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Behavioral response of beef cattle in feedlot in warm desert environment

Respuesta conductual de bovinos productores de carne en finalización intensiva en clima desértico cálido

Romo-Valdez Ana[1], Pérez-Linares Cristina[2], Figueroa-Saavedra Fernando[2], Portillo-Loera Jesús[1], Ríos-Rincón Francisco*[1]

[1]Faculty of Veterinary Medicine and Zootechnics. Autonomous University of Sinaloa, Culiacan, Mexico. [2]Institute of Veterinary Science Research. Autonomous University of Baja California. Mexicali, Mexico. *Responsible and correspondence author: Ríos-Rincon Francisco. Faculty of veterinary medicine and zootechnics. Autonomous University of Sinaloa. Blvd. San Angel s/n, Colonia San Benito, Culiacan, Sinaloa, Mexico. CP 80246. e.ana.romo@uas.edu.mx, cristinapl@yahoo.com, fernando_figueroa@uabc.edu.mx, portillo6422@yahoo.com, fgrios@uas.edu.mx

ABSTRACT

The modification of the natural environment in beef production can induce behavioral changes in cattle. In order to assess the behavioral response based on indicators of animal welfare of beef cattle in feedlot in warm desert environmental conditions; a prospective observational study was conducted with a duration of four weeks. Behavioral guidelines, environmental temperature, relative humidity and temperature and humidity index (THI), were recorded at 8:00 h, 12:00 h, and 16:00 h. Environmental temperature, relative humidity and THI average was 28.7 °C, 24.1 %, and 72.8 units, respectively. During observational period, the beef cattle to be subject at comfort condition (THI≤74). By environmental effect at 12:00 h the usual indicators: eating and drinking, are inhibited (P≤0.01), and grooming decreased (8.2 vs. 13.2 x 100; P≤0.01) Agonist indicators: mounts, threats, Flehmen sign and bumps decrease significantly at 12:00 h (P≤0.01), when the THI value is greater than 75 units are. The highest panting rate (25 x 10000) was observed at 12:00. The diurnal behavioral response of cattle in feedlot on warm desert climate is due to biological rhythms to adapt to the environment that ensures their survival.
Keywords: animal welfare, beef cattle, warm environmental, THI.

RESUMEN

La modificación del ambiente natural en la producción de carne bovina puede inducir cambios conductuales en los bovinos. Para valorar la variación diurna de la conducta con base a indicadores de bienestar en bovinos productores de carne en finalización intensiva en clima desértico cálido, se realizó un estudio observacional prospectivo con duración de cuatro semanas. Las pautas conductuales, temperatura ambiental, humedad relativa e índice de temperatura y humedad (ITH) se registraron a las 8:00, 12:00 y 16:00 h. El promedio de la temperatura ambiental fue de 28.7 °C, humedad relativa de 24.1 % e ITH de 72.8 unidades. Durante el periodo de observación, el ganado bovino estuvo sujeto a condición de confort (ITH≤74). A las 12:00 h los indicadores habituales: comer y beber, se encuentran inhibidos (P≤0.01), y el acicalamiento disminuido (8.2 vs. 13.2 x 100; P≤0.01). Cuando el valor del ITH es mayor a 75 unidades los indicadores agonistas: montas, amenazas, signo de Flehmen y topetazos disminuyen sensiblemente a las 12:00 h (P≤0.01). La mayor tasa de jadeos (25 x 10000) se observó a las 12:00 h. La respuesta conductual diurna de los bovinos en finalización intensiva en clima desértico cálido obedece a ritmos biológicos para adaptarse al medio ambiente que asegure su sobrevivencia.
Palabras clave: bienestar animal, bovinos, ambiente cálido e ITH

INTRODUCTION

The permanence of cattle in the intensively finished pen may alter or modify the behavioral patterns characteristic of cattle under natural conditions, altering their comfort status in response to stressors (Ratnakaran *et al*., 2017). In this sense, stress has been used as an indicator in the loss of animal welfare (Mormède *et al*., 2007). The modification of natural environments in the production of beef and the persistence of factors that induce stress in animals can be into a reduction in productivity indicators, translated. Therefore, it is necessary to assess the situations that can cause fear, pain, anxiety, hunger, thirst and as far as possible the suffering during the permanence of the cattle in the pen of completion (Aluja, 2011).

In response to the growing demand for protein of animal origin to meet the dynamic increase in food by the human population, production systems have been geared towards intensification; this includes the production of beef. This limits the ability of cattle to perform some natural behaviors and increases the incidence of aggressions among animals, when intervention strategies do not consider bovine welfare in the feedlot as a priority. The classic definition of Broom (1986), states that the well-being of an individual is related to their state of comfort, while trying to cope with their environment. In line with the above, in warm climatic environments, bovines try to compensate for adverse conditions, changing behavioral patterns and to some extent changing their physiological response (Mader *et al*., 2001). For this reason, it is important to know the type of behavioral changes in cattle, housed in intensive production conditions, in regions where the ambient temperature is outside the zone of thermo neutrality.

