Scientific Papers. Series D. Animal Science. Vol. LX, 2017
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

HEAT STRESS IN RUMINANTS

Halit Deniz ŞİRELİ[1], Muhittin TUTKUN[1], Ali Murat TATAR[1], Selçuk Seçkin TUNCER[2]

[1]Department of Animal Science, Faculty of Agriculture, University of Dicle, Turkey
[2]Department of Animal Science, Faculty of Agriculture, University of Yüzüncü Yıl, Turkey

Corresponding author e-mail: hdsireli@gmail.com

Abstract

Heat stress is one of the most important environmental stressors that reduce productivity in animal breeding. The productivity of farm animals is significantly reduced due to temperature increases. As a result, significant economic losses occur during the summer months. Temperature humidity index developed according to air temperature and relative humidity relation is a widely used method for determining the effect of heat stress for domesticated animals. The ruminants entering the heat stress have lower feed consumption and consequently lower yields. This review was conducted to determine the effects of negative stressors on ruminants, to show how to reduce the effects of these factors, and to determine what the physiological changes due to temperature stress are.

Key words: *ruminant, heat stress, yield.*

INTRODUCTION

High air temperature is one of the important environmental influences that affect ruminant animals as well as to all living organism. Accordingly, environmental conditions include all external factors that affect the growth, development and overall efficiency of the animal. Heat stress is defined as vital functions in animals' bodies and the inability to remove body heat caused by digestion of feeds from the body with increased air temperature. In this case, there are many metabolic problems in the body and loss of yields as well. Heat stress causes crucial economic loss and health problems in all animal species. The air temperatures in which the ruminant animals are most comfortable, depending on the relative humidity in the air are between 5°C and 25°C (Akman, 1998; Yousef, 1985; Mellado et al., 2013; Schüller et al., 2014).

When high relative humidity is added to high ambient temperature, the stress effects become even worse. The temperature humidity index THI (Temperature Humidity Index) is used in predicting the stress intensity that the temperature and the nematum are formed together (Hansen 2007). Thus, during the summer and winter months, the physiological responses of the animals to the environmental stress showed that seasonal hot and cold stress had an impact on the change of blood parameters. Reductions in dry matter consumption by 6-30%, loss of milk yield 15-20%, loss of fertility 40-50%, compulsory slaughter rate is 7-8% due to fertility loss, increase in death rate by 2%, respectively, in the heat stress of ruminants. It is known that this loss is about 325 EUR annual loss per animal (St Pierre et al., 2003).

During the hot stress, feed consumption decreases and therefore all yields decrease. In general, the response to warm stress of animals can be expressed as an increase in respiratory rate, a decrease in heart rate and an increase in serum (Dinçel and Dikmen, 2013).

As a result, optimum environmental conditions must be ensured in order to obtain the highest yield from a healthy animal.

Factors that Cause Heat Stress in Ruminants

Ruminants are on the one hand trying to reduce the ambient temperature of the environment they are on, while at the same time reducing the heat they have abzorbed. This indicates that the animals are devoted to metabolic body heat at a certain time. Ruminants have a tendency to heat-up or to lose heat depending on some factors. These factors are following;

- The amount of solar radiation,
- The grade of cooling in the night,
- Ventilation and air flow,
- Duration of hot conditions

As a result of these factors above mentioned the air temperatures remain at high levels and many problems arise due to heat stress if the animals are not able to move heat away.

In ruminants, due to heat stress, all yields, especially milk yield, will come down. This is why animals exposed to heat stress will reduce feed consumption and consequently reduce the amount of dry matter consumed. High-yielding animals also have more natural metabolic activity and will be more affected by high temperature stress as they produce more heat (Jones and Stallings, 1999).

