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THE MOST SIGNIFICANT STRESSORS IN INTENSIVE SHEEP PRODUCTION

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Review paper

Abstract: In this paper are described the most important stressors in intensive sheep production on farms and pastures. Stressors on farms and pastures mostly originate from adverse housing conditions, improper zootechnical procedures, veterinary procedures (treatment, vaccinations, blood tests, surgery), animal husbandry procedures (labeling, weaning, grouping, shearing, shortening the tail, hoof care), unsuitable weather conditions (extreme heat and cold) and insufficient nutrition. The paper puts out special emphasis on the consideration of period of life in which sheep were subjected to additional loads and susceptible to effects of these stressors, such as birth, juvenile period, puberty, oestrus, advanced pregnancy, parturition and the puerperal period.

Key words: farm, pasture, sheep, stress response, stressors

Introduction

For stockmen, zootechnical and veterinary professionals of great importance is to know the most common stressors and their impact on health and production performance of sheep, then mechanism of stress response and finally the consequence of distress condition. In the literature *(Hristov and Bešlin, 1991; Hristov et al., 2007)* the effects of numerous stressors on the body of sheep in intensive production conditions on farms and pastures are described. Although there is no uniform classification of stressors, it might be easiest to divide them according of the origin on the internal stressors (those that come from the animal body) and external stressors (those that come from the environment of sheep). Even though, in essence, stress is physiological response in mammals, in circumstances when action of some stressors is repeated, especially when increases

the intensity of its action or multiple stressors manifest their actions at the same time, there is a possibility that distress arises as a result.

The aim of this study was to review the mechanism of stress reactions and to discuss the effects of major stressors on the body of sheep in intensive production conditions on farms and pastures.

The mechanism of stress response

The term stress, according to scientist *Selye (1936),* implies the system of biological reactions in mammalians based on the interaction of two factors: adverse effect of stimuli on one side, and protective response and reactions to the other. In fact, if it is simplified, the stress, according to Selye, is "the mode and means" of non-specific adaptation of the organism to adverse effects of various external and internal factors, which represents a complex reaction that ensures the maintenance of most life processes and functions within the normal scope. This stress response, which usually leads to adaptation of the organism to the effects of stressors, in the literature is often called as eustress. However, stress can lead to significant disturbances in the organ functions and systems of the body as a whole. In addition to the physiological changes on the influence of the stressor, in this case, there are an obvious function disorders and behavioural changes. Dysfunction of the axis hypothalamus-anterior pituitary lobe-adrenal gland, which is responsible for internal and external homeostatic relationships, can cause pathological conditions or their exhaustion due to the long exposure to the effects of stressors. When disturbances in the function of vital organs and behaviour arise, then distress, hypostress or hyperstress occur, depending on the intensity and duration of the stressor activity and the state of reactivity of the organism.

Stressors of endogenous and exogenous origin in animals trigger a complex reaction flow through the axis hypothalamus-anterior pituitary lobe-adrenal gland. From the hypothalamus, corticotropin releasing factor (CRF) releases, which stimulates the secretion of adrenocorticotropic hormone (ACTH) from the pituitary gland. Under the influence of this hormone, corticosteroid hormones in adrenal gland (primarily cortisol) are released, which in various ways establishes their impact on the body, in an attempt to adapt to the effects of stressors or to variable environmental conditions *(Doubek et al., 2003)*.

Activation of the adrenal gland and the secretion of adrenaline is the beginning of a series of physiological reactions that occur due to activity of neurohumoral systems and metabolic realignment of the body. Adrenaline activates CRF which triggers secretion of ACTH from the anterior pituitary into the bloodstream. ACTH stimulates the adrenal gland cortex which is the center of adaptation reaction on the effects of stressors. It is well known fact that animals

without adrenal glands are not able to adapt to the effects of strong stressors such as fatigue, cold, blood loss, infection and injury.

After endogenous opioid peptides were discovered, a number of studies have demonstrated the complexity of their role in the body's stress response. Comprehensive research, conducted over the last three decades of the 20th century, led to the data that explained the significance of the endogenous opioid system, as modulator of vital functions adaptation in the animal body. Opioid peptides (endorphins, enkephalins and dynorphins) modify the intensity and mode of action of the neurotransmitter. Therefore, endogenous opioids have a greater range of action than neurotransmitters, resulting in local effects. These neuromodulators exercise influence on neuronal synaptic and non-synaptic areas, but also in neighbouring cells. Neuromodulator activity, expressed in this way, puts a whole group of cells in a particular physiological function.

The most significant stressors in intensive sheep production

In our country, the sheep are kept in stables during the cold winter months and pastures in much of the year, mainly from mid-April to mid-November *(Hristov, 2002)*. There are numerous stressors related to the procedures and methods of sheep rearing in the barns and pastures. The most significant stressors on the farms and pastures originate from unfavourable housing conditions, incorrect handling procedures, veterinary and zootechnical measures and procedures (treatment, vaccinations, blood tests, surgery, labelling, weaning, grouping, shearing, shortening the tail, hoof care), inadequate climatic conditions (extreme heat and cold) and nutrition.

