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Dietary Effect on Milk Composition in Different Dairy Cattle Farms in Chattogram Metropolitan Area

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ABSTRACT

In the dairy industry milk is the most valuable product. The market value of milk depends on amount of yield and content of fat in milk. Breed or genetic factors are mostly correlated with the production rate and fat content in milk. For example, Jersey breed cattle have the highest fat and protein percentage in milk than other breeds. However, quality of milk also depends on other dietary factors such as crude fiber and crude protein content of the diet. Fermentation of crude fiber in rumen produces large amounts of acetic acid and butyric acid which act as a derivative of milk fat. Milk protein concentration depends on crude protein level in diet. In this study milk and feed samples were collected from eight dairy farms at Chattogram Metropolitan Area to investigate the dietary effect on milk composition. The highest fat, SNF percentage, and protein percentage of milk sample were found in case of Munna dairy farm in which crude fiber level and crude protein level of feed sample were higher than other dairy farm. The lowest fat, SNF percentage and protein percentage of milk sample were found in case of Moinuddin dairy farm in which crude fiber level of feed sample was lowest but level of crude protein in feed sample was near to Munna dairy farm. A better amount of crude protein in feed sample was found in case of Moinuddin dairy farm. However, due to mastitis and a poor management system, the protein content of milk on this farm was poor.

Keywords: Milk fat, Milk protein, Crude protein, Cattle farm, Dietary milk, Composition, and Crude fiber.

INTRODUCTION:

Bangladesh is an Agro-based nation. A large portion of the general population can acquire their day by day pay from farming and animals division. "Dairy" is a noteworthy piece of domesticated animals. The general term milk alludes to dairy animal's milk; the lacteal discharge, for all intents and purposes free from colostrums, got by the complete milking of one or more sound cows and containing at least 8.25% milk solids (not fat) and at the very least 3.25% milk fat (USPHS, 1965). As indicated by Mather, (2000) milk may contain on normal 87% water, 4.2% lactose, 3% to 4% fat, 3.5% to 4.2% protein, 0.8% minerals and 0.1% vitamin. 30% of membrane material of milk fat consists of phospholipids (25%), cerebrosides (3%) and cholesterols (2%). In dairy cattle ration, crude fiber and crude protein are the most important component. Crude fiber is the water insoluble fraction of carbohydrate consists mainly of cellulose, lignin and hemicelluloses. But recently it has been shown that

hemicelluloses, pectin's and added gums or hydrocolloids are absent in crude fiber (Dhingra *et al*., 2012). Dietary fiber can be defined as sum of polysaccharides and lignin that are not digested by human digestive enzymes. Dietary fiber contains hemi-celluloses, that are the main difference between crude fiber and dietary fiber. Crude protein is calculated as mineral nitrogen multiply with 6.25. The assumption is that proteins of typical animal feeds contain 16% nitrogen in average (Colmenero *et al*., 2006).

So, high fiber diets in dairy cattle ration promote high butter fats via the production of acetic acid in the rumen. High cereals or starch diets promote more protein in the milk via the production of propanonic acid in the rumen. For higher milk production crude fiber level in the feed should not exceed 16 percent when calculated on basis of dry matter content of the ration (Johnny Martin, 2017). That is the main dietary effect on milk composition in cattle. Milk fat is composed of short chain fatty acids and long chain fatty acids. The predominant fat in milk is triacylglycerol which contains of fatty acids of short (C4-C10), intermediate (C12-C16) or long chain (C18) length (Dils, 1983). Dietary fiber is the main source of acetic acid and butyric acid. Short chain fatty acids in milk are produced from acetic acid and butyric acid through de-novo fatty acid synthesis pathway in mammary gland. Beet pulp is the promoter of butyric acid. Long chain fatty acids come from dietary fatty acids, bodies from rumen microbes and the fat from cows back. After 30 to 60 days in milking lactating cow faces problem to take fat from her back and put it into milk when in positive energy balance (Korch and Lascane, 2018).

