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Original article

Influence of the fleece on thermal homeostasis and on body condition in Comisana ewe lambs

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Abstract – The aim of this study was to determine the effect of shearing on the thermal homeostasis of Comisana ewe lambs during summer. The rectal temperature, heart rate, respiration rate, average arterial pressure, percentage of oxygen saturation in blood (SpO_2%), haematocrit value, live weight and body condition score in two similar groups of 9-month-old ewe lambs were compared. Immediately after initial measurements (day 0), ewe lambs in one group were shorn while those in the other group were left unshorn. All the measurements taken on day 0 were repeated after 20, 40, 60 and 80 days from the beginning of the experiment. Rectal temperature and arterial pressure of ewe lambs did not differ ($P > 0.05$) on any of the examination days. Respiration and heart rates were higher ($P < 0.05$) in the unshorn group of ewe lambs. The haematocrit value and the SpO_2% were always higher ($P < 0.05$) in the shorn group. The live weight of ewe lambs increased in both groups, while the body condition score of the lambs at the end of the trial period was lower ($P < 0.05$) in comparison to the initial score. Shearing the fleece of ewe lambs resulted in a lower heat stress during the summer while thermal homeostasis was not influenced.

fleece / dairy ewe lamb / shearing / summer / thermal homeostasis

Résumé – **Influence de la toison sur l'homéostasie thermique et la note d'état corporel chez les agnelles de race Comisana.** L'objectif de cette étude était d'évaluer le rôle de la toison lors du maintien de l'homéostasie thermique en été chez des agnelles de race à lait. Sur deux groupes (A et B) homogènes de 10 agnelles de race Comisana, âgées de 9 mois, ont été déterminés les paramètres suivants : température rectale, fréquence cardiaque, fréquence respiratoire, tension artérielle moyenne, pourcentage de saturation en oxygène (SpO_2 %), valeur de l'hématocrite, poids vif et note d'état corporel. Juste après les mesures initiales (jour 0), les animaux du groupe A (tondu) ont été tondus alors que ceux du groupe B (non tondu) ont gardé leur toison. Les mesures réalisées le jour 0 ont été répétées après 20, 40, 60 et 80 jours suivant le début de l'expérimentation. La température rectale et la tension artérielle n'ont, dans aucun cas, présenté de différences significatives. La fréquence respiratoire et la fréquence cardiaque ont été significativement plus élevées dans le

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groupe B (non tondu) ; tandis que la valeur de l'hématocrite et SpO_2 % ont été constamment plus élevés (P < 0,05) dans le groupe A (tondu). Le poids vif a augmenté dans les deux groupes, alors que la note d'état corporel à la fin de l'expérimentation était légèrement plus faible comparativement à celle du début de l'expérimentation. La présence de la toison en été chez les agnelles de race à lait, tout en provoquant un stress en raison des fortes chaleurs (ce qui résulte en une augmentation des fréquences respiratoire et cardiaque), n'a nullement influencé l'homéostasie thermique.

toison / agnelle / race à lait / tonte / été / homéostasie thermique

1. INTRODUCTION

Thermal regulation in sheep is influenced, among other factors, by characteristics of their fleeces. A sheep fleece is related to breed, age, sex and environmental conditions like temperature, relative humidity and wind [2, 5, 15, 18, 24]. It is also an insulating layer protecting the animal against both heat and cold [2]. The type of fleece is also extremely important. The open fleece of dairy breeds provides less protection against solar radiation in comparison to the closed fleece of the Merino sheep [12].

The effects of shearing on productive performances in wool and meat breeds have been reported by several researchers. Shearing pregnant ewes at mid or late pregnancy resulted in an increase in lamb birth weight [10, 13]. This is probably attributed to an increase in the non-insulin dependent uptake of glucose by the placental-fetal unit [17] or to an increase in thyroid hormone concentrations in the maternal circulation [14]. Shearing Dorset ewes before lambing or during lactation resulted in an increased concentration of milk fat, protein and total solids but the effects on daily yield of milk, protein, fat and total solids were equivocal [11].