The effects of these stressors are manifested in all life periods of sheep, but there are the periods when they are subjected to additional loads and the animals are more susceptible to these stressors, such as birth, shortly after birth, juvenile period, puberty, oestrus, advanced pregnancy, parturition and puerperal period. Some stressors can be qualitatively physical components, such as climate, while others involve certain procedures in the handling procedures, such as manipulation of animals, the introduction of a new diet, a new environment or new animals in the herd, etc. Among the climate components that can cause stress of sheep are ambient temperature, humidity, air flow, solar radiation, etc., among which the most important is the ambient temperature *(Marai et al., 2007)*.

Various aspects of relationship of the concepts of stress, behaviour and welfare of domestic animals are described in publications by *Hristov and Vučinić (1991)*, *Moberg (2000)* and *Veissier and Boissy (2007)*. In sheep, these aspects are discussed in publications by *Moberg et al. (1980)*, *Siegel and Moberg (1980)* and *Moberg and Wood (1981)*.

Hormones as indicators of stress are described by *Möstl and Palme (2002)*. Impact of stress on animal reproduction was described in paper by *Pampiori et al.*

(2010), stress in sheep resulting from management practices by *Kilgour and de Langen (1970)* and the effect of shearing and environmental conditions on physiological mechanisms in ewes by *Piccione et al. (2008)*. Relations among nutrition and stress were discussed by *Sejian et al. (2011)*. Impacts of heat stress and the environment on farm animals were described by *Habeeb et al. (1992)* and the impact of climate on thermal rhythm in pastoral sheep by *Lowe et al. (2001)*. It is believed that the temperature has great impact on grazing patterns *(Thomas et al., 2008)* and *Nix (2007)* states that drought and heat stress go hand in hand.

Various aspects of the effect of heat stress on the body of animals are described by the author *Fuquay (1981)*, and also on the organism of sheep, for example, the effects of heat stress on the welfare *(Silanikove, 2000)*, the physiological and behavioral responses of sheep *(Stockman, 2006)*, production of sheep *(Finocchiaro et al., 2005; Peana et al., 2007)* and also sheep reproduction *(Maurya et al., 2011)*, cardiovascular responses in late gestation of sheep *(Walker and al., 1995)*, serum biochemical parameters of sheep and their correlation with triiodothyronine (T3), thyroxine (T4) and cortisol concentrations *(Nazifi et al., 2003)*, the consequences for fetal and placental growth in sheep *(McCrabb et al., 1993)*, embryo mortality in the ewe *(Thwaites 1971)* and wool growth in sheep *(Thwaites, 1968)*. Effect of cold stress on production in ruminants was well documented by *Young (1983)*.

In the literature is emphasized that the extreme variations in climatic and nutritional conditions are the immediate strain on the body of sheep. Appetite in sheep is reduced if they are exposed to extremely high ambient temperatures. Cold, on the other hand, increases the body's energy requirements of sheep, leading to mobilization of fat from adipose tissue and consequent fat oxidation and formation of non-esterified fatty acid (NEFA) as a byproduct that appears in the plasma. The NEFA concentration in plasma is in fact reliable indicator of the nutritional status of the sheep body and the current level of response to environmental stress in sheep. Lambs, born by Caesarean section or exposed to the cold, have a higher concentration of NEFA in plasma. Other adverse factors, such as complete lack of food or malnutrition, combined with a multiple pregnancies, also, lead to a significant increase of NEFA concentration in plasma, which is closely related to the intensity of stressors. Although the adrenal gland cortex is stimulated on hormone secretion in sheep exposed to cold and wet climate conditions, and the number of eosinophils in the blood significantly decreases, the metabolic response to repeated cold exposure of sheep in the short term is progressively reduced. Progressive changes in climate conditions are likely to lead to a relatively broad range of hematological values found in sheep in different keeping areas.

From the mid-20th century, farm animals are mostly reared in intensive systems which increasingly take on industrial characteristics *(Hristov et al., 2007a)*. Nowadays, maximally intensified production in sheep breeding has contributed to the birth of lambs throughout the year. Highly productive breeds of

sheep were subjected to a rigorous selection, artificial induction of oestrus and crossing with tested rams in order to improve the production and quality of meat. Lambs are weaned and fed with artificial milk by sucking the rubber tits from the second day of age. Studying of the behaviour of these groups of lambs reveal that those keeping systems, where, in essence, social ties between lambs and ewes are interrupted, adversely affect the normal development of the behavioural relationships *(Wiepkema, 1987)*. The literature emphasizes that those artificial feeding systems do not entirely satisfy the need for lambs' oral activities. These allegations are based on the appearance and development of sucking umbilical and scrotal region by some lambs in the group. All attempts to improve diet that would be closest to the biological needs of the sheep were not totally successful in the prevention and reduction of abnormal oral activities of lambs. Although such systems of sheep rearing, which were the subject of a detailed report by *Brambell (1965)*, can be classified as potentially stressful in the physiological and behavioural terms, has not yet been entirely clarified in terms of all their consequences.

