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The effects of body condition score and length of pregnancy on blood biochemistry and prediction of ovine pregnancy toxemia

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ABSTRACT

Introduction: This study was planned to evaluate the pregnancy toxemia (ketosis) and relationship between body condition score (BCS) and blood metabolites and elements in pregnant ewes. Ketosis is among the most significant health problems in high-producing dairy livestock (cows, sheep, and goats) at both national and global scales. Ketosis can also occur as a complication in other deficiency diseases, when a loss of appetite has occurred.

Material and method: In this study, 50 ewes were used to evaluate changes in body condition score (BCS), β-hydroxybutyrate (βHBA) and non-esterified fatty acids (NEFA) in their blood and their relationship in the development of pregnancy toxemia. The pregnant ewes were allocated in two groups (25 thin and 25 fat) for study of subclinical ketosis incidence. The average weight of thin animals were 54 ± 3.3 kg with BCS of 1.5-2. The average weight of fat animals were 79 ± 3.5kg with 2.5-3 BCS. Ewes with 2 to 3 parity were equally allocated in the two groups.Ghezel breed ram were used for mating of ewes. Blood samples were collected three times with 30 days' interval from all ewes (at the end of 3, 4 and 5 months of pregnancy). Concentration of β- BHBA, blood metabolites (glucose, cholesterol, protein, triglyceride, urea) and elements (calcium and magnesium) and packed cell volume(PCV) were measured in blood sera.

Result and discussion: Results showed that serum βHBA, glucose, total protein, triglyceride, magnesium, urea and PCV during pre-parturition period (pregnancy) were not affected by body condition of animals as fat or thin ($P > 0.05$), but serum cholesterol was higher in fat group ($P < 0.05$). Serum calcium tended to be higher in fat group during pre-parturition period ($P = 0.07$). Serum glucose, total protein, cholesterol, calcium, urea, magnesium and PCV during pre-parturition period (pregnancy) were affected by sampling times ($P < 0.01$), while serum triglyceride and βHBA concentration were not affected by sampling times ($P > 0.05$). In overall, fat group only showed higher cholesterol during pregnancy, while did not have any significant effect on other parameters; therefore, it is not possible to comment on the diagnosis of subclinical ketosis.

KEY WORDS Blood metabolites, Body condition score, β-hydroxybutyrate, Ewes, Pregnancy, Subclinical ketosis

