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Nutritional status of high yielding crossbred cow around parturition

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ABSTRACT

Objective: The objective of this study was to evaluate nutritional status of high yielding dairy cattle around parturition.
Materials and methods: Nutritional status of cows around the peri-parturient period was investigated for six months in dairy farm. Seven to eight months' pregnant cows were selected for this study. Blood samples from 24 randomly selected cows were collected at stage-1, -2 and -3. The serum was stored at -20ºC until analyzing glucose, total protein (TP), albumin (Alb), triglycerides (Tg), cholesterol, high density lipoprotein (HDL), low density lipoprotein (LDL), calcium (Ca), magnesium (Mg) and phosphorus (P).
Results: An increasing trend of glucose level was evidenced (P=0.07) during stage-1. Instead, higher levels of TP were found during stage-3 as compared to the stage-1 and -2. The Alb levels differed significantly (P<0.01) among different stages. A significantly increased (P<0.01) cholesterol, Tg, and HDL were found after parturition (stage-2 and -3) than before parturition (stage-1). LDL was significantly (P=0.02) increased during stage-2 and -3. A significantly higher level of Ca (P<0.01), Mg (P<0.01) and P (P=0.03) were present during stage-1. Glucose, TP, cholesterol and Tg were significantly higher (P<0.01) in cows two months after parturition, while Alb was found to be the highest (P<0.01) in cows immediately after parturition. An increasing trend of LDL (P=0.07) and HDL (P=0.07) were found in the cows two months after parturition. However, Ca levels were significantly (P=0.04) higher in cows two months after parturition.
Conclusion: The results indicate that there is alteration of biochemical levels among the study population at three different stages, and these data may be helpful in using the necessary nutrients to the the high yielding cows around their parturition.

KEYWORDS

Crossbred cow, High yield, Nutritional status, Parturition

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INTRODUCTION

Commercial dairy farming has been rising day by day in Bangladesh to fulfill the increasing demand of milk in a growing population and to generate employment opportunity. With the introduction of artificial insemination using semen from exotic dairy breeds in the dairy industry, the population of high yielding crossbred dairy cattle has been increasing, resulting in rise of milk production up to 3.7 million ton per annum (Zahurul et al., 2010). Although the milk production is increased, the high yielding dairy cattle has been facing various problems in and around the peri-parturient period, which includes metabolic disorders, dystocia, retention of placenta and poor fertility.

The peri-parturient period is an important stage for dairy cow since physiology of the dairy cow change due to rapid growth of fetus, milk production and subsequent reproductive health after parturition (Bell, 2000). At the period of late pregnancy and early lactation, massive metabolic challenge is occured to the high-yielding dairy cows. During these periods (late pregnancy and early lactation), the haemato-biochemical profiles are significant in assessing the health position of animals (Bell, 2000; Hagawane et al., 2009). Closely after calving, high rates of body condition score declines are related with a severe negative energy balance, showed by changes in blood metabolites and hormone profiles (Wathes et al., 2009).

The significant indicators of the state of the animal health depend on the changes in biochemical and hematological constituents (Hassan et al., 2012). Some variables such as breed, age, stage of growth, stage of lactation and reproduction status have an effect on several biochemical parameters (Doornenbal et al., 1988). There are limited studies in Bangladesh to evaluate the dairy cows' health status in and around the peri-parturient period. In view of the above circumstances, the present study was undertaken to determine the changes of selective biochemical parameters before and after parturition in high yielding crossbred dairy cows in a well-established dairy farm. Therefore, the present study was aimed at evaluation of nutritional status of high yielding dairy cattle around parturition.

MATERIALS AND METHODS

A cross sectional study was carried out in Paharika Farm Ltd., a well-organized intensive commercial dairy farm at Fatikchari, Chittagong for a period of six months from June 2014 to November 2014. There were a total of three hundred cattle in the farm; among them 30 were male and 270 were female. Among 270 female, 50 were heifers, 90 were dry cows and 130 were milking cows. A total of twenty-four crossbred Holstein Friesian dairy cows were chosen for the study. The selected cows had same parity, similar body condition score (BCS), and were around 25-30 days earlier from the expected delivery date.

