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Evaluation of Baseline Metabolic Parameters in Crossbred Cows during Periparturient Period

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Abstract
The periparturient period in dairy cows is marked by significant physiological stress that often results in metabolic imbalances and increased disease incidence. This study aimed to evaluate the baseline hematological, biochemical, mineral, and energy-related metabolic parameters in crossbred cows during the periparturient period in Bathinda district, Punjab. A total of 32 crossbred cows from three different farms were sampled at three critical phases: Far-Off Dry (FOD), Close-Up Dry (CUD), and Fresh period (3–30 days post-calving) for various metabolic and energy parameters. Results showed a significant decline in Hb, PCV, and glucose levels postpartum, with the lowest values observed in farm no. 3, indicating higher metabolic stress. Elevations in BHBA and NEFA in farms 1 and 3 further suggested negative energy balance during early lactation. Among minerals, calcium and sodium levels declined significantly postpartum, particularly in farm no. 2, suggestive of subclinical hypocalcemia. Inter-farm differences highlighted varying management and nutritional strategies. The findings emphasize the importance of targeted monitoring and nutritional interventions during the transition period to enhance the productivity and health of dairy cows.

Keywords: Periparturient period, Crossbred cows, Metabolic profile, Hematology, Biochemistry, Minerals

Introduction

The transition period in dairy cows, spanning approximately three weeks before and after calving, is a critical phase marked by extensive metabolic and physiological changes. During this time, dairy cows often face reduced feed intake concurrent with increased nutrient demands for fetal development and lactogenesis. This metabolic challenge can lead to a state of negative energy balance and immunosuppression, predisposing animals to disorders such as ketosis, hypocalcemia, and fatty liver syndrome (Grummer, 1995; Goff and Horst, 1997) [1, 2].

Crossbred cows, especially under Indian climatic conditions, are particularly vulnerable due to their high productivity and varying nutritional management practices. Establishing baseline values for metabolic parameters is essential for early detection and prevention of periparturient diseases in such animals.

This study was undertaken to evaluate the baseline hematological, biochemical, mineral, and energy-related parameters in crossbred cows from Bathinda district during different phases of the periparturient period, with inter-farm comparisons to identify possible nutritional and management disparities.

Material and Methods

Selection of Animals

In every selected farm, crossbred cows which were in their last trimester of pregnancy and was dried off milking were selected for the study. Detailed history about age, milk yield, health status, body condition, any kind of disease condition, present and previous feeding history were collected for each animal. Body condition score (BCS) assessment was done as per the methods of Ferguson *et al.* (1994) [3]

Sample Collection

A total of 32 crossbred dairy cows in their last trimester of pregnancy were sampled during the study period. From each animal blood samples were collected thrice during different stages of periparturient period, viz:

Far off dry - > 10 days following dry off and not < 30 days prior to calving.

Close up dry- Between 3 and 21 days prior to calving.

Fresh- 3 to 30 days in milk.

Laboratory analysis

Haematology

Haematological parameters were estimated on the haematological analyser (ADVIA 2120, SIEMENS Hematology Analyzer, USA.) in the Diagnostic Laboratory of Department of Teaching Veterinary Clinical complex, GADVASU, Ludhiana.

Mineral Analysis

Plasma

Concentrations of copper, iron and zinc

Concentrations of various minerals viz. Cu, Zn and Fe were estimated by Atomic Absorption Spectrophotometer (Perkin Elmer Analyst 700, USA).

Concentrations of calcium, magnesium, sodium and potassium: Concentrations of minerals viz. Ca, Mg, Na and K were estimated by Atomic Absorption Spectrophotometer (Perkin Elmer Analyst 700, USA).

Plasma inorganic phosphorus: Plasma Pi was determined using method given by Tausky and Shorr (1953) [4].

BHBA AND NEFA

Both BHBA and NEFA were estimatedon the ELISA plates from the plasma samples with the help of kits provided by Diasys Diagnostics systems, Germany.

