Interpretation of Blood Profiles in Problem Dairy Herds

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Introduction

Blood profiles can be an important extension of the clinical evaluaton of herds with production or reproductive problems. Biochemical and haematological tests can be used to identify many factors involved in herd problems[1]. However, other steps should also be taken to determine the nutritional and health status of a problem herd. For example, feed testing and ration evaluaton should be done along with the blood profile. Interpretation of profiles is most accurate if they are accompanied by clinical history and ration information. The clinician, the nutritionist and the clinical pathologist should work as a team.

Sampling Procedures

From our experience, it appears important to look at discrepancies in mean values and the percentage of animals out of reference range. Therefore, it is important to sample a number of animals from the appropriate stages of lactation. Results can be analyzed and interpreted according to production groups within the herd. Our experience with profiles indicate that interpretation relative to herd problems, rather than individual animal disease, must be stressed. Herd problems are often associated with nutrition and management.

The following information should be recorded for each animal sampled: age, milk production, stage of lactation, and body condition score.

Ten ml each of blood (EDTA - lavender top tube) and serum (Red top tube) are collected from the coccygeal vein in sterile vacuum tubes. (P & K are lower from the jugular vein and metabolites vary greatly from the mammary vein depending on circulation through the mammary gland).

It is important to sample a sufficient number of cows from each production group to be confident in the interpretation. We recommend a random sample of at least five animals from each group: 5 dry cows, 5 mid-lactation cows (100-200 DIM) and 5 early lactation cows (7-100 DIM).

Samples must be handled to minimize artifact. The serum must be separated within two hours. The serum (1-2 mls) can be frozen and refrigerated. Care must be taken to prevent haemolysis throughout the sampling process. Otherwise glucose decreases and phosphorus and potassium increase. Table V illustrates an input form for submission of samples[2]. Samples should be delivered to the laboratory within 24 hours if possible.

Routine tests include: WBC, RBC, PCV, Hgb, serum calcium, phosphorus, magnesium, total protein, albumin, globulin, AG ratio, urea, creatinine, glucose, cholesterol, alkaline phosphatase, gamma-glutamyltransferase, AST, creatine kinase, glutamate dehydrogenase, beta-hydroxybutarate.

Optional tests include: serum iron, copper, electrolytes, glutathione peroxidase, fibrinogen and haptoglobin.

Reference Values

Our laboratory reference values were determined from blood samples collected from 260 cows in three high-producing Holstein herds, in which cows were judged to be healthy and clinically normal. The sample herds were fed a ration balanced to meet NRC requirements. Feedstuffs included mixed legume hay, alfalfa haylage, corn silage, grain ration and protein supplement. Supplementary fat products were not included in any of the rations.

Value of Blood Profiles

We feel that blood profiles are most effective as an aid in the workup of production and reproduction problems. Their values should not be oversold. Close observation of feeding and management practices, ration evaluation, case history, and disease testing often provide the information needed for diagnosis without profiling. As many of these steps are essential for the proper interpretation of blood profiles, we recommend that they be done along with profiling.

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In some cases, blood profiling should be used as one of the initial steps. For example, a production break in a well-fed and managed herd. Sometimes it is difficult to convince a dairyman that ration evaluaton is needed in a problem herd. Profiles with significant findings may convince the owner to evaluate the ration and to adopt appropriate feeding and management changes.

Interpretation

The mean level of the test element in a production group is usually an indicator of central tendency and may be used as a reference point. Variation of the mean level among early lactation, mid-lactation and dry cows may also be a helpful diagnostic aid. Comparison of the mean of each test element with the reference mean is the method of interpretation used by the authors.

(1) Table I - Illustrates the "reference range" and mean values for "normal" high producing Holsteins.

(2) Table II - Illustrates reference means stratified by stage of lactation.

