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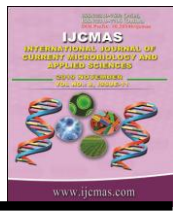

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A Precise Approach for Fulfilling Protein and Amino Acids Requirement in Bovine: A Review

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A B S T R A C T

The gap between demand and supply of feeds and fodder in India is huge, particularly for bovine (Cattle, Buffalo, Mithun and Yak). The total bovine population was 299.9 million (58.57 % of total livestock) in 2012. The deficit of green and dry fodder was presented by Rathod and Dixit (2019) as 63.50 and 23.56 %, respectively in 2015 as per X five year plan which is projected to increase further by 2020 and 2025. Under present deficit condition of feed and fodder and future demands compel us to work on areas which are demand of present scenario. This review article underlines the importance of precision nutrition focusing particularly to protein and amino acids.

Introduction

India maintains around 11 % of total world livestock in limited 2.3 % of world geographical area, moreover for the last three decades the area under fodder production has remained stagnant, only 4-5 % of total cultivated area (ICAR, 2016). Managing the feeds and fodder requirement of 512 million livestock including 300 million bovine therefore is crucial. Despite the huge gap between demand and supply of feeds and fodder, milk production has reached to 176.5 million ton (NDDB, 2018) and meat production has reached 7.4 million tons per annum (DAHD, 2017) respectively which present further scope for increase production if strategies like precision feeding are adopted.

Deficit of green and dry fodder in India was projected 64.21 and 24.81 %, respectively for 2020 (GOI-2002). High producing animals have higher requirement for dietary essential amino acids than supplied by the microbial protein alone (Ratika *et al.*, 2018) and adequate supply of protein is crucial for performance of dairy animals. A Protein efficiency and imbalance of Amino Acids

(AA) have a dramatic effect on growth, milk production and reproduction. Unscientific and imbalance feeding further complicating the present problem, it not only affects the utilization of nutrients but also maximize the ruminal fermentation losses there by increasing the wastage of nutrients into the environment (Chandrasekharaiah and Soren, 2018). Balanced feeding affects the cost of milk production, daily milk yield, milk fat percentage, lactation yield and nutrients required per liter of milk (NDDB, 2018). On account of shortage and to exploit milk production efficient utilization of available feed ingredient is need of hour.

Protein availability and demand

Concentrates in India provides around 8.5-9 million tones of total protein to dairy animals supporting production of only 0.45 million tonnes of milk protein (Tandon *et al.,* 2008). The availability of protein meals annually in India was approximately 19-20 MMT, against a requirement of about 30-35 MMT. Out of available, approximately 4-5 MMT protein meals was exported, which further increases the gap between the requirement and the availability (Nilufar and Hossain, 2012).

Protein requirement in ruminants

Ruminants are unique in the way that their fore stomach has substantial number of beneficial microbes that can digest complex carbohydrates which others cannot. Hence they have protein requirement at 2 levels I. The nitrogen needs of rumen microbes and II.

The protein need of the animal itself

Dietary protein in them can be divided into two parts 1) Rumen Degradable Protein (RDP) and 2) Undegradable Dietary Protein (UDP). RDP is the part of the feed protein which degraded in rumen where as UDP is protein which escape (Bypass) the rumen fermentation gets digested in the abomasum and small intestine to supply AA (Dukes and Reece, 2004) (Table 1)**.**

Importance of maintaining RDP and RUP in Ration

Better utilization of protein resources

Diet containing high RDP results in excess ammonia production more than capacity of rumen microbes to utilize, which after absorption through rumen epithilium converted into urea in liver, and excreted with urine. Ammonia emission from excreta can be reduced mainly by lowering the content of RDP (Van Duinkerken *et al.,* 2005) (Fig. 1).

Protection of protein meals

Protein meal differ in rumen degradability. Some protein contain naturally available rumen bypass protein (30 to 40% of total CP) viz. cotton seed meal, toasted soybean, toasted groundnut meal, maize gluten etc. the cost of these ingredient is high. Whereas rapeseed meal, sunflower meal, Guar meal are available at cheaper rate but rumen by pass content in them is low.

