Effect of Slower Nitrogen Releasing Additive on the Quality of Napiergrass (Pennisetum purpureum Schumach.) Silage

Yunus, Muhammad
Laboratory of Animal Feed Science, Division of Animal Science, Department of Animal and Marine Bioresource Science, Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University

Ohba, Noriko
Research Student under the Supervision of Professor Yasuhisa Masuda, School of Agriculture, Kyushu University

Shao, Tao
Laboratory of Animal Feed Science, Division of Animal Science, Department of Animal and Marine Bioresource Science, Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University

Yano, Yasukatsu
Laboratory of Animal Feed Science, Division of Animal Seience, Department of Animal and Marine Bioresource Science, Faculty of Agriculture, Kyushu University

他

https://doi.org/10.5109/24390

出版情報：九州大学大学院農学研究院紀要. 45 (2), pp.415-421, 2001-02-28. Kyushu University
バージョン：

J. Fac. Agr., Kyushu Univ., **45** (2), 415–421 (2001)

Effect of Slower Nitrogen Releasing Additive on the Quality of Napiergrass (*Pennisetum purpureum* Schumach.) Silage

Muhammad Yunus*, Noriko Ohba, Tao Shao*, Yasukatsu Yano, Manabu Tobisa, Masataka Shimojo, Mitsuhiro Furuse and Yasuhisa Masuda*****

Laboratory of Animal Feed Science, Division of Animal Science, Department of Animal and Marine Bioresource Science, Faculty of Agriculture, Kyushu University, Fukuoka 812–8581

(*Received October 30, 2000 and accepted November 10, 2000*)

Urea is commonly used as a feed additive to improve the quantity of nitrogen (N) and digestibility in ruminants. Supplementation of urea increases crude protein but decreases the fermentation quality of silage with increasing pH by releasing ammonia N. Thus, oxalic acid diamide (oxamide, O) and guanyl urea sulfate (GU), N slow–release compounds, were used as additives in the present study. As much as 650 grams of the napiergrass were ensiled into a laboratory silo (1.0 liter polyethylene container). The treatments were: no additive (control), O, O+glucose (OG), GU and GU+glucose (GUG). O and GU were added at the level of 0.23% N on the napiergrass fresh weight basis, and glucose was added at 1%. Silage was incubated for 7, 15, 30 and 60 days at room temperature (28°C). After the silo was opened, pH, contents of dry matter, total nitrogen (TN), volatile basic nitrogen (VBN) and organic acids were determined. Compared with the control, OG, GU and GUG treatments significantly decreased pH value, VBN/TN, acetic acid and butyric acid contents, and significantly increased contents of dry matter, TN and lactic acid after 60 days of fermentation. The length of storage did not affect dry matter, lactic acid and TN contents and VBN/TN. In conclusion, without glucose addition GU may be a good N supplement for silage making of napiergrass, but glucose is necessary to improve fermentation quality when ensiled with O additive.

INTRODUCTION

Silages made from tropical herbage are generally low in quality and do not contain a large quantity of lactic acid, because tropical herbage contains low amount of fermentable sugar (Humphreys, 1991; Wilkinson, 1983). Napiergrass (*Pennisetum purpureum* Schumach.), one of the most common tropical grasses used for ensilage, contains relatively low level of total nitrogen (TN), and low fermentable sugar and in the fresh crop, particularly when harvested at less than 80 days of age (Wilkinson, 1983).

Urea is commonly used as an additive to improve the quantity of nitrogen and digestibility of low quality roughage in ruminants (Acorda *et al.*, 1992; Jayasuriya and Pearce, 1983; Nakashima *et al.*, 1991; Soebarinoto *et al.*, 1997). Urea also increases crude

* Laboratory of Animal Feed Science, Division of Animal Science, Department of Animal and Marine Bioresource Science, Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University

