*Anadolu Tarım Bilim. Derg., 2010,25(2):113-119*
*Anadolu J. Agric. Sci., 2010,25(2):113-119*

**Research**
**Araştırma**

# PHYSIOLOGICAL RESPONSES AND SOME BLOOD PARAMETERS OF BUCKS UNDER MEDITERRANEAN CLIMATE CONDITIONS

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**Received Date: 19.11.2009** **Accepted Date: 11.05.2010**

**ABSTRACT:** This research was carried out to compare the physiological responses between exotic and local bucks to reveal their adoptation to the Mediterranean region of Turkey. The effect of seasonal variation on rectal temperature (RT), respiration rate (RR), heart rate (HR) and some blood parameters were evaluated in Saanen (S), Hair (H), German Fawn x Hair (GF) and Damascus x Hair (DM) bucks. Blood parameters and physiological responses of bucks were measured three times in a day for one week periods in May, July and December.

The mean heart rate of Saanen (121 beats/min) was higher than Hair bucks (113 beats/min). Heat stress generally decreased the blood glucose levels and reached the highest levels in the mornings in December. Blood glucose concentrations were highest for H bucks (63.8 mg/dl) and lowest in S (34.7 mg/dl) in December. Total serum cholesterol (CHO) levels were found to be similar to blood glucose levels but increased mostly in S and H bucks when the environmental temperature decreased.

Given the blood parameters and physiological responses, it was determined that there were some differences related to blood and physiological parameters between local and exotic breeds. In addition, exotic breeds may adapt to the Mediterranean climate conditions and can be recommended by virtue of their improved performances.
**Key words:** Blood parameters, physiological responses, buck, Saanen, Mediterranean.

## AKDENİZ İKLİM KOŞULLARINDA YETİŞTİRİLEN TEKELERDE KİMİ KAN PARAMETRELERİ VE FİZYOLOJİK TEPKİLER

**ÖZET:** Bu çalışmada Akdeniz Bölgesinde yetiştirilen egzotik ve yerli ırkların bölgeye adaptasyonlarını incelemek için fizyolojik tepkilerinin karşılaştırılmıştır. Saanen (S), Kıl (H), Alman Alaca x Kıl (GF) ve Damaskus x Kıl (DM) tekelerinde mevsim değişikliğine bağlı olarak rektal sıcaklık (RS), solunup sayısı (SS), nabız hızı (NH) ve kimi kan parametreleri değerlendirilmiştir. Tekelerde ölçülen fizyolojik tepkiler ve kan parametreleri mayıs, temmuz ve aralık ayında 7 gün boyunca günde 3 kez alınmıştır.

Ortalama nabız hızı Saanen (121 adet/dak) tekelerinde Kıl tekelerine (113 adet/dak) göre daha yüksek bulunmuştur. Sıcaklık stresi genellikle kan glikoz seviyesini düşürmüş ve aralık ayının sabah ölçümlerinde en yüksek seviyeye erişmiştir. Glikoz konsantrasyonu aralık ayı ölçümlerinde en yüksek Kıl (63.8 mg/dl) en düşük ise Saanen tekelerinde (34.7 mg/dl) ölçülmüştür. Total serum kolesterol düzeyi (CHO) glikoz bulgularına benzerlik göstermiş olup çevresel sıcaklık azalmasına bağlı olarak daha çok Saanen ve Kıl tekelerinde artış göstermiştir.

Kan parametreleri ve fizyolojik tepkiler ışığında yerli ve egzotik ırkların farklılıklar gösterdiği saptanmıştır. Bunlara ek olarak egzotik ırkların Akdeniz Bölgesine adapte olabildikleri saptanmış ve daha yüksek performanslarından dolayı Akdeniz Bölgesi için önerilmelerinde sakınca görülmemiştir.
**Anahtar Sözcükler:** Kan parametreleri, fizyolojik tepkiler, teke, Saanen, Akdeniz.

## 1. INTRODUCTION

Goats are very important animals because of their favourable characteristics and capacity to adjust to harsh environmental (arid, semi-arid, tropical, sub-tropical, etc.) conditions throughout the world. The Mediterranean region of Turkey which has sub-tropical climate conditions (Keskin et al. 2006) has considerable goat potential. The Hair goat is the main breed in Turkey but increasing interest has been shown for other exotic breeds, e.g. Saanen, German Fawn, etc., owing to their high performance in terms of milk yield and multiple births compared with the Hair goat.