Biochemistry

Estimation of Biochemical parameters viz.Total Plasma Proteins (TPP), albumin, plasma urea nitrogen (PUN), creatinine, glucose were analysed by kits provided by Ortho clinical diagnostics, UK. on the semi automatic Biochemistry analyzer (Vitros®DT 60 II by Ortho clinical diagnostics USA.) in the Diagnostic Laboratory of Department of Teaching Veterinary Clinical complex.

Statistical Analysis

Data was analysed by one way analysis of variance (ANOVA) and paired t-test for comparison. The Linear regression for calculating the prediction equation and correlation between different groups were obtained using SPSS software (version 16.0; Microsoft).

Results and discussion

Base line study

Hematological parameters

Haemoglobin and packed cell volume

Mean Hb and PCV levels during FOD, CUD and fresh period are shown in Table 1. A significant decrease (p<0.05) in the mean Hb and PCV values was noticed in the farm no. 1 and 3 between FOD and fresh period, and significantly lower values were recorded in farm no. 3, during the CUD and fresh period, as compared to other two farms of the district.

Table 1: Haematological indices in crossbred cows from Bathinda district (Mean ± S.E.)

Parameters	Period	Farm no.1 (n=25)	Farm no.2 (n=4)	Farm no. 3 (n=3)	Overall (n=32)
Hb (g/dl)	FOD	11.10 ± 0.32^{awz}	11.17 ± 0.75^{ax}	9.13 ± 0.63^{axw}	10.93±0.21
	CUD	10.69 ± 0.39^{ax}	11.22 ± 0.38^{abx}	7.76 ± 0.36^{cxz}	10.48±0.35
	Fresh	9.85 ± 0.38^{axy}	10.92 ± 0.24^{abx}	6.56 ± 0.60^{cyz}	9.67±0.36
PCV (%)	FOD	35.10 ± 0.95^{awz}	34.87 ± 2.17^{abx}	28.26 ± 2.28^{cxw}	34.43±0.87
	CUD	34.02 ± 1.16^{ax}	33.45 ± 1.60^{abx}	24.50 ± 1.00^{cxz}	33.06±1.03
	Fresh	31.29 ± 1.20^{axy}	33.12 ± 0.87^{abx}	20.37 ± 2.05^{czy}	30.50±1.12
TEC (x10^6/µl)	FOD	7.60 ± 0.37^{ax}	6.79 ± 0.46^{ax}	5.46 ± 0.40^{ax}	7.30±0.32
	CUD	7.10 ± 0.41^{ax}	6.57 ± 0.48^{ax}	5.15 ± 0.79^{ax}	6.85±0.34
	Fresh	6.83 ± 0.41^{ax}	6.63 ± 0.36^{abx}	3.80 ± 0.66^{cx}	6.52±0.36
TLC (x10^3/µl)	FOD	7.16 ± 0.34^{ax}	9.96 ± 0.29^{bcx}	8.90 ± 0.97^{acx}	7.67±0.33
	CUD	7.85 ± 0.38^{ax}	10.83 ± 0.52^{bx}	7.89 ± 0.40^{acx}	8.23±0.35
	Fresh	7.78 ± 0.40^{ax}	10.66 ± 0.79^{bx}	7.26 ± 0.64^{acx}	8.09±0.37

Values bearing different superscript (a, b, c, d) in a row differ significantly (p<0.05)

Values bearing different superscript (w, x, y, z) in a column differ significantly (p<0.05)

The overall mean Hb was within the normal range in all the farms, as described by Feldman *et al.* (2000) [5] except in farm no. 3 where it was lower than the normal range during the CUD and fresh period. While the mean Hb was within the normal range, but a constant decrease was observed in all the farms from FOD upto fresh period,

Total erythrocytic count

Significantly lower (p<0.05) than the normal range value was recorded in the farm no. 3, in comparison to the farm no. 1 and 2 during the fresh period (Table 1).

Total Luecocyte Count

Mean TLC values were 7.16±0.34, 9.96±0.29, 8.90±0.97 x10^3/µl during the FOD period; 7.85±0.38, 10.83±0.52 and 7.89±0.40 x10^3/µl during the CUD period and 7.78±0.40, 10.66±0.79 and 7.26±0.64 x10^3/µl during the fresh period from the cows of the farm no. 1, 2 and 3, respectively (Table 1). Between farms, significantly higher (p<0.05) values were recorded in farm no. 2 from the other two farms during the FOD and CUD period, while from farm no. 3 during the fresh period (Table 1).

