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## **Metabolic Blood Profiles and Milk Compositions of Peri-parturient and Early Lactation Periods in Sheep**

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### **ABSTRACT**

Parturition and early lactation are considered as the most critical and stressful periods of dams life cycle because of high nutritional requirements for colostrums and milk production. This study aimed to evaluate the influence of physiological status on the blood metabolic profiles, colostrum, milk compositions and thyroid hormonal status of lactating ewes and their newborn in two sheep breeds (Naemi and Najdi) managed under an intensive system. Ten healthy ewes from each breed were selected at parturition. Blood samples, colostrums and milk samples were collected at parturition and 45 days later both from ewes and their newborns. Ewes were fed concentrate pellets with Rhodes grass for both breeds and kept under the same environmental conditions and management. Colostrum and milk samples were analyzed for nutrients composition. Blood serum of ewes and their newborns were analyzed for albumin, total protein, cholesterol, glucose, calcium (Ca), phosphorus (P), triiodothyroxine (T3) and thyroxine (T4). At parturition, a significantly higher glucose, Ca and P levels in blood serum were reported for ewes and newborns of Najdi compared with Naemi breed. At 45 days postpartum, a significantly lower Ca ( $p < 0.001$ ) and P ( $p < 0.05$ ) levels in blood serum of Najdi ewes and their lambs with significantly ( $p < 0.05$ ) higher T3 and T4 of ewes when compared with Naemi breed. Colostrum and milk fat and Lactose percentages of Naemi ewes were significantly higher ( $p < 0.05$ ) compared with Najdi breed. This study showed a breed variation in term of certain metabolic parameters and colostrum and milk composition during parturition and early lactation.

**Key words:** Sheep breed, metabolites, colostrums, milk, thyroid hormones, minerals

### **INTRODUCTION**

The animal body and organs undergo several metabolic adaptations linked to their physiological statuses. Parturition and early lactation are considered as the most critical and stressful periods of dams life cycle because of high nutritional requirements for colostrums and milk production (Goff and Horst, 1997). The metabolic changes during different physiological statuses mainly controlled by some hormones which cause the activation of these specific metabolic organs according to their needs (Bauman and Currie, 1980). During lactation, thyroid hormones and other hormones play an important role by regulating the metabolism of ewes to balance and compensate the negative energy balance (Hatfield *et al.*, 1999; Peel and Bauman, 1987). Moreover, minerals metabolism, in particular Calcium and phosphorus, undergoes a substantial change to guarantee

colostrum and milk synthesis (Yokus *et al.*, 2004). The quantity and nutritional composition of colostrum and milk are influenced by numerous factors such as genetic (breed and genotype), feeding and management system, environmental factors, stage of lactation and health (Antunac and Havranek, 1999). Previous report has suggested that ewes' milk and colostrum compositions varied widely because of differences between breeds (Abd Allah *et al.*, 2011). Blood metabolic profile is an important laboratory diagnostic technique that can be used efficiently to assess the nutritional status and animal health (Herdt *et al.*, 2000). Most of the research in the local breeds in Saudi Arabia does not focus and consider the important biochemical parameters (glucose, triglyceride, cholesterol, total protein and urea) and hormones, such as triiodothyroxine (T3) and thyroxine (T4), in ewes' blood during the critical physiological status and environment. Thyroid hormones levels in blood serum of farm animals are considered to be an important indicator of their metabolic and nutritional status (Riis and Madsen, 1985; Todini, 2007). This information is very crucial to guarantee the metabolic and nutritional needs of these ewes during the early lactation to reduce the mortality rates of newborns and consequently economic loss. Moreover, the finding of this study will provide us with very important information, not studied before, which helps in establishing a genetic improvement programs and dietary supplementation during these critical stages.

The aim of this study was to evaluate the effect of breeds (Najdi and Naemi) on ewes at parturition and early lactation and how these affect the composition of colostrum and milk under an intensive management system in Saudi Arabia.