In tropical and sub-tropical regions high ambient temperature is the major constraint on animal production (Marai et al. 2007). This effect is aggravated when heat stress is accompanied by high ambient humidity. Excessive heat stress may cause hyperthermia and have several physiological side-effects and economic impacts on the livestock industry (Al-Tamimi, 2007). The ability of livestock to grow and produce to their maximal genetic potential is strongly related to the thermal environment. Body temperature, pulse and respiration rate are important physiological responses commonly used for adaptation parameters to environmental stress in small ruminants (Singh et al. 1982; Ross et al. 1985). Several researchers have studied physiological adaptation mechanisms such as rectal temperature, pulse rate and respiration rate in small ruminants (Marai et al. 2007; Jaber et al. 2004; Maurya et al. 2004; Srikandakumar et al. 2003; Sevi et al. 2001; Ogebe et al. 1996). On the other hand, blood glucose and total serum cholesterol levels are physiological adaptation mechanisms that can be affected by high ambient temperatures (Lu, 1989).

In the present study, the physiological adaptation parameters of goats under heat stress and thermal environment are highlighted. A few studies have been done to improve the performances of the local breeds through exotic breeds (Keskin et al. 2006) but there is still a need for comprehensive studies on physiological responses. Therefore, the objective of this study was to compare the physiological responses and blood parameters of exotic breeds with local goats raised in a Mediterranean climate in different seasons in order to find the adaptation potential.

## 2. MATERIALS AND METHODS

This experiment was carried out at the Research Farm of the Faculty of Agriculture in Cukurova University, Adana, which is located on the Mediterranean coast of Turkey. The mean climatic data of the region are shown in Figure 1. In total, 24 bucks, six from each breed (Saanen (S), Hair (H), German Fawn x Hair (GF) and Damascus x Hair (DM) breeds), were used in the study. All the bucks were two years old and weighed 42 to 45 kg. Animals were kept separately in semi-open pens, and fed with a concentrate diet and ad libitum with alfalfa hay. The digestible crude protein and energy contents of the concentrate were 16 % and 2647 kcal ME $kg^{-1}$, respectively. The diet was given to the animals at a rate of 500 g per day. The animals were monitored every day in the morning, at noon and afternoon during one week in May, July and December for rectal temperature (RT), respiration rate (RR) and heart rate (HR). RT was recorded by a digital thermometer, whereas RR and HR were counted for 15 seconds and multiplied by four with a stethoscope from the jointing point of left-front leg and body. Blood samples (10 ml) were collected in May, July and December three times a day for one week and analysed on the same day. To guarantee the reliability of the cardiac and respiratory data, animals were kept in individual pens. Blood was collected by jugular venipuncture into BD Vacutainer SST II tubes. All blood samples were maintained at room temperature until clotting, then centrifuged for 5 min at 5000 rpm. Total serum cholesterol (CHO) and glucose levels were measured by CHOD-PAP and GOD-PAP calorimetric analysers, respectively (Roche Hitachi Modular DPP).

### 2.1. Statistical Analysis

The assumptions for univariate test of repeated measures were tested and then both the univariate and multivariate tests were applied to a data set to compare the results. The General Linear Model (GLM) procedures of SPSS package for repeated measures were used. The Duncan Multiple Range Test was used to separate the means among the treatment groups.

The mathematical model for the analysis of experimental data was;

$$y_{ijkm}=\mu+\alpha_i+\beta_j+(\alpha\beta)_{ij}+\pi_{m(ij)}+\gamma_k+(\alpha\gamma)_{ik}+(\beta\gamma)_{jk}+(\pi\gamma)_{km(ij)}+(\alpha\beta\gamma)_{ijk}+e_{ijkm} .$$

where, $y_{ijkm}$: measured observation value on mth experimental unit within kth time within jth month within ith genotype. $\mu$ : population mean, $\alpha_i$ : effect of ith genotype, $\beta_j$ : effect of the jth month, $\alpha\beta_{ij}$ : interaction effect of ith genotype and jth month, $\pi_{m(ij)}$: effect of m$^{th}$ experimental unit under i$^{th}$ genotype and j$^{th}$ month (error I), $\gamma_k$ : effect of the k$^{th}$ time, $(\alpha\gamma)_{ik}$ : interaction effect of i$^{th}$ genotype and k$^{th}$ time, $(\beta\gamma)_{jk}$ : interaction effect of j$^{th}$ month and k$^{th}$ time, $(\pi\gamma)_{km(ij)}$: interaction effect of m$^{th}$ experimental unit and k$^{th}$ time under i$^{th}$ genotype and j$^{th}$ month, $(\alpha\beta\gamma)_{ijk}$ : interaction effect of i$^{th}$ genotype, j$^{th}$ month and k$^{th}$ time, $\varepsilon_{ijkm}$: error II which shows variability between error I and repeated factor time.

