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Changes in Blood Biochemical and Mineral Parameters of Ouled Djellal Ewes under the Semi-Arid Environment of North–Eastern Algeria during Late Pregnancy and Early Post-Partum

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ABSTRACT

Mineral and biochemical profiles have been used to predict pre-partum and post-partum metabolic problems and to assess the nutritional status of small ruminants. The concentrations of these metabolites are known to vary according to many factors such as breed, sex, age, nutrition, physiological and environmental conditions. Therefore, current study was conducted to determine changes in some biochemical and mineral indicators of metabolism and to search for their correlations during peri-partum period in Ouled Djellal ewes, reared under semi-intensive farming system in semi-arid environment. The study was conducted on thirteen clinically healthy ewes aged between one and three years and weighed 53,4 ± 1,85 kg, reared at Samaei Mohamed pilot farm (wilaya of Oum El Bouaghi located in North-Eastern Algeria). Blood samples were collected once in the morning before feeding during late pregnancy (4 Weeks Pre-Partum=4WPrP) and early lactation (1 Week Post-Partum=1WPP). Plasma glucose (Glu), cholesterol (CHO), Urea, creatinine (Creat), total protein (TP), albumin (Alb), Ca, P, Na and Cl were measured. During 1WPP, Creat, TP, Alb, CHO, Ca, P, Na and Cl levels decreased significantly (p<0,001, p<0,000, p<0,000, p<0,000, p<0,000, p<0,000, p<0,000, and p<0,008, respectively), while Glu and Urea levels increased (p< 0,05 and p<0,000 respectively), compared to those measured during 4WPrP. Negative significant correlations (p< 0.05) of Urea with Ca and P levels were found during pre-partum period and between Na and CHO (p< 0.05) at the first week post-partum. In conclusion, the results of this study will help breeders and veterinarians to a better control of Ouled Djellal ewe's reproduction, and to understand the metabolic adaptation of this breed to semi-arid environment.

Keywords: *Algerian Semi-Arid Area, Blood Biochemical and Mineral Indicators, Late Pregnancy, Ouled Djellal Ewes, Post-Partum.*

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1. INTRODUCTION

In Algeria, Sheep herd dominates the breeding with a population of 28.1 out of 35 million heads of all types of ruminants (Faostat, 2017). They are mostly concentrated in the semi-arid zone, but this region is characterized by the wide variety of climatic conditions such as the irregularity of the rainfall which often leads to long periods of drought and diminishing land resources, resulting in hindering the production of agricultural sector. This drought affects mainly all physiological processes of growth and development of different animal species including sheep and goats.

Ouled Djellal sheep is numerically the largest national herd exploited mainly for the production of meat and wool because of good maternal skills, high reproductive qualities, better resistance to harsh conditions of semi-arid area, well use of coarse foods and good walking skills (Mennani et al., 2011).

Most blood parameters have been found to reflect the nutritional and physiological animal states. In the last few years, many researchers have shown that the blood parameters of small ruminants are influenced by many factors such as season (Yokus et al., 2006; Sawankumar et al., 2017), age (Baumgartner and Pernthaner, 1994; Bonev et al., 2012), the environment factors such as altitude, landforms, and temperature (Titaouine, 2017; Deghnouche et al., 2013), physical activity and genetic characteristics (Caldeira et al., 2007), breed (Antunović et al., 2011, Sawankumar et al., 2017), different production system (Deghnouche et al ., 2011, Njidda et al., 2014, Raju et al., 2015**,** Antunović, et al., 2017, Stevanović1 et al., 2015), and by physiological stages of production (Antunović,et al., 2011, Sawankumar et al., 2017, Stevanović1 et al., 2015**,** Allaoua & Mahdi 2018a). In sheep, the most relevant changes in serum metabolic profile have been detected at the end of gestation and the beginning of lactation (Goff & Horst 1997, Piccione et al., 2009, Giuliotti et al., 2014).

