Comparison of artificial rearing systems using clinical and hematological parameters: A preliminary study

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ABSTRACT

Comparison of clinical and hematological profile of Anglo Nubian kids was performed under three different rearing systems. Animals were separated from their dams and rearing from birth until pre-weaning at 24 days of age. Kids were fed with goat milk, reconstituted cow powder milk and reconstituted cow powder milk with enrofloxacin in sub-therapeutic doses. Clinical exam and blood analysis were performed at 3, 10 and 21 days of treatment. As a result, body weight did not show significant differences between treatments. However, values of cardiac frequency, cholesterol, urea, serum alkaline phosphatase and segmented neutrophils (%) were higher than the reference values. These results could be explained considering the physiological state and age of the animals. During this experiment, the use of diet supplemented with enrofloxacin did not generate substantial benefits in the animals that received it. In addition, the use of antibiotics in farms needs to be reconsidered in order to avoid negative environmental effects.

Keywords: clinical-hematological parameters, kid goat, sucking period, antibiotic supplementation, artificial rearing.

RESUMEN

El uso de diferentes sustitutos lácteos es una práctica común en la crianza artificial de cabritos, sin embargo, no hay información suficiente sobre el impacto que
puedan tener tanto en el animal como en el ambiente. El objetivo de este estudio fue comparar los perfiles clínicos y hematológicos de cabritos de la raza Anglo Nubian bajo tres sistemas de alimentación diferentes. Al nacer, los animales fueron separados de sus madres y evaluados hasta el periodo de pre- destete (24 días). Los cabritos fueron alimentados con leche de cabra, leche de vaca (en polvo reconstituida) y leche de vaca (en polvo de reconstituida) con el agregado de enrofloxacina en dosis sub-terapéuticas. Sobre los animales ensayados se llevó a cabo un análisis clínico y hematológico a los 3, 10 y 21 días de iniciado el tratamiento. Como resultado se observó que la variable peso no presentó diferencias significativas entre los tratamientos. Sin embargo, los valores de frecuencia cardíaca, colesterol, urea, fosfatasa alcalina sérica, y neutrófilos segmentados (%) se encontraron por encima de los valores de referencia. Estos resultados pudieron ser explicados considerando el estado fisiológico y la edad de los animales. En conclusión, la suplementación de la dieta con enrofloxacina no generó un beneficio en los animales que la recibieron. Por otro lado, la utilización de antibióticos en los establecimientos productivos debe ser reconsiderada en orden de atenuar el efecto negativo en el ambiente.

Palabras clave: parámetros clínicos- hematológicos, cabritos, periodo de lactante, suplementación con antibióticos, crianza artificial.

INTRODUCTION

The most common system of goat production, in Argentina, is a subsistence economy under continuous grazing and meat production as the principal income of the stockmen (Guevara et al., 2009). However, over the last years, the government showed a special interest in dairy production. In this way, different types of policies and credits were implemented with a positive effect in the sector (SENASA, 2017). In goat dairy system, milk is used for the production of artisan cheeses and other by-products (Damian et al., 2008) being milk a critical factor to be utilized for feeding kids. Goat artificial rearing is a common practice in several countries, but in Argentina, it is used only in a few livestock farms. In general, methodologies of artificial rearing are based on local recommendations without any professional basis. For that reason, it is necessary to know if the artificial rearing methodology has a real impact on the health and growth of animals, especially, when antibiotics are incorporated as a productive tool such as prevention actions and growing promoters (Ghosh and LaPara, 2007; Allen et al., 2010; Hu et al., 2010; Chiesa et al., 2015; Van Boeckel et al., 2015). Most farmers choose broad-spectrum antibiotics to reduce morbidity such as oxytetracycline, penicillin, cephalosporin, sulfonamide, and fluoroquinolone. One of the most used is enrofloxacin for its antimicrobial activity against gram-negative bacteria, Mycoplasma spp., some gram-positive bacteria and organisms which have resistance to other antibacterial agents.
(Elmas et al., 2001; Ebert et al., 2011; Bearson and Brunelle, 2015). Sarkozy (2001) reported that the use of fluoroquinolones had no adverse effects if it is compared with its beneficial aspects. Fish (2001) described an association between the enrofloxacin use and some hematological abnormalities such as anemia, leukopenia and an increase or decrease of platelets with very low incidence (0.3 - 1 %). On the other hand, biochemical and hematological variables are often used to monitor and evaluate the health, nutritional and physiological ruminant state (Al-Eissa et al., 2012; Scarpino et al., 2014; Mohammed et al., 2016). In this context, these evaluations could be performed in order to determine nutritional efficiency of additives and foods supplied to animals (Akingbade et al., 2002, Belewu and Ogunsola, 2010) and their immunological state (Al-Seaf and Al-Harbi, 2012). The aim of the present study is to compare three alternatives of artificial rearing in goat through the evaluation of clinical-hematological parameters.

