J. Basic. Appl. Chem., 1(8)65-69, 2011

ISSN 2090-424X
Journal of Basic and Applied Chemistry
www.textroad.com

Hematobiochemical Profile of Pregnant and Experimentally Pregnancy Toxemic Goats

Abd Elghany Hefnawy [1], Saad Shousha [2,*], Seham Youssef[3]

[1] Department of Internal Medicine, [2] Department of Physiology, [3] Department of Pharmacology, Faculty of Veterinary Medicine, Benha University, 13736 Moshtohor, Egypt.

ABSTRACT

Hyperketonemia and hypoglycemia are more common obvious biochemical features of pregnancy toxemia as well as liver and kidney may be involved in the pathogenesis of toxemia. Fifteen pregnant goats with twins (3-4 years, 20-27 kg body weight and 120-130 days of gestation) were classified into two groups, control one consists of six goats and experimental group consists of nine goats for induction of pregnancy toxemia by the stress of fasting with access of water until the symptoms of pregnancy toxemia were appeared within 72 hours. Serum samples were obtained and analyzed for β-hydroxybutyrate, glucose, total protein, albumin, globulin, urea, creatinine, AST, ALT, total lipids, cholesterol, calcium, magnesium, phosphorus, sodium and potassium using kits, while insulin, cortisol, T3, T4, growth hormone were measured by radioimmunoassay. Hematological profile was investigated on whole blood samples. β-hydroxybutyrate, AST, ALT, urea, creatinine, cortisol and insulin hormones were significantly higher in toxemic goats than those of control ones while glucose, sodium, potassium, calcium, magnesium, T4, total protein, globulin, albumin, cholesterol and total lipids values were significantly lower in toxemic goats than those of control ones while, there were no significant changes in phosphorous, T3 and growth hormone. A significant increase in leucocytes, hemoglobin, packed cell volume and neutrophils and a significant decrease in lymphocytes were observed in pregnancy toxemic goats than those of control ones. Clinical chemistry of pregnancy toxemia can affect hormonal, electrolytes and mineral balance as well as immune and hematological picture in goats.

KEY WORDS: Goat, pregnancy, toxemia.

INTRODUCTION

Pregnancy toxemia (gestational ketosis) caused by negative energy balance in late gestation is commonly observed in ewes and goats [1-4], because during pregnancy, fetuses have a large glucose demand that is satisfied by the mother. If the fetal demand and the mother supply become imbalanced due to fasting of the mother or the increased nutritional demands of the rapidly developing fetal placental unit, females suffer from negative energy balance and resulting in severe hypoglycemia [5, 6]. Ovine pregnancy toxemia frequently develops during the last 4 to 6 weeks of gestation, primarily in pregnancies with more than one fetus, about 60% of fetal growth takes place in this last gestation period, and during this time approximately 33 to 36% of the circulating glucose is directed into the fetoplacental unit to satisfy its energetic demands [7]. Hyperketonemia usually develops when, for yet, the capacity of maternal endogenous glucose production can not cope with the increased demand of glucose, which is present in the pregnant ewe.

Goats suffering from pregnancy toxemia become anorexic, depressed and recumbent and some affected animals become constipated, grind their teeth, have acetone smell to their breath and suffering from dystocia. Neurologic signs include blindness, circling, in-coordination, stargazing, tremors and convulsions. Death can occurred if the case is left untreated [8]. Hyperketonemia and hypoglycemia are more common obvious biochemical features. The main ketone bodies in the blood which are normally measured are acetoaectate and β-hydroxybutyrate. Most of acetoacetate produced by the liver is reduced to β-hydroxybutyrate by Hydroxybutyrate dehydrogenase enzyme accounting for the higher blood concentration of β-hydroxybutyrate [9].

In this study, hematological, clinical and biochemical parameters (among others, Hyperketonemia and hypoglycemia) in pregnant and experimentally pregnancy toxemic goats were investigated and the endocrine response to short fasting during late pregnancy in goats (changes in the insulin, cortisol, growth hormone, T4 and T3 blood concentration) had been studied as well as changes in electrolytes, some minerals, total lipids, cholesterol, kidney and liver function tests in pregnancy toxemic goats were investigated.