Both stages are considered as most critical and stressful periods because of high nutritional requirements for foetus, colostrum and milk production (Piccione et al. 2009)

Environment plays an important role in the reproductive performance of farm animals, for this reason understanding the physiological mechanisms of animal adaptation to their environment is a major challenge for the scientific community and the livestock sector. Therefore, the present work was carried out to investigate the influence of late pregnancy and

post-partum period on plasma minero-biochemical profile of Ouled Djellal ewes reared in semi-intensive production system under the semi-arid conditions in order to prevent health disorders which disturbs production and reproduction.

2. MATERIALS AND METHODS

2.1. Animals and experimental area

Examinations were performed at Samaei Mohamed pilot farm in Berriche (35°54'59.99" N 7°22'59.99" E) located 14 km northeast of Aïn Béïda (wilaya of Oum El Bouaghi North-Eastern Algeria). This region is considered as a semi-arid area with agropastoral vocation. The total area of the farm is 1749 Ha, and the useful agricultural area (UAA) is 1737 Ha exploited specifically in cereal cultivation. The climate is characterized by a dry season extending over the largest part of the year and a "wet" season, with low rainfall (between 200 and 400 mm/year). According to technical data, this farm has more than 2038 heads of Ouled Djellal sheep and these animals are reared under semi-intensive production system in order to protect and to preserve this breed of sheep known for the quality of its livestock and its adaptation to this semi-arid area.

A total of thirteen healthy Ouled-Djellal ewes aged between 1 and 3 years and weighing 53,4 ± 1,85 kg were used in this study. All the animals were reared in an semi-intensive production system.

The basic animal feeding throughout the year was provided by vetch-oat hay, chopped straw and pasture grass when needed. During autumn and spring, the herds received barley in green. During the summer, sheep grazed on cereal stalks of barley and wheat and receive good quality straw hay. In winter, the ration was completed by a mixture of bran and barley at the end of gestation and early lactation, they remained stable and received once in morning a concentrate (90% barley, 10% corn, and soy) milled at a rate of 800 g/animal/day and a mixture of vitamins and minerals were incorporated into the diet, water was distributed *ad libitum.*

2.2. Sampling and analyses

Blood samples were collected in early morning before food intake at 4-week pre-partum (4WPrP) and at first week post-partum (1WPP) by jugular venipuncture into heparinized tubes (4 ml) for the biochemical analysis. Then blood samples were centrifuged at 3500 rpm for 15 min and the plasma collected was kept frozen at −20°C until used for the blood parameters analysis.

Plasma glucose (Glu), cholesterol (CHO), Urea, creatinine (Creat), total protein (TP), albumin (Alb), Ca, P, Na and Cl concentrations were measured by commercial kits named spinreact, spain as standard method using UV-visible recording spectrophotometer (UV-160A; SHIMADZU, Corporation, Japan).

2.3. Statistical analysis

All data were expressed as means ± standard Error of the Mean (SEM), differences between groups were estimated using Test-t of Student for paired samples. Pearson's correlation test was used to investigate the relationship between the blood parameters. All obtained data were analysed using the Statistical software program (SPPS, version 20). Results were considered as statistically significant at P< 0.05.

3. RESULTS AND DISCUSSION

The results (mean ± SEM) in Table 1 and 2 show that the changes in plasma biochemical and mineral parameters were influenced by the physiological status of Ouled Djellal ewes aged between 1 and 3 years. Values of coefficient of correlation (r) between plasma biochemical and mineral parameters are presented in Table 3 and 4.

As shown in table (1), data revealed significant (P<0.05) increase in plasma Glu concentrations at 1WPP, and this finding was in agreement with those of Gurgoze et al. (2009) Takarkhede et al. (1999**)** and Teleb et al. (2014) who observed blood Glu level was significantly lower in pregnant compared to that in post-partum and non-pregnant Malpura ewes and Saidi ewes, respectively. Hafez et al. (2010) and Soliman (2014) reported a significant decrease in serum Glu levels during late pregnancy compared to early postpartum stage in bearing Akkaraman ewes and Ossimi ewes. On the other hand, Fýrat and Ozpnar (2002); Karapehlivan et al. (2007) found non-significant changes in serum Glu levels during lactation. In this study, the low blood Glu level at 4WPrP could be attributed to foetal development and mobilization of maternal Glu to foetal tissues**.** On the other hand, the increase in Glu levels during early lactation ascribed to developed Glu sparing mechanisms mostly in mammary gland to prevent hypo-glycaemia which indicated the good adaptation of Ouled Djellal ewes to the metabolic changes during early lactation.

