イタリアンライグラス(Lolium multiflorum Lam.)緑汁液を直接あるいはアルカリ処理後に添加して調製した稲わらサイレージの栄養価

誌名	日本草地学会誌
ISSN	04475933
著者名	西野,直樹 大島,光昭 横田,浩臣
発行元	日本草地学会
巻/号	37巻2号
巻号補足	
掲載ページ	p. 203-212
発行年月	1991年7月

J. Japan. Grassl. Sci. 37 (2) : 203-212 (1991)

Nutritive Value of Rice Straw Ensiled with Intact or Alkalized Italian Ryegrass (*Lolium multiflorum* LAM.) Green Juice

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Synopsis

NISHINO, N., M. OHSHIMA and H. YOKOTA (1991) : Nutritive value of rice straw ensiled with intact or alkalized Italian ryegrass (*Lolium multiflorum* LAM.) green juice. *J. Japan. Grassl. Sci.* **37**, 203-212.

Freshly harvested Italian ryegrass was disintegrated with a herbage crusher and pressed out green juice (GJ) with a screw press. The GJ was used as a protein supplement source for rice straw (RS). Rice straw was mixed with intact GJ (GJ · RS) and with NaOH or NH_3 (4% of RS dry matter) treated GJ (GJ · NaOH · RS or GJ · NH_3 · RS) at 3 : 7 ratio on fresh weight basis and ensiled into polyethylene bags. Rice straw ensiled with water was also prepared as the control (W · RS).

Crude protein content of RS was increased from 5.0 to 7.9% in dry matter basis by mixing intact or NaOH treated GJ and further increased to over 25% by NH_3 treated GJ.

The control W · RS silage contained a trace amount of lactic acid and showed a butyrate type fermentation. The addition of intact GJ to RS significantly increased the lactic acid content, and reduced the butyric acid content, NH_3-N/TN and the pH value of the silage. In contrast to this, the addition of NaOH or NH_3 treated GJ increased the pH value, the butyric acid content and NH_3-N/TN of the silage, and GJ · NH_3 · RS silage showed the lowest chemical quality.

In the feeding trial, four castrated male goats were allocated in a 4 × 4 Latin-square and fed the 3 : 1 (DM basis) mixed ration of RS silage and wheat bran. Besides them, urea was supplemented to W · RS silage at the time of feeding to adjust the nitrogen intake except for that from NH_3 treated silage.

The addition of intact GJ to RS at ensiling had little advantage to feeding urea with W · RS silage in respect to nutrient digestibilities but slightly improved nitrogen balance of goats. Compared with goats fed W · RS and GJ · RS silages, those fed GJ · NaOH · RS silage showed significantly higher fiber digestibilities, less urinary nitrogen excretion and more nitrogen retention with the reduction of ruminal NH_3-N and blood urea nitrogen concentrations. The goats fed GJ · NH_3 · RS silage showed the highest nutrient digestibilities and nitrogen retention. These results suggest that the alkali treatments increased energy supply from fiber and consequently increased nitrogen uptake of rumen microbes. The disadvantage of feeding GJ · NaOH · RS compared with GJ · NH_3 · RS was probably due to the insufficient nitrogen supply to rumen microbes for the maximum fiber digestion and protein synthesis.

Key words : Alkali treatment, Digestion, Goat, Green juice, *Lolium multiflorum*, Rice straw.

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Introduction

Leaf protein concentrate (LPC) can be prepared by mechanically extracting green juice (GJ) from green herbage, coagulating protein in GJ by heat or acid and drying the coagulum. Although GJ can be easily obtained by simple processing leaving an abundant residue which is known to be as nutritious as the material crop for ruminants[12], preparation of LPC needs much energy and reduces the economy of the whole process[5]. Therefore, many attempts have been made to incorporate GJ directly into animal feeds[2,21].

