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METHODS FOR DETERMINING STRESS SYNDROME IN BEEF CATTLE AND ITS RELEVANCE TO QUALITY OF MEAT

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Abstract: Methods for determining stress syndrome in beef cattle is of great importance to identify the physiological state of young cattle before slaughter in order for such animals to be properly treated and restored to a normal physiological state. As a consequence of the state of stress prior to slaughter, meat is obtained which is different from normal. These are non-typical post-mortem changes in meat: "PSE" (pale, soft, exudative) and "DFD" (dark, firm, dry) meat, "watery" meat, usually pork, and "dark" mostly meat of young bulls. Tests were performed on bulls originating from a farm located 50 km from the slaughterhouse and another farm located 150 km from the slaughterhouse. Young bulls were kept in a free system and loading and unloading was done on unloading ramps and animals taken to the boxes using the lane corridor. Also, attention was paid to avoid mixing with unfamiliar animals during transport. The study included 20 males. The same vehicle was used to transport cattle from the farm to the slaughterhouse. The rectal temperature was taken from 20 young bulls, at the time of loading of cattle into a vehicle during transport and immediately before slaughter. The results of measurements of rectal temperature of investigated bulls suggest that prolonging of transport increases the rectal temperature which can serve as an indicator of stress syndrome in bulls. In addition to measuring of rectal temperature as an indicator of bulls' stress syndrome, other methods are still used, such as the measurement of cortisol in saliva and blood, or the latest methods of measuring cortisol in hair. This is the latest method of the 21st century, which can even determine the time of occurrence of stress. This method is the future that will determine whether the stress occured few days, weeks or even months ago.

Keywords: beef cattle, stress, transport, assessment methods, rectal temperature, meat quality

Introduction

The stressors may be physical, associated with excessive activity, temperament, humidity, atmospheric pressure, the outside temperature, ionizing radiation, electric shock, etc. Stress can be psychological, such as fear, excitement and the most important social stress, such as stress of interference with unfamiliar animals. The word "stress" is of Anglo-Saxon origin, and this term is understood as the medical condition in which the body is under the influence of a stimulus. The first research of stress and the stressors was initiated by *Hans Saley (1936; 1953)* Viennese internist in human medicine. Studying stress in humans Hans Saley has discovered one of the most important theories of modern medicine, which is the theory of stress and overall the adaptation syndrome. Saley's General Adaptation Syndrome found the application in explanation of the stress syndrome in animals. Today, there are standard procedures to prepare the animals for slaughter, their preparation is related to the farm where the animals come from, to the transport, to short or long stay in the slaughter depot premises, the method of stunning and bleeding. Holding and tansport of animals just before slaughter are important factors in beef cattle stress syndrome manifested as anxiety, fear, roaring, aggression, etc. *(Aleksić et al., 1995; Aleksić et al., 2006; Broom et al. 2002; Knowles and Warriss, 2007).*

As a consequence of the state of stress prior to slaughter, meat is obtained which is different from normal. These are non-typical post-mortem changes in meat: "PSE" (pale, soft, exudative) and "DFD" (dark, firm, dry) meat, "watery" meat, usually pork, and "dark" mostly meat of young bulls. According to the frequency occurrence of DFD - syndrome, young bulls are the most susceptible, in relation to the other categories of cattle. Today, this problem is associated with a number of factors such as breed, animal housing, food and especially the treatment of animals before slaughter. The basis of this problem is the stress of young bulls, especially their reactions to the new unfamiliar environment during transport and stay in the depot sacrifices. Therefore, it is important to identify the state of stress of young cattle before slaughter in order to adequately treat such animals in order to bring them to a normal physiological state prior to slaughter. Stress is a term for the physiological state of the organism under the influence of a stimulus or psychological burden, therefore mechanism of action involves irritation and reactions of the organism to a given stimulus.

Stimulus (stressor) acts on the body in two ways: specifically, fostering in it a specific defensive reaction, for example, antigen-specific antibody response and nonspecific stimulating defense reaction. This reaction is stereotypical, defensive and adaptive mechanism by which the body tries to defend the stimulus, regardless of its nature. Those stimuli (there are countless), which stimulate the body to mostly nonspecific defense mechanism, are stressors which affect the