**MATERIAL AND METHODS**

Animal, management and treatments: All experiment procedures and animal care practices were in agreement with the Institutional Committee for Care and Use of Laboratory Animals (Comisión Institucional para el Cuidado y Uso de Animales de Laboratorio - CICUAL). Eight Anglo Nubian kids were selected from the campus of Veterinary Faculty of the Buenos Aires University. Goat kids were separated from their dams after birth and were fed with colostrum during first-day of life. All of them were classified as healthy without abnormalities and identified with a plastic-tag in their ears (Rotatag®). Goat kids were placed in indoor pens of 12 m² bedded with wood shavings. Kids were divided into three treatments according to treatment applied. The first group, defined as the control group (T1; n=2) was artificially fed with goat milk obtained from their dams, for comparison. In the second group (T2; n=3), kids received reconstituted cow powder milk in a relation of 150 g of powder per litter of suspension. Finally, kids of the third group (T3; n=3) were fed with reconstituted cow powder milk (in the same proportion than before) supplemented with enrofloxacin (Enromax®- Richmond). Enrofloxacin was added to powder milk in a relation of 17 to 35 mg/ 1500 mL (depending on animal weight during the experiment). In all cases, milk was previously tempered at 40 °C and administrated by a sucking bucket (milk composition is provided in Table 1). Tap drinking water was always available *ad libitum*. This study was performed for twenty-four days in the pre-weaning stage of ruminant where the basic feed is milk.

Sampling and analyses: Goat kids were weighed at birth and body weight was registered weekly. A clinical examination that included determination of cardiac (hear rate, HR; beats per minute) and breathing frequencies (BR; breaths per minute), mucous membrane color, capillary filling time, lymph nodes, sensory and rectal temperature was performed regularly.
Table 1
Composition of feedstuffs offered to goat kids

<table>
<thead>
<tr>
<th>Composition</th>
<th>Cow powder milk</th>
<th>Goat Milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude protein</td>
<td>3.12</td>
<td>3.28</td>
</tr>
<tr>
<td>Fat</td>
<td>3.25</td>
<td>6.40</td>
</tr>
<tr>
<td>Lactose</td>
<td>4.37</td>
<td>4.92</td>
</tr>
<tr>
<td>ME MJ/Kg a</td>
<td>2.78</td>
<td>4.04</td>
</tr>
</tbody>
</table>

aMetabolizable energy (ME) of milk estimated according to the equation: MJ/ Kg= 1.4694 + (0.4025 X milk fat %) (Lama et al. 2014).

Blood samples were collected before the morning feeding by jugular venipuncture at 3 and 21 days of life. Non-anticoagulant and anticoagulant (ethylenediaminetetraacetic acid) tubes were used to collect blood samples. These were placed on ice immediately after collection and transported to the laboratory for further analyses.

