Bangl. J. Vet. Med. (2020). 18 (2): 31–36 ISSN: 1729-7893 (Print), 2308-0922 (Online)

Received: 10-10-2020; Accepted: 30-11-2020 DOI: https://doi.org/10.33109/bjvmjd2020rm1

ORIGINAL ARTICLE

Biochemical status of serum and corresponding milk of cows kept under open grazing system in Sirajganj, Bangladesh

M. Z. Hossion[1], A. J. Shanta[1], K. M. Sujan[1], M. I. Haque[1], M. S. Islam[2], M. K. Islam[1]*

[1]Department of Physiology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh.
[2]Department of Pharmacology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh.

Abstract

Background: In open grazing dairy cattle farming, it is critical to identify and monitor health status and disease incidence. Testing of physiological parameters is essential to monitoring the health status of dairy herds. Therefore, the present study was carried out to evaluate the comparative status of serum chemistry and corresponding milk chemistry in cattle reared in open grazing system.

Methods: The research was conducted in 10 clinically healthy cows reared under open grazing system from different commercial farms of Baghabari in Sirajganj district. Blood samples were collected from individual animal through the jugular vein puncture. Corresponding milk samples were collected directly from teat during the morning milking time. Blood and milk samples were brought to the laboratory in an ice cooled sample transportation box. Total serum protein, glucose, cholesterol, calcium, phosphorus, sodium, potassium, chloride concentration and corresponding milk protein, lactose, cholesterol, calcium, phosphorus, sodium, potassium, chloride concentration were measured by using standard analytical techniques.

Results: Results showed that, there was a partially positive correlation among blood glucose and milk lactose (0.698), blood cholesterol and milk cholesterol (0.709), blood sodium and milk sodium (0.657). In addition, a strongly positive correlation was found between blood calcium and milk calcium (0.905). However, partially negative correlation between blood phosphorus and milk phosphorus (-0.688) was observed.

Conclusions: The study shows the prospect of effectively using comparative analysis of serum and corresponding milk constituents to construct a comprehensive model or technology for the betterment of dairy farming in Bangladesh.

Key words: Biochemical status, serum, milk, cows, correlation

*Correspondence: k.physiol@bau.edu.bd

Introduction

There are two alternative management methods for grazing dairy cows that improve the supply of nutrients and rumen synchrony between energy and protein provided by the diet. The first is stimuli motivation of herbage intake through the daily herbage allowance (Peyraud and Delagarde, 2013) and the second is by supplementation with conserved forages and concentrates (Morrison and Patterson, 2007). In open gazing dairy cattle farming, biochemical determination of serum constituents can provide valuable information's as relating to nutrition, sex, age and physiological status of the animal (Osman and Al-Busadah, 2003). Biochemical analyses of blood serum are very useful to compare the values obtained from ill animals with normal values in healthy animals and evaluate the body's internal condition (Jezek *et al.* 2006). Hematological and biochemical profile within normal physiological limits reflects a good health status and is highly correlated with milk production (Payne *et al.* 1970). The lactation phase also has influence on biochemical parameters of the blood and level of production (Jozwik *et al.* 2012). Blood electrolytes are very important in homeostasis, nerve impulse transmission, muscle contraction, ovarian steroidogenesis and the process of ovulation (Mohammadiha, 1991). The serum chemistry profile is one of the most important initial tests that are commonly performed. The changes in biochemical and hematological constituents are important indicators of the physiological or pathological state of the animal (Ahmed *et al.* 2009). It is well known that variables such as breed, stage of growth, age, reproduction status and stage of lactation have an influence on many blood parameters (Doornenbal *et al.* 1988). Measurement of these parameters provides a practical diagnostic tool for evaluating pathological conditions in live animals or for monitoring the health status of animals (Verheyen *et al.* 2007). There is a good correlation between the serological abnormalities of herd blood parameters and the existence of clinical problems within the herds (Blowey, 1992). The fertility and health status of farm animals has also been found to be significantly inversely related to levels of serum biochemical parameters such as serum inorganic phosphorus, serum potassium, serum total protein and serum urea-nitrogen (Hewett, 1974). Milk is a source of proteins, lipids, vitamins and minerals, and those constituents (lactose, lipids and most proteins) of milk are synthesized in the mammary gland from constituents absorbed from blood (Mohebbi-Fani *et al.* 2005). The composition of milk is of great importance for the dairy industry and there is great interest in changing the composition of milk. The correlation among chemical composition and trace elements in milk, and the relationship of trace elements between milk and serum were few analyzed. Numerous studies have focused on cow milk, although milk from other animal species such as buffaloes, sheep, goats and camels are essential to the human diet in various parts of the world. The correlation between blood and corresponding milk chemistry has been hardly investigated in veterinary research in Bangladesh. A very few experiments focusing this issue have been attempted by some authors but the real relationship has not been exemplified in those works. Therefore, keeping these in view, the study was performed to assess the calcium, phosphorus, potassium, sodium, chloride, total protein, total cholesterol and glucose level of serum in cow and the calcium, phosphorus, potassium, sodium, chloride, total protein, total cholesterol and lactose level of corresponding milk samples.

