Volume 2 • Issue 1 • 2020

Research Article

Archives of Veterinary and Animal Sciences

The ITH and time of the Year in the Production of Dairy cows in the Cuban Tropics

Iván Peña G[1,3], Florangel Vidal F[1], Carlos Miguel Espinosa G[2], Redimio Pedraza O[1] and Aliesky Hernández R[1]

[1,3]Universidad de Camagüey Ignacio Agramonte Loynaz, Cuba

[2]UBPC Maniabo, Jobabo; Tunas, Cuba

***Corresponding Author:** Iván Peña G, University of Camagüey Ignacio Agramonte Loynaz, Cuba.

Received: April 12, 2020; **Published:** May 05, 2020

Summary

The study aimed to determine the effect of temperature and humidity (ITH) variations on cow dairy production in Las Tunas, Cuba. The work was carried out between January 2017 and December 2018. The statistical analysis was carried out, using the multivariate MLG procedure through a variance analysis, and a binary logistic regression analysis to estimate the risk factors affecting milk production, concluding that the problems caused by caloric stress for livestock are evident and accentuated by climate change, reflected in variations in temperature and humidity that negatively impact on dairy production.

Keywords: *Humidity temperature index; Time; Dairy cow; Tropics; Cuba*

Introduction

Heat stress has been widely recognized as a factor affecting the productivity, reproductive efficiency and health of production animals (Allen et al., 2015; Boni and Cecchini, 2014; Dash et al., 2016; Ruiz-García et al., 2018). In cattle ranching, temperature and humidity indices (Allen et al., 2015) and relative humidity (HR) have been used as indicators of animal welfare; considering rates greater than 74 as stressful (Aguilar et al., 2014; Ruiz and Sandoval-Monzón, 2019).

A slight decrease in production can be observed in dairy cattle in short periods of heat stress, but the consequences can be serious in prolonged periods of heat stress (St-Pierrre and Schnitkey, 2003; Ruiz-García and Sandoval-Monzón, 2018). Cattle respond to this type of stress by reducing feed consumption and increasing water consumption, in loss of water by evaporation and with increased respiratory rate and body temperature (West et al., 2003; Wheelock et al., 2010; Allen et al., 2015).

The great specialization of animals in milk production, translated by their great efficiency in the use of ingested food, triggers a high production of metabolic heat, making them more sensitive and susceptible to heat stress (Cerqueira et al., 2016). Furthermore, as a result of its action on food intake, heat stress influences the metabolism of the mammary gland and the composition of milk (Cerqueira et al., 2016). The objective of the present work was to determine the affectation of milk production by the effect of variations in temperature and humidity.

Materials and Methods

This work was carried out between January 2017 and December 2018 in the Vaquería 17 of the Basic Unit of Agricultural Production (UBPC) Maniabo, located in the Jobabo municipality. Jobabo is one of the eight municipalities in the province of Las Tunas, it is located to the southeast of the province, bordering the Gulf of Guacanayabo to the south, the municipalities of Tunas and Río Cauto to the east, Colombia and Guáimaro to the west and the north with the political divisions of Guáimaro and the Tunas municipality; Las Tunas province, Cuba.

The area has a tropical climate, with relatively humid summers, with long dry periods prevailing. Relative humidity is 85%. The duration of the rainy period is just over 80 days, with June and May being the most intense months, with rainfall averages of 219 and 179 mm respectively, while the least rainy are December and January, with 15 and 20 mm, due to their order. The circulation of the winds predominates from north to south, although its monthly behavior is variable, presenting maximum values in the months of September and October, with registered average speeds of 9.9 km/ h, especially in this last month.

Trade winds predominate, counteracted by breezes and reinforced by storms. The temperature is warm, predominantly partly cloudy skies in the period from April to August and slightly lower between December and March. The annual average temperature is 33ºC. The climate behaves with two well defined periods: consistent summer or rainy that was divided from June 1 to October 31 and dry or winter from November 1 to May 31.

