International Journal of Cow Science
Vol. 4&5 Issue 1&2, 2008-09, 6-10

Research Article

Postpartum Plasma Profile of Calcium, Phosphorus and Magnesium in Holstein Friesian Cows Without and with Hormone Therapy*

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ABSTRACT

Recently calved HF cows (24) of University farm were monitored for weekly plasma profile of calcium, phosphorus and magnesium from the day of calving till the 21st week of postpartum without and with GnRH (Receptal) and PGF2α (Lutalyse) treatment at 7th week in anoestrus and suboestrus cows (six each, keeping equal number as controls), respectively. The plasma calcium levels in suboestrus cows were significantly higher as compared to anoestrus cows at 7th, 8th, 17th and 21st week postpartum, including overall mean (8.17±0.08 vs 7.72±0.08 mg/dl), while phosphorus levels were lower throughout the postpartum period, but varied significantly at calving and then at 1st–3rd and 13th week postpartum (overall mean 6.96±0.07 vs 7.12±0.06 mg/dl). The calcium and phosphorus levels were low at calving in all the groups (GnRH/PGF2α treatment, control and their pooled groups), and increased linearly and significantly throughout the postpartum period in suboestrus cows. Furthermore, the cows of GnRH treatment group, in comparison to control, had significantly lower calcium levels at 1st, 5th, 8th and 19th weeks postpartum, but this trend was inversed between PGF2α treatment and control groups. The mean plasma Ca:P ratio of the suboestrus (PGF2α) group was higher throughout the postpartum period as compared to the anoestrus (GnRH) group, and it differed significantly at 13th, 17th–18th and 21st week postpartum. The magnesium levels of anoestrus and suboestrus cows did not differ significantly at any of the intervals postpartum, including the overall pooled values (2.95±0.04 vs 3.14±0.01 mEq/L). Throughout the postpartum period magnesium levels were lower in GnRH treatment than the control group, but varied significantly only at 5th–10th and 13th–15th week postpartum, whereas it was higher in PGF2α treatment than the control group, and differed significantly from calving to 4th week and again from 14th–20th week postpartum. The trend reflected physiological/homeostatic mechanism of mineral metabolism and hormone GnRH/PGF2α did not influence it.

KEYWORDS: Hormone therapy, Mineral profile, Holstein cows, Postpartum period.

INTRODUCTION

Nutritional inadequacy and negative energy balance postpartum are the major causes of delayed resumption of ovarian activity, anoestrus and suboestrus in dairy animals (Butler et al., 2000). Calcium plays an important role in the utilization of cholesterol by mitochondria or by stimulating the conversion of pregnenolone to progesterone. GnRH stimulation of LH release from pituitary cells involves a Ca-dependent mechanism. Phosphorus is often associated with reproductive abnormalities in cattle through infertility. The role of calcium and phospholipid-dependent protein kinase and c-AMP-dependent protein kinase may be crucial in mediating the hormone action. Magnesium is equally essential in all enzyme reactions catalyzed by ATP and in maintaining the physical integrity of RND-DNA. Evaluation of the serum profile during the peripartum period and under various reproductive physio-pathological status of zebu cows and buffaloes (Sato, 1978; Shah et al., 2003) and even in exotic cattle (Kappel et al., 1984) have been made. However, no literature was available on monitoring the postpartum plasma profile of macro-minerals in exotic cattle born and reared under tropical climate. Hence, an attempt was

made to monitor calcium, phosphorus and magnesium levels during early postpartum period with and without GnRH and PGF2α treatment in HF cows under the tropical farm management.

MATERIALS AND METHODS

This study was carried out over the first 21 weeks postpartum on 24 healthy normally calved cows managed under routine feeding and housing protocol of the HF Project, GAU, Anand. A group of six animals having small inactive ovaries till day 48–49 postpartum were treated on that day with the single IM injection of 0.02 mg (5 ml) Buserelin acetate (GnRH analogue, Receptal®, Intervet India Pvt. Ltd.) to induce ovarian activity and six animals of similar nature were kept as controls without treatment. Another group of six suboestrus animals was treated with single IM injection of 25 mg (5 ml) Dinoprost tromethamin, THAM salt (Lutalyse®, Pharmacia & Upjohn), a naturally occurring PGF2α, between day 48 and 55 postpartum after confirming the presence of mature corpus luteum on either of the ovaries, and six animals of similar nature were kept as untreated controls.