## MATERIALS AND METHODS

**Animals and management:** A total number of twenty healthy multiparous ewes of Najdi and Naemi breed (n = 10 each breed; 3-5 years old; single lambing) and their lambs were selected at parturition from Al-Khaldiah farm located in the semi arid area in Al- Khaldiah region close to Al- Riyadh city, Saudi Arabia. The ewes were raised under an intensive production system, identical conditions of feeding and managements. On the other hand, the experimental work followed the animal welfare regulations at King Saud University and Ministry of Agriculture in term of feeding, handling and collecting samples.

The ewes were fed pelleted concentrate diet (450 g head<sup>-1</sup>; pellets consists of: barley, corn maize, soybean hull, Palm Seed Meal (PSM), alfalfa, Sugar Molasses (SM), special mineral, vitamins and additives premix) and Rhodes grass (750 g head<sup>-1</sup>). The chemical composition of the concentrate pellets and Rhodes grass is shown in Table 1. Water and vitamin and mineral premix were provided *ad libitum* to all ewes for the entire period. Newborn lambs from both breeds were weighted at birth and at 30 and 60 days old.

Table 1: Chemical composition of the experimental concentrate pellets and rhodes grass (as fed)

Nutrient (%)	Concentrate pellets	Rhodes grass
Crude protein	13.5	9.80
Energy (Mcal)	2.9*	4.16**
Crude fiber	10.0	32.00
Crude fat	2.0	1.60
Inorganic matter	8.0	12.00
Calcium	1.5	-
Phosphorus	0.5	-

\*Metabolizable energy, \*\*Gross energy

**Samples collection and preparation:** Blood samples were collected from the jugular vein at parturition and at 45 day postpartum from the ewes and their newborns using vacutainer tube without anticoagulant to separate serum. Serum was separated by centrifuge (3000 rpm/15 min) and supernatant were separated in sterilized tubes. Colostrum samples were collected from each ewe at the second day postpartum, morning and evening and homogenized sample were taken. Milk samples were also collected at 45 days postpartum following the same procedure as colostrum. Serum, colostrums and milk samples were stored at -20°C till analysis.

**Samples laboratory analysis:** Serum samples were analyzed for thyroid hormones levels (T3 and T4) by ELISA test kits (Gesellschaft fur Biochemica und Diagnostica, 65205 Wiesbaden, Germany). Validation of these hormones assays assessed the detection limit, standard curve and coefficient of variations of the results. Additionally, the levels of serum glucose, total protein, cholesterol, albumin, Calcium and phosphorus were determined colorimetry by spectrophotometry using different commercial kits (United diagnostics Industry, Dammam 31413, KSA). Moreover, colostrum and milk samples were analyzed for fat, protein, lactose, total solid (TS) and Solid Not Fat (SNF) values by using Milko Scan (Minor Type 78100, Foss Electric, Denmark).

**Statistical analysis:** Data from this study were analyzed using SAS (2001) as a complete randomized design to compare the means of metabolites, calcium, phosphorus, T3 and T4 concentrations in blood serum and colostrum and milk composition between two sheep breeds, Najdi and Naemi. The significant levels were declared at  $p < 0.05$ .

## RESULTS AND DISCUSSION

**Blood serum metabolites of ewes and newborns:** The results of this experiment regarding albumin, total protein, cholesterol and glucose levels in blood serum of ewes and their newborns at parturition are presented in Table 2. A significantly higher levels of albumin ( $p < 0.05$ ) and cholesterol ( $p < 0.01$ ) and lower glucose ( $p < 0.05$ ) were found in blood serum of Naemi newborn lambs compared to Najdi. The same trend was found for the glucose levels in the blood serum of Naemi ewes compared with Najdi ewes. Furthermore, a significantly ( $p < 0.05$ ) higher total protein levels in blood serum of Najdi ewes when compared with Naemi ewes (6.89 vs. 5.50 g dL<sup>-1</sup>, respectively). At 45 days postpartum, there was no significant differences in the albumin, total protein,

