Evaluation of serum electrolyte concentrations in raini cashmere goats during the transition period

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The transition period in small ruminants, particularly the final stage of pregnancy and the early postpartum phase, is a critical stage often associated with electrolyte imbalances. This study aimed to evaluate the serum electrolyte concentrations in Raini Cashmere goats during this period. Blood samples were collected weekly from the jugular vein of twenty-four pregnant goats throughout the six-week transition phase. The results revealed significant differences in serum electrolyte concentrations before and after parturition ($p<0.05$). The lowest levels of most electrolytes were recorded one week postpartum. Serum calcium levels showed a steady decline from three weeks prepartum to one week postpartum, then returned to baseline values within the following two weeks. Phosphorus and sodium exhibited similar trends, while potassium and chloride levels increased significantly during the recovery phase. Magnesium concentrations gradually rose throughout the period, reaching their peak two weeks postpartum. These findings highlight the dynamic changes in electrolyte status during the transition period in Raini Cashmere goats, emphasizing the importance of nutritional management and supplementation to prevent deficiencies and support health during this critical stage.

Keywords: Raini Cashmere goat, Transition period, Serum electrolytes, Pregnancy; Parturition

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Introduction

The goat, as a domestic ruminant, is raised in different parts of the world and plays a crucial role in the livelihood of rural and nomadic households. This animal produces various products including meat and milk (Cappai *et al*., 2019; Ferreira *et al*., 2021). Besides being a source of food, goats also produce useful skin and valuable cashmere in some countries such as Iran. Raini Cashmere goats are considered one of the most significant goat breeds in Iran, producing a very soft, delicate, and light cashmere, with a high international trade value. There are about 5 million cashmere goats in Iran, corresponding to 20% of the total world population of this breed (Baghizadeh *et al*., 2009, Shamsaddini Bafti and Mozaffari, 2012). The need for energy and nutrients significantly increases during the transition period (three weeks before to three weeks after parturition), as a result of physiological changes to support the fetal and kid development (Cappai *et al*., 2019; Zamuner *et al*., 2020).

Electrolytes play a crucial role in the physiological processes of animals, serving as essential ions that facilitate a range of biological functions. These charged particles, including sodium, potassium, calcium, magnesium, and chloride are vital for maintaining fluid balance, transmitting nerve impulses, and supporting muscle contraction (Yadav *et al*., 2024). In particular, electrolytes help regulate membrane potential in neurons and muscle cells, making them critical for neuromuscular function (Grimm *et al*., 2021).

Electrolytes imbalance occurs in the transition period, due to stress, oxidative factors, and free radicals as well as negative energy balance, which leads to kidney disorders, cardiac arrhythmias, dehydration, and shock (Gałęska *et al*., 2022). Evaluation of biochemical parameters such as electrolytes are important tools that provide valuable data on the health and welfare of animals (Fowlie *et al*., 2020). There is little information about the serum levels of electrolytes in transition goats, especially in the Raini Cashmere breed; therefore, the present study aimed to evaluate the concentration of serum electrolytes in *Raini cashmere* goats during the transition period.

Materials and methods

Study area

The present study was performed in Baft city, located in the southeast of Iran at 29°14′06″N and 56°35′56″E and height of 2270 meters above sea level. The climate of the study area consists of two different regions as follows: i) the north and the center of the city with a mountain climate, from which most of the water of Halil Dam originates, and ii) the south with a climate specific to tropical regions. The temperature varies between +10 °C and +35°C during the year, and the amount of rainfall is 320 mm in the mountainous areas and 180 mm in the plain areas.

Study of animal

The number of 24 adult pregnant goats of the Raini Cashmere breed, 2-3 years old, were selected from Baft city, Southeast Iran. The clinical status of the goats (general body condition, temperature, pulse, breathing, mucous membranes in the eyes, oral mucosa, or vaginal mucosa) was examined to confirm their health. The gtanimals received anti-parasitic treatment and were kept in the open-shed system with easy access to water and food. Additionally, their diet was balanced and did not change during the sampling period. To detect pregnancy, an ultrasound was used, and the gestational age of the goats was determined. The animals were then entered into the study 21 days before parturition.

Sampling

Blood samples were collected from the jugular vein of the animal once every week. The samples were transferred to the laboratory and kept at 25°C to separate the serum. Serum samples were then harvested after centrifugation at 6000 rpm for 20 minutes by Behdad Company (Iran، Tehran) and sent to the biochemical and hormonal departments of the laboratory to evaluate the concentration of electrolytes including sodium, chloride, potassium by Jokoh electrolyte analyzer, EX-CA (Japan, Tokyo), calcium, magnesium, and phosphorus by BT3500 autoanalyzer system, Biotecnica (Italy, Rome). All tests were done by using the automatic calorimetric method and approved kits by Pars Azmoon (Iran, Tehran).