In this sense, the thermo-neutral temperature of beef-producing cattle can be very varied is known. In young cattle, the zone of thermo neutrality ranges from 7 to 26 °C, while in mature cows and heavy cattle the range is -17 °C in winter and 23 °C during the summer. It is closely related to the body condition, nutritional status, length, racial group and coat color of bovine animals that under these conditions they have difficulty tolerating temperatures above 27 °C, especially when the relative humidity value is greater than 40% (Mader *et al*., 2007; Arias *et al*., 2008).

The decrease in animal production indicators in warm regions is affected by various factors, the main stress being caused by high environmental temperature (Renaudeau *et al*., 2012), in the so-called "heat waves" that involve periods of heat and relative humidity, uncomfortable for short or prolonged periods (Brown-Brandl *et al*., 2006).

This physiological response occurs when the ambient temperature exceeds the thermo neutral zone of the bovines, which prevents them from dissipating the extra heat (Bernabucci *et al*., 2010). The behavioral expressions made by cattle to mitigate heat stress range go from the search for shade to the isolation or distancing of their peers, in order to increase the body surface in contact with the environment to perform heat exchange by convection (Alves *et al.*, 2017). In the same way that the amount of water consumed can be increased a behavioral state arrives, where the animal increases its leisure time, so activities such as water consumption are decreased or modified to be carried out during cool times during the day (Ferreira *et al.*, 2014).

The HPA axis is the neuroendocrine response, responsible for regulating the secretion of GC in the adrenal cortex and triggering responses to a stress situation; this is only part of the large central system that integrates behavioral, neuroendocrine, and autonomic and immune responses to alterations in homeostasis (Dallman *et al*., 2006).

Brown-Brandl *et al.* (2006), mention that bovines under heat stress reduce their food consumption time; as well as the time in which they remain cast. They also indicate that, under these conditions, bovines decrease their agonist behavior against their pen-mates, in order to remain immobile in cooler places. The behavior of animals, individually or in groups, varies according to factors related to race, sex, temperament, age and the production system (Arias *et al*., 2008; Sampedro y Cabeza, 2010; OIE, 2013). In this sense, the thermal environment can have a negative influence on the welfare of cattle, but beyond the direct impact that heat stress has on the health and productivity of cattle; also the economic impact should be on livestock producers considered (Lees *et al*., 2019).

Based on the foregoing, the objective of the present work was to assess the diurnal variation in the behavior of bovine meat producers in intensive completion in a warm desert climate, during the fall.

MATERIAL AND METHODS

Location of the study site. This work was carried out in a Livestock Production Unit located in the Mexicali Valley, Baja California, Mexico (32° 39 ’48’’ Latitude North and 115° 28’ 04’’ Longitude West, at 8 m a.s.l) according to the Köppen classification system, modified by García (2004). The climate of this region is classified as BW(h´) hs (x') climate, which is defined as warm desert, extreme in excess and rainfall regime in winter. The average annual temperature of the region is 24.1 °C, the average minimum temperature is 13.6 °C in the month of December, and the maximum average is 34.8 °C during the months of June to July. The absolute maximum temperature is 49.5 ° C and the absolute minimum is -6.0 ° C; the average rainfall of 75.8 mm per year (INEGI, 2017).

Type of study. During the month of October 2018, the autumn season for the northern hemisphere, a prospective observational study with a duration of four weeks was carried out. During this time, a total of 692 pens available to the UPP; of 98 pens that at the time of the study and according to the feeding program were receiving diet # 5 (5 of 6 diets); 12 completion pens were chosen at random, which were visited daily to collect the

information; It is worth mentioning that in each pen there were an average of 95 cattle per pen, with body weight close to 500 kg.
The sample under study was 1140 cattle, just over 12% of the total animals in completion, consuming diet # 5 of the feeding program.

Climatic variables. During the experimental period, the ambient temperature and relative humidity were recorded using digital thermo hygrometers (Avaly Taylor, Model VA-EDT-1-55[a], CDMX), placed in the fattening pens under study, at the height of the bovines, two meters outside the shadow area and near the feeders. The temperature and humidity index (THI) was calculated using the formula:
$THI = (0.8\,x\,T) + \left[\left(\frac{HR}{100}\right) x\,(T - 1.4)\right] + 46.4$ (Mader *et al*., 2006), where T is the ambient temperature in degrees Celsius and HR is the relative humidity expressed as a percentage.

