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# Effect of Thermal Stress on Haematological Parameters and Enzymatic Activities in Two Breeds of Goat after Thermal Stress

**Sumeet Kour*, Jonali Devi, Kawardeep Kour, Dibyendu Chakraborty, Aafreen Wahid Ganai, Pallavi Khajuria and Rizwana Zargar**

*Division of Veterinary Physiology and Biochemistry, FVSc and AH, SKUAST-J, R.S. Pura, J&K, INDIA*

**Corresponding author: S Kour; Email: ssonya558@gmail.com*

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## ABSTRACT

The influence of thermal stress (heat and cold stress) on haematological parameters and some enzyme activities were studied in Beetal and Toggenberg goats. A total of 36 healthy adult (2-4 years of age) female Beetal and Toggenberg goats were selected. Blood samples were collected and analyzed for haemoglobin (Hb), packed cell volume (PCV), erythrocyte sedimentation rate (ESR), AST (aspartate aminotransferase), ALT (alanine aminotransferase) and ALP (alkaline phosphatase) activities. Haemoglobin concentrations were found significantly higher (P<0.01) in all seasons, whereas, significantly higher (P<0.01) PCV was found in summer and autumn; ESR in summer season only in Toggenberg as compared to those of Beetal goat. In between three different seasons, irrespective of breed, haemoglobin, packed cell volume and ESR (erythrocyte sedimentation rate) values were significantly higher (P<0.01) in summer followed by autumn and winter season whereas alanine aminotransferase (ALT) activity was significantly higher (P<0.01) in winter than those of other two seasons. In between the breeds, significantly higher (P<0.01) enzyme activities (AST, ALT and ALP) were found in Toggenberg goats in all seasons as compared to Beetal. When the aspartate aminotransferase (AST) and alkaline phosphatase (ALP) values were considered separately in Beetal and Toggenberg goats in different seasons, significantly higher (P<0.01) activities were found in summer followed by autumn than those of winter season in both the breeds.

**Keywords:** AST, ALT, ALP, goat, haematological parameters, season

Environmental temperature of the Jammu region ranges between 4$^{O}$C in winter to 46$^{O}$C in summer season. Wide range of environmental temperature may alter the physiological status of the animal and may lead to stress condition. Stress is a common factor responsible for various physiological and biochemical alteration in the body which indirectly alters immune system of the body leading to increased susceptibility to various infections, reduces overall productivity and fertility leading to economic losses to the farmers (Marai *et al.* 1997; Gill *et al.* 2004; Broucek *et al.* 2007). Heat stress disturbs normal physiology, haematological parameters and effect overall metabolism (Bagha *et al.* 2009). Haemoglobin and packed cell volume are good indicators of thermal tolerance (McManus *et al.* 2009). Enzymes like AST and ALT are involved in amino acid metabolism and hence protein turnover. ALP is involved in energy metabolism and is an indicator of alkalosis and stress. Metabolic regulators are important in elucidating a picture of modulation in physiological mechanisms during stressed conditions

and are best assessed by determining the enzymes governing various metabolic reactions in plasma or serum.

The normal blood values are varying in different breeds as well as in different environment and managemental conditions. Among the breeds of goats of Jammu and Kashmir, Beetal is one of the most important one owing to its contribution to the state economy in terms of milk and meat production. Whereas, Toggenberg is an exotic breed and is amongst the best dairy goats found in this area. Despite their importance in the economy of the state, no established data on the effect of various seasons on the basic physiological parameters are available. Again, it is known that different animal breeds show different degrees of heat tolerance because of varied genetic make-up, which is a function of long time interaction between gene and exposed environmental condition. Being the original habitats, the local breeds of animals are highly adapted to the climatic condition and can withstand the extreme hot and cold climates of Jammu region. Therefore, this study has been undertaken to see the effect of thermal stress on haematological values and enzyme activities in two breeds of goats.

