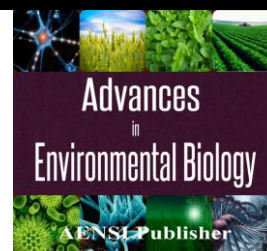




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### Variation of Biological Markers Under Hot and Cold Seasons in Goats

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#### ABSTRACT

The aim of this study is to find out the effect of hot and cold seasons on some biological markers of native Arabia goats from North-east Algeria. A number of 48 healthy goats were selected during winter and summer from the same herd situated 100 km southward the Mediterranean Sea with an altitude of 600m. Animals were then divided into 4 subgroups; nursing males (2-4 months, average weight of  $19.35 \pm 2.47$  kg), nursing females (2-4 months, average weight of  $17.65 \pm 2.41$  kg), adult males (>8 months, average weight of  $46.54 \pm 2.84$  kg) and adult dry females (>8 months, average weight of  $38.12 \pm 1.45$  kg). Blood samples were collected in winter (February at  $9^\circ\text{C}$ ) and in summer (August at  $39^\circ\text{C}$ ). Some hematological and biochemical markers have been investigated, where winter data are compared to that of summer. Results of the cold season showed significantly lower values of RBC count in adult males and females, reduced levels of hemoglobin in nursing males and weak hematocrit in nursing females. WBC count was significantly decreased in adult males during winter; however, monocytes and glucose levels were within the physiological ranges in all groups. Lymphocyte percentage was significantly decreased in adult goats during winter when compared to summer. Cold season demonstrated remarkable decrease of total proteins in young animals and adult females. Cholesterol concentration has been significantly increased only in adult females, but that of triglycerides was significantly higher in all groups during the cold period. Results are discussed according to the weather extremities and environmental factors of the region.

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#### INTRODUCTION

Goats are economically important short-period breeder ruminants [1], which experience a variety of ecological challenges like wide variation in temperature, humidity and pathogenic invasions [2]. In North East Algeria, winter is relatively cold and there is generally the presence of high relative humidity, whereas summer is characterized with hot and dry climate. Seasonal variation in the levels of some blood constituents have been attributed to changes in the environmental weather which vary markedly between the winter and summer months [3].

Blood is an important and reliable medium for assessing the health status of individual animal [4]. Variations in blood markers of animals are due to several factors such as altitude, feeding, age, sex, breed, diurnal and seasonal variation, temperature and the physiological status. In various studies, red blood cells, hemoglobin and hematocrit were reported to reach the highest levels during winter period in different rodents [5]. In contrast, these markers were reported to be at the lowest level during winter months in large animals [6]. The significance of determining hematological and biochemical indices in animals are well documented and the changes in these parameters have been studied in the goats [7]. Moreover, blood biochemical markers including total proteins, cholesterol, triglycerides, free fatty acids and glucose are important indicators for animal health and its nutritional status [8, 9 and 10].

This study was carried out on native Arabia goat breed, it aims to investigate the effect of cold and hot seasons on some hematological (red blood cells, white blood cells, hemoglobin, hematocrit, lymphocyte and monocytes) and serum biochemical markers (total proteins, glucose, cholesterol and triglycerides). However, four physiological states (nursing males, nursing females, adult males and dry females) living in an altitude of

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600 m Southward the Mediterranean Sea (north-east Algeria) and feeding a mountainous rocky pasture during the whole year were chosen.

## MATERIALS AND METHODS

### 1- Study site:

The study was conducted at the livestock farms in Mdjazz-Sfaa situated 70 km south the Mediterranean Sea (province of Guelma, North-East Algeria, latitude of 36°.28' and longitude of 7°.95'E). This region is situated in an altitude of 600 m, characterized by a cold-humid winter and a hot-dry summer. The temperature is in the range of 9 °C during winter to over 35°C during summer; as the average rainfall is up to 600 mm/year.

### 2- Animals:

The study was conducted on healthy herd of 48 native Arabia goats from February to August. Goats are well adapted to the environmental and climatic conditions of the region. Animals were divided according to their age and sex into four Subgroups as follows; 8 nursing males (2 to 4 months), 9 nursing females (2 to 4 months), adults of >8 months (21 males and 10 dry females). Goats spend about 8 hours a day grazing on mountainous rocky and grassy area during the whole year. The grassy site contains varieties of small trees and herbs. However, the pasture found is almost similar to the floristic survey reported earlier [11]. This site is remote from all types of urbanization, industrialization and agricultural activities.