Months	**2017**			**2018**		
	Heifers	**Cows**	**Total**	**Heifers**	**Cows**	**Total**
January	78	56	134	57	58	115
February	75	55	130	65	63	128
March	75	54	129	67	67	134
April	73	54	127	66	68	134
May	75	57	132	68	68	136
June	76	58	134	69	71	140
July	77	58	135	70	70	140
August	77	59	136	67	72	139
September	77	59	136	70	68	138
October	76	59	135	71	69	140
November	64	57	121	71	72	143
December	65	47	112	70	72	142

Table 1: *Structure of the female bovine herd under study (Maniabo, Cuba).*

The dairy population during the study period is shown in Table 1. The dairy has an area of 131 ha, of which 31 are planted with Morerus alba mulberry, 20 ha with sugar cane Saccharum officinarum and 15 ha with titonia, and the rest are occupied by natural pastures. The paddocks are divided at a rate of 1 ha by electric fences. The plants with the highest protein content are dried and used mainly as a supplement at a rate of 2 kg / animal. The cane is ground and supplied together with the protein plants at a rate of 1 kg / animal. The supplement is provided during the afternoon-night when the animals are housed.

The exploited dairy genotype is Siboney de Cuba. Calves are sent to a rearing center and milking is carried out twice a day. The water supply is continuous. The animals start grazing after the first milking (04: 00-05: 00). The second milking is around 17: 00-18: 00.

Data from meteorological records were collected through the national agrometeorological bulletins of the Center for Agricultural Meteorology (Ministry of Science, Technology and Environment) (CITMA, 2017), and caloric stress was determined through the temperature and humidity index (ITH) for months according to the modification proposed by Valtorta (1996), where ITH = (1.8 Ta + 32) - (0.55 - 0.55 HR / 100) (1.8 Ta - 26), where Ta = average air temperature (ºC) and RH = relative humidity (%).

The ITH scale defines critical points or levels of severity of caloric stress (Zimbelman and Collier, 2011; López et al., 2016):
- ITH <72: Normal (no heat stress)
- ITH = 72-79: Alert (moderate caloric stress)
- ITH = 80-89: Danger (moderate to severe heat stress)
- ITH> 90-98: Emergency (severe caloric stress)

The statistical analysis was carried out by means of the multivariate MLG procedure through an analysis of variance, posing as dependent variables the monthly milk production and daily average milk per cow; as a covariate, milking cows were used as independent variables, season and the temperature and humidity index (ITH). For statistical analyzes, the SPSS v. 23 for Windows, with a significance level of 5%.

Results

The average milk production during the period 2017-2018 was 8962.1 ± 423.5 l / cow milking. Total milk production in 2017 was 81 213 L and in 2018 123 878 L, appreciating a difference of 32 665 L. It is interesting to note that the highest productive yield was obtained in the hottest months, a period that coincides with the higher yield of pastures and more abundance of water, as it is the spring season in Cuba.

The ITH was always greater than 72 in all the months (Table 2), especially in the summer months. The months with the highest ITH were June, July, August and September. On the other hand, caloric stress not only occurs in the summer months, but is a problem present most of the year. Normally, in August the average temperature increases with respect to June and July, and it is frequently a very hot month, the hottest of the year.

Table 3 shows the presence of significant differences in the two dependent variables considered in the model (monthly milk production and daily average milk per cow). The covariate milking cows showed significant differences when the monthly milk production was evaluated. The variables of factor, season and temperature and humidity index showed significant differences compared to the two dependent variables. Monthly milk production reached an adjusted R2 = 0,921 and the daily average milk per cow an adjusted R2 squared = 0,775.

Month / year		ITH	Interpretation
January	2017	77	Alert: Moderate caloric stress
	2018	74	
February	2017	75	
	2018	74	
March	2017	73	
	2018	72	
April	2017	73	
	2018	77	
May	2017	76	
	2018	78	
June	2017	80	Hazard: Moderate to severe heat stress
	2018	79	Alert: Moderate heat stress
July	2017	81	Hazard: Moderate to severe heat stress
	2018	80	
August	2017	81	
	2018	81	
September	2017	81	
	2018	80	
October	2017	79	Alert: Moderate heat stress
	2018	78	
November	2017	77	
	2018	75	
December	2017	77	
	2018	76	

Table 2: *Impact of monthly caloric stress according to the temperature and humidity index.*

