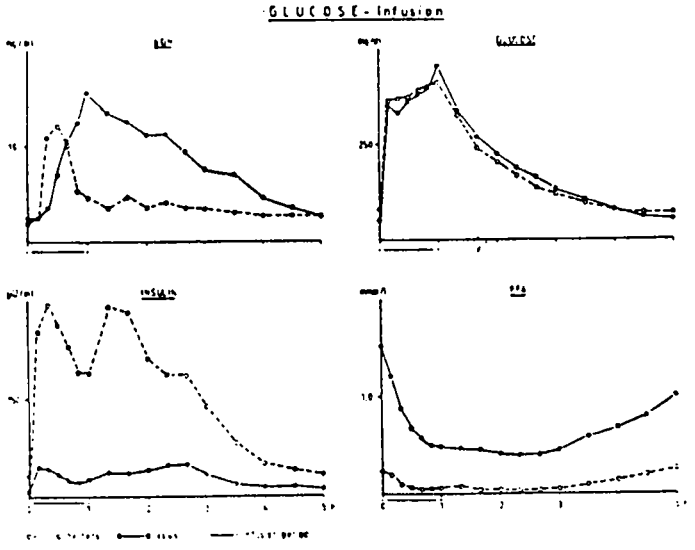

Figure 2. Effect of glucose infusion on plasma growth hormone, glucose, insulin and FFA levels.
Glukoz infüzyonunun, plazma growth hormone, glukoz, insulin ve serbest yağ asitleri düzeylerine etkisi.

Infusion of glucose causes the greatest deviation of growth hormone parameters in comparison to the other substrates, in cows stronger than in heifers. Furthermore growth hormone parameters are correlated to parameters for glucose and free fatty acids, pointing at an interdependence. Insulin response to glucose infusion is characterized by two rises, the first during infusion, the second 1 hour later. This is similar at both ages, but lessened in cows, as reported from others (4).

Most impressive is the decline of free fatty acids in heifers and especially in cows. If this is caused by glucose itself or mediated by the lipotrophe effects of insulin and growth hormone, cannot be decided.

Infusion of propionate(figure 3)has a small effect on plasma growth hormone. Mean concentrations decline little during and after infusion. In lactating cows the infusion did not influence growth hormone values. Others examined cows around birth and found significant changes in growth hormone levels (5). Propionate infusion caused two rises of the insulin level in heifers. The first rise is induced by propionate itself, a fact well known. For the second rise increasing plasma glucose

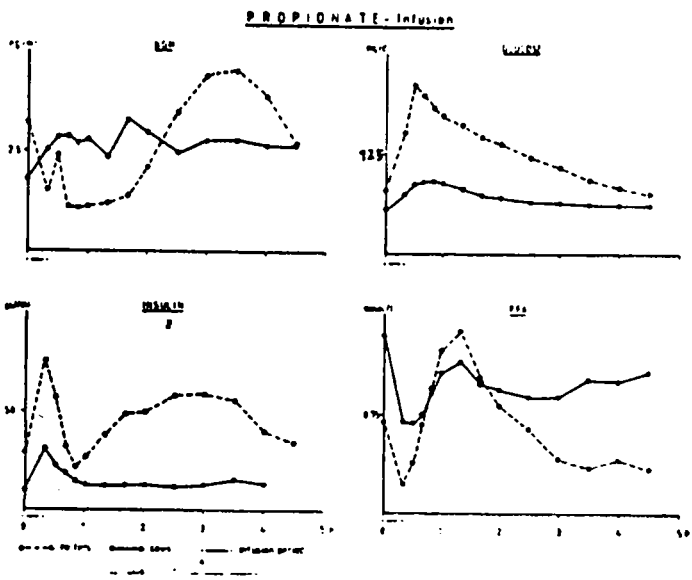

Figure 3. Effect of propionate infusion on plasma growth hormone, glucose, insulin and FFA levels.

Propionat infüzyonunun, plazma growth hormon, glukoz, insulin ve serbest yağ asidi düzeylerine etkisi.

is responsible. In cows the second rise is absent, considering mean concentrations. This corresponds with the small increase of glucose after propionate load.

