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Effect of shearing and environmental conditions on physiological mechanisms in ewes

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Abstract: *The aim of this study was to establish the influence of shearing in dairy sheep during summer season. Several physiological and haematological parameters, which are closely related to thermoregulatory potential, have been investigated with the purpose to assess shearing influence on thermoregulation. Forty dairy sheep, clinically healthy and well-fed, were used. They were divided into two groups of 20 subjects each. Twenty sheep were let unshorn as a control group (Group A), and twenty sheep were shorn (Group B). On each subject of group A and Group B, rectal temperature, respiration and heart rates were recorded and blood samples were collected in order to asses the following parameters: red blood cells, white blood cells, platelets, haematocrit and haemoglobin. All measurements taken on day 0 (before shearing), were repeated after 1, 15, 30, 45 and 60 days after shearing. The statistical analysis, the ANOVA followed by the Bonferroni's test, showed statistical differences between two groups for rectal temperature ($F_{(1,90)}$=5.57, p<0.0001), respiratory rate ($F_{(1,90)}$=18.40, p<0.0001) and white blood cells ($F_{(1,190)}$=7.61, p<0.0001). These results suggest that the shearing induce adaptative responses in the organism.*

Key words: *Fleece, Shearing, Physiological and Haematological parameters, Ewes*
PDF of full length paper is available with author ***(*giuseppe.piccione@unime.it)***

Introduction

Studies of shorn and unshorn sheep, exposed to extreme environmental conditions, have long demonstrated the importance of the fleece for the maintenance of homeothermy (MacFarlane, 1968; Whittow, 1971). Also in a climatically mild atmosphere, the shearing induces in animals adaptive thermogenetics modifications (Caola *et al*., 1998).

It is well known that to maintain body temperature constant, an animal has to satisfy the condition of "stationary equilibrium", in which the metabolic production of heat is equal to its loss. The breadth of the thermoneutral zone depends on age, species and breed (Yousef, 1987). In sheep thermal regulation is influenced, among other factors, by characteristics of their fleeces. The sheep fleece is a natural thermoregulatory structure that is related to breed, age, sex and environmental conditions like temperature, relative humidity and wind (Sleiman, 1995; Hafez *et al*., 1956; Moule, 1954). The fleece represents a compact insulating layer protecting the animal against both hot and cold (Bettini, 1988; Hammel, 1955).

Many studies have been carried out to assess the influence of shearing and the type of shelter on homeostatic balance of sheep (Pennisi *et al*., 2004; Piccione *et al*., 2003a; Piccione *et al*., 2003b). The effects of shearing on productive performances in wool and meat breed have been reported by several researchers. Shearing pregnant ewes at mid or late pregnancy resulted in an increase in lamb birth weight (Kenyon *et al*., 2002; Morris *et al*., 1997). On the contrary, the literature provides only little information about effects of shearing on physiological and productive parameters in dairy sheep. On the base of such considerations with the aim of evaluating the role of the fleece in the maintenance of thermal equilibrium during summer season in dairy sheep, we have studied the course of following physiological and haematological parameters: rectal temperature, respiratory and heart rates, red blood cells, white blood cells, platelets, haematocrit and haemoglobin.

Materials and Methods

The trial was carried out in a farm located in Sicily (38° 7' N; 13° 22' E) at an altitude of 300 metres above sea level. Environmental temperature peacked at 33°C and relative humidity levels, with mean value of 45%, showed an inverse relationship to ambient temperature.

The study started in June and ended in September and it was carried out on dairy sheep. Forty two-years-old, clinically healthy and well-fed Valle del Belice ewes were used in the experiment. As concerning feeding conditions, groups A and B were fed daily on hay (2 kg), wheat straw (1 kg), wheat concentrate (0.5 kg) and water *ad libitum*.