TABLE I Serum Profile Results - Reference Dairy Herds

Test	S.I.N. Units	Minimum	Maximum	Mean
Calcium	mmol/L	2.08	2.71	2.31
Phosphorus	mmol/L	1.43	2.80	2.10
Magnesium	mmol/L	1.00	1.30	1.16
Sodium	mmol/L	140.0	148.0	143.7
Potassium	mmol/L	3.7	5.5	4.5
Chloride	mmol/L	97.0	106.0	100.9
Total Protein	g/L	65.0	81.0	72.5
Albumin	g/L	31.0	39.0	35.1
Globulin	g/L	31.0	47.0	37.4
A:G Ratio		.7	1.2	1.0
Urea	mmol/L	3.2	8.3	6.3
Creatinine	umol/L	84.0	137.0	139.8
Glucose	mmol/L	2.6	4.1	3.6
Cholesterol	mmol/L	1.6	5.9	3.8
Alkaline Phosphatase	U/L	12.0	117.0	53.2
Gamma-GT	U/L	2.0	37.0	25.6
AST	U/L	43.0	128.0	70.7
CK	U/L	87.0	468.0	172.0
GLDH	U/L	6.0	38.0	20.0
GSH-px	IU/L/g Hb	51	144	111.4
Beta-Hydroxybutyrate	umol/L	400	1300	620

TABLE II Reference Means According to Stage of Lactation

Test	Units	7-100 DIM	100-200 DIM	DRY
Calcium	mmol/L	2.32	2.30	2.24
Phosphorus	mmol/L	2.30	2.20	2.12
Magnesium	mmol/L	1.2	1.2	1.1
Total Protein	g/L	73.5	72.4	71.0
Albumin	g/L	35.2	35.5	33.0
Globulin	g/L	38.0	36.9	38.2
Urea	mmol/L	6.6	6.2	4.9
Glucose	mmol/L	3.6	3.6	3.2
Cholesterol	mmol/L	4.2	3.7	2.1

Case Histories of Herd Problems

The following examples illustrate how profiles can be very helpful in the diagnosis or verification of nutritional problems.

A. **Protein Deficiency**

History - 120 cow free stall - milk parlour facility
High Group - 60 cows (>20 litres/day)
Low Group - 60 cows (<20 litres/day)
Dry -20cows (permanent pasture)
Milk cows have access to an 8 acre exercise paddock.

Clinical Signs
Feed refusal and decreased milk production, the High Group being most affected. Herd milk production decreased from 19 litres per cow, per day to 15 litres in a 4 week period. Production had been 21 litres/cow/day 4 months previously. Two fresh cows had lost body condition and became weak and staggery within the first 14-21 D.I.M. All cows were listless and had dull dry hair coats.

Ration Information
Partial mixed ration (P.M.R.): alfalfa haylage and corn silage
High group 2:1 and Low group 1:1
High Group eating 25% of P.M.R.
Low Group eating 75% of P.M.R.
Mixed Hay - round bales free choice
High Group eating 3 lbs per day
Low Group eating 10 lbs per day

Grain ration to High group via computer feeder (1 station/20 cows) according to production (4 feeding periods of 6 hours daily)
H.M. corn and cob meal
Barley
Roasted Soybeans
Vitamin pkg + salt and minerals
Low Group - 10 lbs/cow daily in milk parlour

Body Condition Scores 0.5-1 score below normal for all stages of lactation.

Herd Profile - 14 cows

Test Element	High Group Mean	Reference Mean	Low Group Mean	Reference Mean
		7-100 DIM		100-200 DIM
Total Protein g/L	68.6	73.5	75.0	72.4
Albumin g/L	30.0	35.2	32.0	35.5
Urea mmo 1/L	3.4	6.6	2.6	6.2
Haemoglobin g/L	96.0	110.0	102.0	115.0

Diagnosis: Dietary Protein Deficiency [3]. Investigation revealed that the computer feeder was only delivering 530 lbs of grain per day, whereas 1,600 lbs. daily would normally be required to maintain a 27.5 litre average milk production in the high production group.

The low group was less affected because their grain ration was fed in the milk parlour, however, they had not regained the body condition which they had lost due to underfeeding in early lactation.

R^x Correct the calibration of the computer feeder to deliver correct amount of grain ration.

Outcome: Cows increased production by 15% within 1 week of correcting the calibration of the computer feeder, and returned to normal production and appetite in 2-3 weeks.

B. Reproductive Failure Due to Excess Degradable Input Protein

Clinical Signs Conception rate 22%, interval to 1st service 110 days.

