

## Effect of shearing on some haematochemical parameters in ewes

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**ABSTRACT:** The aim of the present paper was to study the effect of shearing on some haematochemical parameters in ewes. Forty Valle del Belice ewes, clinically healthy and well-fed, were divided into two groups of twenty subjects each. Twenty ewes were let unshorn as a control group (Group A) and twenty ewes were shorn (Group B). After the blood collection by means of jugular venipuncture, some haematochemical parameters were assessed for each subject in the following experimental conditions: before shearing, 1<sup>st</sup>, 15<sup>th</sup>, 30<sup>th</sup>, 45<sup>th</sup>, 60<sup>th</sup> and 75<sup>th</sup> day after shearing. We studied the course of the following haematochemical parameters: glucose,  $\beta$ -hydroxybutyrate, NEFA, triglycerides, total cholesterol, total protein, urea and creatinine. Two-way repeated measures analysis of variance (ANOVA), followed by Bonferroni's test, was used to determine significant differences between the two groups in the studied parameters. The statistical analysis showed statistical differences ( $P < 0.05$  was considered statistically significant) in  $\beta$ -hydroxybutyrate, NEFA, total protein and urea. Data analysis of variance showed a significant effect of time, with  $P < 0.0001$ , on all studied parameters. These results suggest that shearing induces adaptive metabolic responses in the ewes and exposure to elevated ambient temperature induces modifications of some haematochemical parameters.

**Keywords:** Valle del Belice; heat stress; thermal homeostasis; thermoregulation

In the Mediterranean area, the local weather is characterized by mild winters, limited rainfall from autumn to spring, and hot summers. The exposure of ewes to elevated ambient temperatures induces an increase in the dissipation of excess body heat in order to negate the excessive heat load. Adaptation to hot summers in the absence of cold winters is likely to have resulted in enhanced thermoregulatory mechanisms of heat loss at the expense of mechanisms for heat conservation (Piccione et al., 2002). It is well known that to maintain the constant body temperature, an animal has to satisfy the condition of stationary equilibrium, in which the metabolic production of heat is equal to its loss. In these conditions an increase in the metabolism allows the animal's adaptation to the various environmental conditions (Piccione et al., 2002). Thermal regulation in ewes is also influenced by the

characteristics of their fleeces. Studies of shorn and unshorn ewes, exposed to extreme environmental conditions, have long demonstrated the importance of the fleece for the maintenance of homoeothermy (McFarlane, 1968; Whittow, 1971). The ewe's fleece is an insulating layer protecting the animal against both heat and cold. It is related to breed, age, sex and environmental conditions like temperature, relative humidity and wind (Moule, 1954; Hafez et al., 1956; Sleiman and Abi Saab, 1995). It has an extremely low thermal conductivity (3810.17 W/m/K) and it maintains easily, both in winter and in summer, a high thermal gradient between atmosphere and skin (Weast, 1969; Manunta, 1973).

Many studies have been carried out to evaluate the role played by the fleece in maintaining thermal equilibrium in ewes (Piccione et al., 2003; Pennisi et al., 2004) and the effect of shearing on

the energy metabolism of pregnant ewe (Symonds et al., 1986, 1988, 1989): the authors showed that the shearing of the fleece of ewe lambs resulted in a lower heat stress during summer while thermal homeostasis was not influenced; moreover, the effects of shearing on energy metabolism in the ewe are discussed in relation to the nutrient supply for the developing foetus.

On the basis of such considerations we studied the behaviour of some haematochemical parameters in ewes with the aim to evaluate the effect of shearing on maintaining thermal equilibrium during the summer season in ewes since the traditional shearing time is spring and early summer. The course of the following haematochemical parameters was studied: glucose,  $\beta$ -hydroxybutyrate, NEFA, triglycerides, total cholesterol, total protein, urea and creatinine.

## MATERIAL AND METHODS

The study that started in June and ended in September was carried out on a farm located in Sicily (38° 7' N; 13° 22' E) at an altitude of 300 metres above sea level. Forty two-years-old, clinically healthy and well-fed Valle del Belice ewes were used in the experiment. As concerned the 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*.

