COMPARISON OF "METABOLIC PROFILES" BETWEEN DAIRY HERDS WITH AND WITHOUT DISTURBED REPRODUCTIVE PERFORMANCE

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Introduction

The "metabolic profile" or "blood profile" has been defined as a set or combination of blood constituents analyzed together.[1] Blood profiling in dairy cattle has been tested by many investigators with the goal of correlating the blood levels of biochemical parameters with nutrition, fertility and metabolic diseases.[2,3,4] However, the value of metabolic profile tests for monitoring the nutritional stage or identifying metabolic diseases which might have a negative effect on reproductive performance has been questioned, as 60 per cent of herds with no clinical or production problems also had abnormal metabolic profiles.[5] The aim of the following study was to reevaluate the efficacy of metabolic profiling by comparing metabolic profiles of herds with and without reproductive disorders.

Material and Methods

Blood samples (n=540) were taken from cows of two types of dairy herds: (1) "problem herds" (n=33), defined as herds with reproductive disorders. Samples were usually taken by the local practitioner when other methods had failed to identify the cause of the problem; (2) "normal" herds (n=33), i.e. herds without reproductive disorders. Those herds belonged to a dairy consulting group with controlled feeding management. Samples were taken in order to control metabolic state of the cows. For each herd, samples were taken from cows of different stages of lactation: < 100 days, < 200 days, > 200 days (including dry cows). The serum concentration and activity of the following serum parameters were determined and evaluated using routine procedures:[3,6] anorganic phosphorus (P), urea, glucose (G), total bilirubin (TB), aspartate aminotransferase (AST) and glutamic dehydrogenase (GLDH). Data were analyzed as a 2x3 factorial completely random design with herd and stage of lactation being the factors using a computer program (SPSS/PC+).[7] When the F-test proved to be significant statistical differences between pairs of means were detected with the Tukey's test. Data in the tables are means $\pm$ standard error.

Results

Deviations of different serum parameters from normal range were found in "normal" as well as in herds with reproductive disorders. Compared with "normal" herds, in "problem" herds, increased concentrations of serum P and urea above normal range were found more often than concentrations below normal range (Figure 1A). In all "normal" and 81.8 % of "problem" herds, a decrease in G was determined. In "problem" herds, an increase in TB, AST and GLDH was found more often than in "normal" herds (Figure 1B).

In "problem" herds, there was a tendency of higher P concentration and AST activity compared with "normal" herds ($P<0.1$) (Table 1). Average serum concentrations of urea and G, and serum activity of GLDH were higher in "problem" herds than in "normal" herds ($P<0.01$, $P<0.001$ and $P< 0.001$, respectively) (Table 1). With regards to serum TB, there was no statistically significant difference between the two types of herds. Serum P was lower during the first stage of lactation (< 100 days) than during

the last stage (>200 days) ($P<0.05$) (Table 2). In "problem" herds, mean urea concentrations increased towards the end of pregnancy (Figure 2A). Concentration of G was lower during the first two stages of lactation (<100 days, < 200 days) than during the last stage ($P<0.05$) (Table 2). Mean concentration of TB was higher during the first stage of lactation than during the second and third stage ($P<0.05$) (Table 2). In "problem" herds, there was a slower decrease in TB throughout lactation than in "normal" herds (Figure 2B). Activities of AST and GLDH were higher during the first two stages of lactation than during the third stage ($P<0.05$). In "problem" herds, concentration of GLDH was higher during the first and last stage of lactation compared with the second stage ($P<0.05$) (Figure 2C).

Table 1. Mean concentration of anorganic phosphorus (P), urea, glucose, bilirubin, AST and GLDH in serum samples from cows from herds with (Problem) and without (Normal) reproductive disorders.

Farms	Serum Parameter (mean ± standard error)					
	P mmol/l	Urea mmol/l	Glucose mmol/l	Bilirubin µmol/l	AST U/l	GLDH U/l
Problem	1.85 ±0.02	4.21 ±0.08	2.65 ±0.06	4.22 ±0.06	35.44 ±0.64	9.49 ±0.51
Normal	1.80 ±0.02	3.88 ±0.05	2.52 ±0.03	4.05 ±0.11	31.39 ±0.63	6.70 ±0.32
Problem vs Normal	$P<0.1$	$P<0.01$	$P<0.001$	$P>0.05$	$P<0.1$	$P<0.001$

Table 2. Mean concentration of phosphorus (P), urea, glucose, bilirubin, AST and GLDH in serum samples over 3 stages of lactation (1 = 100 days, 2 = <200 days, 3 > 200 days after parturition).

