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Rice Straw , It's Quality and Quantity as Affected by Storage Systems in Bangladesh

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Abstract: The effects of current storage practices on the nutritive quality and the level of mycotoxin contamination of rice straw were studied in four selected villages of Mymensingh district of Bangladesh. Farmers were allowed to store the same variety of rice straw in both improved and traditional systems. Straw samples were collected from both the stores and analysed for nutrient composition and *in vitro* digestibility. Chemical analysis of rice straw showed that storage methods had no significant ($P>0.05$) effect on OM, CP and ME contents of rice straw. However, improved storage method significantly ($P<0.01$) increased nitrogen free extract, *in vitro* dry matter digestibility and *in vitro* organic matter digestibility of rice straw compared with those of traditional storage method. Chemical analyses for mycotoxin content in the rice straw of traditional storage showed lower level of Fumonisin and no detectable level of Aflatoxins (B_1, B_2, G_1 and G_2). The results suggest that improved storage system is essential since it increases the quality of rice straw in respect of nutrient composition as well as *in vitro* digestibility. A definite conclusion regarding the mycotoxin level can only be made after two or three years of monitoring.

Key words: Rice straw, storage method, nutrient composition, *In vitro* digestibility, mycotoxin

Introduction

Ruminant livestock are mainly fed on low quality roughage based diets in Bangladesh. About 70% of the roughage available is crop residue and rice straw constitutes about 87% of the dry roughage available for cattle and buffaloes (Tareque, 1991). Due to inadequate production of green grasses, rice straw has become the major feed resource for livestock production. In some areas of the country rice straw constituting over 90% of dry matter intake due to lack of alternative feed resources. However, heavy rainfall during wet season leads to serious losses in the quantitative and qualitative availability of straw. Post harvest losses of rice straw during that season due to spoilage is a major contributing factor to the subsequent feed shortage. Losses of nutrients during storage have been described by Tripathi *et al.* (1995) which varies from the shattering loss of leaves, leaching of soluble nutrients by rain, potentially large losses due to mold damage and bleaching by exposure to sunshine. In Bangladesh it has been estimated that about 7.7 million tons of rice straw dry matter is being rotten during the monsoon (Chowdhury and Huque, 1996). It has been reported that overall 21% of rice straw is lost due to spoilage as a result of faulty storage and heavy rainfall in Bangladesh (M. A. Akbar, personal communication). Moreover, damp feed residues are susceptible to mold attack with associated mycotoxin contamination (Coker,1979). Rice straw is more frequently contaminated by mycotoxin producing organisms of the genera *Aspergillus, Penicillium, Fusarium, Alternaria, Stachybotrys* and *Cladosporium* (Phillips and Wareing, 1993; Phillips *et al.*, 1996). Among the genera *Aspergillus parasiticus* produces Aflatoxins B_1, B_2, G_1 & G_2 and *Fusarium moniliforme* produces Fuminisin B_1 and ingestion of these mycotoxins can be carried over from the diet into milk and results in toxic and carcinogenic effect (Jones and Coker, 1994). Feeding of moldy straw has adverse effects on animal health and milk consumers. Therefore, there is an urgent need to develop an improved post harvest storage method to reduce nutrient loss and mycotoxin contamination of rice straw and of milk, which will have a positive impact on human health. Considering the above points the present research was undertaken to evaluate the effects of current practices of storage on the quality of rice straw and its comparison with those of the improved storage methods. The other objective was to determine the level of mycotoxin contamination of rice straw in the traditional system of storage.

Materials and Methods

Keeping in view the objectives of the study, PRA was conducted in experimental areas. Four villages in Mymensingh District were selected purposively. Among 4 villages Rajpur and Garaikuti are in Muktagachha Thana, and Mothbari and Bhoradoba are in Trishal Thana. The government officials of respective Thana offices helped in selecting these areas. The experimental period lasts from January to October, 2001.

Climatic condition of the experimental sites: The climatic condition of the experimental sites is characterized by light rainfall during April- May and heavy rainfall during June- September. The soil is silt loamy to silty clay loamy and gray brown to dark gray. The agro-climatic condition of the experimental areas is shown in Table 1.

Construction of improved storage: Eight improved stores were constructed, four in each site. Out of four, two stores were built in each village, one for small farmers and other for medium farmers. The improved store houses were gable type tin shed with raised slate about $1^1/_2$ft height from the ground. The size of the storage was length- 22.5 ft., height- 9ft., and width- 13ft.

Sampling of rice straw: After construction, same rice straw was stored in both improved and traditional stores so that the comparison of the effectiveness of storage technique could be made irrespective of farm size, in regard to nutritive value, *in vitro* digestibility, metabolisable energy content and mycotoxin level in the rice straw. Rice straw was randomly sampled from both improved and traditional stores in two occasions. Ten straw samples of 1 kg was randomly collected from different locations of improved and traditional storage. Straw samples were kept in polyethylene bag and was labeled properly for future use.