The decrease in hemoglobin and PCV values during the transition period, particularly in farm no. 3, may reflect anemia associated with metabolic stress and potential subclinical conditions such as ketosis. Similar reductions in erythrocyte indices postpartum have been reported, linked to decreased erythropoiesis and hemodilution (Rai, 1995; Gavan *et al.,* 2010) [6, 7]. Elevated TLC levels in farm no. 2 may indicate immune system activation or stress responses due to parturition (Mallard *et al.,* 1998; Meglia *et al.,* 2005) [8, 9].

Plasma biochemical parameters

Total plasma proteins

Significantly lower value of mean TPP was observed in the farm no. 2 during the fresh period as compared to the cows of the farm no. 1 and 3. Within a farm, significant decrease (p<0.05) was observed in the farm no. 1 and 2 in between the FOD and fresh period (Table 2).

Albumin

Mean plasma albumin levels observed were 2.90±0.25, 2.95±0.22 and 2.66±0.43 g/dl during the FOD period; 3.15±0.26, 2.62±0.85 and 2.73±0.88 g/dl during the CUD period and 2.72±0.11, 2.37±0.17 and 2.40±0.15 g/dl during the fresh period from cows of farm no. 1, 2 and 3, respectively (Table 2).

Plasma Urea Nitrogen

Between farms the mean PUN levels observed were 9.68±0.80, 7.25±0.25, 7.00±1.15 mg/dl during the FOD period; 8.84±0.64, 8.01±0.70, 6.66±0.33 mg/dl during the CUD period and 9.76±1.05, 12.00±1.73, 7.66±1.33 mg/dl during the fresh period from the cows of farm no. 1, 2 and 3, respectively. Within a farm, a significant increase was observed in the farm no. 2 between FOD and fresh period (Table 2).

Table 2: Biochemical profile in crossbred cows from Bathinda district (Mean± S.E.)

Parameters	Period	Farm no.1 (n=25)	Farm no.2 (n=4)	Farm no. 3 (n=3)	Overall (n=32)
TPP (g/dl)	FOD	7.79±0.17^{aw}	6.67±0.17^{axw}	7.20±0.66^{ax}	7.60±0.16
	CUD	7.12±0.16^{axy}	6.82±0.28^{axz}	7.43±0.12^{ax}	7.11±0.13
	Fresh	7.08±0.23^{axz}	5.65±0.16^{by}	7.26±0.12^{acx}	6.92±0.20
Albumin (g/dl)	FOD	2.90±0.25^{ax}	2.95±0.22^{ax}	2.66±0.43^{ax}	2.88±0.20
	CUD	3.15±0.26^{ax}	2.62±0.85^{ax}	2.73±0.88^{ax}	3.05±0.10
	Fresh	2.72±0.11^{ax}	2.37±0.17^{ax}	2.40±0.15^{ax}	2.64±0.09
PUN (mg/dl)	FOD	9.68±0.80^{ax}	7.25±0.25^{axw}	7.00±1.15^{ax}	9.12±0.66
	CUD	8.84±0.64^{ax}	8.01±0.70^{axz}	6.66±0.33^{ax}	8.53±0.52
	Fresh	9.76±1.05^{ax}	12.00±1.73^{ay}	7.66±1.33^{ax}	9.84±0.86
Creatinine (mg/dl)	FOD	2.23±0.28^{ax}	1.52±0.85^{ax}	1.50±0.15^{ax}	2.07±0.22
	CUD	1.47±0.19^{ax}	1.32±0.06^{ax}	1.30±0.20^{ax}	1.43±0.15
	Fresh	2.09±0.37^{ax}	1.32±0.20^{ax}	0.90±0.17^{ax}	1.88±0.29
Glucose (mg/dl)	FOD	76.28±3.11^{adx}	90.50±2.25^{bdxw}	68.33±10.58^{acx}	77.31±2.75
	CUD	97.48±5.76^{ay}	84.25±3.09^{axz}	61.00±9.29^{ax}	92.40±4.96
	Fresh	62.16±3.44^{az}	66.50±6.25^{aby}	40.00±5.50^{cx}	60.62±3.05
BHBA (mmol/L)	FOD	0.32±0.20^{ax}	0.49±0.28^{bdx}	0.48±0.05^{cdxz}	0.36±0.02
	CUD	0.54±0.03^{ay}	0.55±0.05^{ax}	0.44±0.02^{axw}	0.53±0.02
	Fresh	0.66±0.04^{az}	0.60±0.02^{ax}	0.66±0.04^{ay}	0.66±0.03
NEFA (mmol/L)	FOD	0.15±0.01^{aw}	0.15±0.02^{axw}	0.19±0.05^{ax}	0.16±0.17
	CUD	0.33±0.03^{axy}	0.24±0.02^{axz}	0.18±0.05^{ax}	0.30±0.02
	Fresh	0.36±0.02^{axz}	0.35±0.03^{ay}	0.29±0.05^{ax}	0.36±0.01

