

Original Research Article

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Assessment of Glucose, Total Protein, Albumin and Cholesterol Level and Its Correlation with Milk Production during Different Stages of Lactation in Indigenous and Crossbred Cows

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ABSTRACT

Keywords

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The study was undertaken to determine and compare the biochemical profile and its correlation with milk production in cattle. The study was done on each of six Gir, Kankrej and Crossbred cattle. The animals were divided in to three groups viz. 0-90 days of lactation (Group I), 91-180 days of lactation (Group II) and 181 till dry stage (Group III). Blood was collected aseptically before and after milking. The plasma biochemical estimations were carried out on BS - 120 Chemistry Analyser (Mindray) using the diagnostic kits. The values of glucose, more in Gir, as compared to Kankrej and crossbreds, while cholesterol, total proteins and albumin, were higher in crossbreds as compared to two other breeds. Stages of lactation had significant effect on all biochemical parameters except albumin. Non-significant differences were observed between the milking phases in all the stages and the breeds under study, however all the biochemical parameters were higher in after milking phase.

Introduction

In the beginning of lactation, dairy cows have to cope with the high energy and protein demands for milk synthesis and also when nutrient intake is low. In an effort to obtain the energy necessary for milk production, the cows use up their bodily reserves, predominately fats. An energy deficit at the beginning of lactation negatively impacts, health efficiency and reproduction

performance of dairy cows (Rao *et al.*, 1981). Mobilizing energy and protein from body tissue stores and repartition of nutrients away from extra mammary tissues are the primary alternatives to supply sufficient nutrients for milk production during the first weeks of lactation (Suphake *et al.*, 1989). Blood biochemical attributes are important indicators of the metabolic activity in lactating animals. During lactation, secretory cells of mammary gland utilize 80% of the blood circulating

metabolites for milk synthesis, depending on the speed of infiltration of precursors of milk compounds (i.e. free amino acids, glucose and fatty acids).

The total protein, albumin, are necessary for the maternal requirements of proteins for milking and providing immunoglobulins. The most important indicators of energy status of ruminants are glucose, cholesterol and triglycerides. The blood glucose is utilized by the mammary gland for the synthesis of milk lactose. Total lipids, and cholesterol are significantly affected by the physiological status, probably because, around calving, there is an increase in the demands for regulatory mechanism, responsible for all the processes involved with preparation for milking. Lipolysis and lipogenesis are regulated to increase lipid reserve during pregnancy, and, subsequently, these reserves are utilized following parturition and the initiation of lactation. There is also paucity of literature regarding the detailed biochemical constituents analysis of Gir, and Kankrej cattle at different stages of lactation. Keeping in view the above points, the present study was undertaken in Gir, Kankrej and Crossbred cattle to determine the activity of the biochemical constituents, changes in the levels before and after milking, their correlation to milk production and to apply systematic health monitoring and the animal breeding status in order to identify changes that occur as a consequence of pathological processes and changes in the metabolic status in good time.

Materials and Methods

The research was approved by the Institutional Animal Ethics Committee (IAEC, No.: 179/VPY/2014). The study was carried out on six each of Indigenous Gir, Kankrej and Crossbred cattle maintained at the Livestock Research Station, Anand Agricultural University, Anand, Gujarat. Female cattle of

various ages, parity and Lactation stages were used, The animals were divided in to three groups viz. 0-90 days of lactation (Group I), 91-180 days of lactation (group II) and 181 till dry stage (group III). The average 300 days milk yield (Kg) was 1839.20±86.66 in Gir, 2213.73±134.62 in Kankrej and 3393.22±383.10 in Crossbred cows. The animals were maintained under standard feeding and management conditions followed at Livestock Research Station, Anand Agricultural University, Anand, Gujarat. In Gir and Kankrej, the practise of suckling and hand milking was followed and in crossbred it was weaning and machine milking.