All the animals of the above two groups and their controls were followed and compared for their clinical response, conception and weekly plasma profile of calcium, phosphorus and magnesium till the 21st week postpartum. Cows exhibiting signs of oestrus were bred only after 50 days of calving by AI using frozen–thawed semen and were palpated per rectum for pregnancy 45 days later. Heparinized veinous blood samples were collected from all 24 cows at regular weekly intervals from the day of calving till the 21st week postpartum. The plasma samples were stored frozen at –20°C and used for various estimations. The plasma mineral profile was determined by using the standard assay kits (Crest Biosystems India Ltd., Goa) and an autoanalyzer. Data were analyzed statistically using a completely randomized design, Duncan's new multiple range test and Student's 't' test to know the weekly/group variation, if any (Steel and Torrie, 1981).

RESULTS AND DISCUSSION

The weekly mean plasma calcium, phosphorus, Ca:P ratio and magnesium levels of anoestrus (GnRH) and suboestrus (PGF2α treatment + control) groups of HF cows from the day of calving till 21st week postpartum are presented in Table 1–2 and depicted in Fig. 1.

Plasma Calcium

The suboestrus cows (PGF2α group), in comparison to anoestrus (GnRH) group, had a significantly higher calcium level at 7th, 8th, 17th and 21st week postpartum, including the overall mean (8.17±0.08 vs 7.72±0.08 mg/dl). The calcium levels were lowest at calving in all the groups and then fluctuated nonsignificantly between weeks postpartum. The cows of GnRH treatment group had significantly lower calcium levels than those of the control group at most intervals postpartum, including the overall mean (7.31±0.10 vs 8.11±0.11 mg/dl). In the suboestrus (PGF2α) group, the levels increased linearly after calving to reach a significantly higher value of 8.69±0.38 mg/dl by 6th week postpartum and then fluctuated at the same level till 21st week postpartum (Table 1, Figure 1).

Table 1: Postpartum weekly mean (± SE) plasma calcium and phosphorus profile (mg/dl) in anoestrus (GnRH) and suboestrus (PGF2α treated and control) HF cows

Weeks postpartum	Calcium (mg/dl)		Phosphorus (mg/dl)	
	Anoestrus (GnRH)	Suboestrus ($PGF_2\alpha$)	Anoestrus (GnRH)	Suboestrus ($PGF_2\alpha$)
0	7.00±0.31	6.85±0.50^{c}	6.62±0.19 $$	5.70±0.25
1	7.88±0.25	7.22±0.41^{bc}	7.12±0.25 $	6.42±0.22
2	7.74±0.41	7.78±0.30^{abc}	7.64±0.33 $	6.77±0.25
3	7.82±0.48	7.97±0.31^{abc}	7.45±0.34 $	6.28±0.35
4	7.02±0.36	7.88±0.37^{abc}	6.97±0.34	6.46±0.28
5	7.43±0.43	8.20±0.42^{ab}	6.74±0.30	6.55±0.30
6	7.86±0.39	8.69±0.38^{a}	6.83±0.39	6.67±0.30
7 #	7.85±0.27 $	8.73±0.30^{a}	6.75±0.39	6.34±0.38
8	7.61±0.33 $	8.63±0.32^{a}	6.58±0.32	6.14±0.31
9	7.83±0.39	7.89±0.34^{abc}	6.98±0.30	6.62±0.35
10	8.36±0.37	7.98±0.34^{abc}	6.51±0.23	6.43±0.32
11	7.75±0.30	8.08±0.23^{ab}	6.86±0.30	6.51±0.30
12	8.29±0.28	8.33±0.32^{ab}	6.97±0.27	6.70±0.31
13	8.02±0.37	8.53±0.41^{a}	7.51±0.29 $	6.39±0.33
14	7.77±0.32	8.19±0.37^{ab}	7.28±0.32	6.44±0.27
15	7.97±0.27	8.47±0.40^{ab}	7.48±0.26	6.97±0.29
16	7.61±0.34	7.83±0.27^{abc}	6.90±0.17	6.78±0.23
17	7.34±0.37 $	8.78±0.41^{a}	6.94±0.35	6.30±0.27
18	7.72±0.56	8.56±0.49^{a}	6.71±0.27	5.99±0.41
19	7.92±0.49	8.64±0.40^{a}	6.69±0.33	5.96±0.32
20	7.86±0.50	8.47±0.19^{ab}	6.69±0.35	5.99±0.36
21	7.17±0.39 $$	8.84±0.23^{a}	6.61±0.31	6.44±0.22
Overall	**7.72±0.08 $**	**8.17±0.08**	**6.96±0.07**	**6.43±0.06**
Treated	7.31±0.10	8.32±0.08	7.14±0.10	6.56±0.09
Control	8.11±0.11*	8.01±0.14	6.78±0.09	6.29±0.09

