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Effect of the Cooling Systems and Shearing During the Summer Season on the Performance and Productivity of Farafra Ewes and their Offspring

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Abstract

THIS study was conducted to evaluate the effect of cooling systems and shearing on performance, behavior response, and physiological parameters of Farafra ewes and their offspring. Forty-two ewes during late pregnancy and their 34 newborns after birth were divided in the same sheds into six groups. control (unshorn + under normal conditions); T1 (unshorn + fan treatment); T2 (unshorn + desert cooler treatment); T3 (shorn + under normal conditions); T4 (shorn + fan treatment); and T5 (shorn + desert cooler treatment). The desert cooler and fans operated manually from 8:00 AM to 6:00 PM. The meteorological measurements, body weight, and physiological parameters were recorded once every two weeks. The milk production and behavior were recorded on a weekly basis. The results showed that ambient cooling lowers the temperature and temperature humidity index (THI) in the barns compared with the non-cooled barns ($P \leq 0.05$). Respiration rate, rectal temperature, wool temperature, skin temperature, and ear temperature were significantly reduced ($P \leq 0.05$) in treated with cooling + sheared ewes and lambs than those of the unshorn uncooled. Rumination and lying time increased when shorn ewes and lambs were cooled. While panting and standing time significantly reduced ($P \leq 0.05$) relative to the unshorn and uncooled. Milk yield and milk composition in ewes and daily weight gain in lambs improved in all treatment groups in comparison with control. It can be concluded that the provision of the desert cooler with shearing in sheep created a better microenvironment for ewes and their offspring, leading to improve its productivity.

Keywords: Farafra sheep, Cooling systems, Shearing, Behavior, Physiological parameters.

Introduction

A crucial area of animal husbandry, sheep production plays a significant role in many nations, albeit it varies according to market demand. Because of their behavioral characteristics and great degree of environmental adaptability, sheep have long been raised by communities for their meat, milk, and wool [1].

The Egyptian climate is characterized, with two main seasons: a hot summer from May to October, with temperatures varying between 30°C in Alexandria and 45°C in Aswan, and a cold winter from November to April [2]. Thermal impacts on sheep performance and health are most profound when temperatures drop below 12°C (lower critical temperature) or rise above 25 to 31°C (upper critical temperature) [3]. Stress is a reflexive reaction that can have a lot of bad repercussions and is brought on by an animal's incapacity to cope with the negative impacts of many variables and its difficulties adapting. [1]. Therefore, sheep experience heat stress for approximately six months each year, which causes a number of physiological and biochemical alterations due to increased heat generation and decreased heat dissipation. These changes include increased water intake, decreased feed intake and efficiency, enzymatic activity, and hormone secretion, all of which impair immunity and increase the likelihood of disease outbreaks [4].

Furthermore, the decrease in milk production leads to a reduction in female fertility and embryo quality and sperm quantity and quality [3]. Therefore, used cooling systems are a dire need for

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livestock's thermal comfort for different applications, particularly at low levels in underdeveloped nations, in order to ensure their thermal comfort [5]. Under heat stress, milk yield can drop by 40–50%, while it might only drop by 10% in cooled farms [2]. In addition, wool shearing is another management strategy that may have an impact on sheep growth success. It would improve growth performance and potentially boost environmental adaptability [6]. Also, shearing ewes raises their feed intake, the birth and weaning weights of their lambs, and their milk yield without changing the composition of their milk [7]. However, because sheep's wool blanket isolates them, direct evaporative cooling is useless for cooling them.

Thus, evaporative cooling and shearing wool might be a better method of cooling sheep [8]. Therefore, the objective of our study was to determine the effect of cooling systems and shearing on productive performance, behavior and physiological parameters of Farafra ewes and their offspring.

Material and Methods

This study was carried out at the Mallawi Animal Production Research Station which, (317 km south of Cairo), belonges to Animal Production Research Institute (APRI), Egypt. during the period from April 2024 to September 2024.