** Research Student under the Supervision of Professor Yasuhisa Masuda, School of Agriculture, Kyushu University

*** Corresponding author (E–mail: ymasuda@agr.kyushu–u.ac.jp)

protein but decreases the fermentation quality of silage by increasing pH value and enhancing clostridial bacteria growth (McDonald *et al.*, 1991; Ohshima and McDonald., 1978; Pancholy *et al.*, 1994). One of the reasons for this phenomenon may be due to the rapid production of ammonia through the urease activity. Thus, the slower nitrogen releasing additive might be expected to increase TN without decreasing quality of silage. We examined the quality of napiergrass silage treated with slower nitrogen releasing additives with or without glucose addition. Oxalic acid diamide (oxamide, O) and guanyl urea sulfate (GU), which are known as slow N release fertilizer compounds containing 32% and 28% N, respectively, were applied to napiergrass silage in the present study.

MATERIALS AND METHODS

Napiergrass forage

Napiergrass (*Pennisetum purpureum* Schumach.) was field grown at the Kyushu University, Hakozaki, Fukuoka, Japan. The initial growth was harvested in August 1998 at about 15 cm above the ground level using a hand sickle. Three nodes were visible on the shoots. The harvested grass was immediately chopped into about 1 cm length. Chopped grasses were immediately collected for dry matter (DM), TN and water soluble carbohydrate (WSC) analysis. The DM content of material was determined by drying in an oven at 60 °C for at least 48 h (AOAC, 1984), TN content was determined by the Kjeldahl method (AOAC, 1984) and WSC content by high performance liquid chromatography (HPLC) system from Shimadzu Corp. (Kyoto Japan) with NH2P–50 column (Shoko. Co., Ltd.). The chopped material contained 21.4% DM, 1.8% TN and 3.8% WSC.

Silage making

Before ensiling, chopped grasses were mixed with additives according to the following treatments: no additives (control, C), O, GU, O+glucose (OG), and GU+glucose (GUG). O and GU were added at the level of 0.23% N (fresh weight basis) and glucose was added at 1% of napiergrass fresh weight, respectively. About 650 g of the material was ensiled, using a stick to crush the material, into a laboratory silo (1.0 liter polyethylene container) followed by incubation for 7, 15, 30 and 60 days at room temperature (28 °C). Three replicates were prepared for each treatment.

Chemical analyses of silage

The dry matter (DM) content of the silage was determined by drying 100 grams sample in an oven at 60 °C for at least 48 h (AOAC, 1984) and corrected with volatile components. A sample of sixty grams of silage was soaked in 120 ml of water and stored at 4 °C for 1 day. The filtrates (silage extracts) were used for determining pH, volatile basic nitrogen (VBN), lactic acid and volatile fatty acids. The pH was measured with a glass electrode pH meter (Horiba Co.). Total nitrogen (TN) was determined by the Kjeldahl method (AOAC, 1984); VBN by steam distillation (AOAC, 1984); lactic acid (LA) by the method of Barker and Summerson (1941), volatile fatty acids were analyzed by gas chromatography (Shimadzu GC–17A with 12 m capillary column, condition: column temperature 100 °C, injection and detector temperatures 250 °C).

The data were analyzed statistically by two–way analysis of variance (ANOVA) using a commercially available package (SAS, 1985).

RESULTS

The pH value and DM content in silage are shown in Fig. 1. The fermentation period within 60 days did not alter pH of the control silage. The GU and OG silages tended to decrease pH during the storage. The pH values in GU, GUG and OG treatments were significantly lower than the control. DM values of silage at all treatments were significantly higher than the control and maintained until 60 days of storage. The GUG and OG additives showed slightly higher DM values than the others after 30 days of storage.

