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Evaluation of dietary vitamin E and selenium supplementation on physiological and fertility potential of indigenous breeds of sheep under heat stress

Shakirullah^{1*}, M. Subhan Qureshi¹, Ghufuranullah², Sohail Akhtar¹, Ijaz Ali³

¹Department of Livestock, Breeding and Genetics, University of Agriculture, Peshawar, Pakistan

²Directorate of Livestock and Dairy Development, Peshawar, Pakistan

³IBGE, The University of Agriculture, Peshawar, Pakistan

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Abstract

Sheep production is one of the critical part of agriculture, particularly in developing countries but heat stress leads to severe changes in the body functions causing a reduction in productivity, decrease in reproductive function, milk yield and weight gain of small ruminants. Therefore the present study was conducted to find the effect of vitamin E and Selenium (Se) on the physiological, hormonal and reproductive parameters in two breeds of sheep exposed to heat stress. A total of 40 sheep from each breed of Damani and Bukhai were selected. Each breeds was further divided into control and treated (vitamin E50 mg and Se 0.3 mg). All the three physiological parameters (pulse rate, respiration rate and rectal temperature) were significantly ($P<0.01$) lower in Damani breed as compared to Balkhi breed. Significantly high concentration of T₃ and T₄ ($P<0.01$) was found in Damani sheep compared to Balkhi. Similarly, T₃ and T₄ increased significantly ($P<0.01$) in the vitamin E and Se supplemented sheep compared to the control. Conception rate, abortion, twinning, still birth and live birth were significantly higher in Damani sheep. Similarly, it is also clear that the supplementation improved these parameters in both sheep breeds. From the results of the current study, it was concluded that improved feeding plan along with dietary supplementation of vitamin E plus selenium during heat stress improved the physiological, hormonal, fertility and growth rate parameters of both breeds of sheep. Also it was found that Damani sheep were stronger in tolerating heat stress than Balkhi sheep.

* Corresponding Author: Shakirullah ✉ rukhhhan@gmail.com

Introduction

Thermal comfort for livestock has crucial role which mostly depends upon species, breed and health (Khan *et al.*, 2011; Khan *et al.*, 2014; Laudadio *et al.*, 2012; Zia ur Rehman *et al.*, 2017). Thermal stress is one of the chief alarms of the livestock industry, which badly disturbs their health and productivity (Khan *et al.*, 2012; Alhidary *et al.*, 2016a; Ihsanullah *et al.*, 2017; Shakirullah *et al.*, 2017). Generally, for adult sheep the tolerance level of temperature ranges from 12 to 32°C (Cwynar *et al.*, 2014). For the optimum performance of adult sheep the National Research Council National Research Council (2007) has recommended the nutrient requirements, however, the physical and reproductive capacity of sheep is negatively affected.

Therefore, sheep may be supplemented with some feed supplements to improve the production and reproduction (Alhidary *et al.*, 2016a; Abdurrahman *et al.*, 2017ab). Hence, for the optimum performance and health, the diet of sheep must be supplemented with advanced nutritional formulation and identification of heat tolerant breeds (Alhidary *et al.*, 2016b).

Antioxidants are the nutrients which are necessary to wash cells of reactive oxygen species (Khan, 2011; Khan *et al.*, 2013a, 2014a). Vitamin E and C are distinct examples of antioxidants (Khan *et al.*, 2012b; Khan *et al.*, 2013b). In sheep, the diet supplementation with vit E plus Se may improve the negative influence of heat stress on redox homeostasis in sheep (Chauhan *et al.*, 2014).

The productive and reproductive performance of Baldi sheep may be improved with the supplementation of vitamin E and selenium in summer season (Shahat *et al.*, 2011). The combination of vitamin E and Se has important useful effects than Se alone (Shakirullah *et al.*, 2017).

The objective of the present work was to evaluate the effect of vitamin E and Se on some physiological parameters, metabolic hormones and reproductive

efficiency of Balkhi and Damani sheep under heat stress.

Materials and methods

This experiment was approved by the departmental committee on ethics and welfare of animal approved by the Faculty of Animal Husbandry and Veterinary Sciences, The University of Agriculture Peshawar.

The experiment was conducted at livestock research and development center Paharpur in semi-intensive system of rearing (SIS). The SIS comprises, proper management, vaccination, well-constructed sheds with adjacent sufficient open grazing area. Green forages were provided ad lib and concentrates at the rate of 500 g per day/animal.

