Impact of Protein on Milk Quality and Quantity

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Abstract

Milk is a liquid secreted by the mammary glands of female mammals to nourish their young for a period beginning immediately after birth. The milk of domesticated animals is also an important food source for humans, either as a fresh fluid or processed into a number of dairy products such as butter and cheese. Milk is an excellent source of vitamins and minerals, particularly calcium. It has an important role in bone health. Nutritionists recommend that people have milk and other dairy products, such as yoghurt and cheese, every day as part of a balanced diet.
This study focuses mainly on the importance of protein in the diets of the cattle, mainly in the Indian dairy market.

Keywords

Indian feed, dietary protein, concentrates, milk quantity, milk quality.

1 Introduction

Milk of dairy cows consists of generally 87.7% water, 3.3% protein, fats 3.4% and lactose 4.9%, mineral salts, vitamins and white blood cells constitute the rest of the composition (Tyasi et al., 2015). These proportions may vary from species to species and breed to breed depending upon genetic ceilings, nutrition provided, environmental factors, age, etc. Buffalo milk consists of (approx) 83.18% water, 6.71% fat, 4.52% protein, 10.01% SNF, 4.45% lactose and 0.80% ash (Sindhu., 1999).
Average amino acid composition (g/100 g milk) in proteins of cow milk are:
EAA's : Tryptophan – 0.046, Threonine – 0.149, Isoleucine – 0.199, Leucine – 0.322, Lysine – 0.261, Methionine – 0.083, Cystine – 0.030, Phenylalanine – 0.159, Tyrosine – 0.159, Valine – 0.220.
Non EAA's : Arginine – 0.119, Histidine – 0.089, Alanine – 0.113, Aspartic Acid – 0.250, Glutamic Acid – 0.689, Glycine – 0.070, Proline – 0.319, Serine – 0.179. (Posati et al., 1976), (Haenlein., 2004).

There are various tools at disposal to improve the quality and quantity of milk in dairy animals. Higher milking frequency, ration composition and genetic merit were the major factors resulting in a higher milk yield (Ouweltjes et al., 2007).
'India now has indisputably the world's biggest dairy industry—in terms of milk production; last year India produced close to 146.31 million tonnes of milk, 50% more than the US and three times as much as the much-heralded new growth champ, China', stated apeda.gov.in, which is the official website of India's Agricultural and Processed food products Export Development Authority. The Indian dairy market sees a growth in milk production consistently, yet the quality of the milk produced has been degrading, since, normally, an increase in milk yield is followed by a decrease in the percentages of milk fat and protein (Looper., 1914).
Indian dairy farmers are mainly paid for their milk yield and not the quality, hence farmers have been found to neglect the milk quality aspect from time to time.
The diet of the cattle contains less crude protein. A deficiency of crude protein in the ration may depress protein in milk. Severe restriction of diet crude protein may have a huge impact on milk protein levels (Neitz and Robertson, 1991). Milk yield from the dairy cows under smallholder farmers is far below the expected genetic potential of the cows due to several factors, one of them being improper feeding practice, which deprive nutrients supply to the animals (Mtengeti et al., 2008).

2 Available Feed

The feedstuffs fed to cattle in India depends mainly on the time of the year, the economic viability and access to the feed, etc. Farmers tend to feed their cattle whatever's grown on their farms (which has been traditionally fed), or, it's waste by products.
The feedstuffs are classified as concentrates and roughages. The concentrates contain very less fibre (less than 5%), but have a high TDNV (Total digestible nutrient value). The concentrates include cereals, oilseeds, oilcakes, and cereal and animal by-products. The feeds having a fibre content above 18 percent and a low total digestible nutrient value are classed as roughages, e.g. cultivated fodders, silages, hays and straws. The most economical way of raising livestock is to feed them on legumes and grasses directly from the fields (ikisan.com). It is clearly evident that the cattle feeding upon grasses directly from the fields are deficient in protein. A study in seven districts of Himachal Pradesh (Sharma and Singh, 1993) has also concluded that the farmers could increase milk output by feeding more concentrates. Most of the feeds provided to dairy cows by the smallholder farmers are forage based with little or without concentrate supplementation (Belay., 2020).