Materials and Methods

Experimental site and animal

Blood and corresponding milk samples were collected from 10 apparently healthy cows (Holstein-Friesian cross breed, 4 years of age) selected from different commercial farms of Baghabari in Sirajganj district where cattle were reared under free-range condition. The animals exhibited no signs of disease.

Collection and preparation of sample

All blood samples were collected between 10 am to 12 pm. Blood samples were taken from the jugular vein with proper aseptic measures. About 5 ml of blood was collected and kept in the vacutainer tube without using any anticoagulant. In addition, individual milk samples (1 per animal) were collected during the morning milking of a test day. Collected milk samples were preserved at -20^{o}C temperature at refrigerator until analysis. Then the samples were brought to the laboratory in an ice -cooled sample transportation box.

Preparation of serum

The tubes containing blood were placed in slanting position at room temperature for 1 hour. Then the clot was detached from the wall of the test tube carefully and allowed to settle down and afterward serum was collected. Collected serum was centrifuged at 3000 rpm for 15 minutes to obtain clear serum and then stored at -20^{o}C temperature until used.

Measurement of serum and milk electrolytes

Measurement of calcium, sodium, potassium and chlorine contents of both serum and milk were carried out by flame photometry (Corning 410, Sherwood Scientific Limited, UK) as described by Kirk and Sawyer (1991) and spectrophotometry method mentioned by Darcie and Lewis (2011) was used in the measurement of phosphorus in both serum and milk. Serum glucose concentration was measured by the glucose/oxidase method using a commercial kit (Biolabo, Glucose GOD-PAP, Cat.No 87109). Lactose content of milk was determined by standard high-performance liquid chromatography (HPLC) with a Thermo Scientific Dionex Corona™ Charged Aerosol Detector (CAD™). The determination involved a simple 1:100 dilution of milk.

Determination of total protein and total cholesterol

Total protein was determined by the Kjeldahl method (Barbano and Clark, 1990). Total serum cholesterol was determined by using standard procedure (Tinder, 1969). We used Biochemistry Humlyzer-3000 (Human type, Germany) against the blank reagent at 500 nm, 546 nm wave length. The result was expressed in mg/dl. Total milk cholesterol was determined by the same procedure.

Statistical analysis

Data were analyzed using IBM SPSS statistics 22. The procedure CORR was used to estimate the Karl Pearson's correlations between biochemical indicators in serum with milk parameters.

