Age related changes in serum biochemical profile of Saanen goat kids during the first three months of life

S. ABDOLVAHABI1, M. ZAEEMI2*, M. MOHRI3, A.A. NASERIAN4

1 Ferdowsi University of Mashhad, Mashhad, Iran.
2 Department of Clinical Sciences, Faculty of Veterinary Medicine, Ferdowsi University of Mashhad, Mashhad, Iran.
3 Department of Clinical Sciences and center of excellence for ruminant abortion and neonatal mortality, Faculty of Veterinary Medicine, Ferdowsi University of Mashhad, Iran.
4 Department of Animal Sciences, Faculty of Agriculture, Ferdowsi University of Mashhad, Iran.

Corresponding author: zaeemi@um.ac.ir

SUMMARY

To determine serum biochemical profile in Saanen goats’ kids from the birth until 3 months of age and comparison with that of adult Saanen goats, whole blood specimens were collected from 19 clinically healthy Saanen goat kids (female:14, male:5). The first blood specimen was obtained between 24-48h after birth and this continued to 10±2, 28±2, 56±2 and 84±2 days of age. Plasma fibrinogen and serum concentrations of sodium, potassium, chloride, calcium, magnesium, inorganic phosphate, iron, zinc, copper, total protein, albumin, total bilirubin, glucose, urea, creatinine, triglyceride, cholesterol, gamma-glutamyl transferase (GGT), lactate dehydrogenase (LDH), aspartate aminotransferase (AST), creatine kinase (CK) and alkaline phosphatase (ALP) were measured. The concentration of globulin was obtained by subtracting albumin from the total protein.

Although the results showed significant age related changes for most measured variables except triglyceride (p<0.05), there were significant differences between sampling times for all variables (p<0.01) except for zinc, inorganic phosphate, and triglyceride.

The results of the present study indicate that for most biochemical variables except potassium, albumin, zinc and iron, specific age related reference values are essential for proper interpretation of laboratory results during the first three months of life.

Keywords: Age, Biochemical variables, Saanen goat kids

INTRODUCTION

Saanen is the most well-known dairy goat breeds. They are white or light cream in color with usually short and fine coats [9]. The name of this breed of goat originated from the Saanen valley in Switzerland. It is now the most popular dairy goat breed in many countries because of its high milk production, high reproductive indices, multi parturition, high growth and puberty rates [27]. The Caprinae is one of the less studied groups of domestic animals and limited information is available on the biochemical variables of the kids relative to their adult life.

Diseases of the newborn and neonatal mortality are major causes of economic loss in livestock production. Specific biochemical reference ranges could help with a realistic evaluation of management practices, nutritional status and health conditions. There are few investigations about age related changes of blood biochemical variables of goat kids in comparison with adult goats and these studies often focus on changes in serum total proteins and protein fractions [5, 8, 25, 26]. Considering the profound effects of age on the serum biochemical variables, the aim of this study is to investigate the physiological pattern of biochemical variables by sequential measurements in growing goat kids in order to evaluate the need for defining reference values for different age groups. The obtained data should help in interpreting laboratory results.

MATERIALS AND METHODS

Nineteen (female: 14, male: 5) Saanen goat kids that were born in Large Animal Research Station at the Ferdowsi University of Mashhad were used in the present study. The farm was regularly monitored by a veterinarian with consultation of faculty members of veterinary medicine, Ferdowsi University of Mashhad. Kid’s health status was evaluated before each sampling, based on rectal temperature, heart and respiratory rate, and other routine factors (cough, nasal discharge, ocular discharge, appetite and fecal...
consistency). Blood sampling was performed through jugular vein between 6.00 and 10.00 A.M. after birth until they were 84 days old. Blood specimens were taken within 24–48 ±2 h and at 10±2, 28±2, 56±2, and 84±2 days of age.