***Corresponding Author**: Saad Shousha Ph.D., Department of Physiology, Faculty of Veterinary Medicine, Benha University, 13736 Moshtohor, Egypt. E-mail:physiology2009@yahoo.com

MATERIALS AND METHODS

Animal experiments: Fifteen pregnant goats with twins of 3-4 years old, 20-27 Kg body weight and 120-130-days of gestation were selected after ultrasound examination and divided into two groups, control group consisted of 6 animals and experimentally pregnancy toxemic group consisted of 9 animals and used for induction of pregnancy toxemia by short fasting with access to water until the symptoms of pregnancy toxemia appeared and the animals were examined clinically every 12 hours (pulse, temperature, respiratory rate and ruminal movements). All investigated animals were fed on 250 grams corn/ head / day, concentrates and barseem *ad lib* for two weeks before the beginning of the experiment and NIH guidelines for the care and use of animals have been followed.

Blood sampling and parameters measured: Blood samples were collected from the jugular vein at 72 hours from the beginning of the induction of pregnancy toxemia where the clinical findings of pregnancy toxemia appeared. Whole blood samples were taken for hematological investigation while serum samples were prepared and harvested immediately and stored at +4°C (≤ 48h) until assay of β-hydroxybutyrate and glucose or at -20°C until analysis for total protein, albumin, globulin, urea, creatinine, AST, ALT, total lipids, cholesterol, total calcium, magnesium, phosphorus, sodium and potassium using commercially available kits, while insulin, cortisol, T3, T4, and growth hormone were measured by radioimmunoassay [10].

Statistical analysis: For presentation of results the means and their standard errors means (SEM) were calculated. The results were subjected to Student's *t*-test by using the Statistical Analysis System (SAS) software [11]. Results were considered statistically significant when $p < 0.05$.

RESULTS

Induced pregnancy toxemic goats showed the clinical manifestations of caprine ketosis within 72 hours of fasting in the form of anorexia, dullness, dyspnea, weakness, lateral recumbency, odor of acetone in the breath, drowsiness, stiffness of the body and nervous signs.

In regard to the biochemical analysis, the values of β-HBA, AST, ALT, urea, creatinine, cortisol and insulin hormones were significantly higher in induced pregnancy toxemic goats than those of control ones. The values of glucose, sodium, potassium, calcium, magnesium, T4, total protein, globulin, albumin, cholesterol and total lipids were significantly lower in induced pregnancy toxemic goats than those of control ones while, the values of phosphorous, T3 and growth hormone were not significantly different between induced pregnancy toxemic goats and control ones as shown in table (1).

Table (1): Biochemical parameters (Means ± SEM) in pregnancy toxemic and control goat (n=15) *p< 0.05, **p < 0.01

Parameters	Control	Pregnancy toxemic goats
β-Hydroxybutyrate (µmol/l)	326.57±29.77	744.38±24.97**
AST(u/l)	53±4.16	89±2.31**
ALT(u/l)	28.67±0.38	65.83±1.9**
Urea (mmol/l)	4.82±1.53	8.76±0.49**
Createnin (µmol/l)	110.5±5.30	211.28±12.37**
Cortisol (nmol/l)	488.34 ±77.25	1194.92 ± 121.94**
Insulin (pmol/l)	78.2 ± 1.45	118.41 ± 2.84*
Glucose (mmol/l)	2.9±0.14	1.34±0.04***
Sodium (mEq/l)	155.33±3.48	120±2.97**
Potassium (mEq/l)	4.8±0.34	3.01±0.08*
Calcium (mmol/l)	2.47±0.21	1.63±0.08**
Magnesium (mmol/l)	1.36±0.08	0.74±0.06**
T4 (ng/ml)	11.25 ± 1.33	7.22 ± 0.94**
Total protein (g/l)	63.4±2	31.9±0.5**
Albumin(g/l)	37.6±2.2	16.2±1.4**
Globulin(g/l)	24.9±0.8	15.7±1**
Total lipids (mmol/l)	2.99 ± 0.28	1.78 ± 0.02**
Cholesterol (mmol/l)	16.9 ± 1.96	11.09 ± 0.45*
Phosphorous (mmol/l)	2±0.04	1.56±0.05 NS
T3 (nmol/l)	17.11 ± 5.01	12.22 ±1.54 NS
Growth hormone (Umol/l)	1.56 ± 0.19	1.68 ± 0.1 NS