A total of 20 Damani and Balkhi (3–4 years old) breeds of sheep, which were non-pregnant healthy and multiparous and with almost similar initial body weight (Damani, 36 ± 2.3 kg, Balkhi, 43 ± 1.2 kg). The sheep were further sub grouped such that each group carried equal number of sheep in the control and treated group (n=10).

The sheep were fed green grass (ad libitum) and a concentrate (500 g/day/sheep) diet in a ratio of 3:1. Furthermore, Se (0.3 mg) and vitamin E (50 mg/kg) were also supplemented to the treated sheep. The treatment was continued for 4 weeks.

Measurement of temperature and humidity index (THI)

The climatic data were compiled on a daily basis by measuring the temperature and humidity at morning (08:00), noon (12:00 AM) and afternoon (04:00) using the formula described by Ihsanullah *et al.* [10]. $THI = (1.8 \times T \pm 32) - (0.0055 \times RH) \times (1.8 \times T - 26)$ where T is the temperature (°C), RH is the relative humidity (%) The average THI during the experimental period was 82.81. Sheep in both experimental and control groups experienced the same level of THI with the difference that the treated animals were supplemented with vitamin E and Se.

Physiological parameters

Pulse rate per min, respiration rate per min and rectal temperature were also recorded.

Fertility parameters

Data on following conception rate, live birth, still birth and abortion was recorded after implementation of improved feeding plan along with dietary supplementation of antioxidants.

Blood collection and analysis

After implementation of improved feeding plan along with dietary supplementation of antioxidants, blood samples (10 ml) were collected from each sheep on day 0, mid of the experiment (14 days) and at the end (28 days) of the study and then centrifuged at 3000

RPM for 10 min and stored at -20°C . Triiodothyronine (T₃) and thyroxin (T₄) were determined with help of commercial kits (Bio Check, USA).

Statistical analysis

Data were analyzed by Statistical Analysis System (SAS, 2004). P value less than 0.05 was considered statistically significant.

Results

Physiological parameters

The effect of treatments on Balkhi and Damani breeds at various days on respiration, rectal temperature and pulse rate during heat stress is given in Table 1.

Table 1. Means (\pm SE) of physiological parameters of different sheep breeds in treated and control group of animals at 14 days interval of sampling during stress (THI, 88.82). n=10.

Independent Variable		Respiration rate/min	Rectal temperature/min	Pulse rate/min
Breed	Balkhi	56.40 \pm 1.92	103.50 \pm 0.1	74.56 \pm 1.09
	Damani	49.43 \pm 1.66	103.00 \pm 0.12	70.53 \pm 0.69
	P-Value	<0.01	<0.01	<0.01
Group	Treated	46.53 \pm 1.63	102.92 \pm 0.13	69.40 \pm 0.76
	Control	59.30 \pm 1.35	103.58 \pm 0.16	75.70 \pm 0.82
	P-Value	<0.01	<0.01	<0.01
Day	Day-0	52.70 ^a \pm 1.59	103.30 ^a \pm 0.20	72.25 ^a \pm 1.59
	Day- 14	53.45 ^a \pm 2.69	103.23 ^a \pm 0.17	73.60 ^a \pm 1.22
	Day- 28	52.60 ^a \pm 2.63	103.22 ^a \pm 0.21	71.80 ^a \pm 2.63
	P-Value	0.3	0.43	0.11
Breed \times group		<0.14	<0.97	<0.18
Group \times day		<0.14	<0.97	<0.18
Breed \times group \times day		<0.43	<0.21	<0.68

All the three physiological parameters (pulse rate, respiration rate and rectal temperature) were significantly ($P < 0.01$) lower in Damani breed as compared to Balkhi breed, which clearly indicated that Damani is more tolerant as compared to Balkhi breed. There was no significant difference in these parameters on different days of the supplementation. Interaction was also not significant.

Metabolic hormones

The result of metabolic hormones in Balkhi and Damani sheep is given in Table 2. The blood concentration of T₃ and T₄ was significantly ($P < 0.01$) high in Damani sheep compared to Balkhi. In addition, T₃ and T₄ were significantly ($P < 0.01$) high

in the treated sheep compared to the control. At various days, there was no significant difference between the treated and control group in these parameters.

Fertility and growth parameters

The effect of vitamin E and Se on fertility parameters are given in Table 3. The results indicated that various parameters such as conception rate, abortion, twinning, still birth and live birth were significantly higher in Damani sheep. Similarly, it is also clear that the supplementation improved these parameters in both sheep breeds.

