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Environmental parameters and their influence on the thermal stress of buffaloes in the Sertão de Pajeú

Parâmetros ambientais e sua influência no estresse térmico de bubalinos no Sertão de Pajeú

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ABSTRACT

This study evaluated the impact of climatic conditions on thermal comfort and food intake of buffaloes in the hinterland of Pernambuco. Climate data were collected over 13 months, between May 2023 and May 2024, at the Meteorological Station of the Federal Rural University of Pernambuco (*Universidade Federal Rural de Pernambuco* - UFRPE), in Serra Talhada. The variables analyzed included air temperature, relative humidity, dew point, total solar radiation, and rainfall. With these data, the Temperature and Humidity Index (THI) and the Reduction of Food Consumption (RFC) were calculated. The results indicated that, during most of the year, temperatures exceeded the ideal for the thermal comfort of buffaloes, especially in the dry months. The high THI, resulting from high temperatures and low humidity, pointed to considerable thermal discomfort. This discomfort translated into a significant reduction in dry matter intake by the animals, negatively impacting meat and milk production. The bioclimatic conditions in the studied region pose challenges to buffalo production, with periods of heat stress, leading to yield losses. The adoption of appropriate management practices is essential to mitigate these effects and improve animal welfare and productivity, reducing economic losses in production.

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RESUMO

Este estudo avaliou o impacto das condições climáticas no conforto térmico e no consumo alimentar de bubalinos no sertão de Pernambuco. Os dados climáticos foram coletados ao longo de 13 meses, entre maio de 2023 e maio de 2024, na Estação Meteorológica da Universidade Federal Rural de Pernambuco - UFRPE, em Serra Talhada. As variáveis analisadas incluíram temperatura do ar, umidade relativa, ponto de orvalho, radiação solar total e pluviosidade. Com esses dados, foram calculados o Índice de Temperatura e Umidade (ITU) e a Redução do Consumo Alimentar (RCA). Os resultados indicaram que, durante a maior parte do ano, as temperaturas excederam o ideal para o conforto térmico dos bubalinos, especialmente nos meses secos. O ITU elevado, resultante de altas temperaturas e baixa umidade, apontou para um desconforto térmico considerável. Esse desconforto se traduziu em uma redução significativa no consumo de matéria seca pelos animais, impactando negativamente a produção de carne e leite. As condições bioclimáticas na região estudada impõem desafios à produção de bubalinos, com períodos de estresse térmico, levando a perdas produtivas. A adoção de práticas de manejo adequadas se mostra essencial para mitigar esses efeitos e melhorar o bem-estar e a produtividade dos animais, reduzindo as perdas econômicas na produção.

***Palavras-Chave*:**
Bioclimatologia,
Calor,
Clima,
Estresse.

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Introduction

Within the national livestock, buffalo farming has been growing and has economic potential to expand the frontiers of production in Brazil. The domestic buffaloes Bubalus bubalis originated in Asia, but were introduced in Brazil more than a century ago and since then have adapted to the different regions of the country and climatic characteristics. The main breeds bred in Brazil, according to the Brazilian Association of Buffalo Breeders (*Associação Brasileira de Criadores de Búfalos* - ABCB), are Murrah, Mediterranean, Jafarabadi and Carabao.

Buffalo farming contributes to the offer of products of high commercial value such as meat and milk. Meat is characterized by being healthier compared to beef, with a lower fat content, cholesterol and a higher content of essential amino acids, in addition to its juiciness, tenderness and flavor. In addition, buffalo milk has an attractive nutritional composition for consumers, being a healthier alternative with potential for diversification of dairy products (Marafon and Silva, 2022).

According to ABCB (2024), Brazil has the largest herd in the West, with a total of 3 million animals, present in all regions of Brazil, as it has adaptive characteristics to varied climates, including in areas where cattle ranching would be less viable. The Murrah is the breed that has grown the most in the country in the last 30 years. This growth is due to the characteristics of these animals that have greater rusticity, better use of forage and easier management. However, even though the herd shows a constant growth in all regions of Brazil, buffaloes represent only 1.4% of animals when compared to the cattle herd.

