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Association of parity, fecundity and body condition score with blood serum concentration of some metabolites during pre and post parturient period in German Improved Fawn goats

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ABSTRACT

The aim of present study was to study the effect of parity and fecundity on the body condition score and blood serum concentration of metabolites (beta-hydroxybutyrate, glucose, total cholesterol and triglycerides) during the pre and post parturient period in German Improved Fawn goats. Forty goats (primiparous (n = 18) and multiparous (n = 22) were used in the study. Blood sampling were done 4 times for each goat, starting 20 days before expected parturition, after parturition, and on the 20th and 40th day of lactation. Blood samples were collected by jugular puncture. In the obtained blood serum concentrations of metabolites were determined by the standard method of absorptive spectrophotometry. The total concentration of beta-hydroxybutyrate and triglycerides in goat blood serum was not different within the category of body condition score, but the level of glucose was significantly lower in intermediate and fat goats and the level of total cholesterol was higher ($P<0.05$) in fat goats. The number of kids per doe and parity did not influence the total concentration of metabolites in goat blood serum. At the beginning of lactation and during lactation, the mean values of body condition score in goats were decreased ($P<0.05$). The concentration of beta-hydroxybutyrate was the highest immediately after parturition and the lowest 40 days after parturition. Levels of glucose were higher after parturition when the levels of total cholesterol were lower. Only the concentration of triglycerides in the goats' blood sera did not differ. Some blood serum parameters and body condition scoring can be useful for evaluation of the nutritive and health status of dairy goats.

Key words: body condition scoring, beta-hydroxybutyrate, glucose, small ruminant, total cholesterol, triglycerides

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Introduction

In intensive dairy goat production systems, animals are often obese, especially during late pregnancy. They are raised under optimal environmental conditions, usually fed beyond their nutritional requirements and compelled to store body reserves. Body energy reserves, mainly represented by fat and muscle body content (MORA et al., 2007), are important determinants of reproductive performance and carcass quality. When animals have a positive energy balance, they store surpluses of energy in the adipose tissue as lipids. When the energy balance is negative, animals mobilize their fat reserves (MENDIZABAL et al., 2011). Body condition score is an effective and simple method that can help goat breeders in proper management of nutrition in their herds. Factors that influence BCS besides nutrition are genotype, age, gender, physiological status and enviromental conditions. After the kids are born and during lactation, it is normal for condition scores in does to reduce. Under ideal conditions, does should never be allowed to slip below a body condition score (BCS) of 2 and should never reach a BCS of 5 (SANTUCCI et al., 1991). Values of biochemical parameters depend on many factors such as: species, breed, gender, age, nutrition, physiological conditions (pregnancy and lactation), illness and seasonal variations (KHALED et al., 1999; ZUMBO et al., 2007; BANI ISMAIL et al., 2008; TANRITANIR et al., 2009; TSCHUOR et al., 2008). Good body condition is essential for early postpartum estrus and to induce cyclicity in anestrous does (RIVAS-MUÑOZ et al., 2010). Fertility and fecundity in small ruminants varies by breed, season, age, nutritional status, health and breeding management (ĐURIČIĆ et al., 2012). Body mass and BCS have a significant effect on fertility of goats during the breeding season and the necessity of using higher energy feeding in goats with lower BCS and weight before the breeding season (SERIN et al., 2010).

The aim of the present study was to study the effect of parity and fecundity on the body condition score and blood serum concentration of metabolites (beta-hydroxybutyrate (BHB), glucose (GLU), total cholesterol (TCH) and triglycerides (TGL)) during the pre and post parturient period in German Improved Fawn goats.

Materials and methods

Animals. Forty German Improved Fawn goats (18 primiparous and 22 multiparous) between 2 and 5 years of age were used in this research. The goats were kept on a farm, in individual boxes, in the northwestern part of Croatia (the municipality of Đurđevac). According to the body condition score (BCS), every goat was given an intermediate body condition at first sampling. The following classification was used: thin animals (BCS <2.75), medium (≥ 2.75 to <3.50), and obese (≥ 3.50 to ≤ 5.00). All does were weighed before the start of the study. Their average weight was 67.84 (53.6 - 79.7) kg. Milk production was not measured because suckling kids were kept together with their mothers to the end of study.

