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EFFECTS OF THE GENOTYPE AND THE SEASONS ON PHYSIOLOGICAL PARAMETERS RELATED WITH ADAPTABILITY IN SHEEP IN MEDITERRANEAN CLIMATE CONDITIONS

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Abstract. Climatic conditions, the weather temperature is directly related with the performance of the animals. In general, the negative effects of the high temperature are more significant than the effects of low temperatures. In this study, seasonal variations of body temperature, heart rate, respiratory rate, serum T3 and T4 levels were investigated on Karya, Kivircik and Karacabey Merino sheep in Mediterranean climate conditions. The aim of the study was to describe the stress in animals due to high temperatures all through the year with regard to some physiological and hormonal parameters. In general, heart rates in the spring, the summer, the autumn and in the winter seasons were found as 108.53, 100.10, 101.10 and 107.30 units/min.; the respiratory rates were found as 60.15, 78.99, 56.40 and 46.97 breaths/min.; the body temperatures were recorded as 39.67, 39.49, 39.36 and 39.60 ºC, and the serum T3 levels were found as 1.35, 1.20, 0.95 and 1.54 ng/ml; and the serum T4 levels as 73.90, 61.29, 50.67 and 63.49 ng/ml, respectively. Seasons were found effective on respiratory rates, on body temperatures and on serum T3 and T4 levels. The Genotype trait created differences only on serum T3 and T4 levels. When the so- called seasonal changes in some parameters like respiratory rate were taken into account, it could be said that animals were affected by the high level of ambient temperature in the summer season. Karacabey Merinos displayed reactions to seasonal climatic changes similar to Karya and Kivircik reactions with regard to the physiological parameters and thyroid hormone levels that were dealt with in this study and that are the indicators of the adaptation to the seasonal environmental conditions.

Key words: Sheep, Genotype, Physiological Parameters, T3, T4

Introduction. In breeding, environmental conditions have extremely significant characteristics with regard to both the activities and the productivity of the animals. Factors affecting their performance are various. According to Marai et al. (2007), thermal tolerance, longevity and adaptation have direct relationships with physiological responses of the animals to their environmental conditions, such as temperature, humidity and solar radiation. In addition, it is known that animals respond differently when they are frequently exposed to environmental factors that can affect physiological traits, behavior and productivity (Alvarenga et al., 2013). Thermal, nutritional, and walking stress significantly affect the body weight, the respiratory rate, the heart rate, the rectal temperature, and some blood parameters in sheep significantly (Sejian et al., 2013).

Climatic factors are in the first place among those conditions mentioned above. It is impossible to change weather conditions in desired ways. However, it is possible to take some precautions against some of those conditions that give negative effects on animals Extreme climatic conditions could lead to significant changes in the productivity and in the health of the animals. Thought as the first among those climatic conditions, the weather temperature is directly related with the performance of the animals. In general, the negative effects of the high temperature are more significant than the effects of low temperatures. The effects of high temperature are also related with humidity, which is another significant climatic factor. The negative effects of the humidity, together with an increase in the weather temperature, are naturally bigger.

Like in the other species, sheep try to adapt themselves to altering environmental conditions, as the climatic conditions reach beyond the optimal boundaries.

Different animal species develop some behaviors when they are exposed to different environmental stresses in different environment and production conditions, and they can sustain their existence and production through changes in various biological systems such as pulse and respiratory speeds, body temperature, wool fiber change, and blood hormone levels. The type of the stress, its level, and the measures to be taken could be determined by observing, measuring and evaluating the changes in these biological systems. The physiological reactions to stress are generally displayed by the levels of rectal temperature, respiratory heart rate and blood pressure. In addition, stress levels could also be determined by measuring some metabolic and endocrinological values (Pehlivan – Dellal, 2014). Utilization of both physiologic and bio-chemical parameters to estimate the stress could provide more accurate values in determining the stress levels.

In sheep, a number of changes are observed physiologically under the effects of extremely hot weather. Rectal temperature is usually used for practical purposes in the determination of the core temperature of the animals (Nielen, 1995). Although it indicates variations throughout the year, the rectal temperature is generally lower in the winter than in the summer.

Another physiological criterion that shows the adaptation level of the animal to the environmental conditions is the respiratory rate. When animals are exposed to environmental temperature over the comfort level, the very first reaction to this hardship is the increase in the respiratory rate (Koylu, 2009). That means, the breathing speed is also one of the indicators of temperature stress (Habbeb et al., 1992). During the summer months, the respiratory rate in moving sheep is higher than the rate in the winter (Abi-Saaband – Saleim, 1995). When the relative humidity is added into the high ambient temperature, the respiratory rate of the sheep increases much more.