The breeding of buffaloes in the *Sertão* of Pernambuco goes through several challenges due to the adversity of the environment that directly influences thermal comfort, with an effect on the productivity of these animals. The climate of the region is semi-arid, characterized by high temperatures and low humidity throughout the day, with drops in temperature throughout the night. In addition, it has a long period of drought and short rainy periods. Analysis studies over the years on the occurrence of rainfall in the region made it possible to identify the months with the highest rainfall and the months with scarce rainfall in the region, with the rainy period between the months of January and June and the dry period from July to December (Silva Neto *et al.*, 2022).

Climate change is a reality, despite the efforts of several countries to reduce greenhouse gases in recent decades, the negative effects have been consolidating more constantly and intensely, directly affecting natural resources and the entire production chain. In the semi-arid Northeast, more specifically the *Caatinga*, which is characterized by being exclusively Brazilian, the effects are drastic, such as an increase in the duration and intensification of

droughts throughout the region, directly affecting local livestock by reducing the supply of forage plants for animal feed (Milhorance *et al.*, 2021).

In this sense, it is essential to ensure that the animals, in addition to being well nourished, are able to express their innate behavior (they cannot suffer pain, fear and anguish) and are in an environment that guarantees thermal comfort. Animal welfare is directly linked to the conditions in which animals are living, with effects on the quantity and quality of the products produced (Cardoso, 2023).

Buffaloes are more sensitive to solar radiation because they have structural and functional characteristics, which are very different from cattle, because they have black pigments in the skin and hair, and because they have a thicker epidermis, so they suffer from high temperatures because they are not efficient in heat loss by conduction and irradiation. The number of sweat glands is lower than in cattle, which also ends up making it difficult to exchange heat with the environment. Despite this, they manage to adapt well to the environmental conditions in which they are inserted (Silva, 2000).

Buffaloes can reach thermoneutrality faster when they are subjected to natural or artificial shade conditions. In addition, they manage to minimize these thermal stresses because they are semiaquatic animals, look for water to bathe or dive and usually wallow in mud, as an alternative to lower body temperature, respiratory and heart rate. Not affecting productive performance by decreasing dry matter intake (Souza Junior *et al.*, 2008).

It is essential to ensure that the animals stay within the thermal comfort zone so that they do not have losses in zootechnical indexes. Ensuring that homeothermic animals can stay within the thermoneutral range ensures greater efficiency in production. This is challenging considering that Brazil is a country with a tropical climate and with regions that reach temperatures above 30°C for several hours throughout the day, and this situation persists in most months of the year. In addition, the thermal session of regions with higher peaks of solar radiation and high temperatures is intensified with the relative humidity of the air (Klosowski *et al.*, 2002).

When thinking about thermal comfort, the main variables used to estimate thermal stress are ambient temperature and relative humidity. With this data, the Temperature and Humidity Index (THI) can be calculated and heat stress can be estimated. The use of Bioclimatic indices as a predictor of stress was first investigated in the 1940s for dairy cattle and from this several indices were developed (Thom 1959, Buffington *et al.*, 1981, Baeta *et al.*, 1987, Gaughan *et al.*, 2008, Eigenberg *et al.*, 2005, Mader *et al.*, 2010, Silva *et al.*, 2015 cited by Herbut *et al.*, 2018) for different categories and animal species based on the measurement of meteorological factors.

According to Wijfflels *et al.* (2021), THI and its variants have been a widely used indicator of heat stress in production animals. This index serves to classify heat stress into:

Normal, alert, danger, and emergency, and has an influence on growth, reproduction, and animal production (Mishra, 2021).

Studies on heat stress in buffaloes using THI have been widely carried out in different regions of the world. Silva *et al.*, (2015), evaluated the thermal comfort indices in Murrah buffaloes in the Amazon, and concluded that the THI is effective to identify heat stress in tropical environments. When it exceeds 74, stress can impact milk production and buffalo physiology.

