Plasma and Urine Biochemical Profiles in Grazing Holstein-Friesian First Calf Heifers

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Introduction

The metabolic changes are characterized initially by biochemical alterations in the body fluids (blood, urine, ruminal fluid) and thereafter by reductions in the quantity and quality of milk production, susceptibility to diseases, infertility and increases in morbidity and mortality in calves. Metabolic profiles can be used as monitoring methods for the diagnosis and prevention of subclinical metabolic diseases, for investigation of herd health problems or suboptimal herd performance and for the diagnosis of nutritional deficiencies.[3,5,14]

The objectives of this research were to determine the dynamics of biochemical parameters in plasma and urine in Holstein-Friesian first-calf heifers.

Materials and Methods

Six American Holstein-Friesian first calf heifers (AHF) and 7 New Zealand Holstein-Friesian first calf heifers (NHF) close to parturition were kept in a pasture-only system composed of legumes (alfalfa and white clover) and grass (rye grass and orchard). Dry matter (DM) content of pasture was measured every 2 weeks and the assignment of pasture as square meters for grazing was done twice a day, controlled by electric fences. Dry matter assignations were done considering a daily dry matter intake of 3.6% of the heifers' body weight, with 38.54 lbs of dry matter (17.5 kg) for the AHF group and 35.24 lbs of dry matter (16 kg) for the NHF group. Stocking rate was 3.2 AHF and 3.5 NHF per hectare plus an additional 30% of pasture area was made available to the heifers to procure maximum dry matter intake.

Blood and urine samples were taken between 8 and 11 am on a fixed day of the week at previously determined intervals according to the analysis required. Blood samples from the jugular vein (5 ml in a vacutainer tube with EDTA [10-20 mg/10 ml] were taken for the determination of PCV (microhematocrit) and plasma protein (refractometry).[2] An Additional 10 ml of blood was collected in a vacutainer tube with sodium heparin (15 IU/ml) for determination of glucose, PUN, AST and inorganic phosphorus by photocolorimetry,[19*] sodium and potassium by an electrolyte analyzer[19**] and calcium and magnesium by atomic absorption spectrophotometry.[1,7***]

Urine samples were taken (30-50 ml) by catheterization of the bladder[5] and the analyses were performed immediately. Physical characteristics included color, odor, turbidity, and specific gravity by refractometry. Chemical characteristics included ketone bodies, bilirubin, urobilinogen, hemoglobin and blood using urine strips,[****] proteins by the sulphosalicilic acid method and pH was measured with a pH meter.[6*****]

Statistical analysis consisted of means and standard deviations for each variable studied throughout the entire lactation for each breed of heifers and comparison of the results with reference values.[4,11,12,18]

Results and Discussion

Glucose (Table1) was slightly elevated in the NHF group (84.5 mg/100ml) at 2 weeks pre-calving, but this could have been the result of less management exercised on this group during rearing period. Calcium levels were statistically different between the AHF and the NHF (10.33 and 10.18 mg/100 ml), but they were within the reference values. In addition hypocalcemia is very rare in first calf heifers. Inorganic phosphorus and potassium were low in both groups at 2 weeks pre-calving, but low levels of plasma phosphorus are common in dairy cattle grazing in temperate climates.[16] Pasture can provide sufficient phosphorus for maintenance requirements and for a daily milk production of approximately 44 lbs (20 l). In this study milk production was above 44 lbs (20 l) per day in both groups between 3 and 14 weeks

Table 1. Plasma levels of glucose, calcium, inorganic phosphorus and potassium

Breed*	2 weeks pre-calving	At calving	Weeks after calving 4	8	12	16	24	32	40	X**	sd**	p	refv***
						Glucose (mg/100ml)							
AHF	71.3	74.7	65.4	63.3	70.8	72.0	57.0	73.5	68.0	68.4	5.68	>0.05	45-75
NHF	84.5	77.0	66.5	80.0	74.8	86.3	53.2	65.0	74.0	73.5	###		
						Calcium (mg/100 ml)							
AHF	10.75	10.20	10.62	10.56	10.51	10.66	9.10	10.50	10.03	###	0.51	<0.05	9 - 11.5
NHF	11.03	10.43	10.31	9.88	10.73	10.32	9.85	9.57	9.53	###	0.51		
						Inorganic phosphorus (mg/100 ml)							
AHF	3.2	4.0	4.0	4.9	5.4	4.9	3.9	5.0	4.7	4.44	0.70	>0.05	4 - 7
NHF	4.1	4.5	3.2	4.5	4.2	4.5	5.1	4.8	4.3	4.36	0.53		
						Potassium (mmol/l)							
AHF	3.73	3.95	4.18	4.55	4.22	4.11	4.04	5.03	4.53	4.26	0.39	>0.05	3.9 - 5.5
NHF	3.70	3.93	4.12	4.05	4.35	4.44	4.16	4.95	4.36	4.23	0.36		

* AHF=American Holstein-Friesian first calf heifers; NHF=New Zealand Holstein-Friesian first calf heifers
X**=mean; sd**=standard deviation refv***=reference values [4, 11, 12, 18.]

after calving, but plasma phosphorus was only low in the NHF group on week 4 and in the AHF group at 2 weeks pre-calving. This may indicate that the micromineral mix provided to heifers was effective for satisfying their maintenance and production needs. The slightly low values of potassium (3.73 and 3.70 mmol/l) at 2 weeks pre-partum could have been caused, according to Goff and Horst,[9] by low levels of DM intake and by lack of pasture fertilization. In addition and according to Parker,[15] the potassium levels from the jugular vein are approximately 5% lower than the levels from the coccigeal vein due to intake by the salivary glands. Considering that our samples were taken from the jugular vein, the adjusted values would be in the lower limit of the reference values (3.91 and 3.89 mmol/l).