0 = Day of calving; # Treatment day 49 PP; *P<0.05 between treated and control groups;
$ P<0.05, $$ P<0.01 between anoestrus and suboestrus groups.
Means bearing superscript in common within a column do not differ significantly (P>0.05).

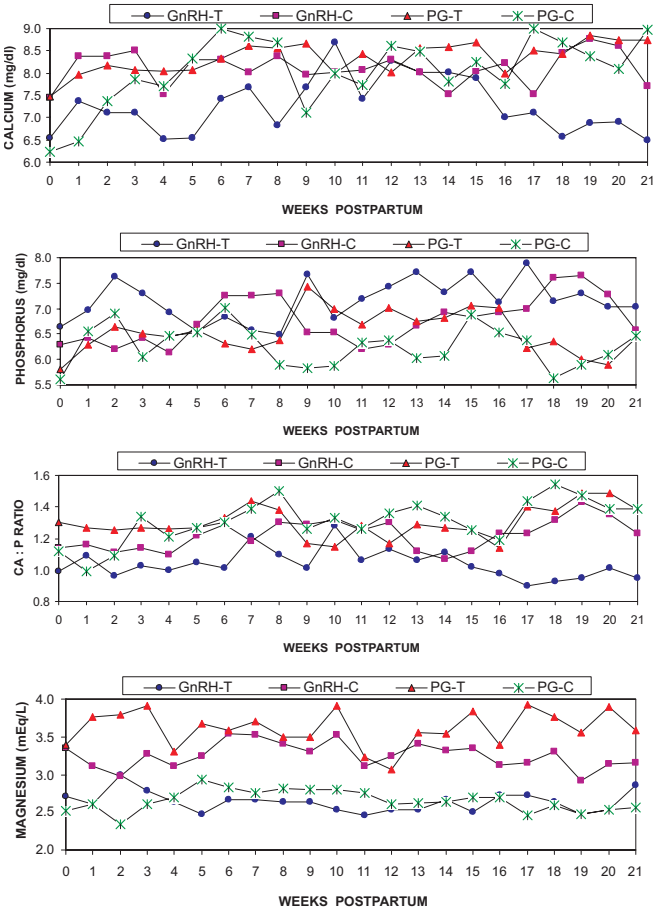

Figure 1: Postpartum weekly plasma profile of macro-minerals in Holstein Friesian cows under GnRH and PGF2α (treatment/control) regimens

These findings on calcium levels and its trend from calving till 21st week postpartum corroborated well with the reports of Belyea et al. (1975) and Sato (1978). Khasatiya (2003) reported comparable findings in Surti buffaloes using the same protocol of weekly sampling from calving till the 15th week and using GnRH and PGF2α treatment at day 40 postpartum in anoestrus and suboestrus animals. Deshpande et al. (1998) reported a significant increase in the calcium level from day of calving to 7th, 14th and 21st day postpartum. Joe et al. (1998) and Dutta et al. (2001) recorded significantly higher values of calcium in cyclic cows as compared to anoestrus cows. The role of calcium in sensitizing tubular genitalia for action of hormones is well established (Moddie and Robertson, 1962). The lower level of calcium at parturition and subsequently at oestrus was thought to be due to high oestrogen levels, as oestrogen may change the appetite in cows, hence diminished calcium intake and absorption (Sahukar et al., 1984). The trend of gradual rise in the plasma calcium level during the postpartum period could be a homeostatic mechanism leading to elevated circulatory levels to meet the drain of calcium in milk during lactation (Sato, 1978).