On the contrary, the literature provides only little information about effects of shearing on physiological and productive parameters in dairy sheep breeds. Shearing in mild climatic conditions (16–28 °C) caused an increase in core body temperature in sheep of three Mediterranean breeds (Comisana, Barbaresca and Pinzirita), probably as an over-reaction to the mild cold stress because of the loss of the fleece [16]. In pregnant Comisana ewes, shearing in early summer caused them to have a higher pasture dry matter intake, an increased use of body reserves and a decrease in the litter weight at birth in comparison to unshorn sheep. So, the fleece maintained up to the end of summer may well help the animals to face heat stress [1].

Traditional Sicilian dairy production system involves shearing in May to June, with multiparous ewes lambing and ewe-lambs mating between August and October. So, both pregnant ewes and ewe lambs, during summer, could be subjected to stressful climatic conditions.

With the aim of evaluating the role played by the fleece in maintaining thermal equilibrium during the summer season in dairy sheep breeds, we observed the behaviour of some physiological and productive parameters in Comisana dairy ewe lambs.

2. MATERIALS AND METHODS

The trial began in May and was carried out in a farm located in Sicily (37°28'N; 14°37'E) at an altitude of 450 metres above sea level.

Twenty 9-month-old, clinically healthy, Comisana ewe lambs were used in the experiment. All the animals grazed on a stubble pasture in early morning and late afternoon. No protection against heat was provided. During the hottest hours of the day and during the night, ewe lambs were put in a shelter covered by a fiber-cement gable roof.

A simultaneous monitoring system (Schiller Argus TM-7) was used to measure climatic condition and physiological parameters. With this system all the measurements are collected in the same moment on each animal. At the same time air temperature and humidity levels are also collected. The following parameters were measured on each subject: rectal temperature (probe was inserted into the rectum to a depth of 4 cm), heart rate, respiration rate, average arterial pressure and oxygen saturation percentage ($SpO_2\%$). Blood samples were also collected from the jugular vein in order to determine the haematocrit value. Ewe lambs were weighed and body condition score (BCS, [20]) determined.

Immediately following the above-mentioned measurements on day zero ten ewe lambs were sheared (group A), while the remaining ten animals were left unshorn (group B).

The measurements recorded on day 0 were repeated for both groups after 20, 40, 60 and 80 days from the beginning of the trial.

All the measurements were always taken between 10.00 and 11.00 a.m.

Data relating to each parameter were subjected to statistical analysis, using Student t-test. Measurements recorded on day 20, 40, 60 and 80 were compared within groups against measurements recorded on day 0, and between groups to compare the two treatments.

3. RESULTS

3.1. Meteorological conditions

The environmental temperature and relative humidity levels on the experimental days are presented in Figure 1. Environmental temperature increased from day zero to day 80 and peaked at 37.4 °C. These temperatures were rather high considering that they represent temperatures during the 10.00–11.00 a.m. interval. This is much higher than the thermo-neutral zone for sheep as suggested by Ruckebusch [19] (–4/+20 °C) as well as the critical temperatures reported by Graham et al. [4] of 24 °C and 33 °C, for high and medium feeding levels respectively. Mean relative humidity level was 60% and showed an inverse relationship to ambient temperature.

Both environmental temperatures and humidity levels indicate stressful conditions for the animals.

3.2. Experimental data

The average values of the parameters, for each day of the measurements, are presented in Table I. At the beginning of the

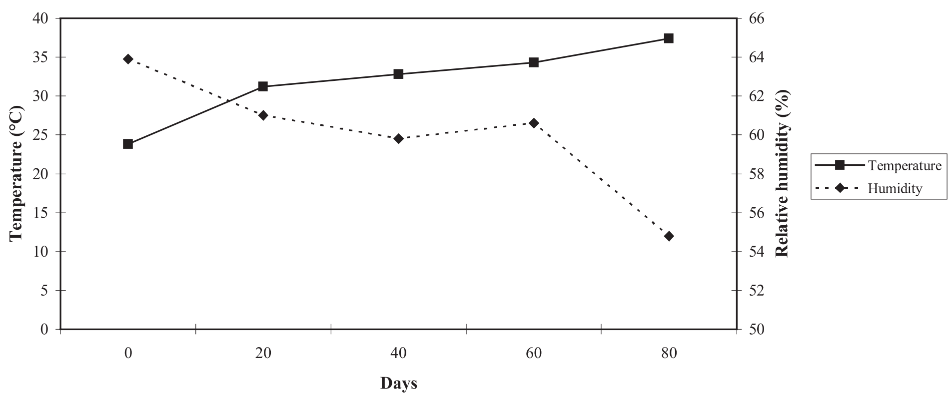

Figure 1. Air temperature (°C) and relative humidity (%) during the experimental period.