Blood assays were performed according to the methodology from Handin et al. (2003). Hematocrit values were determined using microhematocrit capillary tubes, hemoglobin concentration was estimated by a spectrophotometer (Metrolab 1600), white blood cell, neutrophils, and lymphocytes were determined by manual methods. In serum samples, total protein was determined by refractometer, while albumin, urea, creatinine, cholesterol, glutamine-pyruvate transaminase (GPT), glutamic-oxaloacetic transaminase (GOT), and serum alkaline phosphatase (ALP) were determined by spectroscopic measurements (Auto-Analyzer Metrolab 2010).

Statistical analysis: Statistical analysis was performed using statistical software InfoStat 2016 (Di Rienzo et al., 2016). Particularly, a multivariate analysis of principal components was employed for biochemical and hematological variables to identify those that are able to explain the major variability between individuals. Analysis of goat’s weight for the several diets was performed applying Wilcoxon tests.

RESULTS

Figure 1 shows the average body weight of goat kids taking at initial and final time of each treatment. During this trial, it was observed an increment in the body weight regarding the birth weight, as is expected. Average calculated values were 45%, 45% and 49% for groups feeding with goat milk, cow powder milk and cow powder milk supplemented with enrofloxacin, respectively. The Wilcoxon test analysis did not show
any significant differences regarding the different kind of feeding (p> 0.05). Additionally, clinical exam of animals at 3, 10 and 21 days of life was performed to monitor the health status and response to the different diets. In the three groups of animals was observed that cardiac frequency values were ranging from to 150 to 190 beats per minute that were higher than the previously reported in the literature (see Table 2). On the other hand, the cardiac frequency values decrease with the goat growth in the observed period of time. Also, some differences were noticed between the applied treatments, particularly, the addition of enrofloxacin to the diet has caused the lower heart rate values.

Fig.1. Average weight of goat kids and initial (■) and final (■) time breading with goat milk (GM), cow powder milk (CM) and cow powder milk added with enrofloxacin (CME). Error bars are SE.

In a similar way, most of breathing frequency values, registered in this experiment, were ranging below the references values reported by Terra and Reynolds (2014). Therefore, the analyses of breathing frequency data will be regarding the control group. As a principal result there is a difference in the tendency of the values for the control group regarding the T2 and T3. Particularly, the breathing rate, in T1, showed a slight decrease with the goat growth while for T2 and T3 a strong increase was observed.

In the case of temperature, the values remained relatively constant during the experiment and were in the range reported by Nagy and Pugh (2012). From these measurements a little diminution was observed with the time of life of kids during this experiment in all treatment.

Table 2
Average of clinical parameters (±SE) of kids feeding by artificial rearing evaluated at 3, 10 and 21 days.

<table>
<thead>
<tr>
<th>Clinical parameter</th>
<th>Period evaluated / days</th>
<th>Treatment</th>
<th>3</th>
<th>10</th>
<th>21</th>
<th>Reference values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate</td>
<td></td>
<td>T1</td>
<td>192 ± 8</td>
<td>190 ± 10</td>
<td>172 ± 8</td>
<td>120 -160 beats per minute</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T2</td>
<td>192 ± 8</td>
<td>184 ± 18</td>
<td>161 ± 20</td>
<td>(Terra and Reynolds 2014)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T3</td>
<td>179 ± 5</td>
<td>175 ± 8</td>
<td>151 ± 5</td>
<td></td>
</tr>
<tr>
<td>Breathing frequency</td>
<td></td>
<td>T1</td>
<td>38 ± 2</td>
<td>34 ± 6</td>
<td>32 ± 8</td>
<td>40 - 65 breaths per minute</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T2</td>
<td>29 ± 4</td>
<td>46 ± 13</td>
<td>41 ± 12</td>
<td>(Terra and Reynolds 2014)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T3</td>
<td>25 ± 1</td>
<td>48 ± 4</td>
<td>33 ± 5</td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td></td>
<td>T1</td>
<td>40.0 ± 0.1</td>
<td>39.0 ± 0.3</td>
<td>39.0 ± 0.2</td>
<td>38.0-40.0 ºC (Nagy and Pugh 2012)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T2</td>
<td>40.0 ± 0.1</td>
<td>40.0 ± 0.1</td>
<td>39.0 ± 0.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>T3</td>
<td>40.0 ± 0.1</td>
<td>40.0 ± 0.2</td>
<td>39.0 ± 0.1</td>
<td></td>
</tr>
</tbody>
</table>

T1: goat milk, T2: cow powder milk, T3: cow powder milk added with enrofloxacin.