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TABLE 1.

FOLLOWING IS THE AMINO ACID COMPOSITION OF SIX KINDS OF ORGANIC FEED (%DM BASIS):

Amino Acid	Samples					
	CG	SC	WB	CS	OT	AF
Arg	0.36 ± 0.01^{d}	3.37 ± 0.07^{a}	1.12 ± 0.01^{b}	0.18 ± 0.00^{e}	0.28 ± 0.01^{d}	0.73 ± 0.02^{c}
His	0.20 ± 0.01^{d}	1.21 ± 0.03^{a}	0.44 ± 0.01^{b}	0.13 ± 0.00^{e}	0.11 ± 0.00^{e}	0.36 ± 0.00^{c}
Ile	0.26 ± 0.01^{d}	1.99 ± 0.04^{a}	0.50 ± 0.02^{c}	0.27 ± 0.00^{d}	0.29 ± 0.00^{d}	0.72 ± 0.01^{b}
Thr	0.27 ± 0.01^{d}	1.76 ± 0.04^{a}	0.54 ± 0.00^{c}	0.29 ± 0.01^{d}	0.30 ± 0.00^{d}	0.77 ± 0.01^{b}
Trp	0.05 ± 0.00^{e}	0.53 ± 0.02^{a}	0.26 ± 0.00^{b}	0.05 ± 0.00^{e}	0.08 ± 0.00^{d}	0.24 ± 0.01^{c}
Val	0.34 ± 0.01^{d}	2.09 ± 0.04^{a}	0.77 ± 0.00^{c}	0.37 ± 0.00^{d}	0.37 ± 0.00^{d}	0.91 ± 0.00^{b}
Lys/Met	1.53 ± 0.03^{f}	6.07 ± 0.08^{a}	2.99 ± 0.04^{d}	2.31 ± 0.00^{e}	3.79 ± 0.04^{c}	4.74 ± 0.05^{b}
EAA	3.20 ± 0.07^{de}	19.73 ± 0.35^{a}	6.18 ± 0.00^{c}	2.77 ± 0.02^{ef}	2.85 ± 0.03^{de}	7.90 ± 0.02^{b}
Leu	0.91 ± 0.02^{d}	3.47 ± 0.06^{a}	1.02 ± 0.00^{c}	0.77 ± 0.01^{e}	0.54 ± 0.00^{f}	1.23 ± 0.03^{b}
Lys	0.23 ± 0.01^{e}	2.77 ± 0.06^{a}	0.70 ± 0.00^{c}	0.25 ± 0.01^{e}	0.35 ± 0.00^{d}	1.11 ± 0.00^{b}
Met	0.15 ± 0.00^{c}	0.46 ± 0.00^{a}	0.23 ± 0.00^{b}	0.11 ± 0.00^{d}	0.09 ± 0.00^{e}	0.23 ± 0.00^{b}
Phe	0.43 ± 0.01^{d}	2.09 ± 0.02^{a}	0.60 ± 0.01^{c}	0.35 ± 0.00^{e}	0.43 ± 0.01^{d}	0.79 ± 0.03^{b}
Ala	0.54 ± 0.02^{d}	2.00 ± 0.04^{a}	0.79 ± 0.00^{c}	0.77 ± 0.01^{c}	0.40 ± 0.00^{e}	0.94 ± 0.00^{b}
Asp	0.52 ± 0.02^{e}	5.04 ± 0.11^{a}	1.17 ± 0.02^{c}	0.39 ± 0.02^{f}	0.68 ± 0.00^{d}	2.15 ± 0.00^{b}
Cys	0.14 ± 0.00^{d}	0.58 ± 0.01^{a}	0.33 ± 0.01^{b}	0.10 ± 0.00^{e}	0.10 ± 0.00^{e}	0.22 ± 0.00^{c}
Glu	1.35 ± 0.03^{d}	7.90 ± 0.17^{a}	3.12 ± 0.05^{b}	0.82 ± 0.01^{e}	0.87 ± 0.00^{e}	1.65 ± 0.01^{c}

