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Short communication

Fluctuations in energy-related metabolites during the peri-parturition period in Lori-Bakhtiari ewes

A. Raoofi [a,*], M. Jafarian [b], S. Safi [b], M. Vatankhah [c]

[a] Department of Clinical Sciences, Faculty of Veterinary Medicine, University of Tehran, P.O. Box 14155-6453, Tehran, Iran
[b] Department of Clinical Pathology, Faculty of Specialized Veterinary Sciences, Science and Research Branch, Islamic Azad University, Tehran, Iran
[c] Department of Animal Sciences, Agriculture and Natural Resources Center, P.O. Box 415, Shahre-Kord, Iran

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ABSTRACT

This study describes the fluctuations in serum energy-related metabolites during a period of 2 weeks before, to 2 weeks after parturition in Lori-Bakhtiari ewes. The effect of parity was also studied. Blood profiles were determined in 60 healthy pregnant ewes with single ($n=30$) and twin ($n=30$) lambings. Blood was collected from each ewe on days 14 and 7 prepartum, and days 7 and 14 postpartum to determine the serum non-esterified fatty acid (NEFA), β-hydroxybutyrate (BHBA), glucose, cholesterol, blood urea nitrogen (BUN) and calcium (Ca) levels. The age of the ewes had no significant effect on the energy metabolism indicators. Serum NEFA, BHBA, glucose, BUN and calcium concentrations recorded peak levels 7 days before parturition. However, NEFA and BHBA recorded significant changes ($P<0.05$) during the peri-parturition period. All metabolites changed significantly in ewes carrying twin-bearing ewes, compared to single-bearing ewes. Serum BHBA concentrations recorded positive correlations with the serum NEFA ($P<0.01$) and cholesterol ($P<0.05$), while blood glucose had negative correlations ($P<0.01$) with NEFA, BHBA and Ca. Blood NEFA and BHBA recorded positive correlations ($P<0.05$) with the BUN levels and negative correlations ($P<0.05$) with Ca. The results showed that blood NEFA and BHBA levels are sensitive indicators of the energy balance during the peri-parturition period in ewes.

1. Introduction

The Lori-Bakhtiari sheep breed is one of the most common native breeds in the south-western parts of Iran, with more than 1.7 million head. This breed also has the largest fat-tail of all breeds in Iran. The majority of the sheep population is managed under a migratory system, utilizing the natural pastures as the major source of nutrition (Shadnoush et al., 2004; Vatankhah and Zamani, 2007). The physical characteristics, productive and reproductive performances of the Lori-Bakhtiari sheep include an adult live weight of 68–77 kg; fat-tail weight of 8–10 kg; height of 70–75 cm; conception rate of 0.89 ± 0.31; number of lambings per year of 1.17 ± 0.38; a milk yield per 6 months of 85–100 l and a yearly fleece weight of 2.5–3 kg (Vatankhah, 1996).

The peri-parturition period (2 weeks before to 2 weeks after parturition), is generally of critical importance regarding the health, production and profitability of the ewes. This period is then characterized by a negative energy balance, body fat mobilization, and the elevation of circulating non-esterified fatty acids (NEFA) and ketone bodies (Maas and Pearson, 2009). The identification of changes in the metabolism of ewes around parturition, the diagnosing of abnormal metabolic stages, and the prediction of some metabolic disorders, such as pregnancy toxemia and fatty liver could ultimately provide some advantages to producers. In the past metabolic profiles have been used to predict prepartum and postpartum metabolic problems, and for the diagnosis of metabolic diseases and the

* Corresponding author. Tel.: +98 21 66929532; fax: +98 21 66933222.
E-mail address: raoofi@ut.ac.ir (A. Raoofi).

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Table 1
The number of single and twin-bearing Lori-Bakhtiari ewes in each age class (months).

Ewes	Age (months)			
	<30	30–42	43–54	>54
Single-bearing	5	9	9	7
Twin-bearing	7	7	8	8
Total	12	16	17	15

assessment of the nutritional status of the animals (Balıkcı et al., 2007). Many health disorders then occur during the peri-parturition period and an increased understanding of the biology at this time, should help decrease health problems and increase the profitability of the ewes. The aim of this study was to evaluate the changes in energy-related metabolites during this peri-parturition period in Lori-Bakhtiari ewes.

2. Materials and methods

The present study was carried out at the Sholi Station of the Lori-Bakhtiari Sheep Breeding Research Center located in the Chaharmahal and Bakhtiari province of Iran. From the flock at the station, 60 healthy, pregnant Lori-Bakhtiari ewes (30 bearing singles and 30 bearing twin lambs), weighing 71.5 ± 11.2 kg (59.3–87.6 kg) and aged between 2 and 6 years, were used in the trial. Ewes were assigned as single and twin-bearing ewes following ultrasonography 35 days after synchronized mating. The age of the animals was recorded as an experimental factor (Table 1). The diet used consisted of 1.2 kg alfalfa hay, 0.8 kg wheat straw and 0.7 kg concentrate – containing 26.5% wheat bran, 21% corn, 21% wheat, 12% rice bran, 9% canola meal, 6% molasses, 1.5% calcium carbonate, 1% sodium bicarbonate, 1% enzymes, 0.5% vitamins and 0.5% salt per ewe – being offered daily.