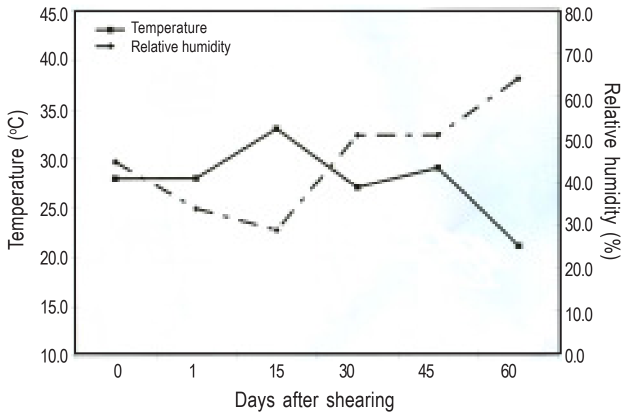

Fig. 1: Air temperature (°C) and relative humidity (%) during the experimental period

The following experimental protocol multiparametric automatic analyzer (CELL DYN R 3500®) was used: the animals were divided into two group (Group A and Group B), each of twenty animals. The sheep in Group A were let unshorn, as a control group, while the sheep in Group B were shorn.

A simultaneous monitoring equipment (Schiller Argus Tm 7) was used to measure climatic condition and some physiological and haematological parameters. With this system all the measurements were collected in the same moment on each animal. All the measurements were always taken between 10.00 and 11.00 am The following parameters were measured on each subject: rectal temperature that was measured using a digital thermometer (HI92704, Hanna Instruments Bedfordshire, UK) whose probe was inserted into the rectum to a depth of 9 cm, heart rate and respiration rate.

On blood samples, collected by means of a jugular venipuncture, the haematological examination was performed. Red blood cells, white blood cells, plateles, haematocrit, haemoglobin were assessed by means of the multiparametric automatic analyzer for haematology (CELL DYN R 3500®), of the Abbot Company Division Diagnostic.

The studied parameters were assessed for each subject on the following experimental conditions: before shearing, 1, 15, 30, 45 and 60 days after shearing.

The statistical elaboration of the data for each parameter was based on the average values obtained. Two-way repeated measures analysis of variance (ANOVA) was used to determine significant difference. p values < 0.0001 were considered statistically significant. Bonferroni's test was applied for post-hoc comparison.

Results and Discussion

The environmental temperature and relative humidity levels on the experimental and relative humidity levels on the experimental days are presented in Fig. 1. The average values of the parameters considered, together with their standard deviation of the means (SD), on the different experimental conditions in sheep of Group A and B, are presented in Tables 1 and 2. At the beginning of the trial (day 0), none of the considered parameters presented any significant differences among the groups, thus confirming the homogeneity of the subjects.