process of postmortem muscle. Stressor, i.e. stimulus, perceived by the animals' senses, is transmitted by neuro - hormonal paths and causes a general non-specific reaction called Saley 's General Adaptation Syndrome. It is "general" because it is the result of a general stress which affects the entire body, and it is called "adaptation" because the the body tends to adapt to one or more stimuli, which act on the organism, and "syndrome" because its individual responses are coordinated and even dependent on each other. The General Adaptation Syndrome occurs in three stages, namely: the alarm stage, the second stage - reparation, and third stage - exhaustion, the collapse or shock. Although the mechanism of general adaptation syndrome has not been fully tested, we can say that all animals receive through certain senses stimuli that are transmitted through the nerve to the hypothalamus. Processed information from the hypothalamus is transmited in the form of CRF, secreted by the hypothalamus, to pituitary gland. Pituitary gland now has the task to identify the severity and intensity of stressor and by secretion of ACTH stimulate the adrenal glands to secrete adrenaline and corticosteroids. Adrenaline is transmitted by humoral paths to all muscles, and affects the discharge of muscle glycogen, and corticoids, primarily glucocorticoids, affect the enhanced synthesis of glycogen, so as to return the spent glycogen to pre-stress level. Because of this, the meat of stressed animals has less glycogen in muscles, and therefore less of lactic acid after the post-mortem glycolysis.

Of all the hormones which are found in the blood stream, due to the stress, cortisol is likely to act on the particularly strong and long-term response of the organism; its activation of neo-glucogenesis and of pituitary gland, this hormone contributes to the re-depositing of glycogen in muscles. Glycogenic effect of glucocorticoids is exhibited by inhibiting the use of amino acids for synthesis of proteins, which then serve for the production of carbon hydrates. Accordingly, the occurrence of DFD meat, in which the muscle glycogen depot is empty, is caused by the stress of such a nature and the intensity which induces strong secretion of adrenaline necessary to exhaust the glycogen restoration hormones of the adrenal cortex, which, in normal conditions, are able to maintain the required level of glycogen in the muscles, but in the above mentioned stress conditions they are not able to maintain the required glycogen level. Studies have shown that the concentration of cortisol in the blood of stressed bulls is increased, whereby in case of weaker stresses, first comes to a short-term initial decrease (*Warriss et al., 1984*), while in case of high intensity of stress, content of blood cortisol rises faster and lasts longer *(Kallweit et al., 1981*). Usually after the second day, the concentration of cortisol begins to decline gradually, but reaches pre-stress level only after seven days. In contrast to cortisol, which can be taken as an indicator of long-term stress *(Kallweit et al., 1981*), aldosterone increases in the first few hours of the beginning of stress, usually only during the transport of animals to slaughter (and therefore can be considered as an indicator of short-term stress).

Materials and Methods

Tests were performed on bulls that come from the farm, which is located 50 km from slaughterhouse (farm A) and another farm, which is located 150 km from slaughterhouse (farm B). Beef cattle was housed in the free system and loading and unloading was carried out on unloading ramps and animals taken to boxes using a lane corridor. Also, attention was paid to avoid mixing with unfamiliar animals during transport. The study included 20 males. The same vehicle was used to transport cattle from the farm to the slaughterhouse. Measurement of rectal temperature was carried out on 20 young bulls, at the time of loading of cattle into transportation vehicle, during transport and immediately before slaughter. The same mercury thermometer for large animals was always used. After each individual use, the thermometer was properly washed and disinfected.

Results and Discussion

The results of measurements of rectal temperature, before transport, during transport and at slaughter, of young bulls originating from farm A are shown in Table 1. Based on the measurement results in Table 1 it can be seen that the bulls' rectal temperature increased from the time of loading to the time of slaughter. Normal range for the rectal temperature of cattle is from 36.7°C to 39.3°C *(Gregory and Grandin, 1998).* The average rectal temperature of bulls tested before transport was in the normal range - 37.7°C, while during transportation and especially before slaughter it increased to 40.0°C.

Table 1. Rectal temperature (°C) of young bulls from farm A before and during transportation and before slaughter

No. of bull	Before transport	During transport	Pre-slaughter
1	36,9	37,4	38,6
2	38,7	38,8	39,6
3	37,1	37,3	38,5
4	38,2	38,4	40,2
5	37,3	38,5	40,3
6	37,8	38,6	39,9
7	37,5	37,6	40,1
8	38,0	37,7	42,0
9	39,0	38,8	42,2
10	37,2	37,3	39,3
Average	37,77	38,04	40,07

The results of measurements of rectal temperature, before transport, during transport and at slaughter, of young bulls originating from farm B are shown in Table 2. Based on the measurement results presented in Table 2 it can be seen that the bulls' rectal temperature increased from the time of loading to the time of slaughter. The average rectal temperature of bulls tested before transport was in the normal range - 38.1°C, while during transportation and especially before slaughter it increased to 40.6°C.