Ration Information

Roughage: Alfalfa haylage, Alfalfa hay — *Grain:* Puramix Dairy Ration, Top Feed B37

Serum Profile - 10 Cows 60-150 D.I.M.

	Sample Mean	Reference Mean
Total Protein g/L	74.0	73.5
Albumin g/L	35.0	35.2
Urea mmol/L	7.9	6.6
Glucose mmol/L	3.2	3.6

Diagnosis: The high average urea level could indicate excess urea in uterine fluid and failure of fertilization[4 & 5].

Treatment: Adjust ration to reduce amount of degradable input protein.

Herd Profile - Same 10 cows (2 months later)

	Sample Mean	Reference Mean
Total Protein g/L	70.0	73.5
Albumin g/Ll	32.5	35.6
Urea mmol/L	5.7	6.6
Glucose mmol/L	3.2	3.6

Outcome: Conception rate 70%, open interval 128 days.

C. Anorexia and Ketosis in Early Lactation and Reproductive Failure

History - Sixty cow tie stall barn
B.C.A. 160-173 -171 Average daily milk/cow 26 kg

Average Days in Milk - 189 - calving interval 14.5 mo.
- frequent brief periods of anorexia
- delayed interval to first heat
- 40% incidence of ketosis
- rapid loss of body condition during first 60 days in milk
- Body scores 1.5-2.0 in early lactation cows.

Feeding Program - mixed legume hay 20 lbs/day
Feed Bunk - alfalfa haylage and corn silage 1:1 (35 lbs/day)
Computer feeder 5 x daily. Grain ration + top-dress 44% to cows producing over 30 kg milk.

Herd profile - 5 cows 4-115 days in milk

	Sample Mean	Reference Mean (or range)
Glucose mmol/L	2.8	3.6
A.S.T. U/L	60.0	72.5
Cholesterol mmol/L	4.84	1.5-5.5
Beta-Hydroxybutyrate umol/l	498.0	620.0
Haemoglobin g/L	90.0	115.0
Albumin g/L	33.6	35.2
Urea mmol/L	4.94	6.6
Sodium mmol/L	133.0	142-150
Potassium mmol/L	4.5	4-5

Diagnosis: The average glucose level is close to the minimum acceptable (2.6 mmol/L) and well below the mean (3.6 mmol/L) indicating the need for increased energy in the ration. Additional findings are low albumin, urea and haemoglobin levels indicating the need for additional protein in the ration. Sodium levels are low due to intentional minimum salt levels in the ration.

Treatment:
(1) Ration evaluation with consideration for additional energy, protein and salt.
(2) Submit a follow-up profile of early lactation cows in 30-60 days after ration adjustment.

Summary

Blood profiles are a valuable tool in individual animal and herd problems. They are most helpful when clinicians and clinical pathologists interpret them in conjunction with herd history and clinical signs, and ration evaluation. The results should be interpreted by comparison with reference means according to stage of lactation.

Ration adjustments are usually indicated in problem herds. If so, a profile should be repeated in 30 days to monitor results.

Metabolic, reproductive and production problems occur during the first 150 days in milk. Therefore, a profile of only the problem groups of cows may be adequate to assist diagnosis in some situations.

Blood profiling could be a useful procedure in dairy health management programs. Practitioners could monitor the effect of new ration formulations and changes in feeding programs with strategic herd profiling.

Practitioners and diagnostic laboratories may wish to establish reference means unique to their area and feeding programs. Profiles from problem herds can then be compared for diagnostic purposes.

References

1. Hewitt, C. On the causes and effects of variations in the blood profile of Swedish dairy cattle. Acta Vet Scan. (Supplementum 50); 1974. 2. Hoff, B., Cote, J.F. Guidelines for the Submission of Metabolic Profiles, O.M.A.F. Extension Notes for Veterinarians, No. 368, November 1988. 3. Cote, J.F. Protein Deficiency in a Dairy Herd. VII World Congress on Diseases of Cattle, 1972 Proceedings. 4. Ferguson, James D. Production and Reproduction in Dairy Cows. SOV Conference 90 Proceedings. 5. Ferguson, James D. Feeding for Reproduction. Proceedings of Symposium "The Application of Nutrition in Dairy Practice". North Carolina State University, 1988.