Due to the decrease in dry matter consumption in animals causes the weakening of the immune system of the animals, growth retardation in young animals, while the high environmental temperature will also have negative effects on reproduction. These effects are respectively; Premature embryonic deaths and low birth weight; Failure of the oestrus cycle, decline in reproductive efficiency; Service period, prolongation of the calving interval, prolongation of time between first insemination and calving, failure in uterine and hormonal functions, decrease in semen quality and quantity (Özkütük, 1990; Smith et al., 1998; West, 2003).

Determination of Heat Stress in Ruminants

Stress determination in domestic animals is rather difficult. Because it is influenced by many factors.

The parameters used to determine the temperature stress are the yield, behavior and health of the animals.

The biggest challenge in measuring stress is variation among animals.

Because the response of each animal to the strase varies according to age, social relations, human-animal relationships, genetic factors. Animals have developed a number of defense mechanisms against changes in internal and external environments.

Abnormal conditions cause stress in animals and try to harmonize with the various responses they have shown. Different stress factors cause the yield to decrease by changing the metabolism in animals (Yorulmaz, 2014).

Behavioral and physiological changes occur in animals during heat stress. These changes are reported below respectively.

Behavioral Changes

- They minimize their movements,
- They prefer cool and shadow places,
- shift feeding behavior to cool times,
- Reduce feed consumption,
- If rough and concentrated feeds are given as alternatives, they prefer concentrate feeds with lower heat increase value,
- They increase water consumption.

Physiological Changes

- They try to remove excess heat from the body by evaporation by raising the respiration. In the meantime, removing excess CO_2 from the body means that H_2CO_3 is removed and the pH of the blood increases.
- H + excretion in kidneys responding to elevation in blood pH is reduced, more HCO- and cations are increased, especially Na excretion.
- In heat stress, animals lose 2/3 of water loss by evaporation, 1/3 by breathing from the body. Sweating increases in hot conditions. However, cattle have up to 10% sweating capacity. In an overwhelming amount of K removes from the body.
- The rate of reticulo-rumen movements and the abandonment of the digestive system of consumed feeds decreases. At the same time the total volatile fatty acid production in the rumen is reduced. The molar ratio of acetic acid in volatile fatty acids increases.
- Blood flow to digestion and other internal organs is reduced and blood flow to the skin surface increases.
- Urine discharge increases.

Detection Methods of Heat Stress in Ruminants

Determination of heat stress in animals can be determined by physiological and biochemical methods.

Physiological methods can be determined by various measuring instruments generally while biochemical methods can be determined by detecting the level of hormone in the blood.

Body temperature regulation

Sweating and breathing are less important to regulate body temperature so that evaporation

becomes more important in the excretion of excess heat in the body. In animals exposed to prolonged hot weather, they have developed some mechanisms to reduce body temperature. An example of these mechanisms is the reduction of heat production and feed intake. When the ambient temperature rises above 36°C, body temperature is distributed to the ears and feet which constitute approximately 23% of the body surface (Young 1983). Body temperature can be monitored by some physiological measures such as respiratory rate and rectal temperature. The effects of the environmental temperature on the respiratory, pulse rate and rectal temperature is given (West, 2003).

Pulse Rate

The number of pulses generally indicates the balance of blood circulation with metabolic status. The heat loss caused by the diffusion is realized by the blood flow. However, the number of pulses is increased due to the increase in blood flow under the skin when the temperature is high according to the studies carried out. Some researchers reported that there is a difference between races in terms of skin cooling rate. At very high temperatures the pulse rate may be reduced due to a decrease in the rate of metabolism. As a matter of fact, the ambient temperature is reported to be higher when the temperature is increased from 20°C to 35°C (Fuquay, 1981). Acid and propionate absorption is greater than 20 ° C, as well as O_2 carried at high temperature (at 35°C). The increase in the amount of O_2 taken through the blood can result heat increase in hot regions in ruminants. Hyperthermia, in other words, a significant increase in heart rate was observed when the rectal temperature rose above 42°C (Fuquay, 1981; Marai et al., 2007).