Inorganic Phosphorus

The weekly mean plasma inorganic phosphorus levels in cows of the anoestrus (GnRH) group were higher throughout the postpartum period as compared to the suboestrus (PGF2α) group, but varied significantly at calving and then at 1st, 2nd, 3rd and 13th week postpartum and there was no significant difference between the overall pooled means of the two groups (6.96±0.07 vs 6.43±0.06 mg/dl). Furthermore, the weekly mean phosphorus levels of all groups (GnRH/ PGF2α treatment, control and their pooled groups) fluctuated nonsignificantly between different intervals postpartum with relatively higher values in treated and control anoestrus groups as compared to suboestrus groups (Table 1, Fig.1). The mean inorganic phosphorus levels were lowest on the day of calving; increased a little for the first 2 weeks and then fluctuated nonsignificantly between different weeks postpartum.

These findings were in agreement with the report of Rowlands et al. (1977). Furthermore, Khasatiya (2003) also recorded weekly inorganic phosphorus levels to vary nonsignificantly for GnRH- and PGF2α-treated buffaloes and their controls from calving till 15th week postpartum. Deshpande et al. (1998) noted a marked decrease in serum inorganic phosphorus at calving followed by a little rise till 4 weeks. Jain and Pandita (1995), however, observed significantly lower phosphorus levels ($P<0.05$) in control than PGF2α-treated crossbred cows. Hurley et al. (1980) suggested that the fertility of animals tended to be reduced if the inorganic phosphorus levels fall, while an increased blood phosphorus level was related to the improvement of ovarian activity. Joe et al. (1998) and Dutta et al. (2001) observed significantly higher serum inorganic phosphorus in cyclic than anoestrus cows.

Plasma Ca:P Ratio

The mean plasma Ca:P ratio of PGF2α (suboestrus) group was higher throughout the postpartum period as compared to GnRH (anoestrus) group, but differed significantly at

13th, 17th, 18th and 21st week postpartum, including the overall pooled mean (1.29±0.01 vs 1.13±0.01). Furthermore, the weekly mean Ca:P ratio in GnRH/ PGF2α treatment, control and their pooled groups varied insignificantly between intervals postpartum. The ratio was lower in cows of GnRH treatment than the control group throughout the postpartum period, but varied significantly only at 16th–19th week postpartum, including the overall mean (1.04±0.02 vs 1.22±0.02). No such differences were found in PGF2α treatment and control groups. In general, the ratio was found elevated at 7th–8th week and again after 16th week postpartum compared to other intervals in all the groups (Table 2, Figure 1). Sahukar et al. (1984) reported the ratio of Ca:P as 2:1, 1.5:1 and 2.5:1 at calving, oestrus and at 1 month of pregnancy in cows. Marinov (1978) also observed a positive correlation between Ca:P ratio and fertility, best fertility was achieved at the ratio of 2:1. In the present study, the mean ratio observed in different groups of cows throughout the postpartum period was relatively low, particularly in the anoestrus (GnRH) group suggesting its adverse effect on reproductive efficiency of HF cows

Table 2: Postpartum weekly mean (±SE) plasma Ca:P ratio and magnesium profile (mEq/L) in anoestrus (GnRH) and suboestrus (PGF2α treated and control) HF cows

