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Spraying Effects on Goat Welfare in Hot and Humid Climate

[1]Nazan Darcan, [2]Fatin Cedden and [1]Okan Guney
[1]Department of Animal Science, Faculty of Agriculture, Cukurova University, 01330 Adana, Turkey
[2]Department of Animal Science, Faculty of Agriculture, Ankara University, Ankara, Turkey

Abstract: Heat stress is one of the major factors adversely affecting animal welfare and thus economic benefits of farms. This study was designed to determine the effects of three different spraying methods on goats for reducing heat stress. Thirty goats divided into three groups for the trial (One time sprayed a day: OTS, Two times sprayed a day TTS and Non-sprayed: Control). Respiration and pulse rates, rectal and surface temperatures (from head and udder skin) were taken three times a day (08.00-09.00, 16.00-17.00 and 12.00-01.00) on hot summer days in July-2005 under Mediterranean conditions. Some behavioural aspects such as eating, ruminating, drinking, walking and resting, daily feed and water consumption were regularly measured. The results showed that rectal temperatures ($p \leq 0.005$), pulse ($p \leq 0.054$) and respiration rates ($p \leq 0.049$), udder ($p \leq 0.041$) and head temperatures ($p \leq 0.033$) in three groups were significantly different. Depending on rising air temperature, rectal, head and udder temperatures and respiration and pulse rates increased during daytime and retired to normal level at night time. TTS goats were superior to the others regarding above-mentioned physiological data. TTS goats spent more time than OTS and Control goats while eating ($p \leq 0.02$), ruminating ($p \leq 0.04$) and walking ($p \leq 0.01$) but less time while drinking ($p \leq 0.01$) and resting ($p \leq 0.01$). Significant changes between three groups were ascertained regarding feed and water consumptions. TTS goats consumed more concentrate feed ($p \leq 0.042$) and alfalfa hay ($p = 0.032$) than other two groups, whereas Control groups consumed more water ($p \leq 0.012$) than the others. Ultimately, the spraying has positive effects on yearling goats for alleviating heat stress and improve animal welfare.

Key words: Goat, thermal stress, spraying, animal behaviour, physiological features

INTRODUCTION

Heat stress in animals causes decreases in feed intake and efficiency, in extreme cases, it can even cause death. These losses amount to millions of dollars each year. In July, 1999, a heat wave killed over 5000 heads of cattle in north-east Nebraska. A subsequent analysis of the death losses was performed to identify the risk factors attributed to loss of the individual animals[3]. Alleviation of the heat load by providing suitable feeding, housing and management could help heat-stressed animals, to express their genetic potentialities, in tropical and subtropical areas[1]. There are several means available to reduce heat stress on livestock. Providing plenty of clean and available water, enough shaded areas and good ventilation should be routine. These areas are the first places to concentrate if a heat stress problem is evident in the herd. Some types of cooling systems can be considered after the more routine practices are taken care of[5,16]. Housing and management technologies are available, through which climatic impacts on livestock can be reduced, but the rational use of such technologies is crucial for survival and profitability of the livestock enterprise[9]. The most economical cooling method is evaporative cooling using spray jets or mini sprinklers and fans[16]. Darcan and Guney[7] reported that the economic benefits of spraying were estimated 2.56 USD for each kid during the fattening trial in hot summer season. Panting score is an effective management tool to assist in the assessment of stress levels due to heat in grain fed cattle and should be used as part of summer management. It has the potential to be used in the assessment of the welfare status of animals[8].

From the point of view of barn ventilation and spraying management, July and August are difficult periods of the year in East Mediterranean region of Turkey because of frequent significant changes in air temperature and relative humidity. This study was

Corresponding Author: Nazan Darcan, Department of Animal Science, Faculty of Agriculture Cukurova University, 01330 Adana, Turkey Tel: +90 322 3386512 Fax: +90 322 3386576

designed to determine the effects of three different spraying methods on crossbred goats in order to decrease heat stress. Therefore, the objective of this initial study was to evaluate to thermal heat stress on goats and determine the cooling methods based on spraying and ease of use in subtropical climate conditions.