Respiratory Rate

Respiratory rate is an important indicator of stress. In domestic mammals, breathing is achieved by removing CO_2 from body tissues by replacing the body tissues with O_2 in order to remove the moisture from the body under normal conditions and to prevent hypothermia at high ambient temperature. Sheep lose about 20% of the body's heat produced by the respiratory tract at neutral ambient temperature (12°C). Moisture loss increases at high ambient temperature (35°C) and this loss accounts for 60% of total heat loss. In ruminants, respiratory rate is higher in summer than in winter (Srikandakumar et al. 2003).

Rectal Temperature

Rectal temperature is a measure taken in the rectal area to measure the internal temperature in animals. For example, in sheep, they try to keep it in a fairly narrow range under unfavorable climatic conditions and try to keep it stable to constant body temperature. Rectal temperature varies from 38.3 to 39.9°C under normal conditions. It is important that the ambient temperature rise from 18° C to 35°C in terms of rectal temperature in sheep. Adverse effects occured when the rectal temperature rises above 42°C. Exposure to elevated temperature is handled by the Temperature Moisture Index (SNI) at which temperature and humidity are assessed together. Changes in the rectal temperature during the year can be observed (Srikandakumar et al., 2003).

Thyroid Hormones (T3, T4) and Cortisol Levels in Blood

Stressors cause changes in the physiology of animals. In Stressed animals, cortisol release, increased body heat and pulse rate as well as the influence of many hormones (Roussel et al., 2006).

In addition to cortisone, thyroid hormones are sometimes used to identify stress. Thyroid hormones (Triiodothyronine = T3, Thyroxine = T4 and TSH) act on target tissues to stimulate oxygen production and heat production in every cell of the body. They change basal metabolism levels by providing more glucose to the cells, stimulating protein synthesis, increasing fat metabolism, circulating and activating the nervous system. Releasing of thyroid hormones is reduced in stress situations such as very Hot and humid weather, lightness, pain, excitement, bleeding, trauma. (Polat and Dellal, 2008).

According to SNI (Temperature Moisture Index) values, T3 and T4 hormone levels decreased with the increase of SNI values. This decline in temperature stress conditions is mainly due to the slowing of carbohydrate metabolism and thus a reduction in energy

(heat) production in order to keep animals' body temperatures (Koluman-Darcan et al., 2013).

Precautions to Reduce Heat Stress

Precautions that can be taken to reduce heat stress must be practical and economical before anything else.

- Selecting an appropriate breed
- Providing shelter space in Animal barn
- Control of water quality and temperature
- Addition of vitamins and minerals to foods
- Restrictions on carriage
- Rectal temperature monitoring
- Feeding (Proper Ration Preparation)
- Ventilation and shower effect (Evaporative cooling)
- Change of feeding hours
- To take care of the cleanliness of the barns
- Wetting of roughage
- Cold Water Supply
- Use of Some Feed Additives

CONCLUSIONS

The most important climatic stress source in animals is temperature and proportional humidity, and these two factors cause different effects on the ruminants. According to this, when the temperature is high, the humidity of the air is high, which makes it very difficult for the animals to have balanced body heat. The adverse effects of environmental conditions are more important in intensive production conditions, especially in high yielded animals.

The highest yield expected those animals may be possible if appropriate environmental conditions are provided. In the summer months when temperature stress is observed, careful regulation of rations will increase the profitability of the enterprise because it prevents less damage to the farm animals from the heat as well as prevents losses in production.During these periods, some arrangements should be made to prevent the negativity of the factors that cause the heat stress.

As a result, optimum environmental conditions must be met in order to obtain the highest yield from ruminants

REFERENCES

Akman N. 1998. Pratik Sığır Yetiştiriciliği. Türk Ziraat Mühendisleri Birliği Vakfı Yayını. Ankara.

Al-Haidary A., 2004. Physiological responses of Naimey sheep to heat stress challenge under semi-arid environments. International Journal of Agriculture & Biology, 6(2):307–309.

