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Effects of prepartum metabolic health of crossbred cattle on birth weight of calves

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Abstract

Calfhood diseases have a major impact on economic viability of cattle operations, due to direct costs of calf losses and treatment, and long term effects on their performance. Physiological measures that have been suggested to influence calf risk of morbidity and mortality include high or low weight at birth of the calf. The present study aimed to investigate influence of pre-partum metabolic profile of crossbred cattle on calf birth weight. Thirty crossbred cattle were monitored, out of which 19 gave birth to normal weight calves (i.e. ≥24 kg) (Group I) and the 11 gave birth to underweight calves (i.e. <24 kg) (Group II). Body condition score (BCS), back fat thickness (BFT), serum non esterified fatty acid (NEFA), oxidative stress markers, serum inorganic phosphorus and magnesium did not differ significantly at far off dry (FOD) and close up dry (CUD) transition stages between Group I and II. The mean serum β- hydroxyl butyric acid (BHBA) was significantly ($p<0.05$) higher at FOD, serum BUN and creatinine were significantly ($p<0.01$) higher at close up dry (CUD) in Group II. The mean serum glucose concentration was significantly ($p<0.01$) lower at far off dry (FOD) and close up dry (CUD), mean serum total proteins and albumin concentrations were significantly ($p<0.05$) lower at close up dry (CUD), mean serum calcium concentration was significantly ($p<0.05$) lower at far off dry (FOD) in Group II. It is concluded that birth weight of calf is affected by pre-partum metabolic health of the dam.

Key words: Cattle calves, Metabolic, Prepartum, Oxidative stress, Birth weight

Raising young calf is one of the most crucial jobs on a dairy farm. Success with the calf starts with proper care of the mother, especially during the dry period. The cow needs a 45 to 60 days dry period to allow her to rebuild body reserves and, regenerate milk secretary tissues, and develop the fetus. Dry cows should be fed properly so that they will be in good but not fat condition at calving (Moss and Coleman, 1991). Several parameters are proposed for measuring a calf's predisposition to morbidity or mortality. Physiological measures that have been suggested to influence a calf risk of morbidity or mortality include high and low birth weight (Pare *et al*., 1993). Energy and nitrogen demands of fetus in the late pregnancy are mostly met by placental uptake of maternal glucose and amino acids. The resulting 30-50% increase in maternal requirements for these nutrients is met partly by increased voluntary intake and partly by an array of maternal metabolic adaptations. The latter include increased hepatic gluconeogenesis from endogenous substrates, decreased peripheral tissue glucose utilization, and increased fatty acid mobilization from adipose tissue (Bell, 1995). Metabolic health of dairy cattle during pre-partum period could affect birth weight of calf. Lighter calves may be premature and unable to suckle adequately (Kotebra and Madigan, 1990), resulting in increased susceptibility to diseases. Such calves may experience additional risk because they have a greater body surface area in relation to their body mass, which would allow heat to dissipate and increase their energy requirements (Guyton, 1981).

Materials and Methods

The study was conducted to assess metabolic profile and oxidative stress in crossbred cattle during pre-partum period in relation to birth weight of the calves. Thirty pregnant crossbred cattle were selected, out of which 19 (Group I) gave birth to normal weight calves (i.e. ≥24 kg) and 11 (Group II) gave birth to underweight calves (i.e. < 24 kg). The cattle were monitored during the different stages of the dry period as follows,

***Far off dry (FOD)*:** Period between 30 and 50 days prior to expected date of calving.

***Close up dry (CUD)*:** Period between 3 and 21 days prior to expected date of calving.

Crossbred cattle in advance pregnancy stages were shifted to individual calving pens, 60 days prior to expected date of calving. They were supplied with

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free access to drinking water, ad-libitum seasonal green fodder and concentrate (2 kg / head + maintenance ration). Healthy animals were shifted from individual calving pens to loose housing system within 4-5 days of calving. Body condition score (BCS) of the cattle was measured on a scale of 0 -5 and subcutaneous back fat thickness (BFT) was measured ultrasonographically at FOD and CUD. Calves born from these buffaloes were weighed immediately after birth. Blood samples of the cattle were collected by jugular venipuncture during the FOD and CUD stages of the prepartum period. Serum was harvested from the blood samples collected in clot-activator vials for analysis of NEFA, BHBA, BUN, creatinine, TP, albumin, Ca, Pi and Mg. Blood samples were also collected in 2 ml vials containing sodium fluoride for glucose estimation. To determine oxidative status, blood samples (8 ml approx.) were collected in 15 ml heparinised vials. Serum Non-esterified fatty acid (NEFA) and β- hydroxyl butyric acid (BHBA) were estimated by ELISA kits (Randox Laboratories Limited, UK). Oxidative status markers viz. erythrocytic lipid peroxidation (melondialdehyde, MDA) was estimated by the method of Placer *et al.*, (1966), and erythrocytic reduced glutathione (GSH) was estimated by the method of Hafeman *et al.*, (1974).