Results and Discussion

The serum values of measured glucose, protein, cholesterol, calcium (Ca), phosphorus (P), sodium (Na), potassium (K) and chlorine (Cl) for cow are presented in Table 1, while the values of milk sample are presented in Table 2. Serum glucose concentration in cow was found to be 3.54±0.88 mmol/L. Serum protein, cholesterol, calcium, phosphorus, sodium, potassium and chlorine level were: 5.84±1.08 mg/dl, 178.56±12.25 mg/dl, 9.97±2.17 mg/dl, 3.72±0.18 mg/dl, 135.33± 10.54 mmol/L, 4.12±1.19 mmol/L and 104.59±11.58 mmol/L respectively. In reference to the normal value, none of the parameters showed any alteration. These findings are in close agreement with the works reported by Ghanem *et al.* (2008). A slight increasing tendency was recorded for glucose, cholesterol and calcium. But a slight decreasing tendency was recorded for protein, phosphorus, sodium, potassium and chlorine. This increasing and decreasing tendency might be due to the preservation or types of grazing land.

In general, the serum concentrations of Ca, Na, K, P and Cl measured in this work are similar to the work of other researchers (Radostits *et al*. 2007; Kaneko, 2008) who registered the normal levels of serum ions in animals including sheep. However, Piccione *et al*. (2011) studied the seasonal concentrations of Na, K, P and Cl ions all over a year and found variations in those levels. On the other hand, milk lactose concentration in cow was found to be 0.64±0.05 mmol/L. Milk protein, cholesterol, calcium, phosphorus, sodium, potassium and chlorine level were: 5.68±1.16 mg/dl, 39.45±4.58 mg/dl, 35.64±7.55 mg/dl, 4.38±0.47 mg/dl, 18.25±3.95 mmol/L, 37.45±5.52 mmol/L and 28.99±7.14 mmol/L respectively.

Table 1. Concentration of serum glucose, protein, cholesterol, calcium, phosphorus, sodium, potassium and chlorine of cow (n=10)

Parameters	Ranges	Mean ± Standard Error (SE)
Glucose (mmol/L)	3.1-4.0	3.54±0.88
Protein (mg/dl)	5.2-6.3	5.84±1.08
Cholesterol (mg/dl)	172.9-182.0	178.56±12.25
Ca (mg/dl)	9.6-10.2	9.97±2.17
P (mg/dl)	3.6-3.9	3.72±0.18
Na (mmol/L)	132.1-139.4	135.33±10.54
K (mmol/L)	3.83-4.55	4.12±1.19
Cl (mmol/L)	101.4-108.1	104.59±11.58

Table 2. Concentration of milk lactose, protein, cholesterol, calcium, phosphorus, sodium, potassium and chlorine of cow (n=10)

Parameters	Ranges	Mean ± Standard Error (SE)
Lactose (mmol/L)	0.5-0.7	0.64±0.05
Protein (mg/dl)	5.1-5.8	5.68±1.16
Cholesterol (mg/dl)	34.3-46.5	39.45±4.58
Ca (mg/dl)	28.4-37.32	35.64±7.55
P (mg/dl)	4.1-4.5	4.38±0.47
Na (mmol/L)	12.8-22.3	18.25±3.95
K (mmol/L)	31.7-40.9	37.45±5.52
Cl (mmol/L)	28.1-29.9	28.99±7.14

Table 3. Correlation between the parameters of blood sample and those of milk sample of cow (n=10)

Parameters	Correlation coefficient	P-value
Blood glucose and milk lactose (mmol/L)	0.698*	* = Partial correlation (P<0.05)
Blood and milk Protein (mg/dl)	0.438*	* = Partial correlation (P<0.05)
Blood and milk Cholesterol (mg/dl)	0.709*	* = Partial correlation (P<0.05)
Blood and milk Ca (mg/dl)	0.905**	** = Strong correlation (P<0.01)
Blood and milk P (mg/dl)	-0.688*	* = Partial correlation (P<0.05)
Blood and milk Na (mg/dl)	0.657*	* = Partial correlation (P<0.05)
Blood and milk K (mg/dl)	-0.338*	* = Partial correlation (P<0.05)
Blood and milk Cl (mg/dl)	0.159*	* = Partial correlation (P<0.05)