Triacylglycerol's are synthesized in the endoplasmic reticulum, as they are formed; they are rapidly incorporated into lipid covered droplets. The droplets then migrate towards the apical membrane of secretory cells where they become encapsulated by the membrane, pinched off and released into the lumen of alveoli in mammary gland (Banks *et al*., 1983). High grain feeding is responsible for declining in milk fat percentage. Amount of unsaturated fatty acid (C16) will be more than saturated fatty acid if fat percentage in milk is decreased (Sutton, 1980). Fat percentage in milk also depends on length of forage particle. Below 25 percentages propionate in rumen fluid can be ensured by providing forage particle whose lengths are 0.64 centimeter. Milk fat will be then above 3.6 percentage (Woodford *et al*., 1983). So, numerous dietary factors effect on rumen fermentation (Sutton, 1980). Changes are occurred in the acetate to propionate ratio in diet. When the feed contains a lot of fiber fermentation of cellulose (main component of fiber) will be slow and resulting a lot of acetic acid. 65 percent butter fat in milk is derived from this acetic acid in rumen. Rumen pH drops below 4.5 if a lot of starchy feed is provided in diet. This condition favours the operation of lactic acid producing bacteria in rumen (Beyero *et al.,* 2015). Ruminal acidosis also causes depression of fat percentage in milk. Providing diet with a blend of fiber, non-fiber carbohydrates and fat (containing palmitic acid) can prevent the deficiency of long chain fatty acid to depress milk fat depression (Korch and Lascane, 2018).

Milk fat percentages also vary with stage of lactation. The highest percentages are usually found in colostrum, followed by a decline during the first two months of lactation, then a slow increase as lactation progresses (Rogers and Steward., 1982). Normal protein percentage in milk is 3.5 percentages. Milk protein is composed of true protein and milk serum. Among of true protein 80 percentage proteins is casein (phosphoprotein). Types of casein are alpha, beta, gama and kappa casein. Caseins are composed of ester bound phosphate with high proline content (Jenness, 1985). Caseins are precipitated from milk at pH 4.6 and 20 degree Celsius temperature. Actually milk serum means whey protein. Main whey proteins are beta lactoglobulin and alpha lactalbumin (Kuzdzal-Savoie *et al.,* 1980). In some research work it had shown that 0.02 percentage unit in milk increase in milk protein with every 1 percentage unit increase in dietary crude protein between 9 and 17 percentage (Emery, 1978). Concentration of milk protein depends on dietary crude protein. One pound crude protein is needed for producing ten pound of milk. If supply of dietary crude protein is less than the amount of protein in milk will be less in amount. But low rumen degradable protein supplement can prevent this problem through abomasal digestion (Kaufman, 1980). Milk protein percentage declines in cow older than 3 years with a 0.4 per-

centage unit drop being reported over five lactation (Rogers and Stewart., 1982). In some research work, it had shown that 0.1273 Mega Kilocalorie in milk protein energy content per I Mega Kilocalorie in milk protein gross energy increase in feed protein. Thus the increased in protein observed may have been in milk non protein nitrogenous substances and not true milk protein (Cragle *et al.,* 1986; Hassen *et al.,* 2022).

So, crude fiber of diet in dairy cattle ration is so important for better fat percentage in milk. High starch diet provides more propanoic acid that decreases digestion and utilization of crude fiber. As a result butter fat level in milk will be decreased due to insufficiency of acetic and butyric acid. Crude protein must be needed in dairy cattle ration for better milk protein concentration and milk production. To investigate these causes this study has been done. Therefore this study has been done with the following objectives:

1) To test of milk sample in different Dairy Farm (Chattogram Metropolitan Area).
2) To test of feed sample in different Dairy Farm (Chattogram Metropolitan Area).
3) To establish a relation between crude fiber in diet and butterfat level in milk and a relation between crude protein in diet and protein concentration in milk.

MATERIALS AND METHODS:

Samples

A total of eight milk samples and eight feed samples from eight dairy farms at Chattogram Metropolitan area were included in this study. Eight dairy farms were Munna Dairy Farm, RVFC (Millitary Dairy Farm), Liza Dairy Farm, Bhuyia Dairy Farm, Moinuddin Dairy Farm, Azizia Dairy Farm, Super Dairy Farm and CVASU Dairy Farm. Milk sample analysis was performed in the laboratory of Dairy Science under the Department of Dairy and Poultry Science in CVASU and in the laboratory of Dairy plant in Millitary Dairy Farm, Chattagram. Feed sample was concentrate type feed. Feed sample analysis was done in the laboratory of the Animal Nutrition under the Department of Animal Science and Nutrition in CVASU. This work was performed between March and May, 2019.