Blood glucose, serum BUN, creatinine, total proteins, albumin, calcium, phosphorus and magnesium were analyzed on Vitros 350 biochemistry analyser Orthodiagnostic's using commercial diagnostic kits supplied by Johnson and Johnson, USA.

Data was analyzed by using Statistical Analysis System (SAS) for window version 9.4 Inc, USA computer software program. Effects of pre-partum metabolic profile of the cows/dams on the birth weight of calves were analyzed using independent sample T test.

Results and Discussion

Energy metabolism: Body condition score (BCS) and back fat thickness (BFT) did not differ significantly at FOD and CUD between Group I and Group II (Table 1). The mean BCS of dams with normal weight calves and underweight calves were 3.42±0.06 and 3.50±0.10 at FOD, and 3.80±0.07 and 3.05±0.13 at CUD, respectively. Serum NEFA did not differ significantly at pre-partum transition stages between Group I and Group II (Table 1). The mean serum NEFA concentrations of dams with normal weight calves and underweight calves were 0.26±0.02 and 0.30±0.04 mmol/l at FOD, and 0.34±0.02 and 0.39±0.04 mmol/L at CUD, respectively. The mean serum BHBA concentration was significantly ($p<0.05$) higher at FOD in Group II. The mean serum BHBA concentration of dams with normal weight calves and underweight calves were 0.39± 0.02 and 0.46± 0.04mmol/L at FOD transition stage. In the present study, there was no significant variation in body condition score and back fat thickness between two groups. Contrary to present results, Spitzer *et al*., (1995) observed that birth weights of calves were influenced by the BCS of cows at parturition. Although cows with BCS of 6 had calves that weigh 3.5 kg more than calves from dams with a BCS of 4, the increase in birth weight was not accompanied by an increase in dystocia. There was also no significant variation in serum NEFA concentration between two groups. Higher NEFA concentrations at close up dry (0.4mEq/L) period are associated with increased risk for many periparturient diseases (Anderson and Rings, 2009). Higher serum non esterified fatty acids (NEFA) concentration reflects more body fat mobilization in response to negative energy balance or stress condition. Elevated NEFA levels indicate that dietary energy intake is insufficient for needs of cattle

Table 1. Body condition score and energy metabolism during prepartum period in cattle of normal weight calves (birth weight ≥24 kg, Group I) and underweight calves ((birth weight <24 kg, Group II) (Mean±SE).

Parameters	Group I (n=19)	Group II (n=11)	Group I (n=19)	Group II (n=11)
	Far off dry		Close up dry	
Body condition score	3.42±0.06	3.50±0.10	3.08±0.07	3.05±0.13
Back fat thickness (cm)	1.24±0.06	1.42±0.09	0.96±0.04	1.03±0.07
Serum NEFA (mmol/L)	0.26±0.02	0.30±0.04	0.34±0.02	0.39±0.04
Serum BHBA (mmol/L)	0.39±0.02	0.46±0.04*	0.50±0.02	0.57±0.04

*Significant at ($p<0.05$).

Table 2. Oxidative status during prepartum period in cattle of normal weight calves (birth weight ≥24 kg, Group I) and underweight calves ((birth weight <24 kg, Group II) (Mean±SE).

Parameters	Group I (n=19)	Group II (n=11)	Group I (n=19)	Group II (n=11)
	Far off dry		Close up dry	
LPO/MDA (nmol/gHb)	208.10±11.30	215.50±9.25	246.95±7.34	253.19±7.36
GSH (mM)	2.67±0.04	2.69±0.06	2.39±0.04	2.44±0.05

*Significant at (p<0.05).

for milk production or fetal growth and that body fat is broken down to compensate the energy deficit. The BHBA concentrations of 0.96 mmol /L and greater are associated with increased risk of a cow experiencing metabolic diseases (Andersons and Rings, 2009). It was reported that prepartum NEFA and BHBA were both significantly associated with development of clinical diseases in dairy cows including RP and metritis (Hammon *et al.*, 2006). Siefi *et al*. (2007) showed higher concentration of NEFA and BHBA in the cows with retained placenta than cows without retained placenta. The decrease in energy intake due to reduced feed intake, result in a negative energy balance (NEB), and this explains why cow lose significant amount of body weight and body score.

Oxidative status: The erythrocytic LPO/MDA (nmol/g Hb) and erythrocytic GSH (mM) did not differ significantly at FOD and CUD transition stages between crossbred cattle that gave birth to normal weight calves and underweight calves (Table 2). However, there was slight increase in values of lipid peroxidation in crossbred cattle that gave birth to underweight calves as compared to other group. Sharma *et al*. (2011) also used lipid peroxidation as a marker of oxidative stress in cattle and found an increase in the LPO levels near calving, as lipids were most susceptible to peroxidative damage due to presence of unsaturated bonds.

