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Study the Effect of Temperature-Humidity Index in Fall and Winter on Some Clinical Parameters and Some Serum Minerals of Ewes in Shatrah District/ Iraq

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Abstract

The study aimed to discover the effective influence of the Temperature-Humidity Index (THI) during the fall and winter on some clinical parameters, including body temperature, heart rate, and breathing rate, and some serum minerals, including calcium, sodium, and potassium, in Awassi sheep south of Iraq. Fifteen non-pregnant Awassi ewes were randomly selected as specimens. The temperature and humidity were measured to calculate the THI with recording of date, and the clinical parameters were measured with the obtaining of blood to measure the studied serum minerals. The results were divided according to the value of the obtained THI, which were (THI 1=78.75), (THI 2=62.74), and (THI 3=67.59). The results were compared with the reference value of each parameter as a control. The studied parameter's results showed a significant increase in body temperature in THI 2 as compared with THI 3 without significant change with control and THI 1. The heart rate increases significantly in THI 3 when compared with other groups. Respiratory rate showed significant decreases in all studied groups as compared with the control value. The serum calcium and sodium decreased significantly in all studied groups in comparison to control values, but the serum potassium appeared to increase significantly in THI 1 in comparison to the control and other studied groups. In conclusion, the THI index has an effective influence on the studied parameters of non-pregnant Awassi ewes that lived in Southern Iraq and these effects should be considered as indicators for the welfare of animals.

Introduction

The climatic conditions are an important factor in providing a comfortable environment, which is an essential factors for increasing animal production, regardless of the system utilized for the flock. Considering climatological conditions has a favorable influence on the metabolic processes and homeostasis of the animals' bodies, leading to improved welfare of the animal. In consequence, it can elevate the production degree of the flock and can show qualities of animals' genes. Therefore, climatological studies are introduced as one of the designing activities for cattle owners before the beginning of the breeding of animals [1-3].

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The effects of the main environmental situation on dairy cattle production are humidity, ambient temperature, wind, and solar radiation [4]. Most research on heat stress in animal flocks has focused on the influence of temperature degree and relative humidity [5,6]. Research on thermal effects discovered many influences that have a relation with the physiological and behavioral parameters of studied animals [7-9].

The Temperature-Humidity Index (THI) is generally utilized as a guide for the degree of environmental stress on animals; it was calculated that a THI of 72 and below is heat stress (cool), 73-77 is considered mild heat stress, 78-89 is moderate, and above 90 is severe [10]. The elevation of climatic temperature and humidity interferes with the ability of cattle to disperse the heat accumulation of their bodies. This causes elevation of the temperature of the body core and can lead to dysfunction of body regulation, like differences in the action of enzymes. The reactions of essential enzymes of metabolism of food, like the digestion and absorption of nutrients, can be compromised under heat stress conditions, causing a reduction in intake of food and decreased efficiency in the conversion of food [11].

Heat stress is a dangerous cause of physiological deterioration on animals and so influences their production [12–15]. The heat stress in animals has a negative influence on productivity [16–20] and physiological activity of hormonal and immune responses [21–24]. As in dairy cattle, when milk yield raises, heat production of metabolism increases with the large amounts of metabolism of nutrients, making the high-yield cattle more sensitive to high ambient temperatures and humidity than animals that have less metabolism [12]. In addition, heat stress decreases the production of small ruminants and raises the demand for maintenance energy [25]. In the investigating of the influence of heat stress on animals, thermoregulatory action traits like rectal temperature, respiratory rate, and cardiac rate were estimated as physiological guides of heat stress [18].

Minerals leave the transport pool by secretion (e.g., digestive juices, milk, and sweat) and excretion (e.g., feces and urine), both of which may concentrate in hot climatic conditions [26]. Many studies mentioned that mineral supplementation can control oxidative stress from growth or external stressors like a hot environment [26,27]. Thus, the supplementation of minerals from pastures only is not enough for grazing ruminants during some seasons of the year [28]. The excretion of essential minerals should be traced through body matrices and can be utilized as a need index of minerals.

