Effects of Environmental Cold on the Preruminant Calf

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Summary and Implications

This study examined effects of sustained environmental cold on growth and health of dairy calves. Functional measures of energy metabolism, fat-soluble vitamin and mineral status, and immune competency were also evaluated. Newborn calves were assigned to warm or cold environments for 7wk. Cold environment temperature were maintained as close to 2°C as possible. Frequent wetting of the environment and calves augmented effects of the cold. The warm environment was maintained as close to 15°C as possible and humidity was not manipulated. Preventative medications or vaccinations were not administered. All calves were fed a non-medicated MR (20% CP and 20% fat fed at .45 kg/d) and non-medicated starter ad libitum. Cold environment averaged 12°C lower than warm environment during the study period. Humidity averaged 10% higher in the cold environment. Respiratory health of the warm environment calves was moderately better than that of cold environment calves. Scour scores were unaffected by cold exposure. Growth rate was unaffected by environmental temperature; however, cold environment calves consumed more starter from wk 5 to 7. Blood glucose concentrations were lower and NEFA concentrations were higher in cold environment calves, indicative of a state of mild negative energy balance. Serum cytokine and fat-soluble vitamin concentrations, and antibody responses to vaccination were not impacted by sustained exposure to cold.

Introduction

Mortality rates for pre-weaned dairy calves range from 8 to 11% and the morbidity rate is approximately 37% (National Animal Health Monitoring Service, 2002). There is a dearth of information regarding the immune competency of the bovine neonate and how management factors influence immune response capacity of the calf and its resistance to infectious disease.

The objective was to evaluate the effects of sustained exposure to cold on the health, metabolism and immune system of preruminant dairy calves. Calves in warm and cold environments were fed the same milk replacer at a fixed rate and were provided starter grain ad libitum.

Materials and Methods

Calves were assigned randomly to environmental treatments at the beginning of the study (d 0) and remained in these environments during the 7wk study. Cold environment calves (n =14) were exposed to temperatures maintained as close to 1.7°C (35°F) as possible. Frequent wetting of the environment and calves augmented the affects of the cold. Warm environment calves (n = 15) were exposed to temperatures maintained close to 15.6°C (60°F). Environmental humidity was not manipulated. All calves were fed a non-medicated MR (0.45 kg/d, 20% CP and 20% fat) and a non-medicated starter (ad libitum, 18% texturized crude protein). From d 0 to 42 MR was fed twice daily and once daily thereafter. All calves were vaccinated subcutaneously on d 0 and d 35 with an ovalbumin in incomplete Freund's adjuvant. Preventative medications or vaccinations that might influence disease resistance were not administered. Calf weights were recorded weekly during the study. Calf health was observed daily. Body temperatures, scour and respiratory scores, and type and amount of antibiotics and electrolytes administered were recorded. Serum glucose and NEFA concentrations were determined using commercial kits; plasma fat-soluble vitamin concentrations by reverse-phase HPLC and RIA; OVA-specific antibody/TNF-α concentrations by capture-ELISA. Data were analyzed as a completely randomized design. Calf served as the experimental unit in the analysis of all data. Body weight, environmental temperature/ humidity, metabolites (i.e. fat soluble vitamins, copper and zinc), antibody and TNF-a levels were analyzed as a split-plot, repeated-measures ANOVA. The model included fixed effects of treatment (warm or cold), time, and the treatment × time interaction. Fisher's protected-LSD test was applied when effects were significant ($P < 0.05$).

Results and Discussion

Cold environment temperatures averaged 4.7°C (range: 1.2 to 10.5°C) and were lower than warm environment temperatures (mean: 15.5°C, ranging: 13.6 to 16.9°C) (Fig. 1). Cold environment humidity was moderately higher than in warm environment (68% versus 59%). Respiratory scores and antibiotics costs were moderately higher for cold environment calves (Table 1); however, the incidence and severity of diarrheal disease and electrolyte usage were not affected by environmental cold. Growth rates of both groups of calves were comparable; however, cold exposure was associated with increased intake of starter grain, and lower glucose and elevated NEFA concentrations (Figs. 2 & 3) suggesting that "cold-stressed" calves were in negative energy balance during the latter wks of the study.

Vitamin A, E, and D concentrations; antibody responses to vaccination; and TNF-α levels were unaffected by cold (data not shown).

In conclusion, growth performance and select metabolic and immune function variables were unaffected or minimally impacted by sustained exposure to cold. Cold environment calves manifested slightly elevated respiratory scores. The assured availability of adequate nutrition during periods of cold-stress calf likely benefited calf growth and health.