Introduction

Ketosis is a metabolic disease in dairy livestock (sheep, cows and goats) that is occurring due to increase of ketone bodies (especially βHBA in blood (Samani, 2018). Blood level of βHBA reflect the magnitude of negative energy balance (NEB) and the lipid mobilization in dairy animals, therefore it is a diagnostic marker for subclinical and clinical ketosis. Blood βHBA in sheep with subclinical ketosis is usually changing from 0.5 $mmol.l^{-1}$ to 1.6 $mmol.l^{-1}$, while in clinical ketosis from 1.6 $mmol.l^{-1}$ to 7 $mmol.l^{-1}$. Some researchers found higher βHBA levels in sheep with ketosis compared to lactating sheep (Marutsova *et al*. 2018). Deviations in body condition Secord (BCS) and βHBA in small ruminants are indicative for negative energy balance and for emergence of metabolic disorders post parturition (Andrews et al. 1997). Dairy ewes experiencing ketosis show high serum NEFA and low blood sugar concentrations when blood βHBA is < 1.0 $mmol.l^{-1}$ (Moallem et al. 2012; Schlumbohm *et al*. 2008). In contrast to this evidence,Ferris et al.(1970)found no significant alterations in blood glucose concentration in sheep with pregnancy toxemia. Subclinical ketosis can be detected by measuring ketone bodies in the blood, urine or milk. Fat mobilization enhancement initially non-esterified fatty acids in the liver that with its turn is partially converted in ketone bodies, mainly βHBA, but also acetoacetate and acetone (Araújo, 2020; Chalmeh et al. 2021; Duehlmeier et al. 2013). At the same time, the capacity of her rumen shrinks since the growing rate of fetus or fetuses in the take up more and more space inside setting off less space for the rumen. Subclinical ketosis occurs mainly within the first two weeks postpartum up to 6 weeks postpartum. Most of the fetal growth occurs during the last six weeks of pregnancy with large amount of maternal glucose being directed towards the fetu-placental unit, a factor that increase energy demands of the ewe (Khan et al. 2021). The prevalence ranges from 31 to 41% of ewes (Feijó, 2015). Sheep pregnancy toxemia results from a decreasing of dietary energy and gluconeogenesis to provide adequate glucose to meet the increasing fetal demands in the last 6 weeks of gestation (Andrews et al. 1996). Body condition is scored using a 5-point scale (Fthenakis et al. 2012; Karagiannisa *et al*. 2014). Outlined 3.0 – 4.0 as the optimum BCS of late of pregnancy and values of 2.5 – 4.0 during early and mid-gestation. At the time of lambing, optimum BCS should be 3.0–3.5 in ewes carrying singletons and 3. 5–4.0 in those carrying twins, while BCS at weaning of lambs should be 2.0 or higher (Sumithran et al. 2013). Prognosis of pregnancy toxemia is generally very poor. Symptoms of ketonemia include depression, anorexia, weakness, staggering gait, apparent blindness, recumbence, coma, and death (Al-Qudah, 2011). The presence of pregnancy toxemia in ewes can only be determined by elevated plasma ketone body (Duehlmeier et al. 2011; Samani, 2018). Hypocalcaemia occur in ewes in late gestation and it which is usually below 6 mg/dl in primary hypocalcaemia. Response to treatment for hypocalcaemia is usually rapid, whereas response to treatment for pregnancy toxemia is often unrewarding. Provide adequate energy in ration especially during last 4-6 weeks of gestation, good quality hay with grain supplementation, avoid abrupt feed changes, avoid stress when possible, provide adequate feeder space, aim for body condition score of 3 to 3+ at lambing and Monitor and control parasitism are important to decrease of pregnancy toxemia (LeValley, 2010; Verbeek et al. 2012; Olfati et al. 2013; Hasanpour et *al*. 2007). Treatment includes oral propylene glycol administration, twice-daily administration 0, 60 mL (Andrews et al. 1998; Rook, 2000; Ermilio and Smith, 2011). The aim of present study was to reveal the blood elements and metabolites changing in pregnancy toxemia, to predict its incidence.

Material and Methods

Sample collection and phenotype recording

The present study was carried out at the Khalat Poushan Research Station of University of Tabriz, Tabriz, Iran. Total of 25 fat (body weight: 79 ± 3.5 kg, BCS: 2-3) and 25 thin (body weight: 54 ± 3.3 kg, BCS: 1.5-2) pregnant ewes with the age of 3 to 4 years were selected from a large sheep herd. Ewes with 2 to 3 parity were equally allocated in the treatments and Ghezel breed ram were used for mating of ewes. Body condition score was evaluated based (subjective assessments of body condition) previous researches (Russel, 1984). During the experiment, ewes were fed concentrate in addition of pasture grazing. Blood samples were collected at three different times with 30 days interval at the end of 3, 4 and 5 months of pregnancy. For this reason, 5 mL blood samples were collected from the jugular vein into non-heparinized tubes, and blood serum was separated by centrifuging at 2200 rpm for 10 mints. Blood sera were poured into micro tubes and kept in the freezer until the test. The packed cell volume (PCV) and serum parameters were evaluated. βHBA was assessed using ELISA (Stat Fax 2100 Awareness Technology USA) and its kit (Randox kit, UK).Glucose, triglyceride, cholesterol, total protein, urea, magnesium , and calcium were measured by spectrophotometry (Geneus20, USA) and biochemical kits (Pars Azmoon, Iran).