MATERIALS AND METHODS

Thirty crossbred goats (75% German Fawn +25% Hair) were studied in Dairy Goat Research Farm of Cukurova University, which is located in Adana city in East Mediterranean region of Turkey. The climate of the region is hot and humid in summer season. The average daily temperature was 29.2°C, while the highest and lowest temperatures were 42 and 23, 1°C in July, respectively. Average relative humidity and wind speed were 86.2% and 1.2 m h^{-1} during the trial, respectively. Goats were 1.5 years old and had not been inseminated. Goats were selected from an initial group of 10 individuals, based on their ages and randomly assigned to two treatments and one control: one time sprayed, two times sprayed and control (no sprayed) during experimental period. These 10 goats in each group were kept into individual pens of 1.30×1.30 m as two heads for each. The first group (Group OTS) was sprayed once a day (from 11.00 to 12.00), the second group (GroupTTS) was sprayed twice a day (at 10.00-11.00 and 14.00-15.00) while third group was not sprayed (C). The Kentucky system was performed for cooling[4]. The physiological data (rectal temperature, respiration and pulse rates, skin temperatures from head and udder) were recorded 3 times a day (morning 8^{00}-9^{00}, midday, 16^{00}-17^{00}, midnight 24^{00}-01^{00}). Rectal temperatures were detected by digital thermometer and the respiration and pulse rates were recorded using stethoscope. Skin temperatures were measured via infrared thermometer (Testo BP-960) at a distance of 10 cm. from the head and udder skin. Additionally, daily food consumptions were detected and some of the activities of these animals were observed and classified as eating, ruminating, drinking, resting, walking and others. Others includes such activities as playing an examining which are comparatively less significant. Behavioural observations were recorded for 24 h, twice a week by portative camera system linked directly to a computer. All animals were subjected to group fed feeding on concentrate (12 % crude protein and 2300 kcaL kg^{-1} ME), corn silage, alfalfa hay and oats. The experiment lasted 30 days, from first of July to first of August 2005. Besides, panting behaviour of the goats was observed as well. The panting scores were assigned based on visual observation of behaviour. Description of panting scores is given in Table 1[3].

Table 1: Description of panting scores

Score	Description
0	Normal respiration, 60 or less breaths min^{-1}.
1	Slightly elevated respiration, 60-90 breaths min^{-1}.
2	Moderate panting and/or the presence of drool or small amount of saliva, 90-120 breaths min^{-1}
3	Heavy open-mouthed panting; saliva usually present, 120-150 breaths min^{-1}
4	Severe open-mouthed panting accompanied by protruding tongue and excessive salivation

At the beginning of this experiment, data of experimental goats were analyzed using a completely randomized design, One-way ANOVA via SPSS computer software package programme. Rectal temperature, udder and head skin temperature data were designed using the following model, a completely randomized block design, $\hat{Y}_{ijk} = \mu + \alpha_i + \beta_j + \alpha\beta_{ij} + e_{ijk}$: where, $\hat{Y}_{ijk}$: observed value, μ: mean of population, α_i: the effects of treatments, β_j: the effects of time, $\alpha\beta_{ij}$: the effects of interaction, e_{ijk}: residual error. Khi-square methods were used for analyzing behaviour aspects of the goats. The differences were tested using Duncan's Multiple Range Test (SPSS 10.0 version, 1999). Respiration and pulse rates were analyzed using Friedman's test. The differences were tested using Dunn's test.

RESULTS AND DISCUSSION

The differences among rectal temperatures ($p = 0.005$), pulse rates ($p = 0.054$), respiration rates ($p = 0.049$), udder temperatures ($p = 0.041$) and head temperatures ($p = 0.033$) of the three groups were found significant. Additionally, significant differences were observed between daily trends of surface temperatures and physiological parameters of three groups ($p<0.05$). Depending on rising air temperature, rectal, head and udder temperatures and respiration and pulse rates increased during the daytime and turned to their normal levels at night time. Midnight measurements of pulse and respiration rates of sprayed goats were detected to be lower than those of the morning measurements. Mean diurnal rectal temperatures, pulse and respiration rates and udder and head temperatures for experimental goats are indicated in Fig. 1- 4 respectively.