Specimens were collected in K3-EDTA (FL medical, Italy) and plain (WEGO, China) tubes and were placed immediately on ice for transferring them to the laboratory. Blood specimens in plain tubes (7.5 mL) were centrifuged (by Jouan, C 412, France) at 1800g for 10 min. Serums were placed into Eppendorf tubes (1.5 mL flat cap microcentrifuge tubes, Germany) and were stored at -70 °C until they were processed approximately for 1 month after the last blood sampling. Anticoagulated blood (1.5 mL) was used for measurement of fibrinogen (Fib) concentration. Fib was estimated by the heat Precipitation-Refractometry method [10]. Biochemical variables such as: total protein (TP), albumin (Alb), Urea, creatinine (Cre), glucose (Glu), triglyceride (TG), cholesterol (Chol), magnesium (Mg), calcium (Ca), inorganic phosphate (Pi), iron (Fe), total bilirubin (BT), alkaline phosphatase (ALP), lactate dehydrogenase (LDH), creatine kinase (CK), gamma-glutamyl transferase (GGT) and aspartate aminotransferase (AST) were measured by commercial kits (Pars Azmoon, Tehran, Iran). Serum concentrations of copper (Cu) and zinc (Zn) were determined by Bioxer diagnostics (Antrim, UK) and ZiestChem Diagnostics (Iran, Tehran) kits, respectively. All these variables were measured by an autoanalyzer (Biotecnica, BT1500, Rome, Italy). Accuracy of the measurements was checked by control serum (Randox control sera, Antrim, UK). The concentrations of sodium (Na), chloride (Cl) and potassium (K) were measured by an electrolyte analyzer (Starlyte™ III, Alfa wassermann, Netherlands). The serum concentration of globulins (Glo) was obtained by subtraction of Alb from the TP. Methods of measurement and details of test characteristics are shown in Table 1.

Statistical analysis was conducted using SPSS for Windows (release 20, IBM, USA). Age effect was examined using non-parametric Friedman test. In addition, a non-parametric paired T test was used for the comparison of each sampling stage with first sampling time. Because of using multiple comparisons the corrected p value was calculated and adjusted at 0.01. For each variable, age-related changes were shown by a graph with upper and lower limits of adult reference intervals (ARI) [17, 28-30].

