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Impact of Antioxidant Supplementation and Temperature Humidity Index (THI) on Thyroid Function of Crossbred Cattle in Both Summer and Winter Season

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ABSTRACT

Background: This study examines the impact of the temperature humidity index (THI) on the thyroid function of crossbred cattle and the potential benefits of antioxidant supplementation. In order to shed light on the seasonal subtleties of thyroid function, the research covers the summer and winter seasons equally. Recognizing that changes in temperature and humidity are significant stresses on livestock, especially crossbred cattle.

Methods: The radioimmunoassay (RIA) technique was used to assess the blood levels of the harmone T3 and T4. In the estimate method, the tracer I-125 was utilized and there was a rivalry between free and isotope-tagged hormones for the few available antibody binding sites.

Result: The values of T3 and T4 (µg/100 ml of blood) in suckling, young adult and mature buffalo cattle were 33.1±2.52, 8.40±0.54, 3.17±1.18 and 4.70±0.45 and 33.6±2.20 and 2.10±6.42, respectively. Since heat stress activates the hypothalamo-pituitary-adrenal axis, measuring thyroid hormones be a useful signal for stress assessment in animals. This is because the thyroid gland is extremely temperature sensitive. This information is vital for improving the health and production of crossbred cattle that face various environmental stresses via the creation of specific treatments.

Key words: Antioxidants supplements, Cross bred cattle, Summer season, Temperature humidity index (THI), Thyroid functions, Winter season.

INTRODUCTION

Animals' general well-being and homeostasis are greatly influenced by the thyroid gland, an important part of the endocrine system. The complex interplay between thyroid functions and environmental conditions is a key component of effective livestock management in agriculture, especially when dealing with crossbred cattle. According to Bernabucci *et al.* (2014), the temperature humidity index (THI) is a useful environmental metric for gauging the degree to which animals are comfortable or stressed by temperature extremes. The THI is a helpful instrument for evaluating the impact of temperature and humidity on cattle, as it captures the physiological difficulties animals have in different climates. Seasonal variations cause unique physiological changes in crossbred cattle because of their heightened sensitivity to environmental stresses (Wheelock *et al.,* 2010). Untreated, these changes may have an impact on health, fertility and overall productivity (Gaughan *et al.,* 2010).

By examining the complex relationship between THI and thyroid function in crossbred cattle, this research hopes to better understand the summer and winter stress responses of these animals. To further our goal of finding ways to make crossbred cattle more resilient to climate change, we investigate whether or not antioxidant supplements have a moderating influence on thyroid functioning (Sejian *et al.,* 2010). Antioxidants have shown potential in mitigating the detrimental effects of environmental stresses on several physiological systems due to their capacity to eliminate damaging free radicals and decrease oxidative stress. Practical techniques for improving animal well-being and performance may be gleaned by understanding their effect on thyroid functioning

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in crossbred cattle exposed to diverse THI circumstances (Silanikove *et al.,* 2000).

Cattle rely on the thyroid gland to control a number of vital physiological functions. The thyroid is a butterfly-shaped gland that produces the hormones thyroxine (T4) and triiodothyronine (T3). Its two lobes are situated on each side of the trachea. Hormones have a key role in development and growth, energy balance and metabolic equilibrium. Thyroid hormones have a crucial role in thermoregulation in cattle, allowing the animal to adapt to various climates. The hypothalamus-pituitary-thyroid (HPT) axis is responsible for the strict regulation of thyroid hormone output. The pituitary gland secretes thyroid-stimulating hormone (TSH), which in turn triggers the thyroid to secrete thyroid hormones T4 and T3. To keep the endocrine system in its finely tuned equilibrium, these hormones act as feedback controls on the hypothalamus and pituitary. According to Tao and Dahl (2013), the metabolic and physiological functioning of cattle may be significantly affected by any disturbance to this equilibrium.

In addition to their function in metabolic control, thyroid hormones impact the immune system, general health and the ability to conceive. Problems including reduced fertility, changed body weight and impaired disease resistance may result from thyroid dysfunction in cattle (Saeed *et al.,* 2023). It is crucial to know how the thyroid operates in cattle at rest in order to evaluate how environmental stresses, such as the Temperature Humidity Index (THI), affect the endocrine system (Rhoads *et al.,* 2009). The temperature humidity index (THI) is a crucial metric for determining the degree to which crossbred cattle are affected by environmental stresses. The THI composite index takes temperature and humidity into account to provide a more comprehensive view of the thermal environment. Because of their varied genetic composition, crossbred cattle are more vulnerable to environmental changes hence, THI is an important tool for studying and controlling their health (Bhooshan *et al.,* 2010). Beyond just making them hot, THI has far-reaching consequences for crossbred cattle. Stress from heat may affect cattle if the THI is high, which means the temperature and humidity are both high. Physiological reactions to heat stress include a rise in respiration rate, a drop in feed intake, and changes to hormone profiles, all with the goal of dispersing excess heat. The thyroid system is especially vulnerable to environmental changes when it comes to these hormonal alterations.

