

## Original Article

## Hematological Parameters in Hair Goats During and out of Breeding Season Hair Goats Seasonal Hematological Parameters

Tahir Karasahin<sup>1\*</sup>, Şükrü Dursun<sup>2</sup>, Neşe Hayat Aksoy<sup>3</sup>, Hüdayi İpek<sup>1</sup>, Göktuğ Şentürk<sup>1</sup>

1. Department of Physiology, Faculty of Veterinary Medicine, Aksaray University, Aksaray, Türkiye.

2. Department of Reproduction and Gynecology, Faculty of Veterinary Medicine, Aksaray University, Aksaray, Türkiye.

3. Department of Biochemistry, Faculty of Veterinary Medicine, Aksaray University, Aksaray, Türkiye.



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## ABSTRACT

**Background:** The hair goat of Anatolia is a breed that has adapted to rugged and mountainous areas and is known to be very resistant to diseases. As the world faces the problem of climate change, we believe that knowing the hematological characteristics of hair goats will provide great benefits for goat breeding.

**Objectives:** This study was performed to determine possible differences in the blood parameters of adult (male and female) hair goats during and out of the breeding season.

**Methods:** For this purpose, blood samples were taken from clinically healthy adult male and female hair goats (n=36, 3-4 years old) in the spring and autumn seasons. Regarding the whole blood, white blood cell (WBC), red blood cell (RBC), hemoglobin (Hb), hematocrit (Hct), mean red blood cell volume (MCV), mean red blood cell hemoglobin (MCH), average red blood cell hemoglobin concentration (MCHC) and red blood cell distribution width (RDW) values were determined.

**Results:** In the study, MCV values in males were not significantly ( $P \geq 0.05$ ) different between spring and autumn, while all other parameters showed significant differences ( $P \leq 0.05$ ). In females, WBC, RBC, Hb, Hct, and RDW blood values were higher in the autumn (estrus period) than in the spring (anestrus period), and the differences were found to be significant ( $P \leq 0.05$ ). Comparing males and females between the estrus and anestrus seasons, WBC and MCHC were found to be significantly different ( $P \leq 0.05$ ) between males and females in May. In contrast, the difference between other parameters was not significant. In October (estrus season), the MCV value was not significantly different between males and females; however, all other parameters were significantly different ( $P \leq 0.05$ ).

**Conclusion:** As a result, there were significant differences in hematological parameters of hair goats based on gender and the breeding season.

**Keywords:** Female, Hair goat, Male, Hematological parameters, Season

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## \* Corresponding Author:

Tahir Karasahi, Professor:

Address: Department of Physiology, Faculty of Veterinary Medicine, Aksaray University, Aksaray, Türkiye.

Phone: +90 (382) 2882859

E-mail: [tahirkarasahin@gmail.com](mailto:tahirkarasahin@gmail.com)

## 1. Introduction

The hair goat of Anatolia is a breed that has adapted to rugged and mountainous areas and is known to be very resistant to diseases. In Turkey, goat breeding has an important place. Hair goat breeding in Turkey is widespread and constitutes the vast majority of total goat presence. Blood is an important indicator in evaluating the health status of animals (Antunovic et al., 2017; Karabahin et al., 2019). Determination of the hemato-biochemical profile is important for monitoring ruminants' metabolism and health status (Antunovic et al., 2017; Kaveh Baghbadorani et al., 2022). The hematologic parameters of goats can be affected by various factors such as breed, age, physiological condition, sex, diet, or season (Arfuso et al., 2016; Antunovic et al., 2017; Redlberger et al., 2017). However, specific reference intervals should be determined to interpret hematological values correctly in goats.

Global warming is currently becoming a reality. Goats that can live in harsh climates have advantages in their adaptation to such areas (Silanikove, 2000). This ability is multi-faceted; low body weight and metabolic requirements can be considered an important advantage in terms of minimizing maintenance and water requirements in areas where water resources and the number of nutrients are limited (Silanikove, 2000). Goats, especially local breeds, have adapted to large climate changes and insufficient food sources and can easily survive in such regions. In addition, goats adapt to harsh environments better than other domestic ruminants in different environmental conditions and show better yield characteristics (Agrawal et al., 2014).