Usually rumen protein degraded in the rumen to the extent 65-70% lead to wastage of nitrogen. These protein meals can be treated suitably so as to their degradability in the rumen from 70% to 30 %. Cost of treating protein meal is less than a rupee per kg and on feeding one kg treated meal in comparison to untreated, there is increase in milk production by more than one litre (Nilufar and Hossain, 2012).

Gulati *et al.,* (2001) reported the change in rdp and rup fraction and amino acid availability at abomassu follwing formadihyde treatment of soyabean oil seeds RUP content increased from 20 to 80 % and amino acids availability at abomasum increased by 4 times.

Table.1 RDP and UDP content of common feed and fodder (Approx.)

S.No	Feed/Fodder	CP%	RDP%	UDP%
1.	Wheat grain	10	75	25
2.	Maize grain	9	26	74
3.	Bajra grain	12	32	68
4.	Jowar grain	10	20	80
5.	Oats grain	10	84	16
6.	Wheat bran	16	73	27
7.	Rice bran	14	65	35
8.	Ground nut cake	42	77	23
9	Soyabean meal	46	54	46
10	Rapeseed meal	38	37	63
11	Sunflower meal	30	47	53
12	Mustard cake	35	75	25
13	Cotton seed cake	35	51	49
14	Linseed cake	28	58	42
15	Beseem green	26	49	51
16	Lucerne fresh	20	76	24
17	Oats grass	13	51	49
18	Cowpea	20	68	32

(Source: NIANP, 2013)

Table.2 Nutrient profile of HCHO treated soybean oil seed

Parameter	Unprotected (g/kg)	Protected (g/kg)
Total Protein	285	285
Rumen Un-degradable Protein	57 (20%)	228 (80%)
Amino Acids Available for Absorption at the Abomasum		
Methionine	0.25	0.98
Lysine	0.78	3.12

(Gulati *et al*., 2001)

Table.3 Summary of bypass protein based feeding trial

Feeding trial with treated meal	Location	Increase in comparision to control			
		Milk (Lt.)	Fat%	Protein %	Net Income (Rs/ani./day)
Sunflower meal in cows	Sarsa	1.00	0.30	0.20	9.85
Rapeseed meal in cows	Ravipura	1.10	0.20	0.20	9.61
Gaur meal in cows	Ravipura	0.90	0.20	0.20	8.60
Sunflower meal in Buffalo	Chikhodra	0.80	0.40	0.30	14.49
Rapeseed meal in low yielding cows	Sarsa	0.70	0.20	0.20	5.80

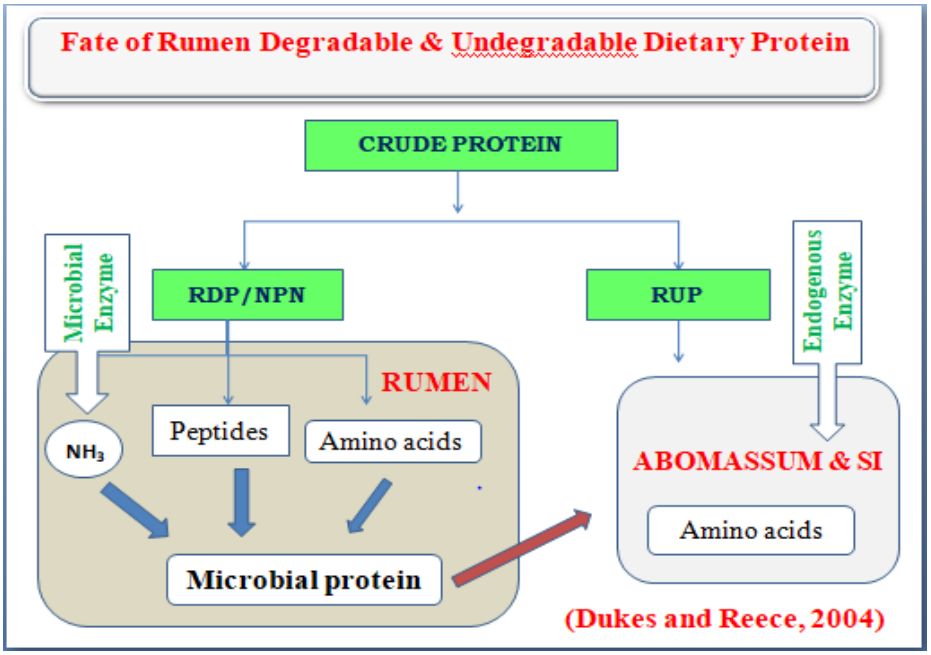
(NDDB, 2006)