Preparation of straw sample : After collection from the stack, straw was chopped to 3-4 cm size with the help of sickle. After that the chopped straw was exposed to sun drying in order to facilitate grinding. Then the chopped straw was ground to 2-3 mm size for chemical analyses. After grinding of each 10 kg straw from one stack, it was mixed properly, piled, flattened and quartered until it was reduced to 2.5 kg. Then 0.5 kg was kept for proximate analysis and *in vitro* digestibility and 2.0 kg of mixed sample was sent to Natural Resources Institute (NRI), UK. for analysis of mycotoxins. For *In vitro* study the ground sample was again oven dried and ground to 1.0mm mesh size with the help of a micro grinder.

Chemical Analyses of rice straw: The chemical analyses was done at the Bangladesh Agricultural University, Animal Nutrition Laboratory following the methods of AOAC (1990). Straw sample was analyzed for dry matter (DM), crude protein (CP), crude fiber

Table 1: Agro-climatic conditions of Trishal and Muktagachha

Experimental area	Agro-ecological zone	Soil texture and colour	Physiography	Climate		Drainage/ Flooded
				Annual rainfall (mm)	Mean annual temp. (°C)	
Trisal and Muktagachha (Mymensingh)	9b	Silt loamy and silty clay loamy. Gray brown to dark gray	Most areas have broad ridges and basins. Relief is irregular. The difference in alleviation between ridge tops and basin centers usually is 2-5 meters.	2000-4000 ($\bar{x}$ = 2966)	25.3 (<15->40)	Shallowly flooded. Early and rapid flooding by run off from adjoining higher land when heavy pre-monsoon or early monsoon rainfall occurs locally. Other time flood level are controlled by flood level in the Jamuna.

Source: FAO-UNDP, 1988.

Table 2: Effect of storage method on nutrient composition, *In vitro* digestibility and Metabolizable Energy (ME) contents of rice straw

Parameters	Storage method		SED	Statistical significance
	Improved	Traditional		
DM (g/100 g sample)	91.68±0.88	91.88±1.09	0.440	NS
Nutrient composition (g/100 g DM):				
OM	85.94±0.52	85.40±0.67	0.254	NS
CP	4.06±0.23	3.85±0.21	0.102	NS
CF	33.59±0.40	34.03±1.28	0.363	NS
EE	1.81±0.27	1.83±0.29	0.159	NS
NFE	46.48±0.84	45.62±1.07	0.177	**
Ash	14.06±0.52	14.65±0.67	0.262	NS
In vitro digestibility (g/100 g DM):				
IVDMD	45.27±0.84	42.81±0.93	0.399	**
IVOMD	48.31±1.02	46.07±1.06	0.473	**
ME (MJ/kg DM)	5.96±0.11	5.64±0.12	0.319	NS

^{NS}Not significant; $^{**}P<0.01$; ^{SED}Standard error of difference

(CF), ash, ether extract (EE) and nitrogen free extract (NFE).

***In vitro* digestibility:** *In vitro* digestibility of rice straw, collected from improved and traditional storage was done using the procedure of Hohenheim Gas Test (Menke and Steingass, 1988).

Mycotoxins Analyses: Twenty four samples of rice straw were used for mycotoxin analyses in duplicate. Finally duplicates were again combined to give 24 samples. Mycotoxins assayed were done for Fumonisin B_1 and Aflatoxins B_1, B_2, G_1 and G_2 following the standard methods described below:

Fumonisin: The NRI standard operating procedure for Fumonisin analysis, MT_SOP209, with immuno-affinity clean-up (VICAM Fumonitest), quantification by high performance liquid chromatography using a Spherisorb ODSI reverse phase column, pre-column derivatisation with o-phthaldialdehyde, fluorescence detection using 335 nm excitation and 440 nm emission wavelengths has been used.

Aflatoxins: The NRI standard operating procedure for Aflatoxin analysis, MT_SOP, (Bradburn *et al.*, 1990) with quantification by high performance liquid chromatography using a Spherisorb ODSI reverse phase column, post column derivatisation by means of a KOBRA electrochemical cell and fluorescent detection at 360 nm excitation and 440 nm emission wavelengths has been used. Extraction is performed by adding acetone:water (80:20) and shaking for 45 minutes and the clean-up uses a phenyl-bonded SPE column (Varian). The method has a limit of detection for Aflatoxin B_1 of less than 1 μg/kg. Due to the high absorbtivity of this matrix, the sample size was reduced to 25 g and the meal to solvent ratio for extraction was increased from 5 to 10.

Statistical Analyses: Data for nutrient composition, *in vitro* digestibility, and metabolizable energy content and mycotoxin level in rice straw kept in traditional and improved storage were analyzed statistically using simple t-test (Steel and Torrie, 1980) and significant difference between the techniques was recorded.