<table>
<thead>
<tr>
<th>Analytes</th>
<th>Methods</th>
<th>Intra assay CV* (%)</th>
<th>Inter assay CV (%)</th>
<th>Analytical range**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total proteins (g/L)</td>
<td>Biuret</td>
<td>1.01</td>
<td>2.55</td>
<td>5-150</td>
</tr>
<tr>
<td>Albumin (g/L)</td>
<td>Bromcresol green</td>
<td>1.12</td>
<td>2.00</td>
<td>2-60</td>
</tr>
<tr>
<td>Urea (mmol/L)</td>
<td>Urease/glutamate dehydrogenase</td>
<td>3.13</td>
<td>3.80</td>
<td>0.72-72</td>
</tr>
<tr>
<td>Creatinine (μmol/L)</td>
<td>Kinetic Jaffe</td>
<td>2.38</td>
<td>0.50</td>
<td>17.68-1326</td>
</tr>
<tr>
<td>Glucose (mmol/L)</td>
<td>Glucose oxidase/PAP (4-aminoantipyrine)</td>
<td>1.28</td>
<td>1.12</td>
<td>0.28-22.2</td>
</tr>
<tr>
<td>Triglycerides (mol/L)</td>
<td>Glycerol 3 phosphate oxidase/PAP (4-aminoantipyrine)</td>
<td>1.82</td>
<td>2.15</td>
<td>0.06-7.91</td>
</tr>
<tr>
<td>Cholesterol (mmol/L)</td>
<td>Cholesterol oxidase/PAP (4-aminoantipyrine)</td>
<td>0.61</td>
<td>1.35</td>
<td>0.13-12.93</td>
</tr>
<tr>
<td>Total Bilirubin (μmol/L)</td>
<td>Dichloroanilin</td>
<td>2.32</td>
<td>2.59</td>
<td>1.71-513</td>
</tr>
<tr>
<td>Magnesium (mmol/L)</td>
<td>Xylidile blue</td>
<td>0.87</td>
<td>0.81</td>
<td>0.02-2.06</td>
</tr>
<tr>
<td>Calcium (mmol/L)</td>
<td>CresophetaleinComplexone</td>
<td>0.62</td>
<td>2.39</td>
<td>0.05-4.99</td>
</tr>
<tr>
<td>Inorganic Phosphate (mmol/L)</td>
<td>Phosphomolybdate</td>
<td>1.12</td>
<td>1.40</td>
<td>0.06-9.69</td>
</tr>
<tr>
<td>Sodium (mmol/L)</td>
<td>Ion Selective Electrode</td>
<td>1.00</td>
<td>2.55</td>
<td>40-205</td>
</tr>
<tr>
<td>Potassium (mmol/L)</td>
<td>Ion Selective Electrode</td>
<td>1.50</td>
<td>1.49</td>
<td>1.5-15</td>
</tr>
<tr>
<td>Chloride (mmol/L)</td>
<td>Ion Selective Electrode</td>
<td>1.00</td>
<td>1.76</td>
<td>50-200</td>
</tr>
<tr>
<td>Zn (μmol/L)</td>
<td>5- Br-PAPS</td>
<td>2.4</td>
<td>2.47</td>
<td>0.61-61.2</td>
</tr>
<tr>
<td>Iron (μmol/L)</td>
<td>Ferene S</td>
<td>1.22</td>
<td>2.57</td>
<td>0.89-89.55</td>
</tr>
<tr>
<td>Cu (μmol/L)</td>
<td>4- (3, 5-dibromo-2 pyridylazo)-N-ethyl-IN-sulopropylaniline</td>
<td>1.83</td>
<td>2.86</td>
<td>0.04-78.7</td>
</tr>
<tr>
<td>ALP (U/L)</td>
<td>P-Nitrophenylphosphate</td>
<td>0.92</td>
<td>0.99</td>
<td>3-1200</td>
</tr>
<tr>
<td>LDH (U/L)</td>
<td>Pyruvate as substrate</td>
<td>2.01</td>
<td>2.30</td>
<td>5-3000</td>
</tr>
<tr>
<td>CK (U/L)</td>
<td>Creatine phosphate as a substrate</td>
<td>0.70</td>
<td>1.00</td>
<td>1-1015</td>
</tr>
<tr>
<td>GGT (U/L)</td>
<td>L-gamma-glutamyl-3-carboxy-4-nitroanilide</td>
<td>1.16</td>
<td>0.97</td>
<td>2-400</td>
</tr>
<tr>
<td>AST (U/L)</td>
<td>L-aspartate/2-oxoglutarate as substrate</td>
<td>3.06</td>
<td>1.38</td>
<td>2-300</td>
</tr>
</tbody>
</table>

* Intra assay CV: The biochemical parameters were analyzed ten times in control serum in the same analytical series. ** Analytical ranges were from kits manufacturers.

Table 1: Methods of measurements and details of test characteristics.
Results

Sampling time (age) had a significant (p < 0.05) effect on most measured variables except TG. The significant differences between all times were presented in figures 1-4.

A decreasing trend was detected throughout the study in some variables such as: Ca, Mg, Glu, BT, GGT, ALP and LDH. Chol, Cl, Zn and Fe concentrations increased until day 28, and thereafter decreased almost to the upper limit of ARI by 84 days of age. After elevation of serum Alb concentration and A:G ratio from birth to day 10, a reducing trend was observed until day 84. Some factors decreased from birth to day 10 (Urea and Cre) or day 28 (AST, TP and Glo) and followed by an increasing trend that extended to day 84.

Discussion

The age-related changes of most biochemical variables except protein and protein fractions have not been studied in small ruminants. There are some reports that investigated biochemical variables of lambs and goat kids in comparison with adult goats [4, 9]; but these variables were not monitored in growing animals by sequential measurements. The results of this study are probably the first comprehensive investigation of serum biochemical profile in growing Saanen goat kids during the first three months of their life.