Pattern of free fatty acids in heifers is characterized by a decrease during and after infusion. The minimum value is negatively correlated to the area under the first insulin rise (-0,98***), demonstrating the antilipolytic effect of insulin. The following increase of free fatty acids value still waits for an explanation.

With infusion of butyrate (figure 4) we expected the greatest influence on metabolic processes. However growth hormone parameters were scarcely affected. Only in cows mean concentrations show an increase.

Butyrate is an even stronger insulin secretagogue than propionate. Peak values reached more than 1000 μU / ml in some heifers in comparison to 100 μU in cows.

Interesting enough was the pattern of glucose values. In heifers we saw a transient rise above basic values, probably through glyco-

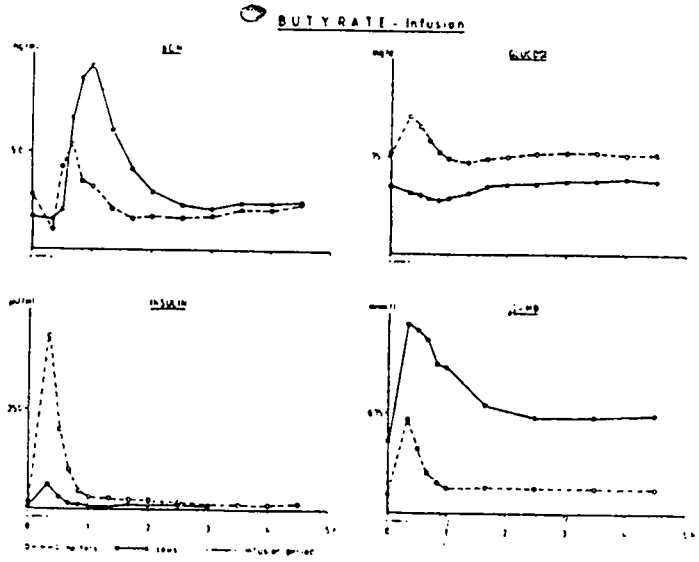

Figure 4. Effect of butyrate infusion on plasma growth hormone, glucose, insulin and β-hydroxybutyrate levels.

Butirat infüzyonunun, plazma growth hormon, glukoz, insulin ve β-hidroksibutirat düzeylerine etkisi.

genolysis. The following decline, caused by insulin, brought in heifers values of lactating cows. On the other side the values of the cows were comparable with those of ketotic animals.

Pattern of free fatty acids (not shown) was like that after propionate infusion, however starting values were not restored. Plasma β-hydroxybuytrate increased with infusion of butyrate as expected. In heifers values declined within 1 hour.

In cows peak values were nearly the same as in ketotic animals, the plateau concentrations from 1 to 4 hours were negatively correlated with the glucose response (–0.88***) indicating probably the need of energy for metabolizing butyrate.

Conclusion

Pattern of hormones and metabolites were comparable between heifers and cows with mainly quantititave differences. In cows the insulin and glucose responses were diminished, growth hormone, free fatty acids and β-OH-butyrate responses were intensified.

Correlation between parameters of heifers and cows are middle graded and significant (table 2). There is a close correlation of growth hormone parameters after infusion of butyrate. All this strengthens the suggestion of possible forecasts concerning performance of cows by measuring metabolic parameters in heifers under a loading test.

Table 2: Correlation of parameters between heifers and cows

growth hormone	starting value	0.31*
insulin	starting value	–0.34*
	Infusion of GLUCOSE	
growth hormone	area under the peaks	–0.49
glucose	area under the curve	–0.50*
	k-value	0.58*
free fatty acids	k-value	–0.52*
	Infusions of PROPIONATE	
insulin	area under the 1. peak	0.56*
	area under the 2. peak	–0.54*
glucose	area under the vurce	0.49
	Infusion of BUTYRATE	
growth hormone	area under the vurce	0.80***
	baseline	0.77***
glucose	maximum value	0.56*
β-OH-butyrate	minimum value	0.41

* $p < 0.05$ *** $p < 0.001$

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