Surgical transplantation of the adrenal glands in the neck, where it is easy blood supply, allows the use of sheep as a model for the study of mammalian adrenocortical function. A relatively simple surgical procedure enabled *Madill and Bassett (1973)* to connect the uterus with the fetal adrenal gland skin and thus to induce stimulation by ACTH and cause the response of foetuses and newborn lambs. The results of studying the dynamics of the adrenal gland response to the application of ACTH in adult sheep under experimental conditions showed that the maximal cortisol secretion is achieved within 10 to 20 minutes. When infusion of ACTH is continuous, maximal cortisol secretion is maintained for the next 30 to 60 minutes, and then slowly establishes a "steady state" secretion *(Olson et al., 1987)*.

Sheep naturally live in a flock in order to be protected against predators. They have a highly developed observation on the effect of new stimuli, especially noise and sudden movement of predators nearby. A sudden loud noise, such as, for example, extremely loud sonic boom, is the stressor and causes substantial initial response of movement of sheep. Depending on the duration and intensity of the acoustic strikes, follows the fast movement of the herd (running behaviour) of different durations and at different distances.

Deviations from the stationary limit concentrations of many constituents in blood plasma were also identified in sheep that were exposed to the qualitatively new stimuli. An increase in the release of thyroid hormones *(Felconer and Hetzel, 1964)* was found in sheep for 15 to 30 minutes, when they are exposed to a series of firework explosions or barking dogs. The increases in these hormones are typically maintained for about 2 hours. NEFA concentrations also increased in sheep when exposed to qualitatively new stimuli such as puncture of the vein *(Patterson, 1963)*. This increase usually lasts no longer than 2 hours *(Slee and Halliday, 1968)* and the magnitude of the increase becomes progressively smaller

with repeated capture in order to take blood samples *(Reid and Hinks, 1962)*. Similarly, the progressive reduction of the resulting increase is caused by venipuncture when taking blood for determination of plasma corticosteroids *(Bassett and Hinks, 1969)*.

Circadian variations in plasma cortisol concentrations of sheep were absent during the first 2-3 days after their introduction in the new environment *(McNatty and Young, 1973)*. During their stay in the new environmental conditions diurnal rhythm in plasma cortisol concentration was restored. However, a significantly higher concentration of cortisol in plasma was established in individuals not adapted compared with the concentrations that were found in the fully adapted sheep. The same authors found that the time required for complete adaptation to the new keeping conditions is 7-28 days.

In the studies of various technological procedures and their effects on the reactivity of the adrenal cortex of sheep *(Kilgour and de Langen, 1970)* it was found that the separation of the sheep from the flock and immobilization are the most influential stimuli. Increasing the shear time of 5 to 15 minutes, causes 50% increase in plasma cortisol concentrations.

Increase in plasma cortisol concentration in sheep can be induced by intravenous infusion of adrenalin. In the study by *Thurley and McNatty (1973)* it was established that the clinical symptoms of disturbed and unrest sheep are partially related to the release of adrenaline. The same researchers point out that a significant dynamic adrenocortical activity is established in the group of sheep exhibiting harassment. The aforementioned researchers suggest that the adrenal response depends on the intensity of stressors.

Conclusion

According to literature data about the most significant stressors in sheep on farms and pastures in intensive production conditions, it can be concluded:

- stressors on sheep farms and pastures mostly originate from adverse housing conditions, improper handling procedures of stockmen, veterinary procedures (treatment, vaccinations, blood tests, surgery), animal husbandry procedures (labeling, weaning, grouping, shearing, shortening the tail, hoof care), unsuitable weather conditions (extreme heat and cold) and insufficient nutrition;
- the periods of life in which sheep were subjected to additional loads and also they are more susceptible to effects of these stressors are birth, juvenile period, puberty, oestrus, advanced pregnancy, parturition and the puerperal period.

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Najznačajniji stresori ovaca u intenzivnim uslovima proizvodnje

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Rezime

U radu su opisani najznačajniji stresori ovaca u intenzivnim uslovima proizvodnje na farmama i pašnjacima. Stresori na farmama i pašnjacima najčešće potiču od nepovoljnih uslova smeštaja i držanja, nepravilnih postupaka odgajivača, veterinarskih postupaka (lečenja, vakcinacije, vađenja krvi, hirurške intervencije), zootehničkih postupaka (obeležavanje, odbijanje, grupisanje, šišanje, skraćivanje repa, obrada papaka), neodgovarajućih klimatskih uslova (ekstremna toplota i hladnoća) i neodgovarajuće ishrane.

U radu se poseban akcenat stavlja na razmatranje perioda života u kojima su ovce podvrgnute delovanju dodatnih opterećenja i podložnije delovanju ovih stresora, kao što su rođenje, juvenilni period, pubertet, estrus, visoki graviditet, porođaj i puerperalni period.

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