Materials and methods

Study area

This study was carried out in the Al-Shatrah district in South of Iraq, about 350 km south of Baghdad. This area is 4 m in altitude and lies al (31°24'35"N, 46°10'18"E). The climate is arid. The temperature ranges from 49ºC in summer to 8ºC in the winter night.

Animals of the study

To nullify and negate the effect of age on studied parameters, fifteen non-pregnant Arabi ewes at age 1.5-2 years and 40-50 kg body weight in the field in the studied area were selected to measure the effect of THI on some clinical (heart rate, respiratory rate, and body temperature) parameters and some mineral (calcium, sodium, and potassium) concentrations. Four treatments were used in the study: Control, THI1 (THI=78.75), THI2 (THI=62.74) and TH3 (THI=67.59) Animals were apparently healthy and in good physical condition; they were allowed to graze with their herd on the free outdoor graze in their natural habitat.

Meteorological data

This study was carried out during the period extending from 20 November 2023 to 20 February 2024. Weather data was obtained at the time of measuring of studied parameters, which included ambient air temperature and relative humidity, by using digital devices (Singlian, Singapore). The Temperature (T) in Celsius degrees (ºC) and Relative Humidity (RH) were utilized to calculate the Temperature-Humidity Index (THI) according to the following formula; $THI = (1.8\times T+32) - (0.55-0.0055\times RH) \times (1.8\times T-26)$ [29].

Clinical and biochemical investigations and sampling

Standard methods were utilized for specific clinical investigations, including measurement of rectal temperature using a digital thermometer and measurement of respiratory rate and heart rate by stethoscope. At the same time, blood was drawn from ewes once monthly by jugular vein puncture (3 ml) and saved in heparinized sterile vacuum tubes directly after clinical examination. The serum obtained after centrifugation of blood is used in serum minerals concentration estimation. Serum freezes (-20ºC) to use in measurement of some serum minerals (calcium, potassium, and sodium) by using a biochemical analyzer (CoBAS E411, China). This investigation was carried out at 9:00 AM on each 20th day of November, December, and February. January is excepted because there was no change in the (THI) value as compared with December.

Statistical analysis

Statistical analysis done by use One-Way ANOVA method (30).

Results

Table 1: Show the measurements of studied clinical parameters (Body temperature, Pulse rate and Respiratory rate) (n=15).

THI3	THI2	THI1	Control (Reference value) *	Parameters
38.63±0.91 B	39.700±0.75 A	39.10±0.71 AB	39.20±0.56 AB	Body temperature
80.933±5.98 A	78.86±3.067 B	69.66±2.25 B	77.86±4.22 B	Pulse rate
18.66±1.046 B	17.933±1.62 BC	16.73±1.624 C	22.93±2.46 A	Respiratory rate

*Clinical Examination of Farm Animals Peter G.G. Jackson, Peter D. Cockcroft Copyright © 2002 by Blackwell Science Ltd.

In the present study, the findings showed that the measurement of body temperature in the studied groups as compared with the referenced body temperature which appeared to have no significant (P>0.05) differences among all studied groups except between the THI2 and THI3 groups, in which there was a significant (P≤0.05) increase in body temperature in THI2 group animals (39.700±0.75) when compared with the THI3 group (38.63±0.91) (Figure 1). Moreover, the pulse rate showed a significant (P≤0.05) elevation in the THI3 group only as compared with the control and other studied groups (Table 1) (Figure 2).

Additionally, the estimation of the respiratory rate of the studied groups, which are to have a significant (P≤0.05) decrease in THI1(16.73±1.624) when compared with the control (22.93±2.46) and THI3 groups (18.66±1.046) but there was no significant change between the THI1 and THI2 groups or between the THI2 and THI3 group. At the same time, there was a significant (P≤0.05) decrease in respiratory rate in THI3 group as compared with the control, and also, THI3 recorded a significant (P≤0.05) elevation in respiratory rate when compared to THI1. The group THI2 showed non-significant (P>0.05) change in comparison to THI1 and THI3, but there was a significant decrease in comparison to the control group (Table 1) (Figure 3).