In Tables 3-4 the principal hematological parameters from kids are presented. Hematocrit values have shown a slow decrease in the studied time, and the registered values for both T2 and T3 treatment have shown to be lower compared with the control ones. However the entire data set are according with the previously reported reference values. Hemoglobin, albumin and total proteins values were already constant during the trial time and for the different applied treatments. Also, hemoglobin and albumin data were according to reference values (8-12 g/dL; 2.7-3.9 g/dL; respectively) while protein data were lower compared with the reference ones. A different situation was observed for the cholesterol results were the obtained values for the control group resulted higher than the reference data (80-130 mg/dL). In T2 and T3 an increase of cholesterol concentration was observed with the time. Although the values are included in the reference range, they are located near to the superior limit.

White blood cell values have shown an increase in the studied time for all the treatments; although only kids from T1 showed higher values than reference values at the end of the experiment.

Segmented neutrophils (%) and lymphocytes (%) have shown an inverse relationship with the trial time. In the case of segmented neutrophils (%) values were higher and overcoming the reference values (30 - 48%), at the beginning of experiment. Nevertheless, at the end of studied time values were closely to lower limit. The opposite situation was observed for the lymphocytes (%) values. In that case, values were lower than the reference data at the beginning. However, in subsequent sampling, lymphocytes
Values were higher and within the range (50 – 70%). Absolute account for lymphocytes and neutrophils have shown the same relation explained before. A greater difference with lymphocytes values were observed in sample time, whereas a smaller difference was obtained with neutrophils values.

Urea and creatinine values have shown a slow diminution in the studied time in control group. Most of urea values were included in the reference range (12-26 mg/dL) but they are located near to the superior limit while creatinine values were according to reference (0.6- 1.60 mg/dL). In T2 treatment, urea values were higher at the beginning and then were within the reference values in the subsequent sample (contrary to the others treatments). For creatinine values, T2 and T3 treatment, showed a low diminution at 21 days of life when they are compared with initial sample time, though the entire data set are according to the previously reported reference values. Values of GPT were already constant during the trial time with a little increased at the end of the sample time. Instead of values of GOT, were increased at the the end of the experiment, except for T2, where a diminution were observed. Nonetheless, data set were according to reference values in all different applied treatments. A different situation was observed for serum alkaline phosphatase results where the obtained values were higher than the reference data during this trial.

### Table 3

Hematological parameters of kids feeding by artificial rearing evaluated at 3 and 21 days

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Hematocrit</th>
<th>Hemoglobin</th>
<th>Total Protein</th>
<th>Albumin</th>
<th>Cholesterol</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>g/dL</td>
<td>g/dL</td>
<td>g/dL</td>
<td>mg/dL</td>
</tr>
<tr>
<td>Days</td>
<td>3</td>
<td>21</td>
<td>3</td>
<td>21</td>
<td>3</td>
</tr>
<tr>
<td>Treatment 1</td>
<td>30 ± 6</td>
<td>29 ± 3</td>
<td>10 ± 2</td>
<td>10 ± 1</td>
<td>5.0 ± 0.1</td>
</tr>
<tr>
<td>Treatment 2</td>
<td>27 ± 2</td>
<td>25 ± 1</td>
<td>8.0 ± 0.6</td>
<td>8.0 ± 0.2</td>
<td>6.0 ± 0.5</td>
</tr>
<tr>
<td>Treatment 3</td>
<td>28 ± 2</td>
<td>25 ± 1</td>
<td>9.0 ± 0.6</td>
<td>8.0 ± 0.2</td>
<td>5.0 ± 0.1</td>
</tr>
<tr>
<td>Reference values*</td>
<td>22 - 38</td>
<td>8.0-12.0</td>
<td>6.4-7.0</td>
<td>2.7 - 3.9</td>
<td>80 -130</td>
</tr>
</tbody>
</table>

Treatment 1: goat milk, Treatment 2: cow powder milk, Treatment 3: cow powder milk added with enrofloxacin. Errors are SE.* Nagy and Pugh 2012.