Rectal temperature is an important indicator of thermal balance and might be used to evaluate the impact of heat stress[15]. Rectal temperatures of Control

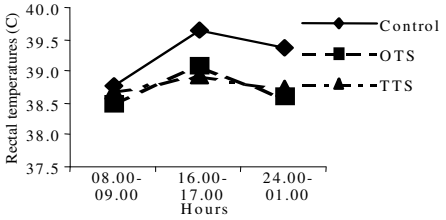

Fig. 1: Diurnal rectal temperature

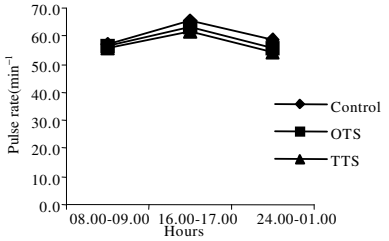

Fig. 2: Diurnal pulse rate

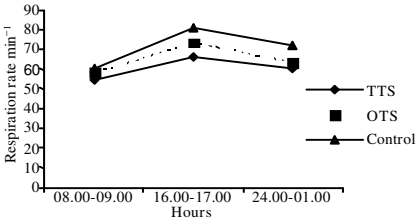

Fig. 3: Diurnal Respiration rate of experimental goats

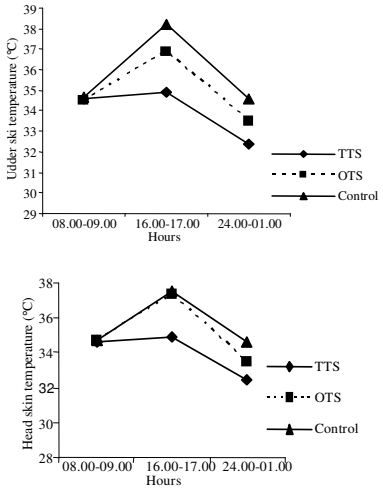

Fig. 4: Diurnal skin temperatures of experimental goats

goats increased rapidly during heat stress (+1°C) and slightly decreased midnight, while OTS and TTS increased between 0.2-0.5 at day time and turned to normal levels at midnight time (Fig. 1). However, the rectal temperatures of Control goats did not turn to normal levels until the early times in the morning. These data demonstrate that spraying increases heat loss, thus minimizing the effect of heat stress during the day.

Table 2: Daily panting score of the experimental goats

Groups	Average morning score	Average afternoon score	Average midnight score	Average daily score
TTS	0.99±0.03[a]	1.06±0.02[a]	0.02±0.01[a]	0.69±0.01[a]
OTS	1.00±0.01[a]	1.25±0.01[b]	0.04±0.01[a]	0.76±0.01[ab]
Control	1.25±0.03[b]	2.00±0.03[b]	1.00±0.02[b]	1.41±0.02[b]
Sig.	p = 0.04	p = 0.002	p = 0.001	p = 0.001

The daily trends of pulse rates of all groups were found to be almost similar (Fig. 2) and the differences were not significant ($p>0.05$). Furthermore, respiration rate of control group were higher than that of TTS and OTS ones (Fig. 3). However, respiration rates of three groups were detected to be similar at night time. Differences between morning and afternoon respiration rates exceed 5-8 units among three groups, whereas diurnal variation varied 10-18 units. In spite of increasing environmental temperatures in daytime, there were no significant changes at the diurnal respiratory rates in sprayed goats. These data were similar Darcan[6]'s findings.

Average diurnal skin temperatures are given in Fig. 4. Daily trends of udder skin temperatures of three groups were found to be almost similar ($p>0.05$) with the exception of a slight increase during day time and a decrease during night time. The differences among Control, OTS and TTS were found to be significant ($p<0.05$). TTS goats had lower skin temperatures than the others.

Panting score of the experimental goats are indicated in Table 2. The high respiration rate and panting score of the goats were attributed to a heat stress.

These results indicate that Control goats had a higher stress load, which might indicate that they were stressed in an extreme temperature situation. Considering average daily panting score, significant differences were detected between experimental groups ($p<0.01$). The daily panting scores of TTS goats were more satisfying compared to the other groups. Both panting score and respiration rate showed that the TTS goats had less stress in the daytime than that of the other groups. Panting scores obtained from sprayed goats showed an increase in daytime and turned to normal levels at midnights. As to Control, these values were invariably higher than those of sprayed ones. Especially in daytime measurements, panting scores were found to be at its highest in Control and the goats belonging to this group experienced heat stress.