Although the heart rate is a metabolic case, it is also the reflection of the blood circulation. It generally increases in high environmental temperatures as well. This ends up giving off more heat from the body, increasing the blood flow from the cells to the surface of the body in felt or unfelt methods. Occasionally, heart rate has been recorded as decreased in extremely high temperatures due to the slowing down of the metabolic rate (Marai et al. 2007). However, some other studies conducted on the issue have proven that high environmental temperature has not changed significantly (Koylu, 2009).

The measurement of the heat stress in sheep facilitates the determination of the welfare level. Stress could prevent regular functions of the body in animals influencing hormonal secretions negatively. For this reason, in addition to the behavioral or physical characteristics, hormonal reactions are also taken into account (Taskin et al., 2008). When warnings get preventive in conducting the normal functions of the body, homeostatic operations turn out to be insufficient in conducting these normal functions. In this respect, Adrenocorticotropic hormone (ACTH), Glicocorticoids, Catecolamines, Prolactine, Tiroid Hormones are secreted at certain levels during stress conditions. While the effectiveness of the Thyroid gland increases in colder regions, it decreases in hot environments (Taskin et al., 2008). Thyroid hormones have an essential role in thermoregulation and homeothermy (Koluman – Daskiran, 2011).

When hot temperatures seen in Aydin Province during the summer months combine with the relative humidity, they could cause negative effects on the sheep. Karya sheep was cross bred type (Chios X Kivircik) Kivircik genotype, which is prevalent in the Marmara Region, is preferred by the breeders particularly living in the regions of high altitude. Karacabey Merino sheep (90-95% Merinolandschaf and 5-10 % Kivircik) were purchased from the Karacabey Agriculture Enterprise, Bursa and were brought to Aydin in 2011. Although the Mediterranean Climate prevails in the region, where Karacabey Merino genotype is the prevalent bred, this region is a kind of a transition area to the Black Sea Climate. The annual rain is between 456.2 – 1217.4 mm. Karya genotype is usually raised in plain areas in Aegean Region, and Kivircik, on the other hand, is the genotype generally preferred in high altitude mountainous regions where maintenance and feeding conditions are limited. The Mediterranean Climate prevails in the region where both of these genotypes are raised. The annual mean temperature is around 28 ºC and winters are warm and rainy and summers are hot and dry. The falling amount of rain annually is 580-1000 mm.

With this study, conducted on Karya, Kivircik and Merino sheep in a farm doing extensive breeding, it was aimed to determine the seasonal alterations in the body temperature, in the pulse and respiratory rates, and in some hormones (T3 and T4), which are accepted to be related with stress. The stress, particularly appearing in the summer due to the hot temperatures, was tried to be defined in the light of the pre-mentioned characteristics. In addition, the local breeds Karya and Kivircik were compared with Merino sheep with regard to their levels in adaptation to seasonal climatic changes.

Material and Method

The study was conducted on a private semi-extensive sheep breeding farm in the town of Kosk of Aydin province in Aegean Region, Turkey, whose location is 37°49′ 51.82″N and 28°03′08.40″E. It is 48 m above sea level. The animals of the study consisted of 14 Karya, 11 Kivircik and 14 Karacabey Merino sheep. The farm where this study was conducted is a member of the Association of Breeders for Breeding Sheep and Goats in Aydın. All of the sanitary and veterinary recordings on this farm are kept according to the regulations and principles brought by the Ministry of Agriculture. All of the animals were chosen from healthy ones according to ministry records. Prior to the study, all experimental procedures were reviewed and approved by the Animal Ethics Committee of Adnan Menderes University, Aydin, Turkey (Approval No.B.30.2.ADU.0.00.00.00/050.04/ 2012/111).