Animals, treatments and cooling regime

Forty-two adult ewes aged 2–3 years were weighed on day 90 of their pregnancies, stratified by live weight and then randomly allocated into six treatment groups. 1st group (unshorn + under normal conditions) (control); 2nd groupT1: (unshorn + fan treatment); 3rd group T2: (unshorn + desert cooler treatment); 4th group T3: (shorn + under normal conditions); 5th group T4: (shorn + fan treatment); 6th group T5: (shorn + desert cooler treatment). All the sheep are kept in hygienic conditions in well-ventilated shelters with concrete corrugated roofs and cement and brick walls that are four meters high. The desert cooler was placed at the floor level, and fans were placed 2.5 m high from the animal for experimental groups, respectively. The desert cooler and fans operated manually from 8:00 AM to 6:00 PM according to [9]. Ewes were fed according to their nutritional requirements as pregnant ewes as detailed in [10], with DM being supplied via concentrate feeding, wheat straw, and green fodder/silage. Every animal was housed in the same experimental shed under comparable conditions, with the same food schedule.

Suckling lambs

After being born, thirty-four lambs—sixteen male and eighteen females were split up into the same groups as their mothers. All the suckling lambs were kept in the same experimental house with their dams, the same treatments regime.

Meteorological measures

The barn's temperature (T, $^{\circ}$C) and relative humidity (RH, %) were measured using a digital thermo-humidity meter (HTC1, China). The measurements were taken at 1:00 to 3:00 p.m. in the center of the shed at a height of one meter. To determine the temperature humidity index, the following formula was utilized. (THI; [11]):

$$THI = (1.8 \times T^{\circ}C + 32) - [(0.55 - 0.0055 \times RH) \times (1.8 \times T\,^{\circ}C - 26)]$$

Where THI: Temperature-Humidity Index T, $^{\circ}$C: average ambient temperature ($^{\circ}$C) and RH: relative humidity (%).

Physiological measurements of ewes and their suckling lambs

Physiological parameters were measured biweekly. Respiration rate (RR) was measured by visual counting of flank movement in one minute. Rectal temperature (RT, $^{\circ}$C) was measured by a clinical thermometer; wool temperature (WT, $^{\circ}$C), skin temperature (ST, $^{\circ}$C) and ear temperature (ET, $^{\circ}$C) were measured using a handheld infrared thermometer. (model 22-325, Radioshack company, USA) according to Al-Ramamneh [12].

Behavioral measurements of ewes and their suckling lambs

The behavioral measures were recorded for ewes and lambs using cameras attached to walls in a shed from 8:00 to 18:00 h during data collection days. These behavioral measurements are defined in Table (1).

Milk production, sampling and analysis of ewes

Milk production during the suckling period was measured once every week by using the milk suckling technique reported by Abd-El Moty *et al*. [13]**.** Milk samples (100 mL) of each ewe were taken to measure milk composition (fat, protein, lactose, solids-non-fat, total solids) according to Inostroza *et al.* [14].

Body weight and body weight gain of suckling lambs

Live body weight of suckling lambs was recorded early in the morning, biweekly for three months, and daily weight gain was calculated, ensuring accurate monitoring of their health in accordance with Kalyan *et al*. [15].

Statistical analysis

Data were statistically analyzed as a completely randomized design using the general linear model (GLM) procedure (SAS, 2008) for Windows (2010). The level of statistical significance was set at $P \leq 0.05$. The model used in statistical analysis was. $\mathbf{Y_{ij} = \mu + Ti + e_{ij}}$

Where: **Yij** = the studied trait; **μ** = the overall mean; **Ti** = the effect of the ith treatment (i=1, 2, 3); **eij** = represents the experimental error.

The differences among means were tested using Duncan`s Multiple- range test [16].

Results

Meteorological conditions

The average air temperature (°C), relative humidity and (THI) during the experimental period are summarized in Table 2. The average air temperature in the barns that were cooled by fans and a desert cooler was lowered, either in shorn or unshorn, by 4.8°C and 1.3°C, then those in the uncooled barns (P≤0.05) whether shorn or unshorn, respectively. There is a slightly increased in air humidity by 13.7% in the barns cooled by desert cooler either in shorn or unshorn, then all experimental treatments. The temperature-humidity index (THI) decreased by 4.5° and 1°C units for barns cooled by desert coolers and fans, whether shorn or unshorn, compared with the uncooled barns (P≤0.05), whether shorn or unshorn, respectively.

