NITRITIVE VALUE IMPROVEMENT OF RICE STRAW VARIETIES FOR RUMINANTS AS DITERMINED BY CHEMICAL COMPOSITION AND *IN VITRO* ORGANIC MATTER DIGESTIBILITY

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(Received by the aditor 6 July 1999)

ABSTRACT

DWI YULISTIANI, JR. GALLAGHER, dan R. Van BARNEVELD. 2000. Peningkatan nilai nutrisi beberapa varietas jerami padi yang ditentukan dari komposisi kimia dan daya cema *in vitro* bahan organik. *Juaal Ilmu Temak dan Veteriner* 5 (I): 23-31.

Penelitian dilakukan untuk mengevaluasi nilai nutrisi beberapa varietas jerami padi dan pengaruh perlakuan urea untuk ternak ruminansia dengan mengukur komposisi kimia (nitrogen/N; serat detergen netral/NDF; serat detergen asam/ADF; hemiselulosa/HC; lignin dan silica) dan kecernaannya secara *in vitro.* Pada penelitian ini digunakan 8 varietas jermni padi yang diperoleh dari Leeton, New South Wales. Jerami dipotong menjadi bagian alas dan bawah yang sama panjangnya. Potongan jerami dari masing-masing varietas diberi perlakuan urea dengan kadar 4% dari bahan kering. Rancangan percobaan menggunakan pola faktorial 8x2x2. Hasil penelitian menunjukkan bahwa komposisi kilnia dan daya cema *in vitro* bervariasi di antara varietas. Sebelum diberi perlakuan dengan urea, kandungan N lebih tinggi pada bagian atas (8,1-11,1 g/kg) dibandingkan bagian bawah (5,8-8,3 g/kg) pada semua varietas. Daya cema *in vitro* (IVOMD) bagian bawah lebih besar dibandingkan bagian alas kecuali pada varietas IIb dan Yrl. Daya cema bagian bawah berkisar antara 325-498 g/kg, sedangkan bagian alas berkisar antara 325-439 g/kg. Perlakuan dengan urea secara konsisten meningkatkan kandungan N dan IVOMD kedua bagian pada semua varietas. Respon peningkatan IVOMD karena perlakuan urea lebih tinggi pada jerami yang kualitas asalnya rendah, di mana peningkatannya sebesar 53% (dari 325 menjadi 499 g/kg). Pengaruh perlakuan urea terhadap komposisi kimia yang lain tidak konsisten. Dari penelitian ini dapat disimpulkan bahwa perlakuan urea lebih bermanfaat dipakai untuk jerami padi yang berkualitas rendah daripada yang berkualitas lebih tinggi.

Kata kunci : Jerami padi, varietas, perlakuan urea, komposisi kimia, daya cema bahan organik *in vitro*

ABSTRACT

DWI YULISTIANI, JR. GALLAGHER, and R. Van BARNEVELO. 2000. Nutritive value improvement of rice straw varieties for ruminants as determined by chemical composition and *in vitro* organic matter digestibility. *Junal Ilmu Ternak dan Veteriner* 5 (1): 23-31.

A study was conducted to evaluate the nutritive value of various rice straws and the effect of urea treatment, using measurements of chemical composition (nitrogen/N; neutral detergent tibre/NDF; acid detergent fibre/ADF; hemicellulose/HC; lignin and silica) and IVOMD (in *vitro* organic matter digestibility). Straws from eight varieties obtained from Yanco Agricultural Institute, Leeton, N.S.W. was used. Straws were cut into upper and lower part in equal length, then chopped. Chopped straw from each varieties and each part was treated with urea at 4% DM. The experiment used an 8x2x2 factorial design. Results showed that the chemical composition and IVOMD varied between varieties. Before treatment with urea, in all varieties the N content was higher in the upper (8.1-11.1 g/kg) than the lower part (5.8-8.3 g/kg). The IVOMD of the lower part was higher than that of the upper part except for lIb, and Yrl varieties. The IVOMD of the lower part untreated straw ranged from 325 - 498 g/kg whereas in the upper part it ranged from 325-439 g/kg. Urea treatment consistently increased the N content and IVOMD of both parts in all varieties. After urea treatment there was no significant difference in IVOMD between upper and lower part in any variety. The increase of IVOMD in response to urea treatment was higher when the original quality of straw is low where the increase IVOMD is 53% (from 325 to 499 g/kg). There was no consistent effect of urea treatment on the other chemical components. This study concluded that the urea treatment would be more beneficial for use with low quality rice straw.

