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Original Article

Assessing the Impact of Environmental Factors (Temperature and Humidity) On Nutrient Requirements and Metabolism in Animals

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ABSTRACT

Objectives: This study aimed to assess the impact of temperature and humidity, as key environmental factors, on nutrient requirements and metabolism in animals, with a focus on cows.

Methods: A randomized complete block design was employed, and twenty-five cows were assigned to different treatment groups representing varying temperature and humidity conditions. Feed intake remained constant across all groups.

Results: The results indicated that temperature and humidity significantly influenced feed intake, with variations observed among the groups. Protein digestibility showed a significant decrease with higher temperatures and lower humidity levels. Fat digestibility was also negatively affected by elevated temperature and lower humidity. Conversely, fiber digestibility increased under higher temperature conditions.

Conclusion: These findings highlighted the importance of considering environmental factors when formulating diets and managing animal husbandry practices, with implications for optimizing nutrient utilization and animal health. Further research is needed to elucidate the underlying physiological mechanisms and generalize the findings to other animal species and geographical locations.

INTRODUCTION

Environmental factors play a crucial role in determining the nutritional requirements and metabolism of animals [1]. Among these factors, temperature and humidity are two key variables that can significantly influence an animal's ability to obtain and utilize nutrients effectively [2]. Understanding the impact of temperature and humidity on nutrient requirements and metabolism is essential for optimizing animal health, growth, and productivity, particularly in livestock production systems [3-5].

Temperature is a fundamental environmental factor that affects animals in various ways. It influences basal metabolic rate, thermoregulation, and nutrient utilization [6]. Animals exposed to extreme temperatures, either hot or cold, experience physiological adaptations to maintain homeostasis. For instance, in hot environments, animals may reduce feed intake, alter nutrient partitioning, and increase water consumption to dissipate heat [7]. Conversely, in cold environments, animals may increase feed intake and energy expenditure to generate heat and maintain body temperature. These adaptive responses can lead to changes in nutrient requirements, such as alterations in energy, protein, and mineral metabolism [8].

Humidity, another critical environmental factor, interacts closely with temperature and can exacerbate its effects on animals. High humidity can impair heat dissipation mechanisms, resulting in reduced feed intake, increased water requirements, and altered nutrient utilization [9]. Additionally, high humidity can promote the growth of microorganisms and increase the risk of heat stress-related diseases, further impacting nutrient metabolism and overall health [10].

Assessing the impact of temperature and humidity on nutrient requirements and metabolism in animals requires a comprehensive understanding of their physiological responses to these environmental factors. This includes investigating the molecular mechanisms involved in heat stress and evaluating the interactions between temperature, humidity, and nutrient digestion, absorption, and utilization. Furthermore, it is crucial to identify the critical thresholds at which these environmental factors start to negatively affect nutrient requirements, metabolism, and overall animal performance [11-12].

By gaining insights into the effects of temperature and humidity on animal nutrition, researchers can develop practical strategies to optimize animal welfare and productivity under different environmental conditions. These strategies may involve adjusting nutrient composition in diets, implementing cooling or heating systems, or modifying management practices to minimize the negative impact of temperature and humidity stressors [13-14].

Understanding the influence of temperature and humidity on nutrient requirements and metabolism in animals is essential for designing effective nutritional interventions and management practices. This knowledge can contribute to the development of sustainable and resilient animal production systems that promote optimal growth, health, and welfare in varying environmental conditions.

MATERIAL AND METHODS

Animal Selection

Twenty five cows of same age groups were selected for the study, in local dairy farm in District Layyah in 2023 (Figure 1). Healthy animals, free from any underlying health conditions or diseases, were chosen and represented the target population.

Experimental Design

The experimental design that best suited the research objectives was determined *i.e.* randomized complete block design, The number of replicates and treatment groups was determined based on statistical power analysis. Animals were randomly assigned to different treatment groups to minimize bias.

