

INFLUENCE OF REARING CONDITIONS ON REPRODUCTION, GROWTH, MILK YIELD AND QUALITY OF MEAT AND MILK OF SHEEP AND GOATS

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Review paper

Abstract: The most important stressors in our country are unfavourable climatic and nutritional conditions. Extreme deviations in climatic and nutritional conditions are immediate stressors for the body of sheep and goats. Appetite in sheep and goats decreases if they are exposed to extremely high ambient temperatures, while cold increases the body's energy needs and leads to the mobilization of fat from body fat and the consequent oxidation of fat and the formation of non-esterified fatty acids. Thyroid activity is reduced when these animals are exposed to high temperatures, and increased when they are exposed to cold. In an environment with high temperatures, blood glucose and cholesterol concentrations decrease due to unsuccessful maintenance of homeostasis. Sheep and goats are naturally kept in a group, which basically protects them from predators. They successfully register the action of new stimuli, especially noise and sudden movements of nearby predators. Early weaning breaks the bond between mother and offspring and adversely affects the development of normal behavioural relationships in lambs and kids, because artificial feeding systems do not fully meet the needs of oral activity, so sucking of the umbilical and scrotal region often occurs. Investigations of the influence of various technological procedures on the reactivity of the adrenal cortex indicate that the separation of the animal from the herd and immobilization are the most significant stimuli. Electrical stunning of sheep at the slaughterhouse causes significant stimulation of the sympathetic system with a sudden release of adrenaline and noradrenaline. In conditions of intensive production, the most significant stressors and physiological conditions that lead to stress are: parturition, birth, puerperal period, weaning, oestrus, high pregnancy, various surgical procedures, veterinary and zootechnical procedures, extreme variations of micro- and macroclimatic conditions, variations in quantity and food quality, etc.

Key words: rearing conditions, reproduction, production, sheep, goats

Introduction

In our climatic conditions, sheep and goats are raised on pastures for a longer period of the year, where the most significant stressors are unfavourable climatic and nutritional conditions (*Hristov and Bešlin, 1991*). Climate variations directly affect these species, influencing their biological reactions (*Hristov et al., 2002*). Detailed studies of certain haematological and biochemical changes related to pregnancy and lactation in sheep and goats in different climatic conditions, different rearing and housing conditions, as well as different feeding conditions have been performed. Periods requiring an abundant supply of nutrients, such as immediately before and after birth in highly productive breeds of sheep and goats under conditions of insufficient and/or unbalanced diet, may include mobilization of body fat and protein, leading to fatty liver and clinical ketosis (known as pregnancy toxæmia) and results in decreased productivity and in some cases even death (*Helman et al., 1995*). Similar metabolic changes can occur in low-yielding breeds of sheep and goats if these animal species are malnourished and/or fed unbalanced rations (*Hristov and Bešlin, 1991*).

Influence of stressors on reproduction, growth, milk yield and meat and milk quality

The connection between stress and animal welfare is a well-known issue in scientific observations (*Hristov et al., 2007*). Climate change is one of the most significant stressors affecting the welfare and production of sheep and goats (*Hristov et al., 2007a*). The impact of climate change is manifested through numerous losses in livestock production. It should be borne in mind that analyze of the conditions of production is an important issue, since each breed has different characteristics of adaptability. Changes in biological functions when exposed to heat stress include physiological, hormonal, haematological and biochemical reactions, which make sheep and goats resilient and enable them to survive in an unfavourable environment (*Darcan et al., 2007*). The extreme variations in climatic and nutritional conditions are the direct stress to the organism of sheep and goats (*Hristov and Bešlin, 1991*).

Appetite in sheep and goats, for example, decreases if they are exposed to extremely high ambient temperatures (*Sarangi, 2018*). Cold, on the other hand, increases the body's energy needs and leads to the mobilization of fat from body fat in sheep and goats and the consequent oxidation of fat, which leads to the formation of non-esterified fatty acids (NEFA – Non Esterified Fatty Acids) as a

constituent of blood plasma. NEFA level in blood plasma of sheep or goat is reliable indicator of nutritive status and reactivity to environmental stressors (Gupta *et al.*, 2013; Milošević-Stanković *et al.*, 2020).