The values of total leucocytes, hemoglobin, packed cell volume and neutrophils were significantly higher in the induced pregnancy toxemic goats than those of control ones and the value of lymphocytes was significantly lower in the induced pregnancy toxemic goats than that of control ones as shown in Figure (1). However, there were no significant changes in the other measured hematological parameters as shown in Figure (1).

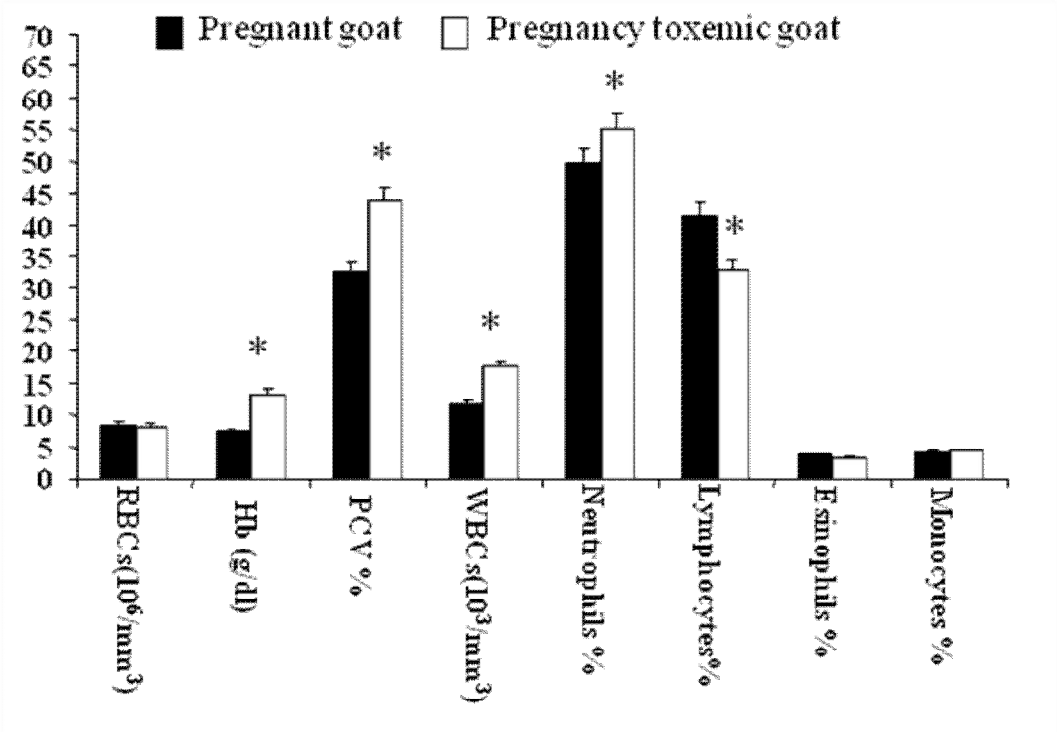

Figure (1): Hematological parameters (Means ± SEM) of pregnant and pregnancy toxemic goats (n=15). $^{*}p < 0.05$.

DISCUSSION

Pregnancy toxemia of goats appears to occur when the animal can not meet the glucose demands of the fetal/placental unit and hypoglycemia and ketonemia develop, and diagnosis of caprine pregnancy toxemia is based on the stage of gestation, physical signs, hematological and biochemical measures.