### 3- Blood samples:

Blood was withdrawn in the early morning from each animal at the external jugular vein into test tubes containing EDTA for hematological markers (RBC, WBC, HB, HT, Lymphocytes and Monocytes) using automatic analyser (Full Automatic Blood Cell Counter Model PCE-2 ON, ERMA INC, Tokyo). Part of the blood was collected in dry test tubes for biochemical analysis. The collected blood was immediately placed in an ice box kept in darkness, and it quickly transported to the laboratory. Dry tubes containing blood were centrifuged at 4000 rpm for 10 min and then the serum was kept in eppendurff tubes at -20°C until further analysis. The measurements of the biochemical markers (Glucose, total proteins, triglycerides and cholesterol) were performed by using freshly commercial laboratory kits (SPINREACT, Spain). The experimental procedures were carried out according to the National Institute of Health Guidelines for Animal Care and approved by the Ethics Committee of our Institution.

### 4- Statistical analysis:

The data obtained were imported stored and coded according to recoded information in data sheet using the Microsoft excel 2010. Results were presented as mean  $\pm$  SD. Student t-test was used to compare the results of different hemato-biochemical markers between cold and hot season. The p-value <0.05 was considered significant.

### Results:

Results of the effect of cold and hot season on some biological markers of Arabia goats are registered in tables 1-4.

#### 1- Nursing males:

Compared to hot season, a significant decrease of hemoglobin and total proteins were recorded in cold season. Contrary, there was a remarkable rise in the level of triglycerides.

**Table 1:** Effect of Cold and Hot Season on the biological markers (Mean  $\pm$  SD) of nursing males (2 to 4 months) of Arabia goat.

Parameters Season	Cold Season	Hot Season	Significance level
RBC ( $\times 10^6/\mu\text{l}$ )	11.080 $\pm$ 2.810	12.523 $\pm$ 3.322	NS
Hb (g/dl)	7.133 $\pm$ 1.815	10.900 $\pm$ 1.356	S
Ht (%)	20.700 $\pm$ 2.722	24.229 $\pm$ 2.087	NS
WBC ( $\times 10^3/\mu\text{l}$ )	09.033 $\pm$ 3.156	10.593 $\pm$ 1.304	NS
Monocytes (%)	1.290 $\pm$ 0.249	1.253 $\pm$ 0.263	NS
Lymphocytes (%)	52.333 $\pm$ 12.055	69.267 $\pm$ 11.405	NS
Total proteins (g/dl)	5.537 $\pm$ 1.486	8.763 $\pm$ 1.545	S
Glucose (mg/dl)	69.606 $\pm$ 13.543	64.596 $\pm$ 15.720	NS
Cholesterol (mg/dl)	54.15 $\pm$ 12.737	65.593 $\pm$ 10.376	NS
Triglycerides (mg/dl)	45.348 $\pm$ 8.10	37.464 $\pm$ 8.794	S

RBC: Red Blood Cells, WBC: White Blood Cell, Hb: Haemoglobin, Ht: Hematocrit.

NS: no significant, S: Value significantly different between seasons at p<0.05.

#### 2- Nursing females:

A noticeable decrease in the level of hematocrit and total proteins, accompanied by significant increase in triglycerides was observed in nursing females during the cold period.

**Table 2:** Effect of Cold and Hot Season on the biological markers (Mean  $\pm$  SD) of nursing females (2 to 4 months) of Arabia goat.