Methodology

Analysis of fat in milk

Acid digestion technique was applied to detect percentages of fat in milk samples.10 ml sulfuric acid (concentrate) was kept in butyrometer. Then 10.75 ml milk sample and 1ml amyl alcohol was added with it. Centrifugation (**Fig. 1**) was done and butyrometer reading (**Fig. 2**) was taken to detect fat percentage of milk sample. Titration technique was applied to detect percentage of protein in milk sample. Using amphoteric property of amino acid in milk sample the formaldehyde solution was added into milk sample and then the sample was titrated by standard alkali. It was formaldehyde value titration technique.

Fig. 1: Centrifugation process.

Fig. 2: Testing of fat percentage in milk.

Lactometer was used to (**Fig. 3**) detect lactometer reading of milk sample. This reading value was applied to detect specific gravity of milk sample.

Usually it works on the principle of gravity of milk which leads to find out the content of the water in milk and to test the richness of milk. Solid not fat in milk sample was counted by applying this equation:

Solid not fat in milk sample: Corrected lactometer reading *0.25+0.22 *Fat percentage + 0.72.

Fig. 3: Specific gravity test of milk.

Analysis of feed Sample

Fig. 4: Acid and Alkali digestion of feed sample.

In case of proximate analysis of feed sample per-centages of dry matter, moisture, ash, crude fiber and crude protein were detected. The moisture content of feed sample was determined by heating at 105 degree celcius to a constant weight under normal atmospheric pressure. After removing moisture resting part was dry matter in feed sample. Crude fiber percentage was measured by acid digestion (1.25 percent Sulfuric acid) and alkali digestion (1.25 percent sodium hydroxide). (**Fig. 4**) Crude protein percentage was measured by Kjeldhal method. This method is composed of three distinct steps: digestion, distillation (**Fig. 5**) and titration technique. Through the incineration of feed sample in the muffle furnace ash percentage was measured.

Fig. 5: Distillation process to detect crude protein.

RESULTS:

Chemical composition of milk sample and its result

Normally chemical or nutrient components of milk are fat, protein, lactose (carbohydrate content in milk) and resting part of milk is water. 3 to 4 percent of the solid content of cow milk is consisted of milk fat. Normal value of protein percentage in milk is 3.5%. But content of protein and fat in milk of cattle may vary from breed to breed. For example the fat content is usually higher in *Bos indicus* than *Bos taurus*. In this study, milk sample was taken at morning time. Number of sample was one for each farm. More fat percentages of milk sample were founded in case of Military dairy farm (4.1%), Super dairy farm (4.6%), Azizia dairy farm (4.9%) and Munna dairy farm (5.6%). Among of this dairy farm, highest fat per-centage of milk was founded in case of Munna dairy farm. Less fat percentages of milk sample were founded in case of Liza dairy farm (3.6%), CVASU dairy farm (3.3%), Bhuyia dairy farm (3.2%) and Moinuddin dairy farm (3%).

Among of this dairy farm, lowest fat percentage of milk was founded in case of Moinuddin dairy farm. Besides fat percentages more amount of protein percentages of milk sample were founded in case of Military dairy farm (3.45%), Super dairy farm (3.5%), Azizia dairy farm (4.2%) and Munna dairy farm (4.5%). Among of this dairy farm, highest protein percentage of milk was founded in case of Munna dairy farm. Less amount of protein per-centages of milk sample were founded in case of Liza dairy farm (3.2%), CVASU dairy farm (3.1%), Bhuyia dairy farm (3.1%) and Moinuddin dairy farm (2.9%). Among of this dairy farm, lowest protein percentage of milk was founded in case of Moinuddin dairy farm.

Table 1: Chemical composition of milk at different dairy farm.