Key words: Rice straw, variety, urea treatment, chemical composition, *in vitro* organic matter digestibility

INTRODUCTION

Rice straw is a crop residue that is widely available in tropical countries and is used in an attempt to meet the energy requirements of growing and lactating ruminants (COLUCCI *et al.,* 1992; DOYLE *et al.,* 1986). However, its nitrogen content and digestibility are too low to meet the nutrient requirements of ruminants. These limitations must be overcome if it is to be used as a feed source. The classical approach has been to treat crop residues physically or chemically. Sodium hydroxide (JAcKsoN, 1977) and aImnonia (SUNOTOL and COXWORTH, 1978) lk'lve been the most widely used chemicals to improve straw quality. Urea has also ,been used to treat straw, and this treatment involves the conversion of urea to aImnonia by the action of bacterial urease (WILLIAMS *et al.,* 1984).

The economic feasibility of adopting chemical treatment to improve the feeding value of rice straw in developing countries has increasingly been questioned (SCHIERE and NELL, 1993; CAPPER, 1988) due to the cost of chemicals and labour. An alternative method of improving the feeding value of straw would be to examine the prospects for increasing the nutritive value of crop residues through plant breeding and selection of varieties with straw of high nutritive value which also retain a high grain yield (CAPPER, 1988). GIVENS *et al.* (1988) found that considerable variability exists in the quality of untreated straw and suggested that identification of the highest quality straw for ruminant production may prove cost effective compared to chemical treatment.

The objectives of the present study were (i) to evaluate the chemical composition and IVOMD *(in vitro* organic matter digestibility) of several varieties of rice straw and the relationship between these two measures, and (ii) to assess the effect of urea treatment on the nutritional value of the rice straws.

MATERIALS AND METHODS

Sample preparation

Eight, semi-dwarf varieties of rice straw were obtained from the Yanco Agricultural Institute, Yanco, Leeton, N.S. W. Doongara (Dong), Ammaro (Amr) , Illabong (IIb), Pelde (Pld), Millin (Mil), Langi (Lan), YRL-39 (Yrl) and YRM-43 (Yrm) straws were divided equally by length into upper and lower parts and dried in a forced draught oven at 60°C for 48 hours. Dried straws were then chopped into 3 cm lengths. A subsample of the chopped straws was then ground in a laboratory hammer mill with a 1 mm screen. Ground samples were stored in air-tight containers prior to chemical analysis and an *in vitro* digestibility study.

Botanical fraction separation

To compare the relative proportion of the botanical fractions, the upper part of each variety was dissected into four components and the lower part into three components. The components were rachis (for the upper part only), leaf blade, leaf sheath and stem. Each component was weighed and then oven dried at 60ºC to constant weight. The weights of the components were expressed as a percentage of the part dry matter.

Urea treatment

For urea treatment, 200 g samples of chopped straw from each part of each variety were prepared by spraying with urea solution and mixed thoroughly to provide urea and moisture levels of 40 g/kg and 400 g/kg of dry matter respectively. Treated straws were then kept in air-tight plastic bags at 22°C for six weeks. The bags were then opened and the contents dried at 50-60ºC for 48 hours (IBRAHIM *et al.,* 1988). The treated straws were then ground for further analysis.

Chemical analysis

Dry matter (DM), organic matter (OM) and nitrogen (N) content of the samples were determined using the methods of the AOAC (1990). Neutral detergent fibre (NDF), acid detergent fibre (ADF), permanganate lignin and silica (insoluble ash) were determined using the methods of GOERING and VAN SOEST (1970). Hemicellulose (HC) was calculated by subtracting ADF from NDF values (GOERING and VAN SOEST (1970).

In vitro digestibility

In vitro organic matter digestibility (IVOMD) was determined using the two-stage technique of *in vitro* digestibility as described by TILLEY and TERRY (1963). Rumen fluid was collected with a stomach tube from three 50 kg Merino sheep which were being fed a maintenance ration of 1,200g DM/day, consisting of 50% lucerne and 50% oaten chaff. The ration was fed in equal meals each day at 09.00 and 17.00 hours.