Table.4 Lys and Met values for common feeds

Particulars	Lys (% of CP)	Met (% of CP)
Corn silage	2.5	1.5
Oats	4.2	2.9
Wheat	2.8	1.6
Linseed meal	3.7	1.8
Soybean meal	6.3	1.4
Rice bran	4.4	2.06
Wheat bran	4.01	1.44
Feather meal	2.32	0.68
Fish meal	6.84	2.50
Meat meal by product	4.90	1.30
Poultry by product meal	5.06	1.58

(NRC, 2001)

Fig.1 Fate of rumen degradable protein (RDP) and rumen undegradable protein (RUP)



How to fed bypass protein supplement and economic benefits

Treated protein meal can be used as top feed or directly at rate of 1kg per animal per day or else treated meal can be incorporated in cattle feed and this feed can be given at the rate 3 to 4 kg per animal as per the production. The cost of feed ranges from 70 to 80 paisa per kg only and result in increase milk production, SNF and Fat% (NDDB, 2006) (Table 2 and 3).

Effect of feeding varying RDP and RUP ratio in bovine ration

Replacement of 10 % crude protein (CP) from soya bypass protein resulted in average daily gain and cost of feeding for per kg weight gain

also reduced when bypass feeding was done in heifers (Kumari *et al.,* (2016). Lactating cows fed 8% RDP and 6% RUP in the diet, minimizes dietary nitrogen input and nitrogen output to the environment without compromising milk production reported by Kaufman (2016). Feeding of concentrate mixture containing formaldehyde treated oil cakes of rapeseed and cottonseeds economically improved yield of milk and its components. Furthermore, the treatment effects were more pronounced during early lactation (Aasiwal *et al.,* 2015). Arewad *et al.,* (2010) reported calves which were fed concentrate with formaldehyde treated bypass protein source showed significant increase in average daily weight gain and the feed conversion efficiency also improved significantly. Cost of feeding for per kg wt gain also reduced by Rs. 3.69 in calves fed with bypass protein source.Buffaloes which were fed with ration having RDP:RUP in ration as 50:50 showed significant increase in milk yield and the urinary nitrogen loss was also lowest. Days open also reduced to 99 and conception rate inceased to 75 % by maintain RDP:RUP of 50:50 (Mahr-Un-Nisa *et al.,* 2008)

Ideal balance of absorbed amino acids

Amino acids composition of each protein is different, key regulators of various physiological processes such as milk production, growth, reproduction and immunity (Schwab, 2012).

Rulquin *et al.,* (1993) used an indirect nutrient-response approach to establish the concentrations of Lysine (Lys) and Methionine (Met) that are needed in Metabolozable Protein (MP) to maximize milk protein yield lactating cow. They reported ideal Lys and Met percentage in MP should be 7·2 and 2·4%, respectively ratio (3:1). Later (NRC, 2001) and Doepel *et al.,* (2004) also reported similar values for ideal concentration of Lys amd Met in metabolizable protein for maximum milk yield which were similar with the concentrations of Lys and Met in Protein content of milk, lean tissue and rumen bacteria reported by (O'Connor *et al.,* 1993). later in 2009 White house and Schwab reported the similar values for concentration of Met and Lys in MP and ideal Lys to Met ratio as 3:1 form maximum content of milk protein.

Plant protein and animal proteins have different AA composition with former are deficient in Lys and Met (NRC, 2001).

Among AA, the availability of Met and Lys in MP across a wide range of feed ingredients for `bovine is low, hence, limiting its use for mammary and liver metabolism (Osorio, 2018).