Physiological parameters of ewes

Data in Table (3) showed the effect of cooling systems and shearing on respiration rate (RR), rectal temperature (RT), wool temperature (WT), skin temperature (ST) and ear temperature (ET) The application of a cooling regime and shearing of ewes resulted in a decrease in their respiration rate by 8.5%, 7.4%, 6.9%, 6% and 2%, respectively, and reduced their rectal temperature by 0.4°C, 0.3°C, 0.3°C, 0.2°C and 0.2°C, in T5, T4, T2, T1 and T3 (P≤0.05) respectively compared to the control group. The wool temperature was higher in CON ewes, followed by T3, T1, T2, T4, then T5. Cooling reduced skin temperature in both the T5 and T2 groups by 0.7°C and 0.6°C, respectively, as compared to different experimental groups. The ear temperature was higher (P≤0.05) in CON ewes followed by T3 T1, T2 and T4 then T5.

Behavioral response of ewes

Table 4 describes the impact of shearing and cooling systems on sheep behavior. There was no significant difference (P≤0.05) in total feeding time between experimental groups. The total rumination and lying time were significantly higher (P≤0.05) in T5 (shorn + desert cooler) which performed better than all other treatments, followed by (unshorn + desert cooler), (shorn + fan), (unshorn + fan), (shorn + uncooled) and (unshorn + uncooled) control, in that order. The total panting and standing times were significantly (P≤0.05) lower, where the highest time was in the control group, followed by (shorn + uncooled), (unshorn + fan), (shorn + fan), (unshorn + desert cooler) and (shorn + desert cooler) in that order.

Milk production and composition of ewes

Table (5) presents the impact of treatments on the milk production and composition of ewes. The average milk yield per day was 0.2 kg/d higher in the 6th, 5th, 3rd, and 2nd groups than the 4th and control groups (P≤0.05; Table 5). Table 5 revealed significant differences (P≤0.05) among treatments in total solid yields, solid-not-fat, fat and protein. The highest percentage of total solid yields, solid-not-fat, fat and protein were observed in the 5th group, followed by 2nd , 4th , 1st , and 3th then the control group, respectively. No significant differences were observed in milk lactose content among the experimental groups.

Physiological parameters of suckling lambs

The average values of (RR), (RT), (WT), (ST), and (ET) in the experimental groups are presented in Table 6. The (RR) was significantly (P≤0.05) lower by 16%, 15.6%, 11.6%, 1.4% and 1.4%, in T2, T5, T4, T1 and T3 respectively, as compared with control. Using the desert cooler reducing (RT) and (WT) by 0.2°C and 0.1°C and 0.8°C and 0.7°C, in both shorn T5 and unshorn T2 respectively, as compared with all different experimental groups (P≤0.05). The (ST) and (ET) were higher (P≤0.05) in CON, followed by T3, T1, T4, T2, and T5.

Behavioral response of suckling lambs

The impact of cooling systems and shearing on behaviour of suckling lambs is described in Table 7. The total feeding time in experimental groups was not affected by cooling systems and shearing treatments. The total rumination and lying time was significantly increased (P≤0.05) in suckling lambs, where the T5 performed better than over all treatments followed by T2, T4, T1, T3 and control in that order. The total panting and standing times were significantly higher (P≤0.05) in CON group, followed by the T3, T1, T4, T2 and T5 in that order.

Total gain and average daily gain of suckling lambs

The impact of using cooling systems and shearing during summer on the total gain (TG) and average daily gain (ADG) of suckling lambs is described in Table 8. Total gain of suckling lambs in T5, T2, T4 and T1 was improved (P≤0.05) by about 14.4%, 11.4%, 11.4% and 11.4%, respectively, then both T3 and control. The statistical analysis revealed that (ADG) increased significantly (P≤0.05) at the 2nd week, 4th week, 6th week, 8th week, 10th week and 12th week T5, T2, T4, and T1 compared to both T3 and control. While, no notable differences were observed among the treatments for (ADG) at the 2nd week, 4th week and 6th week . Although daily weight gain tended to be higher in suckling lambs for T5, T2, T4 and T1 compared to both T3 and control, the differences were statistically not significant.