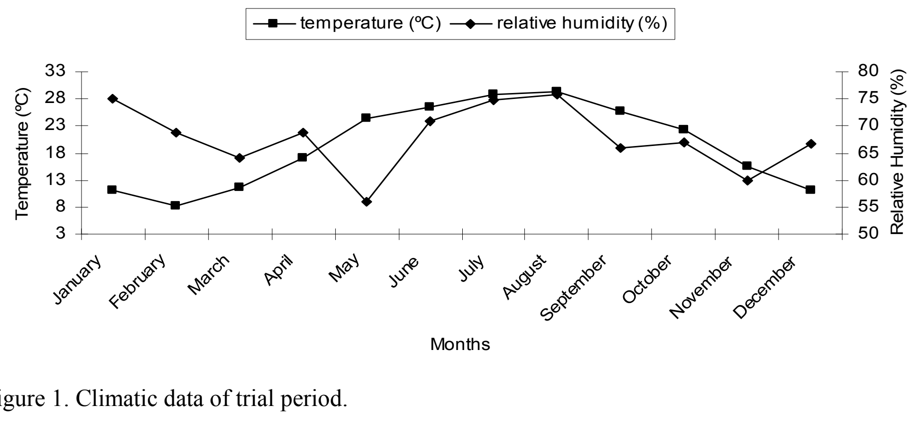


Figure 1. Climatic data of trial period.

## 3. RESULTS AND DISCUSSION

The effect of thermal environment on the changes in the physiological responses and blood parameters in bucks are set out in Table 1. RT and HR of the genotypes were similar (p>0.05). No significant difference was found among genotypes in RT, HR, and CHO. The least square means of RR and glucose was significant (p<0.05).

This kind of difference in various goat breeds was also reported in studies carried out in the Eastern Mediterranean region of Turkey (Keskin et al. 2006). The means for these parameters were determined as higher than that of the thermo-neutral zone reported by McDowell and Woodward (1982), who found that respiration rate was 25.3 per minute for goats in a thermo-neutral zone (comfort zone; 13-15 ºC). A higher respiratory rate in Saanen (54/min) suggests that this breed was more stressed than the other breeds.

The physiological adaptation parameters during the day at different observation times are shown in Tables 2, 3 and 4. Significant differences were observed in May and December in the mornings and in the afternoon of December observations among genotypes (p<0.05). According to the reports of Bianca and Kunz (1978), an increase in environmental temperature first affects pulsation number. Then, such a high pulsation number increases the rectal temperature.

Heat loss via high respiration number was reported as higher than that via other ways (Devendra, 1987). Blight (1985) reported that a daily change of respiration number per minute from the effect of environmental temperature does not show parallelism with change of body temperature and pulsation number. With the removal of this effect, animals go back to the former respiration number. Present results for different respiration numbers depending on time are in line with the reports of other researchers (Quatermain and Broadbend, 1974; Bianca and Kunz, 1978; Ogebe et al. 1996).

Rectal temperature is considered as a good index of body temperature even though there is a considerable variation in different parts of the body core at different times of the day (Srikandakumar et al. 2003). Hair bucks have shown a steady rectal temperature value because of their ability to adapt to the region's conditions. Because it is of oriental origin, the Hair goat is probably most suited to the subtropical climatic conditions. A similar steady rate was reported by Srikandakumar et al. (2003) for local and crossbred sheep. Rectal temperature of goats in the sub-tropical region was reported as 39.3 to 39.5℃ in several studies which were carried out to determine the effect of high environmental temperature on rectal temperature (Joshi et al. 1977; Bianca and Kunz, 1978; Devendra, 1987). The increase in rectal temperature in S and H bucks in summer was found to be lower than in other genotypes. The decrease in rectal temperature in December suggests a tendency to hypothermia in DM and GF bucks (Table 2).