Stage of lactation	Serum Parameter (mean ± standard error)					
	P mmol/l	Urea mmol/l	Glucose mmol/l	Bilirubin µmol/l	AST U/l	GLDH U/l
1 <100 d	1.76 ±0.02	3.89 ±0.09	2.41 ±0.04	4.68 ±0.17	35.16 ±0.75	8.67 ±0.49
2 <200 d	1.85 ±0.02	4.08 ±0.10	2.48 ±0.05	3.84 ±0.68	33.66 ±0.90	8.43 ±0.53
3 >200 d	1.86 ±0.03	4.18 ±0.11	2.84 ±0.05	3.67 ±0.09	30.79 ±0.07	7.38 ±0.49
$P<0.05$	1 < 3	NS*	1,2 < 3	1 > 2,3	1,2 > 3	1,2 > 3

*NS = not significant

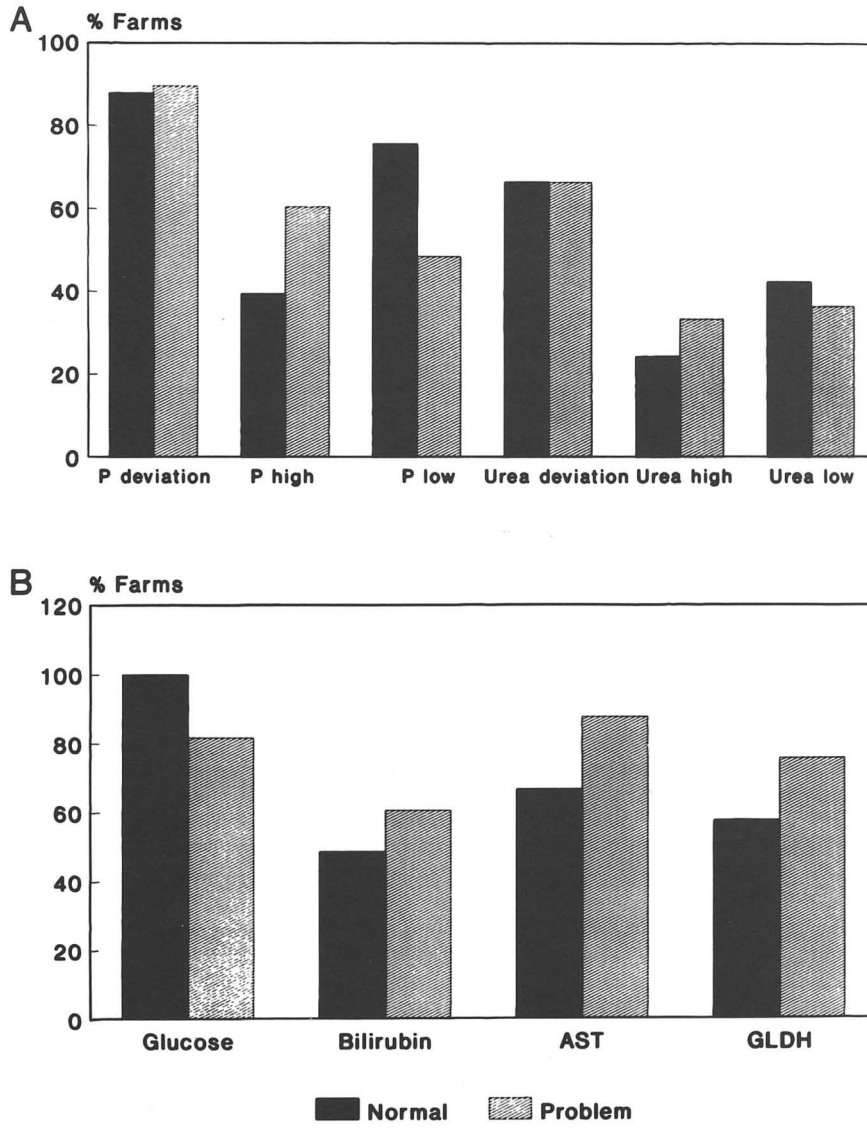

Figure 1 A,B. Frequency of herds with cows with deviations of serum parameters from normal range (1A: phosphorus (P), urea [total deviation, high, low]; 1B: glucose [low], total bilirubin, AST, GLDH [high]).