Blood sampling. Blood samples were collected by jugular venepuncture on day -20 (prepartum), day 1 (one day after parturition), days 20 and 40 (postpartum), and were stored for approximately 30 min at room temperature and centrifuged for 15 min at 700 g. Sera samples were stored at -20 °C until analysed. In the obtained blood serum, the concentration of beta-hydroxybutyrate (BHB), glucose (GLU), total cholesterol (TCH) and triglycerides (TGL) were determined by the standard method of absorptive spectrophotometry. These tests were performed in the Laboratory for Internal diseases at the Faculty of Veterinary Medicine Zagreb, Croatia. An Olympus AU 600 analyser was used (Olympus Diagnostica GMBH, Hamburg, Germany).

Feeding. According to standard farming practice, the animals were fed twice a day and had free access to drinking water. They were fed with good-quality meadow hay (2.2 kg per doe daily) every day at the same time. Concentrate was provided twice a day (0.90 kg per animal per day during lactation and 0.60 kg in late pregnancy) (40% corn, 20% soyabean, 12% oats, 15% barley, 10% wheat flour and 3% mineral and vitamin supplement for dairy goats). The chemical composition of the concentrate during lactation was as follows: 87.56% dry matter, 18.21% crude protein, 5.33% crude fibre, 7.93% ash, 2.97% crude fat, 1.54% calcium, 0.60% phosphorous; Ca:P ratio of 2.57:1, vitamin A 15000 IE, vitamin D 1980 IE, vitamin E 30 mg, Zn 120 mg, Fe 40 mg, Mn 80 mg, Co 0.40 mg, I 2.0 mg, and Se 0.60 mg.

Statistical analyses. Statistical analyses were performed using SAS 9.1.3. software (SAS Institute Inc., 2002-2003). The general linear model (PROC GLM) was used to evaluate the differences of blood serum metabolite parameters between parity, the number of kids per doe and BCS. Before analyses, the variables BHB, GLU, TCH and TGL were log transformed. From BCS the categorical variable with three levels was made (thin (<2.75), medium (≥ 2.75 to <3.50) and fat ≥ 3.50). The mixed model (PROC MIXED) with the repeated measure statement was used to analyse the blood serum metabolite parameters during the period of late pregnancy and early lactation. The goat was the subject variable on which repeated measurements were taken. The statistical model included the fixed effects of blood serum parameters, the period and their interactions with the covariables fecundity, parity and BCS. A multiple comparison test of least-squares means was performed using the Bonferroni correction.

Results

Fecundity and parity did not influence the total concentrations of BHB, GLU, TGL and TCH in goat blood serum. The mean values of blood serum parameters in goats with different parity and fecundity are shown in Table 1.

Average kids per doe was 1.7 kids/doe, 1.7 kids/doe in multiparous (n = 22) and 1.6 in primiparous goats (n = 18).

The total concentration of BHB and TGL in goat blood serum did not vary within the category of BCS, but the level of GLU was lower in medium and obese goats and the level of TCH was higher in obese goats (P<0.05) (Table 2).

Table 1. The least square means of beta-hydroxybutyrate, glucose, triglycerides and total cholesterol in goats with different parity and fecundity

(95%, CI)	N (Blood samples)	BHB	GLU	TGL	TCH
Parity					
First	72	0.59 (0.52, 0.66)	3.78 (3.61, 3.96)	0.17 (0.16, 0.18)	2.91 (2.75, 3.08)
Second	20	0.48 (0.38, 0.61)	3.92 (3.59, 4.28)	0.14 (0.13, 0.16)	2.98 (2.68, 3.31)
Third	52	0.47 (0.41, 0.55)	3.77 (3.57, 3.98)	0.18 (0.16, 0.19)	2.96 (2.77, 3.16)
Fourth	16	0.67 (0.51, 0.86)	3.83 (3.47, 4.23)	0.17 (0.14, 0.19)	2.77 (2.47, 3.12)
Number of kids					
1	56	0.51 (0.44, 0.58)	3.88 (3.68, 4.08)	0.17 (0.15, 0.18)	3.09 (2.91, 3.29)
2	96	0.57 (0.51, 0.64)	3.73 (3.59, 3.88)	0.17 (0.16, 0.18)	2.83 (2.70, 2.96)
3	8	0.44 (0.30, 0.63)	4.09 (3.56, 4.70)	0.18 (0.14, 0.22)	2.90 (2.46, 3.41)

Table 2. The least square means of beta-hydroxybutyrate, glucose, triglycerides and total cholesterol in goats with different body condition score categories

(95%, CI)	N (Blood samples)	BHB	GLU	TGL	TCH
BCS					
Thin	40	0.54^{a} (0.46, 0.64)	4.31^{a} (4.06, 4.56)	0.16^{a} (0.15, 0.18)	2.73^{a} (2.54, 2.93)
Medium	72	0.56^{a} (0.49, 0.63)	3.73^{b} (3.57, 3.89)	0.17^{a} (0.16, 0.18)	2.90^{ab} (2.75, 3.06)
Obese	48	0.52^{a} (0.45, 0.61)	3.53^{b} (3.35, 3.72)	0.16^{a} (0.15, 0.18)	3.13^{b} (2.93, 3.34)