Heart and respiration rates of bucks were increased by the effect of environmental temperature (Tables 3, 4).

No significant differences were observed in HR, except for morning observations in December. Respiration rate was significant among genotypes in July (p<0.05). When animals were exposed to direct sun, metabolic rate and body temperatures of black-haired goats increased, depending on oxygen intake. Such changes have been observed in black- haired goats which were exposed to high solar radiation levels (D'miel et al. 1980). Acharya et al, (1995) also reported that coat colour and hair length could affect these parameters. According to that report, short-haired goats had higher respiratory and heart rates than long-haired goats. Hair colour also has an effect on change of respiration and heart rate and rectal temperature.

No significant difference in interaction effect was determined between genotype x month x observation time. Tables 5 and 6 show the blood chemistry changes of bucks. Means of blood glucose levels were found significant among genotypes (p<0.05) (Table 6).

Blood glucose level reached higher levels in winter except afternoon observations. The highest blood glucose and serum cholesterol levels were determined in Hair bucks in December. The lowest CHO were determined in GF bucks when the environmental temperature decreased.

Table 1. Changes in the overall means and SE for physiological responses in bucks.

| Genotype | Rectal temp. | Heart rate | Respiration rate | Serum cholosterol | Glucose |
|---|---|---|---|---|---|
| S | 38.92±0.06 | 101±2.16 | 54.88±2.76$^{a}$ | 40.85±0.75 | 45.27±0.69$^{c}$ |
| H | 39.06±0.05 | 96.91±1.27 | 44.55±1.86$^{b}$ | 43.50±0.68 | 49.56±0.95$^{b}$ |
| DM | 38.83±0.05 | 100.67±1.28 | 42.59±1.64$^{bc}$ | 40.41±0.71 | 50.69±0.71$^{ab}$ |
| GF | 39.29±0.46 | 98.04±1.51 | 40.77±1,.81$^{c}$ | 42.59±0.85 | 51.94±0.68$^{a}$ |
| P | NS | NS | ** | NS | ** |

P: significance, NS: Not significant (P>0.05) **: significant P<0.01, SE: standard error, small letters indicate the differences in same column.

Table 2. Mean ± SE for rectal temperature of S, H, DM and GF crossbred bucks (ºC) (126 observations per month/breed)

| | Months | | |
|---|---|---|---|
| Genotypes | May | July | December |
| | Morning | | |
| S | 38.6±0.04[a] | 38.9±0.08 | 38.1±0.02[b] |
| H | 38.8±0.08[b] | 39.1±0.06 | 38.6±0.20[a] |
| DM | 38.9±0.09[b] | 39.0±0.07 | 37.9±0.12[b] |
| GF | 39.0±0.05[b] | 39.0±0.10 | 37.7±0.10[b] |
| P | *** | NS | *** |
| | Noon | | |
| S | 38.7±0.10 | 39.3±0.07 | 38.3±0.11 |
| H | 39.0±0.10 | 39.3±0.10 | 38.8±0.20 |
| DM | 38.9±0.09 | 39.4±0.08 | 38.4±0.13 |
| GF | 43.7±4.60 | 39.4±0.08 | 38.5±0.10 |
| P | NS | NS | NS |
| | Afternoon | | |
| S | 39.3±0.12 | 39.9±0.08 | 38.6±0.14[b] |
| H | 39.3±0.10 | 39.6±0.10 | 39.2±0.20[a] |
| DM | 39.2±0.08 | 39.8±0.11 | 38.5±0.10[b] |
| GF | 39.3±0.06 | 39.8±0.10 | 38.4±0.10[b] |
| P | NS | NS | *** |

P: significance, NS: Not significant (P>0.05), *** P<0.001, SE: standard error, small letters indicate the differences in same column.