Recently, many researches have been documented on improving the nutritive value of low quality roughage such as straw, which is a most abundant but little nutritious resource as ruminant feed, by physical, chemical and biological treatments[4]. Low quality roughage usually has insufficient level of nitrogen and slowly degradable fiber, which limits its voluntary intake. It is well known that an adequate nitrogen supplement increases the voluntary intake of straw, improves N utilization of the animal and sometimes improves fiber digestibility[8,16]. GJ contains much protein and soluble components and therefore may serve as a good additive source for low nitrogen feeds. If it is alkalized before addition to straw, an improvement of fiber digestibility can also be expected.

This experiment was conducted to study the effects of the addition of intact or alkalized Italian ryegrass GJ to rice straw (RS) on improving the nutritive value and fermentation quality of RS silage.

Materials and Methods

1. Preparation of green juice (GJ)

First crop of Italian ryegrass (*Lolium multiflorum* LAM.) cultivated on the Farm of Nagoya University was harvested at vegetative growth on April 20th 1988. A 1750 kg of it was disintegrated with a herbage crusher (Nihon Sharyo Ltd.) and was pressed out 1050 l of GJ with a twin roll screw press (Stord Bartz Japan Ltd., TP-24-2.). GJ was stored in a bulk cooler at 4°C until the following day when the preparation of the silages was made with it.

2. Preparation of silage

GJ was used in intact (fresh) or alkalized (NaOH or NH_3 treated) forms. NaOH and NH_3 were added at a level of 4% of RS dry matter, respectively, by mixing their solution with fresh GJ just before ensiling. RS cut into 2 cm length was mixed with intact, NaOH or NH_3 treated GJ at 3 : 7 on fresh weight basis and referred to GJ · RS, GJ · NaOH · RS and GJ · NH_3 · RS, respectively. Then they were packed into polyethylene bags (625 mm in width, 800 mm in height and 0.06 mm in thickness) at a rate of 15 kg per bag. RS ensiled with water in the same way as above was prepared as the control (W · RS) silage. After removing air with a vacuum pump and tying the upside, each bag was preserved in a dark room at ambient temparature. Bags were opened one by one after about one year when animal trial was started.

3. Animal trial

Four *Shiba* strain castrated growing male goats weighing about 12.5 kg were assigned to 4 dietary treatments according to 4×4 Latin square design. They were individually housed in metabolism cages and fed the four kinds of rations at 2.5% of their body weight daily in dry matter basis. The rations were made by mixing three portions of RS silage with one portion of wheat bran in dry matter basis so as to give the protein requirement of goats recommended by NRC[30]. Half of the ration were fed at 9 AM and the other half at 5 PM. Two grams of NaCl and 10 g of $CaHPO_4$ were offered with the morning ration. Water was available *ad libitum*. When the goats were fed the control W・RS silage, 1 g of urea was supplemented at each feeding to adjust the nitrogen intake except for that from NH_3 treated silage. A 7-day preliminary adjustment period was followed by 5-day period during which all feces and urine were collected. Urine was preserved with H_2SO_4. Aliquots of feces and urine were taken from the daily collection and composited as 5-day pooled samples. Rumen fluid by stomach tube and jugular blood samples were taken at 4 hours after morning rations and stored −20°C for later analysis.

4. Analyses

Dry matter content of silage was determined by toluene distillation method[7]. Chemical composition of feeds and feces were determined using samples dried with a draft oven at 60°C for 48 hours except for nitrogen in silage, which was estimated with fresh sample. Nitrogen content was determined by Kjeldahl method and ash was measured by igniting the dried samples at 550°C. Estimation of NDF was made by the method of VAN SOEST and WINE[27] with partial modification by GOLDING *et al.*[10]. In the analysis of NDF in wheat bran, amylase pretreatment[1] was adapted. ADF and ADL were determined by the method of VAN SOEST[26]. NDF, ADF and ADL were all expressed as ash free forms. Hemicellulose and cellulose were calculated as NDF minus ADF and ADF minus ADL, respectively. Calory contents of feeds and feces were measured using a bomb calorimeter (Shimadzu, CA-3). Water soluble carbohydrate contents in GJ and RS were determined according to the method of MCDONALD and HENDERSON[17].

