Indian Journal of Animal Sciences **78** (12): 1404–1407, December 2008

Nutritional improvement of ensiled rice straw through supplementation of urea, molasses, soybean seed meal and aquatic plants

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Received: 6 May 2007; Accepted: 8 June 2008

ABSTRACT

A study was conducted to assess the effectiveness of ensiling rice straw with urea (4%), molasses (2%), soybean meal (4%) and supplementation with aquatic plants *viz.* water hyacinth (*Eichhornia crassipes*), Azolla (*Azolla pinnata*) and two varieties of duck weeds (LT-*Lemna trisulaca* and LP-*Lemna perpusila*) on nutritive value. Proximate composition, NH_3–N production, energy value, organic matter digestibility (OMD) and *in situ* disappearance of dry matter (DM) and crude protein (CP) were studied. Crude protein, organic matter (OM), ether extract (EE), metabolizable energy (ME) and *in sacco* degradability of DM and CP increased progressively with increased level of aquatic plants. Ensiling straw with supplementation of 25% water hyacinth (WH) or azolla (AZ) or duck weeds results in an increase in CP content from 12.2 to 18.7, OM 88.3 to 89.5, EE 3.1 to 4.1, NFE 38.2 to 44.3, ash 10.5 to 11.7 and decreased CF content from 29.7 to 27.4%. Supplementation improved ($P<0.01$) *in sacco* disappearance both DM and CP with the addition of 35% AZ and LP respectively. The CP disappearance showed significant ($P<0.01$) difference both for source and level of aquatic plants used. Use of both species of duck weed significantly ($P<0.01$) improved the OMD. Nutritional value of straw can be improved by ensiling with supplementation of urea, molasses, soybean seed meal (SSM) and aquatic plants.

Key words: Aquatic plants, Ensiling, Molasses, Soybean Seed Meal, Straw, Urea

Straw is used as animal feed in many developing countries, which is less palatable, low in digestibility, with higher content of fibre and insoluble ash. But physical, chemical and biological treatments of straw improve the digestibility and voluntary intake (Ahmed 2003, Saadullah *et al.* 1982, Perdock *et al.* 1982). Treatment with urea increases nitrogen content and helps to loosen lignocellulose complex, so increase the availability of fermentable carbohydrate to microbes and ultimately improves nutritive value (Horn *et al.* 1989). Urea treatment of straw by adding plant extract as source of urease is one the technologies found effective to improve nutritive value of straw (Khan *et al.* 1999, Jamil 2003, Kamruzzaman *et al.* 2005). So, the study was conducted to explore the effect of aquatic plants supplementation with rice straw and ensiled with urea, molasses and SSM on the proximate composition, NH_3–N production, energy value, OM digestibility and CP disappearence.

MATERIALS AND METHODS

Experimental design

Twelve gram urea (46% N), 6g molasses and 12g SSM were added to 300g rice straw. Variable amounts (60/75/90/105g) of water hyacinth (WH), azolla (AZ) and two varieties of aquatic plants *Lemna trisulaca* (LT) or *Lemna perpusila* (LP) were added during ensiling (Table 1). Sixteen different silages were prepared in polythene bags and considered as treatments; T_1, T_2--------T_{15} and T_{16}. There were three replications in each treatment. The layout of the experiment was as per two way factorial design.

Preparation of silage

Rice straw and WH were chopped into 3–4 cm lengths and commercial urea (4%) and molasses (2%) were dissolved into 30ml tap water. The solution was sprayed on 100g rice straw, mixed thoroughly and then aquatic plants (Table 1) were added and mixed evenly.

After uniform mixing the materials were packed by using double layered polythene bags. The bags were made air tight by hand pressure, closed and incubated at room temperature. After 30 days incubation, each bag was opened and representative samples were taken for determination of NH_3–N. The rest of the samples were sun-dried and ground for chemical analysis and *in situ* digestibility.