Parameters Season	Cold Season	Hot Season	Significance level
RBC ( $\times 10^9 \mu\text{l}$ )	9.180 $\pm$ 1.604	11.043 $\pm$ 2.223	NS
Hb (g/dl)	8.850 $\pm$ 1.041	10.333 $\pm$ 2.767	NS
Ht (%)	18.350 $\pm$ 2.367	26.800 $\pm$ 3.122	S
WBC ( $\times 10^3 \mu\text{l}$ )	07.450 $\pm$ 2.511	10.103 $\pm$ 3.034	NS
Monocytes (%)	1.231 $\pm$ 0.100	1.435 $\pm$ 0.694	NS
Lymphocytes (%)	53.700 $\pm$ 12.042	61.100 $\pm$ 18.820	NS
Total proteins (g/dl)	5.758 $\pm$ 1.259	8.300 $\pm$ 1.584	S
Glucose (mg/dl)	75.224 $\pm$ 14.976	72.218 $\pm$ 13.394	NS
Cholesterol (mg/dl)	67.220 $\pm$ 13.735	59.070 $\pm$ 11.139	NS
Triglycerides (mg/dl)	52.122 $\pm$ 6.640	39.89 $\pm$ 4.088	S

RBC: Red Blood Cells, WBC: White Blood Cell, Hb: Haemoglobin, Ht: Hematocrit.

NS: no significant, S: Value significantly different between seasons at  $p < 0.05$ .

### 3- Adult males:

In the cold season, significant decline in the level of RBC, WBC and lymphocytes were observed. On the other hand, the concentration of triglycerides was remarkably raised.

**Table 3:** Effect of Cold and Hot Season on the biological markers (Mean  $\pm$  SD) of adult males of Arabia goat.

Parameters Season	Cold Season	Hot Season	Significance level
RBC ( $\times 10^6 \mu\text{l}$ )	10.066 $\pm$ 1.730	14.103 $\pm$ 2.476	S
Hb (g/dl)	10.91 $\pm$ 1.680	12.867 $\pm$ 1.340	NS
Ht (%)	24.253 $\pm$ 3.975	30.500 $\pm$ 4.780	NS
WBC ( $\times 10^3 \mu\text{l}$ )	9.000 $\pm$ 1.276	13.267 $\pm$ 2.096	S
Monocytes (%)	1.869 $\pm$ 2.732	1.541 $\pm$ 0.1535	NS
Lymphocytes (%)	51.100 $\pm$ 6.860	68.929 $\pm$ 10.097	S
Total proteins (g/dl)	6.104 $\pm$ 1.003	8.024 $\pm$ 1.549	NS
Glucose (mg/dl)	56.519 $\pm$ 11.89	49.499 $\pm$ 9.149	NS
Cholesterol (mg/dl)	65.56 $\pm$ 12.453	61.409 $\pm$ 12.796	NS
Triglycerides (mg/dl)	69.374 $\pm$ 8.099	51.767 $\pm$ 8.420	S

RBC: Red Blood Cells, WBC: White Blood Cell, Hb: Haemoglobin, Ht: Hematocrit.

NS: no significant, S: Value significantly different between seasons at  $p < 0.05$ .

### 4- Adult dry females:

In winter, the levels of RBC, lymphocytes and total proteins were significantly decreased; however those of cholesterol and triglycerides were significantly increased.

**Table 4:** Effect of Cold and Hot Season on the biological markers (Mean  $\pm$  SD) of adult dry females of Arabia goat.

Parameters Season	Cold Season	Hot Season	Significance level
RBC ( $\times 10^9 \mu\text{l}$ )	9.851 $\pm$ 1.030	14.800 $\pm$ 1.846	S
Hb (g/dl)	10.569 $\pm$ 1.323	13.063 $\pm$ 1.426	NS
Ht (%)	24.033 $\pm$ 3.285	28.800 $\pm$ 3.185	NS
WBC ( $\times 10^3 \mu\text{l}$ )	9.858 $\pm$ 3.214	11.692 $\pm$ 3.012	NS
Monocytes (%)	1.764 $\pm$ 0.117	1.307 $\pm$ 0.360	NS
Lymphocytes (%)	54.290 $\pm$ 6.597	72.869 $\pm$ 12.638	S
Total proteins (g/dl)	4.223 $\pm$ 1.091	7.888 $\pm$ 2.046	S
Glucose (mg/dl)	56.344 $\pm$ 8.69	52.259 $\pm$ 10.452	NS
Cholesterol (mg/dl)	78.159 $\pm$ 11.201	55.315 $\pm$ 8.756	s
Triglycerides (mg/dl)	71.501 $\pm$ 10.784	46.656 $\pm$ 7.692	s

RBC: Red Blood Cells, WBC: White Blood Cell, Hb: Haemoglobin, Ht: Hematocrit.