Chemical quality of silages was determined with cold water extracts. Analysis of rumen fluids was made with the filtrates through double gauze. The pH value was determined with a glass electrode pH meter (Horiba, F-12). Lactic acid in silage was determined by the method of BARNETT[3]. Total concentrations of VFA and ammonia were analyzed by steam distillation method and molar proportion of VFA was determined by a gas chromatograph (Shimadzu, GC-12 A). Concentration of blood urea nitrogen (BUN) was estimated with blood plasma using a commercial kit (Chugai Pharmaceutical Ltd.). All data were subjected to analysis of variance and statistical significance among treatment means was determined by DUNCAN's multiple range test.

Results and Discussion

Crude protein and water soluble carbohydrate contents of fresh GJ were 1.18% and 2.74%, respectively (Table 1). These values were in the normal range of ryegrass GJ reported by CHEESEMAN[6]. Crude protein content of W・RS silage was 5.0% in dry matter basis, but it was 7.9% in both the GJ・RS and GJ・NaOH・RS silages showing that 2.9% of crude protein was supplemented to RS from GJ (Table 2). Ammonia treated GJ contained 8 times as high crude protein as intact GJ (Table 1) and consequently, GJ・NH_3・RS silage contained more

Table 1. Characteristics of green juice (GJ) and rice straw.

Item	Intact GJ	GJ treated with NaOH	GJ treated with NH_3	Rice straw
pH	6.12	13.3	10.9	—
Dry matter[1)]	5.25	6.56	4.74	87.9
Crude protein[1)]	1.18	1.12	8.95	4.48
Ash[1)]	1.19	3.10	1.07	13.6
Water soluble carbohydrate[1)]	2.74	—	—	3.40

1) Percent of fresh matter.

Table 2. Chemical composition[1)] of the silages and wheat bran.

Item	W・RS[2)]	GJ・RS[2)]	GJ・NaOH・RS[2)]	GJ・NH_3・RS[2)]	Wheat bran
Crude protein	5.0^c	7.9^b	7.9^b	25.1^a	17.7
Ash	17.7^d	18.6^c	21.5^a	20.4^b	3.9
NDF	69.7^a	63.0^b	59.0^c	60.4^c	23.7
ADF	43.3^a	39.0^b	40.3^b	42.1^a	6.6
ADL	7.4	6.7	7.2	6.8	1.6
Hemicellulose	26.4^a	24.0^b	18.7^c	18.3^c	17.1
Cellulose	35.9^a	32.3^b	33.1^b	35.3^a	5.0
Gross energy[3)]	3884	3926	3902	3902	4539

1) Percent of dry matter. Values in the same row with different superscript letters are significantly different ($P<0.05$).
Statistical analysis was made within 4 rice straw silages.
2) W・RS : Rice straw ensiled with water, GJ・RS : Rice straw ensiled with intact GJ, GJ・NaOH・RS : Rice straw ensiled with NaOH treated GJ, GJ・NH_3・RS : Rice straw ensiled with NH_3 treated GJ.
3) Calory/g DM.

than 25% crude protein. Smith *et al.*[23)] reported that a favorable effect of supplementary nitrogen on increasing the voluntary intake and digestibility could be observed till dietary crude protein content reached 8.5% in animals receiving high fiber diets. In the present experiment, RS silages other than NH_3 treated one contained less crude protein than 8% suggesting that the addition of GJ was not enough to make up for the protein deficiency of animals without any other supplements. Compared with W・RS silage, GJ・RS silage had lower fiber and lignin contents reflecting the composition of GJ added. Both NaOH and NH_3 additions significantly ($P<0.05$) reduced the NDF and hemicellulose contents of respective silages indicating increased solubility of hemicellulose by alkali treatments.