Values bearing different superscript (a, b, c, d) in a row differ significantly (p<0.05)

Values bearing different superscript (w, x, y, z) in a column differ significantly (p<0.05)

Creatinine

In Bathinda district the mean creatinine levels were 2.23±0.28, 1.52±0.85, 1.50±0.15 mg/dl during the FOD period; 1.47±0.19, 1.32±0.06 and 1.30±0.20 mg/dl during the CUD period and 2.09±0.37, 1.32±0.20 and 0.90±0.17 mg/dl during the fresh period from the dairy cows of the farm no.1, 2 and 3, respectively (Table 2).

Glucose

Significantly higher mean glucose values were observed in the farm no. 2 as compared to farm no. 3 during the FOD period. Within a farm, in farm no. 1 a significant increase (p<0.05) was observed in the mean glucose value from the FOD period upto CUD period, and then again it decreased significantly (p<0.05) from the CUD period to the fresh period, where as, in farm no. 2 a significant decrease (p<0.05) was observed between FOD and fresh period. The increase in mean glucose levels in farm no. 1 from FOD upto CUD period might be due to the fact that some cows exhibited a gluconeogenetic effect of epinephrine and cortisol because of the excitement and stress associated with parturition. (Gerardo *et al.,* 2009) [10].

Beta Hydroxy Butyric Acid

Within a farm, a significant increase was observed in the mean plasma BHBA levels in the farm no. 1 from FOD to CUD to fresh period, while between FOD and fresh period in farm no. 3 (Table 2).

Non esterified fatty ACID

Mean plasma NEFA levels observed were 0.15±0.01, 0.15±0.02, and 0.19±0.05 mmol/L during FOD period; 0.33±0.03, 0.24±0.02, 0.18±0.05 mmol/L during CUD period and 0.36±0.02, 0.35±0.03 and 0.29±0.05 mmol/L during fresh period from the farm no.1, 2 and 3 respectively (Table 2). Within a farm, a significant increase in plasma NEFA concentrations in farm no. 4 and 5 and a non significant increase in farm no. 6 was observed from FOD to CUD to fresh period (Table 2).

The decline in TPP and albumin levels, especially in farm no. 2, reflects increased protein demand for colostrum formation and reduced intake postpartum. These findings are consistent with observations of plasma protein reduction during late pregnancy and early lactation due to hormonal changes and immunoglobulin transfer (Bell *et al.,* 2000)[11]. High PUN levels in farm no. 2 may be attributed to enhanced protein catabolism or subclinical kidney dysfunction (Sreedhar *et al.,* 2013)[12]. Lower creatinine in farm no. 3 could suggest reduced muscle mass and metabolic reserves, consistent with early lactation energy mobilization (Doornenbal *et al.,* 1988) [13].