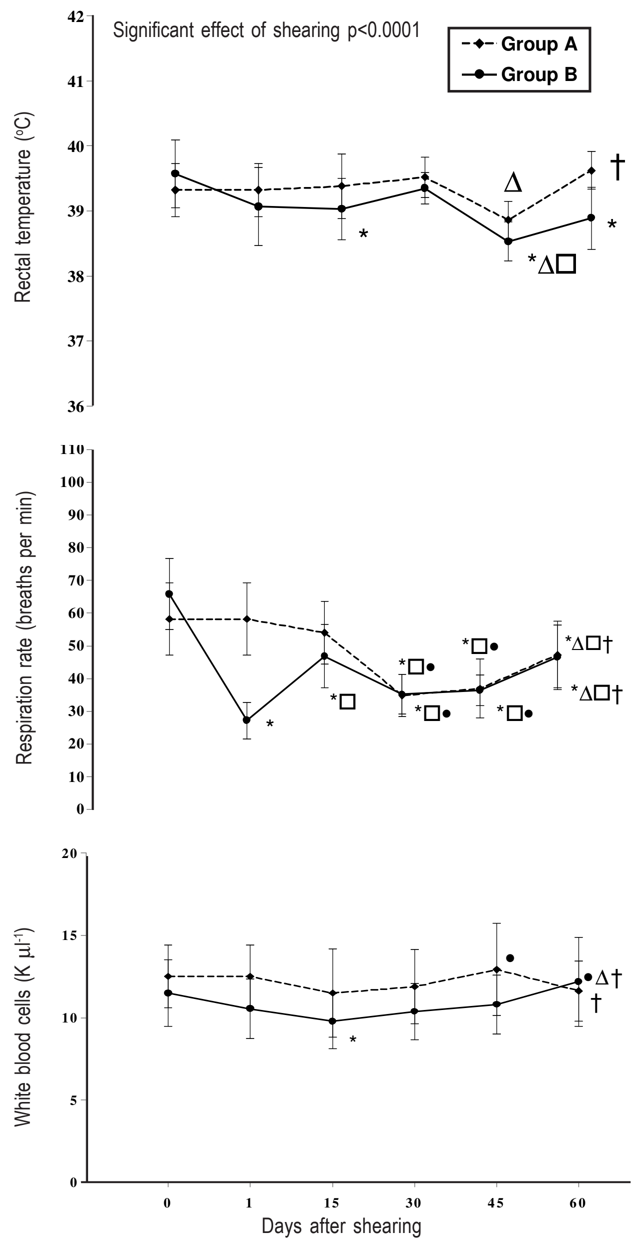

Fig. 2: Rectal temperature (°C), Respiration rate (breaths per min), White blood cells (K/µL) mean value trend, with SD obtained on the different experimental conditions in sheep of Group A and B. Significance: * vs day 0 p < 0.0001; □ vs day 1 p < 0.0001; • vs day 15 p < 0.0001; Δ vs day 30 p < 0.0001; † vs day 45 p < 0.0001

Two-way ANOVA shows a statistical significant effect of shearing on rectal temperature ($F_{(1,90)}$=5.57, p<0.0001); respiratory rate ($F_{(1,90)}$=18.40, p<0.0001); white blood cells ($F_{(1,190)}$=7.61, p<0.0001). Fig. 2 shows the trend of mean values with SD obtained on the different experimental conditions in sheep of Group A and B for rectal temperature, respiratory rate and white blood cells, instead the effect of shearing is considered not significant on heart rate, red

Table - 1: Average values (± standard deviations) of rectal temperature, respiratory rate and heart rate in Group A (unshorn sheep) and in Group B (shorn sheep) during different experimental conditions

Parameters	Group A					
	Day 0	**Day 1**	**Day 15**	**Day 30**	**Day 45**	**Day 60**
Rectal temperature (°C)	39.32 ± 0.41	39.32 ± 0.41	39.38 ± 0.50	39.52 ± 0.31	38.86 ± 0.29$^{\Delta}$	39.62 ± 0.29†
Respiratory rate (breaths per min)	58.20 ± 10.99	58.20 ± 10.99	54.00 ± 9.56	34.82 ± 6.46*□•	36.94 ± 8.98*□•	47.29 ± 10.16*□Δ†
Heart rate (beats per min)	75 ± 11.74	75 ± 11.74	74.60 ± 11.50	90.35 ± 9.43	69.88 ± 9.28	100 ± 7.17
	Group B					
Rectal temperature (°C)	39.57 ± 0.52	39.07 ± 0,60	39.03 ± 0.47*	39.35 ± .0.24	38.53 ± 0.30*□Δ	38.89 ± 0.48*
Respiratory rate (breaths per min)	65.80 ± 10.77	27.20 ± 5.63*	46.84 ±9.72*□	35.25 ± 5.97*□•	36.50 ± 4.70*□•	46.50 ± 9.96*□Δ†
Heart rate (beats per min)	73.70 ± 6.30	75.90 ± 11.56	73.26 ± 9.59	91.25 ± 10.15	68.00 ± 9.71	99.00 ± 9.93

Significance: * = vs day 0 $p<0.0001$; □ vs day 1 $p<0.0001$, ● = vs day 15 $p<0.0001$, Δ vs day 30 $p<0.0001$; † = vs day 45 $p<0.0001$

Table - 2: Average values (± standard deviations) of haematological parameters studied in Group A (unshorn sheep) and in Group B (shorn sheep) during different experimental conditions

