Evaluation of Serum Calcium, Magnesium and Phosphorus During Various Stages of Gestation in Dairy Cattle Under Temperate Conditions

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Abstract

The objective of this study was to determine blood levels of calcium, magnesium and phosphorus in crossbred cows (n=42) during various stages of gestation. The experimental cows were assigned to three groups: Group A (n=14) including clinically healthy early gestation (1-3 months) cows, Group B (n=14) comprising clinically healthy cows in mid gestation (4-6 months) and Group C (n=14) made up of clinically healthy cows in late gestation (7-9 months). Blood samples were collected from harvesting serum which was analysed for calcium, magnesium and phosphorus using commercially available kits. Serum calcium levels showed a gradual decrease from 10.23±0.48 mg/dl in early gestation to 9.64±0.34 mg/dl in late gestation which can be attributed to increased demand for fetal skeletal tissue development in late gestation. Serum concentrations of phosphorus varied significantly during various stages decreasing from 6.03±0.29 mg/dl in early gestation to 5.17±0.25 mg/dl in late gestation. The magnesium levels fall from 1.81±0.24 mg/dl in early gestation to 1.67±0.11 mg/dl in late gestation, however difference in concentration was not significant in any of the stages. Fall in levels of all three minerals indicates there is an increased demand for these macro minerals as the gestation progresses which need to be supplemented.

Introduction

Minerals are indispensable for normal growth, reproduction and health of the animals. They are required for growth of the most organs and particularly mineralization of the bone network. The distribution and status of various minerals varies with different physiological conditions like stage of growth (neonatal period, pre and post pubertal period), pregnancy and lactation [1]. Although the physiological functions of the minerals (eg., Ca, P etc.) have been studied since 19th century [2], still it has been observed that the blood biochemistry of indigenous and their crossbred animals have not been investigated adequately.

Pregnancy and lactation are the two major physiological conditions which considerably modify metabolism in animals especially of minerals [3, 4]. The periparturient period is important as it influences the health and the subsequent performance of dairy cows [5]. The phase of transition between late pregnancy and early lactation presents a huge metabolic challenge especially to the high-yielding dairy cow [6]. During immediate postpartum period high rates of body condition score losses are associated with a severe negative energy balance status, indicated by alterations in blood metabolite and hormone profiles [7].

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Like all species dairy cattle require minerals such as calcium (Ca), magnesium (Mg), and phosphorus (P) for growth, reproduction and lactation, which often affect specific requirements, and are mostly catalytic components of enzymes or regulate mechanism involved just in pregnancy and lactation [4, 8]. Especially at the beginning of lactation, Ca homeostatic mechanisms have to react to a tremendous increase in demand for Ca due to huge losses in milk. Mobilization of Ca from bone and increased absorption from the gastrointestinal tract are required to re-establish homeostasis [9]. So, if it is well known that cows need, especially for the high milk yield, more nutrients and energy supply than other animals [10], little information is available about how this need affects the physiological phase. Our study attempts to provide a picture of dynamics of selected biochemical parameters in dairy cows during various stages of gestation, with the aim of providing new and useful information about the guidelines for the management strategies during these phases.

Materials and Methods

The study was carried out on forty two Crossbred dairy cows ranging about 6 to 9 years of age in good nutritional condition selected from Mountain Livestock Research Station for cattle, Manasbal. During the trial, all animals were kept under natural photoperiod and ambient temperature. All animals were free from parasitic infections confirmed by coprologic examination carried out, using the flotation method, before experimental period. Also no treatments were administered before the start of the experiment. These 42 cows were divided into three groups as per their gestation period as-early, mid and late, with 14 cows in each group.

i. Early gestation (1-3 month)

ii. Mid gestation (4-6 month)

iii. Late gestation period (7-9 month)

Blood collection and serum harvesting

All samples were obtained in the morning by jugular vein puncture from each animal into vacuum glass tubes without anticoagulant, with a 16G needle. After clotting the serum was separated by low speed centrifugation (1600 g for 15 min), transferred in plastic vials and forwarded for biochemical analysis.

