



## Physiological parameters of F1 Holstein × Zebu cows fed with banana peel

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**ABSTRACT:** *The objective was to evaluate the effects of different levels of banana peel inclusion on the physiological variables of lactating F1 Holstein × Zebu cows. Ten cows distributed in two 5 × 5 Latin squares were used. Five experimental diets were tested: sorghum silage (control group); and the addition of 15%, 30%, 45%, and 60% of banana peel to replace sorghum silage. The experiment lasted 80 days. The environmental and physiological variables of the animals were measured. The Black Globe-Humidity Index presented an alert situation in the morning shift and a dangerous situation in the afternoon shift. The respiratory rate was not influenced by the levels of banana peel inclusion ( $P > 0.05$ ) in the morning shift. However, it was influenced ( $P < 0.05$ ) in the afternoon shift. The levels of banana peel inclusion in the diet did not affect the rectal temperature. Under the study environmental conditions, the level of up to 60% of banana peel replacing sorghum silage did not alter the physiological variables of thermoregulation in F1 Holstein × Zebu cows.*

**Key words:** *respiratory rate, semiarid, by-product, rectal temperature.*

## Parâmetros fisiológicos de vacas F1 Holandês × Zebu alimentadas com inclusão de casca de banana

**RESUMO:** *Objetivou-se avaliar níveis de inclusão da casca de banana sobre as variáveis fisiológicas de vacas F1 Holandesas × Zebu em lactação. Foram utilizadas 10 vacas distribuídas em dois quadrados latinos 5×5. Sendo cinco dietas experimentais: silagem de sorgo (grupo controle); e a inserção de 15, 30, 45 e 60% da casca de banana em substituição a silagem de sorgo. O experimento teve duração de 80 dias. Mensuraram-se as variáveis ambientais e fisiológicas dos animais. O índice de temperatura de globo negro e umidade encontrada no turno matutino apresentou uma situação de alerta e no turno vespertino uma situação perigosa. A frequência respiratória foi influenciada pelos níveis de inclusão de casca de banana no turno vespertino. A temperatura retal não foi influenciada pelos níveis de inclusão de casca de banana na dieta. Sob as condições ambientais estudadas, o nível de até 60% de casca de banana, em substituição a silagem de sorgo, não alterou as variáveis fisiológicas de termorregulação em vacas F1 Holandesas × Zebu.*

**Palavras-chave:** *frequência respiratória, semiárido, subproduto, temperatura retal.*

## INTRODUCTION

To maximize efficiency in livestock, it is critical to observe the relationship between man, animal, and environment. These interactions can alter the physiological responses of animals (SANTOS et al., 2019). For example, when animals are exposed to severe environmental conditions, they respond by reducing production. However, F1 Holstein × Zebu

(F1 H × Z) animals have great potential to produce milk in tropical environments, due to their adaptation (CASTRO et al., 2018; PEREIRA et al., 2018; DINIZ et al., 2020; SANTOS et al., 2021).

Some strategies are employed to mitigate the harmful effects of the thermal environment on productivity, such as diet manipulation, which implements a lower heat increment (VASCONCELOS et al., 2014), decreasing

metabolic heat production. Nonetheless, because diet accounts for a large portion of production costs, an alternative would be the use of by-products, due to its low cost; however, new ingredients must be examined to avoid a rise in heat increment, especially in hot climate regions (semiarid).

Banana is one of the main crops in the world (FAO, 2020) because of its ease of propagation, handling, and commercialization (COELHO JUNIOR, 2013). Banana is the fourth most consumed food product in the world (SOUZA et al., 2011), resulting in a large contingent of waste, such as peels. The use of this residue in food animals would be a viable option for the use of this residue and; consequently, a reduction in industrial pollutants (PIMENTEL et al., 2016, 2017; SOUZA et al., 2016; MELO et al., 2017, 2018; RIGUEIRA et al., 2021).