Name of Dairy Farm	Fat%	SNF%	Lactometer reading	Density	Protein%
Munna Dairy Farm	5.6	8.95	28	1.0450	4.5
RVFC (Military Dairy Farm)	4.1	8.63	28	1.0332	3.45
Liza Dairy Farm	3.6	8.30	27	1.0301	3.2
Bhuyia Dairy Farm	3.2	8.18	27	1.0283	3.1
Moinuddin Dairy Farm	3	8.12	27	1.0112	2.9
Azizia Dairy Farm	4.9	8.67	27.5	1.0379	4.2
Super Dairy Farm	4.6	8.60	27.5	1.0483	3.5
CVASU Dairy Farm (in Campus)	3.3	8.20	27	1.0295	3.1

Chemical composition of feed sample and its result

Normally chemical or nutrient components of concentrate type feed are dry matter, moisture, ash (mineral content of feed), crude fiber (water non soluble fraction of carbohydrate), crude protein (true protein with non-protein nitrogenous substances), ether extract (lipid content of feed) and water soluble fraction of carbohydrate which is also known as nitrogen free extract. In this study, percentages of dry matter, moisture, ash, crude protein and crude fiber of concentrate type feed sample were measured. Number of feed sample for each dairy farm was one. On the basis of dry matter content in feed sample, 16% crude fiber and 18% crude protein should be present in dairy cattle ration. More amount of crude fiber percentages of feed sample were founded in case of Military dairy farm (13.41%), Munna dairy farm (13.68%) and Super dairy farm (15%). Among of this dairy farm highest crude fiber percentage of concentrate type of feed was founded in case of Super dairy farm (nearly to 16%). Less amount of crude fiber percentages of feed sample were founded in case of Liza dairy farm (12.5%), Bhuyia dairy farm (12%), CVASU dairy farm (11.8%), Moinuddin dairy farm (8.77%) and Azizia dairy farm (8.30%). Among of this dairy farm lowest crude fiber percentage of concentrate type feed sample was founded in case of Azizia dairy farm. Besides crude fiber percentages, more amount of crude protein percentages of feed sample were founded in case of Super dairy farm (18.37%), Moinuddin dairy farm (18.55%) and Munna dairy farm (18.72%). Among of these dairy farm, highest crude protein percentage of concentrate type feed sample was founded in case of Munna dairy farm. Less amount of crude protein percentages of feed sample were founded in case of Azizia dairy farm (17.85%), Liza dairy farm (17.31%), CVASU dairy farm (17.21%), Military dairy farm (16.75%) and Bhuyia dairy farm (16.27%). Among of these dairy farm, lowest crude protein percentage of concentrate type feed sample was founded in case of Bhuyia dairy farm.

Table 2: Chemical composition of concentrate type feed at different dairy farm.

Name of Dairy Farm	Dry matter%	Moisture%	Ash%	Crude Fiber%	Crude protein%
Munna Dairy Farm	91.07	8.93	6.22	13.68	18.725
RVFC (Military Dairy Farm)	91.2	8.80	5.50	13.41	16.753
Liza Dairy Farm.	89.23	10.72	5.52	12.5	17.314
Bhuyia Dairy Farm	89.37	10.63	7.28	12	16.275
Moinuddin Dairy Farm	88.8	11.2	5.61	8.77	18.55
Azizia Dairy Farm	91.09	8.91	5.00	8.30	17.85
Super Dairy Farm.	91.26	8.74	5.13	15	18.375
CVASU Dairy Farm (In campus)	89.18	10.82	5.45	11.8	17.210

Relationship between milk fat and crude fiber level in feed

On the basis of 10 liter milk and 10 kg concentrate feed, values of crude fiber of eight dairy farm in Chattogram Metropolitan are represented in **Fig. 6** with **Table 3** in OX axis (gram unit) and values of milk fat of those dairy farm are represented in **Fig. 6** with **Table 3** in OY axis (gram unit). In OX axis 1 square centimeter =10 gram, OY axis 1 square centimeter =10 gram. From this relation it was founded that

highest milk fat content was 560 gram in which crude fiber content was 1500 gram & lowest fat percentage was 300 gram in which crude fiber content was 877 gram. But exceptional findings were founded in case of Azizia dairy farm due to adding of colostrum with milk.