In India, Umar *et al.* (2021) correlated the THI with the decline in milk production of riparian buffaloes, highlighting that the increase in index values is detrimental to animal productivity, being more pronounced in environments with high solar radiation, and the monitoring of the index is effective in identifying heat stress, directly influencing the welfare of animals and their production. Although these studies are relevant to tropical regions, there is a paucity of data on the use of THI to assess heat stress in buffaloes in the northeastern semiarid region.

According to Marai and Haeeb (2010), heat stress is also responsible for decreased food intake, efficiency and utilization, as well as disturbances in the metabolism of water, proteins, minerals, enzymatic reactions, hormone secretions and blood metabolites, which results in impaired animal performance.

Mishra *et al.* (1963) and El-Koja *et al.* (1980) reported that direct sun exposure increased water intake and reduced feed intake with increasing temperature (Marai and Haeeb, 2010). Dry matter intake (DMI) is influenced by age, body weight, sex, physiological status, type of production, breeding characteristics and health of the buffaloes.

In view of the above, the objective of this study was to analyze the impact of climatic variables and their influence on the heat stress of buffaloes in the *Sertão* of Pernambuco.

Metodologia

Bioclimatic data on temperature, relative humidity, dew point, total solar radiation, and rainfall were obtained from May 2023 to May 2024 from the Meteorological Station linked to the National Institute of Meteorology (*Instituto Nacional de Meteorologia* - IMET), installed at the Serra Talhada Academic Unit (*Unidade Acadêmica de Serra Talhada* - UAST) - Federal Rural University of Pernambuco (*Universidade Federal Rural de Pernambuco* - UFRPE), located at Fazenda Saco, rural area of the municipality of Serra Talhada - PE, latitude: 07°. 95'42" S; longitude: 38° 29'50"W and altitude: 499 m.

To calculate the Temperature and Humidity Index (THI), the following formula suggested by (Thom, 1959):

$$THI = Tar + (0{,}36 \times Tpo) + 41{,}5$$

Where:

THI: Temperature and humidity index;

Tar: Ambient temperature;

Tpo: Dew point temperature.

Where the THI equal to or less than 70 is classified as adequate thermal comfort and the animals do not present thermal stress; 71 ≤ THI < 78: The environment in critical conditions, in which it can generate thermal discomfort to the animals, causing health problems and reduction in the animals food consumption; 79 ≤ THI < 83: Very hot environmental conditions, where dangerous situations can be and can lead to serious consequences for the health of the animals and low dry matter intake; and THI > 83: Presenting extremely high meteorological indices and very hot environment, where it is classified as a lethal environment the health of the animal and with great zootechnical losses. THI in critical situations leads animals to reduced productive performance as well as lower fertility (Barbosa, 2023).

The reduction in food consumption (RFC) was calculated according to Hahn and Osburn (1969), where RFC = -28,23 + 0391 x THI, being the RFC expressed in kg animal day^{-1}.

The data were tabulated using the Microsoft Excel® program and submitted to descriptive analysis.

Results and discussion

The means found for the environmental variables: Environmental temperature (°C), relative humidity (%), rainfall (mm), dew point (%) and the temperature and humidity index (THI) are described in Table 1 and Figure 1.

Table 1.

Average of the environmental and bioclimatic variables obtained from the meteorological station located in the city of Serra Talhada, during May 2023 to May 2024.