Table 2: Blood serum metabolites of two sheep breed at parturition

Parameter	Breed		SEM	Significance
	Naemi	Najdi		
<b>Newborn</b>				
Albumin (g dL <sup>-1</sup> )	3.12	2.77	0.14	*
Total protein (g dL <sup>-1</sup> )	5.65	5.54	0.13	ns
Cholesterol (mg dL <sup>-1</sup> )	92.14	75.78	3.59	**
Glucose (mg dL <sup>-1</sup> )	66.82	71.54	4.53	*
<b>Dams</b>				
Albumin (g dL <sup>-1</sup> )	3.19	3.08	0.08	ns
Total protein (g dL <sup>-1</sup> )	5.50	6.89	0.44	*
Cholesterol (mg dL <sup>-1</sup> )	82.30	79.70	3.59	ns
Glucose (mg dL <sup>-1</sup> )	49.06	67.04	6.57	*

ns: Not significant, \* $p < 0.05$ , \*\* $p < 0.01$

Table 3: Blood serum metabolites of two sheep breeds at 45 days postpartum

Parameter	Breed		SEM	Significance
	Naemi	Najdi		
<b>Newborn</b>				
Albumin (g dL <sup>-1</sup> )	3.11	3.19	0.07	ns
Total protein (g dL <sup>-1</sup> )	7.55	6.95	0.31	ns
Cholesterol (mg dL <sup>-1</sup> )	92.30	112.20	8.41	ns
Glucose (mg dL <sup>-1</sup> )	56.60	62.30	3.72	ns
<b>Dams</b>				
Albumin (g dL <sup>-1</sup> )	3.19	3.61	0.21	ns
Total protein (g dL <sup>-1</sup> )	6.11	6.06	0.25	ns
Cholesterol (mg dL <sup>-1</sup> )	99.48	100.78	4.73	ns
Glucose (mg dL <sup>-1</sup> )	50.46	58.10	3.15	ns

ns: Not significant

cholesterol and glucose levels in blood serum of the ewes and the newborns from the two breeds (Table 3). According to Kaneko *et al.* (2008), the reference range values for albumin, total protein, glucose and cholesterol are as follow: 2.4 to 3.09 g dL<sup>-1</sup>; 6.0 to 7.0 g dL<sup>-1</sup>; 50.09 to 80.0 mg dL<sup>-1</sup>; 52.12 to 76.06 mg dL<sup>-1</sup>, respectively. The levels of albumin, total protein and glucose for both breeds were fallen within the normal range. For cholesterol, higher levels of cholesterol were detected for newborns and ewes from both breeds at parturition and 45 days with a significantly higher for newborn compared with ewes, especially in Naemi breed. Many researchers reported a drop down in cholesterol level in blood serum of ewes from different species at late gestation and during lactation because of the high cholesterol requirements by dams for ovary steroids genesis and milk synthesis (Bekeova *et al.*, 1987; Krajnicakova *et al.*, 2003; Antunovic *et al.*, 2011). Their findings were disagreed with ours because cholesterol metabolism affected by many complex of factors including nutrition.

The total protein and albumin levels during early lactation agreed with the values reported by Piccione *et al.* (2009) who reported an increase of protein and albumin compared with other physiological statuses of ewes. These high values can be explained by the high energy requirements for milk synthesis, especially during early lactation (Bremmer *et al.*, 2000).

The glucose levels in blood serum of ewes were fallen within the boarder line which caused by using glucose for milk lactose synthesis with insufficient dietary supply to maintain blood glucose homeostasis (Pambu-Gollah *et al.*, 2000; Roubies *et al.*, 2006; Antunovic *et al.*, 2011).

**Calcium and phosphorus and thyroid hormones concentrations:** The calcium, phosphorus and thyroid hormones in the blood serum of ewes and newborn lambs are presented in Table 4. There was no significant difference ( $p > 0.05$ ) between the two breed at parturition in term of T3 and T4 levels in the blood serum, but a significantly ( $p < 0.05$ ) higher concentration of calcium (Ca) and Phosphorus (P) in the blood serum of Najdi ewes and newborn lambs when compared with Naemi breed. At 45 days postpartum, calcium and phosphorus levels in the blood serum of Naemi ewes and lambs were significantly higher ( $p < 0.05$ ) when compared with Najdi breed but no significant difference ( $p > 0.05$ ) between breed in the T3 and T4 levels of lamb (Table 5). On the other hand, a significantly ( $p < 0.05$ ) higher concentration of T3 and T4 in the blood serum of Najdi ewes compared with Naemi ewes (Table 5).

