Southeast Dairy Producer's Check-Off Program
Research Summary

Environmental effects and seasonality of growth and health of growing calves in different housing conditions

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Funding Year: 2023 **Amount Awarded:** $20,000

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Implications

This study identified different seasonal patterns in colostrum quality, passive immunity, preweaning growth of dairy calves under different management practices in different dairy farms. Our data suggested that, in addition to management and nutrition, environments at the day of birth, and during both the far-off and close-up periods impact colostrum quality, and passive immunity and size of the newborn calf. Further, the environments during the preweaning period affect body growth. And, housing conditions, e.g., outdoor vs. indoor, of the dam during the dry period and the calf during the preweaning period influence calf health and growth.

Methods

The experiment was conducted in three commercial dairy farms located in Central Georgia. The experiment spanned from November 2022 to January 2024. A total of 2,383 (Farm A: n = 849, Farm B: n = 836, Farm C: n = 698) heifer calves were enrolled at 2 to 4 days of age. The birth dates of enrolled calves ranged from October 30, 2022, to January 31, 2024.

Each farm utilized different calf housing methods (individual outdoor polyethylene hutches [Farm A], group housed equipped with automatic feeders under a calf barn [Farm B], individual wired hutches under a calf barn [Farm C]) but were close in proximal location to one another. Ambient temperature and relative humidity were measured hourly in dry cow locations, calving pens, and calf housing locations in all farms throughout the experimental period. In farm C, colostrum samples from individual cows were collected at the first milking to analyze colostrum solid using a Brix refractometer (MISCO AP201, Misco, Solon, OH). Blood samples were collected from all calves at the time of enrollment through the jugular vein into a 10-mL serum blood collection tube (BD Vacutainer, Becton, Dickinson and Company, New Jersey, USA). Samples were placed in room temperature for 3-6 h before centrifugation at 1,700 × g at 4 degrees Celcius for 30 min to collect serum. Serum was used to estimate total serum protein using a digital Brix refractometer. Body growth, i.e. heart girth, was measured for all calves every two weeks until weaning.

Results

Segmented analyses were used to examine the seasonal effects on colostrum brix value and passive immunity over a year (Jan 1st to Dec 31st, 2023). In farm C, from May to July, colostrum quality declined, while from July to September, the colostrum quality continued to improve over time. During the remainder of the year, the colostrum quality remained constant. This seasonal pattern of colostrum quality may indicate a negative impact of summer environment on colostrum quality. Correlation analysis suggests that the environment during the far-off period affected the quality of the colostrum as greater daily maximum and minimum THI led to lower colostrum brix value. Serum samples were collected from calves at 2 to 4 days of age to analyze brix values and estimate passive immunity on all farms. Different farms had distinct seasonal patterns for passive immune transfer. However, calves in all farms had greater serum brix value in spring (around March) and low serum brix value during summer and fall. Further, the environmental parameters collected during the far-off and close-up periods had the strongest correlations with the calves' serum brix value. This indicates that heat stress during the dry period negatively impacts the passive immune transfer.

Heart girth was used as a proxy for body growth and measured every two weeks until calving. The changes in heart girth were calculated based on differences between measurements. To understand how the environment during the preweaning period affects calf growth, the experimental period was divided into hot and cool seasons. The period when the average dairy ambient temperature consistently equal to or above 20 °C was defined as the hot season and the remainder of the experimental period was considered as the cool season. In both farms A and B, the hot season was defined as May 29 to October 7 and in farm C, the hot season was defined as May 29 to October 10. Within each season, the correlation between changes in heart girth in two-week increments and the environmental data within two of these weeks collected from locations where calves were housed was examined.

In farm A, during the hot season, the maximum, minimal, and average ambient temperature, and maximum, minimal, and average black globe temperature were negatively correlated with the heart girth growth but with weak coefficient of determination ($r^2 \leq 0.01$). Maximum ($r^2 = 0.03$), minimal ($r^2 = 0.02$), and average relative humidity ($r^2 = 0.04$) had negative correlation with heart girth growth ($P < 0.01$). High humidity prevents heat dissipation, especially without forced ventilation. The greater average daily relative humidity impaired heat dissipation, which may lead to lower heart girth growth. In contrast, during the cool season, on farm A, maximum, minimal, and average ambient temperature, and maximum, minimal, and average black globe temperature were negatively correlated with the growth of heart girth ($r^2 \leq 0.02$). During the cool season, although the average ambient temperature was consistently lower than 20 °C, the maximum temperature often exceeded 20 °C, indicating calves during the cool season did not experience consistent cold stress and experienced sporadic heat stress. Although the temperatures negatively correlated with body growth, the weak coefficient of determinations suggests the actual temperature within a day was not the determinant for body growth of calves in the cool season.

In farm B, during the hot season, the maximum, minimum, and average ambient temperature, and minimal relative humidity were negatively correlated with the heart girth growth ($r^2 \leq 0.02$). These data may indicate that elevated ambient temperature is associated with poor heart girth growth of calves during the hot season. In the cool season, preweaning heart girth growth had no significant correlation with environmental parameters, except for the positive correlations with maximum ($r^2 = 0.03$), minimum ($r^2 < 0.01$), and average ($r^2 = 0.02$) relative humidity. Different from farm A where calves were housed individually in polyethylene hutches and fed limited amount of milk, calves on farm B were housed in a group with ad libitum milk feeding with automatic feeders. Greater intake of calves supports greater metabolic heat production that may protect calves from changes in ambient temperatures in cool season. During the hot season, in farm C, the maximum ambient temperature, and maximum, minimum and average RH were negatively correlated ($P \leq 0.05$) with the heart girth growth but with weak coefficient of determination ($r^2 \leq 0.01$). During the cool season, the maximum ($r^2 = 0.02$), minimum ($r^2 = 0.02$) and average ($r^2 = 0.02$) ambient temperature were negatively correlated ($P < 0.01$), and the maximum RH was positively correlated ($P < 0.01$) with changes in heart girth.

In this study, calves in the 3 farms were housed (individual vs. group; outdoor hutches vs. barn) and fed (waster milk vs. milk replacer, limited vs. ad libitum feeding) differently, but we observed similar trends of correlations between calf growth and environmental parameters during the preweaning period, particularly during the hot season. These data suggest environments affect calf growth similarly regardless of the housing condition. The results from the current study suggest environments during the preweaning period can have significant effects on the calf's body weight gain in both hot and cool seasons. However, it is important to recognize that we observed relatively weak correlations between preweaning growth and environment ($r^2 \leq 0.05$) regardless of farms and seasons. This indicate that factors other than environment, such as management and nutrition, account for most of the variation of calf growth during the preweaning period.