Chemical quality of the silages are summarized in Table 3. The control W・RS silage contained only a trace amount of lactic acid and showed a butyrate type fermentation. This result might be derived from the low WSC content of the material (Table 1) and subsequent clostridial growth. The addition of intact GJ to RS significantly increased the lactic acid content, reduced NH_3-N/TN and the pH value of the silage. By the addition of GJ, WSC content of the silage material increased from 3.87% to 9.78% in dry matter basis, which

Table 3. Chemical quality of the silages[1)].

Item	W・RS[2)]	GJ・RS[2)]	GJ・NaOH・RS[2)]	GJ・NH_3・RS[2)]	SE[3)]
Moisture (%)	72.5[a]	71.4[ab]	70.8[b]	71.2[ab]	0.45
pH	4.99[c]	4.38[d]	5.78[b]	7.43[a]	0.08
Lactic acid (%/DM)	0.08[b]	1.93[a]	0.09[b]	0.03[b]	0.13
Acetic acid (%/DM)	1.59[b]	5.44[a]	2.69[b]	4.70[a]	0.42
Propionic acid (%/DM)	0.21[c]	1.08[a]	0.33[bc]	0.44[b]	0.05
iso-Butyric acid (%/DM)	0.12[b]	trace	0.35[a]	0.37[a]	0.02
n-Butyric acid (%/DM)	2.28[c]	trace	7.08[b]	9.26[a]	0.58
Total acids (%/DM)[4)]	5.06[d]	8.46[c]	11.3[b]	15.4[a]	0.55
Protein-N (%/DM)[5)]	0.51[c]	0.61[b]	0.64[b]	0.73[a]	0.01
NH_3-N/Total-N (%)	22.6[c]	11.2[d]	29.4[b]	71.2[a]	1.17

1) Means of 4 bag silages. Values in the same row with different superscript letters are significantly different ($P<0.05$).
2) See the footnotes of Table 2.
3) Pooled standard error.
4) The sum of lactic and volatile fatty acids including valeric and capronic acids.
5) Trichloroacetic acid precipitable N determined with oven dried sample.

allowed GJ・RS silage for a more desirable fermentation than W・RS silage. More acetic acid was found in all the silages than lactic acid. This result might be attributable to coliform bacterial growth dominated in the aerobic condition which probably lasted for a long time due to the use of hard and tough straw as the silage material. The addition of NaOH and NH_3 treated GJ significantly increased the pH value, the butyric acid content and NH_3-N/TN of the silages with the reduction of lactic acid content. Of the two alkali treatments, NH_3 treatment had more effects on those values. In the studies about corn silage, it was observed that although ammonia addition delayed lactic acid production[13)] and high amounts of addition increased butyric acid[11)], low ammonia addition rather increased the lactic acid concentration of the silage[11)]. Total acid contents of GJ・NaOH・RS and GJ・NH_3・RS silages were higher than that of GJ・RS silage suggesting the increase of fermentable components by the alkali treatments. Protein-N content of the silage was increased with the addition of GJ, and GJ・NH_3・RS silage showed the highest value among all the silages. Although GJ・NaOH・RS silage showed more butyric acid content and NH_3-N/TN than GJ・RS silage, protein-N content of these two silages were not different. In general, butyric acid in silage increases with reduction of protein and increase of NH_3 because butyric acid is formed by clostridia which has proteolytic and amino acid catabolic activities[20)]. But the alkali treatments did not reduce the protein content in spite of enhanced clostridial fermentation.

Results of a digestion and nitrogen balance trial are shown in Table 4. Nutrient digestibilities of GJ・RS silage were almost similar to those of W・RS silage supplemented with urea at feeding. The goats receiving these two silages showed negative nitrogen balance, but those fed GJ・RS silage tended to retain more nitrogen than those on W・RS silage. These results indicated that the addition of intact GJ to RS had little advantage to feeding urea with W・RS silage in respect to digestibility but slightly improved nitrogen utilization of

Table 4. Digestibilities of some nutrients and nitrogen balance in goats given the 3 : 1 mixed ration of rice straw silage and wheat bran[1].