The four additives significantly enhanced TN content than the control, but there were

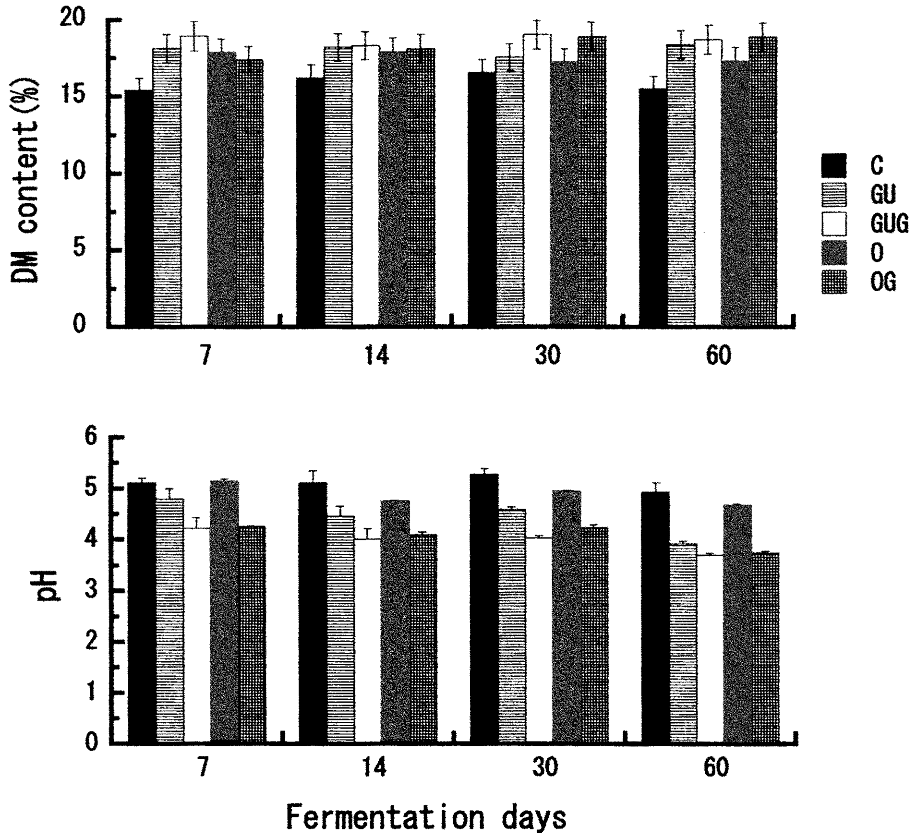

Fig. 1. The effects of slower nitrogen releasing additives and days of fermentation on the pH value and dry matter (DM) content of napiergrass silage. Values are mean±SD (three replicates). C=control (no additive), GU=guanyl urea sulfate, GUG=GU+glucose, O=oxamide and OG=O+glucose.