Table 1. Plasma biochemical levels during pre-partum period In Ouled Djellal ewes aged between 1 and 3years

Parameter	Pre-partum period		*p-value*
	4Week Pre-Partum	1Week Post-Partum	
Glu (g/l)	0,64 ± 0,01 a	0,67 ± 0,01b	0,046
Urea (mg/l)	0,42± 0,01 a	0,51± 0,01 b	<0,000
Creat (g/l)	8,29 ± 0,27 a	7,86 ± 0,26 b	0,001
CHO (g/l)	0,71 ± 0,01 a	0,47 ± 0,01 a	<0,000
TP (g/l)	76,33 ± 1,53 a	62,4 ± 1,5 b	<0,000
Alb (g/l)	22,49 ± 0,80 a	20,16 ± 0,88 b	<0,000

Means in the same row with different superscript letters are significantly different (P< 0.05).

Results are expresses as mean ± SEM

Uraemia is subject to large fluctuations due to the importance of the protein and especially protein efficiency. It is a good indicator of nitrogen intake in sheep and goats (Gürgöze et al.2009). High significant increase of uraemia level (P<0.001) was observed at the 7th day of lactation compared with the last month of pregnancy. Glomerular filtration and Urea clearance were significantly reduced during lactation indicating an effective renal economy of Urea. This latter result might also be due to increased catabolism of muscle protein during lactation when large amounts of body reserves were mobilized. Our result is similar to that of Karapehlivan et al. (2007) in Tuj ewes who found that changes in blood Urea concentration during lactation could depend on milk synthesis. On the other hand, El Sherif and Assad (2001) found that Uraemia began to increase from the 10th week of gestation to maximum concentrations at parturition in Barki ewes under semi-arid conditions. Additionally, in the current research and during

4WPP, plasma Urea was negatively correlated with Ca (r=-0,639, p<0.05) and P (r=-0.558, p<0.05).

The level of plasma Creat showed a significant decrease at 1WPP (p=0,001), which could be compatible with an increased energy requirement coinciding with the beginning of lactation. This finding was also reported by Allaoua & Mahdi (2018a) and Meziane (2001) who explained the increase in Creatinemia in the pregnant female by the protein deficiency or to the intense activity of thyroid during gestation leading to an amplification of muscle protein catabolism and a high production of Crea. Hamadeh et al. (2006) noted non-significant effect of lactation on serum Creat.

In ruminants, serum CHO levels are modified by various factors, for example, diet composition, age, sex, race, season, pregnancy, lactation and biliary tract diseases (Ozpinard and Firat.1995). Blood level of CHO observed in this study differs between the two physiological stages; it increases considerably and significantly (p<0,001) at 4WPrP and drops at 1WPP. The increase in CHO concentration at the end of gestation may be due to insulin, which known to play a direct role in the metabolism of adipose tissue during pregnancy. The sensitivity of adipose tissue to insulin is significantly reduced in late pregnancy which predisposes the animal to an increase in the concentration of cholesterol. Raoofi et al. (2013) reported that the serum concentration of CHO gradually increased around lambing, and peaks 7 days after parturition. Krajnicakova et al, (1993), Hamadeh et al, (1996), Nazifi et al, (2002), Antunovic et al, (2011) have reported elevated cholesterolemia in late pregnancy. In the same context, Balikci et al. (2007) showed a gradual increase in CHO levels during pregnancy compared with postpartum values. Interestingly, CHO was negatively correlated with Na (r=-0,631, p<0.05).