Banana peel has ether extract contents ranging from 2%–10.9% (MOHAPATRA et al., 2010; SOUZA et al., 2016) and a fatty acid profile with a high proportion of polyunsaturated fatty acids (EMAGA et al., 2007), which can favor the reduction of the heat increment by the animal. However, this food is yet to be evaluated as a feed option that affects heat increment in a hot environment.

In this context, the aim was to evaluate the effects of different levels of banana peel inclusion on the physiological variables; rectal temperature and respiratory rate, of lactating F1 Holstein × Zebu cows.

## MATERIALS AND METHODS

The experiment was conducted at the Experimental Farm of the State University of Montes Claros, which is located in the municipality of Janaúba, the North of Minas Gerais, with geographic coordinates 15° 48' 32" latitude and 43° 19' 3" longitude, at an altitude of 533 m. The local climate is tropical mesothermic, almost megathermal depending on the altitude, with subhumid and semiarid characteristics and irregular rainfall, resulting in long periods of drought. According to Köppen's classification, the typical climate is Aw, which means savannah with a dry winter and an average air temperature of over 18 °C in the coldest month.

Ten F1 H × Z cows were used, with an average body weight of 500 kg, 70 ± 11 days of lactation at the beginning of the experiment, and an average production of 15 kg milk corrected to 3.5% of fat day<sup>-1</sup>. The experimental design consisted of two 5 × 5 Latin squares, each with five animals, five treatments, and five experimental periods. The experimental diets had a roughage:concentrate ratio

of 70:30. The forage source varied depending on the treatment, with sorghum silage without banana peel (control group); and the addition of 15%, 30%, 45%, and 60% of the banana peel to replace sorghum silage based on dry matter.

The banana peels were extracted from ripe fruits of the cultivar Prata-Anã and had an average dry matter content of 10.32% and an ether extract concentration of 6.25%. The husks were previously dehydrated by exposure to the sun for 12 ± 3 days. After the dehydration process, the husks were crushed in a stationary grinder, model JF-90 (JF Máquinas Agrícolas Ltda, Brazil) to obtain particles of 3–4 cm and stored in nylon bags in a covered shed.

The food provided was weighed on a digital scale and the supply was adjusted so that the leftovers accounted for 5% of the dry matter supplied. Table 1 shows the proportion of ingredients used in the diets and their chemical composition. The cows were kept in individual pens and milked twice a day, at 8 am and 3 pm, using milking machines.

The experiment lasted 80 days, divided into five 16-day periods, with the first 12 days of each period for acclimating the animals to the diets and the last four days for data and sample collection. On the third day of collection of each period, in the morning shift (9 am) and afternoon (3:30 pm), Physiological variables were measured: respiratory rate (RR), determined by direct observation of the movements of the left flank for 15 seconds, and the result was multiplied by four, to obtain the movements in one minute. Rectal temperature (RT) was measured using a digital clinical thermometer (Incoterm–Cotronic Technology Ltd, China) directly introduced into the animals' rectum, reading was finished after beep sound.

The climatic variables, air temperature (°C), wind speed (m.s<sup>-1</sup>), and relative humidity (%) were measured using the Kestrel 4000 portable mini-station, and the black globe temperature (°C) was obtained using a thermometer of mercury coupled on the black globe. Data for the physiological variables and the arithmetic mean were obtained at the start and end of the measurements. The meteorological variables were used to calculate the radiant heat load (RHL, W.m<sup>-2</sup>), according to SILVA (2000) and the Black Globe-Humidity Index (BGHI), according to BUFFINGTON et al. (1981).

Using a Microsoft Excel Spreadsheet, the climatic variables were analyzed using descriptive statistics. Physiological variables were subjected to analysis of variance using the Sisvar program. When the treatment means were significant, they were

Table 1 - Proportion of ingredients of the experimental diets (%) and chemical composition of diets, on a dry matter basis.