[ab] Different superscript letters in the same column (P<0.05)

Table 3. The least square means of body condition score in goats during the pre parturient period (-20 days), one day after parturition and during early lactation (20 and 40 days post partum)

Period (95%, CI)	BCS
-20 days	3.28^{a} (3.12, 3.43)
Partus	3.15^{a} (3.00, 3.30)
20 days p.p.	2.78^{b} (2.63, 2.94)
40 days p.p.	2.41^{c} (2.26, 2.57)

[abc] Different superscript letters in the same column (P<0.05)

Table 4. The least square means of beta-hydroxybutyrate, glucose, triglycerides and total cholesterol in goats during the pre parturient period (-20 days), immediately after partum and during early lactation (20 and 40 days post partum)

	N (Blood samples)	BHB	GLU	TGL	TCH
Period (95%, CI)					
-20. days	40	0.53^{ac} (0.44, 0.62)	3.48^{a} (3.34, 3.62)	0.18^{a} (0.16, 0.20)	2.91^{a} (2.71, 3.13)
Partus	40	0.81^{b} (0.69, 0.95)	4.79^{b} (4.51, 5.09)	0.17^{a} (0.15, 0.18)	2.43^{b} (2.27, 2.61)
20. days p.p.	40	0.52^{a} (0.44, 0.60)	3.51^{a} (3.39, 3.63)	0.16^{a} (0.15, 0.18)	3.14^{a} (2.94, 3.36)
40. days p.p.	40	0.39^{c} (0.33, 0.47)	3.57^{a} (3.44, 3.71)	0.16^{a} (0.15, 0.18)	3.28^{a} (3.03, 3.55)

^{abc} Different superscript letters in the same column ($P<0.05$)

Twenty and forty days after parturition, the mean values of BCS in goats were decreased (Table 3).

Only the concentration of TGL in goats' blood sera did not vary in the pre parturient period (-20 days), one day after parturition and during lactation (20 and 40 days post parturition). The concentration of BHB was the highest after parturition and the lowest 40 days after parturition. The level of glucose was higher and the level of TCH was lower after parturition ($P<0.05$) (Table 4).

Discussion

Acording to KRAJNICAKOVA et al. (2003) during the whole puerperal observation, the mean values of total cholesterol in dairy goats were from 2.06 ± 0.43 to 2.75 ± 0.01 mmol/L. Physiological ranges of total cholesterol in the blood serum of goats are 2.07-3.36 mmol/L (KANEKO et al., 2008). BARBOSA et al. (2009) found the average of total cholesterol in the first eight weeks after birth at 2.83 mmol/L for thin animals, 2.16 mmol/L for intermediate animals and 2.19 mmol/L for fat animals. In our study, in contrast to BARBOSA et al. (2009), TCH was the highest in fat animals. Lower blood serum concentrations of glucose and total cholesterol were found in goats on native pasture (McDOUGALL et al., 1991; KHALED et al., 1999; ŽUBČIĆ, 2001) and in Alpine goats in organic production during the early lactation period (ANTUNOVIC et al., 2006). In our study, average concentrations of total cholesterol were higher than in previous studies, but within the range of reference values. After parturition, the concentration of TCH was lower than at 20 days before parturition and during lactation. Other authors have found similarly that plasma cholesterol concentrations were higher in lactating goats during months two and three of lactation than in nonlactating goats (MBASSA and POULSEN, 1991), because those body adipose tissue reserves were catabolized during lactation to provide energy for extra-mammary tissues, possibly as a result of depleted glucose