The mean value of TP concentration noted during 4WPrP in Ouled Djellal ewes was significantly higher (p<0,001) compared to that at 1WPP. The decrease in blood TP level at the beginning of lactation could be explained by the extraction and passage of immunoglobulins into colostrum via the mammary glands, and it might also represent an adaptive response of Ouled Djellal ewes under semi-arid conditions to the higher need of water mobilization by blood for milk production. A decrease in serum concentration of TP was noted on the 150th day of pregnancy by Balikci and Yildiz (2005). Our results were opposed to those found by Shetaewi and Daghash (1994) who pointed out a significant rise in serum total protein concentrations in lactating females. Baumgartner and Pernthaner (1994); Roubies et al. (2006), and Yokus et al. (2006) did not describe significant effect of the physiological stage on blood TP level.

The significant decrease in Alb blood concentration observed in Ouled Djellal ewes at post-partum period compared to pre-partum one was also reported by Nazifi et al. (2002), who explained it by the increase in the absorption of cholesterol by the tissues involved in the synthesis of milk. Albumin is a protein synthesized in the liver. It is used to maintain oncotic pressure and other functions such as, thyroid hormone transport, fat-soluble vitamins, free fatty acids, calcium, and unconjugated bilirubin transport. This blood parameter is evaluated as much as total protein as an indicator of protein nutrition (Sakkinen et al., 2005). Plasma Alb levels tended to decrease at 1WPP compared to 4WPrP, this results agreed well with those of Baumgartner and Pernthaner (1994), Shetaewi and Daghash (1994); Deghnouche et al. (2013) and Antunovic et al. (2011), who noted a significant influence of the reproductive stage on serum Alb levels that increase during pregnancy. Some authors attributed the decrease in serum Alb level at the beginning of lactation, to a decrease in protein synthesis of the liver, which was due either to the fatty infiltration that followed the mobilization of body reserves or to the decrease in the availability of amino acids used primarily to satisfy the mammary demand for amino acids and glucose.

Table 2. Plasma mineral levels during pre-partum periodIn Ouled Djellal ewes aged between 1-3 years

	Pre-partum period		
Parameter	4Week Pre-Partum	1Week Post-Partum	*p-value*
Ca (mg/l)	108,98± 4,46a	84,85± 2,70b	<0,000
P(mg/l)	54,38± 1,26a	50,41± 0,92b	<0,000
Na (mmol/l)	136,91± 1,40a	134,57± 1,64b	0,008
Cl (mmol/l)	112,76± 0,92a	105,50±1,14b	<0,000

Means in the same row with different superscript letters are significantly different (P< 0.05).

Results are expresses as mean ± SEM

Table 3. Pearson's correlation coefficient between the studied plasma parameter concentrations for Ouled Djellal ewes aged between 1-3 years During 4WPrP

		Glu	Urea	Crea	Alb	TP	CHO	Ca	P	Na	Cl
Glu		1									
Urea	r	-0,137	1								
	p	0,656									
Crea	r	-0,134	0,264	1							
	p	0,663	0,384								
Alb	r	0,038	-0,117	0,059	1						
	p	0,902	0,703	0,847							
TP	r	-0,071	0,296	0,206	-0,163	1					
	p	0,819	0,326	0,498	0,596						
CHO	r	-0,519	-0,177	0,199	-0,013	-0,12	1				

	p	0,069	0,563	0,513	0,967	0,695					
Ca	r	-0,223	-0,639*	-0,089	0,345	-0,546	0,311	1			
	p	0,465	0,019	0,773	0,248	0,054	0,301				
P	r	-0,072	-0,558*	-0,31	0,126	0,033	-0,146	0,415	1		
	p	0,816	0,048	0,303	0,681	0,913	0,634	0,159			
Na	r	0,326	-0,161	-0,05	0,332	-0,066	-0,455	-0,247	0,358	1	
	p	0,277	0,599	0,872	0,267	0,829	0,118	0,417	0,229		
Cl	r	0,506	0,143	-0,031	-0,336	0,226	-0,082	-0,386	-0,455	-0,198	1
	p	0,077	0,641	0,919	0,261	0,456	0,789	0,192	0,118	0,516	

r: Pearson's correlation coefficient, p: p-value, *: Significant correlation at p < 0,05, **: significant at p < 0.01 and NS: not significant.

