

Study of Variation in Phosphocalcic Metabolism during Pregnancy and Postpartum in the Holstein Cow of Constantine Region

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Abstract: Pregnancy, parturition, and lactation represent physiological changes of organism, which activates adaptation mechanisms dedicated to maintain homeostasis during peripartum period. Despite of the appropriate input of calcium and phosphorus, the homeostasis of phosphocalcic metabolism is sometimes faulty, in particular among animals with high production potential. The aim of this study is to define usual values of calcium and phosphorus during pregnancy and postpartum period. This paraclinic tool will serve to a good interpretation when used by veterinarians. A second goal is to study the influence of physiological stage on phosphocalcic metabolism in milch cow. The hereby study was conducted on 17 Prim' Holsteins cow breed from 3 to 5 years old, clinically healthy, multiparous and derived from two dairy farms located in the wilaya of Constantine. Blood samples were taken from the jugular vein using dry tubes at different physiological stages (early gestation, mid gestation, late gestation, pre-partum, one day after parturition, and one month postpartum). All of the samples correctly identified were transported to a specialized laboratory where specific kits were used. Blood calcium and phosphorus levels have significantly varied depending on physiological stage ($p < 0.01$). They showed a high pre-partum variation, with a rate of 94.71 mg/mL and 61.99 mg/mL, respectively. These results can be used as means of follow-up reproduction for a better management of dairy farming.

Key words: Calcium Blood level, phosphorus blood level, milch cow, gestation, postpartum.

1. Introduction

The cow has always and still been the preferential and principal resource of milk, which constitutes a commodity-type product in the Algerian consumption model. It represents 22% of the global food import of the country Algeria which is the world's second largest milk and dairy product importer [1].

The issue of Milk indeed never left the Algerian diaries since independence. Obviously, many efforts had been made by the different actors of the sector and made of the consumption per habitant per year the highest of Maghreb's country's today [2]. Milk production and reproductive performances are two

major determinants of milch cow's profitability. The goal of each farmer is to have one calf and one lactation per year. That requires a good mastering of reproduction in both zootechnical and medical prophylactic fields.

Gestation, parturition, and lactation represent physiological changes of organism. In cow, parturition is normally associated with a hypocalcaemia and a hypophosphatemia that give clinical manifestation of milk fever when they are very marked.

99% of the calcium is contained in the skeleton. The remaining percentage has several roles such as blood coagulation, enzyme activation, and neuromuscular activity.

A 500 kg cow has 8 to 10 g extracellular calcium, of

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which 2.5 to 3 is in plasma. Phosphorus is found in phosphoproteins, phospholipids, nucleic acid, ATP to mention but a few. The phosphocalcic ratio (CA/P) in bones is equal to 2. There is therefore less phosphorus than calcium in bones (70 to 80%) [3], but phosphorus part in organic liquids and soft tissues are relatively large (20 to 25%). Phosphorus concentration in muscles is 2 to 3 g/kg while calcium's is only 0.1 g/kg. This explains why a chronic shortage of calcium stays clinically insidious for a long time, even if it may lead to skeletal disorders. On the contrary, phosphorus deficiency in young animals leads faster to a poor general state and slow growth; it is after a long time deficiency that skeletal disorders appear [4].

Phosphocalcic profile is a diagnosis tool used by veterinarians all over the world for a better identification of health problems causes observed in milch cows.

In our country, this is not the major concern of our practitioner colleagues, because in order to take advantage of the paraclinical tool this one must be well mastered. It is within this particular framework that our study takes place. It's time for the practitioner veterinarian to be informed of phosphocalcic disorder before the clinical signs began.

The aim of our study is to contribute to make available to practitioner veterinarians typical values of calcium and phosphorus in cow during gestation and postpartum.

2. Material and Method

2.1 Animals

The hereby study was conducted on 17 Prim' Holsteins cow breed from 3 to 5 years old , with a calving level of 2 to 3 from two different dairy farms located in the wilaya of Constantine (Algeria). The choice of the farms was based on the presence of cows at different reproduction stages (heifer, pregnant cow, and lactating cow).

The cows used in this study were selected on the following criteria:

- Animals stated clinically healthy
- Cows that clinically shows a healthy genital tract

The study lasted 12 months (from September 2014 to August 2015).

2.2 Blood Sampling

After disinfecting the neck, the sample is taken from the jugular vein using a 5 mL syringe and placed in dry tubes. A detailed identification of cows is reported on an individual data sheet (cow's number, physiological stage, sampling date and name of the exploitation). Sampling tubes were immediately placed in a cooler and forwarded to a specialized laboratory. They were first left at room temperature for 2 h for coagulation time and then centrifuged at 3000 rpm for 10 minutes. After centrifugation, serum is collected using a micropipette then stored in small 4 mL sterile tubes.

All samples were realized in the early morning (between 8 and 9 AM). A PICTUS 200 (Diatron GROUP, Vienna Austria) semi-automated machine as employed for calcium and phosphorus assays using SPINREACT kit (Zaragoza, Spain) by colorimetric method.

2.3 Statistical Analysis

The statistical analysis of data was realized using the Minitab 15 software which allows the determination of means and standard deviations for quantitative variables. It also supplies the probability P of significance with the ANOVA test. The ANOVA's analysis was used to determinate the effect of physiological stage on the studied blood parameters. The comparisons were considered meaningful at the 5% limit.

3. Results and Discussion

3.1 Results

Table 1 shows the mean and standard deviation's values of calcium and phosphorus in different stages of the study.

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Table 1 serum calcium and phosphorus concentration as a function of physiological stage.

