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The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2018; 7(7): 524-527

www.thepharmajournal.com
Received: 13-05-2018
Accepted: 14-06-2018

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Metabolizable energy and protein evaluation of some common Indian feedstuffs used in ruminant ration

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Abstract
The present study was conducted to evaluate detailed chemical composition (% DM), Cornell Net Carbohydrate and Protein system (CNCPS) proteins fractions (% CP) and to determine metabolizable energy (ME) and metabilazable protein (MP) value of various feed ingredients commonly used in ruminant nutrition under Indian field conditions. Total twelve different feed ingredients were taken and analysed for proximate composition, detergent analysis (cell wall fractions) and CNCPS protein fractions. Results of present study revealed that ME content was highest in full fat soya (17.32 MJ/Kg) while it was found quite similar for maize (8.24 MJ/Kg DM) and sorghum fodders (7.87 MJ/Kg DM). Quickly degradable protein fraction was found to be highest in mustard oil cake (24.65 %), while least degradable protein fraction (% CP) was estimated highest in wheat straw as 25.78. MP content of GNC (29.21) was found highest among all feeds. It can be concluded that it can be possible to determine CNCP protein fraction can be to determine the RDP and UDP fractions as well as MP values of feed and fodder.

Keywords: Cell wall fractions, Chemical composition, CNCPS, Feed ingredients

Introduction
Energy and protein content in the diet is mainly responsible for utilization of various nutrients and thereby affecting productivity of animals (Davis *et al*., 2011) [11]. Inadequate nutrition, particularly of energy and protein depresses overall performance of animals. Energy is generally acquired from carbohydrates, such as starch, cellulose and fat. Feed energy supply to ruminants often remains limiting under tropical conditions. Total digestible nutrient (TDN), has been long in use to indicate energy content of a feed as well as energy requirement of animals in India. However, a number of studies conducted in India and elsewhere proved that the TDN determination by using cell wall fractions (NRC, 2001) [14] is more accurate and can also be used for Indian feeds (Das *et al*., 2015) [8]. On the other hand metabolizable energy (ME) determination includes the corrections due to losses in urine as well as methane. Thus, ME may seems to be a more precise expression of energy utilization efficiency. The concept of digestible crude protein (CP) for ruminants suffers due to its limitations to define extensive degradation of dietary protein in rumen and synthesis of substantial amount of microbial protein and availability of both microbial protein and rumen undegradable protein (RUP) at intestinal level. NRC (1996) [13] defined metabolizable protein as the true protein which is absorbed by the intestine and supplied by both microbial protein and protein which escapes degradation in the rumen; the protein which is available to the animal for maintenance, growth, fetal growth during gestation and milk production. Metabolizable protein systems (Burroughs *et al.*, 1974) [5] define the animal's requirement using estimates of available microbial and dietary escape protein and thus are potentially more accurate than the DCP and CP systems. In addition, MP system is also a better predictor of milk yield than CP (Schwab and Ordway, 2004; Das *et al.*, 2014) [17, 9]. Replacing conventional CP system with MP system provides better idea to define protein utilization and diet formulation as this system fits more precisely with the biology of ruminants. Thus, the objective of present study was to evaluate chemical composition and ME as well as MP value of different feed ingredients using CNCPS and cell wall fractions to economize the ration formulation in ruminant nutrition for better productivity.

Materials and Methods
Commonly used feed and fodder samples viz. maize grain wheat bran, rice bran, mustard cake-deoiled (DOMOC), full fat soya, cotton seed cake (CSC), maize green, sorghum (sugargraze)

green and wheat straw were collected from forage sections of NDRI, Karnal and from local market of Karnal (Haryana) and were dried in hot air oven at 65 ° C for 4 8 h to determine dry matter (DM). The dried samples were ground in a laboratory Wiley mill to pass a 1-mm sieve. All grounded samples were stored in zip lock bags of 9×6 cm, labelled properly and kept for further analysis. After that all samples were analysed for crude protein (CP; # 984.13), ether extract (EE; # 920.39) and total ash (# 942.050) as per AOAC (2005).

The cell wall fractions i.e. NDF, ADF were estimated as per Van Soest *et al*. (1991). Acid detergent and neutral detergent insoluble nitrogen (ADIN and NDIN) was estimated as per Licitra *et al*. (1996) [12]. CNCPS protein fractions were estimated as per equations given by Sniffen *et al.* (1992). Total digestible nutrient (% DM) (TDN) was calculated as per NRC (2001) [14].

