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Araştırma Makalesi

Cooling For Non-Lactating Ewes to Alleviate the Thermal Heat Stress

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Abstract

The aim of this experiment was to determine, showering and ventilating effects on non-lactating ewes for relieving heat stress in subtropical climate conditions. Sixty crossbred non-lactating Çukurova Assaf ewes (75% East-Friesian +25% Awassi) in Sheep Research Farm of Cukurova University were selected according to their ages, and assigned into three different treatments: one time shower (OTS), two times shower (TTS) and not showered (Control). Two treatment groups were ventilated from 8.00 am to 6.00 pm, while Control group was not ventilated. The physiological data such as rectal temperature, respiration and pulse rate, and skin temperatures (from head and udder) were recorded 3 times a day (8^{00}-9^{00}; 16^{00}-17^{00}; 24^{00}-01^{00}). It has been concluded that, depending on the air temperature, head temperatures, udder temperatures, respiration rates, rectal temperatures and pulse rates of control group increased during the day and, decreased to the normal level at night. Additionally, interactions effect (group x times) was significant for rectal, head and udder temperatures of experimental ewes. In conclusion, shower application two times per day during the experimental period days could be effectively used to eliminate heat stress in sheep husbandry.

Key words: Ewes, thermal stress, ventilation and showering, adaptation

Termal Sıcaklık Stresini Önlemek Amacıyla Koyunların Serinletilmesi

Özet

Bu çalışma, duş ve fanla serinletmenin sağmal olmayan koyunlar üzerine etkisini belirlemek amacı ile yürütülmüştür. Çukurova Üniversitesi Koyunculuk Ünitesinde bulunan 60 melez Çukurova Assaf koyunu (75% East-Friesian +25% İvesi) yaşları dikkate alınarak seçilmiş ve üç deneme grubuna ayrılmıştır; bir kez duş uygulanan (OTS), iki kez duş uygulanan (TTS) ve kontrol (Control). İlk iki grup hergün 8.00 ile 18.00 arasında fanla da serinletilmiştir. Günde 3 kez 8 saat ara ile (8^{00}-9^{00}; 16^{00}-17^{00}; 24^{00}-01^{00}) koyunların rektal sıcaklık, solunum ve nabız hızı, deri sıcaklığı (baş ve memeden) gibi fizyolojik özellikleri belirlenmiştir. Atmosfer sıcaklığına parallel olarak serinletilmeyen koyunların serinletilen koyunlara göre kafa derisi sıcaklığı, meme derisi sıcaklığı, solunum hızı ve nabız hızı ve rektal sıcaklık gün içinde önemli düzeyde artmış ve gece saatlerinde normale dönmüştür. İnteraksiyon etkisi (grup x saat) rectal sıcaklık, kafa sıcaklığı ve meme sıcaklığı açısından önemli düzeydedir. Sonuçlar irdelendiği zaman günde iki kez duşun koyunlarda sıcaklık stresini engelleme açısından önemli olduğu belirlenmiştir.

Anahtar kelimeler: Koyun, termal stres, duş ve fan, adaptasyon

Introduction

Sheep are almost dual purpose animals and they are maintained under extensive grazing conditions. In some management practices, ewes are allowed to graze for 3-4h. in the morning and again in the afternoon. But it is also common to keep them in pastures all day long (Hernandez-Ledezma, 1987). Livestock production is thought to be adversely affected by detrimental effects of extreme climatic conditions. Consequently, adaptation and alleviation of detrimental effects of extreme climates has played a key role in the assessment of climatic impact in livestock production (Khalifa, 2003).After exposure to heat stress, the animal body acts in response to keep the body temperature steady. First, some physiological processes are activated to increase the rate of heat loss. If the stress period lasts for a long period of time and physiological processes fail to alleviate the individual from heat stress, then there is a tendency to reduce the production of heat. Not only physiological but also anatomical and behavioral modifications must be met by the species to adapt to the environment if they are to survive and produce efficiently (Hernandez-Ledezma, 1987). The bioclimatic or weather and biological environment of domestic animals may be optimal or may impose varying degrees of constraint on normal physiological functions and performance of the animal, depending largely on the breed or individual physiological characteristics. Many important environmental factors affect an animal's physiology (Johnson, 1987). Whatever the case, some cooling practices are designed to protect from climatic factors in farm animals. Research on-farm demonstrations have shown that micro-sprinklers, spray jets and ventilation (fan cooling systems) can be effective in relieving heat stress in farm animals under hot and humid conditions. The sprinklers create droplets that wet the animal's hair coat to the skin. Fans are used to force air over the animal's body causing evaporative cooling to take place on the skin and hair coat. Ventilation picks up the heat which animal produce and carries it away (Turner et al., 2004). There are several methods available that can reduce air temperatures under outside ambient temperatures. The most familiar is mechanical air conditioning. This method can increase milk production and fertility but generally is too expensive to use in commercial dairy operations. A more economical method is evaporative cooling. Evaporative cooling works by using energy from the air to evaporate water (Bucklin et al., 1991).

June and August are the hottest months of the year in East Mediterranean region of Turkey. The aim of this experiment was to find out how different showering applications for cooling affect the non-lactating ewes in subtropical climate conditions during this period.