In reference to the normal value, none of the parameters showed any alteration. These findings are in close agreement with the works reported by Ghanem *et al.* (2008). A slight increasing tendency was recorded for phosphorus, sodium, potassium and chloride. But a slightly decreasing tendency was recorded for glucose, protein, cholesterol and calcium. This increasing and decreasing tendency might be due to preservation, grazing land and age of lactation. Since a relative decline in the serum ions were recorded to multiple lactations as mentioned by Mayer and Fiechter (2012) who studied the milk constituents in sheep. It could be assumed that milk contains Na, K and P that may be decreased by milking. Weaning time is an important factor as mentioned by Lepherd *et al.* (2009) who described many properties related to weaned Merino lambs (9-16 weeks), they analyzed serum ions of Na, K and P as well as complete blood picture, enzymes and other nutrients.

According to the Table 3, there is a partially positive correlation among blood cholesterol and milk cholesterol (0.709), blood glucose and milk lactose (0.698), blood sodium and milk sodium (0.657), blood protein and milk protein (0.438), blood chlorine and milk chlorine (0.159). There is a partially negative correlation among blood phosphorus and milk phosphorus (-0.688), blood potassium and milk potassium (-0.338). But there is a strong correlation between blood calcium and milk calcium (0.905). Lactose is essential to form lipoprotein, whose main components are protein and cholesterol. May be that relation is exemplified in this findings. The symport type of mechanism which occurs in the intestinal luminal border, there is a couple transport system between the lactose and sodium ion (Bruce *et al.* 1998).

Lactose or milk sugar is composed of glucose and galactose and is synthesized in the gland principally from blood glucose. There is no evidence that the mechanism of synthesis of milk protein is any different from that of any other cell or tissue. Most of the casein complex, α-lactalbumin and β-lactoglobulin are the principal milk proteins synthesized in the gland from precursors found in the blood. In ruminants, the milk fat that is cholesterol is synthesized from blood. β-hydroxybutyrate, free fatty acids and some glycerol from the blood for synthesis of fat within the gland. Milk is high in calcium and phosphorus and has lesser amounts of potassium, sodium, sulfur, chlorine and magnesium. The gland concentrates inorganic phosphorus, calcium, potassium, iodine and some of the vitamins from the blood. The concentrations of sodium and chlorine are lower and potassium are higher than those of blood (McDonalds *et al.* 1989). It is thought that the correlation between the parameters of blood and milk is exemplified in these findings.

Conclusions

Based on the results, it can be concluded that comparative analysis of serum and their corresponding milk constituents can comprehensively evaluate the characterization of milk by cluster analysis. The mammary gland has a remarkable capacity to adapt to maternal deficiency or excess of Ca, P, Na, K, Cl and to homo-statically control milk concentrations of these essential nutrients. Our method along with other improved and enhanced methods, could be applied to construct a more comprehensive model or technology of animal behavior, diagnosis and could be better serviced for people.

Acknowledgement

Ministry of Science and Technology, Government of the People's Republic of Bangladesh.

Competing Interest

The authors declare that they have no competing interests.

References

1. Ahmed I, Gohar A, Ahmed N and Ahmed M. Hematological profile in cyclic and non- cyclic and endometritic cross breed cattle. International of Journal of Agriculture and Biology. 2009; 27: 83-91.
2. Barbano DM and Clark JL. Kjeldahl method for total nitrogen content of milk: Collaborative study. Journal association of official analytical chemists.1990; 73: 849-859.
3. Blowey RW. Digestive disorders of calves. Blackwell Scientific Publications, London. 1992; 10:194 – 201.
4. Bruce A, Dennis B, Julian L, Martin R, Keith R and James DW. Molecular Biology of the Cell. 3rd edn, Garland Publishing. 1998; Inc. 6: 24-25,
5. Darcie, JV and Lewis SM. Practical hematology. 11th edn., Elsevier, London. 2011.
6. Doornenbal H, Tong AK and Murray NL. Reference values of blood parameters in beef cattle of different ages and stages of lactation. Canadian Journal of Veterinary Research. 1988; 52: 99-105.
7. Ghanem AM, Jaber LS, Abi SM, Barbour EK and Hamadeh SK. Physiological and chemical responses in water deprived Awassi ewes treated with vitamin C. Journal of Arid Environments. 2008; 72:141-149.
8. Hewett C. On the causes and effects of variation in the blood profile of Swedish dairy cattle. Acta Veterinaria Scandinavia. 1974; 50:150-151.
9. Jezek J, Klopcic M and Klinkon M. Influence of age on biochemical parameters in calves. Bulletin of the Veterinary Research Institute in Pulawy. 2006; 50: 211-214.
10. Jozwik A, Strzałkowska N, Bagnicka E, Grzybek W, Krzyzewski J, Polawska E, Kolataj A and

