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PERIPARTURIENT CHANGES IN SOME BLOOD CONSTITUENTS AND MAMMARY GLAND SECRETIONS OF FRIESIAN COWS

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SUMMARY

A total of 16 pregnant multiparous Friesian cows used to study changes in some blood constituents and mammary secretions around parturition (-7 through +7 days). Plasma cortisol increased gradually, being the highest at parturition (9.13 ng/ml) and declined thereafter. Meanwhile, plasma progesterone decreased sharply and reached a minimum at parturition (0.62 ng/ml) then slightly increased. Plasma IgG decreased gradually being 952.5mg/dl at parturition. Both total protein (TP) and total lipid (TL) in plasma showed the same trend in which they declined gradually till parturition (7.4 g/dl and 9.1 g/l, respectively).

Stored mammary secretions during prepartum period had higher somatic cell count (SCC) (4337 x 10^3/ml) that declined at parturition (3674 x 10^3/ml) and sharply declined thereafter (814 x 10^3/ml at + 7 days).

Highest values of total solids, protein and solids not fat in mammary gland secretions were obtained at - 7 days and decreased gradually thereafter to be minimum at + 7 days postpartum which indicated the changes from colostrum and transitional milk to normal milk. Fat content in mammary secretions was the highest during the period of colostrogenesis whereas lactose showed a reversed trend.

Keywords: periparturient, immunoglobulins, blood constituents, somatic cell count, Friesian cows and mammary secretions.

INTRODUCTION

A static period of rest is needed for the mammary gland to involute adequately then the regrowth and remodeling of mammary tissue will follow before beginning of lactogenesis (Nickerson and

ers 2003). Massive changes in body physiolo- and mammary gland function occurred around turition, to prepare for calving and the nourish- nt of young. Prepartum milking is a good mod- o study changes in mammary gland function ociated with parturition (**Greene et al. 1988**).

e objectives of this study were two folds: the st was to study changes in some blood parame- s of lactating cows in relation to calving. The cond was to investigate the periparturient anges in mammary gland function.

ATERIALS AND METHODS

he present study was carried out at Sakha Exper- nental Station, Kafr El - Sheikh Governorate, nimal Production Research Institute (APRI), griculture Research Center, Ministry of Agricul- ure, Dokki, Giza, Egypt. The field work of the xperiment lasted for six months starting from eptember, 1999.

A total of 16 multiparous Friesian cows were as- igned to study periparturient changes in relevant o some blood parameters and mammary gland constituents. Cows were late pregnant and spent 45 days of active involution (dry period) before applying prepartum hand milking in the morning. Their age ranged between 3.5 and 9 years, and heir parities from 2 to 6 period. All cows deliv- ered normally without any problems during or af- ter parturition. Cows were housed in semi-shaded open yards and fed according to NRC allowances (NRC, 1985). Periparturient days were consid- ered to be ± 7 days around parturition. During these days blood and mammary gland secretions were collected.

Mammary gland secretions sampling and analysis:

Prepartum milking was done at days -7, -5, -2 and -1 before parturition in the morning after adequate stimulation of the udder. Then, colostrum was collected daily from parturition till 4 days postpartum. Furthermore, transitional milk was collected at days 7 postpartum. Analysis of mammary secretion samples was done using milkoscan (Milkoscan®, 133 B, N. Foss Electric, Denmark) to measure concentrations of fat, protein, lactose, solids not fat and total solids. The somatic cell count in mammary secretion was measured using Somacount® 150, Bentley Instrument Inc, Minnesota, USA).

Blood sampling and analysis:

Heparinized blood samples (10 ml) were taken at days - 7 and - 2 prepartum; at parturition and at days + 2 and + 7 postpartum. Blood samples were collected at 8 a.m. before morning feeding via jugular vein puncture, then centrifuged (at 3000 rpm for 20 minutes) to separate plasma which stored at -20°C until analysis.

Colorimetric methods were executed to measure plasma concentrations of total protein (g/dl) ac-

cording to Sundeman (1964) and total lipids (g/l) according to Eisemann et al. (1986). Single radial immuno diffusion technique was used to quantify total IgG in plasma (Bind ARIDTM Binding site limited, Brimingham, UK.) according to Fahey and McKelvey (1965).

Single antibody radioimmunoassay was applied to quantify progesterone and cortisol in plasma (Coat-A-Count®, DPC, Los Angeles, California, USA) according to Aufrere and Benson (1976) for progesterone and Boyd and Hogg (1981) for cortisol.