Variable	BG	MG	EG	PR	PS1	PS2	Value of <i>p</i>	Signification of exponents
Ca (mg/L)	89.88	79.78	87.98	94.71	86.21	104.78	0.000	a*, b ^{NS} , c*, d ^{NS} , e ^{NS} , f**, g ^{NS}
P (mg/L)	67.29	57.17	43.82	61.99	55.52	117.34	0.000	a*, b**, c**, d ^{NS} , e*, f**, g ^{NS}

BG: beginning of gestation, MG: middle of gestation, EG: end of gestation, PR: prepartum, PS1: one day of post partum, PS2: one month of post partum. a: cow in beginning of gestation VS cow in middle of gestation; b: cow in beginning of gestation VS cow in end of gestation; c: cow in middle of gestation vs. cow in end of gestation; d: cow in beginning of gestation (BG) vs. cow in pre-partum (PR), e: cow in beginning of gestation (BG) vs. cow in post partum 1; f: cow in beginning of gestation (BG) vs. cow in post partum 2; g: cow in pre partum vs. cow in post partum 1. *: $p < 0.05$ significant variation; **: $p < 0.01$ very significant variation; NS: non-significant.

The results reported in Table 1 indicate the significant effect of the physiological stage on the variation of plasma calcium and phosphorus values.

3.2 Discussion

Minerals, notably calcium and phosphorus depend on dietary intake in quantity and quality. The main source is formed by plants ingested at pastures; the second source is bone resumption. They are essential and take action in several biological process notably reproduction. An appropriate intake of calcium results in an acceleration of uterine involution and a resumption of ovarian cyclicity [5].

The plasma concentration of calcium is close to the dependency of endocrine control, which is likely to mask the effects of short-term changes in dietary intakes [6].

Phosphorus deficiencies are classically invoked in fertility disorders in dairy cows. When the phosphoric deficiency exceeds 50% of the need, there is an increase in the frequency of repeat-breeding, ovarian cysts, and anoestrus [7]. The phosphorus content is not subjected to an endocrine control as strict as that of serum calcium, and its blood concentration fairly accurately reflects the level of dietary intakes [3].

The results obtained indicate that serum calcium in the various physiological stages is within the range of results reported by several authors (80-110 mg/L [8]; 84-110 mg/L [9]).

The three major fluctuations in serum calcium observed in this study are: increase in pre-partum period, postpartum decrease in one day before

postpartum, followed by a strong increase one-month before postpartum; whereas in the other stages it remained relatively stable.

The increase in serum calcium in the pre-partum period may be due to increased demand for this mineral for fetal mineralization and for pre-colostrum synthesis. The latter is estimated to be about 1.7-2.3 g/L, resulting in a mobilization of bone reserves of about 13% [10].

The increase in albuminemia and magnesemia during the pre-partum period may be related to the high calcium concentration. Hypoalbuminemia can cause a decrease in the amount of calcium bound to proteins and therefore a possible total hypocalcaemia [11]. Magnesium increases calcium bone resumption by stimulating the osteoclast response to PTH secretion [3].

In addition, Yokus and Cakir (2006) reported that a high calcium level appears to be linked to a late-pregnancy hormonal change with elevated estradiol levels that induce hypercalcemic parathyroid hormone activity and/or the increase of the number of vitamin D receptors [12].

These results differ from those reported by the some studies [13-14] which obtained values that tend to decrease. This decrease could be explained by poor gastrointestinal absorption or insufficient bone resorption coinciding with the massive export of this mineral and thus a failure of the homeostatic mechanism of the organism [15].

High serum calcium during the lactation period according to Yokus and Cakir (2006) is related to a fleeting increase in calcium demand (20-60 g/d),

resulting in accelerated bone resorption and elevation of real absorption coefficient [12]. The increase in the latter may explain the transient hypocalcemia that accompanies parturition and results in a peak of 1,25-dihydroxy-capecalciferol [16]. Moreover, if the amount of calcium ingested is low, absorption becomes remarkably effective [17].

Regarding the variation in phosphorus, the statistic study revealed a very significant decrease in serum levels of phosphorus at the end of gestation. This content increased again in the lactation period.

The decline in phosphoremia observed at the end of gestation seems to be of dietary origin [15], because fodder consumed on pasture is poor in phosphorus.

This coincides with intense use of this mineral for carbohydrate metabolism in order to cover the needs for fetal growth and colostrum synthesis [18].

In the post-partum period, the increase in phosphorus seems to be dependent on a greater distribution of concentrates, especially because the barley grains are very rich in phosphorus [19] or a digestive adaptation to a strong mineral export in Milk, this situation is confirmed within goats by Meschy (2010) who noted that the apparent absorption of phosphorus is high at the beginning of the lactation and then decreases in consequence [20].

Yokus and Cakir (2006) by studying the effect of season and physiological stage on the mineral plasma levels in cows found that plasma phosphorus content was not influenced by the physiological stage [12]. The same finding was observed by Boudebza (2003) [21].

4. Conclusions

The phospho-calcium profile has been practiced in human medicine since the 1970s. It was developed later in veterinary medicine, but it is now part of complementary examinations because of its simplicity, it is relatively low cost and with almost instantaneous results. This profile is usually carried out for diagnostic purposes, in case of suspicion of pathology, but also in a prophylactic setting such as a health check in

different physiological stages (gestation, lactation).

This work allowed us to demonstrate physiological interstate variations of the serum concentrations of the studied parameters.

Calcium and phosphorus showed a high serum level pre-partum period (94.71mg/mL, 61.99mg/mL), respectively.

Our results confirm that the peri-partum period is the period during which the most significant changes occur, in relation to the maximum fetal growth at the end of gestation and the start of lactation.

Overall, most of our findings are consistent with bibliographic data, which reflects the effectiveness of homeostasis mechanisms.

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