Results and Discussion

Findings of the present study are reported in this chapter with elaborate discussion through citation of literatures wherever appropriate.

Nutrient composition of rice straw: The nutrient composition (g/100gDM) of rice straw stored under different conditions (improved storage and traditional storage) is shown in Table 2. Storage method (improved vs traditional) had no significant ($P>0.05$) effect on dry matter (91.60 vs 91.88), organic matter (85.94 vs 85.40), crude protein (4.06 vs 3.85), crude fiber (33.59 vs 34.03), ether extract (1.81 vs 1.83) and ash (14.06 vs 14.65) contents of rice straw. However, nitrogen free extract (NFE) content of rice straw was significantly ($P<0.01$) higher in rice straw kept in improved storage condition compared with that in the traditional storage condition. Although not significantly, OM and CP contents of rice straw from improved storage were slightly higher and CF and ash contents were slightly lower than those of the traditional one. The nutrients OM and CP were expected to be higher in straw of improved storage than traditional one, however, it did not happen, which might be due

Table 3: Level of mycotoxins in rice straw stored in traditional system in two experimental sites

Parameters	Traditional storage method		SED	Statistical significance
	Muktagachha	Trishal		
Fuminisin (ppb) #	31.82±11.42	21.01±13.73	10.31	NS
Aflatoxins B_1, B_2, G_1, G_2 (ppb) ##	0	0	0	

[NS]Not significant ; [SED]Standard error of difference [#]Limit of detection = 20 ppb; [##]Limit of detection = 0.2 ppb

to the reason that the straw under traditional storage was not rotten enough to make significant difference in these nutrients compared to that of improved storage. It is fact that the rainfall of Bangladesh during wet season varies between the years as well as different regions in one particular year and it is also true that the degree of damage of straw depends on the degree of rainfall. As has been expected, the significantly ($P<0.01$) higher NFE content of straw of improved storage compared with that of traditional storage clearly indicates the beneficial effect of improved storage on straw quality. The nutrient NFE contains mostly soluble carbohydrates and which is quite likely to be washed out by the rain water when straw is exposed to rainfall in traditional storage system. It has been supported by Tripathi *et al.*(1995) who reported that during the traditional system of storage, leaching of soluble nutrients by rain is an important loss of nutrients from straw.

***In vitro* digestibility of rice straw sample:** *In vitro* DM digestibility (IVDMD), *In vitro* OM digestibility (IVOMD) and metabolizable energy(ME) contents of rice straw samples stored under different storage conditions (improved and traditional) are presented in Table 2. The values indicated that the storage method had apparently no significant ($P>0.05$) effect on ME content of rice straw, although it is clear that the ME value for straw of improved storage was higher than that for straw of traditional storage. However, the improved storage method significantly ($P<0.01$) increased IVDMD (45.27 vs 42.81%) and IVOMD (48.31 vs 46.07%) of rice straw compared with those of the traditional storage. The significantly higher values for IVDMD and IVOMD of improved storage compared to traditional may be due to the following reasons. In traditional storage condition nutrients of rice straw might be lost by the damaging action of the predators such as rats, birds, anjona, chicken, mongoose etc. Certain portion of nutrients might also be lost by the successive rainfall to which the straw is exposed. In case of traditional storage system excessive surface heat might have been another reason for reduced IVDMD and IVOMD of straw in comparison with improved storage. The results for IVDMD and IVOMD of rice straw stored in traditional storage systems are very close to the results reported by Huque and Akbar (1988) and the ME contents is almost similar to the value observed by Balch (1977).

Level of mycotoxins in rice straw : Table 3. shows the level of mycotoxins (Fumonisin and Aflatoxin B_1, B_2, G_1 and G_2 in rice straw kept in traditional storage in two different areas (Muktagachha and Trishal) of Mymensingh district. The results showed that the experimental area had no significant ($P>0.05$) effect on the level of Fumonisin in rice straw. It is also observed that no detectable levels of Aflatoxins (B_1, B_2, G_1 and G_2) were found in the rice straw samples. The low levels of mycotoxins in rice straw might be due to the reason that the straw was not damaged by excessive rainfall and the moisture level did not permit sufficient mold growth in the straw. It was reported by Phillips *et al.* (1996) that there was no significant amounts of Aflatoxins in rice straw of Bangladesh. The level of mycotoxins in rice straw of improved storage was not determined as there was neither detectable level of Aflatoxin nor the harmful level of Fumonisin even in straw of traditional storage, which was exposed to rain water and there was every possibility of being contaminated with mycotoxin. It was assumed that the level of mycotoxins would be low in rice straw stored in improved condition than that in traditional condition since straw was better stored in improved storage system where it was not exposed to wet and dampness allowing mold growth.

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