Description of facilities. The cattle under study were housed in conventional pens for fattening and finishing: construction with a 1.60 m high metal pipe, dirt floor, shade provided with plant material typical of the region (*Pluchea serícea*), placed 3.5 m high, feeder, and bench of two linear meters in the feeder area, automatic masonry drinker, located at the bottom of each pen. The pens are 31 m long and 26 m wide (806 m^2), designed to accommodate 100 cattle of an average weight of 450 kg at the end of the fattening (living space of 8.0 m^2/cattle).

Management and feeding of cattle. The protocol of handling and feeding of bovines is the one that is commonly followed in technified fattening in northern Mexico, which consists of vaccination, deworming and implant placement (trenbolone acetate, estradiol and tylosin). Cattle are fed twice a day, according to a six-diet program, which basically includes wheat, Sudan hay, tallow, dried distillery grains and mineral premix.

Characteristic of cattle. The bovines included in the present study showed the following characteristics, typical of fattening pens in Mexico: males, encased with Cebú, with a genetic component of approximately 60% *Bos indicus*, and the rest composed of *Bos taurus* from the Simmental, Charoláis and Pardo suizo breeds, in not determined proportions.

Evaluation based on animals. At each visit, behavioral patterns were classified into three categories: habitual (A), social (B) and agonist (C), of cattle related to animal welfare in the completion pens (Marti *et al.,* 2015). The evaluation of the behavioral patterns was carried out during three schedules (8:00, 12:00 and 16:00 h). To observe all the cattle, an observation time of 10 minutes was allocated for each pen.

The registration of behavioral patterns was carried out using the following procedure:

A) Common indicators: the frequency of cattle was recorded: eating, drinking, ruminating, under shade and standing.

B) Social indicators: the frequency of social behavior was recorded, based on the Welfare Quality protocol (2009), grooming; this behavior is recorded when a bovine touches with any tongue any part of the body (face, head, torso, legs or tail); of another group partner, or likewise; the anal region or foreskin is excepted. If the actor stops licking for more than 10 seconds and then starts licking the same receiver, it is recorded as a new action and a new event begins; also if the actor licks another receiver, or if there is a change of roles between actor and receiver.

C) Agonist indicators: the frequency of the manifestation of agonist behaviors was recorded, such as:

1) Bumps, such as the frontal confrontation between two or more bovine members of the same batch.

2) Threats, such as the attempt of aggression by a bovine of greater hierarchy, within a social group to another of lower hierarchical rank.

3) Sign of Flehmen is a reaction generated by smelling urine, feces, mucus and/or the vulva region that contain sex pheromones. During this reaction, the bovine lifts its head, purses its nose, contracts, elevates its upper lip, moves its tongue, and places it on the anterior part of the palate to rub the incisive papilla of the palate (Doving y Trotier, 1998).

4) The frequency of amounts was also recorded in the agonist indicators.
In the cattle under study, the frequency of gasping was recorded at each time (8:00, 12:00 and 16:00 h).

Statistical analysis.
The climatic variables (temperature, relative humidity and THI value) are presented with the average, minimum and maximum value per week and general. For the behavioral variables, the observation unit was each pen, and the recorded values were converted to rates using the formula proposed by Daniel (2002):

$$\left(\frac{a}{a+b}\right)k$$

Where:
a =the frequency with which an event has been presented during a specific period.
$a+b$ = the number of cattle exposed to the risk of the event during the same period.
k =some number, such as 100, 1,000 or 10,000.
Next, histograms were generated to observe the frequency distribution; these were performed with Minitab 16.0 (Minitab, 2000). Following this, the UNIVARIATE SAS

NORMAL option procedure (SAS, 2002) was used to determine the approximation to the normal distribution of the rates with the Kolmogorov-Smirnov (K-S) normality test. Arcosen square root transformation was performed; Once the rates were transformed, the UNIVARIATE SAS NORMAL option procedure (SAS, 2002) was used again, to know if an approximation to the normal distribution of the transformed rates was achieved, using the K-S normality test. Not obtaining normality in the transformed rates, the procedure described by Herrera and Barreras (2005) was performed, using the RANK procedure (SAS, 2002), to calculate ranges, and to these apply analysis of variance with the GLM procedure, declaring the general linear model $Y_{ij} = \mu + H_i + \varepsilon_{ij}$:

Where:

Y_{ij} = Rate ranges for the behavioral variable

μ =The general average

H_i=The fixed effect of the ith observation time

ε_{ij}=The random error

The trend in behavioral patterns in cattle, in intensive completion according to the time of day was analyzed by orthogonal polynomials (SAS, 2002). The results in the tables are presented with the median, minimum value, maximum value and interquartile range of the rates; regression graphs prepared in Minitab 18.0 are presented (Minitab, 2000). In all analyzes, an alpha of 0.05 was used to accept statistical difference.