Ingredients	-----Banana peel replacement levels (% DM)-----				
	0	15	30	45	60
Sorghum silage	70	59.5	49	38.5	28
Banana peel	0	10.5	21	31.5	42
Soybean meal	17.31	17.29	17.27	17.24	17.22
Ground corn	11.73	11.75	11.77	11.8	11.82
Mineral supplement <sup>1</sup>	0.96	0.96	0.96	0.96	0.96
	-----Chemical composition-----				
Dry matter	50.55	56.26	61.97	67.68	73.39
Mineral matter	6.64	7.33	8.02	8.71	9.4
Crude protein	13.65	13.89	14.12	14.35	14.58
Ether extract	2.83	3.28	3.74	4.19	4.64
<sup>2</sup> NFC	20.70	22.16	23.61	25.07	26.52
<sup>3</sup> NDFap	56.38	53.55	50.72	47.90	45.07
Lignin	7.51	7.59	7.66	7.74	7.82

<sup>1</sup>Guarantee levels per kg product: calcium (128g min) (157g max), phosphorus (100g min), sodium (120g min), magnesium (15g), sulfur (33g), cobalt (135mg), copper (2160mg), iron (938 mg), iodine (160 mg), manganese (1,800 mg), selenium (34mg), zinc (5,760mg), fluorine (1,000mg); <sup>2</sup>NFC = Non-fiber carbohydrates; <sup>3</sup>NDFap = Neutral detergent fiber corrected for ash and protein.

subjected to Tukey's test and regression analysis at a 5% probability level.

## RESULTS AND DISCUSSION

The average air temperatures (Table 2) in the morning and afternoon shifts were above the standards considered ideal for dairy cows, according to BERMAN et al. (1985). When animals are outside their thermal comfort zone or thermoneutral zone, physiological mechanisms need to be activated to obtain thermoregulation. In environments with temperatures above the considered critical upper, sensitive heat exchange mechanisms are reduced. In some cases, if the environmental temperature is higher than the animal's surface temperature, these animals will have heat gain. Turning the heat exchange mechanism latent the most important strategy to achieve thermal equilibrium because they do not depend on the temperature gradient. However, the atmospheric environment must be capable of absorbing this moisture, therefore RH values are a crucial indicator for heat exchange occurrence.

According to NÄÄS & ARCARO JUNIOR (2001), the RH value of 70% is considered the upper limit for this heat exchange to occur for lactating animals. In the afternoon, the environment was hot and dry, which facilitates evaporation, but when this occurs quickly, it can predispose to skin irritation and/or even dehydration (STARLING et al., 2002).

According to the classification proposed by BUFFINGTON et al. (1981), the BGHI in the morning shift presented an alert situation and in the afternoon shift, a dangerous situation for the animals. However, F1 H × Z cows, even in adverse weather conditions, that is, with a high BGHI, can perform their feeding behavior activities (CASTRO et al., 2018; PEREIRA et al., 2018; DINIZ et al., 2020; SANTOS et al., 2021). This is primarily due to the lower metabolism of crossbred taurine with Zebu (FINCH, 1985), in addition to considering that F1 H × Z animals express 100% heterosis, giving them greater capacity to adapt to climatic adversities. The RHL, the total radiant load that surrounds the animals, was found to be high in both shifts, with mean values exceeding 463.50 W.m<sup>-2</sup>, a value recovered by

Table 2 - Mean values and standard deviation of environmental variables: air temperature (AT, °C), relative humidity (RH, %), black globe-humidity index (BGHI), and radiant heat load (RHL, W.m<sup>-2</sup>) in the morning and afternoon shifts.

Variables	Morning	Afternoon
AT	27.67 ±1.31	32.00± 3.81
RH	57.96 ±12.36	38.29± 24.12
BGHI	77.28 ±0.87	79.75 ± 1.73
RHL	585.03 ±72.33	628.61 ± 71.29

SANTOS et al. (2019), which did not cause changes in the behavioral and physiological responses of crossbred cows. Therefore, the thermal environment during the study period can be considered stressful for the evaluated cattle.