***Biochemical parameters*:** The mean serum glucose concentration was significantly (p<0.01 and p<0.05) lower at far off dry (FOD) and close up dry (CUD) transition stages in crossbred cattle who gave birth to underweight calves than those gave birth to normal weight calves (Table 3). The mean serum glucose (mg/dl) concentration of dams with normal weight calves and underweight calves were 60.42±1.23 and 54.45±1.24 mg/dl at FOD, 56.74±1.23 and 51.82±1.45 mg/dl at CUD transition stages. The mean serum BUN and creatinine concentration was significantly higher at close up dry (CUD) transition stages in crossbred cattle who gave birth to underweight calves than who gave birth to normal weight calves. The mean BUN concentration of dams with normal weight calves and underweight calves were 10.39±0.31 and 11.32±0.30 mg/dl at CUD

Table 3. Serum biochemical profile during prepartum period in cattle of normal weight calves (birth weight ≥24 kg, Group I) and underweight calves ((birth weight <24 kg, Group II) (Mean±SE).

Parameters	Group I (n=19)	Group II (n=11)	Group I (n=19)	Group II (n=11)
	Far off dry		Close up dry	
Glucose (mg/dl)	60.42±1.23	54.45±1.24**	56.74±1.23	51.82±1.45*
BUN (mg/dl)	9.37±0.27	9.64±0.30	10.39±0.31	11.32±0.30*
Creatinine (mg/dl)	1.26±0.04	1.26±0.06	1.11±0.04	1.34±0.07**
Total Proteins (g/dl)	7.28±0.12	6.95±0.15	7.12±0.08	6.59±0.14**
Albumin (g/dl)	3.12±0.06	2.98±0.06	2.97±0.04	2.85±0.05*
Ca (mg/dl)	10.04±0.16	9.57±0.20*	9.27±0.13	9.11±0.19
Pi (mg/dl)	5.28±0.09	5.47±0.21	5.11±0.08	5.19±0.21
Mg (mg/dl)	2.05±0.03	2.11±0.08	2.17±0.04	2.24±0.09

*Significant at (p<0.05), **Significant at (p<0.01) transition stage. The mean serum creatinine concentration of dams with normal weight calves and underweight calves were 1.11±0.04 and 1.34±0.07 mg/dl at CUD transition stage. The mean serum total proteins and albumin concentrations were significantly lower at close up dry (CUD) transition stages in crossbred cattle who gave birth to underweight calves than who gave birth to normal weight calves. The mean serum total protein concentration of dams with normal weight calves and underweight calves were 7.12±0.08 and 6.59±0.14 g/dl at CUD transition stages. The mean serum albumin concentration of dams with normal weight calves and underweight calves were 2.97±0.04 and 2.85±0.05 g/dl at CUD transition stage. The results were supported by Kumar *et al*. (2016) who observed that crossbred cattle that developed metabolic diseases had significantly lower concentrations of glucose than healthy crossbred cattle. Similarly, Van Saun (2004) suggested that sick cows had lower plasma glucose concentration compared to healthy cows in the transition period. Significant differences for serum BUN concentration have been reported in previous study (Kumar *et al*., 2016). The creatine kinase is increased near calving in cows that had suffered from any disease. Creatine conversion to phosphocreatine is catalyzed by creatine kinase; spontaneous formation of creatinine occurs during the reaction. The fall in serum total proteins and albumin concentrations towards the end of pregnancy might be due to the increasing nutrient requirement of the growing fetus (Lone *et al.,* 2003). These variations reflect the maternal requirements of protein need for milking and providing immunoglobulins. In cows, the total protein level begins to decline towards the term due to the transport of immunoglobulin from serum to mammary gland that begins several weeks before parturition, reaching a peak, 1 to 3 days before birth of the calf (Weaver *et al*., 2000).

Mineral status: The mean serum calcium concentration was significantly ($p<0.05$) lower at far off dry (FOD) transition stage in crossbred cattle who gave birth to underweight calves than who gave birth to normal weight calves (Table 3). The mean serum calcium concentration of dams with normal weight calves and underweight calves were 10.04±0.16 and 9.57±0.20 mg/dl at FOD transition stage. The mean serum inorganic phosphorus and magnesium concentration did not differ significantly at pre-partum transition stages between crossbred cattle who gave birth to normal weight calves and those who gave birth to underweight calves. Assessment of calcium concentrations around the time of calving is a useful indicator of how well the Ca regulatory system works and potential for clinical or subclinical hypocalcaemia problems. The higher risk of an inflammatory situation could contribute to the Ca reduction as an effect of some cytokines. The variations in plasma minerals around parturition might be due to phosphorus mobilization across the placenta for the growth and development of fetal skeleton. Larsen *et al*., (2001) also reported a decrease in the plasma calcium concentration in dairy cows approaching parturition.

It is concluded that birth weight of the crossbred cattle calves is affected by pre-partum metabolic health of the dam.

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