Statistical analysis

The experiment used an 8x2x2 factorial design involving 8 straw varieties, upper and lower parts and either untreated or urea-treated straw. Analysis of variance using Genstat 5 (LAWES AGRICULTURAL TRUST, 1994) was carried out for tIle values for N, NDF, ADF, hemicellulose, lignin, silica and IVOMD. Significant differences were tested using a 95% confidence interval.

RESULTS AND DISCUSSION

The effect of part, variety and urea treatment on chemical composition

The botanical fraction *of* all varieties rice straw is presented in Table 1 shows that, the lower parts *of* the straw contained more stem and less leaf.

There was a highly significant ($P<0.01$) three-way interactions between parts, varieties and urea treatments for N content. The nitrogen content *of* the upper part *of* untreated straw *of* all varieties was higher than the lower part (Figure. 1). Tbe range in N content *of* the upper part was 8.1- 11.1 g/kg, while in the lower part was 5.8 - 8.3 g/kg. A similar difference was observed by WINUGROHO and SUTARDI (1986). This difference may largely be due to the higher leaf content *of* the upper part (63.5%) (Table 1). This was supported by SANNASGALA and JAYASURIYA (1986), who reported the N content in leaves to be higher than in stem. There were also significant difference between the N content *of* the different varieties. The N content *of* the upper parts *of* Dong, Amr, I1b, Lan and Yon, shows similar values and had higher N content compared to Pld, Mil and Yrl. In lower parts the N content *of* Yon variety was significantly higher than the Amr, IIbn and Pld varieties, but was similar with the Dong, Mil and Lan (Figure 1). The high N content both in its upper and lower parts *of* Yon suggested that this variety had higber ability to accumulate N. ROXAS *et al.* (1985) and IBRAHIM *et al.* (1988) also observed a difference in N contents between 4 and 6 varieties respectively. In contrast, CHEVA-ISARAKUL and CHEVA-ISARAKUL (1985) observed no significant differences in CP content between seven varieties because *of* the large variation between samples obtained from a wide range *of* growing conditions (uncontrolled experiment). In the current experiment the samples were obtained from the same plot with the same treatment, and, therefore, the differences in N content between varieties are likely to be due to varietal, rather than environmental, differences.

Urea treatment significantly increased the nitrogen content *of* both parts in all varieties. Urea treatment reduced the difference in N content between parts and varieties (Figure 1). N content in the upper part, after treatment with urea ranged from 16 - 18.8 g/kg, while in the lower part it ranged from 15.5 - 20 g/kg. The dramatical increase in N content, after treatment with urea, was in tile lower part *of* variety lib (from 5.8 to 20 g/kg). The N content *of* the treated lower part *of* the lib variety was higher than its treated upper part, while in other varieties the N content *of* the lower part after treatment with urea, was lower than the upper part. This indicated that the lower part *of* the Ilb variety had a higher respons to urea treatment. The lowest increase in N content after urea treatment was in the upper part *of* Yrn (from 11.1 to 18.2 g/kg). The consistency increased the N content *of* both parts in all varieties after urea treatment also observed by COTTYN and DE BOEVER (1988) in wheat and barley straw. This increase could be due to chemical reactions *of* urea and the straw and the addition *of* N by urea to treated straw. The increase in N content after urea treatment was higher in varieties with lower N content (Fig. I). This suggests that rice straw with low N content could benefit more from urea treatment to improve nutritive value. However, the utilization *of* the N in the urea treated straw will depend upon its digestibility as some

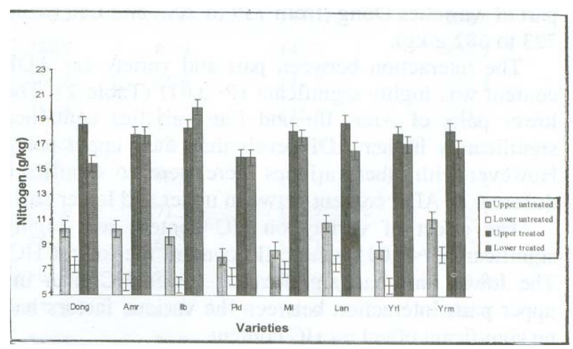

Figure 1. The effect of part, variety and urea treatment on nitrogen content of rice straw (Bar is the value of the confidence interval 95%= ± 0.65; Dong. Dongara; Amr, Ammaro; I1b Illabong; Pld, Pelde; Mil, millin; Lan, Langi; Yrl, YRL-39; *Yrm,* YRM-42)