The analysis of principal components was performed in order to explain the total variability of the 18 variables studied. The first four principal components (PC) explained...
approximately 73% of the total variance, with 32% explained by the first component (Figure 2). The variables that contributed most to the formation of the spatial gradient of the PC 1 scores were lymphocytes (%) (Eigenvector= 0.39), neutrophils (%) (Eigenvector= -0.38), lymphocytes (lymphocytes, cells / mm$^3$) (Eigenvector= 0.37) and weight (Eigenvector= 0.35). The second component (PC 2) explained 18% of the total variability with the most important variables being hematocrit (Eigenvector= 0.50), hemoglobin (Eigenvector= 0.48) and albumins (Eigenvector= 0.34) (Figure 3). In the plot, an association between neutrophils and animals in the initial state (N2T2, N2T3, N1T1, N1T2, and N3T3) were observed. Lymphocytes (%) and weight associated with animal N4T3 and lymphocytes (lymphocytes, cells / mm$^3$) associated with N3T2, N1T1, N3T3. Additionally, an association between animal N4T1 with hematocrit and the same animal with hemoglobin in the final state was observed.

Fig. 2. Biplot of the first two main components (PC) based on the 18 variables studied, PC 1 vs PC 2. The squares represent the treatment one, the triangles the treatment two and the circles the treatment three. In all cases, the full figure (black) is the initial period and the empty figure (white) is the final period.
Table 4
Hematological parameters of kids feeding by artificial rearing evaluated at 3 and 21 days

<table>
<thead>
<tr>
<th>Parameters</th>
<th>WBC (/mm³)</th>
<th>Segmented neutrophils (%)</th>
<th>Segmented neutrophils (/mm³)</th>
<th>Lymphocytes (%)</th>
<th>Lymphocytes (/mm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days</td>
<td>3</td>
<td>21</td>
<td>3</td>
<td>21</td>
<td>3</td>
</tr>
<tr>
<td>Treatment 1</td>
<td>7550 ± 1300</td>
<td>15900 ± 1500</td>
<td>61 ± 20</td>
<td>34 ± 5</td>
<td>4920 ± 2300</td>
</tr>
<tr>
<td>Treatment 2</td>
<td>7450 ± 310</td>
<td>11966 ± 1075</td>
<td>63 ± 7</td>
<td>42 ± 3</td>
<td>4805 ± 780</td>
</tr>
<tr>
<td>Treatment 3</td>
<td>9800 ± 700</td>
<td>12033 ± 720</td>
<td>65 ± 12</td>
<td>39 ± 5</td>
<td>6189 ± 870</td>
</tr>
<tr>
<td>Reference values*</td>
<td>4000-13000</td>
<td>30-48</td>
<td>1200-7200</td>
<td>50-70</td>
<td>2000-9000</td>
</tr>
</tbody>
</table>

Treatment 1: goat milk, Treatment 2: cow powder milk, Treatment 3: cow powder milk added with enrofloxacin, WBC: White blood cell; * Nagy and Pugh 2012.
Errors are SE.