Statistical analysis

Data analyses were performed by SPSS software version 22. Data were presented as mean ± standard deviation. One-way ANOVA with repeated measures over time was employed to analyze data. Moreover, the means were compared by the post-hoc Tukey test. P -values below 0.05 were considered statistically significant.

Results

Data analysis demonstrated that the highest level of electrolytes in serum samples of study animals belonged to sodium, followed by chloride. Normal serum magnesium and phosphorous levels were determined as 2.01 to 3.96 mg/dL and 2.42 to 7.00 mg/dL, respectively, and were considered as the lowest levels. However, the latter parameters were in the maximum dispersion (%16.25), which indicated significant changes in their levels (Table 1).

Table 1: Total levels of electrolytes in serum of studied goats during the transition period.

Variables	Minimum concentration	Maximum concentration	Mean	Standard Deviation (SD)	Changes index (%)
Calcium (mg/dL)	6.10	9.80	8.21	0.99	12.5
Phosphorus (mg/dL)	2.42	7.00	4.34	1.33	16.25
Sodium (mEq/L)	137.00	157.00	144.44	6.61	4.57
Potassium (mEq/L)	4.00	5.20	4.28	0.25	5.84
Chloride (mEq/L)	107.00	131.00	114.39	4.83	4.22
Magnesium (mg/dL)	2.01	3.96	2.83	0.46	16.25

Table 2 indicated that the level of most serum electrolytes varied significantly during the transition period (p<0.05). The serum concentration of all electrolytes (except for magnesium) was at its lowest level one week after parturition. Furthermore, the level of calcium showed a downward trend from three weeks before parturition (9.40±0.15) to one week after (7.01±0.34); then, reached the same value as at the beginning of the period during the next two weeks (8.76±0.13 mg/dL). Similarly, the concentration of phosphorus and sodium also had the same trend during the period. It is worth noting that, despite showing a decreasing trend up to one week after parturition (4.02±0.02 and 109.5±0.7 mEq/liter, respectively), potassium and chloride levels had a significant upward trend during the recovery period. The level of magnesium in the serum increased from the beginning of the period to the end, and its maximum was observed two weeks after parturition (3.36±0.20 mg/dL).

Table 2: The mean electrolyte levels during the transition period of the studied goats.

Variables	Time (week)						*p*-value
	- 3*	- 2	- 1	+ 1	+ 2	+ 3	
Calcium	9.40± 0.15	8.43±0.23	7.51±0.41	7.01±0.34	8.16±0.22	8.76±0.13	0.000
Phosphorus	5.01±0.49	4.43±0.51	4.25±0.55	3.49±0.54	4.48±0.63	4.40±0.57	0.000
Sodium	153.2±2.3	151.5±2.3	140.2±1.0	138.7±0.66	142.2±0.2	141±0.44	0.000
Potassium	4.36±0.05	4.25±0.06	4.11±0.04	4.02±0.02	4.43±0.17	4.51±0.05	0.000
Chloride	115.3±0.9	113.5±0.9	111.5±0.9	109.5±0.7	114.7±1.1	121.8±2.2	0.010
Magnesium	2.33±0.09	2.56±.0.09	2.76±0.07	2.82±0.08	3.36±0.2	3.18±0.18	0.003

*Before (-) and After (+) Parturition

Discussion

The transition period is a sensitive time at the end of the pregnancy stage of animals, in which, dairy animals experience most metabolic and reproductive challenges such as electrolyte imbalance (Van Saun, 2016; Tosto *et al*., 2021). Electrolytes play a significant role in maintaining intracellular and extracellular fluid distribution; electrical conductivity, clot formation, energy production as well as muscle contraction, and their imbalance has negative impacts on animal health and production (Satué *et al*., 2021; Gałęska *et al*., 2022). The analysis of serum electrolyte levels in animals provides valuable insights into the physiological changes that occur during the transition period (Kirsch *et al*., 2019).

The results of the present study indicated that the level of studied electrolytes varied significantly during the transition period, showing a decreasing trend up until the parturition, followed by an increase thereafter, which is in parallel with previous studies (Zamuner *et al*., 2020; Guebli *et al*., 2025). The decrease in the level of electrolytes before parturition can be attributed to digestive problems, defects in digestion and absorption of electrolytes, use of cationic and inappropriate diets, and

stress conditions (Manat *et al*., 2016). Moreover, the need for electrolytes increases in the transition period because both the fetus and the mother need them during pregnancy, resulting in the reduction of electrolytes in the body (García *et al*., 2000). After parturition, due to the lack of recall of electrolytes from the collection centers and reduced stress and increased appetite of the mother, the level of serum electrolytes gradually increases and returns to normal. In ruminants, the supply of serum salts and electrolytes is provided through the food ration. The uterus becomes larger during the pregnancy which reduces the volume of the rumen (Goff and Horst, 1997). On the other hand, stress in the transition period interferes with the pH of the rumen, leading to a decrease in the feed intake and then, a negative energy balance, a deficiency in electrolytes, and even pregnancy toxemia (Souto *et al*., 2013).