Dinçel D, Dikmen S., 2013. Süt sığırlarında sıcak stresinin tespiti, verim özellikleri üzerine etkileri ve korunma yöntemleri. Uludag University J. Fac. Vet Med 2013; 32:19-29.

Fuquay J.W., 1981. Heat Stress as it Affects Animal ProductionJournal of Animal Science, Publication, Vol.52(1):164-17

Jones, G.M., Stallings, C.C., 1999. Reducing heat stres for dairy cattle. Virgina Cooperative Extention. Publication Number 404-200. Virginia Polytechnic Institute and State Universty.

Koluman, Darcan, N., Daşkıran, İ., Şener, B. 2013. Entansif Sistemde Yetiştirilen Keçilerde Sıcaklık Stresinin T4 (Tiroksin), T3 (Triiyodotironin), Kortizol Hormonları Üzerine Etkileri. Journal of Tekirdag Agricultural Faculty, 10 (3).

Marai, I.F.M., El-Darawany, A.A.,. Fadiel, A., Abdel-Hafez, M.A.M. 2007. Physiological traits as affected by heat stress in sheep, Vol. 71(1–3):1–12

Mellado M., Sepulveda E., Meza-Herrera C., Veliz F.G., Arevalo J.R., Mellado J., 2013. Effects of heat stres on reproductive efficiency of high yielding Holstein cows in a hot-arid enviorment. Revista Colombiana de Ciencias Pecuarias, 26(3):193-200.

Özkütük, K., 1990. Hayvan Ekololojisi Ç.Ü.Z.F. Ders Kitabı. No:79, 136 s. Adana

Polat H., Dellal G. 2008. Ankara keçisi oğlaklarında tiroit hormonlarının serum düzeylerinin değişimi. Ankara Üniv. Tarım Bilimleri Dergisi, 14(1): 70-73.

Roussel, S., Hemsworth, P. H., Leruste, H., White, C., Ponter, C. D., Nowak, R., Boissy, A. 2006. Repeated transport and isolation during pregnancy in ewes: Effects on the reactivity to humans and to their offspring after lambing. Appl.Anim.Behav.Sci., vol. 97: 172-189.

Srikandakumar, A.., Johnson, E.H., Mahgoub, O. 2003. Effect of heat stress on respiratory rate, rectal temperature and blood chemistry in Omani and Australian Merino sheep Small Ruminant Research, Vol.49(2):193-198

Schüller L.K., Burfeind O., Heuwieser W., 2014. Impact of heat stres on conception rate of dairy cows in the moderate climate considering different temperature-huminidity index thresholds, periods relative to breeding, and load indices. Theriogenology, 81(8):1050-1057.

Smith, J., Dunham, D., Shirley, J., Senior, M.M., 1998. Coping with summer weather: dairy management strategies to control heat stress. Kansas State University. Agricultural Experiment Station and Cooperative Extension Service. MF-2319.

St-Pierre, N.R., B. Cobanov, G. Schnitkey, 2003. Economic losses from heat stress by U.S. livestock industries. J. Dairy Sci. 86:(E. Suppl.):E52-77.

West J.W., 2003. Effects of heat-stress on production in dairy cattle. Journal Dairy Science 2003 Jun, 86(6):2131-44. Review.

Yorulmaz, E., 2014. Koyunlarda Stresle İlgili Bazı Fizyolojik Parametrelerin Mevsimsel Değişimi. Adnan Menderes Üniversitesi Fen Bilimleri Enstitüsü Zootekni Anabilim Dalı Yüksek Lisans Tezi (Master Thesis), 2014-Yl-020 Basılmamış.

Young, B.A. 1983. Ruminant cold stress: effect on production. J Anim Sci., 57(6):1601-7

Yousef, M. K., 1985. Stress physiology: Definition and terminology. In: YOUSEF, M. K. (ed.). Stress physiology in livestock, Basic principles, Vol. 1, 3-8. Boca Raton, Florida: CRC Press.