Feeding Value of Rice Whole Crop Silage as Compared to Those of Various Summer Forage Crop Silages

Masakazu GOTO, Osamu MORITA, Kenji NISHIWAKI
and Atsushi NAKASHIMA

Faculty of Bioresources, Mie University, Tsu-shi 514

(Received February 28, 1990)

Key words : Feeding value, Rice plant, Whole crop silage

Much recent work on ruminant feeds has concentrated on cereal straw and its upgrading with chemical and physical treatments, due mainly to large supply of rice straw in the most of area in Japan. In addition to rice and wheat straws, whole crop silage of rice plant are receiving attention as an advantageous feed production system in paddy field⁴⁾. The objective of this study was to determine the feeding value of whole crop silage of rice plant as compared to those of various summer forage crop silages.

Materials and Methods

Rice crop (*Oryza sativa* L. cv., Yamahikari), Italian ryegrass (*Lolium multiflorum* Lam. cv., Common), Japanese millet (*Echinochloa frumentacea* Link. cv., Green) and sorghum (*Sorghum bicolor* Moench. cv., FS 401 R) were grown in the Mie Animal Husbandary Experimental Station. The forage crops were harvested at various growth stages and ensiled during different periods; rice crop (yellow ripe stage, 60 days), Italian ryegrass (flowering stage, 150 days), Japanese millet (flowering stage, 90

days) and sorghum (heading stage, 60 days). Dry matter concentration of each silage was determined by the toluene distillation method, and the organic acids was by FLIEG's method¹⁰⁾.

Voluntary intake and apparent digestibilities of dietary components were measured with four individually-penned Holstein heifers (average weight: 325 kg) in a 4-treatment changeover design. Each trial consisted of a 6-day preliminary period followed by a 4-day measurement period. Each silage was offered *ad libitum* to the cattle twice a day as the sole feed. Apparent digestibilities of DM, crude protein, crude fiber, NFE, and crude fat were determined from the analysis of feedstuffs and feces collected daily during the measurement period⁶⁾. Eating and ruminating behavior of two settled heifers was also observed by two observers allotted for each cattle during last 2-day measurement period, using a stopwatch and counter³⁾.

Results and Discussion

The rice crop silage was much poorer in fermentative quality due to high pH value

夏飼料作物サイレージとの比較からみた水稻ホールクロップサイレージの飼料価値: 後藤正和・森田 脩・西脇謙二・中島敦司 (三重大学生物資源学部 津市 514)

Feeding Value of Rice Whole Crop Silage as Compared to Summer forage crops

and high percentage of butyric acid to total organic acids produced, while those of sorghum, Italian ryegrass and Japanese millet were fermented well ; *i.e.*, lactic and acetic acids were preferentially produced (Table 1). Rice crop silage had much higher NFE and corresponding lower crude fiber contents than

the other forage crops, but lower digestibility of crude fiber. The rice crop silage had 496 g kg⁻¹ of TDN content with less 120 g kg⁻¹ and 100 g kg⁻¹ of that value than Italian ryegrass and sorghum silages, respectively. Dry matter intake of dairy cattle fed on *ad libitum* was considerably higher for rice crop silage (83.6

Table 1. Fermentative quality and feeding values of forage crop silages

	Rice crop	Italian ryegrass	Japanese millet	Sorghum
Fermentative quality				
Moisture (g kg ⁻¹)	650	795	743	815
pH	4.6	4.0	4.2	3.7
Organic acid (% of FW)				
Lactic acid	0.41	1.49	0.89	1.54
Acetic acid	0.73	0.70	0.14	0.42
Butyric acid	0.69	0.22	0.04	0.00
Total	1.83	2.41	1.07	1.96
Composition of DM (g kg ⁻¹)				
Crude protein	67	81	66	88
Crude fiber	242	375	357	338
NFE	545	398	458	439
Crude fat	29	56	29	60
Crude ash	117	90	90	75
Nutrient composition (g kg ⁻¹)				
DCP	29	30	16	44
TDN	496	616	486	596
Digestibility (g kg ⁻¹)				
Dry matter	482c	595a	454d	543b
Crude protein	425b	374b	242c	505a
Crude fiber	412c	710a	604b	611b
NFE	610a	554b	472c	524c
Crude fat	542c	788b	588c	853a
Voluntary intake of DM (g kg ⁻¹ W ^{0.75})	83.6a	65.1b	67.3b	69.8b
Eating and ruminating behavior				
Eating time (min. kg ⁻¹ DM intake)				
Cattle A	28.7	30.0	51.0	45.0
Cattle B	44.6	62.3	73.0	52.5
Rumination time (min. kg ⁻¹ DM intake)				
Cattle A	41.9	47.9	44.1	50.0
Cattle B	50.0	66.7	51.1	60.8
Chewing number (100 sec. ⁻¹ bolus ⁻¹)				
Cattle A	110.9c	121.8a	117.6b	123.6a
Cattle B	115.6c	134.1a	113.6c	126.3b

1) Figures with different superscript letters are significantly different at the 5% level (Duncan's multiple range test).