Discussion

Meteorological conditions

In the current study, the temperature and THI of ewes and their offspring were lower in sheds with desert coolers and fans, respectively. These results were consisted with previous studies of Kalyan and his colleagues [15] and Leibovich *et al.* [8] those found that the air temperature decreased by 4.1°C as a result of cooling compared with the control group. The desert cooler uses an evaporative cooling method, converting incoming air through a saturated medium. This process reduces air temperature and humidity, resulting in a decrease in (THI) in the afternoon. The fan's constant operation drives air over the sheep's body, enhancing convective heat loss and evaporative cooling, reducing ambient temperatures and facilitating heat exchange without increasing humidity [17].

Physiological parameters

The study found that the use of cooling systems and shearing effectively reduced animal heat stress. Heat stress in ruminants leads to various homeostatic responses, such as increased respiration rates, panting, and reduced heart rate. The normal resting respiratory rate for sheep is 20-38 breaths/min, but it can be significantly increased when excited [18]. The study revealed that the control group had higher average daily respiratory rates than the counterpart groups. This is consistent with a study on cattle that discovered that 1.3 L/min and 4.5 L/min water sprinkler flow rates considerably lowered respiration rate and body temperature [11]. Also, Correa-Calderon and others [19] observed that respiratory rate and body temperature of cows subjected to two methods for cooling (fan-cooled sprinklers vs. fans) were lower than those of the non-cooling cows. The body temperature of the cooling system was 0.7° and 0.9° C lower than that of the controls. Sweating, panting, and vasodilation can all increase heat loss in animals under heat stress [20]. Heat exposure increased surface temperatures in rump, neck, and ear, demonstrating vasodilation's effectiveness in heat transfer through fans' continuous operation [9].

The approximately 0.7 and 0.6 °C decreases in (ST) for both shorn and unshorn desert cooling groups in our study were comparable to the outcomes with Ahmad *et al*. [21] who found that when dairy cows were given a shower, their skin temperatures dropped by 0.7 and 0.3 degrees Celsius, respectively. It has been shown that sheep are less stressed following shearing [12], indicating that wool cover limits sheep's ability to perform in hot conditions. Control group had higher surface temperatures than air-cooled ewes, suggesting better heat absorption due to higher ambient temperatures.

The study suggests that the increased heat in animals can be transmitted through various methods, including conduction, convection, radiation, and evaporative heat loss. The increase in (RT), (WT), (ST) and (ET) in control and unshorn and fan-cooled sets groups could be explained by the increased warmth outside, which could cause the skin capillary bed to dilate, increasing blood flow to the skin's surface so that heat can be dissipated through perspiration [15]. Additionally, the high ambient temperature causes convection to transfer heat from the surrounding air to the body's lower temperature, which likewise raised the skin surface temperature in the control, unshorn, and fan-cooled sets groups [22].

Behavior response

The behavioral changes of farm animals are frequently utilized as a metric for evaluating animal welfare [23]. In this study, no significant difference ($P \leq 0.05$) in total feeding time between groups was found, which is consistent with Aguilar *et al*. [24], who found no differences in feeding time between fleece and shorn sheep that were kept in climate-controlled rooms under thermo-neutral and hot and humid environmental conditions.

The results presented here show that the cool and shorn animals had increased rumination and lying time and decreased breathing and standing time, followed by the fan-treated and shorn groups. The rams continue to be rather comfortable, which may enable them to lie down and ruminate [25]. Also, when cattle were subjected to heat stress, their rumination time significantly decreased [26]. Under heat stress, ruminants, which are active during the day and rest at night, often lie down to lessen their movement during the day [27]. Additionally, ruminants frequently stand in barns under heat stress to lower their body temperature by exposing their body surface to breeze [28] which is consistent with our results.

As the heat load increased, the animals spent less time reclining and more time standing without food, which must be regarded as a factor that negatively impacts animal welfare [29]. On the other hand, lower ambient temperature allowed sheep to transfer heat by conduction to the attached floor when they were lying down [23].