Postpartum hypoglycemia was most prominent in farm no. 3, indicating negative energy balance. This was corroborated by the highest BHBA levels and notable rise in NEFA in farm no. 1, reflecting lipolysis and risk of ketosis. Similar metabolic patterns have been documented in early lactation cows experiencing negative energy balance (Grummer, 1995; Drackley, 1999) [1, 14]. These findings highlight the metabolic load on cows during early lactation and underline the need for nutritional support and monitoring to prevent ketosis (Goff and Horst, 1997) [2].

Concentrations of plasma minerals

Calcium

Mean plasma Ca concentrations are presented in Table no.3 from FOD to CUD to fresh period. (Table 3). Within a farm, a significant (p<0.05) decrease was observed between the FOD and fresh period in farm 1 and 2. The mean plasma value of the farm no. 2 was lower than the normal range during the fresh period.

Table 3: Plasma mineral concentrations in crossbred cows from Bathinda district (Mean± S.E.)

Parameters	Period	Farm no.1 (n=25)	Farm no.2 (n=4)	Farm no. 3 (n=3)	Overall (n=32)
Ca (mg/dl)	FOD	11.03±0.49^{awz}	9.05±0.67^{axw}	10.60±1.48^{ax}	10.75±0.42
	CUD	10.20±0.41^{ax}	8.24±0.48^{axz}	10.57±0.58^{ax}	9.99±0.34
	Fresh	9.25±0.40^{axy}	7.21±0.41^{ayz}	8.46±0.54^{ax}	8.92±0.34
Mg (mg/dl)	FOD	3.44±0.19^{adx}	2.30±0.37^{dbx}	4.69±0.31^{acx}	3.47±0.26
	CUD	3.32±0.29^{ax}	3.18±0.16^{abx}	4.50±1.69^{cx}	3.51±0.28
	Fresh	3.13±0.21^{ax}	3.17±0.23^{abx}	5.05±0.60^{cx}	3.31±0.20
Pi (mg/dl)	FOD	5.07±0.12^{awy}	4.95±0.24^{ax}	4.70±0.16^{ax}	5.02±0.10
	CUD	4.83±0.16^{axy}	4.59±0.20^{ax}	4.75±0.49^{ax}	4.79±0.13
	Fresh	4.64±0.10^{axz}	4.22±0.24^{ax}	4.70±0.47^{ax}	4.59±0.09
Na (mmol/l)	FOD	130.59±2.65^{aw}	129.50±4.85^{ax}	134.16±9.45^{ax}	130.79±2.26
	CUD	119.52±3.05^{axy}	135.15±3.13^{ax}	129.22±4.82^{ax}	122.38±2.62
	Fresh	114.26±3.05^{axz}	121.61±6.95^{ax}	112.70±7.94^{ax}	114.49±2.70
K (mmol/l)	FOD	6.03±0.20^{acw}	4.52±0.41^{bx}	6.49±1.11^{adx}	5.88±0.21
	CUD	5.26±0.23^{axy}	4.58±0.17^{abx}	6.91±0.22^{cx}	5.33±0.20
	Fresh	4.90±0.17^{axz}	5.25±0.32^{ax}	5.78±0.38^{ax}	5.03±0.15
Cu (ppm)	FOD	1.24±0.09^{awy}	0.87±0.22^{ax}	0.61±0.82^{ax}	1.13±0.08
	CUD	1.15±0.78^{ayz}	0.83±0.19^{ax}	0.73±0.05^{ax}	1.07±0.07
	Fresh	0.95±0.06^{az}	0.83±0.15^{ax}	0.65±0.07^{ax}	0.91±0.05
Fe (ppm)	FOD	3.03±0.31^{ax}	3.69±1.10^{ax}	3.83±1.54^{ax}	3.19±0.30
	CUD	3.20±0.31^{ax}	3.64±1.04^{ax}	2.49±1.19^{ax}	3.19±0.29
	Fresh	3.23±0.36^{ax}	4.38±1.41^{ax}	1.77±0.29^{ax}	3.24±0.34
Zn (ppm)	FOD	1.29±0.08^{ax}	0.99±0.14^{ax}	0.92±0.11^{ax}	1.22±0.07
	CUD	1.27±0.11^{ax}	0.96±0.13^{ax}	0.95±0.18^{ax}	1.20±0.91
	Fresh	1.01±0.09^{ax}	0.81±0.10^{ax}	0.99±0.16^{ax}	0.99±0.07

Values bearing different superscript (a, b, c, d) in a row differ significantly (p<0.05)
Values bearing different superscript (w, x, y, z) in a column differ significantly (p<0.05)

Magnesium

Significantly higher (p<0.05) values were observed in the cows of farm no. 3 as compared to the farm no. 2 from FOD period upto fresh period (Table 3).