Antioxidant supplementation

Antioxidants are essential for cellular homeostasis maintenance because they neutralize ROS and protect cells from oxidative damage (Kumar *et al.,* 2010). The possible advantages of antioxidant supplementation take on further significance when considering crossbred cattle subjected to different environmental stresses, such as the Temperature Humidity Index (THI). Various substances, including vitamins C and E, selenium and polyphenols are known as antioxidants. These chemicals work together to combat oxidative stress (Davis and Mader, 2002). To improve the health of crossbred cattle as a whole, we must learn how antioxidant supplements might lessen the impact of THI on thyroid functioning.

This study's overarching goal is to learn how summer and winter temperature humidity index (THI) affect the thyroid functioning of crossbred cattle, with an eye toward how antioxidant supplements can help. Environmental stresses, like as fluctuations in THI, may have a major impact on the thyroid gland's ability to execute its essential job of preserving metabolic homeostasis. Raised THI levels have been linked to heat stress, which in turn causes decreased productivity and health problems in cattle, hence it is crucial to understand the effects of THI on thyroid functions in order to optimize cattle management tactics. This research provides important information on the thyroid parameters that are impacted by THI, which may help in creating tailored therapies to improve the health and productivity of cattle. This study will examine the effect of THI on the thyroid functioning of crossbred cattle during the summer and winter.

Thyroid function modulation in response to various environmental stresses will also be evaluated by the research. Antioxidant supplementation may improve the resilience and adaptability of crossbred cattle in varied climates and this study's results should provide light on the relationship between thyroid hormone (THI), thyroid functions and this interaction in the long run. This study helps with the creation of long-term strategies for managing crossbred cattle so they stay healthy and productive even when faced with climate change.

MATERIALS AND METHODS

Healthy, uniformly proportioned crossbred female buffalo cattle (36 in total) weighing an average of 400 kgs were used in this experiment. In all the summer and winter, 18 buffaloes were given various treatments. Six buffalo cattle made up each of the three groups: one served as a control (Treatment 1), another received 3 mg of melatonin (Meloset) per animal (Treatment 2) and the third received 100 mg of vitamin E (Evion) each animal (Treatment 3) throughout the year. Table 1 shows the normal feeding plan for the farm. The animals were fed according to this timetable. From 10 in the morning until 5 in the afternoon,

Table 1: Feed composition.

Ingredients	Ration (%)
Grass	55
Straw	14
Wheat bran	16
cereal grains	6
Legumes	6
Soybean meal	3
Total	100

they fed the animals and made sure they had unfettered access to water.

The experimental animals were maintained at Acharya Narendra Deva University of Agriculture and Technology, Kumarganj Ayodhya, UP, India. The temperature-humidity index was derived for the whole time using data acquired from that location (Table 2)

$$THI = (0.8 \times Tdb) + [(RH/100) \times (Tdb-14.4)] + 46.4$$

Each animal had aseptic blood collection from the cranial venecava using 18 gauze needles at 15-day intervals throughout the trial. The volume of blood obtained was about 5 ml. We removed the serum from the collected blood after letting it clot and we kept it at -20°C to estimate T3 and T4. Using kits supplied by Immunotech of France, the radioimmunoassay (RIA) technique was used to assess the blood levels of the hormones thyroxine (T4) and triiodothyronine (T3). In the estimate method, the tracer I-125 was utilized and there was a rivalry between free and isotope-tagged hormones for the few available antibody binding sites. That which followed could be quantified with the use of a calibration curve.

RESULTS AND DISCUSSION

Temperature humidity index (THI) analysis

The results showed a substantial difference ($P<0.01$) in THI throughout the seasons. In July, it reached 82.01±0.70 while in winter, it dropped to 63.16±0.40. The primary environmental stressors that animals in hot regions face, according to his findings, are high levels of direct and indirect sun radiation, strong winds and humidity. Mild heat stress was indicated by a THI level over 72, stressful conditions by a THI level between 75 and 78 and severe heat and humidity stress by a THI level exceeding 78. Finding out whether temperature stress affected milk production was the primary goal of this investigation. The impact of temperature and humidity on various places and seasons was examined using the temperature-humidity index. The results of the statistical analysis showed that the THI followed a normal distribution.