The RDP and RUP values (% CP) for a feedstuff were calculated as per NRC (2001) [14] using the following equations:

$RDP = A + B1\ [k_d\ B_1 /(k_dB_1 + k_p)] + B_2\ [k_dB_2 / (k_dB_2 + k_p)] + B_3\ [k_dB_3 / (k_dB_3 + k_p)]$

$RUP = B_1\ [k_p / (k_dB_1 + k_p)] + B_2\ [k_p / (k_dB_2 + k_p)] + B_3\ [k_p / (k_dB_3 + k_p)] + C$

Where,

RDP = Rumen degradable protein of the feedstuff, percentage of CP

RUP = RUP of the feedstuff, percentage of CP

A = Fraction A, percentage of CP

B_1 = Fraction B_1, percentage of CP

B_2 = Fraction B_2, percentage of CP

B_3 = Fraction B_3, percentage of CP

C = Fraction C, percentage of CP

K_d = rate of degradation of the B fraction, %/h

K_p = rate of passage from the rumen, %/h

Determination of metabolizable protein

MP has two components

A) Digestible microbial true protein (DMTP) as recommended by ARC, (1980;1984)

DMTP (g/d) = 0.75 × 0.85 × MCP (g/d) = 0.6375 MCP (g/d); Where, 0.75 microbial true protein in microbial crude protein (MCP); 0.85 digestibility of microbial true protein (MTP) recommended by ARC (1980; 1984)

B) Digestible undegraded feed protein (DUP)

The proportion of DUP in UDP (undegraded protein) varies from nil to 0.9, depending on the feed, its composition and pretreatment, the digestibility of UDP can be predicted from the Acid detergent insoluble nitrogen (ADIN) content of the feed.

DUP (g/Kg DM) = 0.9 × ((RUP) – (6.25 × ADIN)

MP (g/d) = DMTP + DUP

Results and Discussion

Chemical composition of various feeds and fodders has been presented in Tables 1. Metabolizable energy (ME) content was higher in maize grain (14.02 MJ/Kg DM) as compared to barley grain (12.55 MJ/Kg DM). ME content was highest in full fat soya among all the ingredients analyzed (NRC, 2001) [14] due to higher EE content (20.15 %). These findings are in agreement with Pal (2016) [15] and Sharma (2016) [18] who observed similar EE and ME content of full fat soya. Moreover, chemical composition (%DM) of all the other ingredients were found within the range, reported previously (Bisitha, 2013; Prusty, 2015; Sharma, 2014 and Sharma, 2014) [4, 16, 19]. Results of chemical composition (% DM) of fodder showed similar ME content of maize and sorghum fodders which were 8.24 and 7.87 MJ/Kg DM respectively, due to similar chemical composition. However, ME content was lower in wheat straw (5.61 MJ/Kg DM) as compared to other fodders analyzed. The fodder compositions in the present study corroborates with earlier reported values of Datt *et al.* (2009) [10], Das (2012) [7], Bisitha (2013) [4] and Sharma (2014) [19].

Detailed CNCPS protein fractions and MP content of different feeds and fodders have been furnished in Tables 2 and 3. Results revealed that fraction P_A to be more or less similar among the grains as well as agro-industrial byproducts. Similarly, P_A fraction was similar among protein ingredients sources except that of cotton seed cake which had lower P_A value compared to others. Fraction P_{B1} was lower in barley grains as compared to maize grains. P_{B1} was highest in full fat soya and comparable among other protein sources. P_{B2} fraction comprised bulk of the protein fraction in all the ingredients analyzed except that of full fat soya which had higher P_{B1} fraction than P_{B2}. Moreover, P_{B2} was also comparable among ingredients analyzed except that of full fat soya. Fraction P_C i.e. unavailable protein was lower in all the concentrate ingredients including grains, agro-industrial byproducts, cakes and other protein sources. CNCPS protein fractions of fodders revealed lower P_A fraction in wheat straw and berseem than maize and sorghum (sugargraze) fodders. However, P_B fraction was more or less similar among the fodders except that of wheat straw which had lower P_{B1} than other fodders. Moreover, P_C fraction (unavailable protein) was also higher in wheat straw as compared to other fodders analyzed. All the values were within the normal range and similar to prior findings of Datt *et al.* (2009) [10], Das (2012) [7], Bisitha (2013) [4] and Sharma (2014) [19]. However, marginal variations were observed for some protein fractions than above cited literature which may be due to intrinsic differences in feeds varieties and processing. Recently,