Statically analysis

Data were analyzed as a complete randomized design with repeated measures method, using the PROC MIXED procedure of SAS (9. 2). The model included treatment (fat ewes versus thin ewes), ewes within treatment, time of measurement, and the treatment × time interaction. Also, age was considered as covariate in this analysis. Dependent variables are β-hydroxybutyrate, Glucose, triglyceride, cholesterol, total protein, urea, calcium, and PCV. Ewes within treatments are used as error terms to test. As β-hydroxybutyrate was only measured in the samples of third sampling time, it was analyzed by GLM procedure of SAS (9.2) and birth year was considered as covariate in this analysis. All results are presented as means ± standard error of means (SEM). Differences between means were calculated for statistical significances (p<0.05).

The model was represented as follows:

$$Y_{ijkl} = \mu + T_i + S_j + TS_{ij} + Ewe_k (T_i) + e_{ijkl}$$

Where Y_{ijkl} was the dependent variable (blood metabolites), μ is the overall mean; T_i is the effect of the treatments (i = 1, 2), S_j is the time effect (j=1, 2, 3), TS_{ij} is the effect of treatment×time, $Ewe_k (T_i)$ is error terms of ewes (k=1, 2, …, 25) within treatments, and e_{ijkl} is the experimental error. Effects of the treatments were declared significant at p<0. 05.

Results and Discussion

Ovine pregnancy toxemia is a metabolic disorder of ewes during late gestation. Pregnancy toxemia follows a period of negative energy balance and impaired gluconeogenesis resulting in hypoglycemia, fat mobilization, ketonemia, and ketonuria. This study was aimed at evaluating the relationship between body condition score (BCS) and alterations in blood metabolites, and elements to predict ovine pregnancy toxemia.

The table 1 shows the mean of blood metabolites and elements concentration. PCV was about glucose was approximately 57.70 $mg.dl^{-1}$. Based on this table, the results indicated that blood glucose levels of some ewes were low and may be affected by subclinical ketosis in late of pregnancy. The glucose level was lower than the concentration reported by Anoushepour et al. (2014). βHBA concentration was 10.49 $ng\text{-}dl^{-1}$. Blood βHBA concentrations shows the quantity of negative energy balance (NEB). High blood βHBA concentrations in animals with subclinical ketosis and clinical Ketosis(CK) are a mechanism for compensation of occurring carbohydrate deficiency and the inhibition of the citric acid cycle (Ingvartsen, 2006). In cases of excessive mobilization of fats accompanied by formation of large amounts of acetyl CoA, fatty acids are not completely metabolized via the citric acid cycle and as a result, acetyl CoA is converted to acetoacetate, which is either reduced to βHBA by βHBA -dehydrogenase or is spontaneously decarboxylated to acetone (Marutsova et al. 2018). Non-esterified fatty acids provide the substrate for βHBA synthesis in liver.

Table 1. Descriptive statistics of blood metabolites and elements in pregnant ewes

Measured traits	Count	Mean	Minimum	Maximum	Standard Deviation
PCV (%)	150	40.70	31	65	4.82
Glucose ($mg.dl^{-1}$)	150	57.70	38	84	31.26
Protein ($gr.dl^{-1}$)	150	9.90	5	19.22	5.72
Urea ($mg.dl^{-1}$)	150	23.20	4.3	54.5	9.95
Triglyceride ($mg.dl^{-1}$)	150	7.37	0	42	7.17
Cholesterol ($mg.dl^{-1}$)	150	79.12	26	205	28.63
BHBA ($mg.dl^{-1}$)	50	10.49	6.6	16.9	2.35
Ca ($mg.dl^{-1}$)	150	8.83	4	13	5.78
Mg ($mg.dl^{-1}$)	150	3.49	0.28	8.29	2.15

Result analysis in table 2 shows the effect of BCS (fat or thin), length of pregnancy and their interaction on the concentration of blood elements and metabolites in pre-parturition ewes. The BCS was only significant effect on cholesterol concentration ($P< 0.05$), while length of pregnancy was significant in all blood factors ($P< 0.05$), except for triglyceride ($P> 0.05$). Their interaction had not significantly effect on all blood metabolites and elements except urea.