At the beginning of the study, the animals were around 1-and -a half year old. During all the 12 months period long, during which the study was conducted, the animals had the same physiological (pregnancy, birth, lactation, etc.) characteristics. During the study, the animals were kept in a half-open pen. The sheep were tried to be grazed in an area belonging to the farm as long as the conditions were convenient. By means of an instrument, Hobo U12 model, the data related with ambient temperature and relative humidity were recorded all the year long. Temperatures and relative humidity values were also recorded particularly once more on the days and at the hours when the checks were done. In addition to these, making use of the mean temperature and relative humidity values for the mentioned times, Temperature Humidity Indexes (THI) were calculated according to the equation below (Marai et al., 2000; Marai et al., 2007)

$$THI = db\ ^{\circ}C - \{(0.31-0.31RH)\ (db\ ^{\circ}C-14.4)\}$$

In this Formula; db means dry thermometer temperature (˚C) and RH means Relative Humidity (%)

If $THI<22.2^{\circ}C$, then it is accepted there is no temperature stress;

If $22.2^{\circ}C<THI<23.3^{\circ}C$, then it indicates a medium degree temperature stress;

If 23.3˚C<THI<25.6˚C, then it means there is a strong temperature stress;

If 25. 6 ˚C ≤THI, then we should talk about an extreme temperature stress.

The study material sheep were not applied a different feeding program other than the one used in the farm. The experiment started in April. Compiling the data was planned to be carried out once between the 10th and the 15th days of October, January, April and July. Winter coincides with a period when the animals are in cold environmental conditions, spring and falls coincide with a period when they are in the comfort zone, and summer coincides with a period when the temperature strain is at the maximum level. 6 hours before the measurements were taken the animals were put in another section separated from the group. In this frame, in the afternoon between 13:00 and 15:00, measurements related with the rectal temperatures, heart rates and respiratory rates, were done and 10 ml blood samples were taken from each sheep. The animals were tried to be caught in the section where they were kept by their accustomed keepers without causing extensive activities and the measurements were done after 1-2 minutes pauses. Heart rates and respiratory rates were taken with the help of a stethoscope from the left front leg's junction point to the body for one minute long. Rectal temperature was taken from the rectum using a digital thermometer.

Blood samples (10 ml for each sheep), taken from the neck veins (vena jugularis) were centrifuged at 3500 rotate per minute for 15 minutes, and the separated serums were immediately put in a deep freeze at -80 ºC and kept there until they were analyzed. (Total Triiodothyronine (T3), Thyroxine (T4), analyzes were done in Elisa Device and used Cusabio kit for sheep in the Biochemistry Lab of the Veterinary Faculty of ADU using Immunoassay technique.

After all the measurements were done, each animal was weighed with an electronic scala.

The statistical analyses of the characteristics mentioned above were done according to the Repeated Data Model with Proc. Mixed Procedure included in the SAS (1999) packet Program, by taking the genotypes and live body weights into account.

Results

1.Climatic Data

The data related with the temperature, the relative humidity and the temperature-humidity index were summarized in Table 1as not only mean monthly values, but also as the values taken on the day and at the hour of the checks in the pen in which the study conducted.

2.Physiological Characteristics

Heart rate, respiratory rate and rectal temperature are the characteristics mostly tackled as physiological criteria related with stress. Findings of the analyses of the factors affecting the physiological parameters and serum hormone levels are presented in Table2.

2.1.The Heart rate

The heart rate was not influenced significantly for breed, season and live weights of the sheep ($p<0.05$). The respiratory rate was affected by the season and by live weight values at a significant level ($p<0.0001$) as seen in Table 2.

Table1. **Climatic parameters in the study unit during check periods**

Seasons	Mean Tem (ºC)	Min. Tem. (ºC)	Max. Tem. (ºC)	Mean. Hum (%)	THI
Falls					
September	17.10	4.41	31.88	60.66	16.80
Check Day	14.95	6.67	26.10	64.59	14.89
Check Hour	23.87			34.23	21.88
Winter					
January	10.89	1.11	20.04	75.66	11.07
Check Day	11.96	9.96	15.47	81.50	12.10
Check Hour	13.97			74.45	14.00
Spring					
April	17.49	5.96	36.40	63.81	17.15
Check Day	14.45	7.78	20.71	61.54	14.33
Check Hour	20.36			45.70	19.34
Summer					
July	28.67	16.62	39.84	50.08	**26.38**
Check Day	28.91	22.33	35.43	62.64	**27.17**
Check Hour	34.80			45.13	**31.33**

Least square means related with the heart rates in Kivircik, Karya and Merino sheep according to seasons are given in Table 3.

Generally, the average heart rate per minute belonging to the three genotypes are 108.53, 100.10, 101.10 and 107.30 beats in the spring, the summer, the falls and the winter, respectively. The heart rate did not significantly change according to seasons in sheep genotypes. On the other hand, among the genotypes, no significant change was performed.