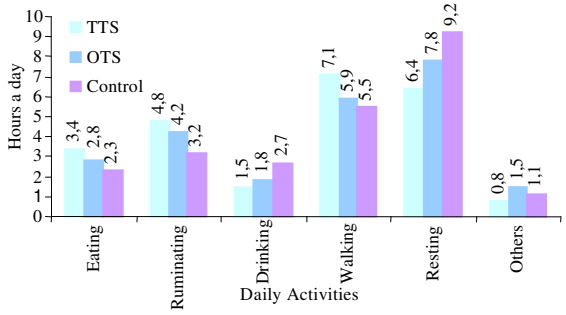

Fig. 5: Daily activities of experimental goats

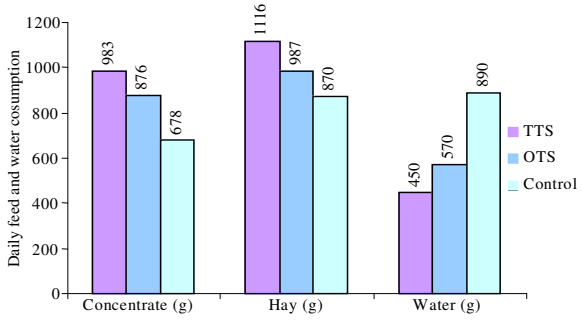

Fig. 6: Daily feed and water consumptions of goats

As indicated in Fig. 5, TTS goats spent more time than OTS and Control goats during the activity of eating ($p = 0.023$), ruminating ($p = 0.042$) and walking ($p = 0.018$) but less time during drinking ($p = 0.015$) and resting ($p = 0.011$). During heat stress, eating and resting behaviours decreased, whereas drinking and standing behaviours increased. Spraying had positive effects on activities and feeding behaviour of goats. During heat stress, eating behaviour (21-48%), ruminating (31-50%), walking (7-33%) decreased, while drinking (50-80%) and resting (18-43%) increased. These results seem to support the reports of different researchers[3,11,12].

Figure 6 shows the feed and water consumption of experimental goats in a day. Significant changes between the groups were ascertained in terms of feed and water consumptions. TTS goats consumed more concentrate feed ($p = 0.042$) and alfalfa hay ($p = 0.032$) than other two groups, while Control groups consumed more water ($p = 0.012$) than the others. According to Beede and Collier[2], water requirement of the animal was highly influenced by the demands of maintaining homeothermy during heat stress. At this time, the water requirement of animals increases, leading to more frequent drinking in response to rising ambient temperatures. Obtained results were in harmony with the reported findings in the literature[2,10,13,14].

CONCLUSION

Normally, it is difficult and expensive to maintain the welfare of farm animals under hot and humid weather conditions. There are a few cooling methods used to accomplish desired welfare in animals. Spraying, which is economically more viable, is one of the commonest methods benefited by animal keepers to cool off livestock in hot and humid climates. It can enhance animal welfare and rearrange some of the animal behaviours, which may be reflected in the productivity.In this study, the effects of the spraying method on physiological and behavioural aspects of goats were examined. The spraying was found to be very effective on the experimental goats: Sprayed goats did not experience stress, while control did. The respiration rates, panting scores, rectal and skin temperatures of the sprayed goats were found to be within normal levels, whereas they were significantly high in control. The observations on the animal behaviours revealed that heat stressed goats spent less time for eating, walking, ruminating but more time for resting and drinking. As to the sprayed goats, their behaviours were observed to be similar to those seen in comfort zone due to the minimized thermal stress: Their feed intake and physical activities were higher compared to those of Control ones, while their water consumption was within normal range. It was found that two times spraying is much more effective in order to comfort the animals under heat stress. Our results, in harmony with the literature, suggest that under hot and humid weather conditions, spraying has positive effects in order to alleviate heat stress and improve goat welfare and should be performed at least one time to reach the desired result.

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