Twenty-four selected cows were given unique identification numbers by proper tagging and monitored for 3 months for three different phases during June to November of 2014. The phases were included as one month before projected date of parturition (stage 1), within 7 days after parturition (stage 2) and 2 month after parturition (stage 3). From each cow, blood samples were collected during three consecutive phases. A total of 72 blood samples were collected during three phases.

Necessary consent from the farm owner was taken, and the samples were collected as per the ethical guidelines giving no harm to the animals. Approximately 5 mL blood was aseptically collected between 7 am to 10 am from the jugular vein via vein puncture by proper restraining technique. Collected blood samples were preserved in a vaccutainer (BD Vaccutainer, NJ, USA) without using any anticoagulant for perfect coagulation. After 3 h, the coagulated blood samples were centrifuged using a centrifuge machine (Hettich ZENTRIFUGEN-EBA 20, Tuttlingen, Germany) for 20 min at 3000 rpm. The serum samples were centrifuged at the farm level before transporting them back to the research laboratory. Obtained serum samples were transferred to eppendorf tube and given a unique identification number. Then the samples were kept in a cool box for transportation from study area to research laboratory at the Department of Physiology, Biochemistry and Pharmacology (DPPB), Faculty of Veterinary Medicine (FVM), Chittagong Veterinary and Animal Sciences University (CVASU). After reaching the laboratory, the serum samples were further centrifuged using micro-centrifuge machine (CR-68X, Odense, Denmark) at 3000 rpm for 15 min to get pure serum. The serum was separated and transferred to a new eppendorf tube using a micropipette. The eppendorf tube was tagged properly and stored in -20^{o}C until further analysis.

Appropriate aseptic methods were taken at the serum analysis time in the laboratory. Before the analysis, serum and all reagents were thawed at room temperature for 30 min. The serum samples were vortexed for homogenous mixing components of serum. Concentration of glucose, TP, Alb, Tg, Cholesterol, HDL, LDL, Ca, P and Mg were assayed using an automated biochemical analyzer (Humalyzer-3000®, Guatemala, Germany) according to the prescribed protocol given by the kit manufacturer.

Randox kits (Randox Laboratories Limited, London, UK) were used for determination of glucose, TP, Alb, Tg, Cholesterol and Ca; Chroma test kits (BioAnalyt, Rheinstraße 17, Teltow, Germany) for P, and Mg; Biorex kits (Linear Chemicals, S.L. Mongat, Barcelona, Spain) for HDL, and LDL. A total number of 72 serum samples were analyzed according to manufacturer's instructions.

Statistical analysis: All results were stated as mean±standard deviation (SD). The biochemical analysis data were first entered in MS-Excel Worksheet and then exported into STATA 11 (Stata Corporation, Texas, USA). One way ANOVA was used to comparison the biochemical values among three stages of cow (stage-1- one month before the expected date of parturition, stage-2- within 7 days after parturition and stage-3- two months after parturition) whilst between the last two groups compared by t-test. Significance level was fixed for $^{A,B}P \leq 0.01$ and $^{a,b}P \leq 0.05$, $0.05 < P \leq 0.1$ was considered as a trend.

RESULTS

Glucose, total protein and albumin level in dairy cow before and after parturition (Figure 1):

A higher level of serum glucose (65.8±13.5 mg/dL) was found in stage 1 than stage 2 (49.8±8.6 mg/dL) and stage 3 (59.1±9.6 mg/dL). An increasing trend for the level of glucose was evidenced (P=0.07) during the stage-1. On the other hand, higher levels of TP were found in stage 3 (79.9±5.9 g/L) compared to stage 1 and stage 2. The Alb level significantly decreased (P<0.01) in stage 1 **(Figure 1)**.

Lipid profiles in dairy cattle before and after parturition (Table 1):

A significant increased (P<0.01) of cholesterol, Tg, and HDL was found in dairy cows after parturition (stage 2 and stage 3) compared to before parturition (stage 1). LDL was significantly (P=0.02) increased during stage 2 and stage 3 **(Table 1)**.

