IMPROVEMENT IN THE NUTRITIVE VALUE OF RICE STRAW BY TREATMENT WITH THE URINE OF GOATS

S. Hasan[2], M. Shimojo[1] and I. Goto

Department of Animal Science, Faculty of Agriculture
Kyushu University 46-06, Fukuoka 812, Japan

Summary

This study was conducted to measure the improvement in nutritive value of rice straw by treatment with urine of goat under different temperatures. Straw samples were japonica I (comprising 15 varieties with culms longer than 123 cm and mean silica content of 13.0%), japonica II (comprising 20 varieties with culms less than 87 cm and mean silica content of 13.7%), indica I (Java 14 variety with a high content of silica of 13.9%) and indica II (comprising IR-8 and IR-20 varieties with a low content of silica of 11.0%). Urine was collected from four Japanese Saanen goats fed alfalfa hay. The different straws were sprayed with urine at the rate of 1 ml/g straw DM, put in double layer plastic bags, sealing and stored for 4 weeks at either 20℃ (GU-20) or 40℃ (GU-40).

The *in vitro* dry matter digestibility (IVDMD) and organic matter digestibility (IVOMD) of the straws were improved by the GU-40 treatment (13.5% and 13.2%), but the GU-20 treatment had little effect on digestibility (1.5% and −0.2%) except with the low silica indica II varieties. The GU-40 treatment tended to decrease NDF and hemicellulose content of straws. Crude protein content of the straws was improved by both the GU-20 and GU-40 treatments.

It was concluded that treatment of rice straw with goat urine at 40℃ for 4 weeks improved the crude protein content and digestibility *in vitro*, the greatest improvement occurring with straws of lowest digestibility in the untreated state.

(**Key Words**: Crude Protein, Digestibility, Goat, Rice Straw, Silica, Urine Treatment)

Introduction

Rice straw has a low digestibility and nitrogen content (Morrison, 1951). The quality of rice straw must be improved before it is fed to ruminant animals and this can be achieved by many different chemical and physical treatments (Sundstøl and Owen, 1984).

The digestibility of straw may be increased by treatment with anhydrous ammonia (Sundstøl and Coxworth, 1984) but this requires special equipment. Recent work has shown that urine collected from animals can be used as a safe and inexpensive source of ammonia. Studies in Bangladesh showed that urine treatment improved the crude protein content and digestibility of rice straw (Saadullah et al., 1980; Haque et al., 1983).

There is a need for further studies of urine treatment of rice straw in relation to characteristics of straw, conditions of treatment and effect on the chemical composition of the straw. This study examines the effect of urine of goats on the nutritive value of japonica and indica type rice straws stored at two temperatures.

Materials and Methods

Samples were collected from 35 varieties of japonica and 3 indica type rice plants grown and fertilized with a mixture of N-P_2O_5-K_2O at the rate of 0.15 kg/a in a paddy field of Kyushu University Farm in 1985.

The japonica type rice straws varieties were divided into two groups according to culm length; japonica I (comprising 15 varieties with culms longer than 123 cm; long culm) and japonica II (comprising 20 varieties with culms less than 87 cm; short culm). Indica type rice straws were divided into a high and low silica group; indica I (Java 14 variety, 13.9% silica) and indica II (comprising IR-8 and IR-20 varieties, 11.0% silica).

[1]Address reprint requests to M. Shimojo, Department of Animal Science, Faculty of Agriculture, Kyushu University 46-06, Fukuoka 812, Japan.

[2]Department of Animal Husbandry, Hasanuddin University, Ujung Pandang, Indonesia.

Received June 23, 1992
Accepted September 21, 1992

Samples of straw were dried at 65℃ for 48 hr, chopped to about 3 cm lengths and treated with urine. Urine was collected from four Japanese Saanen goats fed on alfalfa hay and contained 4.224 mgN/ml. The urine was applied to 12 mg samples of rice straw at the rate of 1 ml/g straw DM. The treated samples were put in double layer plastic bags, sealing and stored for 4 weeks at 20℃ (GU-20) or 40℃ (GU-40). There were two replications of each treatment.