The following experimental protocol was used: the animals were divided into two groups (Group A and Group B), each of twenty animals. The ewes in Group A were let unshorn as a control group while the ewes in Group B were shorn.

Before shearing the animals of each group were subjected to the measurement of body condition score (BCS, 0 to 5 scale). The ewes' BCSs were also measured 45 and 75 days after shearing.

Blood samples were collected by means of a jugular venipuncture. Samples were centrifuged at 3 000 rpm for 10 min and sera were stored at  $-4^{\circ}\text{C}$  until being assayed for parameters. In each individual sample serum concentrations of  $\beta$ -hydroxybutyrate, NEFA, triglycerides, total cholesterol, total protein, urea and creatinine were assessed. Sera were analysed with commercially available kits by means of a UV spectrophotometer (Slim SEAC model, Firenze, Italy). Moreover, in blood samples, collected using vacutainer tubes (Terumo Corporation, Japan) with  $\text{K}_3\text{-EDTA}$ , glucose was assessed by means of blood

glucose meter (Glucotrend 2, Roche) immediately after the collection.

The studied parameters were assessed for each subject on day 0 (before shearing) and the assessments were repeated on day 1, 15, 30, 45, 60 and 75 after shearing.

The statistical analysis of data was based on the average values obtained. To compare overall parameters studied, two-way repeated measures analysis of variance (ANOVA) was used to determine significant differences. Two-way ANOVA with repeated measures was used for the assessment of effects due to shearing and time.  $P < 0.05$  was considered statistically significant. Bonferroni's test was applied for post-hoc comparison. Data were analyzed using Statistica 5.5 (StatSoft Inc.) software package.

## RESULTS

The environmental temperatures and relative humidity levels on the experimental days are presented in Figure 1. The average value of environmental temperature was  $27.57^{\circ}\text{C}$  while the average value of relative humidity was 59.71%. Environmental temperature peaked at  $32^{\circ}\text{C}$  and relative humidity level, while the mean relative humidity level was 51.5%, showed an inverse relationship to ambient temperature.

Table 1 shows the average values of the parameters considered, together with their standard deviations of the means (SD), in different experimental conditions in the ewes of Group A and B.

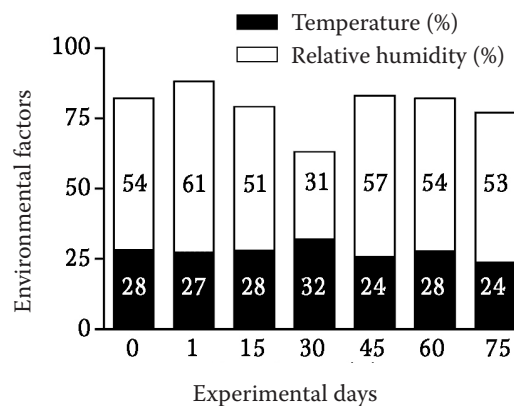


Figure 1. Air temperature ( $^{\circ}\text{C}$ ) and relative humidity (%) during the experimental period

Table 1. Average values ( $\pm$  standard deviations) of the studied haematochemical parameters, together with the relative statistical significances, in Group A (unshorn ewes) and Group B (shorn ewes) in experimental conditions