Parameters	Group A					
	Day 0	**Day 1**	**Day 15**	**Day 30**	**Day 45**	**Day 60**
Red blood cells (M µl^{-1})	8.20 ± 1.33	8.20 ± 1.33	7.99 ± 1.48	7.68 ± 1.01	8.42 ± 1.15	7.70 ± 1.05
White blood cells (K µl^{-1})	12.49 ± 1.92	12.49 ± 1.92	11.49 ± 2.67	11.87 ± 2.25	12.92 ± 2.81•	11.62 ± 1.83†
Plateletes (K µl^{-1})	487.75 ± 114.97	487.75 ± 114.97	234.81 ± 114.81	372.24 ± 104.16	377.73 ± 117.57	339.03 ± 116.93
Haematocrit (%)	24.14 ± 2.55	24.14 ± 2.55	23.85 ± 3.97	21.72 ± 2.22	23.77 ± 2.37	21.61 ± 2.24
Haemoglobin (g dl^{-1})	8.98 ± 1.06	8.98 ± 1.06	8.47 ± 1.36	8.96 ± 1.34	8.97 ± 0.99	8.19 ± 0.89
	Group B					
Red blood cells (M µl^{-1})	8.24 ± 1.23	8.78 ± 0.95	7.90 ± 1.06	7.96 ± 0.89	8.35 ± 1.08	7.87 ± 0.69
White blood cells (K µl^{-1})	11.49 ± 2.04	10.53 ± 1.82	9.77 ± 1.67*	10.36 ± 1.71	10.80 ± 1.79	12.17 ± 2.72Δ•†
Plateletes (K µl^{-1})	428.07 ± 131.28	363.60 ± 129.41	218.15 ± 104.65	415.34 ± 127.18	432.00 ± 129.87	335.09 ± 139.20
Haematocrit (%)	23.36 ± 2.86	24.71 ± 2.10	23.18 ± 2.27	22.41 ± 2.08	23.21 ± 2.40	22.15 ± 1.76
Haemoglobin (g dl^{-1})	8.91 ± 0.98	9.21 ± 0.89	8.31 ± 0.95	8.43 ± 0.72	8.80 ± 0.96	8.44 ± 0.63

Significance: * = vs day 0 $p<0.0001$; □ vs day 1 $p<0.0001$, ● = vs day 15 $p<0.0001$, $^{\Delta}$ vs day 30 $p<0.0001$; † = vs day 45 $p<0.0001$

blood cells, plateletes, haemoglobin, haematocrit whose values were within the physiological range for the ewes (Kaneko, 1989).

The effect of time is considered extremely significant on all parameters: rectal temperature ($F_{(5,190)}$=5.65, $p<0.0001$), respiratory rate ($F_{(5,190)}$=40.31, $p<0.0001$), heart rate $F_{(5.190)}$=66.95, $p<0.0001$), red blood cells ($F_{(5,190)}$=1.46, $p<0.0001$), white blood cells ($F_{(5,190)}$=4.04, $p<0.0001$), platelets ($F_{(5,190)}$=18.23, $p<0.0001$), haemoglobin ($F_{(5,190)}$=4.10, $p<0.0001$), haematocrit ($F_{(5,190)}$=14.28, $p<0.0001$).

The analysis of the results obtained under experimental conditions used in the present study indicates the influence of the fleece in parameters studied on dairy sheep. Under our experimental conditions, the rectal temperature measurements carried out after shearing show that this practice determines an alteration in thermal homeostasis. The day after shearing, the rectal temperature decreases, as response to hot, while 30 days after shearing it increases and returns to pre-shearing level, probably as an acclimation to a heat environment, termed "heat habituation". In fact our shorn sheep were actually under heat stress like in the cold climate condition (Slee, 1972; Slee, 1987).

Rectal temperature is an indicator of thermal balance and may be used to assess the adversity of the thermal environment which can affect the growth, lactation and reproduction of dairy ewes (Hahn, 1999; West, 1999). Variations in rectal temperature are a sensitive indicator of physiological response to heat stress in the ewe because it is nearly constant under normal conditions (Silanikove, 2000).

The respiratory rate differed between shorn and unshorn dairy 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 (Hales *et al*., 1984; Yousef, 1985). So, the respiration rate represents a significant and accessible indicator in evaluating stress (Pennisi *et al*., 2004). According to Silanikove (Silanikove, 2000), who proposed to quantify the severity of heat stress according to painting rate, the heat stress under our conditions could be defined as of low intensity in both groups.

In hot climates, high ambient temperatures, and high direct and indirect solar radiation, wind speed and humidity, are the main environmental stressing factors that impose strain on animals (Finch, 1984; Silanikove, 2000). Both shorn and unshorn sheep are subject to heat stress, but the higher sensitivity of shorn sheep to heat stress in comparison with unshorn sheep it is evident by a greater lessening of white blood cells in shorn group.

Furthemore there is a statistical significant effect of time on all parameters considered. The variation in the time is not probably due to phenomena of thermoregulation but rather to chronophysiological modifications of the parameters. Further investigations need to be carried out in order to gain a better understanding these modifications.

In conclusion we can claim that different environmental conditions can highly influence thermoregulatory mechanisms. So the presence and the absence of fleece resulted from shearing take part in productive performance and in the welfare of sheep.

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