Elevation of β-hydroxybutyrate resulted in a significant drop of glucose turnover [12-14], and theoretically the possible mechanism responsible for the hypoglycemic effects of high concentration of β-hydroxybutyrate is reduction of food intake and glucose turnover [13], but insulin cannot be involved in this effect, but ketone bodies have a weak stimulus for insulin secretion in ruminant [14]. In this study, significant increase of insulin concentrations in the induced pregnancy toxemic goats may refer to the fact that insulin may have an inhibitory role of ketogenesis [15]

A significant decreased plasma calcium concentration accompanied by an elevated concentration of ketone bodies observed in sheep during late pregnancy in other studies [1] and this agreed with the results of this study. 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 [12] 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. Ovine pregnancies with more than one fetus are in fact more often accompanied with hypocalcaemia and pregnancy toxemia than those with one lamb.

The marked drop in serum total protein, globulin, albumin, cholesterol and total lipids with significant increase in AST and ALT could throw some light on the hepatic origin of caprine pregnancy toxemia which may be attributed to fat mobilization [16-18] that associated with inadequate dietary intake [17] or due to hepatic damage [19-21] or hepatic lipidosis [3].

Urea and creatinine concentrations were significantly higher in pregnancy toxemic goats than those of control ones and these may be considered as indicator to involvement of the kidney in the pathogenesis of caprine pregnancy

toxemia and increased catabolism and this expectation agreed with previous studies [17, 18, 20, 22]. It is found that there was significant negative correlation between blood glucose and urea concentration while the correlation between β-hydroxybutyrate and urea concentration was significantly positive [23] and this supports the result of this study.

Significant decrease in the serum levels of sodium, potassium, magnesium and calcium as well as significant increase in the packed cell volume (PCV) and hemoglobin concentration in the pregnancy toxemic goats indicated that there were disturbances in the electrolytes and some minerals which may be attributed to stress of starvation, dehydration and involvement of the kidney in the pathogenesis of caprine pregnancy toxemia or also due to enhanced lipolysis that can induce hypomagnesemia and hypocalcemia [24, 25]. It found that hypokalemia and hypocalcaemia that are associated with pregnancy toxemic ewes may be attributed to anorexia and metabolic acidosis, respectively, which are often associated with pregnancy toxemia [2, 3, 21] or inadequate feed intake and incomplete renotubular absorption of potassium [1].

Studies of the effects of ketosis on the bovine immune system, thus far, have concentrated on the role of ketones. In vitro responses of lymphocytes from calves with experimentally induced ketonemia compared with normal calves were suppressed [26] and this agreed with the results of this study where there was significant decrease in lymphocytes in pregnancy toxemic goats than that of control ones. Many studies indicated that toxic and subtoxic concentrations of β-hydroxybutyrate and acetoacetate inhibited bovine lymphocytic proliferation [27, 28] and reduced bovine T-lymphocyte blastogenesis [29]. A direct effect of ketone bodies on specific defenses has already been reported [29], and the functional activity of neutrophiles- polymorphonuclear leucocytes can also be affected [27, 30, 31]. Also, it is showed that in vitro concentrations of bovine ketone bodies similar to those of mild or sever ketosis decreased chemotaxis and uptake of latex particles in sheep neutrophiles and these support the results of this study and indicated that pregnancy toxemia has immunosuppressive effect in goats [31, 15].

The significant decrease in T4 in pregnancy toxemic goats may be attributed to excessive secretion of cortisol as there is a negative correlation between free T4 and cortisol as concluded in early study [32, 33]. The response to fasting (negative energy balance) incorporates hormonal signals which initiate energy preservation. Insulin, T4 and T3 are important hormones in the regulation of energy homeostasis. The decreases in T4 in experimental pregnancy toxemic goats in the present study were similar to that recorded in ewes [4] and ferret [34] with pregnancy toxemia.

In Conclusion, we can conclude that, kidney and liver are involved in the pathogenesis of caprine pregnancy toxemia as well as pregnancy toxemia can affect the hormonal, electrolytes and minerals balance, as well as hematological and immune status in goats.

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