Parameter (mmol/l)	Group	Experimental period							
		day 0	day 1	day 15	day 30	day 45	day 60	day 75	
Glucose	A	3.53 $\pm$ 0.39	3.53 $\pm$ 0.39	3.14 $\pm$ 0.41	3.16 $\pm$ 0.22	3.32 $\pm$ 0.34	2.83 $\pm$ 0.36	3.67 $\pm$ 0.33	
	B	3.41 $\pm$ 0.33	3.40 $\pm$ 0.37	3.05 $\pm$ 0.40	3.22 $\pm$ 0.36	3.36 $\pm$ 0.25	2.84 $\pm$ 0.12	3.51 $\pm$ 0.20	
$\beta$ -hydroxybutyrate	A	0.68 $\pm$ 0.14	0.68 $\pm$ 0.14	0.80 $\pm$ 0.20	0.51 $\pm$ 0.12	0.45 $\pm$ 0.13	0.40 $\pm$ 0.10	0.80 $\pm$ 0.20	
	B	0.58 $\pm$ 0.17	0.49 $\pm$ 0.15*	0.75 $\pm$ 0.16	0.44 $\pm$ 0.08*	0.45 $\pm$ 0.09	0.37 $\pm$ 0.08	0.74 $\pm$ 0.11	
NEFA	A	0.86 $\pm$ 0.42	0.86 $\pm$ 0.42	0.60 $\pm$ 0.16	0.57 $\pm$ 0.36	0.55 $\pm$ 0.22	0.66 $\pm$ 0.31	0.65 $\pm$ 0.18	
	B	0.71 $\pm$ 0.40	0.49 $\pm$ 0.22*	0.42 $\pm$ 0.12*	0.36 $\pm$ 0.13*	0.57 $\pm$ 0.11	0.70 $\pm$ 0.23	0.69 $\pm$ 0.16	
Triglycerides	A	0.17 $\pm$ 0.04	0.17 $\pm$ 0.04	0.19 $\pm$ 0.03	0.17 $\pm$ 0.04	0.14 $\pm$ 0.03	0.16 $\pm$ 0.06	0.22 $\pm$ 0.04	
	B	0.19 $\pm$ 0.04	0.16 $\pm$ 0.04	0.22 $\pm$ 0.02	0.16 $\pm$ 0.03	0.12 $\pm$ 0.02	0.17 $\pm$ 0.04	0.24 $\pm$ 0.04	
Total cholesterol	A	1.62 $\pm$ 0.13	1.62 $\pm$ 0.13	1.58 $\pm$ 0.13	1.62 $\pm$ 0.13	1.38 $\pm$ 0.11	1.39 $\pm$ 0.13	1.35 $\pm$ 0.12	
	B	1.65 $\pm$ 0.14	1.72 $\pm$ 0.13	1.62 $\pm$ 0.18	1.59 $\pm$ 0.14	1.45 $\pm$ 0.17	1.46 $\pm$ 0.14	1.36 $\pm$ 0.14	
Total protein (g/dl)	A	7.63 $\pm$ 0.48	7.63 $\pm$ 0.48	7.33 $\pm$ 0.47	7.64 $\pm$ 0.64	6.72 $\pm$ 0.69	7.31 $\pm$ 0.40	7.24 $\pm$ 0.43	
	B	7.71 $\pm$ 0.56	7.50 $\pm$ 0.63	7.65 $\pm$ 0.66*	7.80 $\pm$ 0.51	7.07 $\pm$ 0.72	7.24 $\pm$ 0.50	7.46 $\pm$ 0.65	
Urea ( $\mu$ mol/l)	A	7.80 $\pm$ 0.92	7.80 $\pm$ 0.92	7.00 $\pm$ 1.31	8.77 $\pm$ 1.18	8.34 $\pm$ 1.02	7.39 $\pm$ 1.02	13.68 $\pm$ 1.19	
	B	7.47 $\pm$ 1.00	7.24 $\pm$ 0.97	6.12 $\pm$ 0.68*	8.11 $\pm$ 0.84*	8.53 $\pm$ 1.00	6.72 $\pm$ 1.14	13.20 $\pm$ 0.70	
Creatinine	A	83.98 $\pm$ 7.07	83.98 $\pm$ 7.07	84.86 $\pm$ 8.84	88.40 $\pm$ 7.07	74.25 $\pm$ 8.84	82.20 $\pm$ 6.18	63.64 $\pm$ 6.18	
	B	86.63 $\pm$ 6.18	81.32 $\pm$ 7.07	80.44 $\pm$ 7.07	85.74 $\pm$ 7.95	75.14 $\pm$ 9.72	77.79 $\pm$ 7.07	64.53 $\pm$ 7.07	