Table l. Distribution of the botanical fractions on the upper and lower parts of eight varieties rice straw (% dry matter)

Part	Botanical Fraction	Varieties								Mean
		Dong	Amr	Ilb	Pld	Mil	Lan	Yrl	Yrm	
Upper	Rachis	19.6	24.1	33.4	24.1	8.7	17.7	21.4	27.3	22.0
	Leaf blade	59.8	41.1	34.2	47.4	22.6	39.3	46.4	25.9	39.6
	Leaf sheath	12.2	20.6	19.8	18.0	41.7	27.8	21.9	29.4	23.9
	Stem	8.3	14.3	12.6	10.5	27.0	15.2	10.3	17.4	14.5
Lower	Leafblade	14.0	6.1	10.6	19.4	1.9	ILl	22.5	5.4	11.4
	Leaf sheath	44.4	47.6	43.8	37.1	53.6	54.0	37.3	53.1	46.4
	Stem	41.6	46.3	45.6	43.5	44.4	34.8	40.2	41.6	42.3

of the N bound to cell wall in urea treated straw was not fully utilised in the rumen (HASEN and CHENOST, 1992).

The interaction between urea, part and variety on NDF content was significant (P<0.05) (Table 2). The NDF content of the upper and lower parts varied between varieties and between treatments. Before treatment with urea, the NDF content of upper and lower parts was significantly different (P<0.05) between Dong, Ilb, Yrl, Yr varieties. This result is different with SANNASGALA *et al.* (1985), CHEVAISARAKUL and CHEVA-ISARAKUL (1985), and CHOWDHURY *et al.* (1995) who reported no significant differences in the NDF content between varieties. In the current study, the variation in the NDF content was higher in the upper part than in the lower part. The lower part of the Dong variety had the lowest NDF content (653 glkg) while the upper part of variety Pld was the highest (750g/kg).

There was no consistent effect of urea treatment on NDF content in each variety and part (Table 2). There was no significant effect of urea treatment on NDF content of Amr, Ilb, Pld, and Mil. On the other hand urea treatment significantly increased the NDF content in the lower part of Yrl (from 704 to 743 g/kg), and significantly decreased the NDF content in the upper part of varieties Dong (from 739 to 705) and Lan (from 723 to 682 g/kg).

The interaction between part and variety for ADF content was highly significant (P<0.0I) (Table 2). The lower parts of Amr, Ilb and Lan varieties contained significantly higher ADF levels than their upper parts. However with other varieties there were no significant different of ADF content between upper and lower part.

The effect of variety on HC content was highly significant (P<0.01), where Ilb contain the lowest HC. The lower part had significantly lower HC than the upper part. Interaction between the various factors had no significant effect on HC content.

Urea treatment significantly (p< 0.05) increased the ADF content of rice straw but significantly (P<0.05) reduced the HC content of rice straw. The interaction between part and urea treatment was significant (P<0.05) on lignin content (Table 2). The lignin content of the upper part of untreated straw was significantly higher than that of the lower part. After treatment with urea, however, the lignin content was not significantly different between upper and lower parts. There was a highly significant (P<0.01) effect of variety on lignin content (Table 2). Ilb had the highest lignin content (78 g/kg) compared with other varieties. The silica content was not significantly different between upper and lower parts in any varieties except Amr, where the lower part contained a higher silica content (P<0.05). There was no significant effect of urea treatment on silica content.

Lignin and silica content are associated with the lower digestibility of rice straw (VAN SOEST, 1982). In the current study, lignin content varied between varieties, with variety Ilb having the highest lignin content (78 glkg). The mean value of parts showed that the upper part had a higher lignin content than the lower part. This result suggests that the lower part will have a higher nutritive value, however, digestibility assessment are required to confinn this.

Silica content in paddy plants is important to maintain the erectness of the leaf (GRIST, 1986), therefore, it can be expected that the leaf will have a higher silica content than the stem. In the current study, silica content was not sigillficantly different between parts except for the Amr variety in which tlle silica content of the lower part was higher than the upper part, even though the upper part contains more leaf. This suggests that the differences in the proportion of leaf had no effect on silica content. In contrast, DOYLE and CHANPONGSANG (1990) reported that leaf blade and leaf sheath contained more ash, and in particular, silica.