Origin	Dependent variable	Sum of Squares Type III	GL	Square root	F	Sig.
Corrected model	Milk / month	92256169.1a	3	30752056.3	90.9	0
	Milk / day / cow	12.0b	3	4.0	27.3	0
Intersection	Milk / month	52504.6	1	52504.6	0.1	.698
	Milk / day / cow	25.8	1	25.8	176.3	.000
Milking cows	Milk / month	55324569.2	1	55324569.2	163.6	.000
	Milk / day / cow	0.2	1	0.2	1.4	.248
Epoch	Milk / month	3118782.5	1	3118782.5	9.2	.007
	Milk / day / cow	1.7	1	1.6	11.4	.003
ITH	Milk / month	1616562.6	1	1616562.6	4.7	.041
	Milk / day / cow	0.9	1	0.9	6.6	.018

Epoch * ITH	Milk / month	0	0	.	.	.
	Milk / day / cow	0	0	.	.	.
Error	Milk / month	6763135.5	20	338156.7		
	Milk / day / cow	2.9	20	0.1		
Total	Milk / month	2026691733.0	24			
	Milk / day / cow	1221.9	24			
Total corrected	Milk / month	99019304.6	23			
	Milk / day / cow	14.9	23			
a. R^2 = .932 (R^2 adjust = .921)						
b. R^2 = .804 (R^2 adjust = .775)						

Table 3: *Results of the action of heat stress on milk production.*

Discussion

Caloric stress has been widely recognized as one of the factors that affect the productivity and reproductive efficiency of production animals in different parts of the world (Bernabucci et al., 2014; Molina, 2017; García and Monzón, 2018). Caloric stress has a significant impact on all livestock species causing economic losses (Olivera et al., 2015; Sandoval and Carcelén, 2017). St-Pierre et al., (2003) and García and Monzón (2018) propose annual economic losses produced by heat stress of the order of US $ 897-1500 million for the dairy industry in the United States and of $ 369 million for the meat production in Peru, respectively.

Bos indicus is known to be more thermotolerant when subjected to heat shock (Bó and Martínez, 2003; Espinoza et al., 2011). Perhaps, this aspect helps to explain the peak of estrous presentation of the Holstein x Cebu genotypes reported by Bertot et al. (2009) in the hottest months. Likewise, Peña et al. (2012) indicate that the highest productive yield is obtained with mixed breeds and not with pure breeds in the Cuban province of Camagüey.

The ideal climatic conditions for milk production occur at room temperature between 5° and 25°C, this interval being considered the thermal comfort zone; cows tolerance to temperatures below 5°C depends on age and level of milk production (Cerqueira et al., 2016).

Heat stress can reduce the conception rate to levels of 10% and milk production can decrease between 10 and 30%, in part due to a decrease in food intake, although the main reason is due to a direct effect of caloric stress (Flamenbaum, 2013). One of the alternatives to reduce the effects of high summer temperatures on animals of temperate breeds is the use of shades and cooling systems.

Heat stress in high-production dairy cattle results in less lactose synthesis and thus a reduction in milk production. Likewise, it affects the estrous cycle by altering the follicular selection process and increases the duration of the follicular waves, which results in a lower quality of the oocytes, as well as a reduction in the duration and intensity of the estrus (Pedersen, 2014).

Cerqueira et al. (2016) states that a significant effect of the ITH was registered in milk production per day, when the ITH value was above 78, revealing a lower production of the order of 1.8 kg / cow / day; results that coincide with the present study.

Conclusion

The problems caused by heat stress for livestock are evident and accentuated by climate change, reflected in variations in temperature and humidity that negatively impact milk production.

Literatura Citada

1. Aguilar A, Pimienta E, Aguilar G. (2014). Respuesta al estrés por calor en la vaca lechera criolla Holstein en la región Ciénega del estado de Jalisco, México. Abanico Veterinario. 4(3).
2. Allen JD, Collier RJ, Smith JF. (2015). Effect of core body temperature, time of day, and climate conditions on behavioral patterns of lactating dairy cows experiencing mild to moderate heat stress. J Dairy Sci 98: 118-127.
3. Bernabucci U, Biffani S, Buggiotti L, Vitali A, Lacetera N & Nardone A. (2014). The effects of heat stress in Italian Holstein dairy cattle. Journal of Dairy Science. 97(1): 471–486.