The treated samples were exposed to air for 2 days before drying at 65℃ to constant weight. Samples were ground in a laboratory-mill fitted with a 1.0 mm aperture screen prior to analysis. Crude protein was determined by the Kjeldahl method and ash by combustion at 600℃ for 3 hr. Cell wall components were determined by the methods of Goering and Van Soest (1970), and *in vitro* dry matter digestibility (IVDMD) and organic matter digestibility (IVOMD) by the method of Minson and McLeod (1972) using rumen fluid collected from goats fed alfalfa hay.

The statistical analyses of the data were carried out according to the methods described by Snedecor and Cochran (1967).

Results and Discussion

Applying urine to rice straw and storing at 40℃ for four weeks increased the IVDMD and IVOMD of all types of straw (table 1). The extent of improvement in IVDMD was 14.6% unit with japonica I which was 36.0% digestible before treatment, and 12.7% unit with indica II which was initially 39.6% digestible. Similar improvements were found in IVOMD. Largest improvement was found with the least digestible straw. Storage at 20℃ had little effect on all straws except the low silica indica variety where there was an increase of 7.6 and 6.3% for IVDMD and IVOMD respectively (table 1).

The crude protein content of the straw was increased by the addition of urine with no consistent differences in response between straw types or treatment temperatures (table 2). The increase in crude protein was probably a direct result of adding the urinary nitrogenous compounds (Saadullah et al., 1980; Haque et al., 1983) but microbial protein could also have been produced from the urea during incubation. Other components of the straw were generally changed more

TABLE 1. *IN VITRO* DRY MATTER DIGESTIBILITY (IVDMD) AND ORGANIC MATTER DIGESTIBILITY (IVOMD) OF RICE STRAW TREATED WITH URINE OF GOAT

Straw group	Treatment	IVDMD (%)	IVOMD (%)	Improvement	
				IVDMD (% unit)	IVOMD (% unit)
Japonica I (long culm)	*Untreated*	36.1[a3]	39.0[a]	0	0
	GU-20[1]	37.5[a]	39.3[a]	1.4	0.3
	GU-40[2]	50.7[b]	54.0[b]	14.6	15.0
Japonica II (short culm)	Untreated	37.8[a]	42.3[a]	0	0
	GU-20	38.3[a]	40.3[a]	0.5	−2.0
	GU-40	51.3[b]	54.9[b]	13.5	12.6
Indica I (Java 14)	Untreated	36.2[a]	40.1[a]	0	0
	GU-20	38.8[a]	41.2[a]	2.6	1.1
	GU-40	49.4[b]	53.0[b]	13.2	12.9
Indica II (IR8 and IR20)	Untreated	39.6[a]	43.2[a]	0	0
	GU-20	47.2[b]	49.5[b]	7.6	6.3
	GU-40	52.3[c]	55.3[c]	12.7	12.1

[1] Treatment with goat urine at 20℃ for 4 weeks.
[2] Treatment with goat urine at 40℃ for 4 weeks.
[3] Figures within a group in each column with different superscript letters are significantly different ($p < 0.05$).