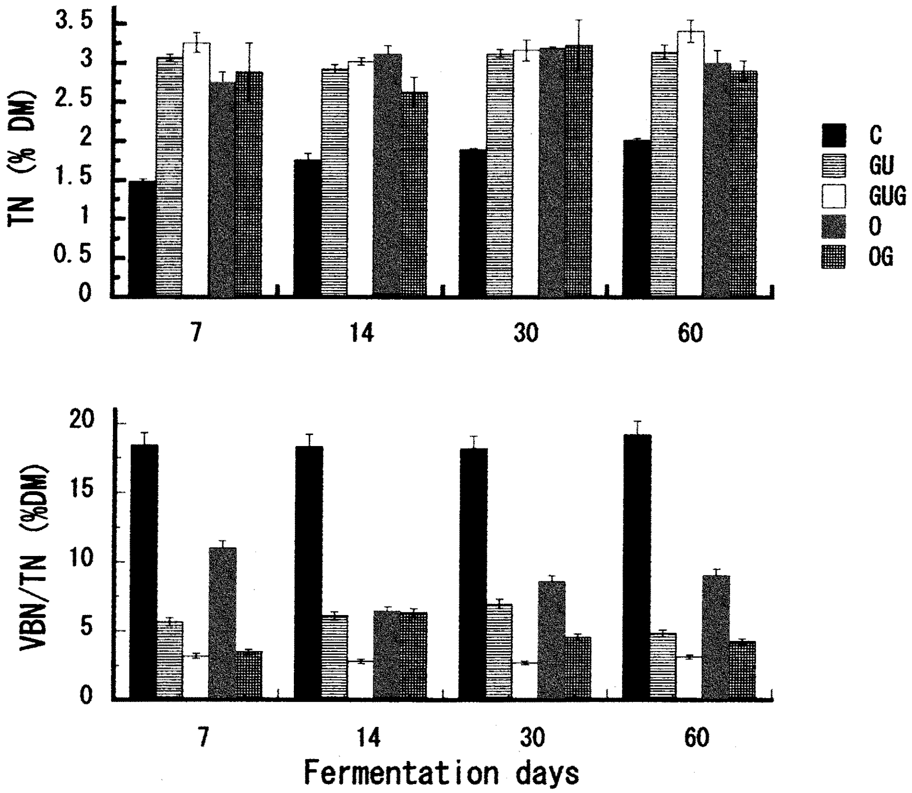

Fig. 2. The effects of slower nitrogen releasing additives and days of fermentation on the total nitrogen (TN) and VBN/TN of napiergrass silage. Values are mean±SD (three replicates). C=control (no additive), GU=guanyl urea sulfate, GUG=GU+glucose, O=oxamide and OG=O+glucose.

no significant differences among four treatments (Fig. 2). The period of storage within 60 days did not change TN values greatly in each treatment. The effect of glucose on this parameter was not consistent in the addition to O and GU.

The VBN/TN after ensiling was affected by additive treatment (Fig. 2). Compared with the control, both N and glucose additives significantly decreased VBN/TN of the silage. In the control, GU and GUG silages, the VBN/TN did not change until 30 days, but there was a slight increase in the control and a slight decrease in GU after 30 days, whereas in GUG almost stable value was shown until 60 days. When the silage was treated with O and OG the fermentation period significantly affected VBN/TN of the silage, showing that there were changes between 7 and 14 days but little changes between 30 and 60 days.

The concentration of lactic acid (LA), acetic acid (AA) and butyric acid (BA) are shown in Fig. 3. There were significant effects of treatments and the storage period on LA production. The LA was produced similarly in the control and O treatment, while LA