The study was conducted between October 2010 (autumn) and March 2011 (spring). Blood samples were collected from the jugular vein at 05h00–06h00 (before feeding) on days 14 and 7 before the expected date of delivery, and days 7 and 14 postpartum in test tubes, and the blood allowed to coagulate. Serum was then harvested following centrifugation, frozen and stored at −70 °C, until analyzed.

Blood chemistry was analyzed according to the following colorimetric methodologies – glucose: glucose oxidase; cholesterol: CHOD-PAP; BUN: urease UV and calcium: arsenazo. For these determinations, commercial kits (Parsazmoon, Tehran, Iran) were used with the aid of an automated biochemical analyzer (Biotecnica, Targa 3000, Rome, Italy). β-Hydroxybutyrate (BHBA) and non-esterified fatty acids (NEFA) were determined using a D-3-hydroxybutyrate kit and a NEFA kit (Randox Laboratories Ltd., Ardmore, UK).

As the serum metabolites were measured over time, a repeated measures approach using the General Linear Models procedure of SAS (2000) under the following model was employed to determine the least square means of considered traits, corrected for age of the ewe. Since the interaction between factors was not significant for any trait, it was not included in the final statistical model.

$$y_{ijkl} = \mu + A_i + L_j + W_k + e_{ijkl}$$

where y_{ijkl} = the observations, μ = the overall mean, A_i = the ith age of ewe (i = 2–5), L_j = the effect of jth type of birth (j = 1, 2), W_k = being the kth week of recording (k = −2, −1, 1, 2) and e_{ijkl} = the residual effects. Least squares means for significant (P < 0.05) differences were compared using the multiple t-test. The correlation procedure of SAS was also used to obtain the Pearson coefficient between traits.

3. Results

The serum metabolite concentrations during the peri-parturition period are set out in Table 2. The serum NEFA and BHBA concentrations were high before lambing and then started to decrease after parturition. Fluctuations in blood glucose, cholesterol, BUN and calcium concentrations were not significant. However, the blood NEFA and BHBA levels recorded significant changes (P < 0.05) during the peri-parturition period. The age of the ewes had no significant effect on the energy metabolism indicators (Table 3). The serum NEFA, BHBA, cholesterol and BUN concentrations were higher (P < 0.05), while blood glucose and calcium concentrations were lower (P < 0.05) in the twin-bearing ewes, compared to the single-bearing ewes (Table 4). Glucose recorded negative correlations (P < 0.01) with NEFA, BHBA and Ca concentrations, while NEFA recorded positive correlations with BHBA (P < 0.01) and BUN (P < 0.05) and a negative correlation (P < 0.05) with Ca. BHBA recorded positive correlations (P < 0.05) with cholesterol and BUN and a negative correlation (P < 0.05) with Ca (Table 5).

Table 2
Least square of means (LSM) and standard error (SE) of serum metabolite concentrations in Lori-Bakhtiari ewes during the peri-parturition period.

Parameters		Days relating to lambing			
		−14	−7	+7	+14
NEFA (mmol/l)	LSM	0.54[a]	0.60[a]	0.48[b]	0.40[c]
	SE	0.04	0.04	0.04	0.04
BHBA (mmol/l)	LSM	0.73[ab]	0.76[a]	0.69[b]	0.60[c]
	SE	0.03	0.03	0.03	0.03
Glucose (mg/dl)	LSM	62.96	63.23	62.73	62.64
	SE	1.48	1.48	1.48	1.48
Cholesterol (mg/dl)	LSM	68.21	68.33	69.23	68.23
	SE	1.63	1.63	1.63	1.63
BUN (mg/dl)	LSM	18.43	19.16	19.09	18.93
	SE	0.55	0.55	0.55	0.55
Ca (mg/dl)	LSM	9.01	9.15	9.10	9.13
	SE	0.14	0.14	0.14	0.14

[abc] Means in the same row with different superscripts differ significantly (P < 0.05).

4. Discussion

In the present study changes in blood glucose concentrations were not significant during the peri-parturition period. Several researchers recorded serum glucose levels to be higher during lactation than for pregnancy in ewes

Table 3
Least square of means (LSM) and standard error (SE) of serum metabolite concentrations in Lori-Bakhtiari ewes of different ages (months) during the peri-parturition period.

Parameters		Age of the ewes (months)			
		<30	30–42	43–54	>54
NEFA (mmol/l)	LSM	0.53	0.46	0.53	0.50
	SE	0.10	0.05	0.05	0.05
BHBA (mmol/l)	LSM	0.65	0.65	0.78	0.70
	SE	0.07	0.04	0.04	0.04
Glucose (mg/dl)	LSM	63.35	65.12	61.41	61.69
	SE	3.66	1.89	1.88	1.92
Cholesterol (mg/dl)	LSM	67.89	69.90	69.33	66.88
	SE	3.97	2.06	2.04	2.08
BUN (mg/dl)	LSM	19.91	18.82	18.73	18.16
	SE	1.4	0.75	0.74	0.76
Ca (mg/dl)	LSM	9.47	9.01	8.82	9.09
	SE	0.37	0.19	0.19	0.19

No significant differences.