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Biochemical parameters variations with season, age, sex, parity and pregnancy in crossbred goats raised in Tiaret, Algeria

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Abstract: *The aim of this study was to determine the influence of season, age, sex, parity and gestation status on some biochemical parameters in local cross-bred goats raised in Tiaret, Algeria. Ninety cross bred local goats, from 2019 to 2020, aged between nine and seventy-two months at different physiological stage were used. Animals belong to different farms in Tiaret located at the north-west Algeria (35°22' N, 1°19' E). The mean values of triglycerides, creatinine and calcium were significantly ($p < 0,05$) higher in winter than in spring. The physiological state of the goat had a significant influence ($p < 0,05$) on cholesterol, urea, total proteins, calcium and phosphorus, with a high average values in non-pregnant goats, while triglycerides and globulin had significant higher values in postpartum and pregnant femals, respectively. In our work, parity had a significant influence ($p < 0,05$) on cholesterol, calcium and phosphorus, with high average values in young goats and a significant influence ($p < 0,05$) on triglycerides and creatinine with high average values in primiparous ones. Age significantly influenced ($p < 0,05$) cholesterol, triglycerides, total protein, calcium and globulin. The results obtained from this study could serve as reference values for the local goats and other regions or countries with similar climatic and nutritional conditions.*

Keywords: Goats, season, pregnancy, parity, biochemical parameters, age, sex

Introduction

Goats are considered as an important source of good quality meat for many populations around the world, as it is rich in protein and got low fats compared with other animals. However, goats are valued for their excellent skins [1]. The goats raised in Algeria are mainly composed of local breed animals without breed type [2]. A local breed had best resistance and adaptability to diseases and the environment. Selecting a local breed is always the best place to start a healthy goat herd [3]. In Algeria these animals are well adapted to the environmental conditions [4]. This herd is owned by private breeders (rural population) for the most part. Despite the importance of this species as a source of animal protein, it has not benefited from sufficient studies to characterize and develop this type of breeding [5]. Hematological and biochemical values are widely used to determine systematic relationship and physiological adaptation including the assessment of general health condition of animal [6]. Concentrations of metabolites and enzymes in blood serum are biochemical values having strong relationships with physiological events in goats [7]. There is a great variation in the biochemical parameters as observed between breeds of goats [8, 9], and in this regard it may be difficult to formulate a universal metabolic profile test for goats [10]. The significance of determining a biochemical index of domestic animals has been well documented and changes of these parameters have been studied [9, 11, 12, 13, 14, 15, 16]. Many researchers have shown that the blood parameters of small ruminants are influenced by many factors such as age [10, 17], geographical locations, climate, gender, season, breed [2, 8, 18, 19, 20, 21], and the physiological stages of production [19, 22, 23]. The aim of this study was to determine the influence of season, age, sex, parity and pregnancy status on biochemical parameters in goats raised traditionally in Tiaret, Algeria.

Materials and methods

The present study was conducted to ninety cross bred local goats, from 2019 to 2020, aged between nine months and seventy-two months at different physiological stage were used. The animals belong to different farms in Tiaret located at the north-west Algeria. Animals were provided with barley, seasonal available fodder and water, was available *ad libitum*. The goats were divided into two groups. Each group contains 45 goats distributed as follows (N=15 pregnant), (N=15 post-partum), (N=15 non pregnant). Age, sex, parity and the pregnancy status were noted. Two blood samples were taken from the jugular vein and collected on separate heparine from vacuum tubes, the first during the spring; the second during the winter season. Blood was centrifuged at 3000 round for 10 minutes. Serum was stored in dry plastic tubes and conserved at -20°C until analysis. The blood samples from each group were analyzed in terms of the total cholesterol (TC), triglyceride (TG), total protein (TP), urea, creatinine, bilirubine (TB), globulin, Albumin (AL), calcium (Ca) and phosphorus (P) concentrations, were carried out using kits (spinreact kits, spain) and

the readings were carried out using a “Beckman coulter” biochemistry analyzer. For each parameter, mean and standard deviation values were determined and a statistical analysis using SPSS IMB© 20 software and the ANOVA1 test was made to determine the different factors influence.