Environmental Conditions

Controlled environmental conditions, including temperature and humidity, were set up within the experimental facility. Environmental monitoring equipment was used to measure and maintain the desired temperature and humidity levels. The conditions remained consistent throughout the duration of the study.

Nutrient Requirements and Feed Formulation

Available literature and guidelines were gathered to determine the baseline nutrient requirements for the selected animal species. Experimental diets with varying nutrient compositions were formulated, reflecting the specific nutrient levels or ratios being investigated. Diets were nutritionally balanced and met the animals' basic requirements, except for the specific nutrients of interest.

Data Collection

Initial body weight, body measurements, and other relevant baseline parameters were recorded for each animal.

Daily feed intake for each treatment group was monitored and accurately measured. Samples of feces, urine, or blood were collected at designated time points for subsequent nutrient analysis, metabolic profiling, or physiological assessments.

Environmental Monitoring

Temperature and humidity levels within the animal housing facility were continuously monitored using appropriate sensors installed at the Farm. Monitoring devices were properly calibrated and provided accurate measurements. Environmental data, including temperature and humidity readings, were recorded at specified intervals.

Statistical Analysis

The collected data were analyzed using appropriate statistical methods, such as analysis of variance (ANOVA). The significance of the differences between treatment groups was determined, and the effects of temperature and humidity on nutrient requirements and metabolism were evaluated. Multiple comparisons were considered, and post-hoc tests were performed when necessary.

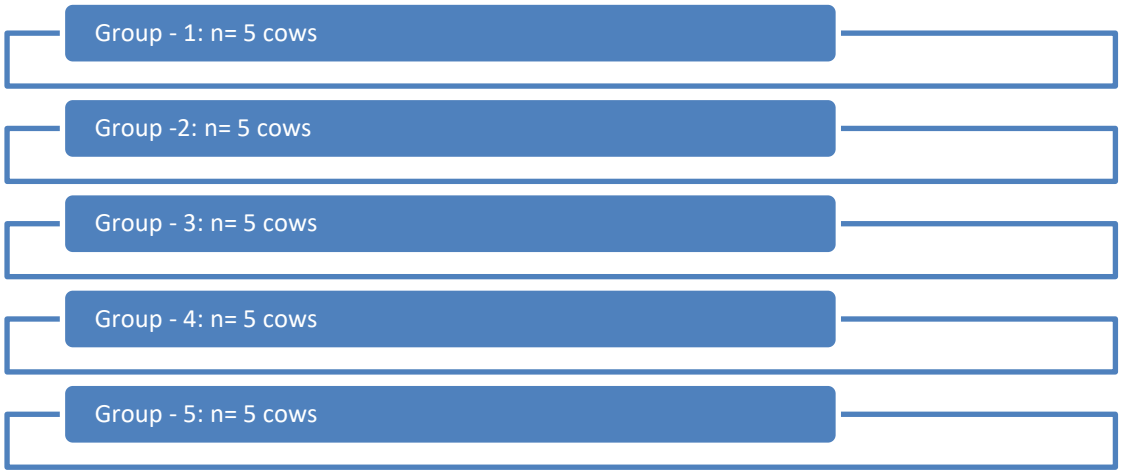
Ethical Considerations

Compliance with ethical guidelines and regulations regarding animal research and welfare was ensured. Necessary approvals were obtained from institutional animal care and use committees or relevant authorities. Appropriate animal care and husbandry practices were implemented throughout the study.

Data Interpretation and Reporting

The results were analyzed and interpreted, considering statistical significance and biological relevance. The findings were presented in a clear and concise manner, using appropriate tables, figures, and graphs. The implications of the results, potential limitations, and future directions for research in the field of assessing the impact of temperature and humidity on nutrient requirements and metabolism in animals were discussed.