Table 5
Average of biochemical parameters (±SE) of kids feeding by artificial rearing evaluated at 3 and 21 days

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Urea (mg/dL)</th>
<th>Creatinine (mg/dL)</th>
<th>GPT (UI/L)</th>
<th>GOT (UI/L)</th>
<th>ALP (UI/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days</td>
<td>3</td>
<td>21</td>
<td>3</td>
<td>21</td>
<td>3</td>
</tr>
<tr>
<td>Treatment 1</td>
<td>27 ± 2</td>
<td>34 ± 18</td>
<td>0.74 ± 0.08</td>
<td>0.83 ± 0.12</td>
<td>21 ± 6</td>
</tr>
<tr>
<td>Treatment 2</td>
<td>38 ± 6</td>
<td>24 ± 2</td>
<td>0.87 ± 0.02</td>
<td>0.62 ± 0.15</td>
<td>21 ± 4</td>
</tr>
<tr>
<td>Treatment 3</td>
<td>27 ± 5</td>
<td>30 ± 5</td>
<td>0.76 ± 0.13</td>
<td>0.68 ± 0.06</td>
<td>19 ± 6</td>
</tr>
<tr>
<td>Reference values*</td>
<td>12-26 (Jackson and Cockcroft 2002)</td>
<td>0.60-1.60 (Jackson and Cockcroft 2002)</td>
<td>15 - 52</td>
<td>66 - 230</td>
<td>93 - 387 (Christian and Pugh 2012)</td>
</tr>
</tbody>
</table>

Treatment 1: goat milk, Treatment 2: cow powder milk, Treatment 3: cow powder milk added with enrofloxacin.
The third axis (PC 3) explained 14% of the variability with the most important parameters being GOT (Eigenvector= 0.59), total protein (Eigenvector= 0.48) and urea (Eigenvector= 0.38). Finally, the fourth component explained 9% of the variability with the most significant variables being breathing rate (Eigenvector= 0.54), heart rate (Eigenvector= 0.50) and creatinine (Eigenvector= 0.40). According to the third and fourth component, an association between total protein and the animal N2T2, and also urea with animals N2T3 and N4T3 were observed, In addition, heart rate and creatinine are associated with animal N2T2 (Figure 3). The cophenetic correlation coefficient was 0.915 for this study.

Fig.3. Biplot based on the 18 variables studied, PC 3 vs PC 4. The squares represent treatment one, the triangles treatment two and the circles treatment three. In all cases, the full figure (black) is the initial period and the empty figure (white) is the final period.

DISCUSSION

In this study, three diets were compared in order to estimate which one is the most appropriate to be used for artificial rearing in goats. Body weight could be an important tool to evaluate the growth rate and viability of diets. In this trial, there were no significant differences in weight between groups of animals, although the T3 group weight range were slightly more than the others groups. However, data suggest an extension of the experiment. The physiological state of animals can be determined by their clinical and hematological parameters (Khan and Zafar, 2005, Etim et al., 2014), providing information on diagnosis and prognosis of different diseases (Olafadehan, 2011). Most of the neonate's parameters differ from the adult because of changes related to age and colostrum intake (Ježek et al., 2006), as is the case of heart rate. That could explain why reference values differ from the taking ones. Despite values of heart rate, tachycardia should be considered normal in young animals, in rumination, lactation or
the last gestation period (Nagy and Pugh, 2012). Data shown higher heart rate values at few days of life with a diminution afterwards. Furthermore, according to Terra and Reynolds (2014), in the absence of pathologies heart rate returned to normal with the animal at rest. Total serum proteins could be influenced by changes in protein intake, whereas albumin values are an indicator of long-term dietary deficiencies (Atasoglu et al., 2008, Piccione et al., 2011). At birth, serum protein concentration is usually low due to lower levels of immunoglobulin and albumin present in the blood of neonates (Allison 2012a), these agree with the results of the present trial. In the case of albumin values, these remained relatively constant from birth to the end of the experimental period within reference values. Plasmatic cholesterol values were higher than reference ones, though according to Öztabak and Özpinar (2006), high values are normal in this category of animals due to the consumption of colostrum.