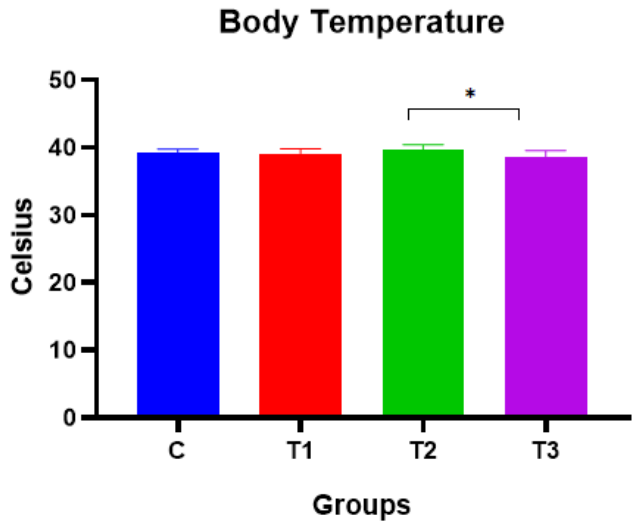

Figure 1: Show the measurement of body temperature.

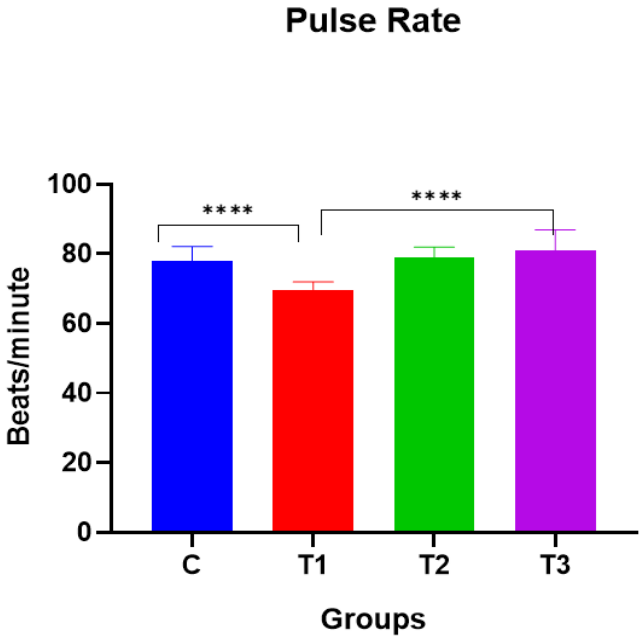

Figure 2: Show the measurement of pulse rate.

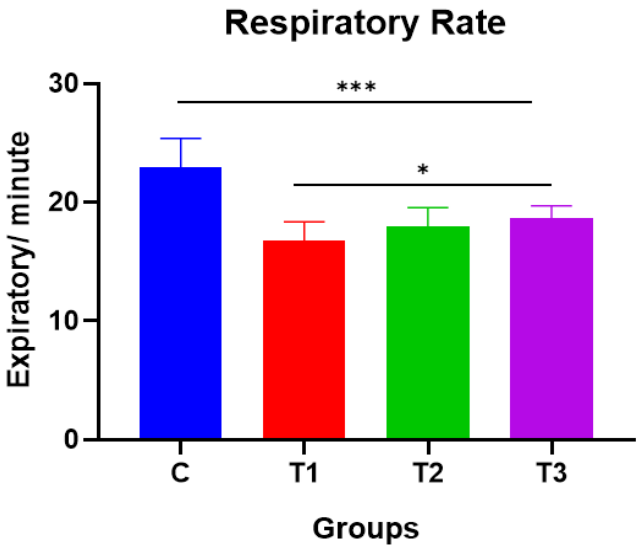

Figure 3: Show the measurement of Respiratory rate.

Table 2: Show the concentrations of studied blood minerals (Calium, Sodium and Potassium) (n=15).

THI3	THI2	THI1	Control (Reference value)*	Parameters
0.510±0.01 C	0.57±0.04 C	2.03±0.13 B	2.34±0.17 A	Calcium
144.26±2.43 B	144.13±2.79 B	121.80±7.37 C	149.40±4.89 A	Sodium
3.89 ± 0.103 B	4.13 ± 0.28 B	5.56 ± 1.46 A	3.96 ± 0.26 B	Potassium

*COGA Giessen: Clinic for Obstetrics, Gynecology and Andrology of Large and Small Animals with Veterinary Ambulance, Justus-Liebig-University, Giessen, Hesse, Germany.