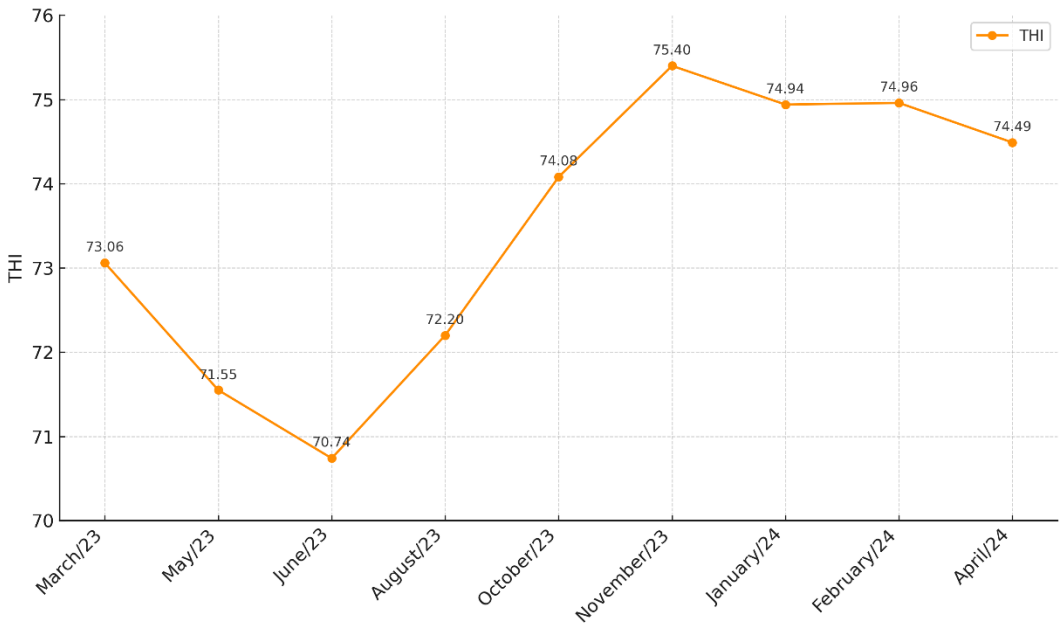
Months	Temperature	Humidity	Rainfall	Dew Point
May/23	24.90±0.87	69.69±6.27	122.80±12.2	18.50±1.17
June/23	23.88±0.89	68.08±5.99	26.60±1.17	17.14±1.77
July/23	23.76±0.82	61.82±7.19	20.80±1.75	15.19±1.59
August/23	25.50±1.64	54.55±6.54	8.80±0.57	14.43±1.47
September/23	26.52±1.56	48.84±6.66	0.20±0.04	13.38±1.57
October/23	28.25±1.17	41.16±5.05	2.60±0.44	12.03±1.80
November/23	29.17±0.94	41.40±5.92	16.00±2.16	13.14±2.43
December/23	28.22±1.48	48.28±9.78	112.80±4.45	14.94±2.00
January/24	27.07±1.12	59.61±8.43	74.00±5.83	17.70±1.61
February/24	26.39±1.43	65.17±10.42	188.60±14.49	18.44±1.70

March/24	26.38±0.65	68.82±5.85	104.20±7.62	19.66±1.07
April/24	25.85±0.72	71.61±5.69	176.80±12.54	19.81±1.08
May/24	24.85±0.85	68.94±6.67	87.80±6.71	18.25±1.39

The environmental temperature values in almost the entire year were above the recommended, with the exception of the months of June and July, in which they were below 24°C and thus within the ideal temperature. Damasceno *et al.* (2010) indicate that buffaloes can stay within their thermoneutrality range between the average temperatures of 4°C and 24°C, where they do not go through thermal stress due to the cold and thus do not spend energy to keep the body at the ideal temperature, consequently, the animals in these conditions have a better productive performance.

Figure 01.

Variation of the Temperature and Humidity Index (THI) obtained from the meteorological station located in the city of Serra Talhada, during May 2023 to May 2024.



The relative humidity of the air did not present an average higher than 75%, being a region characterized by having a low relative humidity of the air, this, within the climatic situation, is favorable for the animals to be able to lose heat through convection where the animals lose body heat through contact with the wind and the sweat can evaporate quickly removing heat from the animal. This is possible because the humidity in the air is not saturated.

The accumulated rainfall is quite irregular in the region, where the dry period reaches less than 1 mm. In addition to the scarcity of water for the animals, it directly affects the

production of quality forage, and thus, generating an environmental stress in which it can lead the animal to productive losses within the property.