Effect of supplementation of rumen protected Met and Lys on bovine

Abdelmegeid *et al.,* (2018) supplemented the diet with Rumen-Protected Met at the rate (0.08% of DMI) during peripartal period and studied its effect on abundance of major species of rumen bacteria. The dry matter intake increased significantly due to supplementation and did not compromise growth of major bacterial species in the rumen. In fact, had a positive effect on three major species (Table 4). Gavade *et al.,* (2019) reported calves which were fed with 3 g rumen protected Met and 20 g rumen protected_Lys had highly significant increase in average fortnight gain in weight and significant increase in average daily gain in weight. Feeding cost for per kg weight gain also reduced in calves supplemented with rumen protected Met and Lys. Feed conversion efficiency of Murrah buffalo heifers due to supplementation of commercial bypass AAs. was also improved significantly (Kumar *et al.,* 2018. Feed conversion ratio

(FCR) was lowest in heifers which were supplemented with 2 g/d of RPM +10 g/d of RPL (Singh *et al.,* 2015). Supplementation of bypass Met and Lys at the rate of 5 g and 10 g/day resulted in significant increased in daily weight gain and feed conversion ration also reduced when heifers were supplemented with bypass Met and Lys. Cost of feeding per animal per day was significantly higher; when diet was supplemented with bypass Met and Lys but cost of feeding for per kg weight gain reduced due to supplementation (Movaliya, 2013).

The milk yield and protein yield was increased significantly only when diet was supplemented with both rumen-protected Met and Lys (Awawdeh, 2016). Ahmed *et al.*, (2016) studied effect of supplementation of Rumen Protected Lys and Met on production performance in early lactating Nili-Ravi buffaloes. Buffaloes which were provided with 40 gm rumen protected Lys and 14 gm rumen protected Met and 30gm rumen protected Lys and 10 gm rumen protected Met, respectively showed significant increase in milk production. Supplementing rumen protected lysine from 4 wk prepartum improves performance. Milk yield and protein yield increased significantly during fresh and high production period (Batistel *et al.,* 2017). Supplementation of rumen- protected Met at the rate of 0.034% on dry matter basis did not improve milk yield, fat % and protein % but incidence of mastitis was lower when diet supplemented with rumen- protected Met was fed (Tamura *et al.,* 2019). Supplementation of Met to make Lys: Met near to 3:1. Milk yield, fat% and protein % was comparable between the groups but feeding ration with lysine and met ratio nearly 3:1 showed higher pregnancy rate (Toledo *et al.,* 2017).

A study was conducted at Werner Meyer GbR farm in North-West Germany by Kemin feed company to see the effect of top supplementation of rumen bypass lysine on performance of milk yield along with reproductive behavior **s**upplementation of rumen bypass lysine at the rate of 25 gm increased energy corrected milk by 1.3 kg and open days reduced to 97 and service per conception also reduced to 1.9 (Kemin, 2017). Pregnancy rate of heifers which received 14 % CP and 25 gm protected Met was comparable with heifers receiving 16% cp and 15 gm protected Met (Titi *et al.,* 2013).

There is a huge gap between demand and supply of feed and fodder to bovine, and increasing population of high productive animal, adding complexity to this problem.

The RUP and RDP fraction and composition of amino acids in protein is more important than CP content for growth, production and reproduction. Feeding excess RDP results in more nitrogen loss, wastage of nutrients therefore intelligent selection feed ingredient and using treated protein meal and optimal RDP and RUP ratio in very important. UDP level can be increased to 50% in high producing animals during early lactation.

Feeding bypass protein is more beneficial in terms growth and more economical for calf and heifers. The availability of Met and Lys in plant proteins is low therefore supplementation of Met and Lys is essential. Optimal amount of Lys and Met is 7.5 and 2.5 %, respectively in MP (ratio be 3:1). Average daily weight gain, milk production, milk fat and protein, fertility, conception rate and immunity increases by adding 2 to 50 g of rumen protected Met and Lys.

Future prospect

Research is needed to improve diet formulation models to balance for amino acid requirements as well as RDP: RUP Quantify the potential to reduce protein feeding when

using protected amino acids, thereby reducing the wastage and excretion of nitrogen in to the environment.

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