Table 3. Mean ± SE for heart rate of S, H, DM and GF crossbred bucks (beat/min) (126 observations per month/breed)

| | Months | | |
|---|---|---|---|
| Genotype | May | July | December |
| | Morning | | |
| S | 96.0±2.50 | 94.1±3.21 | 91.2±2.60[a] |
| H | 92.7±2.00 | 95.7±1.90 | 92.3±1.50[a] |
| DM | 100.3±2.11 | 101.1±2.60 | 100.1±2.44[b] |
| GF | 99.1±2.23 | 101.1±4.32 | 100.9±2.60[b] |
| P | NS | NS | ** |
| | Noon | | |
| S | 96.8±2.30 | 121.6±3.20 | 140.5±7.70 |
| H | 106.1±3.93 | 113.1±3.60 | 120.0±4.11 |
| DM | 112.3±3.10 | 117.5±3.75 | 121.9±3.30 |
| GF | 103.1±4.24 | 114.7±3.30 | 125.2±4.80 |
| P | NS | NS | NS |
| | Afternoon | | |
| S | 81.2±1.80 | 79.2±2.23 | 85.8±2.73 |
| H | 88.20±2.03 | 84.8±2.21 | 88.90±1.90 |
| DM | 88.4±2.21 | 88.5±1.30 | 88.4±1.80 |
| GF | 85.1±2.14 | 81.2±2.14 | 86.0±2.43 |
| P | NS | NS | NS |

P: significance, NS: Not significant (P>0.05), ** P<0.01, SE: standard error, small letters indicate the differences in same column.

Table 4. Mean ± SE for respiration rate of S, H, DM and GF crossbred bucks (number/min) (126 observations per month/breed)

| | Months | | |
|---|---|---|---|
| Genotype | May | July | December |
| | | Morning | |
| S | 39.0±1.81 | 57.9±3.90$^{b}$ | 24.6±1.70 |
| H | 41.1±3.23 | 60.2±3.11$^{b}$ | 26.6±1.21 |
| DM | 41.9±2.23 | 55.6±3.54$^{b}$ | 26.0±1.33 |
| GF | 40.0±1.51 | 43.2±2.50$^{a}$ | 23.5±0.81 |
| P | NS | ** | NS |
| | Noon | | |
| S | 46,5±2.93 | 89.4±3.90$^{b}$ | 21,6±1.10 |
| H | 40.3±2.52 | 80.8±4.80$^{ab}$ | 24.8±1.23 |
| DM | 41.9±2.10 | 70.7±4.61$^{a}$ | 24.0±1.01 |
| GF | 40.9±2.80 | 67.9±4.90$^{a}$ | 21.9±0.80 |
| P | NS | ** | NS |
| | Afternoon | | |
| S | 54.5±4.26 | 100.1±7.40$^{b}$ | 22.8±1.20 |
| H | 43.1±2.30 | 76.1±4.04$^{a}$ | 26.5±2.00 |
| DM | 45.9±2.94 | 70.0±4.10$^{a}$ | 25.0±0.10 |
| GF | 45.6±3.90 | 79.3±6.30$^{a}$ | 22.8±0.72 |
| P | NS | ** | NS |

P: significance, NS: Not significant (P>0.05), ** P<0.01, SE: standard error, small letters indicate the differences in same column.

Table 5. Mean ± SE for serum cholesterol level of S, H, DM and GF crossbred bucks (mg/dl) (126 observations per month/breed)

| | Months | | |
|---|---|---|---|
| Genotype | May | July | December |
| | | Morning | |
| S | 36.9±1.13$^{a}$ | 42.31±2.94 | 44.9±2.52$^{ab}$ |
| H | 42.0±2.20$^{ab}$ | 39.5±1.10 | 47.7±2.30$^{b}$ |
| DM | 41.1±2.20$^{a}$ | 41.6±2.70 | 39.0±1.71$^{a}$ |
| GF | 47.3±2.33$^{b}$ | 45.3±2.10 | 38.3±2.73$^{a}$ |
| P | ** | NS | * |
| | | Noon | |
| S | 38.1±1.37$^{a}$ | 39.9±2.70 | 42.8±2.34$^{ab}$ |
| H | 38.6±1.90$^{a}$ | 38.1±1.30 | 47.3±1.80$^{b}$ |
| DM | 41.7±2.20$^{ab}$ | 41.7±2.62 | 38.2±1.80$^{a}$ |
| GF | 47.4±2.51$^{b}$ | 45.4±2.10 | 36.4±2.51$^{a}$ |
| P | ** | NS | ** |
| | | Afternoon | |
| S | 42.0±1.30 | 39.4±2.40 | 44.9±2.30$^{b}$ |
| H | 44.8±1.90 | 41.6±1.34 | 47.9±1.94$^{b}$ |
| DM | 43.3±2.30 | 42.6±2.13 | 37.0±1.93$^{a}$ |
| GF | 45.9±1.71 | 47.0±1.90 | 36.0±2.23$^{a}$ |
| P | NS | NS | *** |

P: significance, NS: Not significant (P>0.05),*P<0.05,** P<0.01,*** P<0.001, SE: standard error, small letters indicate the differences in same column.

