PUBLICATIONS
1993

FIELD DAY REPORT - 1993

Texas A&M University Agricultural Research and Extension Center at Overton

Texas Agricultural Experiment Station
Texas Agricultural Extension Service

Overton, Texas

May 28, 1993

Research Center Technical Report 93-1

NONSHIVERING THERMOGENESIS IN *BOS TAURUS* AND *BOS INDICUS* NEWBORN CALVES

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Background. Neonatal calf mortality losses are second only to infertility in contributing to low reproductive rates in cattle. One of the primary factors associated with newborn calf mortality is hypothermia caused by extremely cold ambient temperatures and(or) thermoregulatory dysfunction during the neonatal period. The incidence of neonatal calf mortality relating to cold intolerance appears to be influenced by breed. A recent study has reported mortality rates of 3, 3, 8 and 21% for calves with 0, 25, 50 and 75% *bos indicus* breeding, respectively, demonstrating that *bos indicus* calves are more susceptible to cold stress during the neonatal period than *bos taurus* calves.

Maintenance of thermal balance in newborn calves requires an acute and sustained thermogenic response, which is derived from shivering thermogenesis in muscle tissue and nonshivering thermogenesis in brown adipose tissue (BAT). In response to cold stress, newborn calves have been shown to elevate their thermogenic rates by up to 3.6 times the thermoneutral thermogenic rate. It is estimated that roughly half of the cold-induced thermogenesis is derived from nonshivering thermogenesis, therefore it is critical for newborn calves to have functional BAT during the early postnatal period to avoid hypothermia and ensure calf survival. The objective of this experiment was to examine nonshivering thermogenesis in *bos taurus* and *bos indicus* newborn calves.

Research Findings. Angus (A) and Brahman (B) females were bred by artificial insemination to Angus, Brahman and Tuli (T) sires to produce the following calf breedtypes: (1) purebred A calves from A dams (n=5), (2) B x A calves born to A dams (n=8), (3) T x A calves born to A dams (n=7), (4) purebred B calves born to B dams (n=10), (5) A x B calves born to B dams (n=7) and (6) T x B calves born to B dams (n=9). The Tuli breed is an African *bos taurus* breed that is subtropically adapted. At birth, calves were separated from their dams, fitted with indwelling catheters and placed in a temperature-controlled water immersion system maintained at 37°C. Once positioned in the water-immersion system, a temperature probe was inserted into the right ear in close proximity to the tympanic membrane to monitor tympanic temperature (TT) changes, and calves were fitted with a ventilated face mask to collect expired air in order measure metabolic rates using indirect-respiration calorimetry. Metabolic rates were

measured before (thermoneutral metabolic rate; TM) and after norepinephrine infusion to determine norepinephrine-induced peak metabolic rate (PM). Peak metabolic rate is proportional to nonshivering thermogenesis and thus reflects brown adipose thermogenesis in newborn animals.

Birth weights of calves born to B dams were 11.8% lighter (P=.008) than calves born to A dams (see Table below). Breed of sire and dam had no effect on TM rates, although breed of sire and dam, and its interaction were significant for PM rates and PM to TM rate ratios. Calves born to B dams had lower PM rates than calves born to A dams, but the magnitude of the reduction was breed of sire dependent. The B maternal reduction in PM rate was greatest for T-sired calves (34.3% decrease in TB vs TA), intermediate for B-sired calves (15.3% decreased in BB vs BA) and lowest for A-sired calves (4.1% decrease in AB vs AA). The PM to TM ratios were highest for TA calves (2.43) and lowest for BB calves (1.66). The B maternal reduction in birth weights and PM rates produced even greater reductions in total PM (cal•calf^{-1}•min-1). NE-induced peak TT were significantly correlated with PM rates (r=.46; P<.001) and reflected treatment differences noted in NE-induced thermogenesis.

Table 1. Thermoneutral (TM) and peak metabolic (PM) rates and peak tympanic temperatures (TT) in newborn Angus- (A), Brahman- (B) and Tuli-sired calves born to Angus and Brahman dams.

	--------Breedtype (sire, dam breed)---------						-------P values----------			
	AA	BA	TA	AB	BB	TB	Dam	Sire	DxS	SE
Birth weight, kg	34.7	38.1	33.6	32.3	31.5	30.0	.008	.23	.51	2.24
TM rate[a]	28.6	27.6	29.7	30.0	28.9	26.5	.69	.92	.19	1.73
PM rate[a]	60.8	56.3	71.7	58.3	47.7	47.1	.0001	.009	.001	3.35
PM:TM ratio	2.14	2.05	2.43	1.94	1.66	1.80	.0001	.02	.09	.112
Total PM[b]	2110	2146	2403	1872	1494	1404	.0001	.40	.02	148.1
Peak TT, °C	38.54	37.82	38.55	38.16	37.54	37.51	.01	.05	.29	.323

[a]TM and PM rates, cal•kg^{-1}•min^{-1}. [b]Total PM, cal•calf^{-1}•min^{-1}.

Application. These research results suggest that newborn Brahman calves as well as newborn calves born to Brahman dams have lower nonshivering thermogenic rates than *bos taurus* calves. A lower nonshivering thermogenic capacity may be one factor which contributes to higher neonatal mortality in *bos indicus* calves. Results from this study will form the basis for future experiments to determine the mechanisms which limit nonshivering thermogenesis in newborn Brahman calves. Successful completion of these experiments will eventually lead to the development of strategies to minimize newborn calf mortality.