Results showed that the measurement of blood calcium concentration in studied groups showed significant (P≤0.05) decreasing in THI2 (0.57±0.04) and THI3 (0.510±0.01) when compared with THI1 (2.03±0.13) and control (2.34±0.17) groups. At the same time, the THI1 has a significant (P≤0.05) decrease in comparison to the control group (Table 2), (Figure 4). Moreover, all studied groups have a significant (P≤0.05) decrease in serum sodium level as compared with control (149.40±4.89) Also, the THI1 (121.80±7.37) groups showed a significant (P ≤0.05) decrease when compared to THI2 (144.13±2.79) and THI3 (144.26±2.43) groups, as illustrated in (Table 2) (Figure 5).

Finally, the concentration of potassium in blood measured in all studied group sowed the significant (P≤0.05) elevation in the THI1 group as compared with all treated and control groups with non-significance (P>0.05) among them (Table 2) (Figure 6).

Discussion

Extensively managed animals, like Awassi ewes, often live in harsh and unfavorable environments where they need to be capable to coping with variable weather conditions and availability of forage and lack of supervision [31]. The rectal temperature may be utilized as an indicator of weather stress to estimate the negative influence of hot climate on growth, reproduction, and lactation [32,33]. The rectal temperature in current research did not mention significant change between the reference value and studied groups, and these results agree with [34], who mentioned in his study that when the THI was 65.62±2.43 in the spring season, it was characterized by a removal of heat stress situations.

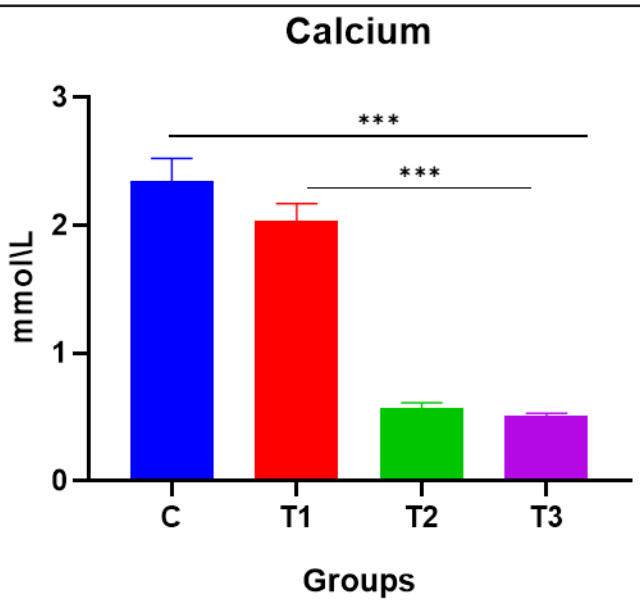

Figure 4: Show the serum calcium concentration (mmol/l).

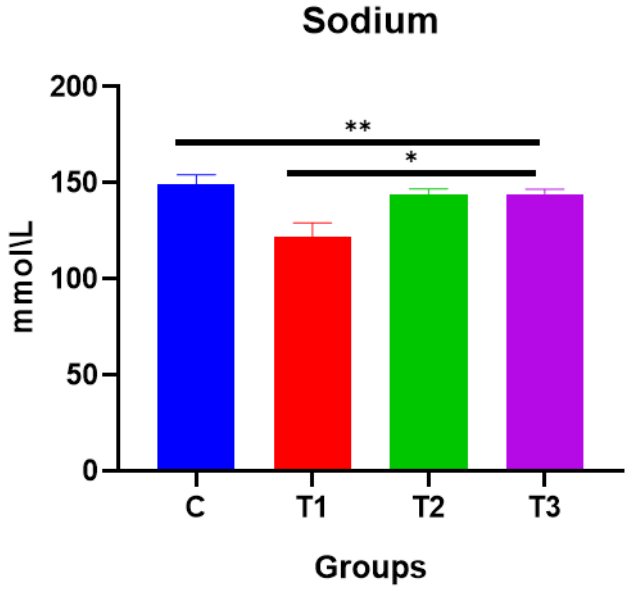

Figure 5: Show the serum sodium concentration (mmol/l).