Milk production and composition

This study's results on milk production and composition align with previous research. For example, Leibovich *et al.* [8] found that providing sheared sheep with ambient cooling under heat-load situations improves the quantity and composition of their milk. In another study, Van Wettere *et al.* [3] indicated that exposing sheep to high ambient temperatures during the latter stages of pregnancy or the first few months of lactation alters the quantities of milk fat and protein and lowers their 4%-FCM output by interfering with their thermoregulatory systems and energy feed intake. According to Tresoldi *et al*. [30], Using fans and sprinklers combined increased milk production in hot weather by producing much greater evaporative cooling in cattle than either fan or sprinkler alone. Additionally, our results were in accordance with the findings of

Knight *et al.* [31] that found that shearing increases fat and protein concentration by 8-24% in milk, with an accompanying increase in total solids, and those of Elhadi *et al*. [32], who stated a 9% increase in milk fat content of Sarda ewes shorn during lactation and attributed the impact to the cold nights. Our results were inconsistent with those of some previous studies [20,33] in lactating ewes sheared, which had no discernible impact on milk production and composition. The improvement in milk production and composition between the desert cooler and fans in the current study may be due to a 4.1°C and 1.3°C decrease in air temperature, due to using the desert cooler and fans, respectively (Table 2). Also, Shearing may improve performance through adaptive metabolic changes and alterations in nutrition partitioning [34].

Total gain and average daily gain

In present study, we found significant differences in (TG) and (ADG) among all excremental groups, which are consistent with previous studies [22,27] who found that, in lambs living in thermocol-insulated houses and bamboo domes gained 0.17 kg and 0.20 kg more weight per week than the control group. Also, shearing increased ($P<0.01$) total gain and daily gain of lambs by 13.27 and 12.87%, respectively over that of the control lambs [35].

In the current study, the lambs housed in the cold shed gained more weight, which can be partially explained by their considerably ($P\leq0.05$) longer total feeding time and higher milk intake [27]. The considerably lower feed intake in terms of dry matter intake may be the cause of the decreased body weight. Furthermore, it might be the consequence of a confluence of changed metabolic and gastrointestinal physiological processes, increased energy expenditure for heat dissipation, and decreased feed intake, which collectively lead to increased tissue catabolism and decreased anabolic activity [36].

Conclusion

Based on the above results, it can be inferred that the clear enhancements in milk production, milk composition, body weight, daily weight gain, behavior measurements and physiological response of the ewes and their offspring by enhancing the thermal comfort of lactating ewes and their offspring alleviated heat stress on the animals, which could reflect the importance of supplying sheep with cooling systems and shearing, ultimately contributing to sustainable sheep production systems in challenging climatic conditions. Finally, the best treatment is a desert cooler with shearing during summer heat stress conditions.

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Author`s contribution

All researchers participated in the research equally.

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Declaration of Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical of approval

The animal study was reviewed and approved by Al-Azhar University animal ethics committee.

TABLE 1 Summary of definition of behavioral measurements of sheep according to [22].

Items	Definition
Feeding behavior	The animal was deemed to be feeding when it stood next to the feed trough and continued to eat, chew, and swallow.
Ruminating behavior	An animal is said to be engaging in ruminating behavior when it chews ruminal material. Additionally, the ruminating behavior may occur when standing or while lying down.
Standing behavior	The standing behavior indicated that the animal was in a standing condition, while the standing behavior showed that the animal was not feeding or ruminating.
Lying behavior	The animal's lying behavior indicated that it could lie in any position and may engage in other activities as well.
Panting behavior	when the animal was moving its abdomen violently and breathing quickly.

TABLE 2. Summary of meteorological measures during the study period.

Items	Treatments						p-Value
	CON	T1	T2	T3	T4	T5	
Temperature, °C	36.3±0.8[a]	35±0.7[a]	31.5±0.4[b]	36.3±0.7[a]	35±0.7[a]	31.5±0.4[b]	0.001
Humidity, %	38.0±0.8[b]	38.2±0.8[b]	44.3±1.7[a]	38.2±0.8[b]	38.2±0.8[b]	44.3±1.7[a]	0.003
THI	83.7±0.8[a]	82.7±0.7[a]	79.2±0.5[b]	83.7±0.8[a]	82.7±0.7[a]	79.2±0.5[b]	0.001

CON = unshorn + uncooled treatment. T1 = unshorn + fan treatment, T2 = unshorn + desert cooler treatment. T3 = shorn + uncooled treatment. T4 = shorn + fan treatment. T5 = shorn + desert cooler treatment. [a,b,c]Means in the same row with different superscripts are significantly (P≤0.05) different.

