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Evaluation of certain crop residues for carbohydrate and protein fractions by cornell net carbohydrate and protein system

Venkateswarulu Swarna[1], Srinivas Kumar Dhulipalla[2,*], Raghava Rao Elineni[2] and Narendra Nath Dhulipalla[3]

[1]*College of Veterinary Science, Proddatur, India;*
[2]*NTR College of Veterinary Science, Gannavaram, India;*
[3]*College of Veterinary Science, Tirupati, India.*
[*]*Corresponding author's e-mail: kumardhulipalla@rediffmail.com*

ABSTRACT

Four locally available crop residues *viz*., jowar stover (JS), maize stover (MS), red gram straw (RGS) and black gram straw (BGS) were evaluated for carbohydrate and protein fractions using Cornell Net Carbohydrate and Protein (CNCP) system. Lignin (% NDF) was higher in legume straws as compared to cereal stovers while Non-structural carbohydrates (NSC) (% DM) followed the reverse trend. The carbohydrate fractions A and B_1 were higher in BGS while B_2 was higher in MS as compared to other crop residues. The unavailable cell wall fraction (C) was higher in legume straws when compared to cereal stovers. Among protein fractions, B_1 was higher in legume straws when compared to cereal stovers while B_2 was higher in cereal stovers as compared to legume straws. Fraction B_3 largely, bypass protein was highest in MS as compared to other crop residues. Acid detergent insoluble crude protein (ADICP) (% CP) or unavailable protein fraction C was lowest in MS and highest in BGS. It is concluded that MS is superior in nutritional value for feeding ruminants as compared to other crop residues.

Keywords

Carbohydrate fractions, CNCPS, Crop residues, Protein fractions

ARTICLE HISTORY

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INTRODUCTION

The conventional feed analysis (proximate and detergent systems) provides information only about the concentration or quantity of nutrients present in the feedstuffs and gives little information about their availability in animal system. Further, the different fractions of a particular nutrient vary considerably in their utilization pattern. The different carbohydrate fractions like soluble sugars, starch, non starch polysaccharides and protein fractions like non protein nitrogen, soluble peptides and soluble true proteins are utilized by different rumen microbes and animals differently (Sniffen et al., 1992) and thus, their estimation in feed stuffs gives valuable information **(**Chaurasia et al., 2006**).**

The accurate prediction of biological value and performance of animals fed forages has been proposed by Russel et al. (1992**)** using Cornell Net Carbohydrate and Protein (CNCP) system. However, only few reports are available on carbohydrate and nitrogen fractions of crop residues (Kamble et al., 2011; Raja Kishore and Srinivas Kumar, 2013) in India for feeding ruminants and substantially more information is needed in preparation of balanced rations and in adaptation of advanced standards such as NRC (2001) and CNCP (2007). The present study was therefore undertaken to provide information on the nutrient components especially in terms of carbohydrate and protein fractions of some crop residues available in coastal belt of Andhra Pradesh using CNCP system.

MATERIALS AND METHODS

Crop residues *viz.* jowar stover (JS), maize stover (MS), red gram straw (RGS) and black gram straw (BGS) were procured from the farmers in and around Gannavaram. The samples were dried in hot air oven at 60^0C and then ground to pass through 1 mm sieve and stored in plastic bottles. Ground samples of crop residues were analyzed for proximate composition (AOAC, 2007) and fibre fractions (Van Soest et al., 1991).

Estimation of starch in dried samples was followed as per AOAC (2007). Non-structural carbohydrates (NSC) were derived by the equations given by Van Soest et al. (1991) *i.e.*, NSC = 100 – [(NDF - NDIP) + protein + fat + ash]. The carbohydrate fraction *viz.*, A, B_1, B_2 and C of different crop residues were estimated using the procedures of Sniffen et al. (1992). This fractionation is based on degradation rates of feed stuffs. Fraction A is fast and is sugars, fraction B_1 is intermediate and is starch, fraction B_2 is slow and is available cell wall and fraction C is unavailable cell wall.

Primary protein fractions such as non-protein nitrogen (NPN), soluble protein (SP), neutral detergent insoluble nitrogen (NDIN) and acid detergent insoluble nitrogen (ADIN) were estimated by the methods of Licitra et al. (1996). The ptotein fractions *viz.*, A, B_1, B_2, B_3 and C of different crop residues were estimated using the equations of Sniffen et al. (1992). Fraction A is the instantaneously degradable protein *i.e.*, NPN, fraction B_1 is rapidly degradable, fraction B_2 is intermediately degradable, fraction B_3 reprsents bypass protein while fraction C is unavailable protein.

RESULTS AND DISCUSSION

Chemical composition of crop residues (**Table 1**) revealed that CP content was higher in legume straws as compared to non legume straws whereas, lower lignin was observed in non-legume straws than legume straws.