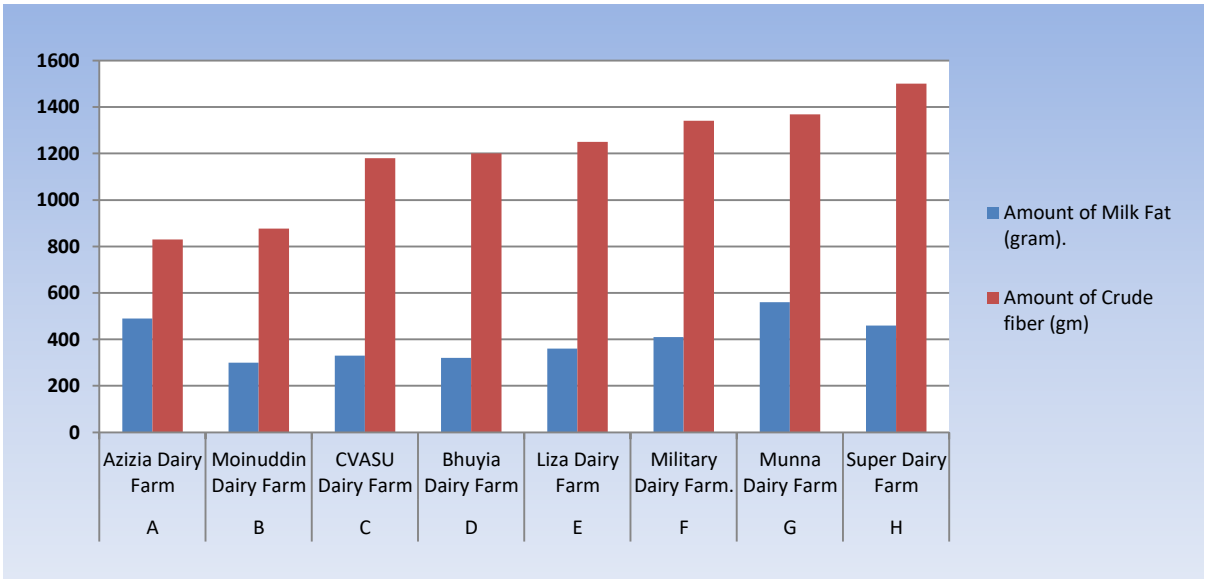

Fig. 6: Graphical relation between milk fat and crude fiber level in feed.

Table 3: Relationship between milk fat and crude fiber level in feed.

Marking letter	Name of Dairy Farm	Amount of Milk Fat (gram).	Amount of Crude fiber (gm)
A	Azizia Dairy Farm	490	830
B	Moinuddin Dairy Farm	300	877
C	CVASU Dairy Farm	330	1180
D	Bhuyia Dairy Farm	320	1200
E	Liza Dairy Farm	360	1250
F	Military Dairy Farm.	410	1341
G	Munna Dairy Farm	560	1368
H	Super Dairy Farm	460	1500