Item	Diets containing				SE[2]
	W・RS[3,4]	GJ・RS[3]	GJ・NaOH・RS[3]	GJ・NH_3・RS[3]	
Digestibility (%)					
Dry matter	49.9^{b}	51.3^{b}	56.6^{a}	60.3^{a}	1.31
Organic matter	54.6^{c}	55.3^{c}	60.8^{b}	65.1^{a}	1.31
Crude protein	53.4^{b}	57.7^{b}	54.6^{b}	77.5^{a}	2.84
NDF	46.9^{c}	46.9^{c}	55.2^{b}	64.6^{a}	2.08
ADF	46.7^{c}	45.1^{c}	53.0^{b}	61.0^{a}	1.82
Hemicellulose	47.1^{c}	49.4^{bc}	58.6^{b}	71.3^{a}	3.34
Cellulose	52.6^{c}	51.5^{c}	62.1^{b}	71.5^{a}	1.68
DE/GE[5]	52.7^{c}	53.9^{c}	58.6^{b}	62.7^{a}	1.24
Nitrogen balance (g/day)					
Intake N	4.51^{b}	4.60^{b}	4.64^{b}	10.3^{a}	0.05
Fecal N	2.07^{ab}	1.95^{b}	2.11^{ab}	2.37^{a}	0.11
Urinary N	3.53^{b}	3.20^{bc}	2.69^{c}	6.88^{a}	0.22
Retained N	-1.09^{c}	-0.55^{bc}	-0.16^{b}	1.07^{a}	0.23

1) Means of 4 goats. Values in the same row with different superscript letters are significantly different ($P<0.05$).
2) Pooled standard error.
3) See the footnotes of Table 2.
4) Urea was supplemented at the time of feeding to adjust the nitrogen intake except for that from NH_3 treated silage.
5) Digestible energy/Gross energy.

goats. Amino acid supplements substituted for urea to low quality diet could increase ruminal microbial yield and *in vitro* N incorporation into microbial cells[9], which could lead to the improved N utilization. The cell wall of RS, especially epidermis and mechanical tissues, deposits lignin and silica and hinders the microbial invasion into the inner tissues[14]. It indicates the potentially low digestibility of cell wall constituents of RS. Therefore, even if microbial yield became greater in the rumen of goats by feeding GJ・RS silage which contained more amino compounds than W・RS silage, no improvement of fiber digestibilities could be observed. Compared with W・RS and GJ・RS silages, GJ・NaOH・RS silage showed significantly higher digestibilities except for that of crude protein which was not different among them. Increased fiber digestibility by alkali treatment could be ascribed to swelling effect on cell wall constituents[25] followed by enhanced microbial digestion in the rumen[29]. The goats fed GJ・NaOH・RS silage excreted less urinary N and retained more N compared with those fed W・RS and GJ・RS silages, however, the difference to the latter was not significant. These results suggested that ruminal protein synthesis was enhanced by the NaOH treatment due to supplying more fermentable energy for rumen microbes with the increase of fiber digestibility. SRISKANDARAJAH and KELLAWAY[24] reported that the amount of bacterial N leaving the abomasum was higher with steers receiving a NaOH treated wheat straw than those on untreated one whereas the proportion of bacterial N to apparently digested organic matter was not affected by the treatment. Digestibility of every component

Table 5. Rumen fluid characteristics and blood urea nitrogen (BUN) concentrations of goats given the 3 : 1 mixed ration of rice straw silage and wheat bran[1,2]

