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In vitro ruminal digestibility of different varieties of paddy straw

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Abstract

Straw quality in terms of chemical composition and *in vitro* dry matter digestibility (IVDMD) and *in vitro* organic matter digestibility (IVOMD) was evaluated for 25 varieties of paddy. There was significant (P<0.01) difference among the varieties in proximate principles (except EE), fibre fractions and IVDMD/IVOMD. IVDMD and IVOMD were found to have significant (P < 0.01) negative correlations with total ash, Acid Insoluble Ash (AIA) and lignin contents.

Keywords : chemical composition, feed quality paddy straw, fibre fractions, *In vitro* digestibility, ruminant feeding systems

INTRODUCTION

Paddy straw is the major dry roughage fed to ruminants in Kerala, South India. There are wide variations in straw quality among the varieties of paddy grown under similar conditions (Sohane and Singh, 2000; Reddy and Sivaiah, 2001). Considering the importance of paddy straw in the ruminant feeding systems of Kerala and non-existence of information on its nutritional characteristics, an attempt was made to evaluate different varieties of paddy straw in terms of chemical composition and digestibility using *in vitro* techniques.

MATERIALS AND METHODS

Samples of straw of 25 varieties were collected from ten rice growing districts of Kerala. The varieties were: Jyothi, Uma, Makom, Ponni, Mattatriveni, Triveni, Rohini, Sabari, Cheradi, Jeeraka sala, Gandhaka sala, Vyttila 1, Vyttila 5, Gouri, Jaya, Aiswarya, Kanchana, Onam, Revathy, Varsha, Harsha, Hraswa, Karuna, Neeraja and Makaram. The samples were dried in hot air oven at 65^{o}C, ground and passed through 2 mm sieve. Proximate principles (AOAC, 1995) and fibre fractions (Goering and VanSoest, 1970) were determined.

In vitro dry matter digestibility (IVDMD) and organic matter digestibility (IVOMD) were determined for each straw variety in triplicates using two-stage technique (Tilley and Terry, 1963). Three rumen fistulated crossbred adult male cattle that were fed according to the requirements (NRC, 2001) were used as donor of rumen liquor which was used as inoculum source for *in vitro* studies. The data obtained were subjected to statistical analysis by following Snedecor and Cochran (1989).

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RESULTS AND DISCUSSION

There were significant differences (P< 0.01) among the varieties for the values of proximate principles except ether extract (Table 1). The Crude Protein (CP) values ranged from 3.7 to 6.5 per cent with an overall average of 4.7 ± 0.1 per cent. The Crude Fibre (CF) content averaged 29.5± 0.3 per cent ranging from 26.4 to 33.4 per cent. Pronounced variations were also recorded for Nitrogen Free Extract (NFE) content in the straws of different paddy varieties with the overall mean value of 49.8 ± 0.4 per cent. Similarly, large variations were observed in Total Ash (TA) contents, the values ranging from as low as 12.3 to as high as 19.8 per cent. The overall mean value for TA was 14.8 ±0.3 per cent. The acid insoluble ash (AIA) concentration varied from 8.1 (Hraswa) to 14.8 per cent (Kanchana) with an overall mean value of 10.9± 0.2 per cent. The differences in the level of cell wall constituents also indicated genetic variability among the straws of different varieties (Table 2). The Neutral Detergent Fibre (NDF) level varied from 64.3 (Mattatriveni) to 85.1 per cent (Vyttila 5) averaging 72.6± 0.8 per cent. The lowest value for Acid Detergent Fibre (ADF) was found to be 40.4 per cent (Sabari) while the highest value was 53.5 per cent (Vyttila 5). Hemicellulose and cellulose concentrations averaged 26.3± 0.4 per cent (ranging from 22.0 to 32.6per cent) and 33.7± 0.5 per cent (ranging from 28.9 to 40.4 per cent), respectively. The level of lignin varied significantly from 4.1 (Sabari) to 6.0 per cent (Vyttila 5).

