

VARIATION IN SERUM LIPIDS AND MINERALS DETERMINED DURING DIFFERENT PRODUCTIVE PERIODS IN FASTED GOATS

Variaciones de lípidos séricos y minerales en diferentes períodos productivos en cabras sometidas a ayuno

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SUMMARY

Experimental ketosis was studied in a total of 70 female Murciano-Granadina goats divided into two groups: a control group of 30 animals and a treatment group of 40. Five blood samples were taken from each animal at the following intervals: a month before parturition, during parturition, and 30, 60, and 90 days post-parturition. The animals from the treatment group were deprived of solid foodstuffs for five days before blood sampling.

The following parameters were assessed in serum: cholesterol, triglycerides, total lipids, calcium, inorganic phosphate and magnesium. The mean values for cholesterol, triglycerides and total lipids in serum were significantly higher in the ketotic group. Differences in calcium, inorganic phosphate and magnesium were statistically significant between groups with lower mean values for these three parameters in ketotic animals.

Key words: Fasting, goats, lipids and minerals.

RESUMEN

Se ha estudiado la cetosis experimental en un total de 70 cabras de raza Murciano-granadina divididas en dos grupos: un grupo control de 30 animales y un grupo experimental de 40. Se realizaron 5 extracciones de

sangre a cada uno de los animales de ambos grupos con los siguientes intervalos: día 120 de gestación, durante el parto, 30 días de lactación, 60 días de lactación y 90 días de lactación. Los animales del grupo experimental fueron privados de alimento sólido durante cinco días, después de los cuales se realizaban las extracciones de sangre.

Se midieron los siguientes parámetros en suero: colesterol, triglicéridos, lípidos totales, calcio, fosfato inorgánico y magnesio. Los valores medios para colesterol, triglicéridos y lípidos totales en suero fueron significativamente superiores en el grupo experimental en relación al grupo control. Para el calcio, fosfato inorgánico y magnesio hubo diferencias estadísticamente significativas entre grupos, con valores medios más bajos en los animales del grupo experimental respecto de los controles.

Palabras clave: Cabras, ayuno, lípidos y minerales.

INTRODUCTION

Metabolic problems represent a high percentage of ruminant diseases, and ketosis is one of the main problems associated with dairy production (VRZGULA, 1990). Ketosis occurs worldwide, resulting in major production losses (FORD, 1983). Although only a few studies concerning ketosis in goats have been reported (VIHAN and RAI 1984 a,b; SOTILLO, 1992), it is an important disease in this species (ALI et al. 1984), specially in tropical and arid areas where goats are an important food source, and animals suffer feed restriction during dry seasons.

The study of minerals such as calcium, inorganic phosphate and magnesium and parameters related with lipid metabolism in ketosis can be of great importance since these minerals are important in metabolism due to their role in carbohydrate and lipid metabolism and lipid mobilization is one of the basic steps in the pathogenesis of this disease. However, there are no complete studies about these minerals and parameters related to lipid metabolism in goats with ketosis, nor reports of their variation during different stages of reproduction, i.e., pregnancy, parturition and lactation.

The purpose of this study was to investigate variations in serum parameters related to lipid metabolism (total lipids, triglycerides and cholesterol) and calcium, inorganic phosphate and magnesium in ketotic goats compared to normal animals during different reproductive stages (pregnancy, parturition and lactation).

MATERIALS AND METHODS

Seventy, 3-5-year-old healthy female Murciano-Granadina goats in their third to fifth lactation located at the Murcia Regional Animal Research Center (E.M.E.G.A., Spain) were used in this experiment. Estrus was induced by placing flurogestone acetate sponges in the vaginas of 90 goats for 11 days and, on the ninth day, 400 I.U. of pregnant mare serum gonadotropin (PMSG) and 5 mg of PGF-2 alpha were injected intramuscularly. Two days after the injections, the vaginal sponges were removed, and after 30 hours, 11 males of the same breed were introduced into the group for 3 days. This procedure resulted in 70 pregnant goats that were used in the experiment. Pregnancy was confirmed using ultrasound.

Pregnant animals were divided in two groups: 1) 30 control animals on a normal feeding regimen, and 2) 40 treatment animals for which feed was withheld for 5 days, but with water provided «ad libitum». All animals in the treatment group were fasted at 5 successive stages of reproduction at: 1) day 115 of pregnancy, 2) 5 days prior to expected parturition 3) 25 days of lactation, 4) 55 days of lactation and 5) 85 days of lactation.