NS: no significant, S: Value significantly different between seasons at  $p < 0.05$ .

### Discussion:

Results of the present study marked declined RBC count in adult goats during the cold season, which was in line with those reported by [12]. Haematological and biochemical parameters could be affected by many factors including sex, age, reproductive status and seasonal variations [13,14 and 15]. Seasonal changes in the thermal environment always affect animals' physiological responses. Thus, variation in the levels of haematological markers such as total RBC count [16], PCV [17] and Haemoglobin [18] are a sign of adaptation to unfavorable environmental conditions. Indeed, haematological values are used to assess stress and welfare of animals [19]. Malnutrition during the cold season may lead to a decrease in the RBC count, this is entirely constituent with the results obtained in this study and it is supported by the findings of Kaneko *et al* [20]. It has been reported that seasonal temperature affects goats much more than that of winter because summer period is longer than winter [21].

Hemoglobin values in this study were lower in all groups of animals, especially in nursing males. Reduced hemoglobin concentrations in young animals do not affect the respiratory rate since the oxygen carrying capacity of the blood is higher because of high hemoglobin affinity. Accordingly, hematological findings were similarly obtained from the study carried out on Kilis goats [22]. Azab and Abdel-Maksoud [12] have reported significant difference in Hb level during the early neonatal period, whereas Iriadam [23] found no remarkable change in Hb concentration from Kilis does. The higher Hb concentration in summer than that of winter is in line with the findings of Saror and Coles [24] on white Fulani cattle; and that is probably caused by the liberation of red blood cells from spleen or the increase in oxygen consumption due to tissue demand by releasing the erythrocyte-stimulating factor. As a result, animal can diffuse internal heat outside its body to cope with climatic stress [25]. On the other hand, Low hemoglobin concentration in the winter could confirm the bad nutritional status which may lead to anemia [26]. The high altitude reduces the oxygen tension in mountainous regions, leads to an increased production and release of erythropoietin, thereby, stimulating erythropoiesis as an adaptive mechanism to low oxygen level [27, 28 and 29].

Hematocrit is generally lower in winter than summer, but it is remarkably decreased in young females. The raise in hematocrit in this study during summer may be attributed to increase in environmental temperature [30, 31]. Hence, high hematocrit values indicate either an increase in the number of circulating RBC or a reduction in circulating plasma volume [32]. Hematocrit can also be affected by seasonal variations, where high temperature leads to the loss of body fluids, as well as the quality of food could intervene remarkably with hematocrit level, especially during malnutrition. Accordingly, hematocrit level was found to be higher in summer than that of winter as result of thermal and food differentiation [33, 34]. Moreover, hematological traits, especially Hematocrit and hemoglobin were correlated with the animal nutritional status [35]. In this study, it is important to note that Arabia goats had a minimum hematocrit value without any clinical manifestation concerning anemia.

White blood cells are the soldiers of the body and their high counts may be due to the increase of the complement in the animal immune system. Dry season differs then cold one, not only in terms of climatic changes of temperature and humidity, but also in dietary diversity and closely linked to the quality of soils and the life cycle of small organisms such as parasites, which are considered as one the most important pathogens of small ruminants [36,37]. This is exactly what this study demonstrated where the number of total WBC count was lower in the Arabia goats during the winter, especially in adult males. Accordingly, Saror and Coles [24] reported a higher total WBC values in White Fulani Cattle during summer season. Also, during winter total WBC count of the West African dwarf goat [38] was lower than the values reported by Oduye [39] for this breed during the summer. The result of Arabia goats concerning the present study demonstrated higher levels of WBC during summer period, which could be the result of infections. Generally, the seasonal variation observed in these markers is related mainly to many climatic and nutritional factors.

Mean monocytes percentage was similar between all animals studied in the two seasons and no seasonal difference was recorded. But in other study, the ratio of monocytes during wet and dry summer was higher compared to the value obtained in winter [40]. This result is consistent with the findings of Al-Busaidi *et al.*, [41] that reported slightly higher monocyte ratio during summer. Thus, it was reported that monocyte levels at day 5 postpartum resembled to the reference values of goat [42]. The fluctuation in monocyte levels may be associated with weather extremities and poor management. According to the results of this study, monocytes seem not affected by the mentioned factors.