Urea treatment increased ADF and lignin content and decreased hemicellulose content. A similar result was reported by SEAWALT *et al.* (1996) who observed the ADF content of corn stover increased with ammonia treatment. This is due to urea treatment resulting in partial solubilitation of hemicellulose (GIVENS *et al.,* 1988; MASON *et al.,* 1988). The hemicellulose is probably rendered soluble in the neutral detergent solution (VAN SOEST *et aI.,* 1983 and MASON *et al.,* 1988). The decreased hemicellulose content results in increased cellulose and lignin levels (GIVENS *et al.,* 1988 and MASON *et al.,* 1988).

VAN SOEST (1988) suggested that the analysis of lignin is the most obvious means to evaluate the efficiency of delignification. A chernical method to evaluate alkali treated straw must distinguish cleaved lignin from unc1eaved lignin. Unfortunately, lignin analysis using 72% acid or through oxidation using permanganate solution did not distinguish cleaved from unc1eaved lignin. In the present study, the lignin content was determined using permanganate lignin, therefore the changing of lignin content af1er urea treatment was not consistent and only the ligylln content of the lower part significantly increased due to urea treatment

The effect of part, variety and urea treatment on IVOMD

There was a highly significant (P<0.01) interaction between part, variety and urea treatment on IVOMD (Table 2). The IVOMD of the lower part of all varieties was higher than that of the upper part except in Ilb and Yrl (Figure 2). The IVOMD of the lower part of untreated straw ranged from 325 - 498 g/kg whereas in

Tabel 2. Mean values of the chemical composition of the upper and lower part of rice straw varieties either untreated or treated eith urea (g/kg dry matter).

Variety (V)	Part (P)	Treatment (T)	Chemical composition				
			NDF	ADF	Lignin	Silica	HC
Dongara	Up	U	738.6	534.2	59.6	138.4	204.4
	Lo		653.2	484.8	49.5	101.5	168.4
	Up	T	705.5	548.9	61.7	130.7	156.7
	Lo		680.7	545.7	69.8	115.7	135.0
Ammaro	Up	U	711.6	532.1	57.5	122.9	179.6
	Lo		737.4	573.2	47.3	140.8	164.2
	Up	T	698.5	572.8	66.0	140.0	125.6
	Lo		741.9	603.6	67.2	155.1	138.3
Ilabong	Up	U	658.8	557.8	82.4	132.3	128.0
	Lo		745.2	626.3	80.0	139.8	118.9
	Up	T	695.0	567.7	83.4	124.2	127.3
	Lo		722.2	615.1	75.1	144.2	107.1
Pelde	Up	U	750.4	577.9	61.5	140.3	172.6
	Lo		735.3	577.3	60.2	129.7	158.0
	Up	T	739.0	595.3	54.8	138.2	143.7
	Lo		723.3	579.7	57.3	133.2	143.6
Millin	Up	U	717.2	566.1	70.4	131.5	151.2
	Lo		729.1	562.6	50.1	132.3	166.5
	Up	T	713.9	575.2	57.6	144.1	138.6
	Lo		705.6	568.9	63.6	143.3	136.7
Langi	Up	U	722.9	530.1	66.4	121.7	192.8
	Lo		733.4	559.5	55.2	132.5	175.9
	Up	T	682.3	550.2	72.5	127.7	132.1
	Lo		718.5	591.3	70.8	141.4	127.2
Yrl	Up	U	749.3	573.0	71.3	121.1	176.3
	Lo		704.2	556.5	63.2	121.1	147.7
	Up	T	742.8	601.1	76.4	124.9	141.8
	Lo		719.8	571.6	63.8	124.9	148.2
Yrm	Up	U	735.5	565.7	70.2	154.9	169.7
	Lo		693.5	571.0	59.9	142.7	122.5
	Up	T	730.6	583.3	74.7	134.9	147.3
	Lo		709.8	597.7	67.6	148.5	112.2
Significant							
Main factor:	P		NS	*	*	NS	*
	V		**	**	**	**	**
	U		**	*	*	Ns	*
	PXV		**	**	NS	**	NS
	UXV		NS	NS	NS	NS	NS
	UXP		NS	NS	*	NS	NS
	UXPXV		*	NS	NS	NS	NS