RESULTS AND DISCUSSION

Table 1 shows the results corresponding to ambient temperature, relative humidity and THI, recorded during the observation period in the intensively finished pens.

It is observed that the average general temperature during the observation period was 28.7 °C, with a maximum of 38.4 °C and a minimum of 18.9 °C; In the case of relative humidity, the general average was 24.1%, with a maximum of 28 and a minimum of 20%. The overall average THI was 72.8 units, with a maximum of 82.9 and a minimum of 62.7 units.

Table 2 shows the descriptive statistics of the environmental conditions, according to the evaluation schedule in the fattening pens in intensive completion. It is observed that at 8:00 hours, the maximum value of THI was 74.2 units, at 12:00 it rose to 81.9 units, and at 16:00 it was 82.9 units; while the average was 68, 75 and 75 units, respectively.

Table 1. Average ambient temperature, relative humidity and heat and humidity index during the observation period

	Temperature °C			Relative humidity, %			THI[1]		
Week[2]	Min	Max	Mean	Min.	Max.	Mean	Min.	Max.	Mean
1	20.2	34.9	28.9	20.0	28.0	24.0	64.2	79.2	73.0
2	20.2	33.5	27.0	22.0	28.0	24.8	64.1	77.8	71.1
3	21.5	38.4	31.1	22.0	26.0	23.5	65.3	82.9	75.2
4	18.9	36.1	27.7	22.0	28.0	24.2	62.7	80.1	71.8
General[3]	18.9	38.4	28.7	20.0	28.0	24.1	62.7	82.9	72.8

THI= Temperature and Humidity Index; Min= Minimum; Max= Maximum.
[1]THI= [0.8 x room temperature] + [(% relative humidity /100) x (room temperature – 14.4)] + 46.4 (Mader *et al*., 2006); THI comfort < 74; alert 75 > THI < 78; danger 79 >THI < 83; and emergency THI > 84. [2]For each week, n = 90. [3]General, n = 360.

THI has been widely used as an indicator of thermal stress in cattle (Gaughan *et al.,* 2008). This index combines the values of relative humidity and the ambient temperature into a simple value, to estimate the potential of caloric load in the environment. It is generally considered as potentially stressful for cattle, when the THI value exceeds 74 units (Igono *et al*., 1992).

Table 2. Descriptive statistics of the environmental conditions by evaluation schedule in the fattening pens in intensive termination of cattle

	08:00			12:00			16:00		
	T[1], °C	HR[2], %	THI[3]	T[1], °C	HR[2], %	THI[3]	T[1], °C	HR[2], %	THI[3]
Mean	23.7	26	68	31.3	23	75	31.2	23	75
Minimum value	18.9	24	62.7	24.4	20	68.3	25.5	21	69.7
Maximum value	29.8	28	74.2	37.9	26	81.9	38.4	26	82.9

[1]T: Temperature; [2]HR: Relative Humidity; [3]THI = [0.8 x room temperature] + [(% relative humidity /100) x (room temperature– 14.4)] + 46.4 (Mader *et al.,* 2006); normal THI < 74; alert 75 > THI < 78; danger 79 >THI < 83; and emergency THI > 84.

Based on the above, in the Livestock Production Unit, located in the Mexicali Valley, the overall average value of the THI was 72.8 units, with an average maximum value of 82.9 units. This THI average value means that bovines are in the comfort category, although the value close to 83 units may indicate that it is in the danger category, at a certain time of day, specifically at 12:00 and 16: 00 hours that can be interpreted as a temporary stay of heat thermal stress. As seen in Figure 1, which shows the quadratic effect for the THI, with its respective prediction equation.

For practical purposes, it is possible to estimate the value of the THI using this equation and interpret its results based on animal welfare indicators, which can be modified by the combined effect of ambient temperature and relative humidity. In this case, 61.5% of the variation in the THI depends on the time of day.

