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ADAPTATION CAPACITY to HEAT STRESS of DIFFERENT GENOTYPES COWS BRED on a PASTURE in the REGION of the CENTRAL BALKAN MOUNTAINS

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Summary. *Physiological characteristics were studied, such as body temperature, respiratory rate and heart rate, which take into account the thermal tolerance of cows of different genotypes raised on pasture. The heat resistance index, adaptation coefficient and temperature and humidity index were calculated. Genetic selection for these indicators leads to improved heat-resistant ruminants. The calculation of the temperature and humidity index allows the annual production of a portfolio of the farm to avoid the negative impact of stress-unfavourable, high summer temperatures.*

Keywords: adaptation, temperature, respiratory rate, summer months.
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АДАПТАЦІЙНА ЗДАТНІСТЬ ДО ТЕПЛОВОГО СТРЕСУ КОРІВ РІЗНИХ ГЕНОТИПІВ, ВИВЕДЕНИХ НА ПАСОВИЩАХ У РЕГІОНІ ЦЕНТРАЛЬНИХ БАЛКАН

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Резюме. *Вивчено фізіологічні характеристики, такі як температура тіла, частота дихання та частота серцевих скорочень, які враховують теплову переносимість корів різних генотипів, вирощених на пасовищах. Розраховано індекс теплостійкості, коефіцієнт адаптації, індекс температури та вологості. Генетичний відбір цих показників призводить до поліпшення теплостійкості жуйних тварин. Розрахунок індексу температури та вологості дозволяє щорічно складати портфоліо ферми та уникнути негативного впливу стрес-несприятливих високих літніх температур.*

Ключові слова: адаптація, температура, частота дихання, літні місяці.
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СПОСОБНОСТЬ АДАПТАЦИИ К ТЕПЛОВОМУ СТРЕСУ КОРОВ РАЗНЫХ ГЕНОТИПОВ, ВЫВЕДЕННЫХ НА ПАСТБИЩАХ РЕГИОНА ЦЕНТРАЛЬНЫХ БАЛКАН

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Резюме. *Изучены физиологические характеристики, такие как температура тела, частота дыхания и частота сердечных сокращений, которые учитывают тепловую переносимость коров разных генотипов, выращенных на пастбищах. Рассчитан индекс теплостойкости, коэффициент адаптации, индекс температуры и влажности. Генетический отбор этих показателей приводит к улучшению теплостойкости жвачных животных. Расчет индекса температуры и влажности позволяет ежегодно составлять портфолио фермы и избежать негативного влияния стресс-неблагоприятных высоких летних температур.*

Ключевые слова: адаптация, температура, частота дыхания, летние месяцы.
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INTRODUCTION

Heat stress affects cows of dairy and combined breeds, grazing on artificial and natural pastures, especially during the summer months. High temperature, combined with low humidity and solar radiation, leads to a significant reduction in milk productivity, eating disorders and reproductive problems (Shuchai et al., 2009; Chan et al., 2010; Kurbanova, 2018).

A number of researchers have worked on the significance of summer heat for dairy cattle breeds, as specific patterns of animal compensatory-physiological mechanisms have been identified during lactation (Rauschenbach, 1975; Madjarov, 1980; Sing et al., 2013; Barnabuci et al., 2014).

Heat stress is important not only for the thermal environment and metabolic, biochemical processes occurring in the body of cattle, but is also a factor related to maintaining homeostatic status (Dismen et al., 2012; Mokhov and Shabalina, 2013; Vdovichenko et al., 2017; Validov and Talashina, 2019).

According to Carabano et al. (2019), the strategies in cattle breeding are related to improving tolerance to heat stress and have an impact on technological production systems. This problem will be addressed and developed in cattle breeding programs in the future.

The aim of the present study was to determine indicators, such as body temperature, respiratory rate, pulse rate per 1 minute, ambient temperature and humidity and to calculate the indices characterizing the compensatory reactions and adaptability of cows of different genotypes raised on pasture in the region of the town of Troyan, in the Central Balkan Mountain, to heat stress.

MATERIAL AND METHODS

The scientific and production studies were conducted on the farm of the Experimental Base of the Research Institute of Mountain Stockbreeding and Agriculture (RIMSA) in Troyan, Bulgaria on July 2nd and 3rd in 2020. Three groups were formed, of 15 cows on the principle of analogues: by age, live weight and productivity of 'Bulgarian Rhodope cattle', 'Simmental' and 'Montbeliarde' breeds. The animals were raised and fed in identical and typical way. The body temperature was measured twice, early in the morning, between 6 and 7 o'clock, when the ambient temperature is 17-19 ˚C and in the middle of the day, between 15.30 and 16.30, when the ambient temperature is 35-37 ˚C and the cows return from the pasture with the help of a non-contact thermometer-Sejoy-DET-306. At the same time, respiratory movements, visually for 1 minute and pulse, were measured by palpation of v. Cava per a time interval, 1 minute per cow.

The minimum and maximum temperatures, the average daily temperature and the humidity of the air were taken from the meteorological bulletin of the meteorological station located in the region of RIMSA-Troyan.