Results and discussion

The majority of blood component levels were within the general normal limits reported for goats by authors [9, 27, 28, 29, 30], with the exception of calcium which was recorded with an average value of $85,23 \pm 4,12$ mg/L below the standards of these authors, but in parallel this value is included in the range of standards [10, 31], on the other hand Ndoutamia and Ganda [32] recorded average values higher than our results for total cholesterol, triglycerides, urea, total proteins and albumin (Table 1) in the Sahelian, kirdimi and caprine breeds of the Borkou Ennedi-Tibesti region.

Table 1. Biochemical parameters values variation within season

<i>Parameters</i>	<i>Season</i>		
	<i>Winter</i>	<i>Spring</i>	<i>All</i>
	<i>N=45</i>	<i>N=45</i>	<i>N=90</i>
<i>Cholesterol (g/l)</i>	$0,84 \pm 0,16$	$0,83 \pm 0,16$	$0,84 \pm 0,16$
<i>Triglycerides (g/l)</i>	$0,21 \pm 0,05^*$	$0,17 \pm 0,07$	$0,19 \pm 0,06$
<i>Urea (g/l)</i>	$0,33 \pm 0,06$	$0,32 \pm 0,05$	$0,32 \pm 0,05$
<i>Creatinine (mg/l)</i>	$10,51 \pm 1,03^*$	$10,02 \pm 0,88$	$10,26 \pm 0,98$
<i>Total protein (g/l)</i>	$66,90 \pm 5,70$	$66,06 \pm 6,12$	$66,52 \pm 5,90$
<i>Albumin (g/l)</i>	$29,20 \pm 3,30$	$28,77 \pm 3,97$	$28,98 \pm 3,63$
<i>Globulin (g/l)</i>	$37,77 \pm 6,19$	$37,28 \pm 7,19$	$37,53 \pm 6,67$
<i>Calcium (mg/l)</i>	$86,66 \pm 4,08^*$	$83,86 \pm 3,69$	$85,26 \pm 4,12$
<i>Phosphorus (mg/l)</i>	$64,17 \pm 5,94$	$62,62 \pm 7,08$	$63,40 \pm 6,35$

* Indicate a significant difference ($p < 0,05$) in the same line

In our study, cholesterol, urea, total protein, albumin, globulin and phosphorus do not seem to have been affected by the season. The highest average cholesterol level was recorded in winter with $0,84 \pm 0,06$ g/L, while in spring it was $0,83 \pm 0,16$ g/L, the same results are found with those of [33] in local Iraqi black goats with a high value in winter and low in spring, our results do not agree with those of [34] who noted that the season had an influence on cholesterol, the same conclusion was recorded in sheep [35] the highest average value of urea recorded was also in winter with $0,33 \pm 0,06$ g/L while in spring was $0,32 \pm 0,05$ g/L with no significant difference ($p > 0,05$), which is in agreement with those of [36] for total proteins, the highest

average value was also recorded in winter with $66,97 \pm 5,70$ g/L, while in spring it was $66,06 \pm 6,12$ g/L without difference significant ($p > 0,05$), this decrease can be explained by the effect of the increase in temperature [29] which is in contradiction with Safari et al. [36] who reported the opposite.

Otherwise, we recorded that the mean values of triglycerides, creatinine and calcium were significantly ($p < 0,05$) higher in winter than in spring, with concentrations respectively of $0,21 \pm 0,05$ g/L, $10,51 \pm 1,03$ mg/L, $86,66 \pm 4,08$ mg/L in winter against $0,17 \pm 0,07$ g/L, $10,02 \pm 0,88$ mg/L, $83,86 \pm 3,69$ mg/L in spring. Safari et al. [36] found the same results as we did for calcium and they reported that the value of calcium was more washed out during the rainy season compared to the dry season, however others author [37] reported that triglycerides and creatinine were not influenced by the season. For the physiological stage (Table 2), we recorded that the physiological state of the goat had a significant influence ($p < 0,05$) on cholesterol, triglycerides, urea, total proteins, globulin, calcium and phosphorus.