precursor reserves (PAMBU-GOLLAH et al., 2000). Energy and some macromineral needs become higher at the beginning of lactation and during lactation, and it is normal for condition scores in does to fall (SAMARDŽIJA et al., 2011). Plasma glucose concentrations increased rapidly after parturition and subsequently decreased until the end of lactation in ruminants (HUSSAIN et al., 1996). Glucose concentrations were lower in lactating does than in non-lactating does during the first two months of lactation (PAMBU-GOLLAH et al., 2000). In our study, glucose values were similar during pregnancy and lactation, but higher at birth. BARBOSA et al. (2009) found lower glucose values at birth for intermediate than for thin or fat goats, but they were higher than reference values, as in our study. According to KANEKO et al., (2008) the range of reference values for blood serum glucose was 2.74 to 4.18 mmol/L. ANTUNOVIC et al. (2006) analysed the metabolic profile of Alpine dairy goats in organic production in the early lactation period and found the average blood glucose level (3.17 mmol/L) in the goats confirmed a sufficient energy supply. PAMBU-GOLLAH et al. (2000) found that glucose concentrations during lactation were very different among dairy goat farms in the Republic of South Africa. In Italian autochtonous dairy goats, the blood serum level of glucose was 3.6 mmol/L, on the 30th day of lactation (CASAMASSIMA et al., 2007), as was found in our study. Comparing the results of metabolic parameters in puerperium between meat and dairy goats, higher levels of glucose were found in Boer goats (4.21 ± 0.07 mmol/L) than in dairy goats (3.47 ± 0.06 mmol/L), while levels of BHB and total cholesterol were higher in dairy goats (DJURICIC et al., 2008).

BARBOSA et al. (2009) analysed the values of BHB at birth in Alpine goats and found that thin animals had twice the values than intermediate and fat goats. In our study, there was no difference in BHB concentrations between thin, fat or intermediate does, but the highest concentration of BHB was at birth and the lowest 40 days post partum. During puerperium, there were higher levels of triglycerides in Boer goats than in dairy goats (DJURICIC et al., 2008). According to SERIN et al. (2010) there was no difference between sera levels of TGL in pregnant and non pregnant Saanen goats in Turkey. Similar results were found in our study, where the average values of TGL were almost equal during late pregnancy and early lactation as in Montefalcone goats in Italy (CASAMASSIMA et al., 2007).

The energy metabolism of dairy goats, with medium milk production, decreased even though they were supplied with high quality feed, regardless of the body condition at birth (CABIDDU et al., 1999). BCS in does decreased during lactation in our study, too. At forty days of lactation only one third of the fat goats (n = 4) (33.33%) and 61.11% of the intermediate does (n = 11) became thin at the end of our study. Probably, nutrition was properly managed, so the goats were fed with high energy nutrients and their meals were well balanced.

Fecundity and parity did not influence the total concentration of BHB, GLU, TGL and TCH in goat blood serum. Some blood serum parameters and body condition scoring can be useful for evaluation of the nutritive and health status of dairy goats.

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SAMARDŽIJA, M., S. VINCE, D. ĐURIČIĆ: Povezanost pariteta, fekunditeta i ocjene tjelesne kondicije s nekim metaboličkim pokazateljima iz krvnog seruma njemačke šarene koze prije i nakon porođaja. Vet. arhiv 83, 469-477, 2013.

SAŽETAK

Cilj istraživanja je bio odrediti utjecaj pariteta i fekunditeta na ocjenu tjelesne kondicije i koncentraciju metabolita iz krvnog seruma (beta-hidroksibutirat, glukoza, ukupni kolesterol i trigliceridi) za vrijeme, prije i poslije puerperalnog razdoblja u njemačke šarene koze. U istraživanje je bilo uključeno 40 koza, 18 primiparnih i 22 multiparne. Krv je kozama vađena iz jugulane vene četiri put počevši od 20. dana prije očekivanog jarenja, poslije jarenja, te 20. i 40. dana poslije jarenja. U dotičnom serumu određivane su koncentracije metabolita standardnom metodom apsorptivne spektrofotometrije. Ukupna koncentracija beta-hidroksibutirata i triglicerida u krvnom serumu koza nije se razlikovala u odnosu na kategoriju ocjene tjelesne vanjštine, ali je razina glukoze bila značajno niža u umjereno gojnih i pretilih koza, dok je razina ukupnog kolesterola bila viša ($P<0,05$) u pretilih koza. Broj jaradi po kozi i paritet nisu utjecali na ukupnu koncentraciju metabolita u krvnom serumu koza. Na početku i za vrijeme laktacije, srednje vrijednosti ocjene tjelesne vanjštine koza su padale ($P<0,05$). Koncentracija beta-hidroksibutirata bila je najviša neposredno nakon porođaja i najniža 40. dan poslije porođaja. Razina glukoze bila je najviša poslije porođaja dok je razina ukupnog kolesterola bila niža. Jedino se nije razlikovala razina triglicerida u krvnom serumu koza. Neki pokazatelji u krvnom serumu i ocjena tjelesne vanjštine mogu se koristiti pri vrednovanju hranidbenoga zdravstvenog statusa muznih koza.

Ključne riječi: tjelesna kondicija, beta-hidroksibutirat, glukoza, mali preživači, ukupni kolesterol, trigliceridi