The *In Vitro* Dry Matter Digestibility (IVDMD) and *In Vitro* Organic Matter Digestibility (IVOMD) values (Table 2) were found to be significantly (P<0.01) different amongst straw types, which could be due to variation in their chemical composition. IVDMD was found to be the highest in Hraswa (54.8 per cent) and the lowest in Kanchana (37.9 per cent) with a overall average of 45.9± 0.6 percent. The IVOMD values also showed a similar trend. The differences in the

Table 1. Proximate Composition of different varieties of paddy straw (Mean % on dry matter basis)

Variety	OM**	CP**	EE	CF**	NFE**	TA**	AIA**
Jyothi	86.5	5.4	1.4	32.1	47.7	13.5	9.6
Uma	87.7	3.9	1.4	28.1	54.3	12.3	8.4
Makom	81.6	6.5	1.2	27.6	46.4	18.4	13.2
Ponni	85.9	5.5	1.3	28.4	50.8	14.1	10.3
Mattatriveni	84.9	3.7	1.1	29.5	50.7	15.1	10.5
Triveni	85.4	3.9	1.4	26.4	53.6	14.7	11.5
Rohini	83.8	4.5	1.3	27.0	51.0	16.2	12.5
Sabari	85.5	4.4	1.1	29.5	50.5	14.6	11.4
Cheradi	86.0	3.8	1.2	31.8	49.2	14.0	10.0
Jeerakasala	85.8	4.4	1.3	29.3	50.9	14.2	11.2
Gandhakasala	87.0	4.3	1.1	28.8	52.8	13.0	9.3
Vyttila 1	84.5	3.9	1.2	28.6	50.7	15.5	11.2
Vyttila 5	84.4	4.1	1.4	27.4	51.6	15.6	12.6
Gouri	82.4	3.7	1.1	33.4	44.2	17.6	14.2
Jaya	84.6	5.9	1.3	31.1	46.3	15.4	11.3
Aiswarya	85.1	4.0	1.1	29.9	50.1	15.1	10.9
Kanchana	80.2	3.9	1.4	29.6	48.9	19.8	14.8
Onam	84.7	4.5	1.1	32.1	47.0	15.3	10.4
Revathy	85.2	4.7	1.2	29.5	49.8	14.8	10.9
Varsha	86.4	5.5	1.3	29.6	50.1	13.6	9.9
Harsha	85.9	6.0	1.1	27.3	51.5	14.1	10.9
Hraswa	87.1	6.5	1.1	30.3	49.2	12.9	8.1
Karuna	84.5	4.7	1.1	28.0	51.1	15.0	11.0
Neeraja	87.5	5.0	1.3	33.0	48.2	12.5	10.0
Makaram	86.8	5.0	1.3	29.4	51.2	13.2	9.6

OM - Organic Matter; CP - Crude Protein; EE - Ether Extract; CF - Crude fibre; NFE - Nitrogen Free Extract; TA – Total Ash; AIA – Acid Insoluble Ash

Table 2. Cell wall composition and *in vitro* digestibility of different varieties of paddy straw

Variety	Cell wall constituents, Mean % (DM basis)				*In vitro* digestibility, Mean %		
	NDF**	ADF**	HC**	Cellulose**	ADL**	DM**	OM**
Jyothi	74.8	47.9	26.9	33.7	4.9	47.8	49.3
Uma	65.3	43.3	22.0	33.0	5.0	53.1	54.8
Makom	71.6	47.7	23.9	31.3	5.8	38.6	40.7
Ponni	69.4	43.5	25.9	29.0	5.5	49.9	51.8
Mattatriveni	64.3	41.4	22.9	32.7	5.3	51.4	53.4
Triveni	65.7	43.4	22.3	32.7	5.5	39.9	41.8
Rohini	69.8	43.8	25.9	31.5	5.2	42.4	44.3
Sabari	64.9	40.4	24.5	29.2	4.1	46.5	48.5
Cheradi	69.6	42.1	27.8	30.0	4.8	45.2	47.2
Jeerakasala	69.5	44.5	24.9	33.9	5.0	43.1	45.2
Gandhakasala	70.0	44.7	25.3	35.3	4.8	50.2	51.9
Vyttila 1	74.1	46.2	27.9	28.9	5.6	51.2	53.4
Vyttila 5	85.1	53.5	31.6	39.4	6.0	41.5	43.7
Gouri	79.9	52.1	27.8	36.2	5.5	39.3	41.3
Jaya	78.4	49.8	28.5	36.3	5.4	50.8	52.3
Aiswarya	68.6	43.4	25.2	32.2	5.1	51.0	53.2
Kanchana	72.7	50.2	22.5	33.8	5.9	37.9	39.6
Onam	74.5	48.3	26.2	36.1	5.6	49.2	51.4
Revathy	72.6	46.3	26.3	33.7	5.2	45.9	47.6
Varsha	74.0	48.7	25.3	37.2	4.9	47.8	49.6
Harsha	70.8	44.3	26.5	32.2	4.5	44.2	46.1
Hraswa	77.5	51.1	26.4	40.4	5.0	54.8	56.1
Karuna	74.1	46.27	27.9	33.1	5.4	39.2	40.2
Neeraja	77.7	47.7	30.7	36.9	5.5	38.4	40.1
Makaram	79.3	46.7	32.6	32.9	4.8	49.0	50.6