2.2. Respiratory Rate

Least square means related with the respiratory rates according to seasons in the research material sheep are given in Table 4.

In Table 4, the seasonal averages belonging to the three genotypes, the average respiratory rate in the spring, in the summer, in the falls and in the winter were found as 60.15, 78.99, 56.40 and 46.97 times respectively. These values found for all seasons were seen to be higher than the standard respiratory rates for sheep.

2.3.Rectal Temperature

Rectal temperature was affected quite significantly ($p<0.0001$) by the season. On the other hand, the genotype effect was found insignificant ($P<0.05$) in Table5.

3.Serum T3 and T4 Levels

Serum T3 level was affected by season ($p<0.0001$) and serum T4 level was affected by both season ($p<0.0001$) and by genotype ($p<0.0144$) significantly In Tables 6 and 7. Evaluation results of the seasonal changes of serum total T3 and T4 levels, which were accepted to be related with thermal stress, were given in Table 6 and Table 7.

Table2. **Evaluation results related with the effects of the factors taken into account for the mentioned characteristics**

Characteristic / Factor	Season	Genotype	Live Weight (kg)	Season X Genotype
Heart rate	p=0.1245	p=0.7267	p=0.7377	p=0.3105
Respiratory Rate	**p<0.0001**	p=0.7800	**p<0.0001**	p=0.5261
Body Temperature	**p<0.0001**	p=0.5547	p=0.4721	p=0.8707
T3	**p<0.0001**	p=0.0791	p=0.0504	**p=0.0031**
T4	**p<0.0001**	**p=0.0144**	p=0.2604	**p<0.0001**

Table3. **Least square means related with the heart rates and standard errors (beats/min)**

Genotype	N	Seasons Spring	Summer	Falls	Winter	Average
Kivircik	11	105.46 ± 5.99	104.00 ± 5.97	99.44 ± 5.97	103.63 ± 5.96	103.13 ± 2.81
Karya	14	114.03 ± 5.54	91.89 ± 5.52	103.02 ± 5.40	114.85 ± 5.29	105.95 ± 2.69
K. Merinos	14	106.11 ± 5.42	104.40 ± 5.42	100.83 ± 5.42	103.42 ± 5.59	103.69 ± 2.77
Average	39	108.53 ± 3.20	100.10 ± 3.19	101.10 ± 3.19	107.30 ± 3.25	

Table4. **Least square means related with the respiratory rates and standard errors (breaths/min)**

Genotype	N	Seasons Spring	Summer	Falls	Winter	Average
Kivircik	11	58.28 ± 4.78^{a}	84.38 ± 6.32^{b}	58.50 ± 4.46^{a}	45.01 ± 4.02^{a}	61.54 ± 3.56
Karya	14	61.77 ± 4.40^{ab}	75.82 ± 5.72^{b}	57.66 ± 4.04^{ab}	51.76 ± 3.57^{a}	61.75 ± 3.24
K.Merino	14	60.40 ± 4.31^{ab}	76.77 ± 5.67^{b}	53.03 ± 4.05^{a}	44.14 ± 3.74^{a}	58.59 ± 3.28
Average	39	60.15 ± 2.56^{a}	78.99 ± 3.38^{b}	56.40 ± 2.38^{a}	46.97 ± 2.19^{c}	
a,b,c:The difference between averages carrying a different letter in the same row or column in a month are significant.(P<0.05)						

Table5. **Least square means related with the rectal temperature and standard errors (°C)**

Genotype	N	Seasons Spring	Summer	Falls	Winter	Average
Kivircik	11	39.70 ± 0.09	39.44 ± 0.09	39.43 ± 0.09	39.67 ± 0.09	39.56 ± 0.06
Karya	14	39.68 ± 0.09^{a}	39.56 ± 0.09^{ab}	39.35 ± 0.08^{b}	39.58 ± 0.08^{ab}	39.54 ± 0.06
K.Merino	14	39.63 ± 0.08	39.47 ± 0.08	39.32 ± 0.08	39.55 ± 0.09	39.49 ± 0.06
Average	39	39.67 ± 0.05^{a}	39.49 ± 0.05^{bc}	39.36 ± 0.05^{c}	39.60 ± 0.05^{ab}	
a,b,c:The difference between averages carrying a different letter in the same row or column in a month are significant (P<0.05).						