Our data indicated that sodium was the predominant electrolyte, followed closely by chloride, which aligns with previous studies (Madan *et al*., 2020), emphasizing the role of sodium in maintaining osmotic balance and nerve function. The elevated serum sodium levels observed may reflect the body's mechanism to prepare for the increased physiological demands that occur during lactation (Fazio *et al*., 2024). Chloride, being closely related, often mirrors sodium trends, affirming their co-regulatory roles in extracellular fluid balance (Andrukhova and Erben, 2017).

The present study revealed a steady increase in serum magnesium levels throughout the transition period, peaking two weeks after parturition, which could suggest a compensatory mechanism in response to initially low magnesium levels. Similarly, Kord *et al*. (2021), documented an increase in the concentration of magnesium in Lori-Bakhtiari ewes in the last month of parturition. Conversely, a decrease in serum magnesium levels was observed in Sahel goats in the transition period (Waziri *et al*., 2019). It has been reported that magnesium-rich concentrates such as wheat bran, flax seed meal, and soybean meal are mainly used during this period (Marutsova and Marutsov, 2018). Furthermore, the high concentration of magnesium in the soil, plants, and fodder of the study area is another reason for the stability of this element during the transition period.

Recent studies have demonstrated that magnesium plays a crucial role in enzymatic reactions, and its deficiency can lead to suboptimal lactation performance and muscle dysfunction (Pinotti *et al*., 2021).

The calcium levels showed a distinct downward trend from three weeks pre-partum (9.40 ± 0.15 mg/dL) to just one-week post-partum (7.01±0.34 mg/dL), before recovering to baseline levels. This finding is consistent with results from previous studies (Soares *et al*., 2018; de Paula Cajueiro *et al*., 2021) which reported the lowest value of calcium at parturition. In the initial stages of lactation, decreased dry matter

intake, coupled with physiological changes in females during the transition period lead to a reduced intake of calcium (Smith and Sherman, 2009). The subsequent rise in calcium levels as the animals transitioned into the recovery phase is indicative of successful dietary or physiological adaptation to increased demands.

In the present study, phosphorus levels demonstrated a trend analogous to that of magnesium, with a notable decline immediately post-partum (4.02±0.02 mg/dL). Similar findings were reported by Tharwat and Sobayil (2015). However, Waziri *et al*. (2010) found no significant changes in phosphorus levels in dairy goats. Recent studies suggest that phosphorus requirements increase during lactation due to its integral role in energy metabolism and skeletal health (Kulcu and Yur, 2003). The significant decline observed could also point to the possibility of inadequate dietary phosphorus during late gestation.

As reported by Madan *et al*. (2020), potassium levels in the current study presented a counterintuitive trend. Despite its decline following parturition, potassium showed significant increases during the recovery period. Similarly Kulcu and Yur (2003) reported a decrease and an increase in potassium levels before and after parturition, respectively, suggesting that the reducing trend during this period is due to the increased needs of the fetus. Furthermore, this dynamic could reflect the role of potassium as a crucial player in muscle and nerve function (Arnold *et al*., 2019), wherein demand spikes post-parturition as the body recuperates. Recent studies indicate that potassium homeostasis is vital during the stress of lactation (Skrzypczak *et al*., 2014; Udensi and Tchounwou, 2017) and may explain the observed rise as physiological functions normalize. A large number of factors such as species, type or breed, gender, age, nutrition, and health status, as well as seasonal and physiological changes, can affect serum electrolytes (Yokus and Cakir, 2006; Durak *et al*., 2015).

Conclusion

The results of the present study showed that there is a significant difference in the concentration of serum electrolytes of Raini Cashmere goats in the transition period. This study indicated that the level of all serum electrolytes (except for magnesium) varied significantly during the transition period. Serum electrolytes and trace minerals participate in many important catalytic, enzymatic and structural functions of higher vertebrates, and their concentration in mammals depends on several environmental and biological conditions. If these electrolytes decrease around parturition, the possibility of metabolic diseases and complications increases. Therefore, it is possible to prevent the reduction of minerals and nutrients needed during the transition period by providing more information about the needs of livestock in each stage of rearing.

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