Table 2. The variance analysis of factors affecting the blood elements and metabolites concentration in pre-parturition ewes

	Glucose.	Protein	Triglyceride	Cholesterol	PCV	BHB	Ca	Mg	Urea
BCS	ns	ns	ns	*	ns	ns	ns	ns	ns
LP	**	**	ns	**	**	-	**	**	**
BCS× LP	ns	ns	ns	ns	ns	-	ns	ns	*

*****Stands for significance at the level of 0.05, ** stands for significance at the level of 0.01, **ns** stands for non- significant, **-** no number. LP= Length of pregnancy

The body condition score was not significant on glucose concentration ($P> 0.05$), while the length of pregnancy was significant on blood glucose ($P< 0.05$), (Table 3).

Table 3. Least square means of blood glucose, cholesterol, protein, urea, calcium, magnesium and blood packed cell volume (PCV) at different BCS and length of pregnancy

	BCS		Length of pregnancy(month)		
Traits	Fat	Thin	3	4	5
Glucose (mg.dl^{-1})	54.67±3.52	59.97±3.59	56.08±4.07^{b}	43.61±4.06^{c}	72.27±4.06^{a}
Protein (gr.dl^{-1})	9.78±0.28	10.18±0.28	4.60±0.38^{c}	16.60±0.38^{a}	8.72±0.38^{b}
Triglyceride (mg.dl^{-1})	8.02±0.84	6.72±0.85	7.24±1.03	6.18±1.03	8.69±1.03
Urea(mg.dl^{-1})	23.27±0.88	22.98±0.89	16.56±1.19^{c}	23.48±1.19^{b}	29.33±1.19^{a}
Cholesterol (mg.dl^{-1})	83.14±2.53^{a}	75.23±2.59^{b}	92.58±2.92^{a}	51.15±2.92^{b}	93.83±2.92^{a}
Ca (mg.dl^{-1})	9.69±0.66	7.92±0.66	9.33±0.79^{a}	6.66±0.79^{b}	10.43±0.80^{a}
PCV (%)	40.37±0.61	40.93±0.62	39.75±0.67^{b}	42.38±0.67^{a}	39.81±0.67^{b}
Mg (mg.dl^{-1})	3.64±0.22	3.31±0.23	2.10±0.28^{a}	4.22±0.28^{b}	4.10±0.28^{b}

Non-identical letters in each row indicate significant differences between samples (P<0.05).

According to Table 3 results, serum glucose concentration was numerically higher in thin ewes (P>0.05), which was similar with (Andrews et al. 1997), but dissimilar with (Aynalem et al. 2020). Also, serum glucose concentration was significantly higher in the last month of pregnancy (third sampling time), (P<0.01).

Pregnant sheep have higher rate of glucose production than non-pregnant sheep and respond to fasting with the rapid development of hypoglycemia and ketosis. These observations suggest that the utilization rate of glucose by the fetus is larger in relation to the glucose demands of the maternal organs and that it persists at a relatively high level even under conditions of maternal hypoglycemia (Hay et al. 1983). Pregnancy toxemia of ewes is a metabolic disease, which is caused by glucose deficiency in mothers in response to rapid increases in fetal requirements.

The impact of treatments was not significant on total protein concentration (P> 0.05), while the impact of time of sampling was significant on blood total protein (P< 0.01), (Table4).