Table 2. Means (\pm SE) of metabolic hormones of different breeds of sheep in different treated and control group of animals at 14 days interval of sampling during stress (THI, 88.82). n=10.

Independent Variable		T3 (nmol/l)	T4 (nmol/l)
Breed	Balkhi	50.01 \pm 1.29	1.08 \pm 0.02
	Damani	59.87 \pm 1.19	1.42 \pm 0.02
P-Value		<0.01	<0.01
Group	Treated	61.00 \pm 1.06	1.38 \pm 0.03
	Control	48.88 \pm 1.04	1.12 \pm 0.03
P-Value		<0.01	<0.01
Day	Day-1	55.62 ^a \pm 1.72	1.24 ^a \pm 0.05
	Day- 14	54.89 ^a \pm 2.00	1.26 ^a \pm 0.04
	Day- 28	54.32 ^a \pm 1.96	1.25 ^a \pm 0.05
P-Value		<0.01	<0.01
Breed \times group		<0.01	<0.01
Group \times day			<0.90
Breed \times day \times group		<0.01	

The effect of vitamin E and Se on growth parameters are given in Figure 1. The results indicated that various parameters such as birth weight (B.WT), weaning weight (W.WT), daily weight gain (D.WT.G)

and adult weight (AD.WT) were significantly higher in Damani sheep. Similarly, it is also clear that the supplementation improved these parameters in both sheep breeds.

Table 3. Percentage values of fertility parameters in different breeds of treated and control group of animals during stress (Temperature Humidity Index (THI), 88.82). n=10.

Independent Variable	Conception rate (%)	Abortion (%)	Twining (%)	Still birth (%)	Live birth (%)	
Breed	Balkhi	90	02	00	02	96
	Damani	96	01	20	01	100
	P-Value	<0.05	<0.05	<0.05	<0.05	<0.05
Group	Balkhi	100	00	00	00	100
	Treated					
	Balkhi	90	02	00	02	96
Control						
	Balkhi	90	02	00	02	96
	P-Value	<0.05	<0.05	NS	<0.05	<0.05
Group	Damani	100	00	50	00	100
	Treated					
	Damani	96	01	20	01	100
Control						
	Damani	96	01	20	01	100
	P-Value	<0.05	<0.05	<0.05	<0.05	NS

CR = conception rate, AB = abortion, SB = still birth, LB = lives birth %.

Discussion

Physiological parameters

To assess the harmful effect of heat stress, pulse rate,

rectal temperature and respiration rate are the important indicators of thermal stress (Al-Haidary, 2000; Srikandakumar *et al.*, 2003). From the results

of physiological parameters it is clear that Damani breed is stronger in tolerating the heat stress as compared to Balkhi breed. Remarkably, the joint effect of vitamin E and Se reduced the respiratory rate demonstrating the encouraging effect in alleviating the severity of the heat stress. During heat stress, increased rectal temperature and respiratory rate were also reported in different breeds of sheep (Sivakumar *et al.*, 2010; Alhidary *et al.*, 2012).

Reduced values of all physiological parameters in the supplemented animals compared to the control may be due to the vitamin E plus Se. Chauhan *et al.* (2014) recorded decreased respiratory rate and rectal temperature in Merino 9 Poll Dorset crossbred ewes exposed to heat stress and supplemented with antioxidants. Similarly, Alhidary *et al.* (2012)

reported reduced rectal temperature by 0.3°C in Australian Merino sheep under heat stressed condition. Sivakumar *et al.* (2010) concluded that vitamin E, Se and vitamin C supplementation may improve the physiological parameters of heat stressed Black Bengal goats. Decreased concentration of blood cortisol was reported by the supplementation of various antioxidants (vitamin E, C and Se) in Black Bengal and Malpura goats (Sivakumar *et al.*, 2010; Sejian *et al.*, 2012). The thyroid hormones are critical to the thermal stress, which modulates the general metabolism and developmental processes (Rasooli *et al.*, 2004). Furthermore, in the present study, sheep in the treated groups were benefited from the combined supplementation of vitamin E plus Se during heat stress.