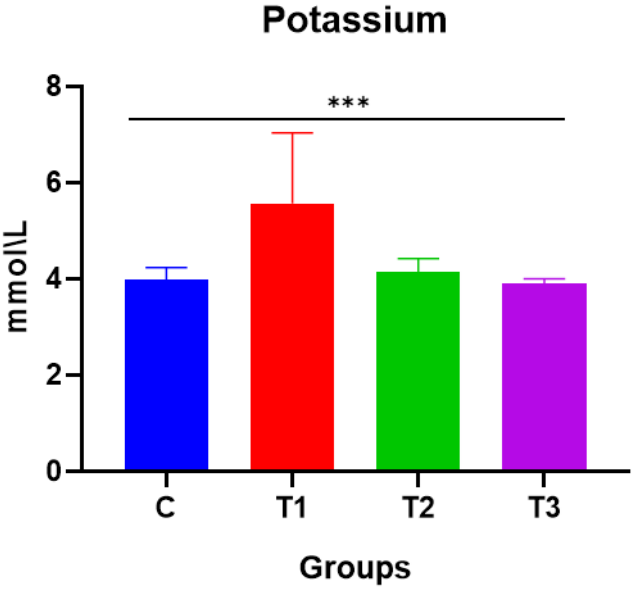

Figure 6: Show the serum potassium concentration (mmol/l).

The heat stress in cows causes thermal regulatory actions to attempt to preserve heat balance [35]. These reactions involve elevated respiratory rate and heart rate, decreased dry matter intake elevated milk production, and plasma vitamin C level via elevation of body temperature.

Respiration rate in this study decreased significantly in all studied groups as compared with the reference value as the control group. Knowingly, the respiration rates elevated with increasing temperatures from 14 to 34°C, and the starting of sweating and elevation of saliva production. Increased water intake [36]. The respiration rate increased with the rising of rectal temperature and was highly correlated with THI. Whereas the rectal temperature is less responsive to THI, the respiration rate is a better and sensitive indicator for thermal stress than rectal temperature. So, the decreasing of respiratory rate in the current study indicated that the breeds of research were well adapted to heat stress and overcame the cited THI [10].

The heart rate measurement revealed that the THI3 (67.59) in which the climate temperature was 25ºC and relative humidity was 10%, this THI recorded the highest value significantly as compared with the control, THI1, and TH2. These results consistent with [37], who suggest that all of the heart rate variability parameters decreased with elevation of THI. However, it is noticed that the relation between THI and heart rate variability was important but considerably weak, which might be caused by the presence of a thermoneutral range for the studied animals during the experimental times. In the same context, [38] mentions that the ewe has better high temperature tolerance than the ram, and heat stress can change physiological and behavioral patterns, including respiratory rate and heart rate, in Small-tail Han sheep housed indoors. These alterations may permit the sheep to acclimate better to the ambient temperature.

The interpretation of biochemical parameters is complex because the mechanisms that control the blood mineral concentrations of different metabolites [39]. The health and immunity of animals depend mainly on minerals, and deficiencies of minerals can inhibit the resistance of animals' bodies to diseases [40,41]. Sodium and potassium have important roles as electrolytes in maintaining acid-base balance and osmotic pressure [42]. Grazing animals like sheep take the main portion of minerals from pasture forage and grasses, so their mineral contents can be changed as a result of seasonal changes, climatic factors, rainy seasons, and hot or cold stress [43]. The study of some blood minerals (calcium, sodium, and potassium) revealed that there was a significant decrease in serum calcium and sodium concentrations in all studied groups as compared to the normal reference value (control) group, but there was a significant increase of serum potassium in THI1 when compared with the control and other studied groups. These results pointed to the fact that the correlation coefficient denoted that THI was positively correlated with plasma sodium and negatively correlated with plasma potassium concentrations, as mentioned by [10]. Also, the results agreed with [44], who recorded an increasing in plasma potassium concentration and a decreasing in serum calcium concentration in sheep. Current study concluded that weather members such as air temperature and humidity have important effect on general health anf specific parameters in animals. So, these effectros should be studied accurately.

Author declarations

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