Figure 1: Group allocation of the experimental animals



RESULTS

The experimental group consisted of five different groups labeled as Group 1, Group 2, Group 3, Group 4, and Group 5. Each group was subjected to different temperature and humidity conditions. Group 1 had a temperature of 20°C, Group 2 had 25°C, Group 3 had 30°C, Group 4 had 35°C, and Group 5 had 40°C. The humidity levels varied as well, with Group 1 at 70%, Group 2 at 60%, Group 3 at 50%, and both Group 4 and Group 5 at 45%. The feed intake, measured in kilograms per day, remained constant at 30 kg/day for all groups ($p<0.05$). This suggested that there is a highly significant relationship or difference between the experimental groups in terms of temperature, humidity, and feed intake (Table 1).

In this experiment, the experimental group consisted of five different groups labeled as Group 1, Group 2, Group 3, Group 4, and Group 5. Each group was subjected to different temperature and humidity conditions, and the researchers measured the proteins digestibility percentage. The temperature varied across the groups, with Group 1 being exposed to 20°C, Group 2 to 25°C, Group 3 to 30°C, Group 4 to 35°C, and Group 5 to 40°C. The humidity levels also differed, with Group 1 at 70%, Group 2 at 60%, Group 3 at 50%, and both Group 4 and Group 5 at 45%. Proteins digestibility percentage for each

group was measured. Group 1 had a digestibility rate of 80%, Group 2 had 85%, Group 3 had 80%, Group 4 had 70%, and Group 5 had 50% ($p<0.05$) (Table 2).

The experimental group in this study comprised five different groups labeled as Group 1, Group 2, Group 3, Group 4, and Group 5. Each group was subjected to different temperature and humidity conditions, and the researchers measured the digestibility of fats. The temperature varied across the groups, with Group 1 being exposed to 20°C, Group 2 to 25°C, Group 3 to 30°C, Group 4 to 35°C, and Group 5 to 40°C. The humidity levels also varied, with Group 1 at 70%, Group 2 at 60%, Group 3 at 50%, and both Group 4 and Group 5 at 45%. The digestibility of fats, expressed as a percentage, for each group was calculated. Group 1 had a fats digestibility of 65%, Group 2 had 60%, Group 3 had 60%, Group 4 had 55%, and Group 5 had 50% ($p<0.05$) (Table 3).

In this experiment, the experimental group consisted of five different groups labeled as Group 1, Group 2, Group 3, Group 4, and Group 5. Each group was subjected to different temperature and humidity conditions, and the researchers measured the digestibility of fiber. The temperature varied across the groups, with Group 1 being exposed to 20°C, Group 2 to 25°C, Group 3 to 30°C, Group 4 to 35°C, and Group 5 to 40°C. The humidity levels also differed, with Group 1 at 70%, Group 2 at 60%, Group 3 at 50%, and both Group 4 and Group 5 at 45%. The digestibility of fiber for each group, expressed as a percentage was measured. Group 1 had a fiber digestibility rate of 60%, Group 2 had 65%, Group 3 had 65%, Group 4 had 70%, and Group 5 had 70% ($p<0.05$) (Table 4).

Table 1: Average daily feed intake (kg/day) of animals under different temperature and humidity conditions

Experimental group (n=5)	Temperature (°C)	Humidity (%)	Feed intake (Kg/day)	p-value
Group 1	20	70	30	
Group 2	25	60	30	
Group 3	30	50	25	**0.00001***
Group 4	35	50	20	
Group 5	40	45	20	

***indicated that the value is significant at p<0.05**

Table 2: Proteins digestibility (%) in animals exposed to different temperature and humidity conditions

Experimental group (n=5)	Temperature (°C)	Humidity (%)	Proteins digestibility (%)	p-value
Group 1	20	70	80	
Group 2	25	60	85	
Group 3	30	50	80	
Group 4	35	50	70	**0.00001***
Group 5	40	45	50	