Mineral profiles in dairy cattle before and after parturition (Table 2):

It was found that a significantly higher level of Ca (P<0.01), Mg (P<0.01) and P (P=0.03) was present in stage 1 dairy cows. However, the lowest value of Ca (P<0.01) and Mg (P<0.01) were observed as 6.5±1 mg/dL and 2.1±0.3 in stage 2, respectively **(Table 2)**.

Overall nutritional assessment in serum biochemical level between two stages of dairy cows after parturition (Table 3):

Glucose and TP were higher significantly (P<0.01) in cows two months after parturition while Alb was found highest in cows immediately after parturition, which was also significant (P<0.01). Alternatively, a significant increase in cholesterol (P<0.01), Tg (P<0.01) was found in cows two months after parturition. An increasing trend for the level of LDL (P=0.07) and HDL (P=0.07) were found in cows after two months of parturition. Furthermore, levels of Ca were found to be significantly higher (P=0.04) in cows two months after parturition, no significant variation was observed in Mg and P levels when compared between the two stages of dairy cows after parturition **(Table 3)**.

DISCUSSION

The aims of the current study were to decide nutritional status around parturition of high yielding dairy cattle. Alterations of serum metabolic profiles in and around parturition of high yielding dairy cows are great challenge in the dairy industry. Before parturition, serum glucose levels of dairy cows was found to be within the normal limit (50-75 mg/dL) (Kaneko et al., 2008) but after parturition, glucose level reduced and a significant difference was found between two stages after parturition. This may be due to degree of hypoglycemia in peri-parturient cows that are more noticeable before than after calving (West, 1990). In contrast, serum glucose concentration was found to be significantly higher before parturition (stage-1) than early (stage-2) and late lactation (stage-3) which is coincided with the earlier findings (Al-Mujalli, 2008).

No significant variation (P=0.27) of TP level was found in the three stages of samples whereas highest TP was found two months after parturition. In a previous study it is found that the levels of total serum protein are affected significantly by the biological period and increases during lactation than late gestation (Piccione et al., 2012). The differences consider the maternal requirements of proteins which needed for milking and for providing immunoglobulin. The TP values are found in Holstein Friesian cows as 5.52±0.45 gm/dL, 4.83±0.88 gm/dL, 6.38±0.46 gm/dL in late gestation, post-partum and 15th week of lactation, respectively (Piccione et al., 2012). A TP decreasing trend in advanced pregnancy was reported in non-descriptive cows (Mehta et al., 1989), and Jersey and Holstein Friesian cross cows (Ghosh et al., 1991).

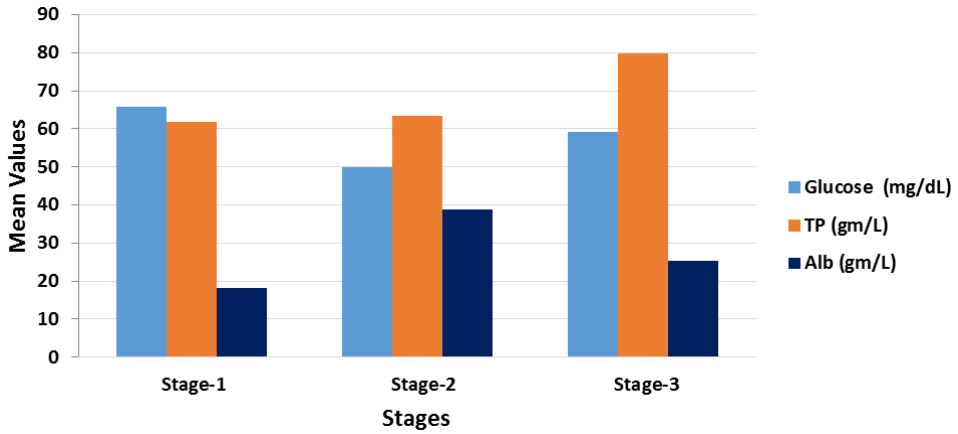

Figure 1: Assessment of glucose, total protein and albumin in three different physiological stages. TP=Total Protein, Alb=Albumin, $^{A,B}P \leq 0.01$ and $^{a,b}P \leq 0.05$, $0.05 < P \leq 0.1$.