Table 6. **Least square means related with Serum T3 Hormone levels and standards (ng/ml)**

Genotype	N	Seasons Spring	Summer	Falls	Winter	Average
Kivircik	11	1.45 ± 0.07^{a}	1.32 ± 0.05^{a}	0.97 ± 0.03^{b}	1.56 ± 0.12^{a}	1.32 ± 0.04^{a}
Karya	14	1.33 ± 0.06^{b}	1.13 ± 0.05^{b}	0.92 ± 0.02^{c}	1.76 ± 0.10^{a}	1.29 ± 0.04^{ab}
K.Merino	14	1.28 ± 0.06^{a}	1.14 ± 0.05^{ab}	0.97 ± 0.03^{b}	1.29 ± 0.11^{a}	1.17 ± 0.04^{b}
Average	39	1.35 ± 0.04^{b}	1.20 ± 0.03^{c}	0.95 ± 0.01^{d}	1.54 ± 0.06^{a}	
a, b, c; *A, B*: The differences between averages carrying a different letter in the same row or column in a month are significant. (P<0.05)						

Table7. **Least square means related with Serum T4 Hormone levels and standards (ng/ml)**

Genotype	N	Seasons Spring	Summer	Falls	Winter	Average
Kivircik	11	70.46 ± 4.56^{a}	64.81 ± 3.11^{a}	48.09 ± 3.01^{b}	82.53 ± 5.49^{aA}	66.47 ± 2.35^{A}
Karya	14	75.42 ± 4.19^{a}	63.54 ± 2.97^{ab}	52.02 ± 2.78^{b}	68.10 ± 4.87^{abA}	64.77 ± 2.21^{A}
K.Merino	14	75.84 ± 4.11^{a}	55.51 ± 2.87^{b}	51.90 ± 2.80^{b}	39.85 ± 5.10^{bB}	55.78 ± 2.27^{B}
Average	39	73.90 ± 2.44^{a}	61.29 ± 1.66^{b}	50.67 ± 1.61^{c}	63.49 ± 2.98^{b}	
a, b; *A, B*: The differences between averages carrying a different letter in the same row or column in a month are significant. (P<0.05)						

Discussion

1.Climatic Data

In the Aydin Province, the Mediterranean Climate is effective form of climate, which is hot and dry in the summer and warm and rainy in the winter. The hottest temperature is observed in July and the coldest in January in the province. According to the statistics of the State Meteorology Office, the average temperature level was recorded in July as 36.0 ^{o} C between 1954 and 2013 years (DMI 2015). As seen in Table1, the average monthly temperature in the pen was 28.67 ^{o} C, and this value is in harmony with the value of 28.4 ^{o} C given for the average for many years in Aydin (SMI 2015). The air temperature was always outside of the environmental comfort zone for sheep, of 24^{o}C to 27^{o}C, reported by Dickson (2006). When the temperature and the humidity were evaluated together, it was seen that the THI value was not at a level to create any kind of stress in the falls, winter and spring. However, when looked at THI values, Marai et al. (2007) noticed that the temperature and the humidity, two of the climatic factors, are at a level that could create an extremely violent thermal stress.

2.Physiological Characteristics*:*

2.1. Heart rate

Heart rate indicates how many times per minute the heart contracts, in other words the heart rate. As seen in Table 2, the heart rate was not influenced significantly for genotype, season and live weights of the sheep ($p<0.05$). On the other hand, that the heart rate displayed differences according to seasons or months was emphasized by many researchers (Ceyhan et al., 2006; Marai et al., 2007; Kayabasi, 2011; Yorulmaz, 2014).

That heart rate increases in high environmental temperatures was reported by Marai et al. (2007) based on various research findings. Similarly, Kayabasi (2011), too, reported that the heart rate was higher in June than in February and April in Cukurova and Balcali doeling.

On the other hand, it was also expressed that heart rate could decrease in extremely high temperatures due to the decline in the metabolic speed (Marai et al., 2007). Yorulmaz (2014), supporting the same thesis, measured the heart rate in Karya sheep lowest in the summer season and highest in the winter. Ceyhan et al., (2006) recorded the highest heart rates in winter months in a study they conducted on different genotypes. Researchers found the heart rates as 79.3 times/min in January, 77.4 times/min in April and 72.5 times/min in October (Ceyhan et al. 2006).

