Caloric Stress on Milk Production in Holstein Cows

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Abstract

There are several factors that can affect milk production, among which is the time of calving, but more specifically, the month of the year in which the cows have the parturition, due to environmental factors that can affect the degree of comfort of the animal. Particularly, the environmental temperature is extremely important; and it is estimated that when the maximum temperature exceeds 27°C, the environment stresses the Holstein cattle, affecting its productive behavior. The month of calving affects not only the shape of the lactation curve, but also the amount of milk produced. The objective of this study was to determine the effect of caloric stress of the calving month of the cows on the production adjusted to 305 days. The work was carried out in an agribusiness located in the municipality of Zapotlanejo, in the central region of Jalisco, with an inventory of 88 stabled Holstein cows, with feeding based on concentrate, corn silage and alfalfa, with two milkings and 100% artificial insemination. In the municipality, there is a maximum average temperature from March to June of 31 to 34°C. The information was obtained from the global report generated by the LACTO software of AGROPEC Star®, 73 births occurring in the year 2015 were analyzed. Data were processed through a polynomial regression using the SAS statistical package, considering the adjusted production at 305 days as a dependent variable and as an independent variable the month of calving. A significant effect ($p < 0.01$) of the month of parturition was observed in the production of milk adjusted to 305 days, which indicates that the month of parturition influences 88.35% of the production of milk, obtaining the lowest production in the month of June of 6,601 kg and the highest in the month of December of 10,365 kg with an average of 8,359.67 kg. The environmental conditions in the months of March to June, such as the temperature, significantly affected the milk production. It is recommended that the breeding season be scheduled so that calving occurs in the months where the temperature is more favorable to increase the productivity of the agribusiness.

Keywords

Cattle, Dairy, Housing, Temperature, Humidity

1. Introduction

In cattle, the time of calving affects the amount of milk produced and under stable conditions where feeding is not a limiting factor, milk production is influenced mainly by the climatic conditions present in the region where the agribusiness is located [1, 2]. In this regard, Johnson [3] mentions that the influence of climate on milk production in cattle has long been recognized. On the other hand, Rotter and Van de Geijn [4] and Zhao *et al.* [5] establish that climate af-

fects animal production in four ways: a) the impact of changes in the availability and price of grains to feed livestock; b) the impact on the production and quality of pastures and forage; c) the direct effect of weather and external meteorological phenomena on animal health, growth and reproduction; and, d) changes in the distribution of plant and animal diseases.

Among the main climatological factors that affect dairy cattle are temperature and relative humidity [6], which produce caloric stress in the animal. This is due to the fact that the animal is not able to lower its body temperature and overcome the existing heat, since the high relative humidity makes it difficult to evaporate the animals' sweat and, therefore, its thermoregulation [7, 8].

Another negative effect of caloric stress is the low consumption of feed, with the consequent decrease in energy consumption, generating in turn a negative energy balance, which would partially explain why cows lose weight and end up with a poor body condition when subjected to caloric stress [9]; in addition, cows in this condition tend to lose more saliva and minerals such as sodium and potassium [10]; under these circumstances, the combination of temperature and humidity values become more relevant [11], because humidity increases the effects of temperature. In this sense, it has been accepted that, to evaluate the environment from the point of view of caloric stress, the temperature-humidity index (HTI) is one of the best and most accurate [6, 8, 11], which determines the impact of caloric stress on dairy cattle. It has been considered that when the HTI is above 72, cows begin to suffer heat stress, the respiration rate exceeds sixty breaths per minute and a decrease in milk production begins to be observed; the rectal temperature of cows will rise above 38.5°C; recent studies suggest that even with an HTI below 72 some cows—especially high producing cows—may be negatively affected [11, 12]. The aim of this work was to evaluate the effect of caloric stress of the calving month on the production of milk adjusted to 305 days in a herd of Holstein cows.

2. Materials and methods

The present work was developed in an agribusiness located in the municipality of Zapotlanejo in the central region of Jalisco, with an inventory of 88 stabled Holstein cows, with concentrate feeding, corn silage, and alfalfa, two milking and 100% artificial insemination. The information was obtained from the global report generated by the software LACTO of AGROPEC Star®, 73 births occurred in the year 2015 were analyzed. Data were processed through a polynomial regression using the SAS statistical package [13], considering as a dependent variable the adjusted production at 305 days (P305D) and as an independent variable the month of parturition (MP).