Material and Methods

The animal materials of this experiment were sixty crossbred Cukurova Assaf ewes (75% East-Friesian +25% Awassi) raised at Sheep Unit of Research Farm of Cukurova University. They were kept in group pens separated by walls in the same paddock. All animals were group-fed on concentrate (12 % crude protein and 2300 kcal ME in kg DM), corn silage, alfalfa hay and oats. The ewes were 2 years old and had not been inseminated. The average daily temperature was 29.2° C while the highest and lowest temperatures were 42° C and 23.1° C, respectively. Average relative humidity and wind speed were 86 % and 1.2 km/h respectively during the trial. The sheep Research Farm of Cukurova University is in Adana, located in the East Mediterranean region of Turkey. Sixty ewes were selected according to their ages and randomly assigned to one of three treatments (twenty ewes in each group): one time showering, two times showering and the control group during the experimental period. The first group (Group OTS) was sprayed only one time a day (from 11.00 to 12.00) while the second group (Group TTS) was sprayed two times a day (at 10.00-11.00 and 14.00-15.00). Both groups were ventilated from 8.00 am to 6.00 pm. The Kentucky system was performed for cooling the ewes (Bucklin et al., 1991). The control group was neither ventilated nor sprayed. The experiment was started on the 1st of July and ended on the 31st of August 2005. The physiological data such as rectal temperature, respiration rate, pulse rate, head and udder skin temperatures (from head and udder skins) were recorded 3 times a day (morning 8^{00}-9^{00}; afternoon ; 16^{00}-17^{00}; midnight 24^{00}-01^{00}). Rectal temperatures were detected by digital temperature and the respiration and pulse rate was collected using stethoscope. Skin temperatures were recorded by infrared thermometer. At the beginning of the experiment, some body measurements of experimental ewes were analyzed using a completely randomized design, one-way ANOVA by SPSS computer software package program. The mathematical model for rectal temperature, udder and head skin temperature is given as: $\hat{Y}_{ijk} = \mu + \alpha_i + \beta_j + \alpha\beta_{ij} + e_{ijk}$; where $\hat{Y}_{ijk}$: observed value of trait, μ : mean of population, α_i : the effects of treatments, β_j : the effects of time, $\alpha\beta_{ij}$: the effects of interaction between treatment and time, e_{ijk} : residual error. The differences were tested using Duncan's Multiple Range Test (SPSS 10.0 version, 1999). Also, respiration and pulse rates were analyzed using Friedman's test. The differences were tested using Dunn's test.

Results and Discussion

Detailed data on daily changes in the body surface temperature (udder and head skin temperatures) rectal temperature, respiration and pulse rates, in response to different cooling methods are given in Table 1. The differences among rectal temperatures (P=0.05), udder temperatures (P = 0.03), head temperatures (P = 0.05), respiration rates (P = 0.03), and pulse rates (P = 0.04) of the three groups were significant. Head temperatures, udder and rectal temperatures, respiration and pulse rates increased during the day and decreased to normal level at night. Interactions of groups and times were found to be significant in rectal (P = 0.05), head (P = 0.05) and udder temperatures (P = 0.03) as well. It can be said that, rectal, head, udder temperatures and respiration and pulse rates of TTS ewes were much lower among three groups. This finding corresponds with results reported by Knizkova et.al. (2002); a change in thermal conditions will promptly trigger a vascular response in the skin that will result in higher or lower heat losses of the individual. Correlation coefficients between some physiological characteristics and body measurements of the animals were given in Table 2. Hair length of different animals varies tremendously in their ability to resist environmental effects. As seen in Table 2 physiological parameters could be affected by the morphological traits of ewes.

Table 1. The average measurements and daily trends of physiological parameters

Treatment[1]	Time	Parameters				
		RT (°C)	HT (°C)	UT(°C)	RR (Per/min.)	PR (Per/min.)
Controla	08.00-09.00b	39.19 ± 0.035b	33.87 ± 0.359c	36.29 ± 0.080b	50.70 ± 2.001 b	56.90 ± 1.632 b
	16.00-17.00a	39.71 ± 0.075a	37.84 ± 0.348a	37.65 ± 0.198a	60.62 ± 2.121 a	60.40 ± 1.842 a
	24.00-01.00b	39.62 ± 0.069a	33.75 ± 0.417c	34.13 ± 0.207d	47.10 ± 1.314 c	56.50 ± 0.953 b
OTSb	08.00-09.00	39.19 ± 0.050b	33.88 ± 0.135c	36.16 ± 0.169b	45.46 ± 0.787 c	53.40 ± 1.326 c
	16.00-17.00	39.25 ± 0.065b	37.80 ± 0.247a	37.39 ± 0.290a	50.58 ± 0.743 b	55.56 ± 1.532 b
	24.00-01.00	39.23 ± 0.051b	30.50 ± 0.143d	33.98 ± 0.194d	43.80 ± 0.530 d	53.56 ± 1.264 c
TTSc	08.00-09.00	38.91 ± 0.043c	33.62 ± 0.171c	35.19 ± 0.447c	43.62 ± 1.308 d	52.38 ± 0.843 c
	16.00-17.00	38.95 ± 0.062c	34.61 ± 0.140b	37.22 ± 0.158a	47.92 ± 1.323 c	54.96 ± 0.793 bc
	24.00-01.00	39.22 ± 0.047b	30.95 ± 0.182d	34.71 ± 0.268cd	43.32 ± 1.199 d	53.24 ± 1.198 c
SEM		0.015	0.051	0.034	0.313	0.401
Effects	Treatment	*	*	*	*	*
	Time	ns	*	**	**	*
	Interaction (Treat. x time)	**	**	**	-	-