Heart rates in Kivircik, Karya and Merino sheep are 103.13, 105.95 and 103.69 respectively on average per minute. The heart rates were found by Demiroren et al. (2002) as 92.5 times/min in Tahirova sheep, as 93.50 in Chios sheep, and as 97.75 times/min in Sonmez lambs, which are the breeds belonging to the same region, under extreme temperature pressure, and Yorulmaz (2014) found it as 109.4 times/min in Karya yearlings. These results are in harmony with the ones we obtained in our study. Ceyhan et al. (2006) reported that the heart rates were 78.6 in Kivircik sheep, 75.1 in Black Headed German Meat Sheep, 76.3 in F_1 (BHG x Kivircik) and 77.4 in G_1 (BHG x F_1). Both these reports and the results Marai et al. (2007) found for different type genotype sheep on different conditions are lower than the ones found in this study.

2.2.Respiratory Rate

Respiration is one of the significant ways of temperature exhausting from the body. This is closely related with the environmental conditions. Table 2 clearly shows that the respiratory rate was affected by the season and by live weight values at a significant level .

There are various studies indicating the effect of the month or season on the respiratory rate values (Ceyhan et al., 2006; Marai et al., 2007; Yorulmaz, 2014). Srikandakumar et al. (2003) determined that the respiratory rate changed in December and in July in Omani and Australian Merino sheep. In a study conducted by Sejian et al. (2013) on Malpura sheep, the respiratory rates appeared to have changed between the morning and afternoon measurements. In a study carried out on goats (Kayabasi 2011), the season effect was found significant in Cukurova Saanen and Balcali genotype doeling.

As seen in Table 4, when looked at the seasonal averages belonging to the three breeds, the average respiratory rate in the spring, in the summer, in the falls and in the winter were seen as 60.15, 78.99, 56.40 and 46.97 times respectively. It could be said that the respiratory rate functions in similar processes according to seasons. The respiratory rate generally increased in parallel with the rise in temperature or THI in the summer, but recessed back to the lowest level in the winter. As for the spring and the falls, during which animals feel themselves more comfortable in view of climatic environmental conditions, similar values appeared. The seasonal change of the respiratory rate is as expected and is in harmony with the change in environmental temperature. It was observed that the higher the ambient temperature raised, the higher respiratory rate increased to meet the requirements of the thermal stress in sheep. It was reported that the thermal stress was characterized with the increase in the respiratory rate and was higher in the summer than in the winter (Marai et al., 2007). For the physiological parameters (respiratory rate and heart rate in afternoon hours), the values were found to be significantly higher under heat stressed condition for all the three breeds (Singh et al., 2016). Yorulmaz (2014) reported the respiratory rate in Karya sheep in April, July, September and January in the Aydin Province conditions as 60.8; 78.2; 51.2 and 42.5 respectively. As seen, the results are in the same parallel with each other. Srikandakumar *et al.* (2003) found that the respiratory rate per minute increased in hot conditions in Omani sheep and Australian Merino sheep and that it was 50 and 34 times in December; however, it was 128 and 65 times in July. On the other hand, Ceyhan et al. (2006) reported that the respiratory rate was the highest (81.5 times / min) in August when the temperature was measured high and the lowest (48.8 times / min) when the temperature was low in Kivircik, Black Headed German Meat sheep, F_1 (BHG x Kivircik) and G_1 BHG x F_1) sheep. Kayabasi (2011) observed that the respiratory rate increased in Cukurova Saanen doeling together with the temperature rise in February, April and June. The average respiratory rates per minute in Kivircik, Karya and Merino sheep in our study are 61.54, 61.75 and 58.59 times respectively. Yorulmaz (2014) found the average respiratory rate per minute for Karya yearlings as 56.3 times, Demiroren et al. (2002) found it in Tahirova and Chios sheep as 58.8 and 65.1 respectively (40-42 ^{o} C ambient temperature) and Ceyhan et al. (2006) found it for Kivircik, Black Headed German Meat (BHG x K) F_1 and (BHG x F_1) G_1 sheep as 50.37, 54.28 and 56.67 times/min respectively, all of which are similar results.