The intensity of the detrimental effects of high environmental temperatures on sheep and goats depends on the efficiency of their thermoregulatory mechanisms (Caroprese *et al.*, 2009; Shaji *et al.*, 2017). Thyroid activity is reduced when these animals are exposed to high temperatures, and increased when they are exposed to cold (Habibu *et al.*, 2016; El-Tarabany *et al.*, 2017). Well-adapted animals react quickly to changes in the environment so they can make the necessary physiological adjustments. Research shows that in the environment with high temperatures, the concentrations of glucose and cholesterol in the blood decrease, which points out the unsuccessful maintenance of homeostasis.

Heat stress has a greater impact on total cholesterol concentration, which may be due to increased use of fatty acids for energy production and decreased glucose concentration in animals exposed to heat stress (Gupta *et al.*, 2013; Das *et al.*, 2016). Similarly, researchers point out protein level increase when these animals are exposed to heat stress (Nazifi *et al.*, 2003; Gupta *et al.*, 2013). During physical exertion a faster release of oxygen is present as well as an increase of oxygen consumption and thus an increase of the concentration of haemoglobin. Reduced food intake in animals under long-term heat stress reduces erythrocyte production and haemoglobin levels, resulting in a reduction in the number of red blood cells in the bloodstream (Alam *et al.*, 2011; Gupta *et al.*, 2013).

Lambs and kids born by caesarean section or exposed to cold have an increased concentration of NEFA in the blood plasma (Clarke *et al.*, 1994; Hristov *et al.*, 2012). Other adverse factors such as, for example, complete lack of food or malnutrition combined with multiple pregnancy also lead to a significant increase in the concentration of NEFA in the blood plasma of sheep and goats, which is closely related to the intensity of stressors (Eşki *et al.*, 2015; Di Giacomo *et al.*, 2016; Milošević Stanković *et al.*, 2020). In sheep and goats exposed to cold as well as humid climate conditions, the adrenal cortex is stimulated to increase hormone secretion while the number of eosinophils in the blood is significantly reduced. The metabolic reaction to repeated exposures of sheep and goats to cold in a short duration is progressively reduced. Progressive changes in climate conditions are likely to lead to relatively wide ranges in haematological values in sheep and goats in different geographic areas (Ghosh *et al.*, 2014; Snyman *et al.*, 2017).

Increased cortisol levels in sheep and goats occur after acute heat stress (Marai *et al.*, 2007; Seijan *et al.*, 2008); intensive chronic stress can result in periods of high concentrations of cortisol, followed by a decrease in individual health condition through immuno-suppression and atrophy of the body's defence tissues. In addition, cortisol reduces the energy available to the immune system, which increases the susceptibility of animals to infectious diseases.

Today, the most intensive production in sheep and goat breeding has contributed to the production of lambs and kids throughout the year. Basically, the existing systems in use in the housing and rearing of sheep and goats during the year and the artificial induction of oestrus have contributed to the reduction of exposure of sheep and goats to daylight (*Alcalde et al., 2017*).

Highly productive breeds of sheep and goats have been subjected to rigorous selection and crossbreeding with tested rams and goats to improve meat quality. The lambs and kids are weaned and fed with artificial milk using rubber teats from the second day of age. A study of the behaviour of groups of lambs and kids reveals that housing systems where the social bond between mother and offspring is broken, adversely affect the development of normal behavioural relationships (*Sevi et al., 2009*). As it was found for calves (*Johnsen et al., 2016*), artificial feeding systems do not fully meet the needs of oral activity of lambs and kids, since it was noticed that those lambs and kids develop the habit of sucking the umbilical and scrotal regions by individual lambs and kids in the group (*Stephens and Baldwin, 1971; Napolitano et al., 2008*). Previous attempts to improve the diet in order to achieve the most optimal in accordance with the biological needs of sheep and goats have not been completely successful in preventing the occurrence or reduction of abnormal oral activity of lambs and kids (*Miranda-de la Lama and Mattiello, 2010*).