Table I. Average values (± standard deviations) of the parameters studied in the various experimental conditions.

Parameters	Day 0		Day 20		Day 40		Day 60		Day 80	
	Group A	Group B	Group A	Group B	Group A	Group B	Group A	Group B	Group A	Group B
Rectal temperature (°C)	39.8±0.7	40.1±0.4	39.9±0.5	40.0±0.7	39.5±0.3	39.8±0.2	39.6±0.5	39.9±0.3	39.5±0.4	39.8±0.3
Arterial pressure (mm Hg)	106.2±18.6	106.4±7.8	105.0±7.2	104.4±13.4	111.3±27.2	102.4±13.8	115.6±15.7	106.1±13.7	107.3±12.1	99.2±11.2
Haematocrit (%)	35.2±2.1	35.8±3.0	38.2±1.7^{b*}	33.0±1.7^{a*}	39.4±1.6^{b*}	33.2±1.0^{a*}	39.0±1.1^{b*}	31.8±1.5^{a*}	38.0±1.6^{b*}	32.4±2.1^{a*}
Respiratory rate (breaths per min)	38.4±10.5	39.0±9.9	67.0±17.0^{a*}	92.0±19.3^{b*}	59.0±14.5^{a*}	91.0±28.5^{b*}	68.0±14.8^{a*}	105.0±25.9^{b*}	68.0±24.8^{a*}	105.0±17.2^{b*}
Heart rate (beats per min)	86.0±11.1	98.7±15.5	100.2±11.5^{a*}	114.0±13.5^{b*}	100.8±17.5^{a*}	119.0±12.9^{b*}	99.6±20.7^{a*}	118.1±11.8^{b*}	102.2±11.8^{a*}	119.0±17.9^{b*}
SpO_2%	88.4±5.2	86.8±9.1	97.2±3.3^{b*}	85.5±9.3^{a}	97.0±2.9^{b*}	89.7±6.6^{a}	97.0±2.3^{b*}	89.0±10.5^{a}	97.4±3.3^{b*}	89.3±6.2^{a}

Group A: shorn ewe lambs; Group B: unshorn ewe lambs; SpO_2%: percentage of oxygen saturation in blood.
$^{a, b}$: $P < 0.05$ among the groups, within the same control data; *: $P < 0.05$ vs. day 0 measurement, within the same group.

trial (day 0), none of the considered parameters presented any significant differences among the groups, thus confirming the homogeneity of the subjects.

The *rectal temperatures* and *arterial pressure* of sheep did not differ ($P > 0.05$) from day 0 nor between shorn and unshorn sheep.

The *haematocrit value* of shorn sheep was higher ($P < 0.001$) than that of unshorn sheep. Within the group of shorn sheep, haematocrit value was higher ($P < 0.05$) on day 20, 40, 60 and 80 in comparison to day zero. Conversely, in the group of unshorn sheep the haematocrit value was lower ($P < 0.05$) in the various test days in comparison to day zero.

The *respiration rate* and *heart rate* of unshorn sheep were higher ($P < 0.05$) than those of shorn ewe lambs on all days except day zero. Within each group the respiration rate and heart rate were higher ($P < 0.05$) on all days post shearing. Respiration rate was ($P < 0.001$) correlated with ambient temperature in both groups (R^2 = 0.270 for shorn sheep and R^2 = 0.546 for unshorn sheep).

The *oxygen saturation percentage* *(SpO_2%)* was higher ($P < 0.05$) in the shorn sheep in comparison to the unshorn sheep on all the dates following day 0. Furthermore, the SpO_2% of the shorn group increased ($P < 0.05$) in comparison to the initial value in all the considered periods (20th, 40th, 60th and 80th day post shearing). No significant differences were observed in the unshorn group.

As expected the *live weight* of the ewe lambs increased in both groups, from 40.6 to 43.5 kg and from 39.0 to 41.9 kg in the shorn and unshorn groups respectively. This is because the ewe lambs were still growing. Live weight gain was not affected by the presence or absence of the woolly coat ($P = 0.582$). The *body condition score (BCS)* of the ewe lambs at the end of the trial (BCS = 2.62 and 2.70 in groups A and B respectively) proved to be slightly lower compared with the initial score (BCS = 2.80 and 2.92 in groups A and B respectively). The variation in BCS was not influenced by the presence or absence of the fleece ($P = 0.697$).