Calcium (Ca) and Phosphorus (P) are major minerals, mainly stored in the skeleton, and are very strongly mobilized at the beginning of lactation. Sodium (Na) and Chloride (Cl) are often considered as a complex because of their functional interrelationships, their relations to the needs of animals, and their mode of supply (often supplied as sodium chloride).

In the present study, mineral plasma concentrations varied during pre-parturient period in Ouled Djellal ewes, where we observed a significant decrease in Ca and P blood levels at 1WPP (p<0,000); a drop in plasma Ca levels at post-partum period, as a warning signal to the parathyroid gland to release more of hormone parathyroid hormone in order to meet the increased Ca requirements for maintaining lactation. Barlet et al. (1971) indicated that, contrary to what happened in the cow and in the goat, it did not appear in the ewes at post-partum. Neither significant hypocalcaemia nor hypophosphatemia was observed

Plasma concentration of these minerals in blood of Ouled Djellal ewes showed a significant decrease for Na (p<0,05) and Cl (P<0,000) at 1WPP. This downward trend was probably a consequence of the loss of these elements in colostrum and milk. In mammals, the aqueous phase of colostrum contains high concentrations of Na and Cl. These results are in agreement with those determined in Awassi ewes and published by Al-Hadithy et al. (2012) who attributed the decrease in serum Na and Cl levels during lactation to high temperatures and low water consumption. Despite the salt requirements of the animals during lactation were higher, it can be concluded that the majority of mineral needs of Ouled Djellal ewes were covered during the period of transition.

Table 4. Pearson's correlation coefficient between the studied plasma parameter concentrations for Ouled Djellal ewes aged between 1-3 years During 1WPP

		Glu	Urea	Crea	Alb	TP	CHO	Ca	P	Na	Cl
Glu	r	1									
	p										
Urea	r	0,147	1								
	p	0,630									
Crea	r	-0,321	0,020	1							
	p	0,285	0,949								
Alb	r	-0,313	-0,471	0,084	1						
	p	0,297	0,105	0,784							
TP	r	0,058	0,529	-0,279	-0,044	1					
	p	0,851	0,063	0,356	0,885						
CHO	r	-0,017	-0,089	-0,026	-0,432	-0,191	1				
	p	0,957	0,773	0,934	0,141	0,531					
Ca	r	-0,186	-0,132	-0,105	-0,098	0,387	0,336	1			
	p	0,544	0,668	0,732	0,751	0,192	0,262				
P	r	0,275	-0,533	-0,184	0,346	-0,376	-0,253	-0,056	1		
	p	0,363	0,061	0,546	0,247	0,206	0,405	0,855			
Na	r	0,215	-0,242	-0,191	0,298	-0,071	-0,631*	-0,522	0,356	1	
	p	0,480	0,427	0,532	0,323	0,818	0,021	0,067	0,232		
Cl	r	0,169	0,069	-0,241	0,327	-0,221	-0,265	-0,316	0,237	0,079	1
	p	0,582	0,823	0,428	0,275	0,469	0,381	0,293	0,436	0,797	

r: Pearson's correlation coefficient, p : p-value, * : Significant correlation at p < 0,05, ** : significant at p < 0.01 and NS: not significant.

4. CONCLUSION

In Algerian semi-arid area, Minero-Biochemical profiles of Ouled Djellal ewes were affected by the period of transition. Blood concentrations of Creat, Alb, TP, CHO, Ca and Na decreased significantly while concentrations of Glu and Urea increased after parturition. On the other hand, Urea was highly correlated with Ca and P during 4WPrP but at 1WPP, but Na was highly correlated with CHO. Our results confirm that the pre-partum is the period during which the most important blood metabolic changes coincide with maximal foetal growth at the end of gestation and at the beginning of lactation. Ouled Djellal ewes have showed some adaptive characteristics to produce and survive in semi-arid conditions during the pre-partum period.

The obtained results will certainly help breeders and clinical veterinarians in order to control health and nutritional status of Ouled Djellal ewes in semi-arid zones of Algeria to avoid decline in productive performance and consequently economic loss.

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