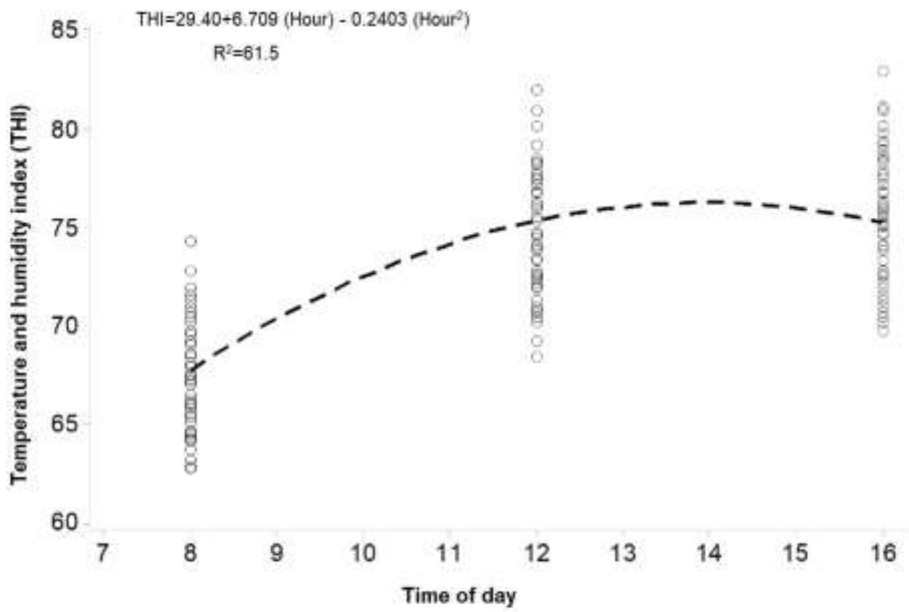


Figure 1. Quadratic effect for the Temperature and humidity index according to the time of day

In this regard, Renaudeau *et al*. (2012) state that cattle suffer from inconvenience in relation to comfort, and their productive function may be affected, since in intensive production systems cattle have more restricted physiological mechanisms, to cope with excess heat and relative humidity high, and thus maintain thermo neutrality. In that sense, Hahn *et al*. (2003) report that the behavior of cattle should be monitored for various periods of time (weeks or months), to know and interpret the development of their behavioral response and other performance measures based on the value of the THI.

Table 3 shows the results of the usual and social indicators related to the welfare of beef producers in intensive completion. It is noted that based on the value of THI, at 8:00 a.m. cattle are in the comfort category; however, at 12:00 and 16:00 h, the THI value indicates that it is in the alert category (THI> 75 units; P ≤ 0.01), depending on heat stress.

The bovines were with greater (P <0.05) frequency, eating, drinking water and standing at 8:00 and 16:00 h; while at 12:00 the majority (P <0.05) of cattle were lying and ruminating under the shade. Grooming behavior was higher (P <0.05) at 16:00 h, followed by 8:00 h (P <0.05) and lower (P <0.05) at 12:00 h. Pereyra *et al.* (2010), report that when cattle are exposed to adverse conditions to their state of comfort, habitual activities such as eating, drinking and walking decrease. Under the climatic condition of the region where the UPP is located, the tendency of bovines is to decrease their usual activities; as shown in figure 2, which shows the quadratic effect for the variable bovine eating, according to the time of day. 27.8% of the variation of cattle eating depends on the time of day.

Table 3. Regular and social indicators related to the welfare of beef producers in intensive completion under warm and dry environmental conditions

		Common indicators [2]					Social indicator[2]
Time	THI[1]	Eat[3]	Drink[4]	Under shade[3]	Standing[3]	In rumination [3]	Groom[3]
8:00	67.7	11.4	10.3	29.7	82.5	4.1	10.1
Min		0.0	0.0	11.9	10.1	0.0	2.1
Max		56.6	94.6	82.6	100.0	21.6	21.6
IQR		17.4	10.9	23.5	22.6	6.1	6.0
12:00	75.3	1.0	0.0	71.4	28.3	8.1	8.2
Min		0.0	0.0	23.2	7.0	1.0	2.0
Max		26.3	40.8	98.1	99.0	19.2	24.3
IQR		3.1	10.1	25.0	19.3	5.3	4.2
16:00	75.2	11.6	10.1	34.3	63.9	6.1	13.2
Min		1.0	0.0	9.1	14.9	0.0	1.0
Max		26.2	51.6	83.5	96.1	17.6	27.0
IQR		7.1	20.0	26.4	25.5	4.3	5.9
				Orthogonal polynomials			
Linear effect	0.01	0.01	0.08	0.10	0.01	0.14	0.01
Quadratic effect	0.01	0.01	0.01	0.01	0.01	0.01	0.01

THI: Temperature and Humidity Index; IQR: interquartile range. [1]Means, standard error of the average set for hour is 0.26, n = 120. [2]Medians; for hour n=120. [3]Cup x100. [4]Cup x 1000. [abc] Different literals in the same column within hours indicate statistical difference (P≤0.01).