TABLE 2. CHEMICAL COMPOSITION[1] OF RICE STRAW TREATED WITH URINE OF GOAT

Straw group	Treatment	Crude protein (%)	NDF (%)	ADF (%)	Hemi-cellulose (%)	Cellu-lose (%)	ADL (%)	Silica (%)	Ash (%)
Japonica I (long culm)	Untreated	2.6[a]	67.8[a]	39.7[a]	28.2[a]	35.9[a]	3.8[a]	13.0[a]	19.4[a]
	GU-20[2]	5.6[b]	66.1[a]	40.0[a]	26.4[a]	33.7[a]	6.3[b]	14.6[b]	22.0[b]
	GU-40[3]	4.2[b]	64.1[a]	42.8[b]	21.3[a]	37.2[a]	5.7[b]	15.4[b]	22.5[b]
Japonica II (short culm)	Untreated	4.6[a]	64.9[a]	38.0[a]	26.9[a]	34.3[a]	3.7[a]	13.7[a]	20.0[a]
	GU-20	5.6[a]	65.2[a]	39.6[a]	25.7[a]	33.7[a]	5.9[b]	14.2[a]	21.7[b]
	GU-40	4.7[a]	66.9[b]	44.9[b]	22.0[a]	38.2[b]	6.7[b]	14.3[a]	21.5[b]
Indica I (Java 14)	Untreated	1.6[a]	64.3[a]	38.5[a]	25.8[a]	34.5[a]	4.1[a]	13.9[a]	19.9[a]
	GU-20	4.1[b]	65.0[a]	40.4[a]	24.6[a]	34.9[a]	5.5[b]	14.6[a]	22.0[b]
	GU-40	5.0[b]	62.1[a]	40.6[a]	21.5[a]	35.2[a]	5.4[b]	16.2[b]	23.1[b]
Indica II (IR8 and IR20)	Untreated	3.1[a]	69.4[a]	39.0[a]	30.4[a]	36.1[a]	3.0[a]	11.0[a]	17.8[a]
	GU-20	4.3[ab]	69.3[a]	40.6[a]	28.8[a]	36.5[a]	4.1[b]	13.0[b]	19.3[b]
	GU-40	5.1[b]	64.1[a]	38.9[a]	25.3[a]	33.5[a]	5.4[c]	14.2[c]	20.9[c]

[1] % dry matter basis.
[2] Treatment with goat urine at 20℃ for 4 weeks.
[3] Treatment with goat urine at 40℃ for 4 weeks.
[4] Figures within a group in each column with different superscript letters are significantly different ($p < 0.05$).

by the 40℃ treatment than by the 20℃ treatment, the chemical changes being accelerated by the higher temperature. The 40℃ urine treatment tended to decrease NDF content of the straws except japonica II, the decrease being mainly due to the degradation of hemicellulose. By the urine treatment, the content of ADF tended to be slightly increased and ADL was significantly increased, but cellulose showed small changes with no consistency. This result is similar to that of ammonia treatment (Itoh et al., 1975).

The contents of silica and ash were increased by the urine treatment, a result in agreement with Haque et al. (1983) who showed an increase in ash content of rice straw when treated with cattle urine. This increase might be due to the minerals, including silica (Jones and Handreck, 1967) in the urine. However, it is likely that most of the increase was as a result of the loss of organic matter during the incubation and subsequent drying.

The relationships between *in vitro* organic matter digestibility and silica or the sum of silica and ADL is shown in figure 1. This indicates that the improvement in digestibility of the rice straw when treated with urine could not be accounted for by a reduction in silica and lignin contents. The increase in digestibility was probably caused by swelling of fibrous materials through ammoniation (Sundstøl and Coxworth, 1984) making the fibre, particularly the hemicellulose more accessible to microbial attack. This improvement might also be associated with the increased activity of rumen microbes that utilized the urinary nitrogen.

Collection of urine must be simple and inexpensive if the treatment of straw is to be successfully applied in Asia. Sundstøl and Coxworth (1984) suggests the possibility of treating straw with human urine which is easily collected and often wasted. In this study the straw was incubated in an oven but in farm conditions a temperature of 40℃ can probably be obtained in most tropical countries by the use of black plastic sheet during urine treatment and leaving the treated straw exposed to the sun.

It was concluded that treatment of rice straw with goat urine at 40℃ for 4 weeks improved the crude protein content and digestibility *in vitro*, the greatest improvement occurring with straws of lowest digestibility in the untreated state, and the 20℃ urine treatment was available for the increase in crude protein.

