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Calf Note 179 – Effect of heat stress prepartum on basal metabolism of calves after birth

Introduction

Research continues to show that prenatal stress can affect metabolism of the offspring. This appears to hold true for many different species of animals, including cattle. One stress that consistently affects pregnant dairy cows is heat stress. Previous research has shown that prenatal heat stress on the dam affects calf body weight (calves from heat stressed cows are up to 5 kg lighter than calves from cooled cows), and immune function (Tao et al., 2012).

The Research

Researchers at the University of Florida (Tao et al., 2014) housed 20 dry cows in a cooled (**CL**) or non-cooled, heat stress (**HT**) environment at drying off. When calves were born, they were immediately separated from their dams and fed 3.8 L of high quality colostrum by 1 hr after birth and then 1.9 L of colostrum again in about 12 hr. From d 2 to 42, calves were fed pasteurized milk (1.9 to 3.8 L/day) and decreasing amounts to weaning at d 49. Calf starter and water were available for ad lib consumption from 2 d of age. On d 55, calves were exposed to two different metabolic tests, a glucose tolerance test (**GTT**) and an insulin challenge (**IC**).

The goal of the GTT is to find out how calves respond when a dose of glucose is infused into the jugular vein. Typically, blood glucose will increase after administering the glucose into the vein, followed by an increase in blood insulin concentration. The body secretes insulin into the circulation to regulate blood glucose; as glucose rises, insulin is secreted, which promotes uptake of the glucose from the circulation into many different body tissues. In this way, blood glucose can be closely regulated by the animal.

Table 1. Descriptive statistics for cows exposed to cooled (CL) or heat stress (HT) environments and their calves on d 55 of age.

Item	CL	HT	SE	*P*
n	10	10	…	…
THI	74.4	75.2		NS
Cow rectal temp, °C	38.7	39.0		0.05
Cow respiration, bpm	49.1	69.7		0.05
Calf BW, kg	45.0	40.2	1.4	0.03
BW gain, kg	28.0	26.3	2.2	NS
Calf glucose, mg/dl	65.2	70.7	2.5	0.14
Calf insulin, ng/ml	0.26	0.26	0.02	NS
Calf NEFA, µEq/dl	442.8	434.6	55.3	NS

Source: Tao et al., 2014.

In the study by Tao et al., the concentration of both glucose and insulin in calves in both groups increased up to two hours after glucose infusion. Although there was no effect on insulin concentrations, the concentration of plasma glucose was lower in calves from HT cows. This suggests that when glucose was infused, calves from HT cows were more efficient in moving glucose from the circulation into other body tissues, so the pool of circulating glucose remained lower. So, it appears that other tissues, including fat cells, utilized glucose more efficiently when

calves came from HT cows. Although we want calves and heifers to utilize glucose efficiently, we also want to avoid directing that glucose towards adipose tissue, when it may contribute to over-fattening instead of good growth.

Results of the insulin sensitivity test also showed little effect of insulin injection on blood insulin AUC (area under the curve, a measure of concentration over time). However, when insulin was injected, calves born from HT cows had lower glucose AUC compared to calves from CL cows.

Taken together, these data suggest that basal metabolism of calves is affected by the stress imposed on the mother during gestation. This study shows that the way calves use glucose is altered.

Whether this alteration in metabolism of glucose affects the animal's predisposition is not completely clear; however, other data suggest that increased uptake of glucose in response to GTT or IC does predispose animals to increased risk of adipose deposition.

Managing the environment of cows is important to their health and continued productivity. Results from this study suggests that cooling dry cows is also important for the health and, perhaps, future productivity of the calf.

Table 2. Response of calves to glucose tolerance and insulin sensitivity in calves from cows exposed to cooled (CL) or heat stress (HT) environments.

Item	CL	HT	SE	P
Glucose tolerance test				
Insulin AUC[1]				
30 min	10.91	9.74	3.20	NS
60 min	17.41	14.81	3.75	NS
120 min	25.59	20.37	3.98	NS
Glucose AUC[2]				
30 min	1,838	1,633	56	0.02
60 min	3,074	2,642	177	0.11
120 min	3,796	3,146	371	NS
Insulin sensitivity test				
Insulin AUC[1]				
30 min	46.46	42.02	2.53	NS
60 min	54.12	48.24	3.11	NS
Glucose AUC[2]				
30 min	-505	-648	41	0.03
60 min	-1,392	-1,783	98	0.01

Source: Tao et al., 2014.

[1]AUC: ng x min /dl

[2]AUC: mg x min/dl

References

Tao, S., A.P.A. Monteiro, M. J. Hayen, and G. E. Dahl. 2014. Short communication: Maternal heat stress during the dry period alters postnatal whole-body insulin response of calves. J. Dairy Sci. 97:897–901.

Tao, S., A.P.A. Monteiro, I. M. Thompson, M. J. Hayen, and G. E. Dahl. 2012. Effect of late-gestation maternal heat stress on growth and immune function of dairy calves. J. Dairy Sci. 95:7128–7136.