Gly	0.27 ± 0.00 ^{d}	1.96 ± 0.04 ^{a}	0.88 ± 0.01 ^{b}	0.34 ± 0.00 ^{c}	0.32 ± 0.00 ^{c}	0.79 ± 0.00 ^{b}
Pro	0.69 ± 0.01 ^{d}	2.04 ± 0.06 ^{a}	1.07 ± 0.02 ^{c}	0.52 ± 0.01 ^{e}	0.53 ± 0.02 ^{e}	1.19 ± 0.03 ^{b}
Ser	0.36 ± 0.01 ^{d}	2.30 ± 0.05 ^{a}	0.72 ± 0.01 ^{c}	0.24 ± 0.01 ^{e}	0.31 ± 0.00 ^{d}	0.81 ± 0.01 ^{b}
Tyr	0.31 ± 0.01 ^{d}	1.39 ± 0.02 ^{a}	0.44 ± 0.00 ^{c}	0.20 ± 0.01 ^{f}	0.25 ± 0.01 ^{e}	0.48 ± 0.01 ^{b}
NEAA	4.17 ± 0.08 ^{c}	23.22 ± 0.50 ^{a}	8.52 ± 0.13 ^{b}	3.38 ± 0.00 ^{d}	3.48 ± 0.02 ^{d}	8.22 ± 0.01 ^{b}
TAA	7.37 ± 0.15 ^{c}	42.95 ± 0.85 ^{a}	14.70 ± 0.12 ^{b}	6.14 ± 0.00 ^{d}	6.64 ± 0.01 ^{d}	15.31 ± 0.01 ^{b}

EAA: Essential amino acid, NEAA: Non-essential amino acid, TAA: Total amino acids, Arg: Arginine, His: Histidine, Ile: Isoleucine, Leu: Leucine, Lys: Lysine, Met: Methionine, Ala: Alanine, Thr: Threonine, Trp: Tryptophan, Val: Valine, Asp: Aspartate, Cys: Cystine, Glu: Glutamic acid, Pro: Proline, Ser: Serine, Tyr: Tyrosine. Data in the same column of the superscript mark different lowercase letters indicate a significant difference ($p < 0.05$).
Corn grain (CG), soybean cake (SC), wheat bran (WB), corn silage (CS), oat hay (OT), and alfalfa hay (AF).
Adapted from : (Luo *et al.*,2002).

TABLE 2.

ANALYSIS OF MISSING ELEMENTS IN INDIAN FEED COMPOSITION:

Feed Sample	Ca (%)	P (%)	Zn (ppm)	Cu (ppm)	Fe (ppm)
Critical Conc.	(<0.30)	(<25.0)	(<30.0)	(<8.0)	(<50.0)
Wheat Bran	0.67 ± 0	1.04 ± 0.04	54.5 ± 0.12	8.29 ± 0.72	175.5 ± 0.41
Rice Bran	1.09 ± 0	0.66 ± 0.03	17.7 ± 0.23	3.67 ± 0.43	140.16 ± 0.21
MOC	0.60 ± 0	1.10 ± 0.23	40.03 ± 0.41	12.65 ± 0.03	522.9 ± 0.23
Linseed	1.63 ± 0	0.86 ± 0.41	50.5 ± 0.04	13.7 ± 0.02	821.6 ± 0.25
Local grass	0.85 ± 0	0.26 ± 0.03	3.53 ± 0.03	2.63 ± 0.03	182.8 ± 0.04
Oat hay	0.36 ± 0	0.23 ± 0.04	11.79 ± 0.01	3.5 ± 0.04	328.1 ± 0.02
Paddy straw	0.41 ± 0	0.24 ± 0.02	0.52 ± 0.02	0.13 ± 0.43	0.39 ± 0.03
Maize straw	0.65 ± 0	3.61 ± 0.01	2.44 ± 0.01	199.5 ± 0.21	4.83 ± 0.02
Wheat straw	2.41 ± 0	187.7 ± 0.03	3.74 ± 0.01	3.14 ± 0.76	139.1 ± 0.02

Adapted from: (Reshi *et al.*, 2016).