TABLE 3. Effect of cooling systems and shearing on some physiological parameters in ewes.

Items	Treatments						p-Value
	CON	T1	T2	T3	T4	T5	
Respiration rate, breaths/min	43.1±0.4[a]	40.5±0.5[b]	40.1±0.6[b]	42.2±0.5[a]	39.9±0.7[b]	39.4±0.4[b]	0.001
Rectal temperature, °C	39.7±0.0[a]	39.5±0.2[b]	39.4±0.1[b]	39.5±0.0[ab]	39.4±0.0[b]	39.3±0.0[b]	0.0351
Wool temperature, °C	33.7±0.0[a]	33.5±0.1[bc]	33.3±0.1[cd]	33.6±0.0[ab]	33.2±0.1[de]	33.1±0.1[e]	0.001
Skin temperature, °C	34.8±0.1[a]	34.7±0.1[a]	34.2±0.1[b]	34.7±0.1[a]	34.7±0.1[a]	34.1±0.1[b]	0.001
Ear temperature, °C	34.7±0.1[a]	34.4±0.2[a]	34.0±0.1[cb]	34.4±0.1[a]	34.0±0.2[cd]	33.6±0.1[d]	0.001

CON = unshorn + uncooled treatment. T1 = unshorn + fan treatment, T2 = unshorn + desert cooler treatment. T3 = shorn + uncooled treatment. T4 = shorn + fan treatment. T5 = shorn + desert cooler treatment. [a,b,c]Means in the same row with different superscripts are significantly (P≤0.05) different.

TABLE 4. Effect of cooling systems and shearing on behavior responses of ewes.

Items	Treatments						p-Value
	CON	T1	T2	T3	T4	T5	
Feeding time (min/10 h)	114±1.9	112±2.2	111±1.3	113±1.8	111±3.0	109±1.9	0.710
Rumination (min/10 h)	113±1.5[d]	118±1.4[cd]	123±1.4[ab]	115±2.1[cd]	119±1.3[bc]	125±1.8[a]	0.001
Standing (min/10 h)	136±3.7[a]	132±2.2[ab]	127±2.2[bc]	135±2.4[ab]	129±1.8[bc]	125±2.2[c]	0.0269
Panting (min/10 h)	58.6±1.1[a]	49.4±1.3[b]	45.4±1.6[bc]	57.0±1.1[a]	47.7±2.1[b]	43.3±1.4[c]	0.001
Lying (min/10 h)	56.6±2.0[c]	59.3±2.3[c]	65.7±1.6[ab]	57.4±2.3[c]	60.7±2.0[bc]	67.3±1.4[a]	0.014

CON = unshorn + uncooled treatment. T1 = unshorn + fan treatment, T2 = unshorn + desert cooler treatment. T3 = shorn + uncooled treatment. T4 = shorn + fan treatment. T5 = shorn + desert cooler treatment. [a,b,c]Means in the same row with different superscripts are significantly (P≤0.05) different.

TABLE 5. Effect of cooling systems and shearing on milk production and composition of ewes.

Items	Treatments						p-Value
	CON	T1	T2	T3	T4	T5	
Milk yield, kg/sheep per day	0.32±0.0[b]	0.51±0.0[ab]	0.52±0.1[a]	0.31±0.0[b]	0.51±0.1[ab]	0.52±0.1[a]	0.0409
Milk fat, (%)	3.9±0.6[b]	4.8±0.3[ab]	5.1±0.3[a]	3.9±0.1[b]	4.9±0.3[ab]	5.2±0.2[a]	0.0443
Milk protein, (%)	3.6±0.1[c]	3.8±0.1[bc]	4.0±0.1[ab]	3.7±0.1[bc]	3.9±0.0[bc]	4.3±0.2[a]	0.0147
Milk lactose, (%)	5.9±0.1	6.2±0.1	6.2±0.0	6.0±0.1	6.2±0.2	6.5±0.1	0.090
solids not fat(%)	9.5±0.1[c]	10.0±0.0[bc]	10.3±0.1[ab]	9.7±0.2[bc]	10.1±0.2[bc]	10.7±0.3[a]	0.0078
Total solids (%)	13.3±0.4[c]	14.8±0.3[ab]	15.4±0.3[a]	13.6±0.3[bc]	14.9±0.5[ab]	16.0±0.5[a]	0.0036