The following indices and coefficients were calculated:

Heat resistance index (IH) according to Rauschenbach (1975)

$IH = 2(0.6t2 – 10\Delta T+26)$

Where: T 1 is the body temperature in a neutral zone
T 2 is body temperature under load
ΔT is the difference between T2 and T1
t 2 is the average daily temperature
26 is reduction factor

Coefficient of adaptation (CA) according to Benezra (1954)

$$CA+\frac{BT}{38.3}+\frac{FR}{23.3}$$

Where: BT is the body temperature when measured
FR is the frequency of respiratory movements for 1 minute
38.3 is the optimal temperature for cattle breeding
23.3 is the optimal number of respiratory movements

Temperature and humidity index (ITH)

ITH = 0.8 X ambient temperature + (relative humidity : 100 X ambient temperature - 14.4) + 46.6

The data were processed by the methods of variation statistics using the program 'Statistica-2010' and presented in tables and figures.

RESULTS AND RESEARCHES

Visual observations showed adaptability and adaptive plasticity of the studied cows in all three breeds. On days with high temperatures, at 35-37 C˚ the animals grazed, lay or stood in the sun without showing side effects.

The heat resistance indices are presented in Table 1.

As can be seen from Table 1, the heat resistance index is higher in 'Montbeliarde' cows - 78.6 units, a difference of 5 to 7 units, compared to the other two studied breeds. At an ambient temperature of 17-19 C˚, the body temperature of the cows in the three breeds is in the range of 38.2 to 38.6 C˚.

With an increase in air temperature to 35-37 C˚, the body temperature increases by 2.3 C˚ in 'Bulgarian Rhodope cattle', by 2.6 C˚ in 'Simmetal' breed and by 3.1 C ˚ in 'Montbeliarde'.

Table 1. Temperature indicators of cows of different genotypes

Body temperature, ambient	Bulgarian Rhodope Cattle n=15	Simmental n=15	Montbeliarde n=15
In the morning at 17-19 ˚C	38.2±0.3**	38.6±0.2***	38.4±2.0
At the end of the day at 35-37 ˚C	40.5±0.8**	41.2±0.9**	41.5±0.9**
Heat resistance index	71.3	73.6	78.6

P<0.05*, P<0.01**, P<0.001***

The heat resistance index turned out to be lower by 7.3 units in 'Bulgarian Rhodope cattle' and with lower values by 5 units in 'Simmental' breed.

Table 2. Physiological indicators of cows of different genotypes

Indicator	Number n	Bulgarian Rhodope Cattle	Simmental	Montbeliarde
Body temperature	15	40.5±0.8***	41.2±0.9**	41.5±0.9**
Frequency of respiratory movements per +1 min	15	27±1.4*	25±1.6*	26±1.7
Frequency of pulse per 1 min	15	64±0.9***	67±1.0**	69±1.2*
Coefficient of adaptation	45	2.23	2.12	2.17

P<0.05*, P<0.01**, P<0.001***

The result of the physiological status of the examined cows shows that the monitored indicators are within the permissible norms (Table 2). In the large veins adjacent to the heart, rhythmic oscillations of the vessel walls are detected, etc. venous pulse (Mokhov and Shabalina, 2013). The highest pulse rate of 69 beats per 1 m was found in 'Montbeliarde' cows, and the lowest in the representatives of 'Bulgarian Rhodope cattle' with 64 beats/m. The number of respiratory movements per 1 m gives the frequency of respiration. As the ambient temperature rises above the thermoneutral zone, respiratory movements increase (Singch et al., 2013; Kurbanova, 2018).

The highest frequency of respiratory movements was registered in the representatives of 'Montbeliarde' breed with 27 movements/m. The representatives of the other two breeds have relatively similar parame-

ters, 26 and 25 movements/m. The registered increase in respiratory movements for the representatives of the three studied breeds of cows is 8.6%, 9% and 9.3%, respectively.

The adaptation coefficient shows relatively close values in all three breeds, and differences in the order of 0.11 and 0.06 units, at a desired value of 2.00.

The temperature and humidity index are shown in Table 3. It is an empirically created parameter describing the combined effect of temperature and humidity on the body of cows. High temperatures combined with low humidity are more tolerable for animals than high temperatures combined with high humidity (Vdovichenko et al., 2017).

Table 3. Ambient temperature and humidity

Indicator	02.06.2020	03.06.2020	Average temperatures
Ambient temperature early in the morning, ˚C	17	19	18
Ambient temperature late in the afternoon, ˚C	35	37	36
Ambient humidity, %	49	51	50
Index of temperature and humidity	77.35	80.67	79.00

The calculated temperature and humidity index showed values for classification on the scale of heat stress from moderate to severe. The studied animals coped well with the heat challenge and did not reduce productivity by not demonstrating health disorders. Naturally, the water consumption of cows of the three breeds increased by 30-35%.

The data obtained from us are close in value and correspond to the results obtained by Barnabuci et al. (2014), Validov and Talashina (2019) and Carabano et al. (2019).

CONCLUSIONS

The three studied cattle breeds showed adaptability to high temperatures.

Physiological parameters: body temperature, respiratory rate and heart rate are of practical importance for establishing the metabolic nature of cows during the summer months and reflect their physiological state. Genetic selection based on these indicators leads to improved heat-resistant animals.

The calculation of the temperature and humidity index allows an annual portfolio of the farm to be developed to avoid the negative impact of stress-unfavourable, high summer temperatures.

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