Inter- and Intra-assay coefficient of variability for cortisol were 5.4 and 3.5%, respectively and those for progesterone were 3.9 and 2.7%, respectively. The sensitivity of the assay of cortisol was 3.62 ng/ml. And that of progesterone was 0.02 ng/ml.

Statistical analysis:

Data were subjected to analysis of variance as repeated measurements (split plot in time) according to Neter et al. (1985) using SAS (1998), while differences among means were tested using Duncan multiple range test (1955).

RESULTS AND DISCUSSION

Changes in blood constituents relative to parturition are presented in Table 1 and Figures 1, 2 and 3. A gradual decrease in plasma concentrations of total protein and total lipids were noticed during prepartum period followed by a sharp decrease at parturition being 7.39 g/dl for total protein and 9.03 g/l for total lipids. After calving, a gradual increase was noticed for both metabolites being the highest at the 7th days postpartum (8.34 g/dl for total protein and 10.38 g/l for total lipids). Changes in concentrations of plasma total protein and total lipids reflected the partitioning of nutrients from plasma to the gravid uterus and the mammary gland to start the biosynthesis of precolostrum and colostrum thereafter. In lactating dairy cows, Guillermo et al. (1990) stated that total serum protein and total serum lipids concentrations were 7.81 g/dl and 11.78 g/l, respectively, for total serum protein concentration (6.67 g/dl). Also, our results were in accordance whith those obtained by West et al. (1991)

Concentration of IgG in plasma of lactating Friesian cows showed a gradual decrease by 12.7% from -7 to -2 days prepartum being 952.5 mg/dl at parturition. Further decrease of plasma IgG was noticed at + 2 days postpartum (919.7 mg/dl) and increased slightly thereafter. A massive transfer of IgG from blood plasma to the mammary gland during prepartum period reflects its accumulation inside the mammary gland till parturition. In agreement with the present results, Guy et al. (1994b) stated that serum IgG1 concentrations av-

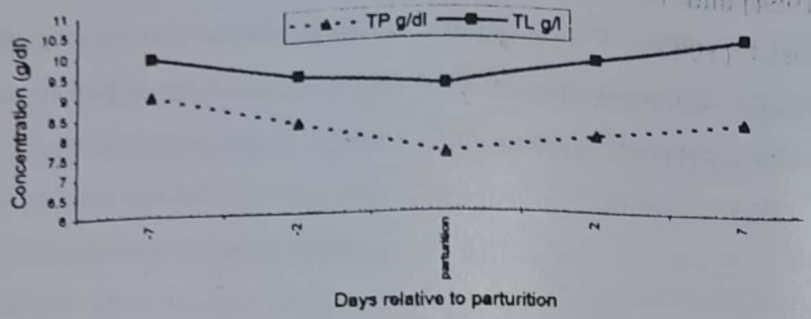

Fig. 1: Periparturient changes in concentrations of Total protein and Total lipids in plasma.

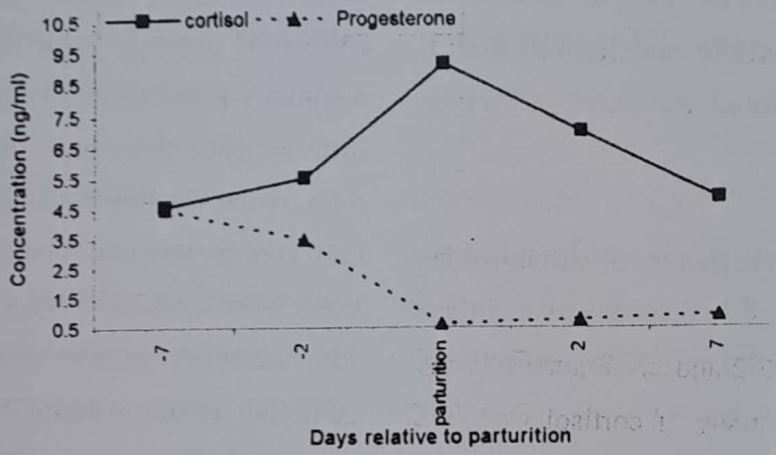

Fig. 2: Periparturient changes in plasma cortisol and progesterone concentration.