Blood collection was conducted during the months of July 2014 to April 2015. Blood was collected aseptically, between 0600 hrs to 0800 hrs of the day, 20 minutes before milking (B.M) and within 5 minutes after completion of milking (A.F), through the jugular vein. Ten ml blood was collected in a single venepuncture in Lithium Heparin vacutainer. The plasma biochemical estimations were carried out in the Department of Physiology and Biochemistry, College of Veterinary Science and Animal Husbandry, Anand Agricultural University, Anand, on BS - 120 Chemistry Analyser (Mindray) using the diagnostic kits manufactured by Crest Biosystems, Coral Clinical Systems, Goa (India)

The data obtained in the present study were subjected to statistical analyses by using BASIC (Beginners All purpose Symbolic Instructional Code) programme of the computer and applying the Factorial Completely Randomised Design (CRD) as per Snedecor and Cochran (1990).

Results and Discussion

The plasma glucose increased significantly ($P \leq 0.05$) in both before and after milking

stages with the advancement of lactation from stage -I to stage- III, in Gir, Kankrej and Crossbreds In each stage of the lactation a non-significant difference was observed between the milking phases (before and after milking) for plasma glucose. The range of mean plasma glucose in the present study was higher than that reported by Rao *et al.*, (1981) and Sharma *et al.*, (2001) for indigenous cattle, while it is in conformity with values reported by Ninan Jacob, (2012). The range of mean plasma glucose in our study was lower than that reported by Sreedhar *et al.*, (2013) for indigenous cattle and Singh *et al.*, (2005) for crossbred cattle. When the overall mean values, between the breeds and stages of lactation were compared it was observed that significantly ($P \leq 0.05$) higher values of plasma glucose were noted for crossbred cattle (86.58 ± 0.78) followed by Kankrej- (59.30 ± 0.56) and Gir cattle (58.58 ± 0.47), however this was not in agreement with the findings of Rawat *et al.*, (2006), who reported higher values in indigenous cows. The plasma glucose differed significantly ($P \leq 0.05$) among the stages of lactation, in all the breeds. Glucose values increased along with the progress of lactation, with lowest values reported in stage-I (65.31 ± 0.77) followed by stage-II (68.19 ± 0.82) and highest value in stage-III (70.95 ± 0.76). The difference, may be due to the fact that in early lactation, milk yield is more and thus milk sugar lactose. Therefore, for more synthesis of lactose more glucose is required, and thus lower levels in circulation. These findings were similar as reported by Krsmanovic *et al.*, (2013). However Suphke *et al.*, (1989) reported highest glucose values at the beginning of lactation.

The relatively low levels of plasma glucose at lactation could be indicative of a greater demand for glucose by the mammary gland for the synthesis of lactose which in turn controls the milk volume. Maintenance of

stable glucose concentration in blood involves, a finely regulated mechanism in which the liver, extra hepatic tissues and hormones like insulin, glucagon, epinephrine, glucocorticoids and thyroid hormones, play a major regulatory role (Collier, 1985).

The plasma total protein decreased significantly ($P \leq 0.05$) in both before and after milking stages with the advancement of lactation from stage -I to stage- III, in Gir while in Kankrej, the values increased in stage III of after milking stage. However, in the Cross bred the values increased significantly ($P \leq 0.05$) in both before and after milking stages from stage -I to stage- III, In each stage of the lactation a non-significant difference was observed between the milking phases (before and after milking) for plasma total protein. The range of mean plasma total protein in our study, was higher than that reported by Singh and Choudhary (1988) for indigenous cattle while Kumar *et al.*, (2001) and Dhama *et al.*, (2005) reported higher values for crossbred cattle. The finding in the present study on mean plasma total protein was in accordance with Singh *et al.*, (1996) and Zambrano *et al.*, (2009) for Crossbred cattle and Ninan Jacob (2012), Mahima *et al.*, (2013) for indigenous cattle. The range of mean plasma total protein in our study was lower than that reported by Amle *et al.*, (2014) for crossbred cattle. When the overall mean values, between the breeds and stages of lactation were compared it was observed that, the plasma total protein differed significantly ($P \leq 0.05$) among the breeds with highest values being recorded for cross bred cattle with (8.67 ± 0.09) followed by Kankrej (6.76 ± 0.15) and Gir cows (6.69 ± 0.12) which are at par. The plasma total protein differed significantly ($P \leq 0.05$) among the stages with total plasma protein decreasing as the lactation progressed with highest values in stage I (7.61 ± 0.18) followed by stage-III (7.27 ± 0.14) which was at par with stage-II (7.24 ± 0.16).