It is clear from the above table that various micro molecules are deficient in the Indian feed and fodder since they are below the critical level. This study also reported that the quality of the roughages in India are poor. It was concluded that most of the farmers in the hilly areas of Kashmir valley fed locally available feeds and fodders to dairy cattle that are poor in quality in terms of protein and trace minerals.
In Europe and US on the other hand, ration composition is given the importance it deserves to provide the cattle with a balanced diet, and hence, their milk composition has been

found to be superior to ours. The Dutch dairy industry improved the milk production per cow per lactation successfully in the last few decades with the help of high heritability of milk production traits and effective milk recording schemes, genetic improvement, and most importantly, ration composition (Ouweltjes et al., 2007), (Beerda et al., 2007).

There have been reports stating that meat is fed to cattle in the UK to meet their protein demands. An article by greatbritishmeat.com stated that the farmers in the UK reported that the cattle preferred to stay indoors during the winters and hence couldn't meet their protein requirements. In such cases, feeding meat was only reasonable.

3 Nutrition and its effect on milk components

The main three components which define milk quality are Fat, Protein and SNF.
The factors affecting the components of milk include: breed/genetics, environment, health, and most importantly, nutrition. Between and within breeds, fat varies the most and lactose the least (Woodford et al., 1986). Dietary manipulation can affect milk protein concentration to approximately only 0.6% concentrations (Jelen and Lutz., 1998), whereas fat concentration is most sensitive to dietary changes and can vary over a range of nearly 3.0 percentage units (Grainger and Goddard., 2007).

3.1 Fats

The major constituent of fat in milk is triacylglycerol, which contains fatty acids of short- (C_4-C_{10}), intermediate- (C_{12}-C_{16}), or long-chain (C_{18}) length. The short-chain acids are synthesized within the mammary gland from acetate and beta-hydroxybutyrate; long-chain acids are almost exclusively derived from blood plasma fatty acids of dietary origin; and intermediate-chain acids arise from both sources. Their synthesis could be summarized as: about 50 percent of the fatty acids in milk are synthesized in the mammary gland and the other 50 percent are derived directly from blood (Dils., 1983, 1986; Larson., 1985; Book and Thomas., 1980).

Dietary fats can alter milk fat composition in a number of ways (Christie, 1979).
The changes in milk fat percentage and composition observed with the use of fat in diets of dairy cows are a reflection of the change in output of different fatty acids from the mammary gland; short and medium-chain fatty acids (C_4 to C_{14}) are synthesized in the mammary gland, the C_{18} fatty acids come from the diet, and the C_{16} fatty acids come from both synthesis and dietary sources. Although dietary fats and oils may alter milk fat composition, the output of total milk fat depends on the balance of increased dietary transfer and decreased synthesis. However, there is probably a minimum content of short-chain fatty acids necessary to maintain melting points at body temperatures (Christie, 1979).
Protected polyunsaturated fatty acids appear to be the most promising for consistently increasing milk fat percentage and altering milk fat composition. Protected oil-seeds or oils rich in linoleic acid (sunflower, corn, and soybean) produce large, rapid increases in the linoleic acid content of milk fat when fed. The increases in linoleic acid content are generally associated with declines in myristic, palmitic, and oleic acids.
Transfer of linoleic acid from protected supplements to milk is reported to be between 20 and 40 percent (Christie, 1979; Fogerty and Johnson, 1980).
Feeding of protected saturated fats, the most common source being tallow, generally invokes the same response in increase of milk fat percentage as feeding of protected polyunsaturated fats. However, protected hydrogenated soybean oil has decreased the milk fat percentage (Banks et al., 1983). Protected tallow increases the amounts of C_4, C_{161}, C_{180}, and C_{181} fatty acids found in milk fat (Christie, 1979). Similar results were reported for unprotected tallow.