2.3. Rectal Temperature

Another physiological parameter, the rectal temperature, is usually used in determining the inner temperature of the animal. Sheep are quite homoeothermic, that is, they try to keep their body temperature in a particularly narrow range. Rectal temperature changes between 38.3 and 39.9 ^{o} C in thermo-neutral conditions (Marai et al., 2007). The sheep try hard to maintain their body temperature within a quite narrow range under negative climatic conditions. The rectal temperature alters between 38.3- 39.9 ºC in thermo-neutral conditions. An increase in the ambient temperature from 18 ºC up to 35 ºC causes an increase in the rectal temperature of the sheep as well. (Abdel-Samee, 1991; Shafie et al., 1994; Marai et al., 1997). In case the rectal temperature is 42 ºC, or over, it is accepted as life threatening. (Thwaites, 1985).

As could be understood from Table5, rectal temperature was affected quite significantly ($p<0.0001$) by the season. On the other hand, the genotype effect was found insignificant ($P<0.05$). It was reported by various studies that the body temperature changes due to the changes of climatic characteristics, the ones primarily in the ambient temperature and in the moist, during the day and at different periods of the year. Marai et al. (2007) observed that the rectal temperature increased due to the increase in the ambient temperature from 18 ^{o} C to 35 ^{o} C and it changed according to the seasons (summer and winter).While Ceyhan et al. (2006) found that the month affected the body temperature significantly in Kivircik, Black Headed German Meat (BHG x K) F_1 and (BHG x F_1) G_1 sheep, Kayabasi (2011) reported that the season was effective significantly on the same characteristics in Cukurova Saanen and Balcali doeling. Least square means related with the changes in the body temperature and in the genotype are given in Table 5.

In Table 5, the average rectal temperatures are 39.67, 39.49, 39.36 and 39.60 in the spring, summer, falls and winter respectively. The difference seen between seasons is due to the fact that body temperature of Karya sheep changes significantly throughout the year. During the falls, rectal temperature was definitely seen lower. On the other hand, it was higher during the winter and spring. For the other genotypes, the rectal temperature did not display a significant change. Pelibuey and seven Suffolk ewes were kept in a climatic chamber for 6 h daily during 10 days (temperatures within the 18 to 39.5 °C range). As chamber temperature rose, sheep rectal temperature increased in both groups (Romero et al., 2013). Kayabasi (2011) determined that the rectal temperature in goats increased during spring and summer months.

Yorulmaz (2014) found the rectal temperature in Karya yearlings as 39.39, 39.34, 39.40 and 39.55 ^{o} C in April, July, October and January respectively. The rectal temperature was reported to be high in the winter and low in the summer. Ceyhan et al. (2006) found the rectal temperature higher in the winter and in the first months of the spring than in the summer months in a study they conducted. Conversely, Marai et al. (2007) reported that the rectal temperature was lower in the winter than in the summer. Srikandakumar et al. (2003) determined the rectal temperatures as 39.5 and 39 in December and as 39.8 and 39.7 in July in Australian Merino and Omani sheep respectively and emphasized an increase in the rectal temperature under thermal stress. In a study, The average rectal temperatures in Kivircik, Karya and Merino sheep are close to each other as 39.56, 39.54 and 39.49 respectively. The average rectal temperatures were found as 39.37 ^{o} C by Yorulmaz (2014) in Karya yearlings and as 39.81, 39.97 and 40.30 ^{o} C in Tahirova, Chios and Sonmez genotypes respectively in 40-42 ^{o} C ambient temperature by Demiroren et al. (2002). Ceyhan et al. (2006), too, reported the rectal temperatures as 39.05, 38.99, 38.93 and 39.03 ^{o} C for Kivircik, Black Headed German Meat (BHG x K) F_1 and (BHG x F_1) G_1 sheep respectively. The results found in our study are in the natural range when compared with the info (Marai et al., 2007) that the rectal temperature changes between 38.3 and 39.9 ^{o} C in thermo-neutral conditions and with the other findings presented above.

4.Serum T3 and T4 Levels

It is known that Thyroid Hormones are among the significant modulators of the general metabolism and development processes (Nazifi et al., 2003). According to research findings, seasonal change has an effect on the activity of the Thyroid Gland and on blood thyroid hormone concentrations. Thyrothropin, and in this way Thyroid hormone secretion diminishes in case of many stress conditions such as too hot or humid weather. In that case, temperature production is lowered and metabolic speed decreases (Yilmaz, 1999). In Tables 6 and 7, it can be seen that serum T3 level was affected by season ($p<0.0001$) and serum T4 level was affected by both season ($p<0.0001$) and by genotype ($p<0.0144$) significantly. Evaluation results of the seasonal changes of serum total T3 and T4 levels, which are accepted to be related with thermal stress, are given in Table 6 and Table 7.