Item	Diets containing				SE[3]
	W · RS[4,5]	GJ · RS[4]	GJ · NaOH · RS[4]	GJ · NH_3 · RS[4]	
pH	6.47	6.41	6.41	6.31	0.06
Total VFA (mmol/dl)	6.62	7.77	8.25	7.46	0.74
Molar % of VFA					
Acetic acid	68.5	73.6	68.6	71.7	2.39
Propionic acid	20.7	18.9	18.3	17.0	1.66
iso-Butyric acid	1.2^{a}	0.9^{ab}	1.1^{ab}	0.8^{b}	0.11
n-Butyric acid	7.9^{ab}	5.2^{b}	10.6^{a}	12.2^{a}	1.53
NH_3-N (mg/dl)	17.2^{b}	21.9^{b}	9.1^{c}	49.9^{a}	2.52
BUN (mg/dl)	22.5^{b}	18.6^{b}	12.3^{c}	31.4^{a}	1.51

1) Samples were taken 4 hours after morning rations.
2) Means of 4 goats. Values in the same row with different superscript letters are significantly different ($P<0.05$).
3) Pooled standard error.
4) See the footnotes of Table 2.
5) Urea was supplemented at the time of feeding to adjust the nitrogen intake except for that from NH_3 treated silage.

of GJ · NH_3 · RS silage was the highest among all the silages except for that of DM which was not significantly different from that of GJ · NaOH · RS silage. In comparison of alkali treatments of low quality roughage, NaOH was more effective than NH_3 on improving fiber digestibility[28], while in the present experiment an opposite result was obtained. As the fiber contents (Table 2) and the chemical quality (Table 3) were not greatly different between GJ · NaOH · RS and GJ · NH_3 · RS silages, the different fiber digestibilities between them were attributed to the amount of nitrogen offered. Though NaOH and NH_3 might have been effective to the same extent on improving fiber digestibilities, GJ · NaOH · RS silage did not offer enough nitrogen to goats for utilizing the potentially digestible nutrients which were increased by the NaOH treatment. The goats offered GJ · NH_3 · RS silage excreted the highest N in feces and urine, but retained the most due to the highest N intake.

Postfeeding rumen fluid characteristics and BUN concentrations of goats are described in Table 5. The goats receiving GJ · RS silage showed no significant differences in these values from those on W · RS silage. Feeding GJ · NaOH · RS silage tended to increase ruminal total VFA concentration with significant reductions of ruminal NH_3-N and BUN concentrations, and the latter two values were the highest in goats fed GJ · NH_3 · RS silage. These results confirmed the supposition made on differences in the digestibility between GJ · NaOH · RS and GJ · NH_3 · RS silage. Lower ruminal NH_3-N concentration in goats fed GJ · NaOH · RS silage than in those fed GJ · RS silage suggested improved microbial N uptake with the increased energy supply by the alkali treatment, while higher ruminal VFA concentration on GJ · NaOH · RS silage than on GJ · NH_3 · RS silage suggested the deficiency of N in GJ · NaOH · RS silage for the maximum utilization of the increased energy supply. The ruminal NH_3-N level in goats fed GJ · NaOH · RS silage was higher than 5 mg/dl, the level which has been widely accepted as an optimum NH_3-N in the rumen fluid for maximizing microbial protein production[22]. However, it was also reported that as high ruminal NH_3-N level as 20 mg/dl was necessary for a maximum intake and *in situ* digestibility[15,18]. In our similar experiment using lucerne juice which provided more nitrogen than Italian ryegrass green juice (unpublished results), the digestibilities of RS ensiled with NaOH treated lucerne juice were improved with increase of ruminal NH_3-N and BUN concentrations compared with those obtained in this study, while the other RS silages showed quite similar digestibilities to the present experiment. Although the goats receiving GJ · NH_3 · RS silage had a high ruminal NH_3-N concentration around 50 mg/dl suggesting considerably high initial concentration after feeding, they showed no symptom of ammonia toxicity and were in good health during the experiment. The molar proportion of butyric acid in the rumen was higher in goats fed GJ · NaOH · RS and GJ · NH_3 · RS silages than in those fed other silages. Although viable bacterial population of *Eubacterium* spp., which contributes to the butyric acid production in the rumen, was increased when steers received ammoniated rice straw[19], the major cause of the difference found in the present study was attributable to the different butyric acid content of the silages.