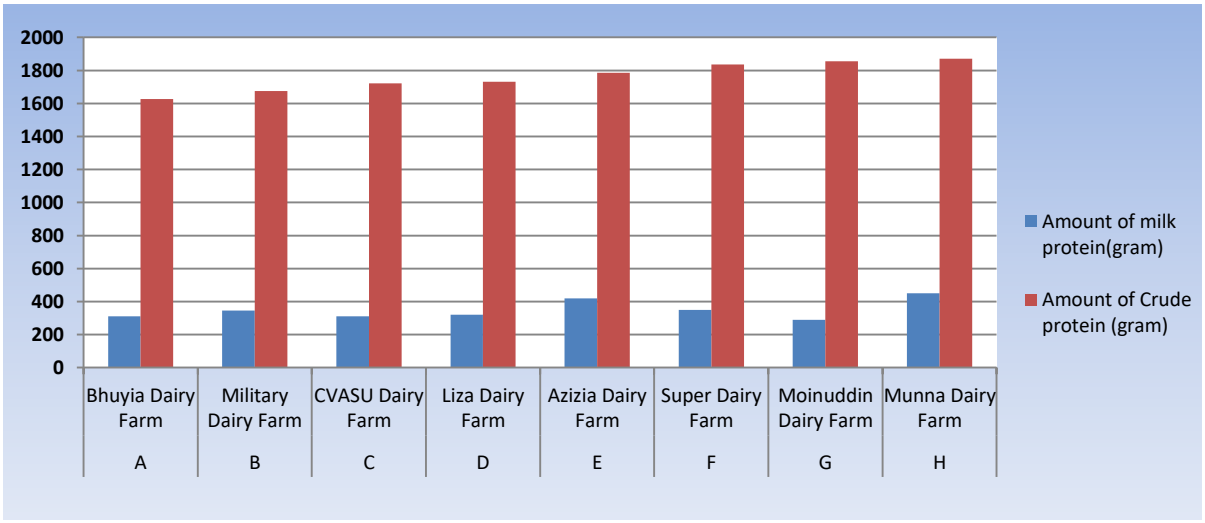

Fig. 7: Graphical relation between milk protein and crude protein level in feed.

Relationship between milk protein & crude protein level in feed

On the basis of 10 liter milk and 10 kg concentrate feed, values of crude protein of eight dairy farm in Chattogram Metropolitan are represented in **Fig. 6** with **Table 4** in OX axis (gram unit) and values of milk protein of those dairy farm are represented in **Fig. 6** with **Table 4** OY axis (gram unit). In OX axis 1 square centimeter = 10 gram, OY axis 1 square centimeter =10 gram. From this relation it was founded that highest milk protein content was 450 gram in which crude protein content of feed was 1872 gram. In some cases high amount of crude protein content was founded but milk protein content was low. Improper metabolism of crude protein causes low milk urea level. So for this case milk protein content was low in some dairy farm (example: Moinuddin dairy farm).

Table 4: Relationship between milk protein and crude protein level in feed.

Marking Letter	Name of Dairy Farm	Amount of milk protein(gram)	Amount of Crude protein (gram)
A	Bhuyia Dairy Farm	310	1627
B	Military Dairy Farm	345	1675
C	CVASU Dairy Farm	310	1721
D	Liza Dairy Farm	320	1731
E	Azizia Dairy Farm	420	1785
F	Super Dairy Farm	350	1837
G	Moinuddin Dairy Farm	290	1855
H	Munna Dairy Farm	450	1872

DISCUSSION:

Here in result, it has been shown that providing sufficient amount of crude fiber in diet can ensure better fat percentage in milk. Insufficiency of crude fiber in diet enhances the effect of starch or cereal which is actually water soluble carbohydrates. Rapid fermentation of starch or cereal grain in rumen enhances more production of propanoic acid due to insufficiency of crude fiber in diet. Beyero *et al*. (2015) described that if a lot of starchy feed is provided in diet, rumen pH drops below 4.5 due to production of more lactic acid with propanoic acid. Ruminal acidosis also causes depression of fat percentage in milk. Fat percentage of milk also depends on other factors. Such as breed, genetics, effect of temperature, season, effect of colostrums, diseases, etc. Between and within breeds fat varies the most and lactose the least (Woodford *et al*., 1986). Repeatability of milk fat percentage for Holsteins is 0.76 and Jersey has the highest heritability for milk fat percentage (0.71) (Gaunt, 1980). Milk fat percentage is usually lower in summer than winter. Christie (1979) described that milk fat in the summer tends to be lower in palmitic acid relative to stearic and octadecanoic acids than milk fat from the same cows during the winter. Adding of colostrum with milk also enhances fat and protein percentage in milk. This incidence has been occurred in case of Azizia Dairy Farm. 100 mililiter bovine colosturm contain 14.9 percent protein and 6.7 percent fat (Guthrie, 1989). So adding of slight amount of colostrum with milk (after milking) enhances the fat percentage in milk instead of providing low amount of crude fiber in diet. In case of Moinuddin Dairy Farm, lower fat percentage in milk sample has been founded due to providing lowest amount of crude fiber in diet. Instead of providing sufficient amount of crude protein amount of milk protein is lower than normal due to mastitis also. Normal protein percentage in milk is 3.5 (Davies *et al.,* 1983). Some diseases such as mastitis, udder edema are responsible for declining fat and protein percentages in milk. Kitchen, (1981) described that decreasing in fat percentage is less (about 10 percent) than that observed for lactose or casein (about 15 percent) (Bekere *et al*., 2022).