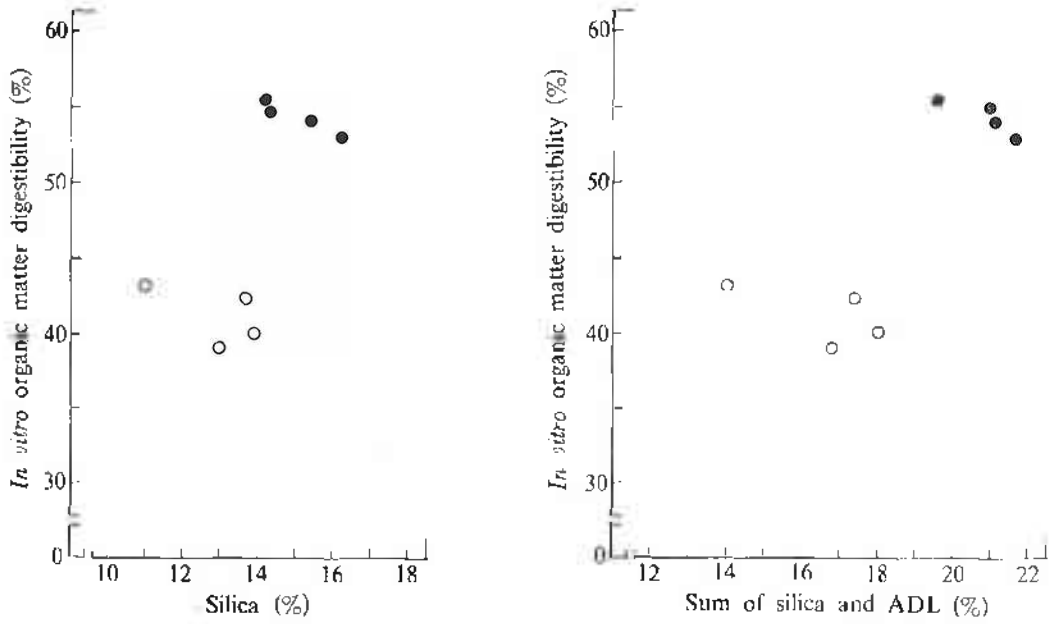

Figure 1. Relationships between *in vitro* organic matter digestibility and silica or sum of silica and ADL in rice straws untreated (open) and treated with urine of goats (closed) at 40°C for 4 weeks.

Acknowledgements

We wish to thank Dr. D. J. Minson for helpful suggestions during the writing this paper and Prof. N. Iwata, Assoc. Prof. H. Sato, Assoc. Prof. A. Yoshimura and Asst. Prof. H. Yasui for supplying us with rice straws.

Literature Cited

Goering, H. K. and P. J. van Soest. 1970. Forage fiber analyses. Agriculture Handbook (U.S.D.A.) No. 379:1-20.

Haque, M., C. H. Davis, M. Saadullah and F. Dolberg. 1982. A note on the performance of cattle fed treated paddy straw with animal urine as a source of ammonia. Trop. Anim. Prod. 8:276-278.

Itoh, H., Y. Terashima, N. Tohrai and Y. Matsui. 1975. Improving the nutritive values of rice straw and rice hulls by ammonia treatment. Jap. J. Zootech. Sci. 46:87-93.

Jones, L. H. P. and K. A. Handreck. 1967. Silica in soils, plants, and animals. Advan. Agron. 19:107-148.

Minson, D. J. and M. N. McLeod. 1972. The *in vitro* technique: its modification for estimating digestibility of large numbers of tropical pasture samples. C.S.I.R.O., Div. Trop. Pastures Tech. Paper. No. 8:1-15.

Morrison, F. B. 1951. The hay and pasture grasses-the cereals for forage-straw. In "Feeds and Feeding". The Morrison Publishing Company, Ithaca, New York. pp. 414-442.

Saadullah, M., M. Haque and F. Dolberg. 1980. Treating rice straw with animal urine. Trop. Anim. Prod. 5:273-277.

Snedecor, G. W. and W. G. Cochran. 1967. Statistical Methods (6th ed.). The Iowa State University Press, Ames, Iowa.

Sundstøl, F. and E. M. Coxworth. 1984. Ammonia treatment. In "Straw and other fibrous by-products as feed", ed. by F. Sundstøl and E. Owen, Elsevier Science Publishers B. V., Amsterdam. pp. 196-247.

Sundstøl, F. and E. Owen. 1984. "Straw and other fibrous by-products as feed", Elsevier Science Publishers B. V., Amsterdam.