Table 2. Rectal temperature (°C) of young bulls from farm B before and during transportation and before slaughter

No. of bull	Before transport	During transport	Pre-slaughter
1	37,1	38,3	40,2
2	38,2	38,4	39,8
3	37,3	38,5	42,0
4	39,0	39,0	40,0
5	38,0	38,5	39,0
6	39,2	40,0	41,0
7	39,4	40,0	41,0
8	37,2	38,8	41,0
9	38,0	39,0	40,8
10	38,0	39,0	42,0
Average	38,1	38,95	40,68

The results of measurements of rectal temperature of investigated bulls suggest that prolonging of transport increases rectal temperature which can serve as an indicator of stress syndrome in bulls.

There are EU regulations regarding animal transport modes. According to the regulations, the transport must not last longer than 8 h, or 14 h with the condition to ensure the rest of animals of at least 1h (*Tarrant and Grandin, 2000*). In times of stress, or one hour after mixing unfamiliar young bulls, heart rate and rectal temperature are increased (*Mc Veigh and Tarrant, 1981*). If the bulls are slaughtered at the time when the rectal temperature, and the temperature of the entire body is increased, post mortem elevated temperature in the meat are recorded (*Augustini, 1981; Fischer, 1981*).

In the literature, there are many attempts to solve the problem of stress syndrome and resulting DFD - meat. To date there is no conclusive solution, although many authors recommend measures to mitigate the intensity of the frequency of occurrence. Thus (*Warris et al. 1984*) have reached the conclusion that young bulls who have experienced the stress of mixing with unfamiliar bulls need a rest in the depot at least 48 hours prior to slaughter.

In addition to measuring of rectal temperatures as indicators of stress syndrome in bulls today other methods are used, such as:

- *Measurement using infrared tomography* - temperature measurement using infrared tomography
- *Measurement of cortisol in saliva and blood* - General adaption syndrome, i.e. physiology of stress, indicates an increased concentration of cortisol during stress. Nowadays, as a method for the determination of cortisol, saliva and blood are used.
- *Measuring cortisol in hair* - This is the latest method of the 21st century, which can even determine the time of occurrence of stress . This method is the future that will determine whether the stress was created a few days, weeks or even months ago.

Conclusion

The results of measurements of rectal temperature before transport, during transport and at slaughter of bulls originating from farm A and farm B indicated that prolonging of transport increases rectal temperature which can serve as an indicator of stress syndrome in bulls. In order to minimize the influence of transport on bulls' stress syndrome it is neccessary to enact specific legislation on the conditions and method of transport. Examples include the EU regulations regarding animal transport modes. According to the regulations the transport must not last longer than 8 hours, or up to 14 hours provided that the rest for animals of at least 1 hour is ensured.

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Metode utvrdjivanja stres sindrom junadi i njegov značaj za kvalitet mesa

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Rezime

Metode za utvrdjivanje stres sindoma junadi imaju veliki značaj u identifikaciji fiziološkog stanja junadi pre klanja, kako bi se takva grla adekvatno tretirala i povratila u normalno fiziološko stanje. Kao posledica stresnog stanja pre klanja dobija se meso koje se razlikuje od normalnog mesa. Ovo obuhvata

netipične postmortalne promene mesa kao što su "BMV" meso (bledo, mekano i vodnjikavo meso) najčešće svinjsko i "TTS" (tamno, tvrdo i suvo meso), najčešće juneće meso. Ispitivanja su vršena na junadima koja potiču sa farme udaljene 50 km od klanice i sa druge farme koja je udaljena 150 km od klanice. Junad su držana u slobodnom sistemu a utovar i istovar obavljani su na istovarnoj rampi pri čemu su životinje koridorom odvođene u boksove štala. Takodje se vodilo računa da ne dodje do mešanja nepoznatih životinja u toku transporta. Ukupno je ispitano 20 muških grla. Istim vozilom junad su transportovana od farme do klanice. Rektalna temperature merena je kod 20 junadi, i to u momentu utovara u stočno vozilo, za vreme transporta i neposredno pre klanja. Rezultati merenja rektalne temperature ispitivane junadi ukazuju da prolongiranjem transporta raste i rektalna temperatura što može poslužiti kao pokazatelj stres sindroma junadi. Pored merenja rektalne temperature kao indikatora stres sindroma junadi danas se koriste i druge metode kao što su merenje kortizola u pljuvački i krvi ili najnovija metoda merenje kortizola iz dlake. Ovo je najnovija metoda 21. veka kojom se čak može odrediti vreme nastanka stresa. Ova metoda predstavlja budućnost kojom će se utvrditi da li je stres nastao pre nekoliko dana, nedelja pa čak i meseci.

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