Table 4: Thyroid hormones, calcium and phosphorus levels in blood serum of two sheep breeds at parturition

Parameter	Breed		SEM	Significance
	Naemi	Najdi		
<b>Newborn</b>				
T3 (ng mL <sup>-1</sup> )	2.86	3.25	0.42	ns
T4 (µg dL <sup>-1</sup> )	12.14	13.89	1.54	ns
Calcium (mg dL <sup>-1</sup> )	13.76	17.48	0.68	*
Phosphorus (mg dL <sup>-1</sup> )	6.49	7.29	0.319	***
<b>Dams</b>				
T3 (ng mL <sup>-1</sup> )	2.10	1.92	0.12	ns
T4 (µg dL <sup>-1</sup> )	6.62	7.37	0.53	ns
Calcium (mg dL <sup>-1</sup> )	13.70	16.81	1.27	***
Phosphorus (mg dL <sup>-1</sup> )	5.87	6.76	0.60	*

ns: Not significant, \*p<0.05, \*\*p<0.01, \*\*\*p<0.001

Table 5: Thyroid hormones, calcium and phosphorus levels in blood serum of two sheep breed at 45 days postpartum

Parameter	Breed		SEM	Significance
	Naemi	Najdi		
<b>Newborn</b>				
T3 (ng mL <sup>-1</sup> )	1.69	1.60	0.09	ns
T4 (µg dL <sup>-1</sup> )	6.60	6.98	0.63	ns
Calcium (mg dL <sup>-1</sup> )	15.42	13.35	1.03	***
Phosphorus (mg dL <sup>-1</sup> )	8.09	6.49	0.44	**
<b>Dams</b>				
T3 (ng mL <sup>-1</sup> )	1.36	1.61	0.09	*
T4 (µg dL <sup>-1</sup> )	7.06	9.22	0.16	*
Calcium (mg dL <sup>-1</sup> )	16.92	13.18	1.01	***
Phosphorus (mg dL <sup>-1</sup> )	7.90	6.01	0.45	*

ns: Not significant, \*p<0.05, \*\*p<0.01, \*\*\*p<0.001

The normal range of P and Ca are 5.02 to 8.05 and 11.25 to 12.8 mg dL<sup>-1</sup>, respectively (Kaneko *et al.*, 2008). Calcium levels in blood serum of ewes and lambs, at parturition and 45 days, were higher compared with the normal range, even though, there was significant differences between breeds. These values were disagreed with that reported by Antunovic *et al.* (2011) and Yildiz *et al.* (2005) who reported a lower Ca concentration in blood serum of lactating ewes compared with the normal ranges. For P concentrations, all values for both ewes and lambs were fallen within the normal range for both periods with breed variation. These values were agreed with those reported by Antunovic *et al.* (2011) and Azab and Abdel-Maksoud (1999). Furthermore, the levels of T3 and T4 in blood serum of the lactating ewes and lambs were higher (0.81 ng mL<sup>-1</sup> and 3.37 µg dL<sup>-1</sup>, respectively) than reported by Antunovic *et al.* (2011). The higher levels of thyroid hormones in the blood serum could increase the rate of oxidation and tissue metabolism of different metabolites for milk formation, mostly protein and fat and consequently improve milk yield (Riis and Madsen, 1985). Moreover, Todini (2007) reported an increase in thyroid hormones activities during lactation in all mammalian species which supported our findings.