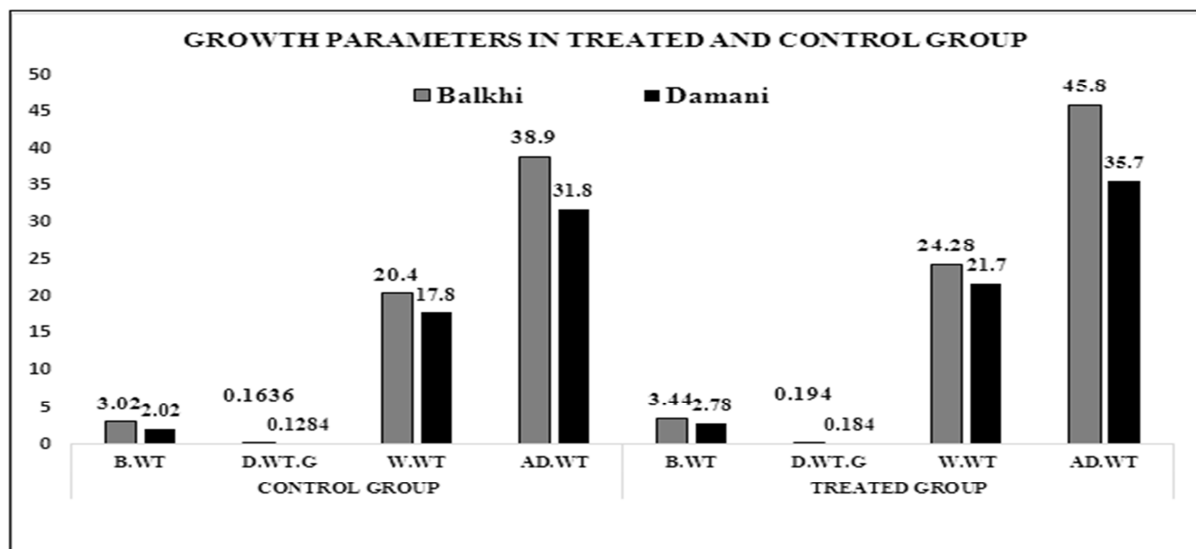


Fig. 1. The effect of vitamin E and Selenium on the reproductive parameters of sheep.

Fertility and growth parameters

Fertility and growth rate parameters were severely affected by thermal, nutritional and physical stress resulting into decreased productive and reproductive performance. Improved feeding plan along with antioxidant supplementation had an optimizing effect on fertility and growth rate parameters during heat stress. In this study a significant ($p < 0.05$) increase in growth rate and fertility parameters were observed in different breeds and groups (treated and control).

Increased values of growth rate parameters like birth weight (12.2%), daily weight gain (15.9%), weaning weight (15.9%) and adult weight (15%) were observed in Balkhi sheep of treated group as compared to control (SIS) group. Similarly corresponding increased values for Damani sheep is 27.3%, 30.4%, 17.9% and 10.9% were recorded respectively in treated group. Improved values of fertility parameters like conception rate (10%), live birth (4%), still birth reduced (10%), abortion reduced (100%) and twinning (0%) were observed in treated Balkhi sheep as compare to control group. In the same way, for local

Damani breed the conception rate improved 4%, live birth 0%, still birth reduced 100%, abortion reduced 100% and twinning 50% were observed as compared to control group of SIS. Capper *et al.* (2005) recorded a significant raise in lamb birth weight resulted from rising the dietary vitamin E supplementation to the ewe as shown in the present study. A notable improvement in the lambing rates was also recorded by Shahat and Monem (2011) in Se + vit E2 groups which strongly support our study. They also recorded lower percentage (62.5%) in control group as shown in control group (96%) of our study. Our findings are in accordance with the results of Shahat and Moneme (2011) who recoded average body weight of lambs born to (Se + vit-E2) supplemented groups were significantly higher ($p < 0.05$) than those in control. It means that vitamin E plus selenium supplementation improved the metabolic hormones and hence improved values of fertility and growth parameters. In the current study thirty percent (30%) twinning were higher/boosted in treated group animals as compared to control group might be the effect of NRC standard feed along with supplementation of vitamin E plus selenium which supported by findings of Shahat and Moneme (2011). They reported that the frequency of ewes bearing twin was noted to be higher in groups supplemented with Se and vitamin E.

Conclusion

From the results of the current study it was concluded that supplementation of vitamin E plus selenium during heat stress improved the physiological, hormonal, fertility and growth rate parameters of both breeds of sheep. In addition, Damani sheep were more tolerant to heat stress than Balkhi sheep.

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