Figure 1. Mean daily temperatures (panel a) and relative humidities (panel b) in warm (—■—) and cold (--◇--) environments.
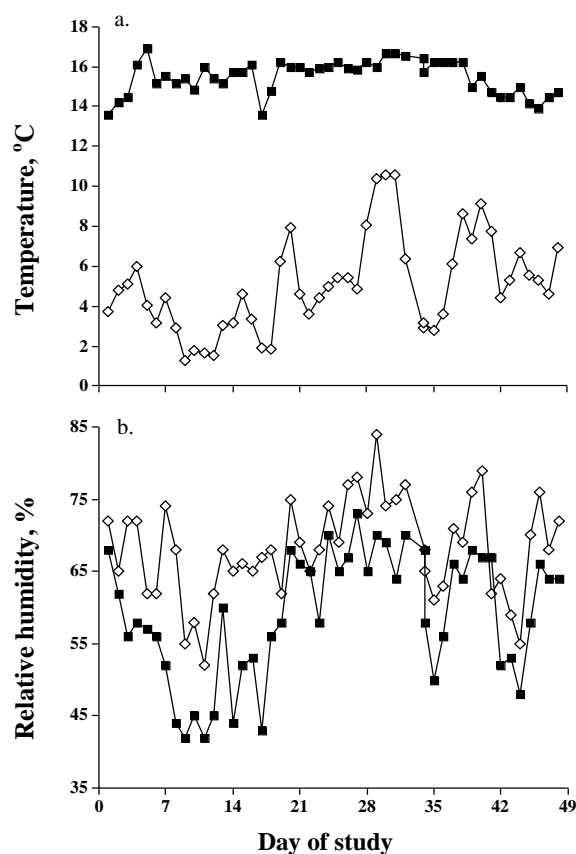
Figure 2. Body weights (kg, mean ± SEM) recorded weekly of calves in warm (—■—) and cold (--◇--) environments (panel a). Starter consumption (kg/wk, mean ± SEM) by calves in warm (solid bars) and cold (open bars) environments (panel b).
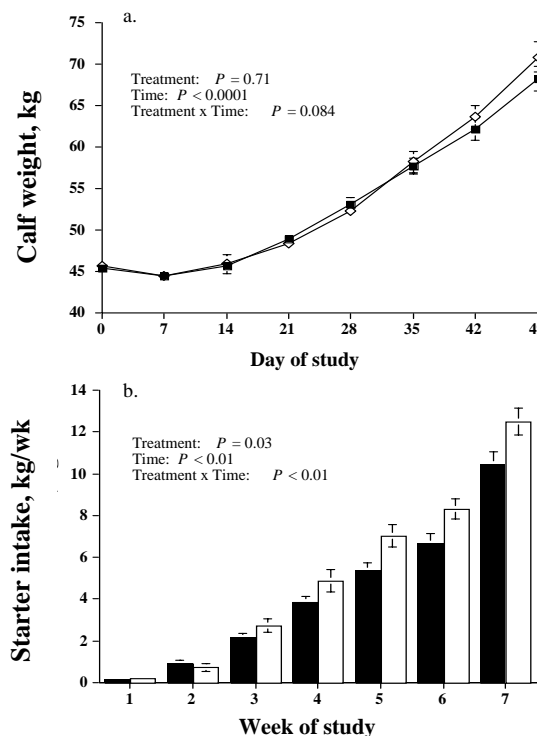
Figure 3. Blood glucose (mg/dL) and NEFA (mmol/L) concentrations (means ± SEM) in calves housed in warm (—■—) and cold (--◇--) environments.
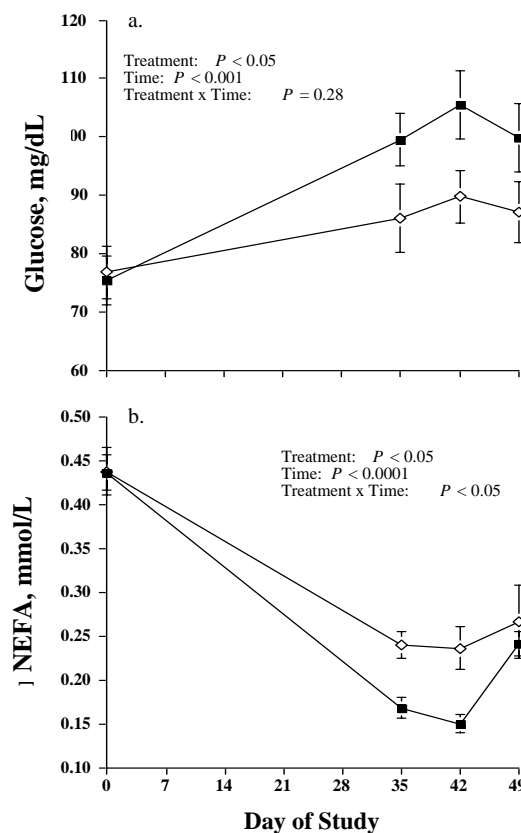
Table 1. Health of neonatal calves reared in warm and cold environments.

Variable[2]	Week of study[1]					
	1	2	3	4	5	6
Mean respiratory scores:						
Warm	1.6	2.8	0.7	0.6	1.6	0.7
Cold	0.7	2.2	2.8*	1.8*	2.0	2.2*
Mean antibiotic costs ($)						
Warm	2.94	3.21	1.16	1.23	2.31	0.88
Cold	1.04*	2.63	3.27*	2.20*	3.11	2.84*

[1]Wk 7 data not shown because treatment differences were not significant (P > 0.05)
[2]Scour score days, days scouring, and electrolyte costs were not affected by cold. These data are not shown.
*Treatment difference significant at specific week of study, P < 0.05.