CON = unshorn + uncooled treatment. T1 = unshorn + fan treatment, T2 = unshorn + desert cooler treatment. T3 = shorn + uncooled treatment. T4 = shorn + fan treatment. T5 = shorn + desert cooler treatment. [a,b,c]Means in the same row with different superscripts are significantly (P≤0.05) different.

TABLE 6. Effect of cooling systems and shearing on some physiological parameters in suckling lambs.

Items	Treatments						p-Value
	CON	T1	T2	T3	T4	T5	
Respiration rate, breaths/min	49.9±0.8[a]	49.2±0.7[a]	41.9±0.6[b]	49.2±0.7[a]	44.1±0.9[b]	42.1±0.8[b]	0.001
Rectal temperature, °C	39.8±0.1[a]	39.8±0.0[a]	39.7±0.1[a]	39.8±0.0[a]	39.8±0.0[a]	39.6±0.1[b]	0.017
Wool temperature, °C	35.0±0.1[a]	35.0±0.1[a]	34.3±0.1[b]	35.0±0.1[a]	35.0±0.1[a]	34.2±0.1[b]	0.001
Skin temperature, °C	35.1±0.1[a]	34.6±0.2[a]	34.2 ±0.2[a]	34.6±0.1[a]	34.5±0.1[a]	33.6±0.1[c]	0.001
Ear temperature, °C	35.5±0.1[a]	35.5±0.6[a]	34.7±0.1[ab]	35.5±0.1[a]	35.2±0.2[ab]	34.3±0.2[b]	0.0357

CON = unshorn + uncooled treatment. T1 = unshorn + fan treatment, T2 = unshorn + desert cooler treatment. T3 = shorn + uncooled treatment. T4 = shorn + fan treatment. T5 = shorn + desert cooler treatment. [a,b,c]Means in the same row with different superscripts are significantly (P≤0.05) different.

TABLE 7. Effect of cooling systems and shearing on behavior responses of suckling lambs.

Items	Treatments						p-Value
	CON	T1	T2	T3	T4	T5	
Feeding time (min/10 h)	105±2.5	102±2.6	102±1.6	103±2.3	99.8±3.4	97.5±1.9	0.352
Rumination (min/10 h)	104±2.4[b]	107±1.6[ab]	112±1.1[a]	106±1.4[b]	109±1.4[ab]	111±2.0[a]	0.0265
standing (min/10 h)	146±4.4[a]	139±2.6[bc]	135±2.7[c]	144±2.1[ab]	137±2.1[bc]	134±1.9[c]	0.0143
Panting (min/10 h)	57.6±2.4[a]	53.2±1.4[ab]	51.8±2.1[ab]	57.4±1.5[a]	52.8±2.1[ab]	50.0±1.3[b]	0.0433
Lying (min/10 h)	53.6±2.5[c]	55.8±2.7[bc]	62.5±1.9[ab]	55.2±3.1[c]	57.2±2.2[ab]	63.3±1.2[a]	0.0262

CON = unshorn + uncooled treatment. T1 = unshorn + fan treatment, T2 = unshorn + desert cooler treatment. T3 = shorn + uncooled treatment. T4 = shorn + fan treatment. T5 = shorn + desert cooler treatment. [a,b,c]Means in the same row with different superscripts are significantly ($P \leq 0.05$) different.

TABLE 8. Effect of cooling systems and shearing on total gain and average daily gain of suckling lambs.