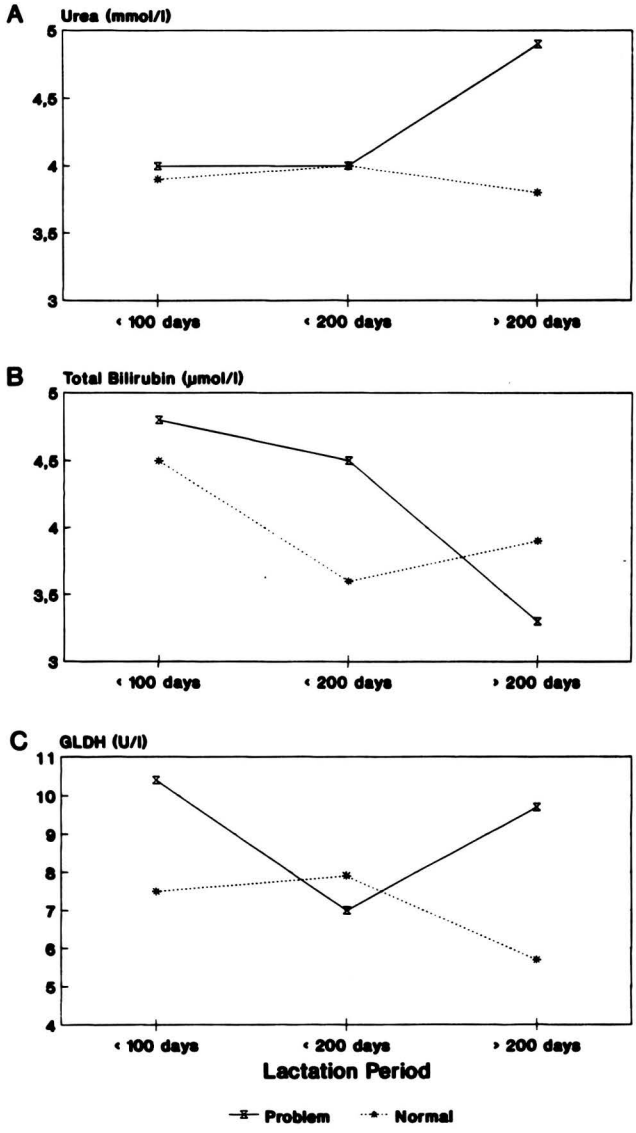

Figure 2 A,B,C. Interaction between herd (normal vs problem) and stage of lactation (< 100 days vs < 200 days vs > 200 days) for urea (A), total bilirubin (B) and GLDH (C).

Discussion

In agreement with other authors,[1,8,9] deviations of different serum parameters from normal range were found in "normal" as well as in herds with reproductive disorders. Changes over time of lactation of concentration and activity of various serum parameters were similar as described recently.[10] However, there were differences between the two groups regarding the direction of deviation (e.g. P, urea), the degree (liver enzymes) and temporal changes during lactation (urea, bilirubin, GLDH). Taking those findings together, there are indications that in "problem" herds, there are nutritional imbalances in direction of oversupply with P and protein which is known to cause reproductive disorders.[3] As to the latter, a positive interaction between herd and stage of lactation for urea suggests that in "problem" herds rations with high protein content are fed at the end of lactation and during dry period probably because of the reduction of concentrates and other feeds rich in carbohydrates (e.g corn silage). This might also explain the increase in activity of GLDH at the end of lactation. The depressed liver function might persist throughout subsequent lactations and could have a negative effect on further reproductive performance. This is supported by the fact that in "problem" herds frequency of increased activity of liver enzymes indicating liver damage is higher than in "normal" herds and that normalizing of liver function over lactation occurs more slowly in "problem" herds than in herds without fertility problems (positive interaction between herd and stage of lactation for bilbirubin and GLDH). The time course of bilirubin concentration might also suggest a higher rate subclinical or clinical ketosis in "problem" herds due to insufficient supply with nutrients. Serum concentration of G was found to be below normal range more often in "normal" herds than in "problem" herds, and mean concentration of G was lower in "normal" herds than in "problem" herds. This is surprising as cows in "normal" herds were fed well balanced and adequate rations. These results support findings by other authors that evaluation of serum G might not be a suitable parameter for evaluation of energy supply [5,11] and differentiation between "normal" and "problem" herds. According to our results, the liver status seems to be factor which indicates and maybe determines the occurrence of disturbed herd fertility.