detailed knowledge on various protein fractions of feed ingredients as per CNCPS has provided better vision in terms of both ruminal degradability and intestinal digestibility, which can be further extended to determine the RDP and UDP fractions as well as metabolizable protein values. Metabolizable protein content of various feeds and fodders determined through this approach (detail provided in material method section) was similar to previous reported values of Das *et al.* (2015) [8] who used the traditional *in sacco* nylon bag technique to determine rumen degradation constant compared to the present study which involved use of various equations of NRC (2001) [14]. MP estimated through utilizable crude protein (Zhao and Lebzien, 2000) [22] and intestinal digestibility by Calsamiglia and Stern (1995) [6]; Prusty (2015) [16] and Sontakke (2015) [20] were similar to the present findings. Thus, these results further extend the scope of the present approach in determining the MP values of feed and fodders.

Conclusion

Among all test feed samples, CP content (% DM) was observed to be highest for GNC (45.15) and lowest for wheat straw (4.15). ME content was highest in full fat soya (17.32 MJ/Kg) while it was found quite similar for maize (8.24 MJ/Kg DM) and sorghum fodders (7.87 MJ/Kg DM). Instantaneously degradable protein fraction was found to be

highest in Mustard oil cake (24.65%) while least degradable protein fraction (% CP) was estimated highest in wheat straw as 25.78. MP content of GNC (29.21) was found highest among all feeds. Nowadays, along with chemical composition, detailed knowledge on CNCPS protein fractions and MP value of various of feed ingredients has gained importance considering its immense significance in integrating both ruminal degradability and intestinal digestibility, which can be further used to economize the ration formulation in ruminant nutrition for better productivity.

Table 1: Chemical composition (% DM basis) of different feeds and fodders

Ingredient/ Parameter	OM	CP	EE	Ash	NFC	NDF	ADF	Hemi-cellulose	Cellulose	Lignin	TDN	DE (Mcal/Kg)	ME (Mcal/Kg)	ME (MJ/Kg)
Maize grain	97.90	9.45	5.70	2.10	65.51	18.80	10.13	8.67	8.59	1.54	86.32	3.75	3.35	14.02
Barley	97.26	10.74	3.33	2.74	60.67	24.78	13.25	11.53	9.35	3.90	77.76	3.41	3.00	12.55
Wheat Bran	94.83	15.42	2.09	5.17	40.93	39.70	11.53	28.17	6.64	4.89	67.76	3.05	2.62	10.96
DORB	93.11	12.48	0.85	6.89	33.23	48.70	19.63	29.07	16.72	2.91	64.75	2.88	2.45	10.25
Ground nut cake	92.49	45.15	1.39	7.51	24.41	24.91	13.57	11.34	8.43	5.14	69.58	3.54	3.11	13.01
Cotton seed cake	95.22	24.31	5.04	4.78	23.61	48.27	25.10	23.17	14.05	11.05	62.48	2.95	2.54	10.62
Mustard cake	93.35	36.83	8.63	6.65	22.13	28.21	24.21	4.00	18.26	5.95	75.96	3.68	3.30	13.81
Full fat soya	92.98	39.79	20.15	7.02	4.05	33.80	22.45	11.35	18.74	3.71	92.93	4.47	4.14	17.32
Fodders														
Maize	90.53	10.13	2.16	9.47	18.56	62.70	32.15	30.55	26.68	5.47	54.39	2.40	1.97	8.24
Sorghum (Sugargraze)	90.29	10.25	2.04	9.71	18.29	63.10	33.27	29.83	27.04	6.23	52.42	2.31	1.88	7.87
Wheat straw	89.97	4.15	1.05	10.03	8.83	77.70	42.88	34.82	33.04	9.84	41.53	1.78	1.34	5.61
Berseem	90.53	18.50	2.10	9.47	28.22	48.10	29.55	18.55	22.03	7.52	55.54	2.54	2.11	8.83