The findings were in conformity, with the studies of Ninan Jacob (2012) in Gir cattle in first stage of lactation and Rawat *et al.*, (2006). The plasma total protein decreased with progress of lactation in Gir and Kankrej however it increased with advance of lactation in crossbred cattle. The physiological status or lactation stage of the cows significantly can change the serum levels of protein, (EI-Sherif and Assad, 2001). The higher concentrate to forage ratio provided during the early lactation is generally associated with lower levels of fibre and higher levels of starch in the diet, which gives rise to an increased production of propionic acid in the rumen and an increased microbial protein supply (Heck *et al.*, 2009). This is reflected in the present study by an increase of total serum protein during the early stage of lactation.

The difference in the observations noted in the present study, with those of other authors may be due to the different breeds, stages of lactation, nutritional, management and environmental factors. Serum protein level indicates the balance between anabolism and catabolism of protein in the body and its concentration at any given time in turn is a function of hormonal balance, nutritional status, water balance and other factors affecting health (Samanta and Das, 2007). Furthermore, this increase in protein concentrations may also be ascribed to a disproportionate increase of high protein fed

to the yielders or an increased mobilization of protein in lactating animals (Setia *et al.*, 1992).

The Plasma albumin decreased significantly ($P \leq 0.05$) in both before and after milking stages with the advancement of lactation from stage -I to stage- III, in Gir while in Kankrej, the decrease was not significant. However, in the cross bred the values increased significantly ($P \leq 0.05$) in both before and after milking stages from stage -I to stage- III, In each stage of the lactation a non-significant difference was observed between the milking phases (before and after milking) for plasma albumin. When the overall mean values, between the breeds and stages of lactation were compared, it was observed that the plasma albumin differed significantly ($P \leq 0.05$) among the breeds with highest values recorded in cross bred cattle (4.68 ± 0.08) followed by Kankrej (4.03 ± 0.09) and Gir cattle (3.77 ± 0.08). The plasma albumin did not differ significantly among the stages of lactation. However the decreasing rate of serum albumin in Gir and Kankrej could be due to the decreased rate of biosynthesis by the liver due to metabolic stress of lactation (Kulkarni and Talvelkar, 1984). Plasma albumin levels are a reflection of plasma protein levels. The physiological status or lactation stage of the cows significantly can change the serum levels of albumin, (Otto *et al.*, 2000) (Table 1 and 2).

Table.1 Correlation between the biochemical constituents and milk yield in Gir, Kankrej and Crossbred cows

	Glucose	Protein	Albumin	Cholesterol
Gir	-0.502±0.98	-0.293±0.52	-0.436±0.87	-0.262±0.44
Kankrej	-0.487±0.89	-0.308±0.98	-0.426±0.62	-0.242±0.33
Cross bred	-0.442±0.18	-0.269±0.79	-0.394±0.87	-0.303±0.49

Table.2 Biochemical profile at different stages of lactation in indigenous and crossbred cattle (Mean \pm S.E.)