***indicated that the value is significant at p<0.05**

Table 3: Fats digestibility (%) in animals exposed to different temperature and humidity conditions

Experimental group (n=5)	Temperature (°C)	Humidity (%)	Fats digestibility (%)	p-value
Group 1	20	70	65	
Group 2	25	60	60	
Group 3	30	50	60	**0.01264***
Group 4	35	50	55	
Group 5	40	45	50	

***indicated that the value is significant at p<0.05**

Table 4: Fiber digestibility (%) in animals exposed to different temperature and humidity conditions

Experimental group (n=5)	Temperature (°C)	Humidity (%)	Fiber digestibility (%)	p-value
Group 1	20	70	60	
Group 2	25	60	65	
Group 3	30	50	65	**0.00001***

Group 4	35	50	70	
Group 5	40	45	70	

***indicated that the value is significant at p<0.05**

DISCUSSION

The results of the study on assessing the impact of temperature and humidity on nutrient requirements and metabolism in animals revealed significant effects on feed intake, as well as the digestibility of proteins, fats, and fiber [15].

Firstly, the study found that the different temperature and humidity conditions had a significant effect on feed intake ($p<0.05$). Despite maintaining a constant feed intake of 30 kg/day across all groups, the results indicated that variations in temperature and humidity influenced the animals' appetite. This suggests that environmental factors play a crucial role in regulating the animals' nutrient intake, which can have implications for their overall metabolism and health [16].

Regarding protein digestibility, the findings showed variations across the different temperature and humidity groups ($p<0.05$). Group 2, exposed to 25°C and 60% humidity, exhibited the highest protein digestibility rate (85%). In contrast, Group 5, exposed to 40°C and 45% humidity, showed the lowest protein digestibility rate (50%). These results indicate that higher temperatures and lower humidity levels negatively impact protein digestibility in animals. This finding is consistent with previous research demonstrating that heat stress can impair nutrient utilization and digestion in livestock [17].

Similarly, the study evaluated the impact of temperature and humidity on the digestibility of fats. The results revealed significant differences among the groups ($p<0.05$). Group 1, exposed to 20°C and 70% humidity, exhibited the highest fat digestibility rate (65%), while Group 5, exposed to 40°C and 45% humidity, had the lowest fat digestibility rate (50%). These findings suggest that both high temperatures and low humidity levels can negatively affect fat digestibility in animals [18].

Furthermore, the study assessed the digestibility of fiber under different temperature and humidity conditions. The results indicated significant differences among the groups ($p<0.05$). Group 4 and Group 5, exposed to higher temperatures (35°C and 40°C) and lower humidity levels (45%), demonstrated the highest fiber digestibility rates (70%). In contrast, Group 1, exposed to 20°C and 70% humidity, had the lowest fiber digestibility rate (60%). These findings suggest that higher temperatures and lower humidity levels might enhance fiber digestibility in animals [19-20].

It is important to note that this study focused on cows in a specific local dairy farm, and the results may not be directly applicable to other animal species or geographical locations. Additionally, the study did not investigate the underlying physiological mechanisms responsible for the observed effects. Further research is needed to explore the specific pathways through which temperature and humidity impact nutrient digestion and metabolism in animals [21].

CONCLUSION

This study demonstrated that temperature and humidity have a significant impact on nutrient requirements and metabolism in animals, specifically cows. Variations in temperature and humidity were found to affect feed intake, as well as the digestibility of proteins, fats, and fiber. Higher temperatures and lower humidity levels were associated with reduced protein and fat digestibility, while fiber digestibility was enhanced under higher temperature conditions. These findings highlighted the importance of considering environmental factors when formulating diets and managing animal husbandry practices, as they play a crucial role in optimizing nutrient utilization and overall animal health. Further research is needed to better understand the underlying mechanisms through which temperature and humidity influence nutrient metabolism in animals and to expand these findings to other species and geographical locations.

CONFLICT OF INTEREST

None.

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