Table 2: Protein fractions of different feeds and fodders

Ingredient/ Parameter	NDICP (% DM)	NDICP (% CP)	ADICP (% DM)	ADICP (%CP)	TP (% DM)	TP (% CP)	NPN (%DM)	NPN (%CP)	BSP (%DM)	BSP (%CP)	BIP (%DM)	BIP (%CP)	NPN (%BSP)
Maize grain	1.55	16.41	0.79	8.36	8.23	87.14	1.22	12.86	4.50	47.64	4.95	52.36	27.00
Barley	2.25	20.91	0.73	6.80	9.15	85.24	1.59	14.76	2.35	21.89	8.39	78.11	67.45
Wheat Bran	3.31	21.44	0.64	4.18	13.35	86.60	2.07	13.40	3.66	23.71	11.76	76.29	56.50
DORB	2.15	17.23	1.35	10.78	11.15	89.38	1.33	10.62	3.50	28.06	8.98	71.94	37.86
Ground nut cake	3.36	7.43	2.32	5.13	36.00	79.74	9.15	20.26	23.32	51.66	21.82	48.34	39.21
Cotton seed cake	6.00	24.69	2.23	9.18	22.60	92.98	1.71	7.02	8.60	35.38	15.71	64.62	19.83
Mustard cake	2.45	6.65	4.98	3.52	27.75	75.35	9.08	24.65	18.19	49.39	18.64	50.61	49.92
Full fat soya	4.80	12.06	2.64	6.62	33.75	84.83	6.04	15.17	24.82	62.38	14.97	37.62	24.32
Fodders													
Maize fodder	3.02	29.76	1.78	17.58	8.40	82.92	1.73	17.08	3.85	38.01	6.28	61.99	44.94
Sorghum (Sugargraze)	3.39	33.09	2.19	21.41	8.00	78.09	2.25	21.91	4.70	45.91	5.54	54.09	47.73
Wheat straw	2.08	52.07	1.03	25.78	3.66	91.49	0.34	8.51	0.36	8.89	3.64	91.11	95.77
Berseem	6.39	34.54	3.29	17.76	16.85	91.08	1.65	8.92	6.35	34.32	12.15	65.68	25.98

Table 3: CNCPS protein fractions (%) and metabolizable protein content of different feeds and fodders

Ingredient/Parameter	P_A	P_{B1}	P_{B2}	P_{B3}	PC	RUP (% CP)	RDP (% CP)	DMP (% CP)	DUP (% CP)	MP (%DM)
Maize grain	12.86	34.78	35.94	8.05	8.36	27.14	72.86	4.40	1.60	6.00
Barley	14.76	7.13	57.20	14.11	6.80	36.98	63.02	4.33	2.92	7.25
Wheat Bran	13.40	10.31	54.85	17.26	4.18	36.41	63.59	6.27	4.47	10.74
DORB	10.62	17.43	54.71	6.45	10.78	33.73	66.27	5.29	2.58	7.87
Ground nut cake	20.26	31.40	40.91	2.30	5.13	20.42	79.58	22.99	6.21	29.21
Cotton seed cake	7.02	28.37	39.93	15.51	9.18	35.54	64.45	10.03	5.77	15.79
Mustard cake	24.65	24.73	43.96	3.13	3.52	20.36	79.64	18.77	2.27	21.04
Full fat soya	15.17	47.21	25.55	5.44	6.62	20.11	79.89	20.34	4.83	25.17
Fodders										
Maize fodder	17.08	20.93	32.23	12.18	17.58	40.42	59.58	3.86	2.08	5.94
Sugargraze fodder	16.67	25.57	35.79	10.71	11.27	34.17	65.83	4.52	2.21	6.74
Wheat straw	8.51	0.38	39.05	26.28	25.78	63.17	36.83	0.94	1.34	2.29
Berseem	8.92	25.41	31.14	16.78	17.76	44.39	55.61	6.58	4.43	11.02