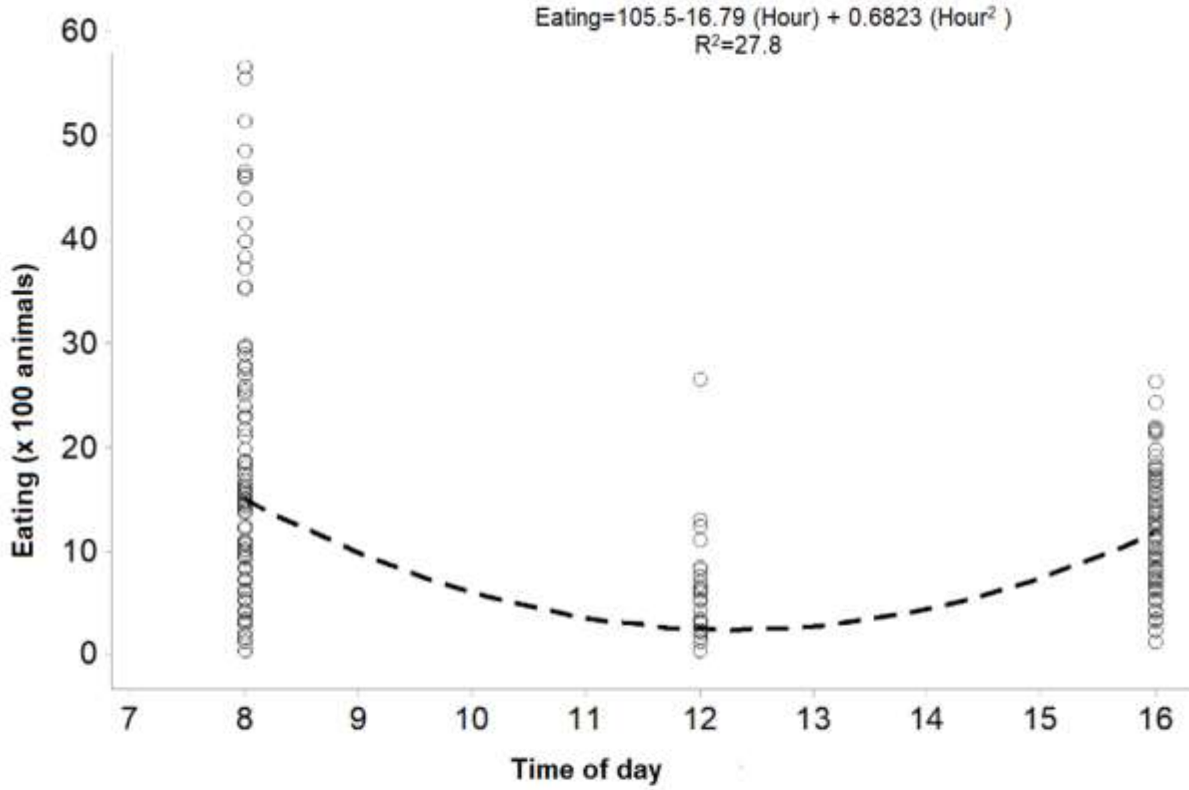


Figure 2. Quadratic effect for cattle eating according to the time of day

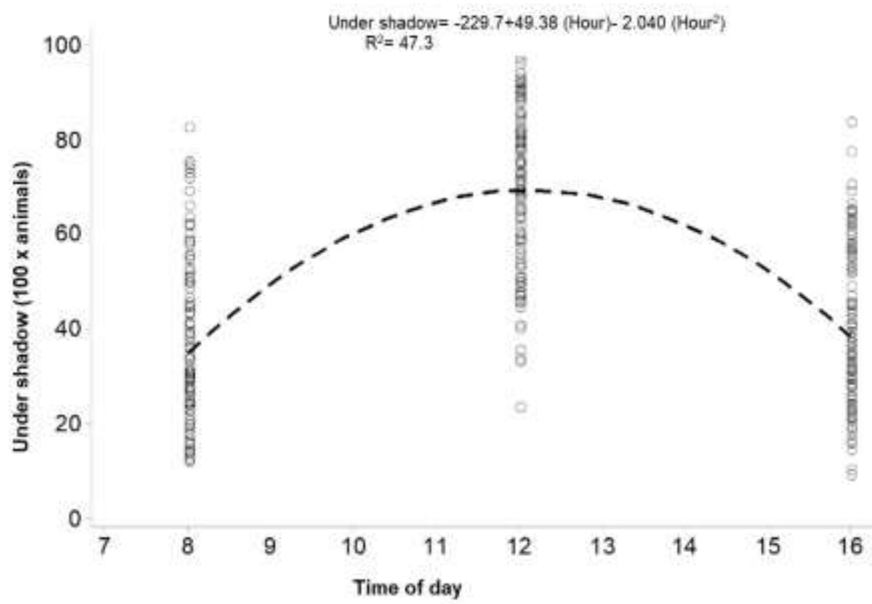


Figure 3. Quadratic effect for cattle under shade according to the time of day

Figure 3 shows the quadratic effect for the bovine variable under the shade, according to the time of day. The increase in the number of cattle under the shade coincides when the value of the THI tends to increase, so they seek refuge under the shade, to decrease the impact of solar radiation and reduce the heat load (Brown-Brandl *et al.*, 2013). In the present study, 47.3% of the response in this variable depends on the time of day.