Determination of proximate components, NH_3–N and in sacco *degradability*

For determination of NH_3–N, 2g representative samples

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Table 1. Layout of the experiment

% Level (g)	WH[1]	AZ[2]	LT[3]	LP[4]
20 (60)	T_1	T_5	T_9	T_{13}
25 (75)	T_2	T_6	T_{10}	T_{14}
30 (90)	T_3	T_7	T_{11}	T_{15}
35 (105)	T_4	T_8	T_{12}	T_{16}

[1]WH (water hyacinth), *Eichhornia crassipes*; AZ[2](azolla), *Azolla pinnata*; LT[3] = *Lemna trisulaca*; LP[4]=*Lemna perpusila*.

of silage material was taken into a beaker and 20ml 0.1N HCl was poured and kept for ten minutes and mixed by hand stirrer. The solution was filtered through Whatman filter paper No. 44 and 10ml of filtrate was taken for distillation. Fifty ml distillate was collected into a conical flask and titrated against 0.1N H_2SO_4. The ammonia nitrogen were calculated using following formula

1 ml 0.1 N H_2SO_4 = 1.4 mg N

1000/10 × titration in ml × 1.4 = mg-N per litre.

Proximate components of treated straw were determined as per AOAC (1990). *In sacco* disappearance of DM and CP was estimated as per Mehrez and Ørskov (1977).

Metabolizable energy and digestible organic matter

Estimations of ME and DOM were made according to Kamphues *et al.* (1999) as follows.

ME (MJ/kg) =13.69–0.016245g CF+0.00693g CP–0.0067g ash

DOM (%) =90–0.885g CF

Statistical analysis

Data were analysed by using "MSTAT" statistical programme to compute analysis of variance (ANOVA). Duncan's Multiple Range Test (DMRT) was conducted to identify significant differences among the treatment mean (Steel and Torrie 1960).

RESULTS AND DISCUSSIONS

Proximate composition

There was significant variation in OM content of ensiled straw (P<0.01) due to different types of supplementation and the highest value was observed due to addition of WH (Table 3). It was supported by findings of Ghosh (1987). The significant interaction between level and source was found (P<0.01) for CP, CF, NFE and OM content of ensiled straw, where 25% supplement caused highest for those parameters. Ullah (1996) used different levels of WH to urea treated straw and found best result for 20% WH than 5, 10 or 15%.

Maximum CP content of ensiled straw was observed in LP added silage which differed (P<0.05) from AZ and WH but there was no differences between LT and LP. It revealed that the degree of increment in CP content is highly and positively correlated with the level of aquatic plants. Difference in CP content among treatment groups may be due to difference in composition of ingredients used (Table 2).

A positive interaction between sources and level of supplementation exists which was highly significant (P<0.01) for CF content. Response was significant for sources of supplementation but not for levels. The effect was more pronounced (P<0.05) for LP (27.8) compared to WH, AZ and LT respectively. The CF content of treated silage decreased (P<0.05) in comparison to untreated straw (Table 2). The reason for decreasing fibre content was due to increased solubility by the treatment. The findings of this experiment are in agreement with other works (Ibrahim and Pearce 1983 and Khan *et al.* 1999. Kamruzzaman *et al.* 2005). Similarly, Kiangi *et al.* (1981) also reported a decrease in cell-wall constituents treated with ammonia plus urease enzyme. Ullah (1996) also found decrease in CF content due to use of WH and ipil-ipil with urea treated straw.

Ether extract content was found higher (p<0.01) in LT and LP compared to other groups (Table 3). Ash and NFE contents decreased (P<0.01) due to different sources which correspond to the findings of Ullah (1996). The ash content was higher for all the supplementations at a level of 35%. The reason may be due to higher accumulation of various mineral ions with silage.

Production of NH_3–N

Ammonia nitrogen content increased (P<0.01) in aquatic plant added straw. Interaction between sources and levels was negligible. The reason for lowest NH_3–N in LP added silage might be due to presence of other factors which can impede diffusion of ammonia, hindering nitrogen retention and consequently increased the CP content.

Table 2. Chemical composition (g/100gDM) of feed ingredients used in the experiment

Feed ingredients	DM (%)	OM	CP	CF	EE	NFE	Ash
Rice straw	86.7	86.4	4.0	37.9	1.1	43.5	13.6
Water hyacinth leaf (*Eichhornia crassipes*)	8.9	87.6	18.9	14.0	1.8	52.9	12.4
Duck weed (*Lemna trisulaca*)	7.0	76.2	28.8	14.0	2.6	30.9	23.8
Duck weed (*Lemna perpusila*)	7.4	79.9	29.1	10.4	2.0	38.2	20.3
Azolla (*Azolla pinnata*)	8.2	82.7	21.2	11.3	5.0	45.3	17.3
Soybean seed meal	90.9	94.5	48.6	5.9	18.1	22.0	5.5