3.2 Protein

The crude protein requirement for a 1,350pound cow producing 3.6 percent milk fat ranges from 14.0 percent of total dry matter (TDM) for 50 pounds of milk to 18.0 percent TDM for 100 pounds of milk. Depending on the stage and level of production, the recommended level of undegradable intake protein (UIP) ranges from 32 to 38 percent of crude protein. Keep soluble protein between 30 to 32 percent of crude protein or about half of the degradable protein intake level.
The total (crude) protein content of milk is determined by analyzing milk for nitrogen and multiplying by a factor of 6.38. The total protein percentage of milk is generally considered to be about 3.5, of which 94 to 95 percent is in the form of true protein (Davies et al., 1983; Jenness, 1985). Casein accounts for approximately 80 percent of the true protein, and milk serum or whey proteins account for about 20 percent. Urea is the largest single non-protein nitrogen (NPN) component, accounting for approximately 50 percent of the total NPN (Wolf schoon-Pombo and Klostermeyer, 1981).
Casein proteins are characterized by ester-bound phosphate, high proline contents, and few or no cysteine residues and are precipitable from milk at pH 4.6 and 20ºC. The main casein types in milk are alpha-, beta-, gamma-, and kappa-caseins. Whey proteins are distinguished from casein by remaining in solution upon precipitation of casein proteins. The major whey proteins are beta-lactoglobulin and alpha-lactalbumin. Serum albumin, immunoglobulins, proteose peptones, lactoferrin, and transferrin represent a smaller proportion of the whey protein fraction (Davies et al., 1983; Jenness, 1985; Kuzdzal-Savoie et al., 1980).

Feedstuffs contain several sources of true protein and non-protein nitrogen compounds. Proteins are large molecules that differ in size, shape, function, solubility and amino acid composition. It is important to keep in mind that amino acids and not protein per se are the nutrients required by ruminants. Absorbed amino acids are vital nutrients for maintenance, growth, health, reproduction and lactation, and are used mainly as building blocks for protein synthesis, as well as precursors for glucose and fatty acids synthesis.
More specifically, amino acids are involved in tissue growth and repair, enzymatic activity, transport of molecules, genetic storage, immune function and cell differentiation. Therefore, supplying adequate amounts of amino acids is necessary to maintain the basal metabolism in ruminants.

CLASSIFICATION OF PROTEIN MATERIAL IN FEED:

Crude protein (CP) — Generally, CP concentration in feedstuffs is calculated using the nitrogen (N) concentration × 6.25. This definition assumes that the average N concentration of a protein molecule is 16%. Crude protein can be divided into ruminally undegraded protein (RUP) and RDP, which includes the non-protein N.
Natural (or true) protein — Protein constituted by amino acids. It differs from non-protein N (see below), which does not have an amino acid profile but can be used as N source by ruminal microorganisms.
Non-protein N (NPN) — Generally, this group is represented by nucleic acids and ammonia. The most well-known NPN compound used for cattle nutrition is urea. These compounds (NPN) are quickly degraded and converted into microbial protein by the rumen microorganisms. Two main factors support the use of NPN in cattle diets: 1) nutritionally, it adjusts the RDP amount in the diet; and 2) economically, NPN is less expensive compared with natural protein sources.
Ruminally degraded protein (RDP) — After entering the rumen, this fraction provides a mixture of peptides, free amino acids, and ammonia that are used by microorganisms for growth and synthesis of microbial protein, which is the most important protein source for the ruminant and supplies the majority of amino acids entering the small intestine.
Ruminally undegraded protein (RUP) — It is the second most important source of absorbable amino acids to the animal. It represents the protein that enters the intestine without any previous modification in the rumen, and then can be absorbed or not by the animal's intestine. Feeds containing high RUP concentrations include heat-treated soybean meal and cottonseed meal.
Endogenous CP — Comprised by salivary and digestive secretions of ruminants, as well as sloughed epithelial cells.
Metabolizable protein (MP) — It represents the total amount protein absorbed by the animal, and it is supplied by the diet (RDP and RUP), microbial CP (MCP) and to a much less extent, endogenous CP.
Microbial crude protein (MCP) —The most important protein source for cattle, supplying from 50% to 100% of the daily MP required by the animal. Microbial crude protein, which is mainly originated of bacterial source (about 90%), is the protein content of ruminal microorganisms that passes and are absorbed by the small intestine.