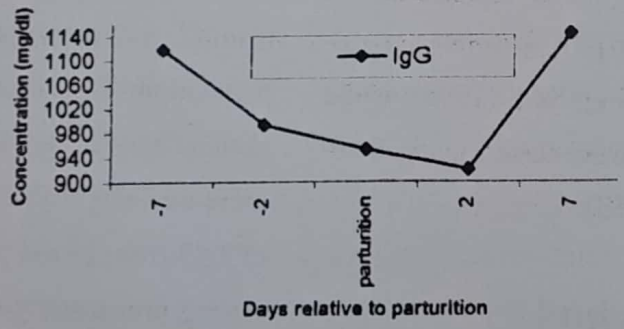

Fig. 3: Periparturient changes in plasma IgG level

eraged 5.7 mg/ml in dairy cows between day 28 and 24 prepartum and declined to 1.4 mg/ml between - 4 days prepartum and calving. Serum IgG1 concentration decreased in association with colostrogenesis. Brandon and Lascelles (1976) added that prepartum milking increases the massive transfer of IgG1 from blood plasma into the mammary gland. Furthermore, William and Millar (1979) stated that IgG secreted earlier from serum to colostrum starting from - 30 days prepartum and during prepartum period IgG stored inside the mammary gland till the delivery of the young.

A gradual increase in plasma cortisol was noticed during prepartum period followed by a sharp increase at parturition (9.13 ng/ml) and a sharp decrease thereafter. Furthermore, prepartum values of plasma cortisol ranged from 4.59 to 5.52 ng/ml, after that, the corresponding post partum values ranged from 6.99 to 4 85 ng/ml. In agreement with the present results, Kejela et al. (1978) reported that concentrations of glucocorticiods in plasma were relatively constant between - 13 and - 2 days with a mean of 5.3 ± 0.4 ng/ml, whereas at - 1 day prepartum it increased to 9.0 ± 1.5 ng/ml. By day 0, which corresponded to 4 to 12 hours prepartum, the concentration was 14.8 ± 3.0 ng/ml. Concentrations on days 1 and 2 postpartum were 11.7 ± 2.1 and 12.9 ± 1.7 ng/ml, respectively.

A gradual decline in plasma progesterone was recorded from - 7 to - 2 days prepartum followed by a sharp decline at parturition (0.62 ng/ml), furthermore a slight decrease was noticed postpartum. Chew et al. (1976) stated that concentrations of progesterone in plasma of cows were 3.6, 2.8, 1.3 and 0.7 during (- 6 to - 3 days), (- 2 to - 1 days), at parturition and (+ 1 to + 2 days) postpartum, respectively. Guy et al. (1994a) added that serum progesterone concentration fluctuated between 3.4 ± 0.4 ng/ml at 6 days prepartum and 4.3 ± 0.6 ng/ml at 1.5 days prepartum, decreased precipitously to 0.9 ± 0.1 ng/ml at parturition, and continued to fall to <0.2 ng/ml by 2 days postpartum. In Holstein cows Guy et al. (1994b) reported that serum progesterone concentration fell from 5 to 3 ng/ml ($P < 0.05$) between 30 and 10 days prepartum. Pregnancy, parturition and initiation of lactogenesis were considered as stress factors affecting dairy cows [Badr et al. 2002; Abd El-All et al. 1990 and Sahukar et al. 1985].

Using prepartum milking, mammary secretions were collected at days - 7, - 5, - 2 and - 1 prepartum. A conditioning of 5 minutes was applied to stimulate late pregnant cows for precolostrum letdown. All cows responded to prepartum milking and yielded mammary secretions ranged from 100 to 250 ml per cow .

The prepartum secretions were very viscous and honey-like in color. The secretions varied in the hue of the yellow color and in the viscosity from looking like glue to less viscous and a rapid drying property.

Keller et al. (1977) started his experiment on 11 cows, six of which were considered as responding cows which provided 60 ml prepartum mammary secretion per day. But when it reached the day before delivery, some cows provided an average of 4 to 17 kg of the mammary secretions. The remaining 5 cows did not respond to prepartum milking .

Variations in the concentrations of some nutritive constituents as protein, total solids (TS) and solids not fat (SNF) in mammary secretions due to different periods relative to parturition are presented in Table (2) and Fig 4. A gradual decline in concentrations of TS, SNF and protein in mammary secretions during prepartum period starting from -7 to - 1 days being 16.6, 12.93 and 9.43 g/dl at parturition , respectively.

At 1st day after calving a sharp decrease in TS, SNF and protein of mammary secretions were noticed and followed by another sharp decrease at the 2nd day postpartum . The lowest concentrations of TS, SNF and protein in mammary secretions were recorded at the 7th day postpartum being 11.72 , 7.03 and 2.52 g/dl, respectively. Change in values of TS, SNF and protein in mammary secretions revealed the transformations of mammary gland activity from biosynthesis of precolostrum , colostrum, transitional milk and milk thereafter. Prepartum values of mammary secretion fat ranged from 1.91 at -7 days to 3.11 g/dl at -1 day before calving then sharply increased to 4.49 g/dl at parturition, slight changes were noticed thereafter. The lowest value of lactose was 0.2 g/dl at - 2 days prepartum being 1.64 at parturition and increased gradually thereafter . Hafez and Head (1998) found that mean concentrations of 1st colostrum of dry matter, protein, fat, solids not fat and lactose were 22.2, 16.7, 4.0, 18.2 and 2.3 g/100ml, respectively.