Concentration of serum total protein was significant under the effect of sampling time in this study and it was different with result of Mohammad et al. (2016), but in accordance with some results such as Antunovic et al. (2002); Feijó *et* al. (2015); Andrews A H et al. (1997); Ismail *et* al. (2008); Anoushepour et al. (2014); Balikci et al. (2007); Piccione et al. (2009). In dry period an increase in total protein content was found as compared with diestrum, gestation, post-partum and early lactation. A study had not found a significant effect of the reproduction stage on the serum concentration of total protein in Karakul sheep. Maternal serum protein concentration decreases due to an increase in fetal growth and especially the utilization of amino acids from the maternal circulation for protein synthesis in the fetal muscles. The significant increase in early, mid and late lactation of serum total protein compared with diestrum and early gestation could be due to a decrease in serum globulin. The higher values of total protein in lactating ewes compared with diestrum phase prove the high energy need due to milk synthesis which exists in animals, as confirmed by other authors, especially during the early lactation by Piccione *et al.* (2009). Animal grouping (fat-thin) had not effect on the concentration of blood serum protein, but it was none significantly higher in thin animals (P>0.05), which was dissimilar with the results of Aynalem *et al.* (2020) in goat.

The impact of treatments was not significant on triglyceride concentration (P> 0.05). Also, the impact of time of sampling was not significant on blood triglyceride (P> 0.05), (Table3).

Sampling time and treatments had no significant effect on blood serum triglyceride (P>0.05), these results were in contrary with the results of Mohammad et al. (2016); Balikci et al. (2007); and Dashti et al. (2006). Significant decrease in serum triglycerides was found in this study during late pregnancy, which is in accordance with increase in concentration of these compounds in the ewes' liver as reported by Balikci *et al*. (2007). The significant increase in serum triglycerides during pre-partum could be explained by increasing in lipolysis, which is hormonally regulated. The adipose tissue metabolism is strictly related to insulin, which stimulate lipogenesis in pregnant ewes, while lactating individuals show a significant decrease in that compound's level. The significant decrease in triglyceride of serum during early and mid-lactation of sheep has also been reported by Dashti et al. (2006), while post-partum by Nazifi et al. (2002), who observed the lowest concentrations of the compound 2-3 weeks post-partum. This was in accordance with other authors working on goats, who showed increased values of serum triacylglycerol to occur just before parturition. During lactation the insulin stimulation of lipogenesis becomes inefficient, which is accompanied by the significant decrease in serum triglycerides and total cholesterol post-partum compared with early pregnancy as reported by Piccione et al. (2009), after foaling, because of an increased lipoprotein lipase activity consistent with the induction of the enzyme into mammary tissue to provide fat synthesis for milk. The decreasing pattern of serum triglycerides and total cholesterol in early lactation was also reported in dairy cows, which showed the lowest values of these compounds at the onset of lactation for their growing requirement for energy. Grouping animal in the present study (fat-thin) had no significant effect on blood triglyceride concentration ($P>0.05$), but it was none significantly higher in fat animal. The impact of treatments was not significant on urea concentration ($P> 0.05$), while the impact of time of sampling on blood urea ($P< 0.01$), as well as the interaction effect of treatments by time was significant ($P< 0.05$), (Table 3 and 4).

Table4.The interactions of treatments (fat-thin) by pregnancy length on blood urea concentration

Treatments	3 (month)	4 (month)	5 (month)
Fat	16.032± 1.68 [a]	21.407±1.68[b]	32.360±1.68[c]
Thin	17.095±1.70 [a]	25.545±1.72[a]	26.295±1.72[b]

Dissimilar letters (a, b and c) indicate a significant difference between pregnancy length.