The synthesis of milk proteins has been extensively reviewed (Larson, 1979, 1985; Mercier and Gaye, 1983). In general, protein synthesis in mammary alveolar cells is similar to other protein synthesis systems in which DNA controls protein synthesis. Casein must be phosphorylated, bound with calcium, and stabilized by calcium phosphate linkages and other ionic bonds before being released from the vesicles. The presence of alpha-lactalbumin in the region of the Golgi apparatus promotes synthesis of lactose. The secretory vesicles containing essentially nonfat milk constituents leave the cell by moving to the apical surface and fusing with the plasma membrane and discharging the vesicular contents into the cell lumen.
Most of the proteins present in milk are synthesized in the mammary gland, although some immunoglobulins and albumins are transferred from the blood (Larson, 1979). Blood leukocytes can also cross mammary barriers either by passing between secretory cells or by pushing secretory cells directly into the lumen. Urea diffuses freely across mammary cells, so there is a high correlation between blood plasma and milk urea concentrations (Thomas, 1980).
The synthesis of milk protein requires both, essential and nonessential amino acids to be supplied to the mammary gland (Clark et al., 1978; Mepham, 1982).

A small effect of dietary crude protein concentration on milk protein percentage was reported by Emery (1978): a 0.02 percentage unit increase in milk protein with every 1 percentage unit increase in dietary crude protein between 9 and 17 percent. This study, however, did not consider the source of dietary crude protein or change in milk protein composition. Thus, the increases in milk protein observed may have been in milk NPN and not true milk protein. Elevated milk protein concentrations from cows fed diets high in rumen-degradable protein or NPN most likely will be from increased milk urea or NPN levels (Oltner et al., 1985; Thomas, 1980).
On the other hand, diets low in rumen-degradable protein or balanced for optimal microbial protein synthesis should increase supplies of amino acids available to the mammary gland for protein synthesis, and thus, more true milk protein should be produced (Kaufman, 1980; Old-ham, 1984; Thomas, 1980). With inadequate protein intake, vital organs and systems, including mammary gland activity, reproductive and immune functions, do not operate properly.
More specifically for the ruminant, adequate protein level (> 7% CP) in the diet is required for maximal growth and activity of ruminal microorganisms, thus producing desired MCP (Microbial Crude Protein) amounts and maximizing ruminal

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fermentation. In contrast, feeding diets with protein content ≤ 7% CP may result in impaired growth of ruminal microorganisms, fermentative functions, ruminal synthesis of MCP and amount of MCP absorbed in the small intestine. This is extremely important because MCP is the main protein source for ruminants, and inadequate protein levels may negatively impact ruminal function, performance and subsequent productivity of the animal. Moreover, not only protein amount but type of protein (RDP vs. RUP) in the diet is very important for the rumen microorganisms, given that RDP (Ruminally Degraded Protein) is used by rumen microorganisms for MCP synthesis, whereas RUP (Ruminally Undegraded Protein) is absorbed in the small intestine without ruminal modification.

The balance between these two types of protein is critical, and in diets where protein is not limiting microbial growth and ruminal functions, feeding RDP in excess may not further benefit, in fact may harm the ruminal environment and the animal.

In experiments where protein (usually casein) has been abomasally infused to increase amino acid supplies to the tissue, increases in milk protein percentage along with milk yield have been reported (Clark, 1975; Clark et al., 1977). Based on these responses, it could be concluded that increasing the intestinal supply of amino acids through increased rumen protein synthesis or low rumen-degradable protein sources would increase milk protein percentage and probably milk yield.

Insufficient amounts of dietary protein will reduce milk protein concentrations, but the reduction is minimized when low rumen-degradable protein supplements are fed. Increasing dietary crude protein supply has little effect on milk protein percentage (Kaufman., 1980).

The amount of energy consumed, density of energy in the diet, and the source of energy in the diet all influence milk protein percentage and yield. Cragle et al. (1986) compared 59 percent versus 49 percent concentrate feeding and found that cows fed rations containing 59 percent concentrate produced an average of 11 percent more milk, 13 percent more protein, 3 percent more fat, and 11 percent more lactose than cows fed 49 percent concentrate rations. Of the increase in milk protein, 85 percent was attributed to increased yield and only 15 percent to increased percentage in the milk.