## MATERIALS AND METHODS

The influence of thermal stress on haematological parameters and enzymatic activities were studied in goats which were maintained at Government Dairy Goat Farm, Rajbagh, Kathua district of Jammu and Kashmir. Goat flock of this farm was maintained under semi-loose type of housing. These animals were fed according to their requirements and were vaccinated regularly. Blood samples collected from these goats were carried to the Division of Veterinary Physiology and Biochemistry, Faculty of Veterinary Science and Animal Husbandry, SKUAST-J, R.S. Pura, Jammu (Jammu and Kashmir) for haematological and enzymatic study. The goats were cared according to the guidelines of the Institutional Animal Ethics Committee (IAEC) of SKUAST-J, R.S. Pura, Jammu (J&K).

### Animals and experimental design

A total of 36 healthy, female Beetal (n=18) and Toggenberg (n=18) goats of 2-4 years of age were selected for the study. Blood samples were collected from each animal in three seasons that is summer (June-July), autumn (October-November) and winter (January-February) at 10 days interval.

### Experimental procedure and chemical analyses

Seven milliliter of blood was collected from each animal by venipuncture from which 2ml was kept in heparinised vials for haematological study and 5 ml blood sample was allowed to clot and serum was separated and collected in storage vials. Haemoglobin concentration of blood was estimated by acid-haematin method using Hellige-Sahli's haemoglobinometer. The packed cell volume was measured by micro-haematocrit method as per international council for standardisation of haematology (ICSH, 1978). Erythrocyte sedimentation rate (ESR) of blood was estimated by Wintrobe tube method. Aspartate aminotransferase (AST), Alanine aminotransferase (ALT) and Alkaline phosphatase (ALP) were analyzed by UV kinetic (IFCC) method using analytical kits manufactured by Erba Mannheim, Solan (H.P), India and expressed the unit as U/L.

### Statistical analyses

For all the observed data in the present experiment, the standard statistical procedures recommended by Snedecor and Cochran (1994) have been followed. The data were presented by showing mean and standard error. The significant differences of values for different parameters studied statistically analyzed by the Two Way ANOVA. Analysis of variance (ANOVA) was done with the help of Tukey's test using Sigma Stat.

## RESULTS

### Haemoglobin

The haemoglobin (Hb) concentrations (Mean ± S.E.) of Beetal and Toggenberg goats in different seasons are presented in Table 1. For the season and the breed interaction, it was observed that haemoglobin concentrations were significantly higher ($P<0.01$) in all seasons in Toggenberg as compared to Beetal goat. Between season, significantly higher ($P<0.01$) level was found in summer (8.78 ± 0.03 g%) followed by autumn (8.61 ± 0.03 g%)than that of winter (8.26 ± 0.03 g%) in Beetal. Similarly, in Toggenberg goat, significantly higher ($P<0.01$) value was found in summer followed by autumn and winter season and the values were 9.11 ± 0.03, 8.98 ± 0.03 and 8.53 ± 0.03 g%, respectively.

It was found that in between three different seasons, irrespective of breed, haemoglobin levels were significantly higher ($P<0.01$) in summer than those of autumn and winter seasons (Table 2). The values were 8.94 ± 0.02, 8.79 ± 0.02 and 8.39 ± 0.02 g%, respectively in summer, autumn and winter seasons.

Analysis of variance (Table 3) depicted that breed and season had highly significant ($P<0.01$) for haemoglobin.

The result indicated that there was no significant effect on breed and season interaction for haemoglobin.

### Packed cell volume (PCV)

The packed cell volume (PCV) values (Mean ± S.E.) of Beetal and Toggenberg goats in different seasons are presented in Table 1. For the season and the breed interactions, it was observed that, significantly higher (P<0.01) PCV was found in Toggenberg in summer and autumn seasons as compared to Beetal. In both Beetal and Toggenberg goats, the PCV values differ significantly in different seasons. The values showed significantly higher (P<0.01) levels in summer than those of other seasons. The haematocrit (PCV) percentage in summer, autumn and winter were 25.28 ± 0.20, 25.50 ± 0.20 and 23.39 ± 0.20 % in Beetal and 26.06 ± 0.20, 25.25 ± 0.20 and 23.86 ± 0.20 % in Toggenberg goats, respectively.