We found colostrum intake has essential effects on serum biochemical variables such as: serum enzyme activity and concentration of protein, lipid, glucose and minerals. The maximum and minimum values of TP and Glo were detected on the first day of age and day 28, respectively and these

Figure 1: Dot plots of concentrations (○) and median (●) of organic compounds in serum of kids from 1 to 84 days of age (Gray shading indicates adult reference intervals; Non-similar letters indicate significant difference (p<0.01).
variables were in ARI except days 10 and 28. Similar patterns have been reported for these variables in goat kids [7]. In mammals, plasma protein and globulin concentrations are low at birth, increase after absorption of colostrums and then decline for 1 to 5 weeks as absorbed Ig in colostrums is degraded [11]. Increasing serum TP and Glo from the age of 1 month could be related to the elevation of acute phase proteins (APP) and Ig due to stimulation of immune system.
The plasma concentration of Fib was approximately equal to the upper limit of ARI on days 10 and 56. The significant elevations of Fib were observed in all times compared to first day of life except day 84. The significant increase of Fib previously was reported on the second day of life in goat kids [26]. The secretion of glucocorticoids at birth stimulates transcription of Fib genes in liver [26]. The higher concentration of APPs in neonates shortly after birth is not always a sign of disease. It may be related to normal growth process or exposure to new environmental and nutritional conditions [22]. During the present study, Alb concentrations were within ARI and significantly increased from birth up to day 10 of age and after that had a decreasing trend. This pattern probably reflects hepatic synthesis of Alb in order to compensate for decrease of serum osmotic pressure due to declined globulin concentrations [21]. Furthermore, nutrition conditions should not be ignored because Alb is the main protein in milk and colostrums [10]. Opposite to our results, PICCIONE et al. (2011) reported a significant reduction of serum Alb concentration in goat kids during the first 2 weeks of life and stated that this trend reflects the medium half-life of Alb (14-16 days) in ruminants [25].

Glucose concentrations were above the ARI up to day 84. The higher concentration of blood glucose compared with adults was reported in young goats [9, 23, 32] and other ruminant’s neonates [4, 18, 31]. The higher concentration of glucose in young ruminants may be related to different metabolism. In kids, blood glucose comes from lactose after digestion of milk while in adults; it comes mainly from liver gluconeogenesis because of rumen carbohydrates metabolism. In addition to colostrums intake, endogenous corticosteroids release during parturition may lead to a higher amount of glucose in newborns.

The increasing pattern in cholesterol concentration also may be attributed to high intake of dietary fat provided by colostrums and milk. In several weeks after birth, a rapid rise of plasma lipids has also been observed in calves [15] and goat kids [6]. The concentration of plasma phospholipids, free and esterified cholesterol in the unbuckled newborn goats were about a third of those in their mothers at parturition [19]. We did not have access to reliable ARI for serum TG in goats. A gradual increase of TG concentration happened during the first week of life of calves [13]. The high concentrations of TG on the first days of life may be related to colostrums and milk intake because of their high chylomicrons and very low density lipoproteins (VLDL) content.

In this study, the maximum activities of ALP and GGT were recorded at the first sampling time. The higher activities of ALP and GGT have been demonstrated in goat kids [7, 9] and newborn calves [18, 21] previously. Although, GGT activity in goat’s colostrums is much lower than in cow’s, but elevation of GGT was demonstrated in suckling newborn kids and was considered as a good indicator for evaluating passive transfer status [7]. However, quality, quantity, and timing of colostrums feeding have an influence on the activity of GGT during the first few days of life. In addition to colostrums intake, the higher activity of ALP in growing goats may be related to Bone-ALP iso-enzyme [28].

Throughout this study, the activities of LDH and CK were above the ARI while the activities of AST were below the ARI. Our results are in accordance with the findings about goat kids [9, lambs [4] and calves [18, 21]. Considering the concurrent marked elevation of AST, LDH and CK serum activities at the first sampling time, muscle injury should be suspected during the birth process.

