THE POTENTIAL FOR SUBCLINICAL AMMONIA TOXICITY IN DAIRY COWS HOUSED WITH A TUNNEL VENTILATION COOLING SYSTEM: YEAR 1

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ABSTRACT: Tunnel ventilation may be a novel and viable alternative cooling system for dairy cows under heat stress. However, the effects of housing environment on air quality and performance need to be addressed if dairy cows are to be housed in an enclosed facility with tunnel ventilation during the entire lactation period. The effects of naturally occurring environmental ammonia concentrations on cows housed within a barn using a tunnel ventilation system were investigated using forty mature, lactating Holstein cows. Cows were assigned to one of two housing treatments (Freestall barn [Outside] or Tunnel Ventilation barn [Inside]) based on parity, stage of lactation, milk production, and energy corrected milk and fed the same ration. Blood samples and environmental data were collected at established intervals for seventy days from February until April 2002. Year 1 data suggest that there were no effects of type of housing on plasma ammonia-N (Inside mean = 173.9 µg/dL vs. Outside mean = 169.9 µg/dL) . Environmental measurements also show that the amount of ammonia (< 5 ppm), methane (< 5 ppm), and hydrogen sulfide (< 5 ppm) were below levels determined to be detrimental to animal and human health (25 ppm). The data also suggest that milk production (Inside mean = 75 lbs. vs. Outside mean = 73 lbs.) did not vary with treatment. Although the environmental ammonia levels were low in inside the tunnel ventilation barn, the cows did experience a slight sub-clinical ammonia toxicity.

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KEY WORDS: ammonia, subclinical ammonia toxicity, dairy cows, tunnel ventilation, dairy housing

MATERIALS AND METHODS: Forty mature lactating dairy cows were assigned to one of two housing treatments (Freestall Barn [Outside] or Tunnel Ventilation barn [Inside]). The tunnel ventilation barn was constructed by the conversion of an existing dairy barn and is a self-contained housing unit with cooling pads and four fans for pulling air originating at the cool cells. The facility has feed bunks, water tanks, freestalls bedded with sand, controlled lighting and waste management flush tanks to support 20 mature high-producing Holstein dairy cows. Cows that were housed inside were confined throughout the experimental period and only left the barn twice daily for milking.

Cows were allocated to treatments based on parity, stage of lactation, milk production, and energy corrected milk. Outside and Inside cows were fed the same corn-silage based ration formulated to meet NRC (2001) recommendations for Holstein cows. Blood samples were collected via jugular venipuncture into 7-mL blood-collection vacuum tubes containing potassium oxalate and sodium fluoride on days 0, 7, 28, 42, 56, and 70. Blood samples were placed on ice, transported to the laboratory for processing and stored at -20EC until analysis. Plasma was analyzed for ammonia N (McCullough, 1967) and will be analyzed for glucose (Diagnostic Kit #315, Sigma Chemical Co), urea-N (Chaney and Marbach, 1962), and nonesterified fatty acids (Kit #990-75401, Wako Chemicals USA). Insulin will also be measured using appropriate radioimmunoassay techniques. Environmental data (temperature, humidity, ammonia, methane, and hydrogen sulfide) from within the facility and the traditional free stall barn were collected. Temperature and humidity readings were recorded at five minute intervals using a HOBO® RH/Temperature data logger (Onset Computer Corporation, Bourne, MA) and environmental ammonia, methane, and hydrogen sulfide were measured via an Omni 400 portable gas and vapor detector (Enmet Corporation, Ann Arbor, MI). Environmental data was collected at the same time intervals as the blood in order to monitor and compare the air quality. Three of the four fans were set to automatically turn on at 10° F intervals beginning at 50° F. The fourth fan was set to run continuously. Milk production data was recorded daily and reproductive records was collected via the DHIA records. All data will be statistically analyzed using the general linear models procedures of SAS (1992).

RESULTS AND DISCUSSION: Year 1 data suggest there were no effects of type of housing on plasma ammonia-N (Inside mean = 173.9 μg/dL vs. Outside mean = 169.9 μg/dL; Figure 1). However, the data suggest that there was an effect of day with plasma ammonia-N concentrations being highest on Day 28 in both the Outside and Inside housed cows (Figure 2). Plasma ammonia-N levels in the range from 150 - 1,000 Φg/dL indicate a sub-clinical toxicity. The levels of plasma ammonia-N for the cows on the study suggest that all the cows (Inside and Outside) were experiencing slight cases of subclinical ammonia toxicity. However, this could have been due to the ration since all the cows were receiving the same ration.