In conclusion, the addition of intact GJ to RS at ensiling improved the chemical quality of the silage but had little effect on improving the nutritive value over W · RS silage supplemented with urea at the time of feeding. The addition of alkali (NaOH or NH_3) treated GJ to RS at ensiling was effective on improving the nutritive value of the silage whereas chemical quality was shifted to a butyrate type fermentation. Compared with NaOH treatment, NH_3 treatment caused better digestibilities and nitrogen balance probably because more nitrogen was provided to the rumen microbes for maximizing digestion and protein production in the rumen.

Acknowledgements

The authors are grateful to Dr. T. Okajima for his helpful advice on statistical analysis and to Mr. T. Nagatamo, Mr. T. Harada, Mr. M. Tsuge and Mr. N. Inagaki for their technical assistances. A part of this study was supported by a Grant-in-Aid for scientific research (B) No. 01480094 from the Ministry of Education, Science and Culture, Japan.

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(Received on September 28, 1990)

イタリアンライグラス（*Lolium multiflorum* LAM.）緑汁液を直接あるいはアルカリ処理後に添加して調製した稲わらサイレージの栄養価

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要約

イタリアンライグラスを破砕および圧搾して得た緑汁液（GJ）を，直接あるいはアルカリ処理後に稲わら3に対して7の割合で混合してポリエチレンバックに詰め込みサイレージを調製した。アルカリ処理は，混合する稲わら乾物当たり4%になるようにNaOHあるいはNH_3をGJに加えて行った。対照として水のみを混合したサイレージを調製した。以上4種類のサイレージとふすまを乾物比で3：1の割合で混合して去勢雄山羊に給与して消化試験を実施した。なお対照サイレージを給与する場合にはふすまとともに尿素を与えてNH_3処理GJ以外のGJ添加に相当する窒素量を補った。

稲わらサイレージの粗蛋白質含量は無処理GJあるいはNaOH処理GJの添加により乾物当たり5.0%から7.9%まで高まり，アンモニア処理GJの添加により25%以上にまで高まった。

水を添加して調製した対照サイレージは乳酸含量が少なく酪酸型の発酵品質を示したのに対し，無処理GJを添加したサイレージは乳酸が多く，酪酸をほとんど含まずpHが低いより優れた発酵品質を示した。これに対してNaOH処理あるいはNH_3処理GJを添加すると，サイレージ中の酪酸含量およびアンモニア態N（% TN）が高まりpHが上昇した。

水添加サイレージおよび無処理GJ添加サイレージの消化率はほとんど変わらなかったが，山羊の窒素保留は後者を給与した場合の方がやや高い傾向を示した。これらに対しNaOH処理GJを添加したサイレージでは繊維の消化率が有意に高く，山羊の尿中への窒素排泄量が減少して保留量が増加し，また第1胃内容液のNH_3-N濃度および血中尿素態窒素（BUN）濃度が低下した。すなわちアルカリ処理によって繊維の利用性が高まり，第1胃内微生物に対してより多くのエネルギーが供給されて微生物体蛋白質の合成が高まったことが示唆された。NH_3処理GJを添加したサイレージは全成分の消化率および山羊の窒素保留量のいずれについてもNaOH処理GJ添加の場合よりもさらに有意に高い結果を示した。これはNaOH処理GJを添加したサイレージを給与した場合に比し，第1胃内微生物に対して繊維の消化および蛋白質合成に十分な窒素源が供給されたためであろう。

キーワード： アルカリ処理，イタリアンライグラス，稲わら，消化性，山羊，緑汁液.

日草誌 37（2）：203-212（1991）