Significant variations of serum Ca and Pi concentrations have been noted with regard to age and these variables are higher in young goats compared with adults [28]. In this study, the serum concentrations of Ca was above the ARI, but decreased to the ARI after 10 days and the serum concentrations of Pi and Mg were almost equal to the upper and lower limits of the ARI, respectively. In calves, Ca and Mg concentrations were within ARI at 3 months of age; but Pi concentrations were above ARI after 14 days [21]. But serum concentrations of Ca and Pi in lambs were respectively below and above the ARI [4]. The higher amount of Pi in younger animals in comparison to adults was caused by growth hormone, which increases renal phosphate reabsorption [21], and also may be related to the composition of meals [4]. Enhanced Mg utilization for bone mineralization and also decreased availability of this element in ingested food result in decreasing trend of Mg during the first week of life in newborns [14, 20]. Ca is essential for bone formation in growing neonates and the higher amount of Ca is probably due to higher amount of milk intake that is the main source of Ca [14]. Throughout this study, serum Fe and Zn concentrations were in ARI and showed a biphasic trend; increasing trend was from birth until day 28 and decreasing was up to day 84. A similar trend has been observed in lambs and calves [4,21]. KONWLES et al. (2000) reported that the concentrations of iron in calves were below the ARI, but increased almost to the lower limit of the ARI by 83 days of age [18]. These differences may be due to the amount of body iron storage and iron content of diet [21]. Other studies revealed higher Zn concentration in young animals compared to adults [1, 2, 24] and stated that this could be related to the higher Zn- enzymes activities during high growth [1] and high Zn concentrations of colostrums [2]. In this study, low serum Cu concentration was observed in newborns compared to adults. There was a mild increasing trend in serum Cu concentration that was in agreement with previous reports [1, 2, 14]. The increased Cu concentration with age could be associated with colostral intake, an adequate supply of this trace element [3] and also increase of plasma ceruloplasmin [14].

During this study, Cl and Na concentrations were almost at the higher and lower limits of ARI, respectively. NJIDDA et al. (2013) found that serum concentration of Na and K in goat kids is higher than those in adults [23]. The serum concentration of electrolytes was within ARI in

lambs and calves [4, 21]. We found significant elevations in CI concentration on days 28 and 56 compared with the first sampling time. Selective increases in CI are often associated with metabolic acidosis or metabolic compensation for chronic respiratory alkalosis [12]. These acid-base disorders were not observed in the present study; therefore, the exact cause of this hyperchloremia is not clear. Considering the declining trend of Alb from day 28, reduction of albumin-related anions perhaps resulted in relatively higher plasma concentrations of CI [12].

BT concentration decreased significantly from birth until day 10 and then remained approximately stable up to day 84. Postnatal higher concentration of BT is associated with destruction of fetal RBCs in mononuclear phagocyte system and slower excretion rate of bilirubin due to lower concentration of ligandin protein in newborns [17]. In the present study, serum concentrations of Urea and Cre were below the ARI except in the first sampling time. The decrease in serum Cre and Urea concentrations during the first 10 days of life in neonates is in accordance with previous studies [4, 14] and may be associated with increased glomerular filtration rate [14]. Lower muscular mass in neonates may also result in lower Cre concentrations.

**Conclusion**

The results of the present study indicated that for most biochemical variables except K, Alb, Zn and Fe, specific age-related reference values are essential for proper interpretation of laboratory results in Saanen goat kids during the first three months of life.

**Acknowledgments**

This research was supported by the College of Veterinary Medicine, Ferdowsi University of Mashhad, Iran (Grant No 3/29137). We thank H. Barati for technical assistance.

**References**


2. - **AMOUOGHLI TABRIZI B., HASSANPOUR A., HAJJALILLOU S., SAFARMASHAEI S.**: Study on serumic levels of Zn on interim Holstein cows and their calves during colostrum nutrition. Advances in Environmental Biology., 2011a, 5, 1192-1194.


17. - **KLINKON M., JEZEK J.**: Values of Blood Variables in Calves, A Bird’s-Eye View of Veterinary Medicine, Dr. Carlos C. Perez-Marin (Ed.), 2012, 156, 301-320.

18. - **KNOWLES T.G., EDWARDS J.E., BAZELEY K.J., BROWN S.N., BUTTERWORTHA., WARRISS P.D.:**