Figure 4 shows the quadratic effect of the bovine standing variable according to the time of day; at 12:00 hours, the bovines, in addition to being under the shade, are mostly lying down; it is observed that 52.3% of the variation in this variable is a function of the time of day.

Changes in the behavioral behavior of bovine animals confined in intensively terminated pens, occur depending on environmental factors, such as solar radiation and the temperature above the thermo neutral zone, which combined with high relative humidity; generating increase in caloric load (Beretta *et al*., 2013). Although the *Bos indicus* and *Bos taurus* racial types show great ability to maintain homeothermia, under conditions of caloric stress, changes in their habitual behavioral behavior can occur (Beatty *et al*., 2006). In this sense, Dikmen (2013) indicates that the behavioral changes of cattle occur in response to the increase in ambient temperature during the day.

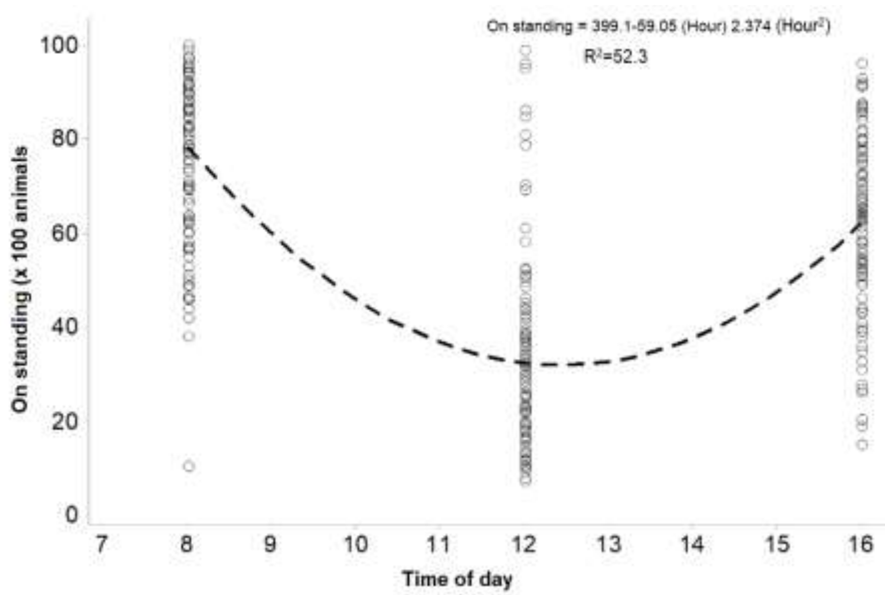


Figure 4. Quadratic effect for bovine standing according to the time of day

With regard to grooming, Sato *et al.* (1991), mention that it is an expression of the behavioral behavior of the bovine, which mainly performs with its most familiar peers within the feedlot, to fulfill specific functions, such as cleaning effect, reduction of group tension and binding effect.

In the present study, grooming rates were different at each schedule (10.1 vs. 8.2 vs. 13.2; P <0.01), at 8:00, 12:00 and 16:00, respectively. The lowest grooming rate observed at 12:00 h, may be related to the fact that not all bovines accept this type of social behavior, and it is commonly the subordinates who groom the dominant bovines; It commonly occurs moments after the food has been served, although this activity can also be nocturnal (Val-Laillet *et al*., 2009).

Table 4 shows the results corresponding to the agonist indicators, related to the animal welfare of bovine meat producers in confinement under desert and dry environmental conditions. It was observed that the expression rate of the agonist indicators: mounts, threats, Flehmen sign and bumps, appears inhibited after 12:00 h (P <0.01), in relation to the expression rate observed at 8: 00 h. At this time, cattle are in comfort conditions (THI 67.7 units); however, as this indicator increases (75.2 units), the agonist expression rate decreases.

Table 4. Agonist indicators related to the welfare of beef producers in intensive completion under warm and dry environmental conditions