Table 3. Proximate composition (g/100gDM), ammonia nitrogen, *in sacco* disappearence of nutrient, ME content and OM digestibiulity of various treated ensiled rice straw

Parameters	Sources of supplementation (S)				Supplementation (%) level (L)				Significance		
	WH[1]	AZ[2]	LT[3]	LP[4]	20	25	30	35	S	L	I
OM	89.93[a]	88.98[a]	88.24[b]	88.21[b]	88.83[ab]	88.96[a]	88.77[ab]	88.20[b]	**	*	NS
CP	13.15[c]	15.55[b]	18.85[a]	19.13[a]	15.71[c]	16.36[bc]	16.92[ab]	17.69[a]	**	**	*
CF	29.14[a]	28.59[ab]	28.02[bc]	27.83[c]	28.04[a]	28.33[a]	28.75[a]	28.45[a]	**	NS	*
EE	3.33[b]	3.33[b]	3.64[ab]	4.05[a]	3.88[a]	3.63[ab]	3.54[ab]	3.29[b]	**	**	NS
NFE	43.98[a]	41.69[b]	38.27[c]	37.27[c]	41.24[a]	40.91[ab]	39.99[bc]	39.07[c]	**	**	*
Ash	10.66[c]	10.94[bc]	11.34[ab]	11.79[a]	11.17[ab]	11.04[b]	10.90[b]	11.63[a]	**	**	NS
NH_3–N (mg/liter)	742.8[a]	733.8[a]	755.3[a]	704.6[b]	732.3[a]	729.6[a]	737.1[a]	737.6[a]	**	NS	NS
ME (MJ/Kg DM	9.2[c]	9.4[b]	9.7[a]	9.7[a]	9.5[a]	9.5[a]	9.5[a]	9.5[a]	**	NS	**
DM Disappearance	51.7[a]	51.8[a]	51.62[a]	46.0[b]	50.4[a]	51.3[a]	49.2[a]	50.2[a]	**	NS	**
CP Disappearance	46.8[c]	59.4[b]	65.8[a]	66.1[a]	55.6[c]	59.4[b]	61.3[ab]	61.7[a]	**	**	**
OM Digestibility	64.5[b]	64.9[ab]	64.8[ab]	65.1[a]	65.2[a]	64.8[ab]	64.5[b]	64.8[ab]	*	**	*

[1]WH (Water hyacinth), *Eichhornia crassipes*; AZ[2](azolla), *Azolla pinnata*; LT[3], *Lemna trisulaca*; LP[4], *Lemna perpusila;* I, interaction between the main effect; **significant at (P<0.01); *significant at (P<0.05); NS, Not significant.
[a,b,c,d] Different superscript in the same row differs significantly (P<0.05).

In sacco disappearence of DM and CP

The DM and CP disappearance of ensiled straw were higher than that of untreated straw (Table 3) and variations were significant (P<0.01). The level of sources had insignificant effect on DM disappearance.

The CP disappearance of LP treated silages was highest (p<0.01) and lowest in WH treated straw (P<0.01). The value for CP disappearence for LT and LP was similar but, highly significant (p<0.01) for both source and level. This result is in agreement with the findings of other researchers (Virk and Kamphues 1995, Ullah 1996, Rao *et al.* 1997, Wanapat *et al.* 2000, Kamruzzaman *et al.* 2005).

Organic matter digestibility

Ensiling straw with different aquatic sources increased (p<0.01) the organic matter digestibility (OMD) in comparison to silage. The result is in agreement with other findings (Ghosh 1987, Ullah 1996, Rao *et al.*1997).

Metabolizable energy

The effect of sources varies (P<0.01) for ME content of ensiled straw but the effect in different levels was similar (Table 3). The highest (P<0.01) value was obtained for LP. Similar trend for ME values was also observed by Khan *et al* (1999) and Cafantaris *et al* (1985).

It is concluded that ensiling of rice straw with aquatic plants (WH, AZ, LT and LP) and addition of urea, molasses and SSM improve nutritive values. The plant LP has been proved to be best to use for this purpose. So, rice straw ensiling is recommended with urea (4%), molasses (2%), SSM (4%) and LP (35%) for a period of 30 days under anaerobic condition for improvement of nutritive value.

ACKNOWLEDGEMENT

The authors acknowledge to the Bangladesh Agricultural University Research System, Bangladesh Agricultural University for funding the project from which data generated is presented in this paper.

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