PUN values (Table 2) found in this study (14.69 and 15.79 mg/100 ml, respectively,) were within the reference values. Hof et al.[10] and Payne et al.,[17] reported elevated values of urea nitrogen in serum of dairy cows grazing pastures with high levels of fertilization with nitrogen. In addition, Kolver and Mac Millan[13] stated that the nutritional value of pasture and the stocking rate produced daily variations in the values of urea nitrogen.

PCV, plasma protein, AST, magnesium and sodium were within the reference values (Table 2). There were ketone bodies (Table 3) in urine at very low levels (10 mg/100 ml) in 33% and 16% of the AHF at 4 and 8 weeks after calving, respectively, and in 29% and 14% of the NHF at calving and 4 weeks after calving, respectively. These levels of ketone bodies are indicative of subclinical ketosis at its lowest level and are transitory during the same day. This, along with normal plasma levels of glucose, suggest that it did not have any impact upon the productivity or health of the heifers. Some authors consider this level of marginal ketonuria as normal at the beginning of the lactation.[8,17] Urine pH was within the reference values. There were no proteins, bilirubin, hemoglobin/blood and no increase in urobilinogen. There were no alterations in the specific gravity, color, smell or the turbidity of the urine.

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Table 2. Plasma levels of PUN, PCV, proteins, AST, magnesium and sodium

Breed*	2 weeks pre-calving	At calving	Weeks after calving 2	4	6	8	10	12	16	24	32	40	X**	sd**	p	refv***
							Plasma urea nitrogen (mg/100 ml)									
AHF	12.85	15.09	12.90	12.06	11.50	16.45	14.21	14.35	16.17	15.56	17.76	17.43	###	2.07	>0.05	10 a 18
NHF	14.02	14.39	13.60	13.83	17.85	15.84	16.26	15.56	15.42	18.36	17.48	16.82	###	1.62		
							PCV (%)									
AHF	33.3	34.3		34.1		28.8		29.3	30.1	31.3	31.5	33.2	31.8	2.07	>0.05	28-38
NHF	35.7	32.9		34.6		34.3		30.7	33.7	32.3	33.0	33.2	33.4	1.44		
							Protein (g/100 ml)									
AHF	7.8	7.2		8.0		8.3		8.5	8.7	8.6	8.2	7.9	8.1	0.47	>0.05	6.5-8.5
NHF	6.9	6.8		7.7		8.1		7.9	8.4	8.0	8.3	7.4	7.7	0.58		
							AST (UI/l)									
AHF	57.3	71.7		86.8		81.3		82.8	73.3	55.5	64.5	77.0	###	###	>0.05	40-90
NHF	70.8	78.2		67.0		70.2		65.7	71.1	83.5	84.7	74.8	###	6.84		
							Magnessium (mg/100 ml)									
AHF	2.82	2.51		2.49		2.30		2.51	2.56	2.80	2.80	2.37	2.57	0.19	>0.05	1.9 a 2.8
NHF	2.00	2.63		2.06		1.93		2.43	2.74	2.55	2.57	2.55	2.38	0.30		
							Sodium (mmol/l)									
AHF	141.0	142.7		141.8		141.0		137.4	135.2	137.0	140.5	140.3	###	2.5	>0.05	135 a 150
NHF	141.3	144.0		138.8		139.8		139.7	137.1	137.8	138.0	136.8	###	2.3		

* AHF=American Holstein-Friesian first calf heifers; NHF=New Zealand Holstein-Friesian first calf heifers
X**=mean; sd**=standard deviation refv***=reference values [4, 11, 12, 18].

Table 3. Ketone bodies and urine pH

Breed*	2 weeks pre-calving	At calving	Weeks after calving 4	8	12	16	24	32	40	X**	sd**	p	refv***
						Ketone bodies ****, % (+ / n)							
AHF	0% (0/6)	0% (0/6)	33% (2/6)	16% (1/6)	0% (0/6)	0% (0/6)	0% (0/6)	0% (0/6)	0% (0/6)	5% (3/54)	-	-	0%
NHF	0% (0/7)	29% (2/7)	14% (1/7)	0% (0/7)	0% (0/7)	0% (0/7)	0% (0/7)	0% (0/7)	0% (0/7)	4.7% (3/63)	-	-	0%
						pH							
AHF	8.42	8.33	8.58	8.37	8.38	8.33	8.13	8.50	8.31	8.37	0.13		
NHF	8.33	8.41	8.25	8.38	8.55	8.20	8.29	8.26	8.30	8.33	0.10	>0.05	7.7 - 8.4

* AHF=American Holstein-Friesian first calf heifers; NHF=New Zealand Holstein-Friesian first calf heifers
X**=mean; sd**=standard deviation refv***=reference values [4, 11, 12, 18]. Ketone bodies ****=10 mg/100ml

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** Ciba Corning, 644, Essex, United Kingdom.
*** Perkin Elmer, 3119, Norwalk, CT, USA.
**** Comburtest, Boehringer Mannheim, East Sussex, Great Britain.
***** Hanna Cheker Instruments, portable pH meter.