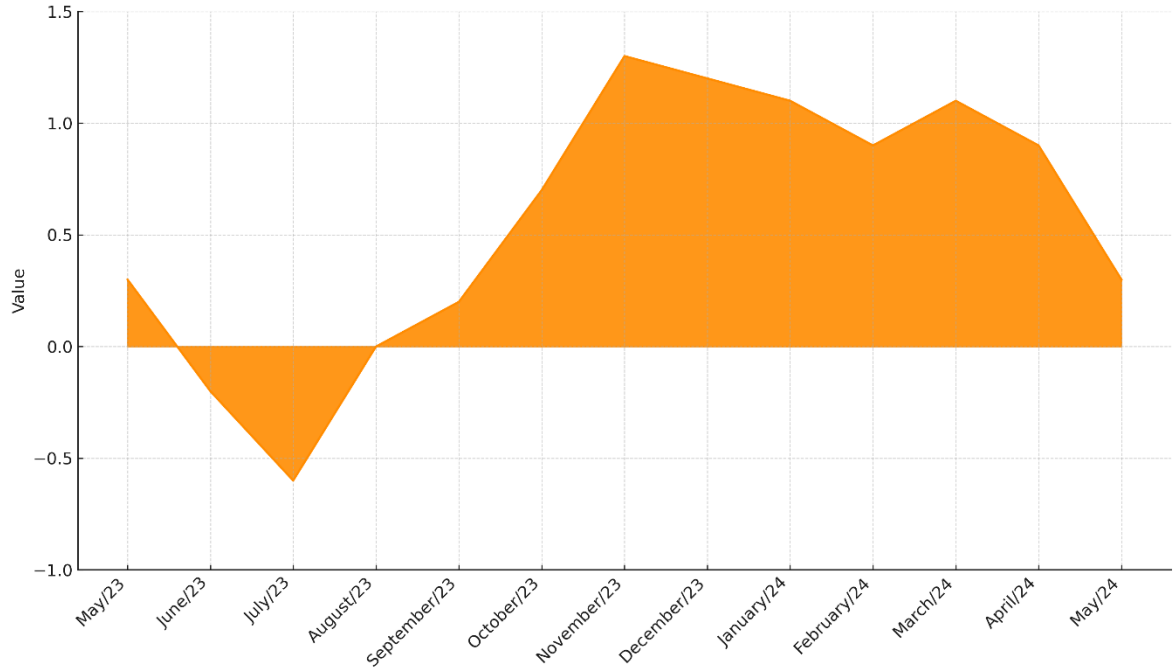
It can be observed that during November, the temperature and humidity index presented the greatest discomfort in relation to the other months, in which the variable begins to decrease after the beginning of the December rains. During the rainy season, which varies from December to May, due to the high humidity of the environment, the THI remains constant above 74%, which leads the animals to have thermal discomfort and lower food intake. It is only in May that the THI decreases again, but it is still not in the ideal range for buffaloes. Throughout the year, the animals presented thermal discomfort, which was intensified during the dry season, leading the animals to greater productive losses.

The THI values presented results that directly impact the reduction of food consumption. It is noted that almost every month observed had a reduction in feed intake, even during periods when the THI was less than 73, promoted a significant reduction in the intake of dry matter by the animals (Figure 2), consequently this can directly impact the production of meat and milk of buffaloes.

It is possible to observe that the most alarming results of RFC is precisely during the period that presented less precipitation, in which temperatures were higher and presented higher values for THI. Within the production chain, the reduction in dry matter consumption is extremely alarming, taking into account that the animals will not consume the ideal amount of nutrients for their maintenance and production.

Figure 2.

Estimated Food Consumption Reduction (RFC) in the city of Serra Talhada during May 2023 to May 2024.



During the most severe period, the animals had maximum RFC, showed a reduction in dry matter of 1.6 kg per animal per day. The months in which the animals had the least impact were June and July, which did not show a reduction in feed consumption, and August was the transition period, where they already showed a response to the negative impact of climate variations with the increase in THI and consequently the decrease in food intake.