Parameter	Breed	Stages of Lactation						Overall mean
		I		II		III		
		BM	AF	BM	AF	BM	AF	
Glucose (mg/dl)	Gir	56.85 ^b \pm 0.32	56.79 ^f \pm 0.28	58.55 ^a \pm 0.24	58.55 ^e \pm 0.21	60.36 ^a \pm 0.66	60.38 ^d \pm 0.45	58.58 ^u \pm 0.47
	Kankrej	57.33 ⁱ \pm 0.47	57.46 ^l \pm 0.39	59.38 ^h \pm 0.47	59.26 ^k \pm 0.43	61.33 ^g \pm 0.33	61.05 ^j \pm 0.27	59.30 ^t \pm 0.56
	Cross bred	81.80 ^o \pm 0.76	81.65 ^r \pm 0.75	86.79 ⁿ \pm 0.79	86.62 ^q \pm 0.77	91.51 ^m \pm 0.72	91.11 ^p \pm 0.54	86.58 ^s \pm 0.78
	Overall Mean	65.31^x \pm0.77		68.19^w \pm0.82		70.95^v \pm0.76		
Total Protein (g/dl)	Gir	7.20 ^a \pm 0.11	7.11 ^d \pm 0.16	6.63 ^{ab} \pm 0.19	6.53 ^c \pm 0.18	6.36 ^b \pm 0.12	6.31 ^e \pm 0.05	6.69 ^t \pm 0.12
	Kankrej	7.40 ^g \pm 0.11	7.21 ^j \pm 0.03	6.62 ^h \pm 0.18	6.39 ^k \pm 0.15	6.45 ^h \pm 0.13	6.48 ^k \pm 0.10	6.76 ^t \pm 0.15
	Cross bred	8.35 ⁿ \pm 0.06	8.38 ^q \pm 0.04	8.67 ⁿ \pm 0.06	8.60 ^q \pm 0.08	9.04 ^m \pm 0.11	9.01 ^p \pm 0.10	8.67 ^s \pm 0.09
	Overall Mean	7.61^v \pm0.18		7.24^w \pm0.16		7.27^w \pm0.14		
Albumin (g/dl)	Gir	3.96 ^a \pm 0.08	3.97 ^d \pm 0.06	3.93 ^a \pm 0.08	3.77 ^e \pm 0.04	3.48 ^b \pm 0.07	3.49 ^e \pm 0.07	3.77 ^u \pm 0.08
	Kankrej	4.25 \pm 0.18	4.20 \pm 0.16	3.95 \pm 0.05	3.96 \pm 0.07	3.90 \pm 0.06	3.97 \pm 0.04	4.03 ^t \pm 0.09
	Cross bred	4.32 ^o \pm 0.06	4.30 ^r \pm 0.07	4.70 ⁿ \pm 0.06	4.61 ^q \pm 0.07	5.11 ^m \pm 0.03	5.06 ^p \pm 0.03	4.68 ^s \pm 0.08
	Overall Mean	4.16 \pm0.08		4.15 \pm0.10		4.16 \pm0.11		
Cholesterol (mg/dl)	Gir	173.20 ^c \pm 0.74	172.71 ^f \pm 0.06	180.40 ^b \pm 0.85	179.25 ^e \pm 1.22	191.03 ^a \pm 1.13	195.40 ^d \pm 1.74	181.99 ^t \pm 2.11
	Kankrej	174.05 ^h \pm 1.32	173.76 ^k \pm 1.13	179.88 ^h \pm 0.79	179.54 ^k \pm 0.93	195.97 ^g \pm 2.34	195.96 ^j \pm 2.05	183.19 ^t \pm 2.38
	Cross bred	180.81 ⁿ \pm 2.85	180.53 ^q \pm 2.78	186.99 ⁿ \pm 1.65	186.05 ^p \pm 1.59	190.20 ^m \pm 1.02	189.14 ^p \pm 1.19	185.62 ^s \pm 1.99
	Overall mean	175.84^x \pm2.22		182.02^w \pm1.85		192.95^v \pm1.89		

Note: Means having the same superscript do not differ significantly from each other within breed/overall mean (P<0.05), n=6
a-c: between gir before milking j-l: between Kankrej after milking s-u: between breeds
d-f: between gir after milking m-o: between crossbred before milking v-x: between stages
g-i: between kankrej before milking p-r: between crossbred after milking

The increase in values observed in crossbred cattle might be due to the fact that albumin is a transport protein and remains involved in transport of calcium, phosphorus, free fatty acids, fat soluble vitamins etc. So, with progression in lactation, the animal body has some mechanism which triggers to high albumin synthesis to accommodate the transport of several nutrients to the mammary gland (Rana *et al.*, 2009).