A linear increased of milk fat percentage has been shown in graph (**Fig. 6**) from CVASU Dairy Farm to Munna Dairy Farm. Davis, (1978) described that this type of linear increasing of milk fat percentage occurs as the ratio of acetate to propionate increases up to 2.2. Highest amount of crude fiber in diet has been founded in Super Dairy Farm. Butter fat percentage in milk is so good but less than Munna Dairy Farm. At the 7^{th} to 8^{th} month of pregnancy milk production have decreased in this farm. So, fat percentage of milk is less

than Munna Dairy Farm. Milk protein concentration depends on dietary crude protein and milk urea level or NPN (Non protein nitrogenous substance). Milk urea is an approximate indicator of the amount of crude protein in a cow's diet. It is formed from the metabolism of absorbed amino acids and body protein. Normal urea content in milk is 25 mg to 35 mg/ml. So it can be said that protein concentration in milk depend on milk urea level. Milk urea is derived from proper utilization of sufficient amount of crude protein. More protein percentages in milk sample have been founded in Military Dairy Farm, Azizia Dairy Farm, Super Dairy Farm and Munna Dairy Farm. The main cause is that proper metabolism of crude protein has ensured good amount of milk urea level and ultimately resulting of good milk protein in these dairy farms.

Oltner *et al*. (1985) described that elevated protein concentrations from cow's fed diets high in rumen degradable protein or NPN forms increased milk urea level. Management was very poor in the case of Moinuddin Dairy Farm. Mastitis and other disease conditions were remained in this farm. So instead of providing sufficient amount of crude protein in diet proper utilization of crude protein was not occurred and resulting of less milk protein concentration. So it can be said that sufficient amount of crude protein in diet and its proper metabolism can ensure better amount of milk protein in lactating cow.

CONCLUSION:

Best farm management with best dietary effect can ensure to produce best quality of milk in which fat, protein, lactose and other nutritive components of milk will be founded in optimum level. In maximum time only concentrate feed based diet was provided in case of Liza dairy farm, Bhuyia dairy farm, Moinuddin dairy farm. Udder health condition was not good in case of Moinuddin dairy farm due to mastitis and udder edema. So to remove or reduce the occurrence of mastitis before milking concentrate type feed should be provided to cow. After milking roughage should be provided to cow. Because in this time opening of teat canal in mammary gland is still opened. So it should be kept in mind of farmer that, after milking cow cannot sit down on floor instantly. As floor or soil acts as source of mastitis causing organism. So after milking roughage type of feed should be kept in front of cow for better regurgitation and rumination of roughage. This rumination of roughage will prevent ruminal acidosis by producing more alkaline saliva. This will help to produce more fat and protein content in cow's milk.

In this study, it has been observed that Azizia dairy farm used colostrums in order to increase fat% in milk. But this practice is not good. It is better to increase crude fiber percentage in diet by providing available roughage and fodder such as Napier grass, Para grass, Soybean meal, Cotton seed meal, which will ultimately enhance fat and protein% in milk. Besides these, environmentally stressed free dairy farm should be established to get maximum milk production. On the other hand, low fat and protein content of milk was observed in CVASU dairy farm and Moinuddin dairy farm due to feeding only straw and concentrate based diet without providing any roughage. However better amount of milk fat and protein content was founded in case of Munna dairy farm due to better amount of crude fiber and crude protein contain in their diet. So at last it can say that, best management of farm and dietary effect (proper composition of diet) can produce best quality's milk with better amount of milk fat and protein content.

Limitations

As a new work it has faced a few limitations. Such as: Variation in parity or number of lactation period of dairy farm, Production rate of milk was not same in this dairy farm due to other imbalance of management factor.

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CONFLICTS OF INTEREST:

The authors have no conflict of interest.

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