For sustainable production in animal farms, maintenance and management of reproduction are important (Ghasemzadeh-nava et al., 2021; Kaywanloo et al., 2022). The breeding season in goats is restricted to late summer and autumn in the northern hemisphere. It is important to know the blood parameters of the animals in the breeding period and the possible periodic differences. Since there are large differences in hematological parameters observed among different breeds of goats, it is impossible to develop a universal metabolic profile test for goats (Azab & Abdel-Maksoud, 1999). In addition, different biochemical and hematological values could be observed in goats raised in different climatic conditions (Daramola et al., 2005; Elitok, 2012; Njidda et al., 2013). Determining the physiological electrophoretic models of animals is very important in diagnosing diseases for clinicians (Nagy et al., 2014).

In this study, male and female purebred hair goats raised in Turkey were used to determine blood parameters during and out of mating season. According to our current knowledge, although the blood parameters have been examined in many domestic animal species and races, the changes in hematological blood parameters with respect to the reproductive period have not been investigated in hair goats. This study aims to reveal hematological blood values in adult male and female hair goats. As the world faces the problem of climate change, we believe that knowing the hematological characteristics of hair goats will provide great benefits for goat breeding.

## 2. Materials and Methods

This study was performed in farms located in the mountainous area with an altitude of 1200 m of Aksaray Province of Turkey during the spring (May/out of season) and autumn (October/breeding season). Goats were fed green pasture in spring and dry grass and wheat straw in autumn. During the blood sampling period, the ambient temperatures were at the average level of recent years. The animals were clinically healthy 3-4 years old female hair goats (n=18, 47±6.2 kg live weight) and male hair goats (n=18, 75±7.8 kg live weight). The number of animals used was determined based on previous studies (Elitok, 2012, Antunovic et al., 2017). No extra feeding was given during the study period. Blood samples were taken from the vena jugular into tubes with sodium EDTA. Leukocyte (WBC), erythrocyte (RBC) numbers, hemoglobin concentration (Hb), and hematocrit value (Hct) were analyzed. Hematological values were obtained in the blood count device (MS4S Vet, France) using commercial test kits (MS4S Vet, Reagent Kit, France). Mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentrations (MCHC) were calculated. Packed cell volume (Hct) was measured by the Wintrobe tube.

### Statistical analysis

Statistical analysis of the hematological data obtained was performed with Minitab software, version 16. Descriptive statistics were provided as Mean±SD, minimum, and maximum values. One-way ANOVA analysis was performed to compare group averages regarding continuous variables. The statistical significance level was taken as 0.05 in calculations.

### 3. Results

Mean hematological values with respect to gender and seasonal differences in the hair goats are given in Table 1-3. When the values of out of season (May) and breeding season (October) were compared, the MCV was not significantly different ( $P \geq 0.05$ ), while all other parameters investigated differed significantly ( $P \leq 0.05$ ). In females, MCV, MCH, and MCHC values were not significantly different ( $P \geq 0.05$ ), while other parameters (WBC, RBC, Hb, Hct, and RDW) were significantly different ( $P \leq 0.05$ ) (Table 2). Comparing males and females in both out of season and the breeding season based on gender, WBC, and MCHC were found to be significantly ( $P \leq 0.05$ ) different between males and females in May, whereas the differences between other parameters were not significant ( $P \geq 0.05$ ). In October, all parameters except for MCV were significantly different between males and females ( $P \leq 0.05$ , Table 3).

### 4. Discussion

RBC, Hb, MCHC, and WBC values in the female goats in our study were found to be higher than the other goat breeds in general (Opara et al., 2010; Pradhan, 2016; Çelik et al., 2019) and other female goats at the breeding season (Omontese et al.; Azab & Abdel-Maksoud, 1999; Iriadam, 2007; Antunović et al., 2019). Similarly, RBC, Hb, MCHC, and WBC values obtained in the male