In relation to ruminant hematological profile, there are physiological changes regarding the age of the animals and also the species. In sheep and cattle, neutrophils (N) outgrow lymphocytes (L) at birth until the first week of life when a reverse relationship is observed (Morris, 2014). In goats this relationship is observed until adulthood where since then N: L ratio remains at 1:1 (Jones et al., 2012). Data obtained were in concordance with the reference before for the three feeding treatments. The neutrophil counts tended to be higher than the reference values at the first sampling point, but at the subsequent sampling, they modified and acquired values within the range. That could show that animals have had an active immune system during this study (Beléwù and Ojo-Alokornaro, 2007); besides animals fed with enrofloxacin had no direct effects on lymphocyte proliferation or proliferation of bone marrow progenitor cells, in agreement with other studies (Manzella and Clark, 1988; Brown, 1996).

Urea may come from a dietary intake or from a rumen reentry through the ruminal epithelium (Lérias et al., 2015), being the main source of nitrogen for ruminants. Otherwise, creatinine plays an important role in energy metabolism because it is a rapid source of high-energy phosphate via the enzymatic creatinine kinase pathway, which may be related to renal function and body mass (Brosnan and Brosnan, 2010). In this study, creatinine values were within reference range (0.60-1.60 mg/dL). This is important because creatinine increases are related to a negative energy balance in malnourished animals where weight loss and mobilization of adipose tissue and muscle protein is characteristic (Lérias et al., 2015).

The enzymatic values were within the reference range except for ALP enzyme. ALP was increased in all three treatments. At few days of life, values of enzyme were due to the absorption of colostrum (Blum and Hammon, 2000); but subsequent increase was related with endogenous sources such as the bone tissue of growing animals (Zanker et al., 2001). The increase associated with an increase in osteoblastic activity occurs in all
species. Results were accord with Allison (2012b) where values of growth animals were higher than obtained from adult reference intervals (93-387 UI/L).

The use of enrofloxacin in young animals has been questioned for its toxic effects on chondrocytes of canine, horse, and birds (Khazaeil et al., 2012). However, there is little information related to ruminants. The toxicity of fluoroquinolones is largely dose and dependent species (Bertino and Fish, 2000). Most of the reactions are considered to be of low severity and reversible upon discontinuation of treatment. In goats, pre-stomachs are poorly developed and relatively nonfunctional in neonates (Waxman et al., 2004).

The development of the digestive tract could contribute to the increase in the volume of distribution of the different drugs with the age. This is the case of non-ionized compounds, with good lipid solubility, which passes through a passive diffusion mechanism through the ruminal epithelium. Therefore, considering the great capacity of digestive structures in adult goats, fluoroquinolones could diffuse and accumulate passively into the rumen when they are administered parenterally (Gonzalez et al., 2001, Waxman et al., 2004). The use of oral repeated doses in sheep and cattle had minimal effect on the ruminal flora, due to low activity against protozoa, streptococcus or anaerobic bacteria presented by enrofloxacin and its metabolite (Flammer et al., 1991; Gandolf et al., 2005).

The use of this antibiotic is associated with hematological abnormalities such as increases in hepatocellular enzymes (GPT and GOT) and decreases in hematocrit (Brown, 1996). In dogs administration of enrofloxacin for 14 days did not cause significant changes in hemoglobin concentration (Traş et al., 2001), but there is a frequency of 2-3% in the elevation of liver enzymes such as GPT and GOT in those animals. This increase cannot be observed in the present study despite the fact that one of the animals in the enrofloxacin group has higher GOT values in relation to the rest, but this value is within the reference values.

In summary, hematological and biochemical parameters serve as indicators of the physiological and dietary status of animals. In this experiment, there were no differences in the weight gain of the three diets studied, so that, milk powder could be used as a replacement for goat's milk in animals under artificial rearing. In relation to the diet added with enrofloxacin, although it did not generate substantial changes in the animals that received it, its incorporation should be avoided for not having an additional advantage compared with animals that did not consume it. Moreover, the use of antibiotics in farms needs to be revisited in order to avoid negative environmental effects due its use and deposition.

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