References

1. AOAC. Official Methods of Analysis, 18th edition. Assoc. Off. Anal. Chem., Arlington, Verginia, 2005.
2. ARC. The nutrient requirements of ruminant livestock. Commonwealth Agricultural Bureaux, Agricultural Research Council, Slough, U.K, 1980.
3. ARC. The nutrient requirements of ruminant livestock. Suppl.1. Commonwealth Agricultural Bureaux, Agricultural Research Council, Slough, U.K, 1984.
4. Bisitha KS. Variations in energy and protein utilization in growing Murrah buffalo calves. M.V. Sc Thesis. National Dairy Research Institute, Karnal, Haryana, India, 2013.
5. Burroughs W, Trenkle A, Vetter RL. A system of protein evaluation for cattle and sheep involving metabolizable protein (amino acids) and urea fermentation potential of feedstuffs. Vet. Med. Small Anim. Clin. 1974; 69:713.
6. Calsamiglia S, Stern MD. A three-step *in vitro* procedure for estimating intestinal digestion of protein in ruminants.

J Anim. Sci. 1995; 73(5):1459-1465.
7. Das LK. Metabolizable protein availability from different feeds and the effects of its graded levels in the diet on nutrient utilization in growing sahiwal calves. M.V. Sc Thesis. National Dairy Research Institute, Karnal, Haryana, India, 2012.
8. Das LK, Kundu SS, Datt C, Kumar D, Tariq H. In Situ Ruminal Degradation Kinetics of Dry Matter, Crude Protein and Neutral Detergent Fiber of Tropical Ruminant Feedstuffs. Indian J Anim. Nutr. 2015; 32(1):45-51.
9. Das LK, Kundu SS, Kumar D, Datt C. The evaluation of metabolizable protein content of some indigenous feedstuffs used in ruminant nutrition. Vet. World. 2014; 7:257-261.
10. Datt C, Singh NP, Chhabra A, Dhiman KR. Nutritional evaluation of cultivated fodder crops grown under agro-climate of Tripura. Indian J Anim. Sci. 2009; 79:1143-48.
11. Davis R, Vandehaar MJ, Wolf CA, Liesman JS, Chapin LT, Nielsen MS. Effect of intensified feeding of heifer calves on growth, pubertal age, calving age, milk yield, and economics. J Dairy Sci. 2011; 94:3554-3567.
12. Licitra G, Hernandez TM, Van Soest PJ. Standardizations of procedures for nitrogen fractionation of ruminant feeds. Anim. Feed Sci. Technol. 1996; 57:347-358.
13. NRC. Nutrient Requirements of beef cattle. Seventh revised edition. National Research Council, National Academy Press. Washington DC, 1996.
14. NRC. Nutrient Requirements of Dairy Cattle: Seventh Revised Edition. National Research Council, National Academy of Sciences. Washington DC, 2001.
15. Pal M. Effect of feed energy and protein levels in semen quality in buffalo bulls. M.V.Sc Thesis. National Dairy Research Institute, Karnal, Haryana, India, 2016.
16. Prusty S. Metabolizable protein and energy requirements for buffalo calves fed on low methane producing rations. Ph.D. Thesis. NDRI Deemed University, Karnal (Haryana), India, 2015.
17. Schwab CG, Ordway RS. Balancing diets for amino acids: Implications on production efficiency and feed costs. In Proc. Penn State Dairy Cattle Nutrition Workshop, Grantville, PA, 2004, 1-16.
18. Sharma B. Development of calf ration based on protein and lipid quality to enhance immunity and growth rate in neonate Sahiwal calves. M.V.Sc. Thesis. National Dairy Research Institute, Karnal, Haryana, India, 2016.
19. Sharma V. Identification of single nucleotide polymorphisms associated with nutrient utilization and residual feed intake in Murrah buffalo calves. Ph.D. Thesis. National Dairy Research Institute, Karnal, Haryana, India, 2014.
20. Sontakke UB. Metabolizable protein and energy requirements for lactating buffaloes fed on Silage based diets. Ph.D. Thesis. NDRI Deemed University, Karnal (Haryana), India, 2015.
21. Van Soest PJ, Robertson JB, Lewis BA. Methods for dietary fibre, neutral detergent fibre and non-starch polysaccharides in relation to animal nutrition. Symposium: carbohydrate methodology, metabolism and nutritional implications. In dairy cattle. J. Dairy Sci. 1991; 74:3583-97.
22. Zhao GY, Lebzien P. Development of an *in vitro* incubation technique for the estimation of the utilizable crude protein (UCP) in feeds for cattle. Archives of Animal Nutrition. 2000; 53(3):293-302