Feed included a concentrate consisting of 72% cereals grain (corn, oats), 15% soybean meal, 10% mill byproducts and 3% vitamin-mineral mix. The composition of the concentrate was 12.5% moisture, 16% protein, 7% crude fiber, 6.5% ash, 2% ether extract and 56% ni-

trogen free extract. Animals were also given a mixture of sorghum-alfalfa hay and an iodized salt block. All feedstuffs were provided «ad libitum». Goats were hand milked 1 time per day.

Blood samples were collected by jugular venipuncture, and urine was taken by catheterization after the fifth day of fasting in the treatment group and the same day in the controls. Animals in the fasted group were treated after blood and urine samples were taken and returned to the normal feeding regimen until the next time that feed was withheld.

Each animal in the treatment group was treated as follows:

— Glucose, 50 ml IV (glucose 50%, Labiana Analitica, Barcelona, Spain).

— Vitamin B complex (Labridosol-B, Labiana Analitica, Barcelona, Spain) 1 ml IM (12 mg/ml, vit B1; 1,5 mg/ml vit B2; 5 mg/ml vit B6; 100 mg/100 ml vit B12; 20 mg/ml pantothenic acid and 40 mg/ml nicotinamide).

— Clanobutin (Bykahepar, Boehringer Ingelheim, Konstanz, Germany) 1 ml IM (106.4 mg/ml).

— Dexamethasone (Voren, Boehringer Ingelheim, Konstanz, Germany) 2 ml IM (1 mg/ml).

Urine from each goat was tested for ketone levels using a commercial test kit (Labstix, Ames Division, Miles Laboratories Limited, England). Blood was allowed to clot 3 hours at room temperature in slanted glass tubes, and the serum was removed with a sterile pasteur pipette. The serum was centrifuged at 2300 g for 10 minutes.

Determination of serum calcium was made using the ortho-cresolphthalein-complexone technique (Wako Chemicals GmbH, Ref. 997-21809). Inorganic phosphate determination was based on the sodium phosphomolybdate technique (Merckotest. Ref. 3331), and magnesium was measured according to MERCK (1974) (Merckotest. ref. 3338). To determine total lipids, the phosphoric acid-vanillin technique was used (Merckotest. Ref. 3321), triglycerides were determined with the formazone technique (Merckotest. ref. 14341), and cholesterol by the cholesterol-esterase technique (Merckotest. ref. 14366). All the parameters were analysed by colorimetry using the Philips Pye Unicam PU UV/Kinetics spectrophotometer.

Data were processed using the Statgraphic program, and multiple variant analysis of parameters for each group of animals during the 5 stages of reproduction were made. A level of $P < 0.05$ was considered significant (SNEDECOR and COCHRAN, 1982).

RESULTS AND DISCUSSION

Approximately 75% of the fasted goats developed overt clinical signs of ketosis. The signs were of varying degrees of severity beginning the fourth or fifth day of fasting. Signs included decreased rumination, diarrhea, prostration, somnolence and ketone odor in the oral cavity. Urine from all animals in the treatment group tested positive for ketone bodies, so all fasted goats were considered as ketotics. The animals recovered clinically within 2-5 days after treatment, and no deaths occurred. No clinical signs and no positive cases of ketone bodies in urine were observed in the controls.

Values of serum calcium in control goats agree with results obtained by other authors (BOGIN et al. 1981; COLES, 1986). Serum calcium in control goats was significantly decreased ($p < 0.05$) in pregnancy compared with lactation in agreement with ALDASY et al. (1981). Ketotic goats had significant lower serum calcium values than controls. In cases of renal tubular acidosis, there is a low calcium balance with diminished intestinal fractional calcium absorption and excessive renal calcium loss (PREMINGER et al. 1987). This decrease can be influenced too by the hypoalbuminemia that appears in ketosis (HALLFORD and SANSON, 1983; CERON, 1992) since for every gr/dl decrease in albumin, there is an approximate 0.8 mg/dl decrease in total serum calcium (LOEB and QUIMBY, 1989).

