CORTISOL LEVEL CANNOT BE A RELIABLE BIOMARKER FOR ACUTE HEAT STRESS IN DAIRY COWS

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Cortisol, as a major stress hormone, contributes to the activation of metabolic processes that support animal survival under extreme conditions. This process includes metabolic activation, increased respiration and heart rate, and mobilisation of energy to maintain physiological processes in response to short-term heat exposure [1]. Therefore, during short-term heat exposure, cortisol is secreted in increased amounts as a response to the stressful situation [2].

In the case of chronic heat stress (with prolonged exposure to heat), cortisol levels may begin to decrease. This occurs because the cow's body adapts to prolonged exposure to heat and the hypothalamic-pituitary-adrenal system becomes less active. Chronic stress can deplete the endocrine system and weaken the immune system, which reduces the cow's ability to respond to stress with adequate cortisol release. This may be because persistent stress induces compensatory mechanisms to reduce the metabolic response to minimise body damage [3].

The research was conducted at one of the commercial dairy complexes near the city of Dnipro in the central part of Ukraine, where Brown Swiss breed of cows is kept. According to the principle of analogues (physiological state, period and number of lactation), two groups of cows of the second lactation were randomly formed with 8 cows in each group. The first group (experimental) was formed in summer in conditions of heat stress (THI>68), the second group (control) - was in comfortable conditions for animals (THI <68) in autumn period. The cows of the experimental and control groups had 141 ± 11.8 and 142 ± 9.7 days in milk, respectively, and their milk yields in terms of base milk were 39.5 ± 3.61 and 39.3 ± 0.87 kg/day, respectively. Blood sampling for serum cortisol determination in cows of the experimental group was preceded by a heat wave. The heat wave lasted for five days, during which the maximum daily air temperature did not fall below +30 °C (THI from 77 to 82), and on the day of blood sampling was +35 °C (average daily THI=77.6). Blood sampling in cows in the control group corresponded to a prolonged period of isothermal. In addition to cortisol concentration, protein fractions were determined in blood serum. We were interested in the dynamics of gamma-globulins as a response of the immune system to heat stress. Cortisol was determined by immunochemical method with electrochemiluminescence detection (ECLIA) on Cobas 6000 analyser (e 601 module), using standard kits (Hoffmann-La Roche Ltd, Switzerland) [4]. The content of protein fractions in serum was determined by the nephelometric

method. The cows were kept in naturally ventilated barns and received a common mixed diet of the same type, as we briefly described earlier [5].

It was found that during acute heat stress the concentration of cortisol in the serum of cows (11.6±0.54 nmol/l) was 2.1 times lower (P<0.0158) compared to the control group (24.5±8.85 nmol/l). The gamma globulin content (%) in serum of cows of experimental group (34.5 ± 9.56) was higher by 21.1 % (P<0.4126) than control group (27.2 ± 7.35). The Spearman correlation coefficient between cortisol and serum gamma globulins was r=-0.17.

If in the case of chronic heat stress the decrease of cortisol levels in blood looks convincing enough, its low concentrations in acute (short-term) heat stress require justification and, apparently, depend on the specificity of the organism's reaction to the stress situation. Acute stress may initially cause a sudden spike in cortisol, but with its duration or intensity, the endocrine system may not have time to maintain high levels, resulting in lower cortisol concentrations. In addition, in the case of acute stress, especially at high temperatures, the cow's body may exhaust its energy resources and the mechanisms that maintain high cortisol levels may be weakened. This is also associated with suppression of immune system functions and general physiological adaptation [2].

Studies show that there is a close relationship between cortisol levels and the number of immunoglobulins in the blood of cows, especially under conditions of stress. Cortisol, the main stress hormone, suppresses the activity of the immune system, which can lead to a decrease in the level of immunoglobulins such as IgA and IgG. Under heat stress, increased cortisol levels can lead to suppression of immune function, making animals more vulnerable to infections [6, 7]. In addition, heat stress can disrupt the balance of hormones and immune responses, causing prolonged immunosuppression [5, 8, 9].

Thus, although cortisol is an important indicator of stress response, its level can fluctuate depending on the duration and intensity of the stress, making it a less reliable biomarker for acute heat stress in dairy cows.

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ВПЛИВ ЗМІН КЛІМАТУ У ТВАРИННИЦТВІ

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Глобальне потепління, яке спостерігаємо на планеті зараз і в майбутньому може призвести до значних змін у геофізичних, геохімічних та біологічних системах Землі, що є істотною загрозою на екологію та соціально-економічний стан життя людей. До основних екологічних наслідків глобального потепління, яке вже відбувається або може відбутися в найближчому майбутньому в Україні, слід віднести: вплив зміни клімату на сільське господарство, підвищення рівня Чорного та Азовського морів; просторово-зональну трансформацію структури степової фітосистеми; зміни екосистеми в Азовському морі та водних ресурсах; розвиток процесу опустелювання в південних та південно-східних регіонах України.

Аналіз останніх досліджень і публікацій вказує на наступні антропогенні фактори глобальних змін: зростання викидів вуглекислого газу (CO_2) в атмосферу, надмірне та безконтрольне застосування мінеральних добрив та пестицидів, нераціональне природокористування, що призводить до кричущих наслідків — трансформації Землі [1]. У всьому світі на сільське господарство припадає 13 % шкідливого впливу, пов'язаного з парниковими газами; на частку Канади та США припадає від 6 % до 8 %. Викиди парникових газів, в основному, відбуваються у формі метану (CH_4), який утворюється у результаті переробки мікроорганізмами в анаеробних умовах органічної речовини, та закису азоту (N_2O), який утворюється при мікробіологічних та хімічних перетвореннях органічної речовини, як в окис-