TABLE III Hematology Reference Ranges

Test	Reference Range
WBCs	3.8 - 11.0 x10**9/L
RBCs	5.0 - 7.7 x10**12/L
Hgb	85 - 132 g/L
Hct	0.24 - 0.36 L/L
MCV	38 - 56 fL
MCH	14 - 20 pg
MCHC	317 - 404 g/L
WBC Differential Counts	**X10**9/L**
Neutrophils	0.7 - 4.9
Bands	0 - 0.2
Lymphocytes	1.0 - 5.8
Monocytes	0 - 0.9
Other	
Fibrinogen	2.4 - 7.4 g/L
TS Protein	59 - 81 g/L

TABLE IV Protein Degradability in the Rumen[5]

Feeds	Degradability
High protein degradability (>.65)	
Alfalfa (early bloom)	
Haylage (35% dry matter)	.80
Haylage (65% dry matter)	.70
Hay	.75
Corn Silage	.75
Urea	1.00
Soybeans	.80
Soybean meal	.70
Cottonseed meal	.70
Barley	.80
Beet pulp	.80
Citrus pulp	.80
Medium protein degradability (.55 -.65)	
High-moisture corn	.65
Cottonseed	.65
Corn gluten feed	.65
Extruded whole soybeans	.60
Wheat bran	.60
Low protein degradability (<.55)	
Dry corn	.50
Dry brewers' grain	.50
Corn gluten meal	.45
Distillers' dried grain	.45
Hominy	.40
Fishmeal	.30
Corncobs	.20
Straw	.20

TABLE V Guidelines for Submission of Metabolic Profile[2]

Please fill in this form when submitting samples for metablic profile analysis:

1. **Vital Statistics**

   (a) Referring clinic customer #_____

   Veterinarian(s) name/clinic _____

   Clinic Customer # _____

   Address _____

   City _____ Province _____ Postal Code _____

   Phone ( ) _____

   (b) Farmer _____ client customer # _____

   Name _____

   Address _____

   City _____ Province _____ Postal Code _____

   Phone ( ) _____

   (c) Total No. cows _____

   Milking _____

   Dry _____

   (d) Breed _____

2. **Samples**

   (a) Date sampled _____ Time _____ a.m./p.m.

   (b) Cows sampled: (be sure to collect a serum tube, and EDTA lavender tube from each cow).

3. Brief history of herd including chief complaint, herd evidence of metabolic disorders, retained placentas, etc.

_____

_____

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_____

_____

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Cow Name or #	Age	Days in Milk	Current Production lbs/day	Body Score 1-5

4. Feeding Program

Feed	Amount fed (lbs/day)
Grain mix	
Corn silage	
Hay crop silage	
Hay	
High moisture corn	
Mineral Mix	

Abstract:

Studies on the incidence of clinical mastitis and blood levels of vitamin E and selenium in dairy herds in England

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In a trial conducted in the south of England in January to February 1989, blood samples were obtained from nine dairy herds with more than 30 cases of clinical mastitis/100 cows and from nine herds with less than 30 cases/100 cows during the previous 12 months. Whole blood gluthathione peroxidase (GSHPx) activity and plasma vitamin E concentration were determined for 12 cows in each herd. The mean (±sd) values for the herds with the lower incidence of mastitis were 7·57 ± 1·86 μg/ml plasma vitamin E and 23·8 ± 22·8 U/ml rbc GSHPx activity, compared with 7·74 ± 1·69 μg/ml plasma vitamin E and 20·61 ± 8·8 U/ml rbc GSHPx activity for the herds with the higher incidence of the disease. These values indicate that the vitamin E levels were generally adequate but that some animals and herds had low GSHPx activities, suggesting that their diets may have contained inadequate selenium. The activities of GSHPx and the vitamin E levels in plasma were not significantly different in the two groups of herds, and no relationship was found between the two nutrients and the incidence of clinical mastitis. However, there was a significant negative correlation between the activity of GSHPx and the bulk milk cell counts in the herds with a low incidence of mastitis suggesting that there was an association between the incidence of subclinical mastitis or inflammation and the selenium status of these herds.