In between three different seasons, irrespective of breed (Table 2), the haematocrit percentage was significantly higher (P<0.01, 25.67 ± 0.14 %) in summer followed by autumn (24.88 ± 0.14 %) and winter (23.63 ± 0.14 %) season.

Analysis of variance (Table 3) depicted that breed and season had highly significant (P<0.01) for haematocrit value. The result indicated that there was no significant effect on breed and season interaction for PCV.

### Erythrocyte Sedimentation Rate (ESR)

The erythrocyte sedimentation rate (ESR) concentration (Mean ± S.E.) of Beetal and Toggenberg goats in different seasons are presented in Table 1. For the season and the breed interaction, it was observed that significantly higher (P<0.01) ESR was found in summer season in Toggenberg goat as compared to Beetal. In between three different seasons, significantly lower ESR was recorded in winter (0.190 ± 0.007 mm/48hrs) followed by autumn (0.215 ± 0.007 mm/48hrs) than that of summer (0.218 ± 0.007 mm/48hrs) in Toggenberg goat.

Table 2 depicted that in between three different seasons, irrespective of breed, significant variation was not observed in ESR between different seasons. The values were 0.201 ± 0.005, 0.205 ± 0.005 and 0.193 ± 0.005 mm/48hrs, respectively in summer, autumn and winter seasons.

Analysis of variance (Table 3) depicted that breed had significant (P<0.05) effect for ESR. There is no significant effect of season and breed and season interaction for ESR.

### Aspartate aminotransferase (AST)

The aspartate aminotransferase (AST) activities (Mean ± S.E.) of Toggenberg and Beetal goats in different seasons are presented in Table 1. For the season and the breed interactions, it was observed that in between the breeds, significantly higher AST activity was found in Toggenberg goats in all seasons. When the values were considered separately in Beetal and Toggenberg goats in different seasons, significantly higher values were found in summer (278.89 ± 0.43 and 282.56 ± 0.43 U/L, respectively) followed by autumn (276.89 ± 0.43 and 280.75 ± 0.43 U/L, respectively) than those of winter season (274.42 ± 0.43 and 277.64 ± 0.43 U/L, respectively) in Beetal and Toggenberg goats.

It was found that in between three different seasons, irrespective of breed, AST concentration in summer was significantly higher (P<0.01) than those of other two seasons (Table 2). In winter slightly (P<0.01) lower values were recorded. The concentrations of AST in summer, autumn and winter seasons, irrespective of breeds were 280.72 ± 0.31, 278.82 ± 0.31 and 276.03 ± 0.31 U/L, respectively.

Analysis of variance (Table 3) depicted that breed and season had highly significant (P<0.01) for AST. The result indicated that there was no significant effect on breed and season interaction for AST activity.

### Alanine aminotransferase (ALT)

The alanine aminotransferase (ALT) concentrations (Mean ± S.E.) of Toggenberg and Beetal goats in different seasons are presented in Table 1. For the season and the breed interactions, it was observed that slightly higher ALT activities were observed in Toggenberg than those of Beetal in all the seasons. In both Beetal and Toggenberg breed, in between three seasons, the winter values showed significantly higher ALT than those of autumn and summer season. The levels in winter, autumn and summer were 14.81 ± 0.12, 14.13 ± 0.14 and 13.84 ± 0.14 U/L in Toggenberg and 11.67 ± 0.14, 11.01 ± 0.20 and 10.80 ± 0.20 U/L in Beetal, respectively.

It was found that in between three different seasons, irrespective of the breed, ALT activity was significantly higher (P<0.01) in winter than those of other two seasons (Table 2). The ALT activities were 13.14 ± 0.14, 12.57 ± 0.14 and 12.32 ± 0.14 U/L in winter, autumn and summer seasons, respectively.