Oyeniyi and Hunter (1978) reported that Holstein colostrum has a high content of total solids compared to normal milk (25% vs 13%) . They measured the mean constituents in colostrum from the first three milkings postpartum and found that total protein was 11.49 ± 0.63 , 9.43 ± 0.40 , 7.04 ± 0.40 in 0, 12 and 24 hours postpartum, respectively, but total solids was 24.96 ± 0.68, 21.13 ± 0.77, 16.91 ± 0.61 g/dl in 0, 12, and 24 hours postpartum, respectively. But total solids was 24.96± 0.68, 21.13± 0.77, 16.91 ± 0.61g/dl in 0.12 and 24 hours post partum, respecting

Chew et al. (1976) recorded that concentrations of fat in mammary secretions were 3.3 ± 0.4 g/dl, 4.1 ± 0.6 g/dl, 5.3 ± 0.4 g/dl and 4.5 ± 0.4 g/dl be-

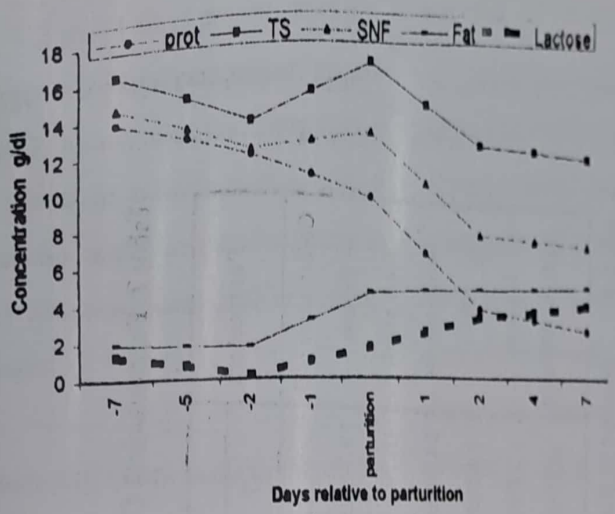

Fig. 4: Periparturient changes in concentrations of mammary secretion.

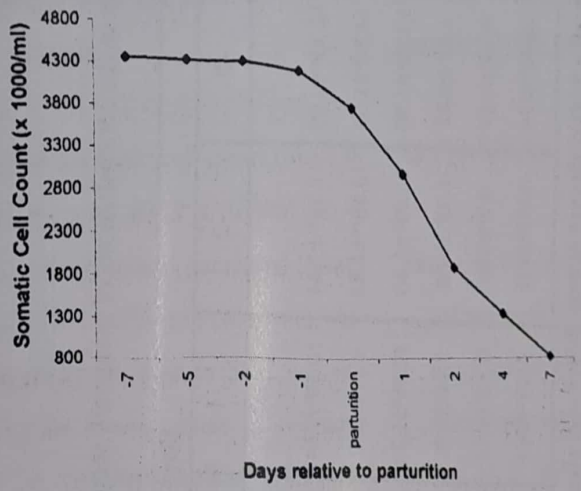

Fig. 5: Periparturient changes in somatic cell count of mammary secretion.

Table 1: Periparturient Changes in the concentrations of some blood plasma parameters (Mean ± S.E).

Parameters	Days relative to parturition				
	-7	-2	0	2	7
Total protein g/dl	$8.97^{a}\pm0.55$	$8.2^{a}\pm0.60$	$7.39^{a}\pm0.72$	$7.87^{a}\pm0.57$	$8.34^{a}\pm0.41$
Total lipids g/l	$9.90^{ab}\pm0.40$	$9.33^{ab}\pm0.82$	$9.03^{b}\pm0.65$	$9.70^{a}\pm0.50$	$10.38^{ab}\pm0.35$
IgG mg/dl	$1118.3^{bcd}\pm48.3$	$992.5^{cd}\pm53.43$	$952.5^{cd}\pm59.53$	$919.7^{cd}\pm50.2$	$1143.4^{cd}\pm40.52$
Cortisol ng/ml	$4.59^{b}\pm0.37$	$5.52^{b}\pm0.74$	$9.13^{b}\pm0.57$	$6.99^{ab}\pm0.45$	$4.85^{b}\pm0.33$
Progesterone ng/ml	$4.51^{b}\pm0.31$	$3.47^{b}\pm0.61$	$0.62^{c}\pm0.46$	$0.77^{c}\pm0.37$	$0.92^{c}\pm0.27$

a,b,c,d Means in the same row with different letters differ significantly ($p<0.05$)
Day o = Day of parturtion

Table 2: Periparturient Changes in the concentrations of mammary secretions constituents (Mean ± S.E).