$\text{g kg}^{-1} \text{W}^{0.75}$) than for Italian ryegrass ($65.1 \text{ g kg}^{-1} \text{W}^{0.75}$), Japanese millet ($67.3 \text{ g kg}^{-1} \text{W}^{0.75}$) and sorghum silages ($69.8 \text{ g kg}^{-1} \text{W}^{0.75}$). The higher DM voluntary intake of rice crop silage was, thus, poorly consistent with the digestibilities of DM and crude fiber. This was not in agreement with a positive correlation between intake of roughages and their digestibility by ruminants^{1,2)}. According to BALCH and CAMPLING²⁾, the food intake of ruminants is restricted primarily by rumen capacity and hence by the rate of digestion and passage of roughages.

Eating time (min. kg^{-1} DM intake) was the shortest for rice crop silage among the crop forages tested, because of less searching of cattle fed on rice crop silage. It was indicative of higher palatability of this material which was probably associated with less differences in palatability between leaves, stems, and grains. As compared within variety, a higher DM content has been found partially to contribute to a shorter eating time and higher voluntary intake. However, the extent to which a higher DM content of rice plant compared to the other crop forages can contribute to shorter eating time and higher DM voluntary intake of this material was not known.

Chewing speed per bolus of rice crop silage was slower than those of other silages, indicating greater physical resistance of rice straw which was resulted in lower digestibility of crude fiber. Rice crop silage was also found less in rumination time (min. kg^{-1} DM intake) than those of Italian ryegrass and sorghum silages and similar to that value of Japanese millet.

In this study some amount of intact rice grains was detected in the cattle feces, in agreement with the previous results obtained for corn (*Zea mays* L.)⁷⁾ and rice (*Oryza sativa* L.)^{8,9)}. NAKUI *et al.*⁸⁾ reported on the nutritive values of whole crop rice silages that a 18 % of grains was intact in the cattle feces. Thus, a higher voluntary intake of whole rice

crop silage compared to the other forage crop silages may be due to some amount of intact grains which involve a higher passage rate of this whole plant through the alimentary tract of cattle^{2,5,11,12)}, as shown in both negative relationships between chewing speed and rumination time and between digestibility and voluntary intake.

Consequently, the voluntary intake of TDN of rice whole crop silage was similar to those of Italian ryegrass and sorghum silages, but higher than a millet silage.

Acknowledgement

The authors sincerely wish to thank Mr. Y. ITO, Mr. N. SAKAMOTO and Mr. Y. YOTANI in the Mie Animal Husbandary Experimental Station, for providing the valuable opportunity to work with their cattle and facilities.

References

- 1) BAILE, C.A. and J.M. FORBES, Control of feed intake and regulation energy balance in ruminants. *Physiological Reviews.*, **54**: 160-214. 1974.
- 2) BALCH, C.C. and R.C. CAMPLING, Regulation of voluntary food intake in ruminants. *Nutrition Abstract and Reviews.*, **32**: 669-686. 1962.
- 3) GOTO, M., A. NISHIJIMA and O. MORITA, Comparisons of nutritive values between sorghum silage and foggage. *Jpn. J. Zootech. Sci.*, **59**: 541-547. 1988.
- 4) HARYU, T., in "Esamai" no Gijyutsuteki-Tenbou (Tsukuba Nouringijyutsu o kangarukai eds.) 97-104. Nourintoikeikyokai. Tokyo. 1982.
- 5) HASHIZUME, T., H. FUJITA, S. MATSUOKA, H. KATO and G. SATO, The effect of different forms of roughages on the digestibility, rumen fermentation and mean retention time in the alimentary tract. *Res Bull. Obihiro Univ.*, **9**: 491-508. 1975.
- 6) HORII, S., in *Dobutsu Eiyou Sikenho* (Edr. MORIMOTO, H.) Youkendo. Tokyo. 280-297. 1971.
- 7) NAKUI, T., R. ABE, K. IWASAKI and M. HAYAKAWA, Toumorokosi-silage chuno sijitsuga gyuhunchuni haisetsusareru

Feeding Value of Rice Whole Crop Silage as Compared to Summer forage crops

- wariai. J. Japan. Grassl. Sci., **23** : 84-85. 1977.
- 8) NAKUI, T., N. YAHARA, S. TAKAI, Ine-whole crop no setsudannchou ga silage no hatsukouhinsitsu to mishouka sijitsu haishitsu ni oyobosu eikyou. Jpn. J. Zootech. Sci., 77th Annu. Meeting Abstr. 10. 1985.
- 9) Norinsuisansho Sougoukenkyu (S. 57-S. 61), Tohoku Nogyoushikenjyo Kenkyuseika (S. 58) 233-234. 1983.
- 10) OHYAMA, Y., in Doubutsu Eiyou Sikenho (Edr. MORIMOTO, H.) Youkendo. Tokyo. 412-427. 1971.
- 11) REES, M.C. and D.J. MINSON, Fertilizer calcium as a factor affecting the voluntary intake, digestibility and retention time of pangola grass (*Digitaria decumbens*) by sheep. Br. J. Nutri., **36** : 179-187. 1976.
- 12) THORNTON, R.F. and D.J. MINSON, The relationship between voluntary intake and mean apparent retention time in the rumen. Aust. J. Agric. Res., **23** : 871-877. 1972.