Surgical transplantation of the adrenal gland to the neck where the blood supply is easy enabled the use of sheep as a model for studying adrenocortical function in mammals. The relatively simple surgical procedure made it possible for the uterus to connect with the adrenal cortex of the foetus and consequently easily stimulate with ACTH and induce a reaction in the foetus and newborn lambs (*McDonald et al., 1958*). Studies of the dynamics of adrenal gland reactions to experimental ACTH stimulation in adult sheep showed that the maximum secretion of cortisol is achieved within 10 to 20 minutes. When the ACTH infusion is continuous, maximum cortisol secretion is maintained for the next 30 to 60 minutes, after which normal secretion is slowly established (*Beaven et al., 1964; Salemi et al., 2000*).

Sheep and goats are naturally kept in a group, which basically protects them from predators. They have a very developed observation about the action of new stimuli, especially noise and sudden movements of nearby predators (*Rutter, 2002*). Sudden loud noise, such as a loud gunshot, is a stressor and causes a significant initial reaction in sheep movement. Depending on the duration and intensity of the sound, the herd moves quickly in different durations and at different distances (*Hargreaves and Hutson, 1990; Grandin, 2011*).

Aberrations from stationary level limits of many constituents in blood plasma have also been found in sheep and goats exposed to qualitatively new stimuli. An increase in thyroid hormone release rate was found in sheep within 15 to 30 minutes, when they were exposed to a series of fireworks explosions or barking dogs. The increase in the concentration of these hormones usually lasts for about 2

hours (Falconer and Hetzel, 1964; Bobek et al., 1986). Plasma NEFA concentrations also increase in sheep and goats when exposed to qualitatively new stimuli, such as vein puncture (Paterson, 1963). This increase usually does not last longer than 2 hours (Slee and Halliday, 1968), and the increase rate becomes progressively lower with repeated seizures in order to take blood samples (Reid and Hinks, 1962; Westgren et al., 1987). Similarly, the consequent progressive decrease was caused by venous puncture when taking blood to determine the concentration of corticosteroids in the blood plasma (Bassett and Hinks, 1969).

Circadian variations in plasma cortisol concentrations in sheep and goats are absent for the first 2 to 3 days after the introduction of noise and sudden movements of nearby predators. During the stay in the new ambient conditions, the diurnal rhythm of cortisol concentration in the blood plasma is reestablished. However, a significantly higher concentration of cortisol in blood plasma is found in unadapted individuals compared to the concentration in fully adapted sheep and goats. It is considered that in sheep and goats require a period of 7 to 28 days for complete adaptation to the new conditions of keeping and accommodation (McNatty and Young, 1973).

In the study of various technological procedures and their effects on the reactivity of the adrenal cortex, it was found that the separation of sheep and goats from the herd and immobilization are the most influential stimuli. Prolonged shear time from 5 to 15 minutes causes an increase in plasma cortisol concentration by 50% (Kilgour and de Langen, 1970).

It has been proven that an increase in the concentration of cortisol in the blood plasma of sheep can be induced by an intravenous infusion of adrenaline. The increasing the concentration of cortisol was dependent on the applied dose of adrenaline, as well as higher in sheep that were housed in the stall. Studies have shown that clinical signs of disorders and disturbances in sheep are partly related to the release of adrenaline. The researchers point out that significant dynamic adrenocortical activity is found when a group of sheep is exposed to disturbance and suggest that the adrenal gland response depends on the intensity of the stressor (Thurley and McNatty, 1973).