4. DISCUSSION

With respect to thermal dispersion systems in farm animals, sheep are in an intermediate position between horses and cattle (species in which sweating prevails) and swine and dogs (in which polypnea is the main means of defence against heat) [19]. In unshorn sheep, heat loss is caused by evaporation through breathing, irradiation and convection, when environmental conditions allow it. A small amount of heat loss also occurs through conduction. In shorn sheep kept at an environmental temperature of 35 °C, it has been observed that heat dispersion increases through cutaneous evaporation [9, 25].

Under our experimental conditions, ewe lambs at the end of growth were used, thus minimizing energetic expense dispersion due to other sources (lactation or pregnancy) than thermoregulation.

The respiration rate differed between shorn and unshorn sheep, but also within each group. It has been observed that, in conditions of high environmental temperatures, an increase in the respiration rate of sheep is the major way of thermal dispersion [7, 26]. Such increases are influenced by the type of shelter used for the animals [3, 23]. So, the respiration rate represents a significant and accessible indicator in evaluating heat stress. Silanikove [22] proposed to quantify the severity of heat stress according to panting rate (low: 40–60; medium-high: 60–80; high: 80–120; severe: above 200 breaths per min). In our research, heat stress was observed from the second measurement period. According to the quantification of Silanikove [22], the heat stress under our conditions could be defined as of medium intensity in the group of shorn sheep and as of high intensity in the unshorn group. In all further measurement periods, heat stress proved to be of high intensity in unshorn group and of medium–low intensity in the shorn group (Tab. I).

The response of the haematocrit value of sheep was of particular interest. The lower haematocrit values in unshorn ewe lambs indicate a higher level of hydration in these animals in comparison to the shorn lambs. The significant variations in the haematocrit value observed did not involve significant haemodynamic consequences. Indeed, it is known that an increase in the haematocrit value corresponds to an increase in the viscosity of the blood and therefore of peripheral vascular resistance, which in their turn result in an increase in arterial pressure [6, 8]. The increase in arterial pressure involves a decrease in heart rate and therefore in cardiac output and arterial pressure (baroceptive reflex). This mechanism explains both the constant arterial pressure in the subjects we studied and the difference in heart rate between the shorn and unshorn ewe lambs. The shorn sheep had lower heart rates probably to compensate for the increase in peripheral vascular resistance and therefore arterial pressure. In accordance with the literature [24], the heart rate of unshorn sheep was higher because of an increase in the peripheral vascular resistance.

As for the oxygen saturation percentage in the blood, shearing of sheep caused an increase implying an improvement in gas exchange. It is well known, indeed, that the oxyhaemoglobin dissociation curve moves to the left when flushing of acids or CO_2, and therefore hydrogenionic concentration decreases at the tissue level [21]. Thermal polypnea, shown by the sheep in this trial, influences this parameter very little because the breathing (panting) is of a superficial type.

Nevertheless, in our opinion the most important aspect of the trial is represented by the constant body temperature of sheep. This seems to indicate that the thermoregulatory mechanisms of the animals proved to be fully effective in both experimental conditions, i.e. with and without a fleece. It may also be because of other factors such as a reduction in feed intake to reduce this specific action [22]. This might also explain the utilization of subcutaneous fat reserves, demonstrated by a reduction in the body condition score of both shorn and unshorn sheep between the beginning and the end of the trial. Nevertheless, the reduction in body condition may also be attributed to the feeding system used, i.e. grazing on stubble, which would be probably insufficient for maintaining growth.

5. CONCLUSIONS

Leaving dairy ewe lambs unshorn during summer caused a more intense heat stress in comparison to shorn lambs, although thermal homeostasis was not affected to a great extent. Shearing reduces heat stress, as shown by a lower respiration rate.

There seems to be no reason not to shear dairy ewe lambs during the summer. On extensive farms, these animals could seek out shelter for protection against the heat.

Further research is needed particularly on pregnant ewes which, with the breeding system prevailing in Sicily, make up the majority of the flock during the summer.

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