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ASSESSMENT OF THE ADAPTATION OF HOLSTEIN COWS TO HOT SUMMER CONDITIONS AT AN INDUSTRIAL DAIRY COMPLEX

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Climate plays a crucial role in dairy and agricultural production systems globally. In recent decades, global warming and rising temperatures have posed significant threats, including to dairy farming, which requires year-round maintenance of dairy herds in naturally ventilated barns [1].

The impacts of climate change include rising summer temperatures, erratic precipitation patterns, extreme weather events, and increased carbon dioxide levels. The effects of heat stress are expected to intensify, negatively impacting agriculture, even in the relatively moderate continental climate of Ukraine [2-3].

Ambient temperatures between -5°C and 24°C have minimal impact on milk yield, but when temperatures exceed 24°C, there is a noticeable reduction in milk's protein, lactose, and fat content. In response to heat stress, cows physiologically adapt by reducing heat production and increasing heat dissipation. Heat stress is marked by higher rectal temperatures, elevated respiratory rates, and decreased feed intake, all contributing to a decline in milk production.

Adaptation strategies for climate change may involve breeding heat-resistant cattle, improving water availability, and developing cultivated pastures. Mitigation strategies could include modifying feeding schedules, using alternative forages, adding nutrients, influencing rumen microflora, and providing shade, fans, or sprinklers. However, under extreme weather conditions, management strategies may not fully restore animal health after thermal stress. Recovery depends on various factors, including species, genetic potential, physiological state, management, productivity, housing system, and feeding level [4-5].

Effective implementation of management strategies can significantly reduce the impact of changing weather on animal welfare and productivity. Therefore, assessing cows' adaptation to hot weather conditions is crucial for identifying potential challenges and taking preventive measures to minimize milk production losses during the summer.

The aim is to evaluate the adaptive capabilities of Holstein cows to hot summers when kept year-round in an industrial dairy complex.

Based on the information in the cow herd management system (DairyComp 305) for 2023 at the dairy enterprise Ukrainian Dairy Company (50°49′11″N, 31°49′22″E) in the Kyiv region, we evaluated the relationship (correlation) between the average daily values of the temperature and humidity index (THI) and the average daily milk yield per cow in the herd (kg/day), as well as milk yield in terms of basic milk parameters (fat and protein). The number of dairy cows on the farm was about 3800 ± 124 during the year.

The relationship between milk yield and temperature-humidity index was investigated to determine which milk yield (absolute or basic) is better to use for assessing seasonal changes in milk production.

Air temperature (°C) and relative humidity (%) were obtained from the nearest weather station. These data were freely available on the official weather website of the Ukrainian Hydrometeorological Centre. The livestock buildings were located at a distance of about 19 km from the weather station. Weather data were systematised using the method described by Mylostyvyi et al. [1]. The analysis included 2920 records of temperature and relative humidity (8 records every three hours during the day) with 365 daily averages calculated from these data. The temperature-humidity index (THI), calculated according to H. Kibler (1964), served as an indicator of heat stress (HS) in cows.

With the onset of the warm period, when the temperature in the premises rose to +19 °C, the system of additional mechanical ventilation (axial accelerating fans) was automatically switched on in all production facilities, which at +25 °C operated at full capacity (up to 3.6 m/s in the location of the cows in the boxes).

The calculation of the basic milk yield was carried out according to the formula:

$$Mb = (M\times F/3.4\times 0.4) + (M\times P/3.0\times 0.6)$$

where: Mb is basic average daily milk yield, M is average daily milk yield, kg, F is fat content, %, P is protein content, %, 3.4 is basic percentage of fat and 3.0 is basic percentage of protein, 0.4 and 0.6 are conversion factors for milk fat and protein.

To possibly evaluate the effect of heat stress on milk productivity of cows, we calculated the "Summer: Winter Productivity Ratio (S: W)" using monthly farm milk data. This indicator was proposed by the Israeli Cattle Breeders Association (ICBA) [6]. The higher production data ratio is (close to or ≥1.0), the better the farm copes with summer heat stress. Daily milk yields for the summer (July-September) and winter (January-March) periods were considered in the calculations, followed by calculation of the S:W ratio.

Statistical software package Statistica 12 (StatSoft, Inc., Tulsa, OK, USA) was used for statistical data processing. The distribution of almost all variation series did not meet the criteria of normality, so non-parametric statistics were used in the analysis. The reliability of differences between groups was assessed using the non-parametric Mann-Whitney test. Differences with p values <0.05 were considered statistically significant.

During the period of the experiment, average temperature-humidity index fluctuations ranged from 26.18 units to 75.87 units. Maximum daily THI values ranged from 28.67 units to 82.79 units. Taking into account that the comfortable THI value is less than 68 units, the exceeding of the comfortable index value for cows was registered already in the middle of May. Maximum index values, which corresponded to moderate stress (THI=72 units) were registered already at the end of June. August was the hottest, the average and maximum index values were 69.8 units and 75.9 units.

Under such weather conditions during the year, milk productivity in the herd was quite high (33-35 kg/day) and, most importantly, relatively stable during the year, which may indicate comfortable conditions for dairy cows.

However, different dynamics in the direction of average and basic milk yields in the herd during summer-autumn period, may lead to erroneous results when assessing the adaptation of dairy cows to summer heat using the S:W ratio.

This was confirmed by the correlation analysis between the average values of temperature-humidity index and average daily milk yield per cow, which showed an unexpected result. The direction of the relationship between the traits was opposite, despite the fact that the absolute and basic daily milk yields of cows were characterised by a drop-in milk in May and August 2023.

The obtained difference in the relationship between the traits is due to the fact that the basic milk yield takes into account the change in milk fat and protein content, and they are known to be more dependent on the temperature-humidity index than just the daily milk yield of cows.

Therefore, it is quite natural that the Summer: Winter ("S:W") ratio, which is used to assess the adaptation of dairy cows to summer heat, as well as the efficiency of the cooling system, had differences depending on the selected value of daily milk yield.

The above data shows a significant difference in the choice of average daily milk yield and basis milk yield for calculations (the difference in the ratio was 6.1 %).

We believe that it's more accurate to use the basis milk yield per cow for the herd in using the S:W ratio to assess the adaptation of dairy cows to summer heat and to evaluate the efficiency of barn cooling systems. Since changes in milk fat and protein are most sensitive to heat, these components are taken into account when using the temperature-humidity index.

It should be noted that the launch of additional mechanical ventilation in the cowsheds of the dairy complex Ukrainian Dairy Company when the air temperature rises to +19 ° C, had a positive effect on preventing a significant drop in milk from cows. The obtained S:W ratio (corresponding to approximately 1.0), indicates the effectiveness of measures aimed at preventing the manifestation and consequences of heat stress in dairy cows [6].

Thus, the use of Summer: Winter (S:W) ratio is acceptable for assessing the adaptation of dairy cows to summer heat conditions. The results obtained indicate that it is better to use the basis daily milk yield per cow per herd to calculate the S:W ratio because it takes into account seasonal changes in fat and protein in milk, milk components that are most sensitive to the influence of high air temperatures.

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