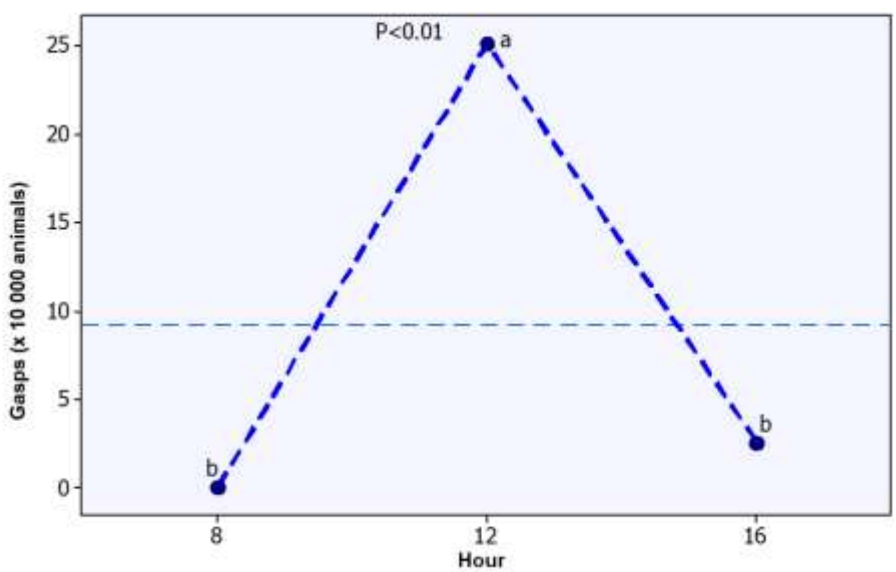
		Behavioral indicators			
Time	THI[1]	Mounts[3]	Threats[3]	Flehmen[3]	Bumps[4]
8:00	67.7	3.1	3.1	3.5	12.0
Min		0.0	0.0	0.0	0.0
Max		52.6	10.1	15.5	155.3
IQR		5.0	3.1	3.1	31.3
12:00	75.3	0.0	2.0	2.0	0.0
Min		0.0	0.0	0.0	0.0
Max		19.6	8.1	9.5	94.6
IQR		2.1	2.1	3.0	30.3
16:00	75.2	1.0	3.1	4.0	10.0
Min		0.0	0.0	0.0	0.0
Max		21.7	14.4	11.3	113.4
IQR		2.6	3.1	2.6	26.4
		Orthogonal polynomials			
Linear effect	0.01	0.01	0.90	0.78	0.01
Quadratic effect	0.01	0.01	0.01	0.01	0.01

THI: Temperature and Humidity Index; IQR: interquartile range. [1]Mean, standard error of the average set for hour is 0.26, n=120. [2]Medians, for hour n=120. [3]Cup x100. [4]Cup x1000. [abc] Different literals in the same column within hours indicate statistical difference (P≤0.01).

This type of agonist behavior classified as intraspecific, occurs when cattle come together to defend their space, through the manifestation of aggressive behaviors (McGlone, 1986). Rao *et al*. (2015), affirm that agonist behavior is defined as an effort to adapt to different internal or external conditions, in response to a stimulus; this includes environmental type and the magnitude of the response corresponds to the nature of the stimulus.

In figure 5, the frequency of gasping in beef-producing bovines in intensive completion is shown, under desert and dry environmental conditions, with respect to the time of day. It is observed that the highest frequency of panting was recorded at 12:00 ($P \leq 0.01$). At this time of day the thermal comfort zone starts working and mechanisms are activated against the increase in the ambient temperature (Roca, 2011), which at 8:00 is an average 23.7 ° C (maximum value 29.8 ° C). At 12:00 h it is an average 31.3 °C (maximum value 37.9 °C); although the relative humidity is low (average value 23%; maximum value 26%). The value of THI tends to rise and moves from the comfort zone to the danger zone. Although the value of the THI remains high, in reducing the gasping rate at 4:00 p.m., the wind speed could influence, as it helps to reduce the effects of heat by improving the dissipation processes by roads evaporative (Silanikove, 2000; Arias *et al*., 2008).

In this sense, the existence of rhythmic variations in physiological functions, allow the body an appropriate response to changes in the environment, known this reaction as reactive homeostasis. This reaction includes circadian rhythms, whose periodicity fluctuates around 24 hours (Scaglione *et al*., 2003).



abc Different literals indicate statistical difference (P≤0.01).

Figure 5. Gasping rate of beef-producing bovines in intensive completion in desert and dry environmental conditions with respect to the time of day

In sum, Lees *et al.* (2019), report that behavioral responses during the day include changes in posture, including increasing the proportion of standing time, greater permanence in shaded areas or increased search for shade; including the shade provided by other animals; and together it can negatively influence the welfare of cattle and impact on the reduction of productivity.

CONCLUSION

The diurnal variation of behavioral expressions in cattle in confinement for intensive meat production, obeys the biological rhythms to adapt to the environment, as well as to maintain an internal physiological order that ensures their survival in the fall, under climatic conditions desert.

IMPLICATIONS

The assessment of the autumn weather conditions and their relationship with the behavioral expressions of cattle in confinement implies that through their correct interpretation it will be possible to influence the improvement of the welfare and productive indicators of bovine meat producers in confinement. Aspects such as accommodation, living space, shadow availability and other elements must be considered. In addition, they should be integrated into a model where interest in animal welfare, the effects of the environment on the behavioral and productive response and the economic aspect are combined; in such a way that at the end of the value chain the ethical quality of beef produced in confinement is identified and recognized.

The results of this research set the tone for the integral assessment of the behavioral and productive response in the winter and summer seasons in the desert region of northern Mexico.

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