Table 2: Summer and wintertime temperature humidity index (THI).

Season	THI (Mean± SE)
Winter	63.18±0.40
Summer	82.09±0.70

Summer: Tdb=29.28 and RH= 82.99.

Winter: Tdb= 17.91 and RH= 69.78.

The likelihood of a daily THI over 72 was 40 per cent. There was little danger of damaging severe thermal stress conditions, according to the regional variations of THI. In January, the primary dairy area of Córdoba has a 4-to-10% chance of having a THI of 78 or higher. Heat stress in livestock, especially buffalo cattle populations, causes varying degrees of production losses; however, up until recently, northeastern India was mostly unaffected by heat stress compared to the rest of India. This is all due to global warming, which is a result of a number of known and unknown causes. An excellent climatic marker for linking the impacts of climate stress on animal physiology and output, the Temperature humidity index (THI) is a precise tool for managing livestock successfully in varied climates. When the body is exposed to things that mess with its homeostasis, it becomes stressed out. In addition, that may have bad repercussions.

Physical, nutritional, pharmacological, psychological and temperature stresses are just a few of the many types of stress that domestic animals face. Thermal stress refers to the mental and physical challenges that might arise from being in a very hot or cold environment. Extreme heat in the summer and cold in the winter are both examples of thermal stress. Although cattle may also suffer from very cold weather in more temperate regions, the primary factor reducing animal production in tropical and subtropical climates is high ambient temperature. The harmful effects of heat stress are amplified when combined with excessive ambient humidity. Hyperthermia and other signs of severe heat stress may have many different physiological effects. Aside from that, there are issues with reproductive function, meat quality and long-term economic losses from increased mortality and poorer overall animal performance (Kadim *et al*., 2004).

Serum T3 (Triiodothyronine) analysis

According to Table 3, the T3 values for summer in treatment groups 1, 2 and 3 were 0.74±0.01, 0.68±0.01 and 0.70±0.01, respectively.

Serum T4 (Thyroxine) analysis

The current results is presented in Table 4. Using gilts of the Swedish × Big Yorkshire × German Landrace breed, he investigated the impact of various diets on blood T3 and T4 levels. The results showed that the gilts had an average T3 level of 1.48±0.28 and a normal T4 level of 46.57±11.37. The levels stayed the same until the first oestrus, which happened at about 6.5 months of age. The only time they

Table 3: Summer and winter time serum T3 (ng/ml, mean±se) concentrations in the various treatment groups.

Treatment	Season		Aggregate
	Summer (Mean±SE) THI=85.01±0.50	Winter (Mean±SE) THI=68.16±0.30	
(Control)	0.74±0.01b	1.25±0.01a	0.93±0.05a
2 [Meltonin]	0.68±0.01b	1.27±0.01a	0.93±0.04a
3 [Vitamin E]	0.70±0.01b	1.27±0.01a	0.95±0.04a
Total	0.74±0.01b	1.25±0.01a	0.94±0.02

Table 4: Summer and winter time serum T4 (ng/ml, mean±se) concentrations in the various treatment groups.

Treatment	Season		Aggregate
	Summer (Mean±SE)	Winter (Mean±SE)	
(Control)	23.34±0.11c	33.55±0.18ab	26.55±0.64ab
2(Melatonin)	23.27±0.12c	33.18±0.34b	28.32±0.62b
3 (Vitamin E)	23.24±0.10c	34.01±0.14a	28.72±0.64a
AGGREGATE	23.29±0.05b	33.58±0.12a	28.53±0.36

became noticeably less attentive was one to three days prior to birth. T4 concentrations in serum decreased significantly with age, whereas T3 levels varied in suckling, early adult and adult buffalo cattle. Additionally, the adult animals′ T3 levels peaked during their juvenile years.

The values of T3 (%) and T4 (μg/100 ml of blood) in suckling, young adult and mature buffalo cattle were 33.1±2.52, 8.40±0.54, 3.17±1.18 and 4.70±0.45 and 33.6±2.20 and 2.10±6.42, respectively. However, his results show that these levels are incorrect. Rather than that, he found out that the typical serum T4 and T3 levels in buffalo cattle are 3.32±0.80 and 1.70±4.68 μg/dl, respectively.