Up=upper; Lo=untreated; T=treated; NDF=acid detergent fibre; ADF= acid detergent fibre; HC=hemicellulose; ** P<0.01; * P<0.05; NS=non-significant.

the upper part it ranged from 325 -439 g/kg. The higher digestibility of the lower part except for I1b and Yrl was caused by the lower part of rice straw having a higher stem proportion (42.3%) (Table 1). This is supported by SANNASGALA and JAYASURYA (1986) who observed the IVOMD of the stem node and intemode was higher than the leaf fraction. Moreover, SANNASGALA and JAYASURYA (1987) reported that the narrower the leaf total stem ratio the higher the IVOMD. Furthermore, RAXAS *et al.* (1985) reported that variation in the semidwarf (improved) varieties had higher IVOMD than the traditional varieties because semi dwarf varieties contained more stem. In contrast, DOYLE and CHANPONGSANG (1990) found the leaf blade of rice straw from 4 varieties had a higher IVOMD than the leaf sheath and stem

In addition to a difference between the IVOMD of the upper and lower parts within a variety, there was a difference between the IVOMD of parts between varieties. BAINTON *et al.* (1991) found that although there were differences between varieties in *in vitro* digestibility, there was no consistent difference between modern and traditional varieties overall. In the current study all the varieties were semi-dwarf. The lower part of the Dong variety had the highest IVOMD (498 g/kg), while the lower part of variety Yrl and the upper part of variety Lan had the lowest IVOMD (325 g/kg each). Most of the upper parts in all varieties the IVOMD were significantly lower than the lower parts, except for the I1b variety (Figure 2). The upper parts were generally low quality (IVOMD<40%), except for variety lIb which was medium quality (IVOMD=43.9%), while the lower parts were of medium quality (40%<IVOMD< 50%), except for varieties Pld and Yrl which were low quality (IVOMD 38 and 32.5%, respectively).

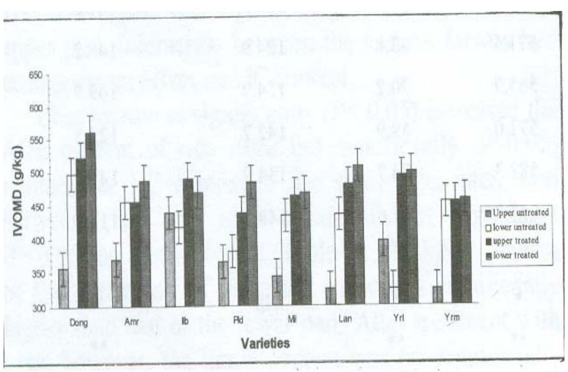

Figure 2. The of part, variety and urea treatment on IVOMD of rice straw (Bar is the value of the confidence internal 95%= ± 24.7; Dong, Dongara; Amr, Ammaro; lib IIIabong; Pld, Pelde; Mil, minin; Lan, Langi; Yrl, YRL39; Yrm, YRM-42)

In contrast to the present study, WIMUGROHO and SUTARDI (1986) reported tlle *in vivo* digestibility of the upper parts was higher than the lower parts. The results from previous studies and the current study suggest that rice straw should not be separated into fractions when it is used as a ruminant feed. However, a particular variety, such as Dong, where the lower part has a much higher digestibility than the upper part, offering the lower part may result in better animal performances.

Urea treatment increased the IVOMD of both parts in all varieties except for the lower part of Yrm and Amr. There was no significant increase of IVOMD in the lower part of Amr, Mil, and Yrm varieties after urea treatment, while for lIb variety urea treatment did not significantly increase IVOMD in the upper part (Figure 2). This condition caused the significant interaction between factors part, variety and urea treatment. The IVOMD in the upper part after treatment with urea ranged from 438 - 522 g/kg, whereas in the lower part it ranged from 458 - 562 g/kg. After urea treatment there was no significant difference in IVOMD between upper and lower parts in any variety. A similar increase in IVOMD after urea treatment was observed by COTTYN and DEBOEVER (1988) on wheat and barley straw. The response to urea treatment was higher in the upper part than the lower part (Figure 2). The greater increase in IVOMD in the upper part is due to a higher lignin and hemicellulose content in the upper part than in the lower part. This is due to the ammonium hydroxide released during urea treatment causing the cleavage of the alkali-labile linkage between lignin and structural carbohydrates, and therefore, structural carbohydrate, such as hemicellulose, becomes more assessible to microbial degradation as a result increase the fibre digestibility (HARTLEY and JONES, 1978; CHESSON, 1988).