\*vs Group A

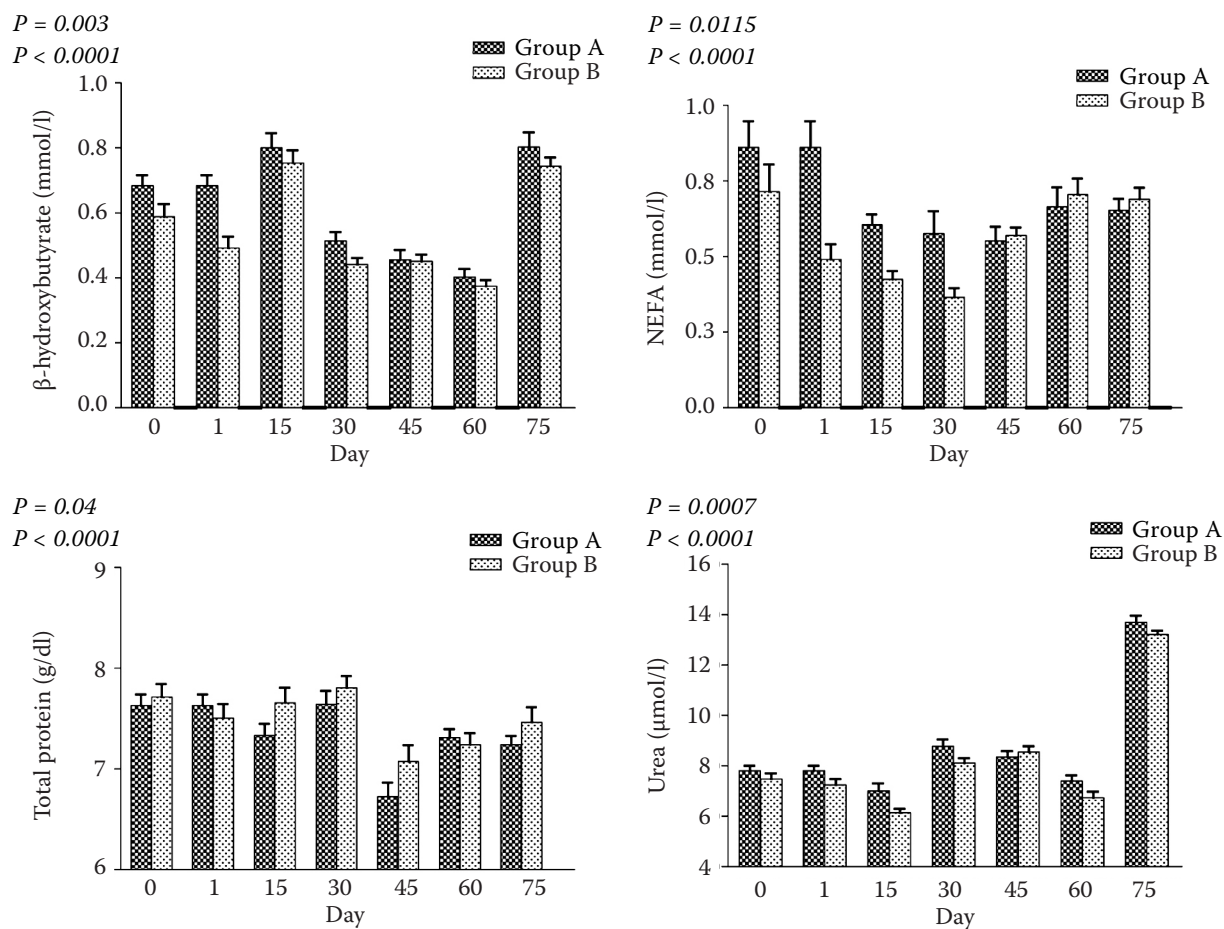


Figure 2. The pattern of mean values of  $\beta$ -hydroxybutyrate (mmol/l), NEFA (mmol/l), total protein (g/dl) and urea ( $\mu$ mol/l), with SD obtained in different experimental conditions in the ewes of Groups A and B

Figure 2 illustrates the relationship between unshorn and shorn ewes in which the effect of shearing is considered significant.

The effect of shearing is considered very significant on  $\beta$ -hydroxybutyrate ( $F_{(1,228)} = 10.03$ ,  $P = 0.003$ ); NEFA ( $F_{(1,228)} = 7.05$ ,  $P = 0.0115$ ); total protein ( $F_{(1,228)} = 4.45$ ,  $P = 0.04$ ); urea ( $F_{(1,228)} = 13.63$ ,  $P = 0.0007$ ). Two-way ANOVA does not show a statistically significant effect of shearing on triglycerides, total cholesterol, glucose and creatinine; however the values obtained were within the range for ewes (Kaneko, 1989).