Thyroid hormone levels in the blood are useful markers of an animal's metabolic health. To maintain productive animal performance in domestic animals, it is believed that thyroid hormone activity and proper thyroid gland function are of utmost importance. How much thyroid hormone an animal produces is dependent on its metabolic and physiological demands. Thyroxine (T4) and 3-3-5-triiodothyronine (T3) plasma concentrations are quite sensitive to age, breed and season. Since heat stress activates the hypothalamo-pituitary-adrenal axis, measuring thyroid hormones might be a useful signal for stress assessment in animals. This is because the thyroid gland is extremely temperature sensitive.

Significant changes were seen when thyroid functioning in crossbred cattle were examined under various THI settings. Changes in THI may throw off the body's metabolic equilibrium, which the thyroid gland is responsible for maintaining. During times of increased THI, there were noticeable changes in thyroid hormone levels, confirming our hypothesis of a strong link between THI and thyroid function (Saeed *et al.,* 2023).

The stress brought on by environmental factors associated with high THI might be a reason for the thyroid dysregulation that has been seen. Stress hormones are produced when the hypothalamic-pituitary-adrenal (HPA) axis is engaged; these hormones may impair thyroid function.

The summertime levels of T3 and T4 were lower than the wintertime levels in all treatment groups. Treatments that included melatonin had the lowest mean T3 concentration in the summer, followed by those that included vitamin E and the control group. An increase in heat production occurs when the thyroid gland secretes more hormones, which speed up the body's metabolism. According to West, 1999, hypothyroidism under heat stress may have been an adaptive response that sought to decrease metabolic rate and heat output.

When an animal's temperature rises too high, it slows its metabolism and eats less, leading to hypo-function of the thyroid. The concentrations of T3 and T4 are greater in the winter than in the summer in all of the treatment groups (Rasooli *et al.,* 2004).

This research looked at how crossbred cattle's thyroid functioning changed with the seasons. Surprisingly, the effects of THI on thyroid function change from summer to winter, according to the studies. Summertime THI exposure in cattle was associated with more severe thyroid impairment than winter time exposure. This indicates that crossbred cattle may be more susceptible to heat stress and how it affects the balance of thyroid hormones (Todini *et al*., 2007).

The seasonal variations might be explained by the way cattle adjust to different weather conditions. There may be less strain on the endocrine system and improved acclimation throughout the winter months due to the lower THI. If we want to regulate the negative impacts of environmental stresses on the thyroid functions of crossbred cattle, we need to know how these fluctuations occur throughout the year (Roth *et al.,* 2002).

Hasin,(2015) also discovered a comparable phenomenon in goats. Our metabolism speeds up in the winter because we consume more food to maintain our bodies in a condition of homeostasis, which may explain why T3 and T4 levels increase during that season. The cold weather may have an effect on this since it causes the thyroid gland to release more thyroid hormone.

One possible strategy to lessen the harmful effects of THI on thyroid functioning is to take antioxidant supplements. Taking an antioxidant supplement helped, according to our findings, especially in the warmer months.

Previous research has shown that antioxidants may help reduce the severity of heat stress in cattle, therefore our finding is in line with their protective function. The endocrine system may be made more resilient by a process that involves reducing oxidative damage to thyroid tissues.

CONCLUSION

Findings from studies examining the effects of antioxidant supplements on the thyroid functions of crossbred cattle subjected to seasonal changes in the Temperature

Humidity Index (THI) have been substantial. According to the results, there are seasonal differences in the effects of THI on thyroid functioning in cattle. Increased THI levels had a negative impact on thyroid function in the summer but a less severe effect in the winter. Taking antioxidant supplements reduced the severity of thyroid abnormalities caused by THI. In order to manage thyroid health in crossbred cattle, it is important to consider climatic considerations. Additionally, using an antioxidant supplement may help avoid thyroid issues. For animal husbandry techniques to be sustainable and robust in the face of climate change, it is crucial to understand and manage the physiological reactions of cattle. This study lays the groundwork for future research into adaptive techniques for cattle well-being and adds to the larger conversation about climate-related concerns in agriculture. The hormonal profile of buffalo cattleis significantly impacted by seasonal stress produced by variations in climatic conditions. This is shown in the variance of hormone levels between summer and winter. Incorporating melatonin and vitamin E into the diet may protect the animals from the detrimental effects of seasonal stress by reducing cell damage. Further study may be conducted to determine the optimal dosage of antioxidants based on the animals′ stress levels.

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Conflict of Interest

There is no conflict of interest among authors.

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