Plasma Inorganic Phosphorus

Mean plasma Pi levels were 5.07±0.12, 4.95±0.24, 4.70±0.16 mg/dl during FOD period; 4.83±0.16, 4.59±0.20, 4.75±0.49 mg/dl during CUD period, while it was 4.64±0.10, 4.22±0.24 and 4.70±0.47 mg/dl during fresh period in the cows of the farm no.1, 2 and 3, respectively. Within a farm, significant decrease was observed in the farm no. 4 between the FOD and fresh period (Table 3).

Sodium

Significant decrease was noted in the mean plasma Na levels in cows from farm no. 4 from late pregnancy upto early lactation period (Table 3).

Potassium

Significantly lower values were observed in farm no. 2 in comparison to farm no. 1 and 3 during FOD and from farm no. 3 during CUD period. Within a farm, a significant decrease was observed in the farm no. 1 between FOD and fresh period (Table 16).

Copper

Within farm, a significant (p<0.05) decrease was observed in the farm no. 1, whereas in farm no. 3 a non significant increase was from the FOD period upto fresh period (Table 3).

Iron

Non significant differences were observed between the farms during various periods (Table 3).

Zinc

From the Bathinda district, the mean plasma Zn concentration were 1.29±0.08, 0.99±0.14, 0.92±0.11 ppm during FOD period; 1.27±0.11, 0.96±0.13, 0.95±0.18 ppm during CUD period and 1.01±0.09, 0.81±0.10 and 0.99±0.16 ppm during fresh period in the cow of farm 1, 2 and 3, respectively. (Table 3).

Overall, the variation across farms points to differences in nutrition, management, and health interventions. The results reinforce the need for targeted mineral and metabolic monitoring during the periparturient period to optimize dairy cow health and productivity.

Calcium levels declined postpartum in all farms, suggesting subclinical hypocalcemia, with farm no. 2 showing the lowest values. This pattern is in agreement with previous findings linking hypocalcemia to high milk yield and insufficient adaptation postpartum (Goff, 2004) [15]. Magnesium levels were better maintained in farm no. 3, suggesting improved mineral nutrition. Decreased phosphorus and sodium postpartum may relate to losses through milk and stress-related hormonal shifts (Deshpande *et al.,* 1998) [16]. Decline in copper and zinc, particularly in farm no. 2, could impair immune function and antioxidant defenses (Yokus and Cakir, 2006) [17]. The inter-farm differences in iron and potassium suggest variable mineral management practices (Jacob *et al.,* 2003) [18]. Similar results were observed in my another study (Singh *et al.,* 2016) [19]

Overall, the variation across farms points to differences in nutrition, management, and health interventions. The results reinforce the need for targeted mineral and metabolic monitoring during the periparturient period to optimize dairy cow health and productivity.

Conclusion

This study provides baseline data on key hematological, biochemical, mineral, and energy-related parameters in crossbred cows during the periparturient period in Bathinda district. A significant decline in hemoglobin, PCV, glucose, calcium, and protein levels, particularly during the fresh period, underscores the metabolic stress experienced by cows postpartum. Elevated BHBA and NEFA levels, along with hypocalcemia and protein depletion in some farms, reflect an increased risk of metabolic disorders like ketosis and hypocalcemia. The observed inter-farm variability in metabolic indices points to differences in feeding practices, mineral supplementation, and overall herd management. These findings reinforce the need for proactive metabolic monitoring and customized nutritional management in the transition phase to safeguard cow health and enhance productivity in high-yielding crossbred dairy animals.

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