The caloric stress index (CSI) was determined taking into consideration the monthly temperature and relative humidity data of 2015 in the municipality of Zapotlanejo [14] and considering the following equation [15].

$$CSI = [(1.8 \cdot T) + 32] - \{0.55 - [(0.55 \cdot RH)/100]\} \cdot [(1.8 \cdot T) - 26]$$

Where:

CSI: Caloric stress index.

T: Temperature in °C.

RH: Relative humidity in %.

The relationship between P305D and CSI was estimated by a simple linear regression using the SAS statistical package [13].

3. Results and discussion

A significant effect was obtained ($p < 0.05$) in the month of calving on the production of milk adjusted to 305 days, which indicates that the month of calving influenced 88.35% in the production of milk, obtaining the lowest production in cows that calved in the month of June (month 6) and the highest production in the births that occurred in the month of December (month 12) and an average of 8,359.67 kg (Figure 1).

On the other hand, a decrease in P305D was observed in calving that occurred from January to June and a constant increase from July. These results are mainly attributed to the effect of environmental factors that directly influence animal welfare, and consequently, production indicators [8]. In this regard, Brown-Brandl *et al.* [16] indicate that animals in intensive production systems have more restricted physiological mechanisms to cope with excess heat from the combination of high energy density (grain) diets, high temperature and high relative humidity summers than colder conditions in autumn and winter, so Hahn *et al.* [6] indicated temperature and relative humidity as the main environmental factors affecting the productivity of dairy cattle.

According to the CSI obtained for the year under study, a constant increase was observed until June with a maximum value of 79.7, from which the CSI begins to decrease (Figure 2). In this regard, Gaughan *et al.* [17] showed that milk production losses were directly related to the CSI, since animals are under heat stress, which reduces feed consumption and the quantity and quality of milk produced by cows [11]. These authors consider that when the CSI is higher than 72,

cows begin to suffer heat stress and suggest that with an CSI below 72 some cows may be negatively affected, especially the high producers.

Figure 1. Effect of calving month on adjusted production at 305 days in Holstein cows.

Figure 2. Monthly behavior of the caloric stress index calculated for 2015 according to Mader *et al.* (2006).

The observed behavior of the CSI during the study year was the opposite of the P305D obtained according to the cows' calving month, which indicates a decrease in the P305D as the CSI increases, this is due to the heat stress to which the animal is exposed, which increases respiratory rate, body temperature, increased need for water consumption and sweating, decreases feed consumption, decreases blood flow and consequently milk production [7, 8]. In this sense, Temple *et al.* [11] indicate that for each unit of CSI above 72, milk production decreases by 0.2 kg per cow per day, so some strategies have been proposed to reduce these effects such as increasing the contribution of fat in the diet, avoiding an excess of total and degradable protein, increasing the digestibility of fiber and providing food in the first and last hours of the day.

When relating the CSI to the P305D obtained according to the cows' month of calving, significant differences were

observed ($p < 0.05$) and an inversely proportional behavior, indicating a decrease in the P305D as the CSI increases (Figure 3). In this regard, Temple *et al.* [11] indicate that cows at the beginning of lactation are particularly sensitive to the effects of high temperatures and relative humidity, this is due to both high milk production and increased feed consumption since it is estimated that the heat generated in the digestion processes increases up to 20% the basal heat so one of the effects of caloric stress is the reduction of feed intake. In most cases, this response is manifested in changes in nutrient requirements, with water and energy being the most affected when the livestock is under caloric stress, these changes in requirements, as well as the strategies adopted by the animals to cope with the period of stress, cause a reduction in their productive performance [8, 16].

Figure 3. Relationship between the caloric stress index and production adjusted to 305 days according to the month in which the cows gave birth in 2015.

4. Conclusions

According to the results obtained, the month of calving influenced the 305-day adjusted production, observing the lowest production when the cows calved in June, coinciding with the highest caloric stress index.

The caloric stress index influenced the milk production adjusted to 305 days according to the month of calving of the cows, observing an inverse behavior among these variables.

5. Recommendations

Use these results to determine the breeding season to schedule births in the most favorable months and increase the productivity of the farm.

Establish some feasible strategies in terms of management and labor to reduce caloric stress on cows and avoid affecting milk production.

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