The highest mean cholesterol values were recorded in non-pregnant goats with $0,90 \pm 0,17$ g/L and then in pregnant goats with $0,84 \pm 0,11$ g/L, while in post- partum, the recorded value was $0,78 \pm 0,17$ g/L and it is the lowest value, it is below the physiological standards cited by several authors [9, 27, 28, 29, 31], but it is included in the range (0,64–1,36 g/L) reported [38,14], however, similar results were found but without significant difference [24]. In contrast higher values were recorded in postpartum goats followed by non-pregnant goats and finally pregnant goats [17]. Otherwise, the highest cholesterol values were recorded in pregnant and the lowest value in non-pregnant goats [39].

For triglycerides, the lowest value was $0,17 \pm 0,06$ g/L for non-pregnant, followed by pregnant with a value of $0,19 \pm 0,06$ g/L, while for postpartum goats, the value was highest with $0,21 \pm 0,06$ g/L with a significant difference ($p < 0,05$), this increase in triglycerides can be explained by the decrease in blood sugar and insulinemia on the one hand, and on the other hand by the increase in the plasma content of growth hormone, glucagon and NEFA (Non Esterified Fatty Acids) [40], for the transition to milk because the milk fat is mainly constituted triglycerides (98%) [41], but in contrast it was found that the triglyceride values are higher in pregnant goats than in postpartumones [1].

Table 2. Biochemical parameters values variation within goat's physiological stage

<i>Parameters</i>	<i>Physiological stage</i>			
	<i>Non pregnant</i> <i>N=30</i>	<i>Pregnant</i> <i>N=30</i>	<i>Postpartum</i> <i>N=30</i>	<i>All</i> <i>N=90</i>
<i>Cholesterol (g/l)</i>	$0,90 \pm 0,17^*$	$0,84 \pm 0,11$	$0,78 \pm 0,17$	$0,84 \pm 0,16$
<i>Triglycerides (g/l)</i>	$0,17 \pm 0,06^*$	$0,19 \pm 0,06$	$0,21 \pm 0,06$	$0,19 \pm 0,06$
<i>Urea (g/l)</i>	$0,35 \pm 0,06^*$	$0,31 \pm 0,03$	$0,31 \pm 0,05$	$0,32 \pm 0,05$
<i>Creatinine (mg/l)</i>	$10,13 \pm 0,73$	$10,56 \pm 1,03$	$10,11 \pm 0,78$	$10,11 \pm 0,78$

Total protein (g/l)	68,46±7,02*	68,06±5,07	63,03±3,59	66,52±5,90
Albumin (g/l)	29,93±3,85	28,30±3,08	28,73±3,84	28,98±3,63
Globulin (g/l)	38,53±7,38*	39,76±5,91	34,30±5,50	37,53±6,67
Calcium (mg/l)	87,06±3,91*	85,43±3,92	83,30±3,75	85,26±4,12
Phosphorus (mg/l)	66,16±6,93*	62,33±5,07	61,70±6,15	63,40±6,35

* Indicate a significant difference ($p < 0,05$) in the same line

For urea, the recorded value was $0,35 \pm 0,06$ g/L for non-pregnant goats, significantly higher ($p < 0,05$) than for pregnant and postpartum goats respectively $0,31 \pm 0,03$ g/L, $0,31 \pm 0,05$ g/L, this significant difference ($p < 0,05$) was reported in the results of [17], unlike others reported that the urea value was higher in postpartum goats than in pregnant goats [1]

After delivery, the mean value of total proteins was the lowest with $63,03 \pm 3,59$ g/L significantly lower ($p < 0,05$) than the values recorded in pregnant and non-pregnant goats, respectively 68 g/L, $08 \pm 5,07$ g/L and $68,46 \pm 7,02$ g/L, this postpartum decrease could be explained by the rapid extraction and passage of immunoglobulins in the colostrum via the mammary glands at the beginning of lactation.

Our results are in agreement with authors records with the low values in postpartum goats $74,10 \pm 10,00$ g/L followed by pregnant goats with $81,00 \pm 5,80$ g/L followed by the highest value in non-pregnant goats of $82,00 \pm 7,50$ g/L meanwhile, the lowest globulin value was $34,30 \pm 5,50$ g/L recorded in postpartum goats [24], Celi et al. [42] found that blood serum total proteins were significantly lower after parturition when compared with that in pregnant goats. It has been demonstrated in Nubian goats that the decrease in blood serum protein, particularly γ -globulin, is due to its removal from the blood stream in order to support mammary secretion after parturition [43] Such proteins were later found in the blood serum of neonatal kids to support trophic and absorption processes [44].