Table 1. Assessment of lipid profiles in three different physiological conditions of studied dairy cow (mean±SD).

Parameters	Stage 1	Stage 2	Stage 3	*P*-value
Cholesterol (mg/dL)	121.3±23.8	188.2±48.9	238.4±45.9	<0.01
Tg (mg/dL)	47.7±20.3	49.5±13.2	85.03±8.8	<0.01
LDL (mg/dL)	37.9±30.8	81.9±54.2	111.8±52.9	0.02
HDL(mg/dL)	92.9±27.2	116.2±42.8	143.6±60.9	<0.01

Tg= Triglyceride, LDL= Low density lipoprotein, HDL= High density lipoprotein, SD= Standard deviation, $^{A,B}P \leq 0.01$ and $^{a,b}P \leq 0.05$, $0.05 < P \leq 0.1$.

Table 2. Assessment of minerals profiles level in three different physiological conditions in studied dairy cow (mean±SD).

Parameters	Stage 1	Stage 2	Stage 3	*P*-value
Ca (mg/dL)	9.3±1.8	6.5±1.0	7.2±0.9	<0.01
Mg (mg/dL)	2.6±0.6	2.1±0.3	2.2±0.3	<0.01
P (mg/dL)	9.3±1.8	6.2±2.6	6.1±1.5	0.03

Ca=Calcium, P=Phosphorus, Mg=Magnesium, SD= Standard deviation, $^{A,B}P \leq 0.01$ and $^{a,b}P \leq 0.05$, $0.05 < P \leq 0.1$.

Table 3. Overall nutritional assessment of selective serum biochemical parameters between two stages of dairy cattle after parturition.

Biochemical parameters	Within seven days after parturition (Stage-2), Mean±SD (95% CI)	Two months after parturition (Stage-3), Mean±SD (95% CI)	*P*-value
Glucose (mg/dL)	49.8±8.6 (46.2-53.5)	59.1±9.6 (55.1-63.2)	<0.01
TP (g/L)	63.5±8.2 (60.04-66.9)	79.9±5.9 (77.4-82.4)	<0.01
Alb (g/L)	38.7±12.7 (33.3-44.03)	25.4±3.4 (23.9-26.8)	<0.01
Tg (mg/dL)	49.5±13.2(45.9-55.04)	85.03±8.8 (81.3-88.7)	<0.01
Cholesterol (mg/dL)	188.2±48.9 (167.6-208.9)	238.4±45.9 (249.02-257.8)	<0.01
LDL (mg/dL)	81.9±54.2 (59.1-104.8)	111.8±52.9 (59.4-134.1)	0.07
HDL(mg/dL)	116.2±42.8 (98.1-134.3)	143.6±60.9 (117.9-169.4)	0.07
Ca (mg/dL)	6.5±1.01 (6.1-6.9)	7.2±0.9 (6.7-7.5)	0.04
Mg (mg/dL)	2.1±0.3 (1.9-2.2)	2.2±0.3 (2-2.2)	0.67
P (mg/dL)	6.2±2.6 (5.1-7.2)	6.1±1.5 (5.5-6.8)	0.98

TP= Total protein, Alb=Albumin, Tg=Triglyceride, LDL=Low density lipoprotein, HDL=High density lipoprotein, Ca=Calcium, Mg=Magnesium, P=Phosphorus, CI=Confidence interval, SD= Standard deviation, $^{A,B}P \leq 0.01$ and $^{a,b}P \leq 0.05$, $0.05 < P \leq 0.1$.

In our study, the level of Alb was significantly ($P<0.01$) increased after parturition and decreased two months after parturition , which is coincided with the previous findings who reported that Alb levels are found to decrease one week before parturition and return to normal limits at the end of fourth week after parturition (Al-Mujalli, 2008). Tainturier et al. (1984) find the Alb level in serum remain unchanged during pregnancy. Some authors (Little, 1974; Manston et al., 1975) have noted an average 10% decrease in serum Alb concentration in dairy cows at or close to calving.