Carbohydrate fractions

The carbohydrate fractions of MS, JS, RGS and BGS were presented in **Table 2**. Lignin (% NDF) was higher in RGS (19.25%) followed by BGS (18.41%), JS (13.6%) and MS (10.90%). Kamble et al. (2011) also reported similar values for lignin (% NDF) in jowar and maize stovers. The NSC (% DM) varied from 29.35% (MS) to 38.66% (BGS). Lignin (% NDF) was higher in legume straws as compared to cereal stovers while NSC (% DM) followed the reverse trend. Similar findings were also reported earlier (Singh et al., 2002). The quantity of NSC present as starch was higher in RGS followed by JS, BGS and MS. These results corroborated with the findings of Raja Kishore (2012). Among the crop residues, the carbohydrate fraction A (fast degradable) was higher in BGS and lower in RGS. However, in contrast to present findings, Singh et al. (2002) and Kamble et al. (2011) reported lower levels of fraction A in cereal straws as compared to legume straws. Fraction B_1 (intermediately degradable in rumen mostly considered as starch) followed the trend similar to fraction A. However, Kamble et al. (2011) and Raja Kishore (2012) reported as higher for fraction B_1 as compared to the values reported in the present study. Fraction B_2 which is slowly degradable and mostly representing the available cell wall content were higher in cereal straws as compared to legume straws. Similarly, Singh et al. (2002) also reported higher B_2 values in non-legume roughages when compared to legume straws. Further, fraction B_2 values reported in the present study was comparable to the values reported earlier (Gupta et al., 2011; Kamble et al., 2011; Raja Kishore, 2012). The available cell wall content was observed to be the lowest in BGS. The unavailable cell wall fraction (fraction C) was lower in cereal stovers as compared to legume straws indicating their superiority in carbohydrate quality. These findings are in agreement with findings of Singh et al. (2002), Kamble et al. (2011) and Raja Kishore (2012).

Table 1. Chemical composition (% DMB) of crop residues.

Nutrient	JS	MS	RGS	BGS
Dry matter	91.45	92.08	93.56	91.67
Organic matter	92.19	92.69	97.65	92.2
Total ash	7.81	7.31	2.35	7.80
Crude protein	3.78	4.68	5.7	7.29
Ether extract	1.76	1.96	1.51	7.23
Crude fibre	41.44	39.34	59.95	54.03
Nitrogen free extract	45.21	46.71	30.49	29.66
Neutral detergent fibre	74.36	76.12	81.98	72.56
Acid detergent fibre	58.65	56.38	72.51	66.69
Acid detergent lignin	10.12	8.3	15.78	13.36
Hemicellulose	15.71	19.74	9.47	5.87
Cellulose	46.9	47.58	58.2	54.6

Protein fractions

Buffer soluble protein fractions among different crop residues was found maximum (38.34%) in BGS and minimum (22.90%) in MS. NPN% of soluble protein was higher in MS (81.92%) and lowest in BGS (33.50%). The SP (% CP) was higher in legume straws as compared to cereal stovers while NPN (% SP) followed

Table 2. Carbohydrate and Protein fractions of crop residues.

Fraction	Jowar Stover	Maize stover	Red Gram Straw	Black Gram Straw
Carbohydrate components				
Lignin (% NDF)	13.60	10.90	19.25	18.41
NSC (% DM)	35.41	29.35	31.30	38.66
Starch (% NSC)	7.40	6.90	7.50	7.20
Carbohydrate fractions				
CA	14.07	12.06	9.98	14.57
CB_1	1.12	0.89	0.81	1.13
CB_2	56.80	63.91	47.33	45.99
CC	28.01	23.14	41.88	38.31
Protein components				
SP (% CP)	24.77	22.90	33.89	38.34
NPN (% SP)	70.70	81.92	58.66	33.50
NDIN (% CP)	23.12	25.97	22.84	27.53
Protein fractions				
PA	17.52	18.78	19.88	12.84
PB_1	7.26	4.14	14.02	25.50
PB_2	52.10	51.11	43.26	34.14
PB_3	9.25	14.79	8.17	10.77
PC	13.87	11.18	14.67	16.75

NSC: Non structural carbohydrate; SP: Soluble protein; NPN: Non protein nitrogen; NDIN: Neutral detergent insoluble nitrogen.

the reverse trend. Similar findings were reported by Singh et al. (2002). The ADICP (% CP) component was highest in BGS (16.75%) and lowest in MS (11.18%). The protein fractions of different crop residues were presented in **Table 2**. The fraction A which signifies the instantaneously degradable protein in the ruminant digestive system *i.e.*, NPN was highest in RGS (19.88%) and lowest in BGS (12.84%). Rapidly degradable protein fraction B_1 was maximum in legume straws when compared to cereal stovers. Similarly, Singh et al. (2002) reported that fraction B_1 was higher in GN haulms as compared to jowar kadbi. Higher B_2 (intermediately degradable protein fraction) value was observed in cereal stovers when compared to legume straws. Singh et al. (2002) and Raja Kishore (2012) also reported similar findings. Among the crop residues, highest percentage of B_3 largely a bypass protein, lowest percentage of fraction C (protein associated with lignin, tannin protein complexes and maillard reaction protein) which cannot be degraded by rumen bacteria and does not provide amino acids post ruminally (Krishnamoorthy, 1983) was present in MS indicating that it is a good nitrogen source as compared to other crop residues. Similar findings were also reported earlier (Kamble et al., 2011; Raja Kishore, 2012). Further, MS with lower $A+B_1$ and higher B_2+B_3 content could be used as source of bypass nitrogen (Sharma et al., 2004) for ruminants.

CONCLUSION

It is concluded that CNCP system provides valuable information regarding nutritional quality of feedstuffs and also useful for screening of large number of feed samples in a limited period of time. In the present study, presence of low levels of lignin, CC and PC fractions and high levels of CB_2 and PB_3 fractions in maize stover indicates its superior nutritional quality as compared to other crop residues.

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