The plasma total cholesterol increased significantly ($P \leq 0.05$) in both before and after milking stages with the advancement of lactation from stage -I to stage- III, in Gir, Kankrej and Crossbreds. In each stage of the lactation a non-significant difference was observed between the milking phases (before and after milking) for plasma glucose. The Mean \pm S.E levels of plasma total cholesterol reported in the present study was higher than the value reported by Mahima *et al.*, (2013) in indigenous cattle and Singh *et al.*, (1996) in cross bred cattle. However the values were similar to findings of Ninan Jacob, (2012) and Rawat *et al.*, (2006) in indigenous cattle and Yaylak *et al.*, (2009) in crossbred cattle. Jadhav *et al.*, (1977) reported lower values than observed in present study in Indigenous cattle. When the overall mean values, between the breeds and stages of lactation were compared it was observed that significant ($P \leq 0.05$) breed differences were observed in the present study with maximum values recorded for cross bred cattle (185.62 ± 1.99) followed by Kankrej (183.19 ± 2.38) and Gir cows (181.99 ± 2.11) which are at par. The effect of stages of lactation was significant ($P \leq 0.05$) with total cholesterol values increasing as the lactation progressed from stage-I (175.84 ± 2.22) to stage-III (192.95 ± 1.89). Similar finding were observed by Rawat *et al.*, (2006), in Indigenous cattle. While, Picconne *et al.*, (2012) and Krsmanovic *et al.*, (2013) reported the similar finding as observed in the present

study in cross bred cattle. The plasma cholesterol values increased significantly as the lactation progressed in all the breeds under the study.

Cholesterol is needed for steroidogenesis. The slightly higher values in pregnant and early lactation are suggestive of increased steroidogenesis (Pal *et al.*, 1991). Moreover, oestrogens influence lipid metabolism through lipogenesis, which causes increased turnover of cholesterol. Additionally cholesterol acts as a fatty acid carrier in the form of cholesterol esters for milk synthesis. This may explain the increased concentration of cholesterol observed in the present study during lactation in all the breeds as higher concentration of cholesterol during lactation is a physiological adjustment to meet lactation requirements (Rawat *et al.*, 2006). Patel *et al.*, (2010) reported that the plasma total cholesterol, the precursor of steroid hormones, is closely associated with physiological status of animal, reproduction and lactation. They suggested that increasing trends of cholesterol concentration post-partum help in gonadal steroidogenesis, which subsequently increase the ovarian rebound and in pregnancy. Krsmanovic *et al.*, (20013) reported that total cholesterol and triglycerides levels were significantly affected by the physiological status. Probably because during the puerperal period, there is an increase in the demands for regulatory mechanism, responsible for all the processes involved with milking. The physiological status or lactation stage of the cows significantly can change the serum levels of cholesterol (Peterson and Walden, 1981). Serum cholesterol levels may be affected by fat content in high ratios during gestation stress and in the early stages of lactation; they may cause an increase in serum cholesterol (Ruegg *et al.*, 1992). Decrease in thyroid activity may explain the rise in serum cholesterol during mid-lactation, as in this

stage, cows are generally in a positive energy balance. Tissues such as the corpus leuteum and adrenal glands, use cholesterol for hormone synthesis, and thus, cholesterol levels may change in lactation period (Arave *et al.*, 1975).

Significant breed differences were observed in all the biochemical parameters under study, with the values of glucose, more in Gir, as compared to Kankrej and crossbreds, while cholesterol, total proteins and albumin, were higher in crossbreds as compared to two other breeds. Stages of lactation had significant effect on all biochemical parameters except albumin. The overall mean levels of glucose and cholesterol increased with progress of lactation, while the overall mean levels of total proteins decreased as the lactation advanced. Non-significant differences were observed between the milking phases in all the stages and the breeds under study, however all the biochemical parameters were higher in after milking phase.

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