Summary

In the study presented, metabolic serum profiles from 33 "normal" (undisturbed herd fertility) and 33 "problem" herds (disturbed herd fertility) with a total of 540 single profiles were compared. The serum concentrations and activities of the following parameters were determined: anorganic phosphorus, urea, glucose, total bilirubin, aspartate aminotransferase and glutamic dehydrogenase. The results suggest the following conclusions: In "problem" herds, metabolic disturbances and liver damages are more frequent, more severe and of longer duration than in herds without fertility problems. In "problem" herds, those disturbances are found also at the end of lactation and during the dry period. The depressed liver function migth persist throughout subsequent lactations and could have a negative effect on reproductive performance. Furthermore, insufficient supply with nutrients with resulting metabolic disorders, and the uptake of rations with high phosphorus or protein contents might be involved in suppression of reproductive performance. Serum G, if considered isolated from other parameters, might not be a suitable parameter for evaluation of energy supply and differentiation between "normal" and "problem" herds.

Zusammenfassung

Vergleich von "Metabolischen Profilen" in Milchviehbeständen mit und ohne Störungen der Herdenfruchtbarkeit

In der vorliegenden Arbeit wurden "Metabolische Serumprofile" aus 33 "normalen" (ungestörte Herdenfruchtbarkeit) und 33 "Problembetrieben" (gestörte Herdenfruchtbarkeit) mit 540 Einzelprofilen miteinander verglichen. Die Serumkonzentrationen und Aktivitäten folgender Parameter wurden

bestimmt: anorganischer Phosphor, Harnstoff, Glukose, Gesamtbilirubin, Aspartataminotransferase und Glutamatdehydrogenase. Die Ergebnisse lassen folgende Schlußfolgerungen zu: Die Proben aus fruchtbarkeitsgestörten Betrieben weisen häufiger und in stärkerem Maße auf länger anhaltende Stoffwechselbelastungen und Leberschäden hin. Dabei wird deutlich, daß in Problembetrieben Leberschäden auch am Ende der Laktation bestehen. Es ist wahrscheinlich, daß diese Schäden vermehrt in den Folgelaktationen bestehen bleiben und sich negativ auf das Fruchtbarkeitsgeschehen auswirken. Die Ergebnisse sprechen dafür, daß stoffwechselbelastende Mängel in der Nährstoffversorgung sowie Phosphor- oder Proteinüberversorgung fruchtbarkeitsdepressiv wirken. Der Serumglukosegehalt erscheint isoliert betrachtet als Parameter zur Beurteilung der Energieversorgung und zur Unterscheidung von normalen und Problembetrieben nicht geeignet.

Résume

'Profils métabolique' en troupeaux bovins avec fecondité non-troublée et avec fecondité troublé

Dans le travail presenté, les 'profils métaboliques' de 33 troupeaux bovins 'normaux' (avec fecondité non-troublée) et 33 troupeaux 'problématiques' (avec fécondité troublée), comprénant un total de 540 profils individuels ont été comparés. Les concentrations et activités des paramètres sériques suivants ont été déterminés: phosphor anorganique, urée, glucose, bilirubine totale, aspartataminotransferase, glutamatdéhydrogénase. Les résultats permettent d'en tirer les conclusions suivantes: Les échantillons provenant des troupeaux avec fécondité troublée indiquent plus souvent et dans un degré plus marqué des surmenages métaboliques et troubles hépatiques. Ils démontrent, que - dans les troupeaux avec fécondité troublée - il y a des troubles hépatiques aussi à la fin de la lactation. Il est donc vraisemblable, que ces troubles persisteront fréquemment aussi pendant les lactations suivantes et qu'ils auront des conséquences négatives sur la fécondité. Les résultats contiennent des indices pour soupconner, que des déficiences dans l'apport des nutrients dues au métabolisme, ainsi qu'un apport exagéré de phosphore ou des protéines ont des effets dépressifs sur la fécondité. Le taux de la glucose sérique - pri pour lui-seul - n'apparait pas utile comme paramètre pour évaluer l'apporovisionnement en énergie ou pour différencier entre troupeaux dont la fécondité est normale et autres à fecondité troublée.

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