Items	Treatments						p-Value
	CON	T1	T2	T3	T4	T5	
2nd week (DG_1 /g)	40±0.31[b]	100±0.4[ab]	100±0.4[ab]	40±0.35[b]	100±0.4[ab]	100±0.39[a]	0.027
4th week (DG_2 /g)	100±0.37	100±0.38	100±0.40	100±0.39	100±0.44	100±0.45	0.984
6th week (DG_3 /g)	100±0.59[b]	100±0.69[a]	100±0.55[a]	100±0.69[b]	100±0.62[a]	100±0.067[a]	0.001
8th week (DG_4 /g)	100±0.84	100±0.87	100±0.81	100±0.77	100±0.89	100±0.86	0.945
10th week (DG_5 /g)	200±0.79[b]	200±0.8[ab]	200±0.80[a]	200±0.90[b]	200±0.89[ab]	200±0.9[ab]	0.038
12th week (DG_6 /g)	200±0.86	200±0.85	200±0.91	200±0.88	200±0.96	200±0.99	0.185
Total gain(kg)	10.1±0.4[b]	11.4±0.1[a]	11.4±0.2[a]	10.1±0.2[b]	11.4±0.1[a]	11.8±0.2[a]	0.001

CON = unshorn + uncooled treatment. T1 = unshorn + fan treatment, T2 = unshorn + desert cooler treatment. T3 = shorn + uncooled treatment. T4 = shorn + fan treatment. T5 = shorn + desert cooler treatment. DG_1 =daily gain at the first weight, DG_2 = daily gain at the second weight, DG_3 = daily gain at the third weight, DG_4 = daily gain at the fourth weight, DG_5 = daily gain at the fifth weight and DG_6 = daily gain at the sixth weight. [a,b,c]Means in the same row with different superscripts are significantly ($P \leq 0.05$) different.

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تأثير نظم التبريد والجز خلال فصل الصيف على أداء وإنتاجية نعاج الفرافره ومواليدها

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الملخص

أجريت هذه الدراسة لتقييم تأثير أنظمة التبريد والجز على الأداء الإنتاجي والسلوك والاستجابة الفسيولوجية لنعاج الفرافرة ومواليدها تم تقسيم 42 نعجة خلال أواخر الحمل و 34و مولودًا من نتاجهم بعد الولادة في نفس الحظائر إلى ست مجموعات CON (غير مجزوزة + تحت ظروف طبيعية) ،T1 (غير مجزوزة + معاملة مراوح) وT2 (غير مجزوزة + معاملة تبريد صحراوى) وT3 (مجزوزة + تحت ظروف طبيعية) وT4 (مجزوزة + معاملة مراوح) وT5 (مجزوزة + معاملة تبريد صحراوى). تم تشغيل المبرد الصحراوى والمراوح يدويًا من الساعة 8:00 ص حتى الساعة 18:00م. تم تسجيل المقاييس الجوية ووزن الجسم والمعاملات الفسيولوجية مرة واحدة كل أسبوعين. تم تسجيل إنتاج اللبن و المقاييس السلوكية على أساس أسبوعي. أظهرت النتائج أن التبريد المحيط قلل من درجة الحرارة ومؤشر الرطوبة والحرارة (THI) في الحظائر المبردة مقارنة بالحظائر غير المبردة. انخفض معدل التنفس ودرجة حرارة المستقيم ودرجة حرارة الصوف ودرجة حرارة الجلد ودرجة حرارة الأذن بشكل ملحوظ ($P \leq 0.05$) في النعاج والحملان المعاملة بالتبريد + المجزوزة مقارنةً بالنعاج والحملان غير المُجزّزة وغير المُبرّدة. أدى تبريد النعاج والحملان المجزوزة إلى زيادة وقت الاجترار والاستلقاء، بينما انخفض وقت اللهاث والوقوف بشكل ملحوظ ($P \leq 0.05$) مقارنةً بالنعاج غير المُجزّزة وغير المُبرّدة. تحسن إنتاج وتركيب اللبن في النعاج ومعدل الزيادة اليومية في الحملان في جميع المجموعات التجريبية مقارنة بالكنترول. يمكن أن نستنتج أن توفير المبرد الصحراوى مع الجز، والذى خلق بيئة أفضل للنعاج ومواليدها ، مما أدى إلى تحسين انتاجياتها.

الكلمات المفتاحية: أغنام الفرافرة، أنظمة التبريد، الجز، السلوك، المعاملات الفسيولوجية.