Environmental measurements also show that the amount of ammonia (< 5 ppm), methane (< 5 ppm), and hydrogen sulfide (< 5 ppm) were very low in comparison to what health experts have determined as detrimental to animal and human health (25 ppm). Since environmental ammonia levels were low, it would follow that plasma ammonia-N concentration would not reach critical sub-clinical levels. The number of cows inside the tunnel ventilation barn (n=20) and the rate of air exchange did not allow for the build up of environmental ammonia. Plasma ammonia-N was elevated on Day 28; however, this rise was seen in both groups, suggesting that a change in the management practice affected the plasma ammonia-N. The other plasma metabolites (glucose and nonesterified fatty acids) remain to be analyzed and will add further information to provide a more complete metabolic profile. The data suggest that milk production was not different between the two groups (Inside mean = 75 lbs. vs. Outside mean = 73 lbs). This study will be repeated to collect additional data.

Although the environmental ammonia levels were low inside the tunnel ventilation barn, the cows did experience a slight sub-clinical ammonia toxicity in this study, further work is needed to determine the effects of a longer confinement period, different ventilation rates, particulates and other air contaminants, and minimal ventilation.

FIGURES AND TABLES:

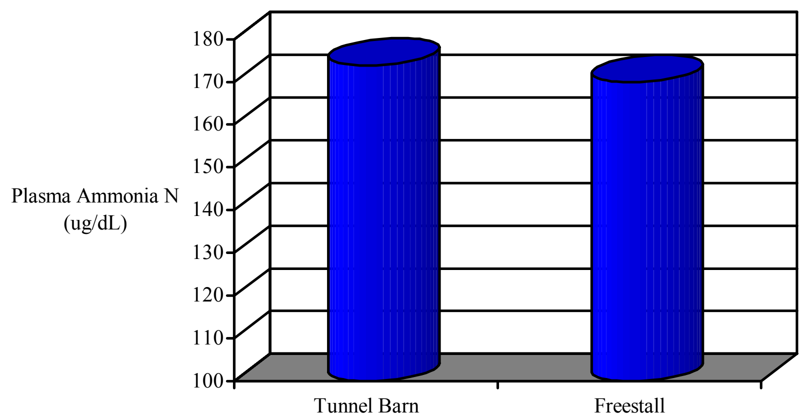

Figure 1. Effect of type of housing on plasma ammonia-N concentrations in lactating dairy cows.

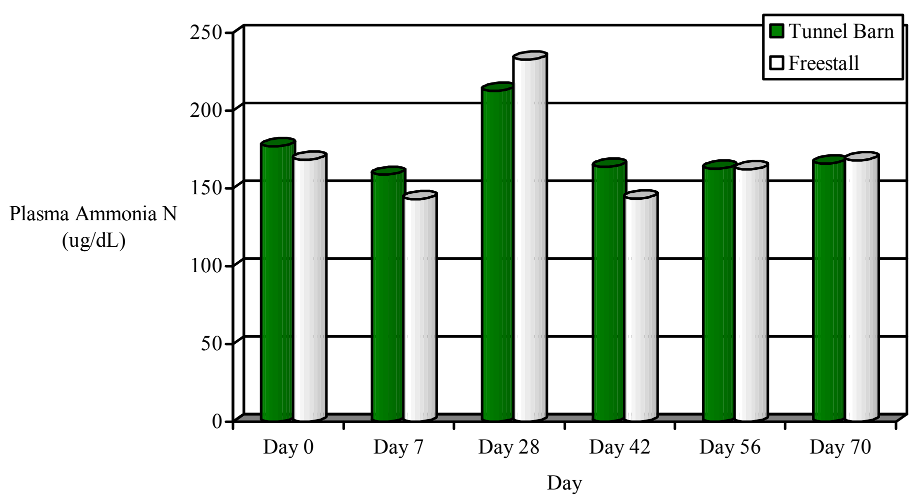

Figure 2. Effect of type of housing and day on plasma ammonia-N concentrations in lactating dairy cows.