The use of inexperienced dogs to chase the flock in sheep causes a greater and longer-lasting response of the organism than the use of trained dogs. Grouping of sheep by humans causes a less stressful reaction of the sheep organism (Beausoleil et al., 2005). Surprisingly, sheep kept together with lambs, although more often in a distressed state, show less reaction to grouping with experienced dogs compared to the same treatment in the same sheep before parturition.

Sheep housed in stables immediately before transport are less susceptible to stress or increased corticosteroid concentrations. However, sheep caught and loaded into a trailer directly on pasture show a greater reaction (Miranda-de la Lama et al., 2012; Pascual-Alonso et al., 2017).

Electrical stunning of sheep at the slaughterhouse causes significant stimulation of the sympathetic system with a sudden release of adrenaline and noradrenaline into the circulation, 14 to 20 times higher than normal values. Concentrations of cortisol, adrenaline and noradrenaline in blood plasma are significantly higher in sheep in large slaughterhouses compared to the values found in the same species in small non-specialized slaughterhouses. This is thought to be due to heavier catching, higher noise and greater disturbance of sheep in large slaughterhouses (*Linares et al., 2008; Sabow et al., 2016*).

Mean concentrations of adrenal hormones in the blood serum of sheep gradually increase with an increase in the duration of transport to 2 hours. When extending the duration of transport to 8 hours, a lower rate of increase in the concentration of these hormones in the blood serum of sheep was observed (*Shannon et al., 1976; Zarogiannis et al., 2006; Kadim et al., 2007*).

Meat breeds of sheep and goats are inevitably exposed to various procedures before and during loading, during transport, during unloading, as well as food deprivation before slaughter. Procedures with sheep and goats before, during and after transport can affect animal welfare and production profitability. Expressed stress before slaughter negatively affects the quality of meat in animals. Weight loss during transport and storage in pre-slaughter depots are of particular importance because in small ruminants the digestive tract represents a larger proportion of live weight than in cattle and pigs (*Ekiz and Yalcintan, 2013; Hashem et al., 2013*).

The researchers used several physiological indicators to assess stress levels in farm animals. Cortisol concentration was used as a reliable indicator of short-term physical stress (*Kannan et al., 2003*). Leptin, a protein hormone synthesized by adipose tissue, has been reported to inhibit the activity of the hypothalamic-pituitary-adrenal axis in response to stress. (*Macedo et al., 2019*). Creatine kinase (CK), an enzyme in skeletal muscle, is released into the blood plasma in response to muscle damage under stress (*Nazifi et al., 2003; Chulayo and Muchenje, 2013*). Stress in sheep and goats due to lack of food causes the degradation of proteins and increase the level of urea in the blood (*McDougal et al., 1991; Wheelock et al., 2010*). The effects of various stressors on leukocyte profiles in farm animals were determined. Physiological responses to pre-slaughter stress have been studied in all species of farm animals, with limited data on goats (*Ekiz and Yalcintan, 2013; Sabow et al., 2016*).

Immediately before and after birth, highly productive breeds of sheep and goats need large amounts of nutrients. If then there is insufficient and/or unbalanced diet, body fat and protein are mobilized, which leads to fatty liver and clinical ketosis (known as pregnancy toxemia), reduced productivity, and in some cases the death of these species (*Brozos et al., 2011; Milošević-Stanković et al., 2020*). Similar metabolic changes can occur in poorly productive breeds of sheep and goats if they are not fed and/or fed an unbalanced diet. Concentrations of free

fatty acids, triglycerides, cholesterol, urea and creatinine in the blood serum are higher in sheep and goats with the occurrence of pregnancy ketosis and multiple pregnancies compared to non-pregnant sheep and goats (*Donoghue and Kronfeld, 1990; Brozos et al., 2011*). Calcium intake decreases with reduced food intake during ketosis, which leads to hypocalcaemia. Serum calcium levels were found to be significantly reduced in sheep and goats with hypocalcaemia and pregnancy toxemia. Also, reduced food intake during grazing is a possible cause of hypocalcaemia (*Kessler, 1991*).