TABLE I
Comparison of the parameters analysed in control and ketosis goats in the various stages of reproduction

	Groups	120 D Preg	Parturition	30 D Lact	60 D Lact	90 D Lact	Mean
Calcium	Control	9.96±0.20	10.54±0.13	10.76±0.18	10.37±0.17	10.57±0.20	10.44±0.17
	Ketosis	9.55±0.09	9.32±1.13	9.40±1.13	9.38±1.13	9.55±1.15	9.44±0.92
Inorg. Phosp.	Control	6.73±0.13	6.65±0.16	6.62±0.14	6.36±0.17	6.64±0.18	6.60±0.15
	Ketosis	5.93±0.13	5.99±0.13	5.94±0.09	6.09±0.13	5.96±0.10	5.98±0.11
Magnesium	Control	2.33±0.08	2.02±0.07	2.32±0.06	2.17±0.06	2.17±0.07	2.20±0.06
	Ketosis	1.67±0.05	1.48±0.06	1.57±0.06	1.72±0.06	1.81±0.08	1.65±0.06
Total Lipids	Control	3.64±0.10	3.28±0.12	3.33±0.06	3.39±0.14	3.41±0.12	3.41±0.10
	Ketosis	4.86±0.14	5.04±0.16	4.86±0.18	4.80±0.16	4.48±0.16	4.82±0.16
Triglycerides	Control	70.06±4.02	87.09±5.43	82.62±4.31	107.59±3.79	94.72±4.08	88.41±4.32
	Ketosis	110.92±4.33	131.88±5.03	136.56±4.20	133.96±5.17	134.72±5.22	129.60±4.79
Cholesterol	Control	96.30±4.25	98.84±3.91	93.80±3.75	96.40±4.22	93.37±3.54	95.74±3.93
	Ketosis	119.98±4.25	133.69±5.45	132.33±4.64	129.61±4.41	128.47±4.87	128.81±4.72

Each parameters expressed as mean of 70 animals ± SD

All data are in mg/dl (except Total Lipids that are in g/l).

All differences between controls and ketotics in different stages are statistically significant (P<0.05)

Serum inorganic phosphate levels in healthy goats were similar to values found in high performance dairy goats breeds (Saanen and Alpine) by RIDOUX et al. (1981). There was a significant decrease in serum inorganic phosphate in ketotic goats, similar to the results obtained by VIHAN and RAI (1984b) in goats with ketosis. The phosphate decrease could have been due to the renal loss of this compound that occurs in the renal acidosis of ketosis (LOEB and QUIMBY, 1989). In cases of metabolic acidosis, there is a depressed phosphorylation and a decomposition of intracellular organic phosphate compounds; inorganic phosphate moves into the extracellular fluid and is excreted in the urine. Concurrent ketonuria causes an osmotic diuresis which further enhances phos-

phaturia (FORRESTER and MORELAND, 1989).

Serum magnesium values in control goats were similar to values found by CASTRO et al. (1977) and BOGIN et al. (1981) in Saanen and Israeli goats, respectively. Magnesium values are significantly lower in ketotic goats. EGAN et al. (1970) and JOPP and QUINLIVAN (1981) found hypomagnesemia in sheep with ketosis. The increase of phosphorus excretion in urine can produce hypomagnesemia (LOEB and QUIMBY, 1989). Another possible reason for low levels of magnesium in ketotic animals could be the interference with magnesium absorption in rumen and large intestine due to the increased fatty acids levels that appear in ketosis (REINHARDT et al. 1988).

Values for total lipids in control goats agree with VALLEJO and FERNÁNDEZ (1991). Total lipids were significantly higher in ketotic goats than controls. Increases in total lipids in different stages of ketosis have been described by others (BAIRD, 1982; MORAND-FEHR et al. 1984). In ketotic animals, there is fat mobilization, so concentration of total lipids in blood is increased (BARTLEY, 1989). Increases in total lipid components such as triglycerides or cholesterol as occurred in ketotic animals would increase serum total lipid values.

Ketotic goats had an significant increase in serum triglycerides compared with the control group. In ketosis, there is an increase in serum triglyceride levels (BICKHARDT et al. 1988). The decreased plasma glucose and the hormonal changes stimulate lipolysis in adipose tissue resulting in increased plasma long chain fatty acids (LCFA) levels. The high plasma LCFA levels promote increased hepatic uptake and conversion to ketones and triglycerides, leading to ketonemia and fatty liver (REID, 1968).

Serum cholesterol levels in healthy goats agree with values of cholesterol given by KANEKO (1989). Serum cholesterol values were significantly higher in ketotic animals compared to controls. The LCFA that appear in ketosis are extracted by the liver at a rate greater than can be oxidized to carbon dioxide and water, reexported as triglycerides synthesized in the liver, or used for cholesterol synthesis (BRUSS, 1993).

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