In our study, significant variation in cholesterol level was found two months after parturition, which was higher than the earlier two stages. Similarly, there was also significant variation found in the case of Tg, which were

highest two months after parturition (85.03±8.8 mg/dL). In a study, it is observed that total cholesterol and Tg are significantly stimulated by the biological status, and exhibited considerable rises throughout the mid-lactation (Piccione et al., 2012). During the puerperal period, there might be an increase in the stipulation for controlling mechanisms accountable for all the procedures demanded with milking (Krajnicakova et al., 2003). For this reason, alterations in typical lipid metabolism are found throughout pregnancy and lactation in maximum animals (Roche et al., 2009). Throughout the pregnancy, endocrine profiles alteration, and lipolysis and lipogenesis are controlled to rise lipid keep in reserve. As a result, these reserves are applied following parturition and the beginning of lactation (Nazifi et al., 2002; Roche et al., 2009). The same effects was found by other researchers, indicating that concentrations of total lipids and triglycerides improved at parturition, in spite of the kind of fed administer (Douglas et al., 2004). On the contrary, some authors recommend that immunological conditions in dairy cows after calving are connected to total serum cholesterol values in the course of the dry period (Hiromichi et al., 2001).

In our study, we found higher levels of HDL (143.6±60.9 mg/dL) two months after parturition. Serum HDL levels were low in one month before parturition and increased significantly after consecutive stages. In the case of LDL, we found highest level of LDL (111.8±52.9 mg/dL) two months after parturition and LDL level was low in one month before parturition and increased significantly after sequential stages. We found both serum LDL and HDL levels were increasing after parturition. An increasing trend for the level of LDL (P=0.07) and HDL (P=0.07) were found in cows after two months parturition. In cattle, HDL is the main element including more than 80% of the lipoproteins (Holtenius, 1988). In an experiment, it is found that the levels of cholesterol and HDL are also suggestively higher in cows in late lactation. LDL concentrations are significantly lower in peri-parturient cows than in late lactation (Basoglu et al., 1998).

Serum Ca level decreased significantly one week after parturition as compared to 4 weeks before parturition. Serum Ca increased at the 8th week after parturition, but the level does not return to the normal limit. This discrepancy is due to more calcium let down for production of colostrum and more milk production. These finding coincide with the earlier study who report that levels of ca were 7.7±0.4 mg/dL, 5.7±1.0 mg/dL, 7.7±0.6 mg/dL, in late gestation; post-partum, 2nd week of lactation respectively (Piccione et al., 2012). Piccione et al. (2012) find P level in their study 5.7±0.7 mg/dL, 4.9±0.8, and 4.5±0.2 mg/dL in late gestation, post-partum, and 5th week lactation respectively. Mg was significantly higher one month before parturition and slightly decreases in the consecutive stages. Piccione et al. (2012) note that 2.1±0.2 mg/dL, 1.7±0.9 mg/dL, 2.1±0.2 mg/dL, 2.07±0.08 mg/dL of Mg level in late gestation, post-partum, 2nd week lactation, 5th week lactation respectively.

The passageway of Ca crossways the placenta is single directional; so, utilization of Ca from bone and elevated absorption from the gastrointestinal tract are essential to maintain optimum homeostasis (Szenci et al., 1994; Liesegang, 2008). Likewise, it is true that the prerequisite of Ca and P depends on the animal's productivity and physiological status of the animal. Milk yield is directly connected on milk phosphorus and calcium output, as milk level of P is persistent (Valk et al., 2002). In fact, more P from the ingested amount is transferred to milk which increasing milk production and less is excreted with feces (Valk et al., 2002). In our study, P and Mg serum levels were decreased after parturition. One study revealed that serum levels of Ca decrease significantly at calving compared with one month before and after calving. Phosphorus also decreases significantly at calving. On the other hand, Mg remains fairly constant over time (Meglia, 2004).

CONCLUSION

The current experiment found dissimilar levels of glucose, total protein, lipid profiles (Cholesterol, Tg, LDL and HDL), and minerals (Ca, Mg and P) around the peri-parturient period in crossbred cows. The analyzed parameters indicate that there was alteration of serum biochemical levels in the study population at three different stages of peri-parturient period. For comprehensive evaluation of the values of different parameters at different stages of parturient event, further studies should be carried out.

CONFLICT OF INTEREST

The authors declare that they have no competing interest.

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