Sampling time (pregnancy length) had significant effect on blood urea concentration ($P<0.01$), this results were in agreement with some research data like Mohammad et al. (2016); Antunovic et al. (2002); Andrews et al. (1997); Ismail et al. (2008); and Balikci et al. (2007). The interaction effect of treatment*time was significant on blood urea concentration, which is similar to Balikci et al. (2007) and Dashti et al. (2006) The elevated values of urea during late gestation compared with diestrum could be ascribed to the high thyroid activity in pregnant females, which induces an increase in protein catabolism. The high requirement for energy pregnant sheep during their second half of pregnancy led to an increase in urea level, which is evident during late pregnancy in this study. The highest values of blood urea in the last trimester of pregnancy were also observed by Piccione et al. (2009); but, it was in contrary with Feijó et al. (2015), because they stated that there was no significant difference in the amount of urea in both control and treated groups.

The effect of the length of pregnancy on the blood parameters was similar with Schmitt et al. (2018), but dissimilar with result of Aynalem et al. (2020) in goat animal. High blood BHBA concentrations in animals with CK and CK are a mechanism for compensation of occurring carbohydrate deficiency and the inhibition of the citric acid cycle. In cases of excessive mobilization of fats accompanied by formation of large amounts of acetyl CoA, fatty acids are not completely metabolized via the citric acid cycle and as a result, acetyl CoA is converted to acetoacetate, which is either reduced to βHBA by βHBA -dehydrogenase or is spontaneously decarboxylated to acetone. Non-esterified fatty acids provide the substrate for BHB synthesis. The increased BHB concentration indicates incomplete oxidation of NEFA in the citric acid cycle at the time of NEB. The rate of ketone bodies formation is proportional to the extent of lipolysis and oxidation of fatty acids (Marutsova et al., 2018).

Concentration of blood serum cholesterol, calcium, magnesium, and packed cell volume percentage

The impact of treatments was not significant on cholesterol concentration (P< 0.05), (Figure 10), while the impact of time of sampling was significant on blood cholesterol (P< 0.01), (Table 3). This result was similar with results of Mohammad et al. (2016); Özpınar et al. (2003); Chalmeh et al. (2017); Balikci et al. (2007); and Dashti et al. (2006). The treatments were not significant on calcium concentration (P> 0.05), while the impact of time of sampling was significant on blood calcium (P< 0.01), (Table 3). Sampling time results was in agreement with Anoushepour et al. (2014; Sakha (2016), but it was in disagreement with result of Schmitt et al. (2018). During the last trimester of pregnancy, the growing fetus also retains an increasing amount of calcium for the circulation, which is required for skeletal development, and ewes that carry twins are in even greater need of calcium and are at the same time at a higher risk of developing pregnancy toxemia than ewes with only one offspring (Ismail et al. 2001; Schlumbohm and Harmeyer, 2008). Also the treatments were not significant on magnesium concentration (P> 0.05), while the impact of time of sampling was significant on blood magnesium (P< 0.01), (Table 3). The impact of treatments was not significant on PCV concentration (P> 0.05), while the impact of time of sampling was significant on blood PCV (P< 0.01), (Table 3). The Present results were dissimilar with reports of Marteniuk et al. (1988); Aynalem et al. (2020). Results of this study were in agreement with reports of Yildiz et al. (2004) on Akkaraman sheep and Adelatif (2010) on Desert Ewes. Have some reported that plasma magnesium concentration increased at three weeks pre-partum followed by a no significant decrease in Baladi female goats. The serum magnesium level is influenced by the levels of protein (Sheeba et al. 2013).

Conclusion

This study indicated that change of some blood metabolites and elements concentrations were occurred specially at 60 days of pregnancy. Only the amount of cholesterol was higher in fat group as compared with thin group (P< 0.05), and had no significant effect on other parameters; therefore, it is not possible to comment on subclinical ketosis diagnosis. On the other hand, duration of pregnancy (blood sampling time) had a significant effect on all measured parameters except for triglyceride in pregnant ewes.

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Conflict of interest:

There is no conflict of interest between authors.