Lymphocytes percentage showed significant decrease in adult goats of both sexes during cold season compared to the hot one. The seasonal change in climate had no significant effects on the ratios of lymphocytes [40], as that of reported concerning Barki ewes [43]. Reference values set for West African Dwarf goats [42] were higher than *Kajli* lamb during the same period. Monocytes are ranging 43.89 to 45.86% for adult goats [44], which look lower than the values observed in this study. Lymphocytes are the key elements in the production of immunity. Low levels can be seen in some bacterial infections, aplastic anaemia, and in some forms of leukemia, while high values can be observed in viral infections, and in some forms of leukemia [45].

A remarkable decrease of total proteins in young animals and adult females was seen during the cold season. This could be due to the fact that Arabia goat was dehydrated during the summer season which lead to elevated serum protein levels [46,47]. Serum proteins are known to be important in osmotic regulation, immunity and transport of several substances in the animal body [48]. Serum total protein is one of the indications of nitrogen metabolism in the organism, and depends on protein content in hay [49,50] and season and, as it showed a considerable individual variation [51]. Furthermore, blood total protein level was low during cold season, but it has not been affected in dry-hot months [3,24]. Thus the normal protein level in summer period, as it was reported in this study, may indicate also the accepted pasture content of essential amino acids. In contrast, the rainy cold period has showed significant decrease of serum proteins, which may be caused by malnutrition, because fresh green leaves perhaps contain less amino acids. It has been reported that low availability of vegetation and fiber during pasture season might result in decreased protein concentrations [52]. Nadji rams reared under hot-dry period have high levels of serum total proteins, accompanied with low

albumin, which were related to weather stressful conditions; dehydration in one hand, and loss of appetite, on the other hand [53].

Blood glucose level has not been affected by season in all groups of goats. The normal glucose concentration perhaps is attributed to a well metabolic regulation and also to carbohydrates' availability in the two seasons. Nutritional status and metabolic activity of animals are the main factor responsible on such level [54]. Lower blood glucose levels in kanni goats [4], and higher levels in wild goats [55] were reported. The augmentation of blood glucose of Nadji rams during the hot summer of Sahara desert was attributed to the stress hormones' release under hot temperature [53]. Feed intake is depressed during autumn high temperature for cashmere goats, which was associated with adverse effects on livestock production [56].

Cholesterol concentration was only higher in adult dry females during the cold season. Similar findings of cholesterol levels were found in kanni goats [4] and in wild goats [55]. Differences in vegetations between seasons and temperature variation are inevitable factors which affect the concentration of cholesterol. Accordingly, food poor in fats decrease the cholesterol concentration [37]. In addition, the concentration of cholesterol may rise as a result of an increase in the catabolism of lipids [57]. However, cholesterol and triglyceride levels were found not be influenced by seasons [15].

Triglyceride concentrations were significantly increased in winter compared to summer in all groups. Goats are very sensitive to cold weather; this is why probably they need more energy by mobilizing fats into the bloodstream in order to produce more ATP.

It was found that Scottish sheep increased the rate of fatty acid synthesis from adipose tissue and the activity of lipoprotein lipase (a key enzyme of tissues of plasma triglycerides) between October and May, i.e. during the cold period. This increase was probably related to a high intake of food [58]. Triglycerides are usually considered as indicators of good nutrition and can be significantly affected by environmental temperature [50]. Triglycerides it is influenced by the energy level of the diet, which at low energy level tends to decrease [59]. Lower values of plasma triglycerides were reported in goats living in poor food conditions compared to other food living conditions considered more or less good [60]. Daily changes in triglycerides are related to diet, it is more stable in low energy diet and higher in a balanced diet [61]. Thus, the high level of triglycerides in the present study is a good sign of acceptable nutrition during the cold winter. In conclusion, this study can increase our understanding of Arabia breed's biological markers, and then help animal breeders to take care on their animals appropriately during the weather extremities.

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