The effect of time is considered significant on all parameters: glucose ( $F_{(6,228)} = 44.81$ ,  $P < 0.0001$ );  $\beta$ -hydroxybutyrate ( $F_{(6,228)} = 51.84$ ,  $P < 0.0001$ ); NEFA ( $F_{(6,228)} = 9.07$ ,  $P < 0.0001$ ); triglycerides ( $F_{(6,228)} = 25.50$ ,  $P < 0.0001$ ); total cholesterol ( $F_{(6,228)} = 21.08$ ,  $P < 0.0001$ ); total protein ( $F_{(6,228)} = 9.96$ ,  $P < 0.0001$ ); urea ( $F_{(6,228)} = 214.37$ ,  $P < 0.0001$ ) and creatinine ( $F_{(6,228)} = 37.86$ ,  $P < 0.0001$ ).

Two-way ANOVA was also applied to determine the body condition score, showing that BCS does not change. Table 2 shows the average values and standard deviations (SD) of the body condition score in Group A (unshorn ewes) and in Group B (shorn ewes) before shearing, 45 days and 75 days after shearing.

## DISCUSSION

The analysis of the results indicates the influence of shearing in some haematochemical parameters studied in ewes.

Ewes share with all mammals their capacity to keep the body temperature within certain limits. With respect to the thermal dispersion system in farm animals, ewes are in an intermediate position between horses and cattle (species in which sweating prevails) and swine and dogs (in which

Table 2. Average values and standard deviations (SD) of the body condition score in Group A (unshorn ewes) and in Group B (shorn ewes) before shearing, 45 days and 75 after shearing

Body condition score	Group A		Group B	
	mean	SD	mean	SD
Before shearing	2.62	0.10	2.61	0.09
45 days after shearing	2.66	0.10	2.65	0.07
75 days after shearing	2.61	0.09	2.56	0.12

polypnea is the main means of defence against heat) (Ruckebusch, 1986).

The ewes in environments with high temperatures are subjected to different stressful climate conditions than sheep in temperate zones (Johnson, 1987).

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). In our study the effect of current climatic conditions on the observed haematochemical parameters can be considered a stress factor.

According to other authors who reported a decrease in the concentration of blood  $\beta$ -hydroxybutyrate during lactation compared to the dry period in goats (Zumbo et al., 2007), the results of this study show a decrease in this parameter in shorn ewes compared to unshorn ones. Shearing, like lactation and pregnancy, may be considered a metabolic stress which determines a variation of biochemical parameters such as  $\beta$ -hydroxybutyrate.

In shorn ewes a decrease in total protein was observed; these changes in plasma protein may be due to the fluid shift between the compartments of the organism that assume an important role in the physical protection in comparisons of the temperature. Therefore it is possible to evidence a haemoconcentration characterized by an increase in total proteins (Piccione et al., 1994).

Significant values of urea concentration are probably due to the metabolic complexity of the ruminants that use various substrates to energetic scope (Demigné et al., 1988).

NEFA also supply usable energetic quotas in conditions of thermal stress (Demigné et al., 1988). As previously observed by Symonds et al. (1989), there is a significant correlation between shearing and NEFA. The effect of shearing on NEFA is consid-

ered significant; initially the shorn ewes had lower values probably due to stress caused by the direct effect of solar radiation that affects the biological functions, but after day 30 the shorn ewes had higher values. These differences might be due to an increase in the plasma concentrations of thyroid hormones in shorn animals as Symonds et al. (1989) found in a previous study.

There is a statistically significant effect of time on all parameters considered. The variation in time is not probably due to the 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 of these modifications.

In conclusion it can be affirmed that the shearing, to which the ewes were subjected, induced adaptive metabolic responses in the organism. Both shorn and unshorn ewes are subject to a heat stress, but the higher sensitivity of shorn ewes to heat stress is evident in comparison with unshorn ones. So, shearing induces modifications of some haematochemical parameters; in fact in the hot environment unshorn ewes were found to be more tolerant than shorn ewes (Piccione et al., 2006).

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