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تاثیر نمره وضعیت بدن و مدت آبستنی بر ترکیب فراسنجه‌های بیوشیمیایی خون و پیش اگهی بروز مسمومیت آبستنی در میش‌های نژاد قزل

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چکیده

زمینه مطالعاتی: کتوز یک مشکل سلامتی مهم در صنعت دام‌های شیری پرتولید در مقیاس ملی و جهانی است. همچنین سایر بیماری‌های ناشی از کمبودها و کاهش اشتها در ایجاد آن نقش دارند

هدف: تاثیر نمره وضعیت بدن و مدت آبستنی بر ترکیب فراسنجه‌های بیوشیمیایی خون و پیش اگهی بروز کتوز تحت بالینی در میش‌های نژاد قزل بود.

روش کار: این مطالعه شامل ۵۰ رأس گوسفند برای نظارت بر تغییرات نمره وضعیت بدن، βHBA و اسیدهای چرب غیر استریفیه (NEFA)در خون آنها و بررسی ارتباط آنها با کتوز تحت بالینی و مسمومیت آبستنی بود. میش‌ها برای بررسی بروز کتوز تحت بالینی و مسمومیت آبستنی به دو گروه (۲۵ رأسی لاغر و ۲۵ رأسی چاق) تقسیم شدند. میانگین وزن میش‌های لاغر ۳/۳ ± ۵۴ کیلوگرمبا نمره وضعیت بدنی ۱/۵ تا ۲ ومیانگین وزنمیش‌های چاق ۳/۵ ± ۷۹ بانمره وضعیت بدنی ۳ تا ۲/۵ بود. میش‌های ۲ تا ۳ شکم زایش به طور تصادفی در تیمارها اختصاص داده شدند. نمونه خون سه بار در فواصل ۳۰ روزه از تمامی میش‌ها (در پایان ماه‌های سوم، چهارم و پنجم آبستنی) گرفته شد. سطوح βHBA ، متابولیت های خون و حجم مجموعه سلول‌های متراکم (PCV) و دو عنصر کلسیم و منیزیم اندازه‌گیری شدند.

نتایج: آنالیز دادها نشان داد که سطوح سرمی βHBA، گلوکز، پروتئین کل، تری گلیسیرید، منیزیم، اوره و حجم سلول های خون (PCV) در طول دوره قبل از زایمان تحت تأثیر وضعیت بدن حیوانات به عنوان چاق یا لاغر قرار نگرفت (۰/۰۵ <P) با این حال، کلسترول سرم در گروه گوسفندان چاق بالاتر بود (P < ۰/۰۵) و کلسیم سرم در گروه چاق در طول دوره قبل از زایمان تمایل به بالاتر بودن داشت (P = ۰/۰۷). سطح سرمی گلوکز، پروتئین کل، کلسترول، کلسیم، اوره، منیزیم و PCV در طول دوره قبل از زایمان تحت تأثیر تاریخ نمونه برداری قرار گرفت (P < ۰/۰۱)، در حالی که تری گلیسیرید سرم و سطوح βHBA تحت تأثیر زمان نمونه برداری قرار نگرفتند (P>۰/۰۵). با افزایش سن آبستنی، غلظت متابولیت‌های خونی گلوکز، پروتئین کل، کلسترول، کلسیم، اوره، منیزیم و PCV تغییرات معنی‌دار داشتند (P< ۰/۰۵) ، ولی تغییرات غلظت‌های تری گلییسرید و βHBA در خون معنی‌دار نبود.

نتیجه گیری کلی: به طور کلی، گروه چاق تنها کلسترول بالاتری را در دوران بارداری نشان دادند، در حالی که هیچ تاثیر معنی‌داری بر سایر پارامترها نداشتند. بنابراین، نمی‌توان فقط با نتایج بدست آمده در مورد پیش آگهی بروز کتوز تحت بالینی اظهار نظر کرد.

واژگان کلیدی: متابولیت‌های خون، امتیاز وضعیت بدن، بتاهیدروکسی بوتیرات، میش، بارداری، کتوز تحت بالینی