Conclusion

Based on a detailed review of the literature data related to the influence of sheep and goat rearing conditions as a stressor on reproduction, growth, milk yield and quality of meat and milk, the following can be concluded:

- Extreme deviations in climatic and nutritional conditions are immediate stressors for sheep and goats;
- Appetite in sheep and goats is reduced if they are exposed to extremely high ambient temperatures. Cold, on the other hand, increases the body's energy needs and leads to the mobilization of fat from body reserve in sheep and goats and the consequent oxidation of fat, which causes the formation of non-esterified fatty acids;
- Thyroid activity is reduced when these animals are exposed to high temperatures and increased when they are exposed to cold. In an environment with high temperatures, blood glucose and cholesterol concentrations decrease and homeostasis fails;
- Sheep and goats have very good registration of the action of new stimuli, especially noise and sudden movements of nearby predators;
- Breaking the social bond between mother and offspring by early weaning adversely affects the development of normal behavioural relationships in lambs and kids;
- Separation of sheep and goats from the herd and immobilization are the most influential stress stimuli;
- Electrical stunning of sheep and goats at the slaughterhouse causes significant stimulation of the sympathetic system with a sudden release of adrenaline and noradrenaline into the circulation.

In the conditions of modern intensive sheep and goat production, the most significant stressors, regardless of origin, and physiological conditions in which these species are more susceptible to stress are: parturition, birth, puerperal period, weaning, oestrus, high pregnancy, various surgical procedures, veterinary and zootechnical procedures, extreme variations of micro- and macroclimatic conditions, variations in the quantity and quality of food, etc.

Uticaj uslova gajenja ovaca i koza na reprodukciju, prirast, mlečnost i kvalitet mesa i mleka

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Rezime

Najvažniji stresori kod nas su nepovoljni klimatski i nutritivni uslovi. Ekstremna odstupanja u klimatskim i nutritivnim uslovima predstavljaju neposredne stresore za organizam ovaca i koza. Apetit kod ovaca i koza se smanjuje ako su one izložene izrazito visokim ambijentalnim temperaturama, dok hladnoća povećava energetske potrebe organizma i dovodi do mobilizacije masti iz masnog tkiva organizma i posledične oksidacije masti i stvaranja neesterifikovanih masnih kiselina. Aktivnost štitne žlezde je smanjena kada su ove životinje izložene visokim temperaturama, a povećana kada su izložene hladnoći. U ambijentu sa visokim temperaturama smanjuju se koncentracije glukoze i holesterola u krvi usled neuspešnog održavanja homeostaze. Ovcе i koze se prirodno drže u grupi čime se u osnovi štite od predatora. One uspešno registruju delovanje novih stimulusa, naročito buke i iznenadnih pokreta predatora u blizini. Rano odbijanje prekida vezu majke i mladunčeta i nepovoljno utiče na razvoj normalnih bihevioralnih odnosa kod mladunčadi, jer veštački sistemi ishrane ne zadovoljavaju u potpunosti potrebe oralne aktivnosti, pa se često javlja sisanje pupčane i skrotalne regije. Ispitivanja uticaja različitih tehnoloških postupaka na reaktivnost kore nadbubrežne žlezde ukazuju da je izdvajanje jedinke iz stada i imobilizacija predstavljaju najznačajnije stimulse. Električno omamljivanje ovaca na klanici izaziva znatnu stimulaciju simpatičkog sistema sa naglim oslobađanjem adrenalina i noradrenalina. U uslovima intenzivne proizvodnje najznačajniji stresori i fiziološka stanja koja dovode do stresa su: porodaj, rođenje, puerperalni period, odbijanje mladunčadi, estrus, visoki graviditet, razni hirurški postupci, veterinarske i zootehničke mere, ekstremna variranja mikro- i makroklimatskih uslova, variranja u količini i kvalitetu hrane i dr.

Ključne reči: uslovi držanja, reprodukcija, proizvodnja, ovce, koze

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