Similar observations have been reported for the mean albumin values recorded in Croatian, Syrian red, Saanean and Oberhasli goats [14, 42, 45], these observations are in agreement with our results, since we recorded the lowest mean value in pregnant goats compared to that of postpartum and non-pregnant goats with no significant difference. Ramón et al. [24] appears to be that blood albumin was directed to the tissues of fetal growth, while globulin can be used mainly for the synthesis of milk. For calcium and phosphorus, the values significantly ($p < 0,05$) the highest were recorded in non-pregnant goats were respectively $87,06 \pm 3,91$ mg/L and $66,16 \pm 6,93$ mg/L, while the lowest values were $83,30 \pm 3,75$ mg/L and $61,70 \pm 6,15$ mg/L respectively in postpartum goats, our results were similar to those reported by Azab and Abdel-Maksoud [8]. In our work the physiological state of the goat did not have a significant influence ($p < 0,05$) on creatinine, the high average value was $10,56 \pm 1,03$ mg/L in pregnant goats and the the lowest value was $10,11 \pm 0,78$ mg/L in postpartum goats, so our results are similar to those of [24].

Table 3. Biochemical parameters values variation within parity

<i>Parameters</i>	<i>Parity</i>			
	<i>Nulliparous</i> <i>N=15</i>	<i>Primiparous</i> <i>N=22</i>	<i>Multiparous</i> <i>N=53</i>	<i>All</i> <i>N=90</i>
<i>Cholesterol (g/l)</i>	0,94 ±0,12*	0,89±0,15	0,79±0,15	0,84±0,16
<i>Triglycerides (g/l)</i>	0,19 ±0,05*	0,22±0,06	0,17±0,06	0,19±0,06
<i>Urea (g/l)</i>	0,33 ±0,07	0,31±0,05	0,32±0,05	0,32±0,05
<i>Creatinine (mg/l)</i>	9,70±0,56*	10,62±1,07	10,28±0,98	10,11±0,78
<i>Total protein (g/l)</i>	64,13±5,18	66,54±5,41	67,18±6,20	66,52±5,90
<i>Albumin (g/l)</i>	29,20±4,31	29,22±3,76	28,83±3,44	28,98±3,63
<i>Globulin (g/l)</i>	34,93±6,16	37,31±6,74	38,35±6,71	37,53±6,67
<i>Calcium (mg/l)</i>	88,73±3,63*	85,86±4,02	84,03±3,72	85,26±4,12
<i>Phosphorus (mg/l)</i>	66,33±8,09*	65,45±5,76	61,71±5,55	63,40±6,35

* Indicate a significant difference ($p < 0,05$) in the same line

In our study (Table 3), parity had a significant effect ($p < 0,05$) on total cholesterol, triglycerides, creatinine, calcium and phosphorus, on the contrary we noticed a non-significant difference ($p > 0,05$) on urea, total proteins, albumin and globulins. The highest mean cholesterol values were recorded in nulliparous with 0,94±0,12 g/L, then in primiparous with 0,89±0,15 g/L and 0,79±0,15 g/L in multiparous, which does not agree with the results of [17], who found that the increase in cholesterol concentration is parallel to the increase in the number of parities.

In this work, the lowest value of triglycerides was always recorded in multiparous with 0,17±0,06 g/L, but the highest value was 0,22±0,06 g/L in primiparous, unlike to Soares et al. [46] who found that the highest value was recorded in nulliparous goats. For creatinine, the value recorded in nulliparous was 9,70±0,56 mg/L significantly lower ($p < 0,05$) than the values recorded in multiparous with 10,28±0,98 mg/L and in primiparous with 10,62±1,07 mg/L.

The results are in agreement with the work of [17], who found that the higher the parity, the greater the increase in creatinine in Dandish Landes dairy goats (*Capra hircus*). in nulliparous goats, the mean values of calcium and phosphorus were significantly higher with 88,73±3,63 mg/L of calcium and 66,33±8,09 mg/L of phosphorus compared to those of multiparous goats which have lower values of 84,03±3,72 mg/L of calcium and 61,71±5,55 mg/L of phosphorus. Our results regarding total proteins are similar to those of [17], who reported that the total concentration of serum proteins was higher in goats with higher parities than lower parities.