Analysis of variance (Table 3) depicted that breed and season had highly significant (P<0.01) for ALT. The result indicated that there was no significant effect on breed and season interaction for ALT.

### Alkaline phosphatase (ALP)

The alkaline phosphatase (ALP) activities (Mean ± S.E.) of Toggenberg and Beetal goats in different seasons are presented in Table 1. For the season and the breed interactions, it was observed that in between the breeds, significantly higher ALP activity was found in Toggenberg as compared to Beetal goat in all seasons. Between seasons significantly higher values were found in summer (128.00 ± 0.34 and 130.25 ± 0.24 U/L) followed by autumn (126.31 ± 0.34 and 128.94 ± 0.24 U/L) than those of winter (123.50 ± 0.34 and 125.72 ± 0.34 U/L) in Beetal and Toggenberg breeds.

It was found that in between three different seasons, irrespective of breed, ALP activity in summer was significantly higher (P<0.01) followed by autumn than that of winter season (Table 2). The concentrations of ALP in summer, autumn and winter seasons were 129.13 ± 0.24, 127.63 ± 0.24 and 124.61 ± 0.24 U/L, respectively.

Analysis of variance (Table 3) depicted that breed and season had highly significant (P<0.01) for ALP. The result indicated that there was no significant effect on breed and season interaction for ALP.

## DISCUSSION

Haemoglobin concentrations were significantly higher (P<0.01) in all the seasons in Toggenberg as compared to that of Beetal, which might be due to their heavier body weight as feed intake is a function of body weight (Gangwar, 1985). Adewuyi and Adu (1983) also reported that exotic and crossbred animals tended to have higher Hb values than that of the local breeds.

Higher level of haemoglobin during summer might be because of higher total binding capacity of Fe+ during summer season (Shrikhande *et al.* 2008) and this is an advantage in terms of the oxygen carrying capacity of the blood (Bhat *et al.* 2011). The increased Hb could be due to severe dehydration during heat stress (Sejian *et al.* 2010). Similar findings were also recorded in Nubian Ibex goats (Al-Eissa, *et al.* 2012) and other species (Toharmat and Kune, 1997; Toharmat *et al.* 1998; Maurya *et al.* 2007; Shrikhande *et al.* 2008; Nawal *et al.* 2012; Indu *et al.* 2014).

In contrast to the present finding, different workers (Wilson *et al.* 1999; Shibu *et al.* 2008; Abdelatif *et al.* 2009; Bhan *et al.* 2012) observed that the concentration of Hb was higher during winter as compared to spring and summer seasons. On the other hand, some authors (Adewuyi and Adu, 1983; El-Nouty *et al.* 1990; Jabbar *et al.* 2012; Hassan *et al.* 2013) reported that season had no effect on the Hb concentration. These differences in the values may be due to breed / species differences, season and management of animals.

Significantly higher (P<0.01) PCV was found in Toggenberg goats in summer and autumn seasons as

**Table 1. Haematological parameters and enzyme activities (Mean±S.E.) of Beetal and Toggenberg goats in different seasons**