A higher increase in IVOMD after urea treatment was also obtained from low quality rice straws (IVOMD<40%), the increase ranging from 20 - 53%. Similar results have also been observed by CAPPER (1988). In the current study the maximum response to urea treatment was obtained from the lower part of the Yrl variety which had the lowest IVOMD before treatment with urea (Figure 2). Its IVOMD increased 53% after treatment with urea (from 325 to 499 g/kg*)*. However, IBRACHIM *et aJ.* (1989) reported that the maximum benefit of urea treatment was obtained with medium quality rice straw. In the current study, the increase in the IVOMD of medim quality straw (40%<IVOMD<50%) with urea treatment only ranged from 1 - 16%.

Relationship between chemical composition and IVOMD

The relationship between the IVOMD and chemical composition of rice straw was investigated. The linear regressions between cell wall components (NDF, ADF, HC, lignin) and silica with IVOMD showed that the relationship between these parameters was poor. Therefore, multiple regression using backward elimination was carried out. The highest coefficient of determination (R2= 0.60) was obtained, following the dropping of NDF and ADF content from the equation. The equation (P<0.001) was

IVOMD = 997 + 7.34 N - 1.46 HC - 2.7 Lignin - 1.95 Silica.

Poor linear relationships between IVOMD and chemical composition have also been reported by SANNASGALA and JAYASURYA (1986) with rice straw, and by MASON *et al.* (1988) with wheat, barley and oats. In contrast, VAN SOEST *et al.* (1983) observed that the relationship between IVOMD and lignin content was significant if the data of treated and untreated straws were regressed separately, but was not significant for the combined data. The difference between untreated and treated populations did not allow crude lignin to become a meaningful measurement. VAN SOEST *et al.* (1983) suggested that, generally, urea treatment did not greatly change the lignin content. Treatments mainly resulted in a shift of the regression line. In tile current study there was no consistent effect of urea treatment of parts and varieties on lignin content. When the untreated and treated data were separated to assess the relationship between lignin content and IVOMD, tile R2 of 0.057 was obtained for untreated straw, and of 0.081 for treated straw. This indicates that the relationship between liglun content and IVOMD was poor with either separated or combined data.

Linear regressions between each chemical component and IVOMD both in the present study and in the literature, resulted in poor correlation. This indicates that each chemical component (N, NDF, ADF, HC, lignin and silica) can not be used as a reliable single factor to explain the variability in the IVOMD of rice straw varieties and their parts before and after treatment with urea. The results suggested that the chemical composition is a poor method of assessing the nutritive value of rice straws and subsequent improvement after urea treatment. IVOMD is a better method of assessing the nutritive value of rice straw varieties and improvement after urea treatment. This observation is supported by ORSKOV *et al.* (1988) who reported that biological measurement is the most appropriate method to differentiate the nutritive value between varieties,botanical fractions and treatments of cereal straws.

The IVOMD is a function of N, hemicellulose, lignin and silica With a determinant coefficient, of 0.60. This indicates that 60% of the IVOMD is reflected by the N, hemicellulose, lignin and silica content. The equation also indicates that HC, lignin and silica content have negative effects on the IVOMD. Alternatively, BAINTON *et al.* (1991) reported that the *in vitro* digestibility is a function of ash content and days to maturity, with a coefficient determinant of 0.74. This result provides further evidence that straw digestibility is affected by a range of chemical parameters and not by any single chemical factor, and hence, IVOMD is a better means than chemical analysis alone of evaluating the nutritive value.

CONCLUSION

The N content of rice straw was consistently higher in the upper part for all varieties, whereas for other chemical composition (NDF, ADF, HC, lignin and silica) content showed no clear trend between parts and between varieties.

The IVOMD values of the lower part of rice straw was consistently higher than upper part in all varieties and that the Dong variety having the highest IVOMD among other varieties.

Urea treatment consistently increased N content and IVOMD. The increase IVOMD due to urea treatment was higher in the original low quality rice straw than medium quality, therefore, urea treatment is more beneficial for use with low quality rice straw to improve its nutritional quality.

IVOMD is more appropriate method than chemical composition for evaluating the nutritive value of rice straw varieties and the effect of urea treatment.

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