Estimation of Ca, Mg and P

The serum levels of Ca, Mg and P were estimated using standard kits (Erba Mannheim Pvt. Ltd) and reading the reaction mixtures by Auto Analyser at wavelength recommended on individual kits.

Results and Discussion

There was gradual a decrease of the serum Calcium from 10.23±0.48 mg/dl in the early gestation to 9.92±0.44mg/dl in the mid and then 9.64±0.34mg/dl in late gestation (Figure 1), however the difference was not statistically significant at three stages (Table-1). Similar findings were observed by Tainturier [11] and Sivaiah et al. [12]. A decline in calcium level during late gestation has also been reported by Sahukare et al. [13]. This may be attributed to increased level of estrogen during this period which favours deposition of Ca in bones, thereby lowering blood calcium levels [14]. Sansom et al. [15] in a study conducted on pregnant sheep reported that serum Ca concentration reached its minimum 3-4 weeks before lambing which could be attributed to increased demand for calcium for mineralization of foetal skeleton.

![Figure 1: Serum Calcium levels in various stages of gestation](image)

Table 1: Serum levels in various stages of gestation

<table>
<thead>
<tr>
<th>Group</th>
<th>Gestation Period</th>
<th>Ca(mg/dl)</th>
<th>Mg(mg/dl)</th>
<th>P(mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Early Gestation (1-3 month)</td>
<td>10.23±0.48*</td>
<td>1.81±0.24*</td>
<td>6.03±0.29*</td>
</tr>
<tr>
<td>II</td>
<td>Mid Gestation (4-6 month)</td>
<td>9.92±0.44*</td>
<td>1.77±0.11*</td>
<td>5.52±0.21*</td>
</tr>
<tr>
<td>III</td>
<td>Late Gestation (7-9 month)</td>
<td>9.64±0.34*</td>
<td>5.17±0.25*</td>
<td>5.17±0.25*</td>
</tr>
</tbody>
</table>

Values with similar superscript don’t differ significantly (P<0.05)
Serum phosphorus levels at early, mid and late gestation were 6.03±0.29 mg/dl, 5.52±0.21 mg/dl and 5.17±0.25 mg/dl respectively (Figure 2). The concentration of phosphorus varied significantly during early, mid and late gestation (Table-1). These results are concurrent with the results of Sahukare et al. [13] and McAdam and O’Dell [16], who reported that there is a decline in serum phosphorus levels during late gestation. On the contrary Sivaiah et al. [12] reported non-significant variation in the P level during various stages of gestation. A significant fall of phosphorus levels during late gestation may be attributed to increased carbohydrate metabolism during late pregnancy [13] or may be due to meeting requirement of the P for the secretion of colostrum [17]. Also milk phosphorus output is directly related to milk yield, as milk phosphorus concentration is constant [18]. In fact, increasing the milk production, more phosphorus from the ingested amount is transferred to milk and less is excreted with faeces [18].

Figure 2: Serum Phosphorus levels in various stages of gestation

There was gradual decrease in the serum magnesium level, as gestation period progresses (Figure 3) being 1.81± 0.24 mg/dl in early, 1.77± 0.21 mg/dl in mid and 1.67±0.11 mg/dl in late gestation, but the difference in serum level of magnesium at various stages was non-significant. Sarmah et al. [19], observed lower Mg concentration in heifers than in pregnant cows, but Cakla and Albrycht [20] did not observe appreciable change in Mg concentration during gestation. Vihan and Rai [21] also observed level of Mg was lowest during prepartum in ewes while in goats there was no significant difference between prepartum, partum and postpartum stages.

Figure 3: Serum Magnesium during various stages of gestation

Conclusion
Thus, it is concluded from the present study that there is a gradual decrease in all three minerals viz, Ca, Mg & P and they need to be supplemented in feed especially during later gestation as they perform vital functions in this period.

References


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