Physiological parameters, including RR and RT (Table 3), are crucial indicators of heat stress in livestock, the increase in RR being the first visible sign. The RR of the F1 H × Z cows submitted to the treatments were normal, except in the afternoon shift ( $P < 0.05$ ) at the 60% level of inclusion of banana peel in the diet, classified as a low-stress situation by SILANIKOVE (2000). With increased banana peel inclusion in the diet, there was an increase in the levels of ether extract and nonfibrous carbohydrates, and a decrease in fiber content. It results in greater concentration and availability of energy in the diet, which may justify increased metabolism and, consequently, the increase in RR observed in the afternoon shift. The minimum estimated value of

inclusion of banana peel to obtain the lowest RR in animals would be 20.75% replacement. This level of inclusion under the submitted environmental conditions would provide the animals with less demand for the respiratory evaporation mechanisms.

PIMENTEL et al. (2017) did not observe a decrease in milk production corrected for fat (16.49 kg.day<sup>-1</sup>) between the same levels of banana peel used, indicating that the F1 H × Z cows managed to thermoregulate without shifting the production energy. High-producing cows use thermogenesis variation as means of thermoregulation, they significantly reduce feed intake and hence the production to maintain internal temperatures compatible with survival. The fact that crossbred animals have a lower production allows them to withstand higher environmental temperatures, without overheating their bodies. What this emphasizes is that F1 H × Z cows are more adapted to the adverse climatic conditions of the semiarid environment, being able to maintain the

Table 3 - Respiratory rate (RR, mov.min<sup>-1</sup>), rectal temperature (RT, °C) as a function of inclusion levels of sun-dried banana peel.

Variables	-----Levels of banana peel (% DM)-----					CV* (%)	P-Value
	0	15	30	45	60		
-----Morning shift-----							
RR	33.5	34.40	32.40	34.40	33.60	18.17	0.95
RT	38.27 <sup>ab</sup>	38.29 <sup>ab</sup>	38.05 <sup>ab</sup>	38.38 <sup>a</sup>	37.98 <sup>b</sup>	0.79	0.03 <sup>1</sup>
-----Afternoon shift-----							
RR	37.45	33.78	37.60	36.40	44.80	19.34	0.03 <sup>2</sup>
RT	38.57	38.38	38.40	38.53	38.38	0.79	0.37

\* CV = Coefficient of variation.

<sup>1</sup> Means followed by the same letter do not differ statistically by Tukey's test ( $P > 0.05$ ).

<sup>2</sup>  $\hat{Y} = 37.07 - 0.25x + 0.006x^2$ ;  $R^2 = 83.65$ .

normal physiological state (SANTOS et al., 2019) and perform feeding behavior activities (CASTRO et al., 2018; PEREIRA et al., 2018; DINIZ et al., 2020; SANTOS et al., 2021); and consequently, maintain milk production.

The RT in the morning shift differed between inclusion levels in the diet of 45% and 60% of banana peel, with a lower RT at the 60% level, which may be attributed to the lipid intake from the peel, indicating a possible decrease in the increment caloric. Furthermore, the non-significance for RT in the afternoon shift indicates that the increase in RR was sufficient for thermoregulation since approximately 15% of endogenous heat is typically lost via the pathway respiratory (McDOWELL et al., 1976).

## CONCLUSION

Under the study environmental conditions, the inclusion level of up to 60% of the banana peel replacing sorghum silage did not alter the physiological variables of thermoregulation in F1 Holstein × Zebu cows.

## ACKNOWLEDGEMENTS

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001. To Fundação de Amparo à Pesquisa do Estado de Minas Gerais and Universidade Estadual de Montes Claros.

## BIOETHICS AND BIOSSECURITY COMMITTEE APPROVAL

The Ethics Committee on Animal Experimentation and Welfare at UNIMONTES approved the research project under opinion 081/2014.

## DECLARATION OF CONFLICT OF INTERESTS

The authors declare no conflict of interest.

## AUTHORS' CONTRIBUTIONS

The authors contributed equally to the manuscript.

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