NDF – Neutral Detergent Fibre; ADF - Acid Detergent Fibre; HC – Hemi Cellulose; ADL – Acid Detergent Lignin; DM - Dry Matter; OM – Organic Matter - ** - $P < 0.01$ (ANOVA)

chemical composition and IVDMD/ IVOMD values might have been due to genotypic variability in the 25 varieties since other factors like stage of maturity, height of cutting, threshing, rate of drying , sample preparations, etc. were same for all the straw types. The results obtained in the present study are in the ranges reported earlier. For example, a range of 2.2 to 9.5 per cent for CP, 4 to 10 per cent for lignin, 17 to 59 per cent for IVDMD/ IVOMD has been reported earlier (Doyle and Chanpongsang, 1990; Krishnamoorthy *et al*., 1995; Reddy and Sivaiah, 2001; Khandaker and Uddin, 2002). However, there are appreciable variations in the values quoted by different workers which could be due to genetic attributes (Rai and Saha, 1997; Sohane and Singh, 2000), agronomic practices (Sannasgala *et al*., 1985) and handling during harvesting, threshing and storage (Walli *et al*., 1994).

The IVDMD and IVOMD values were found to have significant (P<0.01) negative correlations with total ash (-0.495 and –0.489), AIA (-0.713 and –0.698) and lignin (– 0.386 and –0.379). The correlations with NDF (-0.172 AND –0.168) and ADF (-0.201 and-0.205) were not significant. Following regression equations were drawn based on the significance of correlation in order to predict IVDMD and IVOMD values (n=75):

(1) IVDMD (%) = 66.94 –1.42 TA (r=-0.495)

(11) IVOMD (%) = 68.62 –1.41 TA (r=-0.489)

(111) IVDMD (%) = 71.90 – 2.37 AIA (r=-0.713)

(1V) IVOMD (%) = 73.20 –2.32 AIA (r=-0.698)

(V) IVDMD (%) = 70.16 – 4.66 ADL (r=-0.386)

(V1) IVOMD (%) = 71.58 –4.57 ADL (r=-0.379)

Ibrahim *et al*. (1989) have attributed lower IVOMD values of paddy straw to high silica and lignin content. Lignin is known to be strongly bonded to hemicellulose (and probably not to cellulose) and the nature of this bonding has been regarded as a barrier to digestion (Wardrop, 1974). Phenolic groups associated with lignin and acetyl groups associated with hemicellulose have been suggested to be inhibitors of microbial enzymes (Hartley, 1972; Morris and Bacon, 1977). Like wise, silica / AIA has been regarded to be a contributing factor to poor digestibility of plants. Reddy and Sivaiah (2001) also reported negative correlation coefficient values between IVDMD and ash/AIA content of paddy straw. McManus *et al*. (1977) suggested that the cell wall includes a frame work of insoluble mineral complexes of calcium, phosphorus, magnesium and silicon which prevent enzyme actions. The limiting role of silica/AIA and lignin on digestibility has thus been suggested mainly due to their action in preventing enzyme penetration which was also evident in the present investigation.

The study conclusively revealed significant variations in chemical composition and *in vitro* digestibility values for different straw varieties. The highest IVDMD and IVOMD values were found in Hraswa followed by Uma indicating greater potential of these varieties as livestock feed.

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