Parameters	Days relative to parturition								
	-7	-5	-2	-1	0	1	2	4	7
Constituents g/dl									
Protein	$13.74^{ab}\pm0.73$	$12.73^{ab}\pm1.05$	$11.73^{bc}\pm1.44$	$10.58^{b}\pm1.04$	$9.43^{c}\pm1.03$	$6.55^{d}\pm0.75$	$3.86^{d}\pm0.46$	$3.10^{d}\pm0.41$	$2.52^{d}\pm0.51$
Total solids	$16.28^{a}\pm0.93$	$14.92^{a}\pm1.03$	$13.55^{bc}\pm1.83$	$15.1^{a}\pm1.50$	$16.6^{a}\pm1.03$	$14.46^{bc}\pm0.90$	$12.32^{c}\pm0.59$	$12.02^{c}\pm0.62$	$11.72^{c}\pm0.65$
Solids not fat	$14.58^{a}\pm0.71$	$13.30^{a}\pm1.00$	$12.03^{b}\pm1.40$	$12.48^{b}\pm1.20$	$12.93^{ab}\pm1.0$	$10.27^{b}\pm0.70$	$7.61^{c}\pm0.45$	$7.32^{c}\pm0.40$	$7.03^{c}\pm0.50$
Fat	$1.91^{c}\pm0.55$	$1.82^{c}\pm0.82$	$1.73^{c}\pm1.08$	$3.11^{a}\pm0.90$	$4.49^{a}\pm0.78$	$4.6^{a}\pm0.50$	$4.71^{a}\pm0.35$	$4.75^{a}\pm0.36$	$4.8^{a}\pm0.39$
Lactose	$1.28^{b}\pm0.30$	$0.74^{b}\pm0.18$	$0.2^{c}\pm0.05$	$0.92^{b}\pm0.13$	$1.64^{b}\pm0.21$	$2.44^{a}\pm0.15$	$3.24^{a}\pm0.09$	$3.56^{a}\pm0.08$	$3.87^{a}\pm0.10$
SCC (x1000/ml)	$4337^{a}\pm483$	$4299^{b}\pm514$	$4262^{a}\pm945$	$4118^{a}\pm501$	$3674^{a}\pm678$	$2922^{b}\pm320$	$1869^{b}\pm303$	$1342^{b}\pm300$	$814^{b}\pm345.8$

a,b,c,d Means in the same row with different letters differ significantly ($p<0.05$)
Day o = Day of parturition
SCC = Somatic Cell Count

ween - 6 to - 3, - 2 to - 1 days prepartum, at parturition and + 1 to + 2 days postpartum, respectively. Roy (1970) stated that the concentration of lactose was lower in colostrum than normal milk because lactose could induce the young to scour (diarrhea) with subsequent death or unthriftiness (non avoidance of waste)

Changes in somatic cell count (x 1000/ml) present in mammary secretions throughout the different days relative to parturition are illustrated in Fig (5) and presented in table 2.

The highest count of somatic cell count (SCC) in mammary secretions was 4337 x 10^3/ml at -7 days prepartum , furthermore it decreased toward parturition being 3674 x 10^3/ml in colostrum. After parturition , a sharp decline in SCC was noticed till reaching its lowest value at + 7 days postpartum (814 x 10^3/ml milk). Nickerson (1989) reported that SCC ranged between 2.5 x 10^6 to 3 x 10^6 /ml milk. The period of colostrogenesis began about 2 weeks prepartum and continued several days into lactation. Fluid began to accumulate and SCC decreased 1 x 10^6/ml milk and 2.7 x 10^6/ml milk. The reduction in SCC during the peripartum period may be due to a dilution effect or clearance from the udder. After one week freshening, SCC were 1 x 10^5 to 2.8 x 10^5. Also, Sordillo et al. (1997) found that in healthy lactating mammary gland, total somatic cell count was often < 10^5/ml of milk.

It could be concluded that periparturient changes relevant to blood constituents reflected a metabolic adaptation of body physiology paralleled with late pregnancy, parturition, and changes in mammary gland function. Furthermore, periparturient changes in constituents of mammary secretions reflected a great transformations in mammary gland function starting from the biosynthesis and accumulation of precolostrum to colostrum and transitional milk and milk thereafter.

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