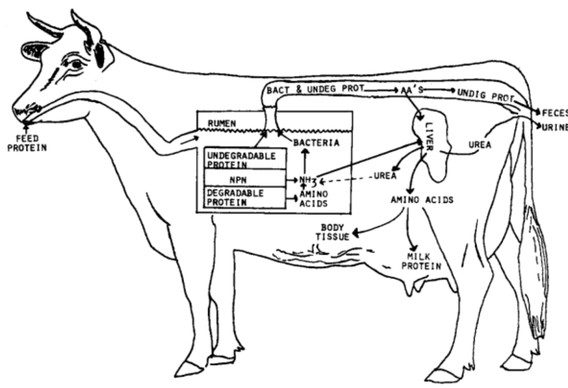

FIG. 1

Degradation of protein in dairy cows.

3.3 SNF (Minerals & Carbohydrates)

The mineral content of milk is derived from minerals found in circulating body fluids. Normal dietary regimes have little influence on the mineral composition of milk, especially the macromineral constituents.

It is well documented that the mineral composition of colostrum is higher than that of milk. Calcium, phosphorus, potassium, and chloride concentrations follow the same lactation curves as fat and protein—that is, high in colostrum, lowest at peak milk yield, and then gradually increasing as lactation progresses (Iyengar, 1982; Jenness, 1985). Milk inorganic phosphorus levels were shown to be higher in first lactation cows than in multiparous cows, and milk phosphate levels were lowest during the summer (Forar et al., 1982).

The predominant carbohydrate in milk is the disaccharide lactose. It is composed of one molecule of glucose and one molecule of galactose joined in a 1-4 carbon linkage as beta-galactoside. The principal biological function of lactose in milk is the regulation of water content and, thus, the regulation of osmotic content (Davies et al., 1983; Jenness, 1985). Because of this function, lactose is the most constant constituent in milk, averaging 4.6 percent.

Carbohydrates other than lactose that are found in milk are monosaccharides, sugar phosphates, nucleotide sugars, free neutral and acid oligosaccharides, and glycosyl groups of peptides and proteins (Jenness, 1985). Free glucose and galactose and the sugar alcohol myo-inositol are also present in milk. However, the amounts of these carbohydrate fractions are minor compared with that of lactose.

Carbohydrates are the major source of energy for rumen microorganisms and the single largest component (60-70%) of a dairy cow's diet.

Milk is a natural source of calcium, vitamin B12, riboflavin (vitamin B2), phosphorus and potassium. It also contains smaller amounts of other nutrients including vitamin A, niacin, folate, vitamin B6, vitamin D, magnesium, selenium and zinc. In some, but not all, European countries milk is also a good source of iodine. The variation in iodine content is mainly due to differences in cows' diets between countries. The cows' diet can also affect the content of other nutrients

4 Conclusion

It has been found that the diets of the Indian dairy cattle is highly deficient in one macronutrient, and that's protein. There are several studies that prove that lack of protein can seriously hinder milk yield, milk fat and milk protein content. The cattle is unable to utilise its gut microbes and nitrogen to the fullest when its protein requirements aren't met.
Excess of protein too has its side effects, as it doesn't affect milk yield after a certain point, and may even degrade the fat content in milk. Excess protein in the body of the cattle is simply excreted while producing excess ammonia. It also reduces the nitrogen utilization efficiency in the gut, and might also affect performance. It has been found that excess feeding of protein over long periods of time may also affect reproductive health of the cattle, and might even degrade rumen health.
The most efficient way to address the issue of protein and micro molecule deficiency would be to include protein concentrates along with micro molecule supplements. Farmers in the west have highly benefited from this style of diet since this fulfills the cattle's protein requirements along with supplying them with micro molecules that are necessary for their good health.
Fulfilling the cattle's protein demands, if deficient, would also result in better reproductive performance, more milk yield, milk protein and fat content as well. The gut microbes would be working on their highest efficiency while keeping the rumen health in check.
Microbial Protein is another way to tackle this problem since it is used as a protein concentrate.
Fulfilling the cattle's nutrient demands only through traditional roughages could be extremely challenging and expensive for the farmers. Concentrate supplements, in most cases, would fulfil the cattle's deficiencies in a relatively cheaper fashion.

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