In our study (Table 4), age had a significant effect ($p < 0,05$) on total cholesterol, triglycerides, total protein, globulin and calcium, the lowest values, cholesterol, triglycerides and calcium were recorded in 72-

month-old goats while the lowest total protein and globulin values were recorded in 9-month-old goats. We recorded $0,96 \pm 0,06$ g/L as high cholesterol, while the lowest value was $0,57 \pm 0,03$ g/L.

Table 4. Biochemical parameters values variation within goat's age

Parameters	Age (Months)						
	9 N=10	12 N=09	24 N=27	36 N=14	48 N=18	60 N=08	72 N=04
Cholesterol (g/l)	0,94±0,14*	0,96±0,06	0,87±0,14	0,86±0,15	0,78±0,14	0,69±0,13	0,57±0,03
Triglycerides (g/l)	0,21±0,05*	0,21±0,07	0,21±0,06	0,23±0,05	0,16±0,04	0,12±0,04	0,10±0,01
Urea (g/l)	0,33±0,09	0,30±0,05	0,33±0,04	0,35±0,05	0,31±0,04	0,32±0,05	0,26 ±0,03
Creatinine (mg/l)	9,55±0,55	10,17±0,86	10,34±1,05	10,52±1,04	10,32±1,02	10,18±0,92	10,74±1,11
Total protein (g/l)	61,30±2,00*	76,11±5,13	65,81±5,54	67,28±5,51	68,66±5,13	70,62±9,37	62,50±2,51
Albumin (g/l)	29,00±4,44	29,00±3,77	29,66±4,27	27,28±2,49	29,33±2,65	28,87±4,35	29,00±2,70
Globulin (g/l)	32,93±4,96*	38,11±4,42	36,14±7,79	40,00±4,55	39,33±5,39	41,75±8,68	33,50±3,69
Calcium (mg/l)	88,60±4,24*	88,88±2,26	85,51±3,82	85,42±3,81	82,77±3,45	83,62±3,24	81,00±2,94
Phosphorus (mg/l)	65,00±8,85	68,55±5,54	63,55±6,65	63,21±4,77	61,44±4,01	61,12±8,44	60,75±2,21

* Indicate a significant difference ($p < 0,05$) in the same line

Ashour et al. [47] found that cholesterol levels were high in the first month of birth, either in lambs or kids. Leat [48] found that the concentration of esterified plasma lipids, mainly phospholipids and cholesterol esters, was very low at birth and peaked about 20 days after delivery before falling back to adult values at birth weaning. These changes have been discussed in relation to diet and rumen development, the concentration of cholesterol is influenced by the degree of stress. Therefore, a decrease in cholesterol with age can be expected from stress (especially in weaned lambs) [47]. Data show that triglyceride concentrations in goat blood plasma increased with age up to 36 months with the highest value of $0,23 \pm 0,05$ g/L, the reverse trend was recorded after this age up to the age of 72 months with the lowest value of $0,10 \pm 0,01$ g/L which is in contradiction with the results of Ashour et al. [47]. The results of the present study demonstrate that the total proteins are lower in 9 month old goats and the average value recorded was $61,30 \pm 2,00$ g/L, while the highest value was $76,11 \pm 5,13$ g/L in goats aged 24 months [47], the concentration of total proteins in the blood plasma of lambs and kids increases with age. As age increases, the concentration of total protein in the plasma of lambs and kids increases. But in our work and after the age of 24 months, we recorded low average values per intake at $76,11 \pm 5,13$ g/L, but which are always higher than those of goats aged 9 months, the same something was observed for globulins, the lowest value was recorded in 9-month-old goats with $32,93 \pm 4,96$ g/L, but the highest value was $41,75 \pm 8,68$ g/L in goats aged 60 months.

Conclusion

This study showed that season, physiological stage, parity and age influenced some biochemical parameters in local goats. These results can also be used to monitor health status, to follow the different physiological stages, diagnose diseases, and improve the management and conservation of this local breed.

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