Serum T3 level displayed the same change according to seasons in all genotypes. It is highest in the winter and towards the falls from the spring the level goes a bit down in all genotypes. In the falls, serum T3 is in the minimum level.

Serum T4 level also decreased from the spring till the falls in all genotypes; however, the situation in the winter changed. While serum T4 level was increasing in Kivircik and Karya genotypes again, it continued to decrease in Merino genotype. That was, serum T4 level was the lowest in the falls for Kivircik and Karya, and close to each other in the other seasons. However, it was the highest in the spring for Merinos and higher than in the other seasons. In addition, both T3 and T4 levels were seen to be lower in Merionos than in the other two genotypes. Yorulmaz (2014) found that the effect of the season on the change of the T3 and T4 hormones in blood in Karya sheep in Aydin province conditions was significant, that T3 hormone was the highest in the winter and the lowest in the summer and that T4 hormone was higher in the spring and in the summer than the others. In the same study, serum T3 levels were reported as 2.27, 2.09, 2.39 and 5.06 ng/ml and serum T4 levels as 189.7, 204. 9,132. 8 and 161.5 ng/ml in the spring, summer, falls and winter respectively for Karya sheep. The so-called findings are higher than the concentrations obtained in this study. Marai et al. (2007) reported that T3 and T4 hormone levels were in the winter and low in the summer in a study he compiled from various sources. Similarly, in a study conducted by Elicin (2008) and referring to Todini (2007), it was reported that T3 and T4 hormone levels ascended in general in cold months in farm animals. These reports support the findings related with the seasonal change of T3 hormone level in this study. In another study, Nazifi et al. (2003) found T3 level as 1.41, 1.26 and 0.98 nmol/l and T4 level as 59.53, 49.46 and 42.44 nmol/l in cold, optimum and hot conditions respectively for Iran Fatty Tailed sheep and the levels of both hormones decreased together with the increase in the temperature.

Similar studies were also done on goats. In a study they conducted, Taskin et al. (2008) determined that T3 and T4 levels in the circulation decreased due to the rise in the ambient temperature. Polat and Dellal, (2008) found the general averages of the blood serums T3 and T4 as 131.92, 138.32, 109.59, 100.27 ng/dl and as 7.16, 8.35, 6.79 and 6.49 in May, June; July and August respectively in Ankara goat kids. It was determined that thyroid hormones were affected significantly by the high ambient temperature in July and August and their levels dropped. In contrast with the findings above, Yokus et al. (2006) found T3 level higher in April and in July than in October and January in Chios X Ivesi hybrid sheep. Thyroid hormones have an essential role in thermoregulation and homeothermy. Concentrations of thyroid hormones can change depending on the environmental conditions (Koluman and Daskiran, 2011)

Conclusion

In the study, some physiological parameters and levels of T3 and T4 serums were investigated in Kivircik, Karya and Merino sheep on a seasonal base. Values related with the heart rate did not change significantly according to the season or to the genotypes. The values obtained for the respiratory rate were in harmony with the expectations. The respiratory rate was fond higher in all genotypes in the summer due to the rise in the ambient temperature. In addition, all genotypes performed similarity for the respiratory rate in all seasons. Rectal temperature was seen apparently lower in the falls. This was due to the significant changes of the body temperature in Karya sheep according to seasons. Generally, rectal temperatures of the genotypes were close to each other. It could be said that the so-called genotypes kept their rectal temperatures in a balance against the changing environmental temperature and that they adapted to the changing seasonal conditions. Serum T3 and T4 levels displayed the same changes usually in all genotypes. They were the highest in the winter and gradually decreased from the spring towards the falls.

Karya and Kivircik are the prevalent genotypes in Aydin Province. Karacabey Merino sheep were brought to the farm where the study was conducted particularly because of their meat yield property. Karacabey Merinos displayed reactions to seasonal climatic changes similar to Karya and Kivircik reactions with regard to the physiological parameters and thyroid hormone levels that were dealt with in this study and that are the indicators of the adaptation to the seasonal environmental conditions. That is, it could be said that Karacabey Merino sheep have no adaptation problems related with the present climatic conditions in view of the parameters used. However, in order to be able to decrease the negative effects of high temperature on the sheep, some measurements could be taken, such as taking the animals to high altitude regions and grazing them during the night, providing wide and airy pens with canopies, providing clean water easily accessible clean water any time, convenient feeding programs, ventilation and douching.

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