[1]**:** Differences were illustrated on treatments for RR and PR as a, b, c
*: P<0, 05, ** : P<0,01, ns: not significant
(RT : Rectal Temperature, HT : Head skin temperature, UT: Udder skin temperature, RR: Respiration rate, PR: Pulse rate)

Table 2. Correlation coefficients between some physiological characteristics and body measurements

Traits	Pulse rate (per/min.)	Respiration rate (per/min.)	Skin temperature (udder, °C)	Skin temperature (head, °C)	Rectal Temperature (°C)
Body length (cm)	-0.131	-0.130	-0.167	-0.042	-0.371*
Height of wither (cm)	0.102	0.015	-0.231	-0.174	-0.023
Height of rump (cm)	0.247	0.159	-0.496*	-0.289	-0.255
Live weight (kg)	0.435*	0.017	0.610**	0.682**	0.655**
Hair length (cm)	0.310*	0.373*	0.380*	0.429*	0.470*
Thickness of skin (cm)	0.218	0.404*	0.392*	0.399*	0.413*
Chest depth (cm)	0.176	0.193	0.528**	0.438*	0.425*
Hearth girth (cm)	-0.028	-0.068	-0.587**	-0.167	0.238

According to data obtained, positive significant correlation was found between pulse rates of ewes and live-weight and thickness of skin. The large size is an advantage because of the smaller relative surface. This is an advantageous situation when there is direct exposure to radiant heat, and where the ambient temperature is above body temperature (Devendra, 1987). Our findings support Devendra's (1987) statements. There were positive and significant correlations found between hair length, thickness of skin and respiration rates of ewes. According to Finch (1976), metabolism is about one-third of the total heat load in an animal in a hot radiant environment. Thus, the ability of animals to remove metabolic heat is extremely important for the maintenance of a steady body temperature. The ease, with which metabolic-heat is moved to the skin for dissipation, depends on the amount of heat transferring in the blood from the body core to the skin. If skin temperature approaches core temperature, resistance to heat removal must decrease; otherwise, heat will accumulate, increasing the total body temperature. In the present study, the surface temperatures of TTS ewes were lower than the core temperatures. It was observed that the sprayed and ventilated ewes showed ability for higher resistance to internal heat transfer than did the OTS ewes. There was significant and positive correlation between skin temperatures and live weight, hair length, thickness of skin and chest depth of ewes. Apart from the body length, there were positive and significant correlation between morphological traits and rectal temperatures of ewes. Only body length has a negative correlation with rectal temperatures. Body length leads to an increased surface area of the body: if an animal has a longer body, they are able to dissipate much more body heat. When body length increased, rectal temperatures decreased. In essence, the ability of the animal to dissipate its body heat to the environment may be attributed to the direct effect of the spray and fan treatment on the animals. Our observations show that different showering applications positively affect the physiological parameters of ewes. Additionally, showering two times per day on hot summer days should be used effectively to eliminate heat stress in sheep production. Such adjustments, as well as their ambient, need to be taken into consideration in order to obtain the desired performances.

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References

Bucklin, R.A., Turner, L.W., Beede, D.K., Bray, D.R., Hemken, R.W. 1991. Methods to relieve heat stress for dairy cows in hot, humid climates. Applied Engineering in Agriculture 7(2): 241-246.

Devendra, C. 1987. Goats. Bioclimatology and the Adaptation of Livestock. Elsevier Publ., Amsterdam, 157-167.

Finch, V.A.1976. An assessment of the energy budget on Boran Cattle. J. Thermal Biology 1: 43-47.

Hernandez Ledezma, J. J. 1987. Sheep. Bioclimatology and the adaptation of livestock. Elsevier Publ., Amsterdam, 169-179.

Johnson, H.D. 1987. Bioclimate effects on growth, reproduction and milk production. Bioclimatology and the Adaptation of Livestock. Elsevier Publ., Amsterdam, 35-57.

Khalifa H.H. 2003. Bioclimatology and adaptation of farm animals in a changing climate. In: Interactions between climate and animal production, EAAP Technical Series, 7: 15-29.

Knizkova, I., Kunc, P., Koubkova, M., Flusser, J., Dolezal, O. 2002. Evaluation of naturally ventilated dairy barn management by a thermographic method. Livestock Production Science 77: 349-353.

Turner, L.W.,Warner, R.C., Chastain, J.P.2004. Micro-sprinkler and fan cooling for dairy cows: practical design considerations. Cooperative Extension Service, University of Kentucky, College of Agriculture, 6: 1-7.