hair goats during the breeding season were significantly higher than those obtained from male goats during the out of season (Opara et al., 2010; Pradhan, 2016; Çelik et al., 2019). The reason for this may be increased body fluid loss due to increased metabolic and physical activity during the breeding season. In studies conducted on cows around the time of estrus (Oliveira et al., 2019) and in women during the menstrual periods (Nowak et al., 2016), the amount of WBC was significantly higher than the other times of the cycle and life. Drastic changes in reproductive hormone secretion could affect this (Nowak et al., 2016). Although the existence of immune cell-specific sex hormone receptors is known (Kovats, 2012), a study showed the effect of reproductive hormones on leukocytes by comparing them at different stages of women’s menstrual cycles (Nowak et al., 2016). Moreover, Chaudhari & Mshelia (2006) stated that the WBC value during pregnancy decreases considerably compared to the estrus period, which can be used to diagnose pregnancy in dogs. As a response to excessive activity in animals during the estrus period, an oxygen deficit arises due to excessive consumption of oxygen, leading to the fact that more blood is released into the circulation which causes an increase in the number of erythrocytes and hemoglobin (Hall & Hall, 2020). The hemoglobin value in the male hair goats during the breeding season was found significantly higher than that of the female goats. This value was even higher than the

Table 1. Mean±SE values of blood parameters in male hair goats in the spring and autumn

Variables	May					October					P
	Mean±SE	SD	Minimum	Median	Maximum	Mean±SE	SD	Minimum	Median	Maximum	
WBC ( $\times 10^3/\mu\text{L}$ )	17.094±0.687	2.9	13.5	16.2	23.3	39.600±1.680	7.1	29.4	37.8	53.4	0.000
RBC ( $\times 10^6/\mu\text{L}$ )	16.431±0.330	1.4	14.2	16.2	19.0	22.545±0.429	1.8	19.4	22.6	25.8	0.000
Hb (g/dL)	8.533±0.239	1.0	7.4	8.2	10.7	12.700±0.354	1.5	10.1	12.8	14.6	0.000
Hct (%)	21.739±0.499	2.1	18.8	22.0	24.7	31.172±0.663	2.8	25.5	31.0	35.9	0.000
MCV (fL) %	13.172±1.291	1.2	11.4	13.3	14.6	13.956±0.375	1.6	11.3	13.8	16.9	0.108
MCH (pg)	5.018±0.096	0.4	4.3	5.0	5.6	5.625±0.094	0.4	5.0	5.6	6.5	0.000
MCHC (g/dL)	38.900±0.403	1.7	37.0	38.6	41.9	40.733±0.750	3.2	35.2	40.1	46.2	0.038
RDW (%)	22.933±0.513	2.2	20.4	22.0	27.8	25.806±0.470	2.0	22.0	25.5	29.2	0.000

Abbreviations: WBC: White blood cell; RBC: Red blood cell; Hb: Hemoglobin; Hct: Hematocrit; MCV: Mean corpuscular volume; MCH: Mean corpuscular hemoglobin; MCHC: Mean corpuscular hemoglobin concentrations; RDW: Red blood cell distribution width.

**Table 2.** Mean±SE values of blood parameters in female hair goats in the spring and autumn

Variables	May					October					P
	Mean±SE	SD	Minimum	Median	Maximum	Mean±SE	SD	Minimum	Median	Maximum	
WBC ( $\times 10^3/\mu\text{L}$ )	19.317±0.808	3.4	12.9	18.8	25.5	26.88±1.260	5.3	16.6	27.7	37.4	0.000
RBC ( $\times 10^6/\mu\text{L}$ )	15.126±0.398	1.7	11.3	15.1	17.3	21.76±1.060	4.5	14.4	20.2	29.2	0.000
Hb (g/dL)	8.017±0.176	0.7	6.7	7.8	9.8	11.461±0.444	1.9	8.7	11.5	14.3	0.000
Hct (%)	21.311±0.508	2.2	18.3	20.7	24.4	29.64±1.080	4.6	23.5	28.8	37.8	0.000
MCV (fL) %	14.189±0.374	1.6	11.6	14.4	16.9	13.494±0.336	1.4	11.3	13.5	15.6	0.176
MCH (pg)	5.278±0.079	0.3	4.8	5.2	6.0	5.137±0.148	0.6	4.1	5.1	6.1	0.409
MCHC (g/dL)	37.656±0.574	2.4	34.0	37.5	41.7	38.558±0.816	3.5	33.2	37.8	47.5	0.372
RDW (%)	22.278±0.439	1.9	19.0	22.6	26.2	24.644±0.372	1.6	22.3	24.1	27.8	0.000

Abbreviations: WBC: White blood cell; RBC: Red blood cell; Hb: Hemoglobin; Hct: Hematocrit; MCV: Mean corpuscular volume; MCH: Mean corpuscular hemoglobin; MCHC: Mean corpuscular hemoglobin concentrations; RDW: Red blood cell distribution width.

findings of other studies (Opara et al., 2010; Manat et al., 2016; Mohammed et al., 2016). The results suggest that male's mate more frequently than females and they need more oxygen due to higher mobility.