Table 6. Mean ± SE for serum glucose level of S, H, DM and GF crossbred bucks

(mg/dl) (126 observations per month/breed)

| | Months | | |
|---|---|---|---|
| Genotype | May | July | December |
| | Morning | | |
| S | 45.8±1.10$^{a}$ | 44.4±1.10$^{a}$ | 50.7±1.20$^{a}$ |
| H | 52.2±2.62$^{b}$ | 40.5±2.60$^{a}$ | 57.3±1.50$^{b}$ |
| DM | 51.1±1.74$^{b}$ | 49.9±1.00$^{b}$ | 58.3±1.10$^{b}$ |
| GF | 54.8±1.72$^{b}$ | 52.6±1.02$^{b}$ | 55.3±1.24$^{b}$ |
| P | * | *** | ** |
| | Noon | | |
| S | 42.6±2.60$^{a}$ | 46.1±1.20$^{ab}$ | 56.8±1.90$^{a}$ |
| H | 52.3±2.10$^{b}$ | 41.9±2.60$^{a}$ | 63.8±1.60$^{b}$ |
| DM | 53.1±1.70$^{b}$ | 47.7±1.73$^{b}$ | 60.2±1.60$^{ab}$ |
| GF | 56.6±2.00$^{b}$ | 53.5±1.24$^{c}$ | 58.0±0.80$^{a}$ |
| P | *** | *** | ** |
| | Afternoon | | |
| S | 44.9±1.40 | 43.8±1.10$^{ab}$ | 34.7±3.20$^{a}$ |
| H | 44.7±2.10 | 42.5±1.70$^{a}$ | 45.0±2.70$^{b}$ |
| DM | 44.8±1.70 | 46.8±1.70$^{bc}$ | 41.6±1.70$^{ab}$ |
| GF | 48.8±1.70 | 50.1±1.20$^{c}$ | 39.0±2.01$^{ab}$ |
| P | NS | ** | * |

P: significance, NS: Not significant (P>0.05) * P<0.05, ** P<0.01,*** P<0.001, SE: standard error, small letters indicate the differences in same column.

Analyses of RT, RR and HR revealed a significant month effect as well as observation time effect (p<0.05). Blood glucose and total serum cholesterol levels show greater differences in hot conditions than in the comfort zone. Some researchers report that hot climate conditions decrease blood glucose and total serum cholesterol levels (Joshi et al. 1977) and some of them indicate the contrary (Webster, 1976; Bianca and Findlay, 1962). Lu (1989) found that blood glucose levels did not change in heat stressed goats. Determining blood parameters may be important in establishing the effect of heat stress. According to the obtained results, blood glucose levels in temperate and hot environmental conditions were found to be lower than in cold environmental conditions. Another finding was that CHO levels of some genotypes decreased at noon. The marked decrease in CHO levels may have a relation with the increase in total body water or the decrease in acetate concentration which is the primary precursor for the synthesis of cholesterol. CHO findings of the present experiment were lower than those reported previously by Webster (1976), Joshi et al, (1977) and Silva et al, (1993). These variations may appear according to sex, genotype and metabolic rate.

## 4. CONCLUSION

The present study sheds some light on the physiological responses of exotic and local genotypes in different seasons under the Mediterranean climate conditions of Turkey. High temperature and humidity in subtropical regions may have some adverse effects on the performance of the goats. Such effects appear more in the exotic breeds. There were significant differences between genotypes in the blood chemistry and physiological responses owing to the seasonal variation. To conclude, Hair goats were found to be more resistant to high environmental temperature, as expected, but the Saanen breed, which shows a better performance than local breeds, can be recommended to goat-keepers in the Mediterranean region.

## 5. ACKNOWLEDGEMENTS

This research was supported with a grant from the Research Project Unit of the University of Cukurova and data were obtained from the MSc thesis of Sezen Ocak. The authors wish to acknowledge laboratory technicians for sample analyses at the Medicine Faculty, Department of Biochemistry in Adana.

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