Weeks postpartum	Ca:P ratio		Magnesium (mg/dl)	
	Anoestrus (GnRH)	Suboestrus ($PGF_2\alpha$)	Anoestrus (GnRH)	Suboestrus ($PGF_2\alpha$)
0	1.06±0.05	1.21±0.09^{bcd}	3.03±0.18	2.95±0.20
1	1.13±0.06	1.13±0.06^{d}	2.86±0.14	3.18±0.26
2	1.04±0.07	1.17±0.06^{cd}	2.98±0.18	3.07±0.28
3	1.08±0.09	1.31±0.07^{abcd}	3.03±0.18	3.26±0.27
4	1.05±0.09	1.24±0.08^{abcd}	2.87±0.14	3.01±0.15
5	1.13±0.10	1.27±0.07^{abcd}	2.86±0.16	3.31±0.21
6	1.15±0.13	1.31±0.05^{abcd}	3.10±0.20	3.21±0.21
7 #	1.20±0.08	1.42±0.08^{abc}	3.09±0.19	3.23±0.26
8	1.20±0.09	1.44±0.08^{ab}	3.02±0.20	3.16±0.18
9	1.15±0.08	1.22±0.06^{bcd}	2.96±0.15	3.15±0.21
10	1.30±0.08	1.24±0.07^{abcd}	3.03±0.21	3.36±0.28
11	1.15±0.07	1.27±0.05^{abcd}	2.79±0.19	3.00±0.20
12	1.22±0.07	1.27±0.06^{abcd}	2.88±0.21	2.83±0.19
13	1.09±0.06 $$	1.35±0.06^{abcd}	2.98±0.17	3.09±0.26
14	1.09±0.07	1.30±0.09^{abcd}	3.00±0.17	3.08±0.22
15	1.07±0.06	1.25±0.09^{abcd}	2.93±0.21	3.27±0.25
16	1.11±0.06	1.17±0.05^{cd}	2.92±0.14	3.05±0.19
17	1.08±0.08 $$	1.42±0.08^{abc}	2.96±0.15	3.19±0.32
18	1.17±0.09 $	1.46±0.08^{ab}	3.04±0.26	3.18±0.27
19	1.22±0.10	1.48±0.10^{a}	2.72±0.17	3.09±0.24
20	1.20±0.09	1.45±0.10^{ab}	2.87±0.18	3.32±0.30
21	1.10±0.07 $	1.38±0.07^{abcd}	3.02±0.13	3.15±0.35
Overall	**1.13±0.01 $$**	**1.29±0.01**	**2.95±0.04**	**3.14±0.05 $**
Treated	1.04±0.02	1.29±0.01	2.64±0.03	3.60±0.08
Control	1.22±0.02*	1.30±0.02	3.26±0.05*	2.66±0.04**

0 = Day of calving; # Treatment day 49 PP; *P<0.05, **P<0.01 between subgroups; $ P<0.05, $$ P<0.01 between anoestrus & suboestrus groups.

Means bearing superscript in common within a column do not differ significantly (P>0.05).

Plasma Magnesium

There was no significant difference in the weekly mean magnesium levels of cows in anoestrus (GnRH) and suboestrus (PGF2α) groups at any of the intervals postpartum, including the overall pooled values (2.95±0.04 vs 3.14±0.01 mEq/L). Moreover in all the groups, the weekly mean magnesium levels varied nonsignificantly from the day of calving till 21st week postpartum. The values were lower throughout the postpartum period in GnRH treatment group as compared to control, but varied significantly (P<0.05) only at 5th–10th and 13th–15th week postpartum, including the overall means (2.64±0.03 vs 3.26±0.05 mEq/L) and so also for PGF2α treatment and its control groups, which differed significantly from calving to 4th week and again from 14th to 20th week postpartum, including the overall mean (3.60±0.08 vs 2.66±0.04 mEq/L; Table 2, Fig. 1).

These findings were in conformity with the reports of Moddie and Robertson (1962), Sato (1978) and Deshpande et al. (1998), where no significant change in the magnesium level was recorded over the postpartum period in cows. Furthermore, our findings on trend and levels of magnesium also confirmed the observations of Khasatiya (2003) in Surti buffaloes. However, Belyea et al. (1975) recorded a gradual decrease in plasma magnesium levels for cows sampled at 4 days interval from parturition to 60 days postpartum. Kalita et al. (1999) reported the mean serum magnesium level to be significantly higher in normal cyclic cows as compared to repeat breeder and postpartum anoestrus cows. It is postulated that all enzyme reactions, which are catalyzed by ATP have an absolute requirement for magnesium. Magnesium and calcium have a reciprocal relationship, but the endocrine gland has got no specific primary regulatory effect over the plasma magnesium level.

It was concluded that lowest levels at calving followed by a gradual rise in plasma calcium and phosphorus levels observed during the postpartum period could be a homeostatic mechanism to meet their drain in milk during lactation, and that a low plasma Ca:P ratio adversely affects the reproductive efficiency in cows. Hormone

therapy, however, did not influence the plasma profile of calcium, phosphorus or magnesium in exotic cows.

ACKNOWLEDGEMENTS

We thank Dr. M.B. Pande, former Officer I/C of HF Project, GAU, Anand, for permitting us to take up this work on their animals. The financial support given by the Principal Investigator, NATP on "Improving Reproductive Efficiency of Cattle and Buffaloes" and Professor of Gynaecology, GVC, Anand, and the Lab facilities provided by ADIO, Navsari Gujarat is also gratefully acknowledged.

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