4. Bertot J, de Armas R, Garay M, Álvarez J, Avilés R, Loyola C, Horrach M. (2009). Modelo estructural para mejorar la organización y el control de la reproducción de sistemas vacunos lecheros. Revista de Producción Animal. 21(2), 157-162.
5. Bó G, Martínez M. (2003). Pattern and Manipulation of Follicular Developmentin Bosindicus Cattle. Animal Reproduction Science 78(11): 307-326.
6. Boni R, Cecchini S. (2014). Heat stress affects reproductive performance of high producing dairy cows bred in an area of southern Apennines. Livest Sci 160: 172-177.
7. Cerqueira J, Blanco-Penedo I, Cantalapiedra J, Silvestre A, Silva S. (2016). Predicción de estrés térmico en vacas lecheras mediante indicadores ambientales y fisiológicos. Archivos de Zootecnia 65(251): 357-364.
8. CITMA. (2017). Boletín Agrometeorológico Nacional. Instituto de Meteorología del Ministerio de Ciencia Tecnología y Medio Ambiente 36(4-36).
9. Dash S, Singh A, Upadhyay A, Singh M, Yousuf S. (2016). Effect of heat stress on reproductive performances of dairy cattle and buffaloes: a review. Vet World 9: 235-244.
10. Espinoza J, Palacios A, Guillén A. (2011). Tolerancia al calor y humedad atmosférica de diferentes grupos raciales de ganado bovino. Rev. MVZ de Córdoba 16(1): 2302-2309.
11. Flamenbaum I. (2013). Ventajas de la gestión del stress calórico en el rodeo lechero. Columnistas FEPAL.E. 1(7): 3-8.
12. García L, Monzón R. (2018). El índice temperatura-humedad máximo y la producción de leche de los establos en Lima-Perú. Archivos de Zootecnia. 67(257): 99-107.
13. López G, Rondán G, Lissaso C, Kemerer A, de los Santos M. (2016). Determinación del índice de temperatura y humedad (ITH) para vacas lecheras, en el departamento Nogoyá, entre ríos. Revista Científica Agropecuaria. 20(1-2): 57-65.
14. Molina R. (2017). El estrés calórico afecta el comportamiento reproductivo y el desarrollo embrionario temprano en bovinos. Nutrición Animal Tropical. 11(1): 1-15.
15. Olvera F, Valenzuela FD, Calderón A, Molina R, Rivera JA, Reyes L. (2015). Efecto de época del año (verano vs. invierno) en variables fisiológicas, producción de leche y capacidad antioxidante de vacas Holstein en una zona árida del noroeste de México. Arch Med Vet 47: 15-20.
16. Pedersen S. (2014). Effects of heat stress in cattle. VetTimes (43): 12-13.
17. Peña I, Vidal F, Rodríguez Y. (2012). Evaluación productiva de bovinos lecheros en condiciones de la provincia Camagüey. Revista de Producción Animal. 24(2).
18. Ruiz L, Sandoval-Monzón R. (2019). Evaluación de los indicadores de estrés calórico en las principales localidades de lechería intensiva del departamento de Lima, Perú. Rev Inv Vet Perú. 30(1): 88-98.
19. Ruiz-García LF, Sandoval-Monzón RS. (2018). El índice temperatura- humedad máximo y la producción de leche de los establos en Lima-Perú. Arch Zootec. 68: 99-107.
20. Sandoval R, Carcelén F. (2017). Determinación de la tasa de servicio y de los factores que la afectan en los establos lecheros intensivos de Lima, Perú. Rev Inv Vet Perú 28: 314-326.
21. St-Pierre NR, Schnitkey G. (2003). Economic losses from heat stress by us livestock industries. J Dairy Sci. 86: 52-77.
22. Valtorta S. (1996). El estrés por calor en producción lechera. In. Instituto Nacional de Tecnología Agropecuaria. Argentina. Miscelánea. (81): 173 – 185.
23. West J. (2003). Effects of heat-stress on production in dairy cattle. J Dairy Sci. 86: 2131-2144.
24. Wheelock J, Vanbaale M, Sanders S, Baumgard L. (2010). Effects of heat stress on energetic metabolism in lactating holstein cows. J Dairy Sci. 93: 644-655.
25. Zimbelman R, y. C. R. (2011). Feeding Strategies for High-Producing Dairy Cows During Periods of Elevated Heat and Humidity, 2019