| Parameters | Beetal | | | Toggenberg | | |
|---|---|---|---|---|---|---|
| | Summer (n=36) | Autumn (n=36) | Winter (n=36) | Summer (n=36) | Autumn (n=36) | Winter (n=36) |
| Hb (g%) | $8.78^{cp}$ ±0.03 | $8.61^{bp}$ ±0.03 | $8.26^{ap}$ ±0.03 | $9.11^{cq}$ ±0.03 | $8.98^{bq}$ ±0.03 | $8.53^{aq}$ ±0.03 |
| PCV (%) | $25.28^{bp}$ ±0.20 | $25.50^{cp}$ ± 0.20 | $23.39^{a}$ ± 0.20 | $26.06^{cq}$ ± 0.20 | $25.25^{bq}$ ±0.20 | $23.86^{a}$ ±0.20 |
| ESR (mm/24 hours) | $0.185^{p}$ ±0.007 | 0.195 ±0.007 | 0.195 ±0.007 | $0.218^{bq}$ ±0.007 | $0.215^{b}$ ±0.007 | $0.190^{a}$ ±0.007 |
| AST (U/L) | $278.89^{cp}$ ±0.43 | $276.89^{bp}$ ±0.43 | $274.42^{ap}$ ±0.43 | $282.56^{cq}$ ±0.43 | $280.75^{bq}$ ±0.43 | $277.64^{aq}$ ±0.43 |
| ALT (U/L) | $10.80^{ap}$ ±0.20 | $11.01^{ap}$ ±0.20 | $11.67^{bp}$ ±0.20 | $13.84^{aq}$ ±0.20 | $14.13^{aq}$ ±0.20 | $14.81^{bq}$ ±0.20 |
| ALP (U/L) | $128.00^{cp}$ ±0.34 | $126.31^{bp}$ ±0.34 | $123.50^{ap}$ ±0.34 | $130.25^{cq}$ ±0.34 | $128.94^{bq}$ ±0.34 | $125.72^{aq}$ ±0.34 |

Figures with parenthesis indicates number of observations.

*a, b, c describe significant differences between seasons within breed.

* p,q describe significant differences between breeds within seasons.

**Table 2. Haematological parameters and enzyme activities (Mean±S.E.) in different seasons**

| Parameters | Seasons | | |
|---|---|---|---|
| | Summer (n=72) | Autumn (n=72) | Winter (n=72) |
| Hb (g%) | 8.94[c] ±0.02 | 8.79[b] ±0.02 | 8.39[a] ±0.02 |
| PCV (%) | 25.67[c] ±0.14 | 24.88[b] ±0.14 | 23.63[a] ±0.14 |
| ESR (mm/24 hours) | 0.201 ±0.005 | 0.205 ±0.005 | 0.193 ±0.005 |
| AST (U/L) | 280.72[c] ± 0.31 | 278.82[b] ± 0.31 | 276.03[a] ± 0.31 |
| ALT (U/L) | 12.32[a] ± 0.14 | 12.57[a] ± 0.14 | 13.14[b] ± 0.14 |
| ALP (U/L) | 129.13[c] ± 0.24 | 127.63[b] ± 0.24 | 124.61[a] ± 0.24 |

Figures with parenthesis indicates number of observations.

*a, b, c describe significant differences between seasons.

compared to the Beetal goats. Generally the crossbred tended to have higher PCV values in all seasons (Adewuyi and Adu, 1983).

In between three different seasons (irrespective of breed), the haematocrit percentage was significantly higher (P<0.01) in summer followed by autumn and winter seasons. Almost similar PCV was found during summer in Baladi goat (27.25 ± 0.59%) and Kashmiri goat (25.7 ± 3.1%) (Azab and Abdel-Maksoud, 1999; Bhat *et al.* 2011). Higher concentration of haematocrit during summer season were recorded by several workers in other species (Tibbo *et al.* 2004; Maurya *et al.* 2007; Indu *et al.* 2014). In hot climate when animals are exposed to high ambient temperatures, haemo-concentrations are developed due to dehydration, asphyxia or excitement, causing the release of erythrocytes in the spleen which can result in abnormally higher PCV levels (Reece, 2005). In contrast, other scientists (Adewuyi and Adu, 1983; Abdoun *et al.* 2012; Bhan *et al.* 2012; Jabbar *et al.* 2012; Nawal *et al.* 2012) showed that the concentration of PCV was lower during summer season, which possibly can be due to haemo-dilution due to consumption of water just before sampling. Hassan *et al.* (2013) reported season had no significant influence on PCV value.