The onset of the breeding season of goats depends on melatonin, a hormone of the circadian rhythm. In living organisms, melatonin secretion varies depending

on light exposure during the day, in other words, the length of the day (Todini et al., 2011). It is also known that melatonin, released in varying amounts due to seasonal changes, is an important stimulant of the immune system and an antioxidant (Jaworek et al., 2021). Our study found that RBC, Hb, Hct, and WBC values were significantly different in the breeding season compared

**Table 3.** Mean±SE hematological values in male and female hair goats in the spring (May) and autumn (October) seasons

Variables	May			October		
	Male	Female	P	Male	Female	P
WBC ( $\times 10^3/\mu\text{L}$ )	17.1±0.7	19.3±0.8	0.027	39.6±1.7	26.9±1.3	0.000
RBC ( $\times 10^6/\mu\text{L}$ )	16.4±0.3	15.1±0.4	0.292	22.5±0.4	21.8±1.1	0.000
Hb (g/dL)	8.5±0.2	8.0±0.2	0.119	12.7±0.4	11.5±0.4	0.000
Hct (%)	21.7±0.5	21.3±0.5	0.448	31.2±0.7	29.6±1.1	0.000
MCV (fL) %	13.2±0.3	14.2±0.4	0.433	13.9±0.4	13.5±0.3	0.900
MCH (pg)	5.0±0.1	5.3±0.1	0.343	5.6±0.1	5.1±0.1	0.047
MCHC (g/dL)	38.9±0.4	37.7±0.6	0.013	40.7±0.7	38.6±0.8	0.048
RDW (%)	22.9±0.5	22.3±0.4	0.100	25.8±0.5	24.6±0.4	0.000

Abbreviations: WBC: White blood cell; RBC: Red blood cell; Hb: Hemoglobin; Hct: Hematocrit; MCV: Mean corpuscular volume; MCH: Mean corpuscular hemoglobin; MCHC: Mean corpuscular hemoglobin concentrations; RDW: Red blood cell distribution width.

with out of season. Several studies conducted in goats at near latitudes have noted seasonal changes in melatonin levels, supporting our study (Todini et al., 2011). Given this information, we hypothesize that seasonally changing light intensity and correspondingly changing melatonin levels influence our study's changes in hematological parameters.

The MCV and MCH values obtained in our study were found to be significantly lower than those reported by the other studies (Omontese et al., 2017; Opara et al., 2010; Piccione et al., 2010; Waziri et al., 2010; Pradhan, 2016; Çelik et al., 2019). This discrepancy could be due to the low-quality feeding of the animals during the breeding period, which may lead to vitamin B12 or folate deficiency (Mohammed et al., 2016).

The extra physical activity shown both in heat and during the mating period causes an increase in the metabolic rate and a series of changes in the body. One of them is thermoregulation. During physical activity, 25%-30% of the chemical energy is used for mechanical work in the muscles, while 75%-80% is released as heat. Another is that erythrocyte is secreted from the spleen into the blood to close the O<sub>2</sub> deficit during physical activity. In addition, respiratory capacity, cardiac output, and frequency must be increased to send more blood to the working muscles. The metabolic rate must be accelerated to a certain extent for all these activities to be carried out properly. Therefore, when considering all these factors, it is possible to see an increase in the number of RBCs, Hct value, and Hb amount.

In conclusion, the hair goats during the breeding season had significantly different blood parameters. For this reason, there is a need for studies that will include feeding different rations and evaluating more parameters in this period.

## Ethical Considerations

### Compliance with ethical guidelines

All experimental procedures of this study were approved by Ethics Committee of Faculty Experimental Animal Production and Research Center of **Selcuk University Veterinary** (Code. SÜVDAMEK 2020/116).

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## Authors' contributions

All authors equally contributed to preparing this article.

## Conflict of interest

The authors declared no conflict of interest.

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