**Growth performance of newborn lambs up to weaning:** Table 6 shows the body weighs of the lambs at birth, 30 and 60 days old of the two breeds. The results indicated that Najdi breed

Table 6: Effect of breed on birth, 30 days and 60 day old body weight

Body weight (kg)	Breed		SEM	Significance
	Naemi	Najdi		
At birth	4.86	5.23	0.08	*
30 days old	13.13	12.14	0.39	ns
60 days old	23.10	20.58	0.70	*

ns: Not significant, \*p<0.05

Table 7: Milk and colostrum composition of two sheep breeds reared under an intensive production system

Composition (%)	Breed		SEM	Significance
	Naemi	Najdi		
<b>Milk</b>				
Fat	9.38	6.49	0.70	*
Protein	4.33	4.93	0.20	*
Lactose	4.33	3.91	0.10	*
Total solid	19.74	16.51	0.721	**
SNF	9.83	10.26	0.170	ns
<b>Colostrum</b>				
Fat	8.3	7.85	0.610	ns
Protein	10.43	10.87	0.370	ns
Lactose	2.98	2.11	0.234	*
Total solid	21.24	21.83	0.990	ns
SNF	14.85	14.35	0.560	ns

SNF: Solid not fat, ns: Not significant, \*p<0.05, \*\*p<0.01

produce heavier newborn compared to Naemi breed (5.23 vs 4.86 kg, respectively). At 30 day old, there were no significant differences (p>0.05) between breeds on lambs' weight. At 60 days, lambs from Naemi breed showed a significantly (p<0.05) heavier weight at weaning when compared with the Najdi lambs (23.10 vs. 20.58 kg, respectively).

**Colostrum and milk composition:** Table 7 shows the colostrums and milk composition of the two breed. Milk Composition of Najdi ewes' milk showed a significantly lower values (p<0.05) for the fat, lactose and total solid, but significantly higher SNF (p<0.01) and protein when compared to Naemi milk. For colostrum, the trend was differ by detecting a significantly (p<0.05) lower lactose only when compared with the colostrum from Naemi ewes. A wide variation in the chemical composition of milk and colostrum composition were reported in the literature which could be caused by breed differences, stage of lactation, feeding, lambing season, ewes age etc. The results of this study showed a breed effect on all components in milk except for SNF% which partially agreed and disagreed with other researcher. Abd Allah *et al.* (2011) found that milk fat% influenced by breed which agreed with our findings and disagreed with others (Peeters *et al.*, 1992; Hassan, 1984). Very few studies discuss the issue of effect of breed on milk and colostrum composition. Most of studies focus on the milk and colostrum composition in relation to other factors such as stage of gestation and feeding. Naemi breed produced milk at early lactation with high fat% when compare with that reported by Park *et al.* (2007), Ciuryk *et al.* (2004), Ahamefule *et al.* (2004) and Pavic *et al.* (2002). The total solid percentage of Naemi milk agreed with what reported by Park *et al.* (2007) and disagreed with Ciuryk *et al.* (2004) and Pavic *et al.* (2002). On the other

hand, lactose, total solid, SNF, protein in colostrum from Naemi and Najdi breeds were higher than reported by Ahamefule *et al.* (2004) and Ciuryk *et al.* (2004) but no differences between levels of fat.

This study supported the idea of there is a breed effect on milk and colostrum chemical composition which previously established by Mavrogeis and Louca (1980) and Bencini and Pulina (1997). This information is very crucial to guarantee the metabolic and nutritional needs of the Najdi and Naemi breeds during the first few days postpartum and early lactation, raised under an intensive system, to reduce the mortality rates of newborns and consequently economic loss. Moreover, the finding of this study will provide us with very important information, not studied before, which helps in establishing a genetic improvement programs and dietary supplementation during these critical stages.

## CONCLUSION

Results of these investigations demonstrate a significant breed differences in glucose, calcium and phosphorus metabolism at parturition and the first 45 day of lactation. The glucose, Ca and P levels in blood serum of Najdi breed were significantly higher at parturition but Ca and P were lower at 45 days old when compared with the Naemi ewes. Moreover, a significantly higher fat and lactose in colostrum and milk samples from Naemi ewes compared to Najdi breed. Differences between Naemi and Najdi in some economical traits such as milk fat and lactose must be considered for the future trait selection programs.

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