In between three different seasons, significantly lower ESR was recorded in winter followed by autumn than that of summer in Toggenberg goat. Mohamed (1998) also observed no significant seasonal changes, although the values were higher during dry summer. In contrast, Rizvi (1973) showed that the value of ESR was higher during winter season. However Jabbar *et al.* (2012) found that variations in ESR values due to seasons of the year were highly significant (P<0.01) with highest values observed during autumn than other seasons in buffaloe heifers.

Significantly higher (P<0.01) serum enzyme activities (AST, ALT, ALP) in exotic breed like Toggenberg indicated less heat tolerance capacity of this exotic breed (Sreedhar *et al.* 2013).

Significantly higher (P<0.01) AST and ALP values were found in summer followed by autumn than those of winter season in both the breeds (Table 1). Increase activity of some enzymes with rising temperature might be due to fact that reactions simply are accelerated at higher temperatures (Shaffer *et al.* 1981). Helal *et al.* (2010) reported that the prolonged heat stress for 4 days increased (P<0.05) ALP concentrations in both Balady and Damascus breeds of goat. Higher AST activity during summer was reported in goat (Kataria *et al.* 1993; Temizel *et al.* 2009), sheep (Nazifi *et al.* 2003; Gattani *et al.* 2010), cattle (Shaffer *et al.* 1981; Georgie *et al.* 1973; Rasooli *et al.* 2004) and camel (Kataria *et al.* 1991). However, Bahga *et al.* (2009) reported that AST did not vary in different seasons. Triiodothyronine had a significant negative correlation with serum AST and ALP activity (Rasooli *et al.* 2004; Helal *et al.* 2010), which was also reflected in our study. Banerjee (2008) reported that ALP activity has been indicated to be a quick and

**Table 3. Analysis of variance for haematological parameters and enzyme activities in Beetal and Toggenberg goats in different seasons**

| Source of variation | Df | MSS | | | | | |
|---|---|---|---|---|---|---|---|
| | | Hb | PCV | ESR | AST | ALT | ALP |
| Breed | 1 | 5.671** | 24.000** | 0.00150* | 693.375** | 542.450** | 303.407** |
| Season | 2 | 5.805** | 76.292** | 0.000329 | 401.421** | 12.639** | 380.505** |
| Breed × Season | 2 | 0.043 | 0.514 | 0.000729 | 1.931 | 0.439 | 0.977 |
| Error | 210 | 0.043 | 1.465 | 0.000226 | 6.761 | 1.433 | 4.136 |
| Total | 215 | 0.122 | 2.257 | 0.000325 | 13.581 | 4.045 | 8.999 |

*P<0.05 Significant at 5% level.

**P<0.01 Significant at 1% level.

reliable blood marker for heat stress in animals as ALP is involved in maintaining homeostatsis and energy generation in animal body (Vashisht *et al.* 1998; Swenson and Reece, 2005). Increase in ALP activity in summer months was in agreement with the finding of Bahga *et al.* (2009), which possibly due to alkalosis caused by increased alveolar ventilation and resultant alkalosis occurs during heat stress (Cunningham, 2002). Similar activity was also reported in cattle (Bhan *et al.* 2012). On the other hand, Gwaze *et al.* (2012) reported that season had no effect (P >0.05) on ALP activity.

In between three different seasons, irrespective of the breed, ALT activity was significantly higher (P<0.01) in winter than those of other two seasons, indicated decreased metabolic activity due to heat stress (Table 1). Similar findings were also reported in crossbred calves (Bahga *et al.* 2009). According to Kaushik and Bugalia (1999), lower intake during summer may lead to lower nutrient turnover in goats, which may be the reason of decreased ALT activity. In contrast, Nazifi *et al.* (2003) and Bhan *et al.* (2012) found higher activity of ALT in summer as compared to other seasons in sheep and cattle. Serum ALT value found to be increased during heat stress in goats (Sharma and Kataria, 2011).

## CONCLUSION

This study has indicated haematological values and enzyme activities could serve as baseline information for comparison in conditions of nutrient deficiency, physiological and health status of Beetal and Toggenberg goats in different seasons.

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