Conclusion

Bioclimatic variables indicate heat stress during almost the entire year, with the THI being higher than recommended for many consecutive months. Even though the animals are within the ideal THI range, the animals still showed a reduction in feed consumption, which leads to productive and economic losses, being intensified during the dry season. The bioclimatic effects can be minimized by adopting appropriate systems and management to ensure less impact of these variables on the animals.

REFERENCES

Cardoso, L. S. A. (2023). *Influência do clima na produção e no conforto térmico de bubalinos*. Universidade Federal Rural da Amazônia, Campus Belém, PA. http://bdta.ufra.edu.br/jspui/handle/123456789/2861

Hahn, G. L., & Osburn, D. D. (1969). Feasibility of summer environmental control for dairy cattle based on expected production losses. *Transactions of the ASAE. American Society of Agricultural Engineers*, *12*(4), 0448–0451. https://doi.org/10.13031/2013.38862

Klosowski, E. S., Campos, A. T., de Campos, A. T., & Gasparino, E. (2002). Estimativa do declínio na produção de leite, em período de verão, para Maringá-PR, v. 10, n. 2. *Revista Brasileira de Agrometeorologia*, 283–288.

Marafon, A., & da Silva, W. L. (2022). CRIAÇÃO DE BÚFALOS: CARACTERÍSTICAS, PRODUÇÃO, VANTAGENS E DESAFIOS DO MERCADO, v. 6, n. 4. *Revista Alomorfia*, 548–561.

Milhorance, C., Sabourin, E., & Mendes, P. (2021). Adaptação às mudanças climáticas no Semiárido brasileiro: desafios de coordenação e implementação de políticas públicas. Em *A ação pública de adaptação da agricultura à mudança climática no Nordeste semiárido brasileiro* (pp. 81–98). E-papers Serviços Editoriais.

Oliveira, L. M. F. de, Yanagi Junior, T., Ferreira, E., Carvalho, L. G. de, & Silva, M. P. da. (2006). Zoneamento bioclimático da região sudeste do Brasil para o conforto térmico animal e humano. *Engenharia agrícola*, *26*(3), 823–831. https://doi.org/10.1590/s0100-69162006000300020

Silva, R.G. Introdução à bioclimatologia animal. São Paulo: Nobel, 2000. 286p

Silva, J. A. R. de. (2015). Thermal comfort indices of female Murrah buffaloes reared in the Eastern Amazon. International Journal Of Biometeorology, [S.L.], v. 59, n. 9, p. 1261-1267, 4 jun. 2015. Springer Science and Business Media LLC. http://dx.doi.org/10.1007/s00484-014-0937-y.

Silva Neto, M. A. da, Jesus, J. E. G. de, Montenegro, A. A. de A., Sousa, L. D. B. de, Lins, F. A. C., & Chagas, A. M. S. das. (2022). Parâmetros biofísicos como instrumento analítico de degradação do solo em bacia experimental do semiárido pernambucano. *Agrometeoros*, *30*. https://doi.org/10.31062/agrom.v30.e026989

Souza Junior, J. B. F. de, Domingos, H. G. T., Silva, R. B., & Lima, R. N. de. (2008). Termorregulação em búfalos manejados em ambiente tropical. *PubVet*, *2*(10), 1–21. https://doi.org/10.31533/pubvet.v02n10a396

Thom, E. C. (1959). The discomfort index. *Weatherwise*, *12*(2), 57–61. https://doi.org/10.1080/00431672.1959.9926960

Umar, Sofi Imran Ul *et al*. (2021). Delineation of temperature-humidity index (THI) as indicator of heat stress in riverine buffaloes (Bubalus bubalis) of a sub-tropical Indian region. Cell Stress And Chaperones, [S.L.], v. 26, n. 4, p. 657-669, jul. 2021. Elsevier BV. http://dx.doi.org/10.1007/s12192-021-01209-1.