Horbanczuk JO. Relationship between milk yield, stage of lactation, and some blood serum metabolic parameters of dairy cows. Czech Journal of Animal Science. 2012; 57:353-360.
11. Kaneko JJ, Harvey W and Bruss ML. Clinical Biochemistry of Domestic Animals. 6th edn., Academic Press, London. 2008.
12. Kirk RS and Sawyer R. Pearson's Composition and Analysis of Foods, 9th edn (student edition); 1991; 33, 35-36.
13. Lepherd ML, Canfield PJ, Hunt GB and Bosward KL. Haematological, biochemical and selected acute phase protein reference intervals for weaned female Merino lambs. Australian Veterinary Journal. 2009; 87: 5-11.
14. Mayer HK and Fiechter G. Physical and chemical characteristics of sheep and goat milk in Austria. International Dairy Journal. 2012; 24: 57–63.
15. McDonald. Veterinary Endocrinology and Reproduction, 3rd edition, Lea & Febiger, Philadelphia, USA. 1989.
16. Mohammadiha H. Clinical biochemistry for medical laboratory technologists (in parsian). 1st.edn.Tehran university publications, Tehran. 1991; 6: 475-477.
17. Mohebbi-Fani M, Shekarforoush SS, Nahid S and Dehdari M. Changes in and correlations between some serum constituents and milk components from early to late lactation in a dairy herd with subclinical production disorders. Iranian Journal of Veterinary Research. 2005; 6: 2-12.
18. Morrison SJ and Patterson DC. The effects of offering a range of forage and concentrate supplements on milk production and dry matter intake of grazing dairy cows. Grass and Forage Science. 2007; 62:332-345.
19. Osman TEA and AL-Busadah KA. Normal concentrations of twenty serum Biochemical parameters of sheep, camels, cows and Ewes in Saudi Arabia. Pakistan Journal of Biological Science. 2003; 6: 1253-1256.
20. Payne JM, Dew SM, Manston RI and Margaret F. The use of a metabolic profile test in dairy herds. Veterinary Record. 1970; 87:150-158.
21. Peyraud JL and Delagarde R. Managing variations in dairy cow nutrient supply under grazing. Animal. 2013; 7:57-67.
22. Piccione G, Messina V, Vazzana I, Dara S, Giannetto C and Assenza A. Seasonal variations of some serum electrolyte concentrations in sheep and goats. Comperative Clinical Pathology. 2011; 15: 60–8530.
23. Radostits OM, Henderson JA, Blood DC, Arundel JT and Gay CC. Veterinary Medicine: A Textbook of the Diseases of Cattle, Sheep, Pigs, Goats, and Horses. 11th Edn., Bailliere, Tindall Comp. UK. 2007.
24. Tinder P. Cholesterol Determination Test. Clinical Biochemistry. 1969; 6: 24-25.
25. Verheyen AJM, Maes DGD, Mateusen B, Deprez P, Janssens GPJ, de Lange L and Counotte G. Serum biochemical reference values for gestating and lactating sows. The Veterinary Journal. 2007; 174: 92 – 98.