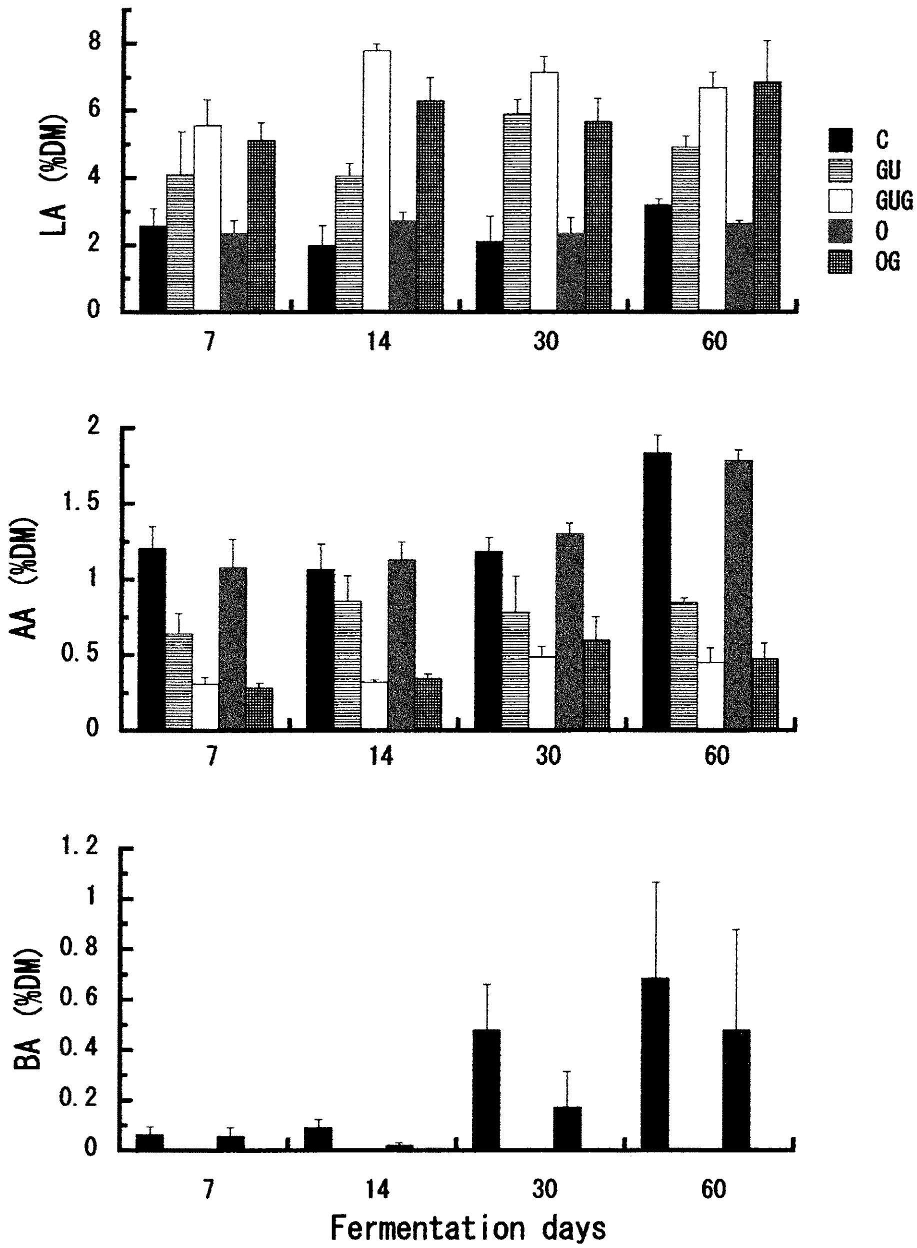

Fig. 3. The effects of slower nitrogen releasing additives and days of fermentation on the lactic acid (LA), acetic acid (AA) and butyric acid (BA) contents of napiergrass silage. Values are mean±SD (three replicates). C=control (no additive), GU=guanyl urea sulfate, GUG=GU+glucose, O=oxamide and OG=O+glucose.

contents in the OG, GU and GUG treatments were significantly higher than the control. The highest value of LA production was found in GUG, and followed by OG, GU and O in the order. The GUG and OG additives were highly effective to increase the amount of LA with similar values at 60 days of storage.

The amount of AA in the silage treated with O showed the tendency similar to the control, but was higher than that of the other three treatments. In the control and O, the amount of AA during 30 days was not changed greatly, but it was significantly increased after 60 days of storage. In the OG treatment there was a slight increase in AA content with reaching the highest value after 30 days followed by a slight decrease. Treating with GU tended to increase AA content between 7 and 14 days and kept it almost constant between 30 and 60 days, whereas GUG showed a slight increase between 14 and 30 days.

In the control, there was a great increase in BA content after 30 and 60 days of storage. The increase in BA content was also observed in the silage treated with O after 30 and 60 days. However, there was little production of BA in the other three treatments.

DISCUSSION

There are five categories of silage additive; fermentation stimulants, fermentation inhibitors, aerobic deterioration inhibitors, nutrients and absorbents (McDonald *et al.*, 1991). Urea or ammonia is one of the silage additives to improve nutrient values (Bolsen *et al.*, 1996; McDonald *et al.*, 1991). Application of urea without sugar might give a higher TN, but increased pH value with the release of ammonia and resulted in the low quality of silage (Pancholy *et al.*, 1994). In the experiment of our laboratory application of urea at the rate of 0.23% N to fresh napiergrass silage gave VBN/TN from 20 to 40% (DM) after 30 days of storage (Yunus *et al.*, 2000). But in the present experiment GU and O additives lowered this parameter from 18.40% (control) to 4.85% (GU) and 8.85% (O) after 60 days of storage. Thus, we conclude that utilization of slower N releaser as a silage additive might be merits to silage fermentation.

It is known that the addition of sugar like glucose to silage crops could increase the supply of substrate for enhancement of the lactic acid bacteria activity (Bolsen *et al.*, 1996; Henderson, 1993), which resulted in high quality silage by increasing LA content and decreasing pH value and consequently inhibition of ammonia release (Davies *et al.*, 1997; Petterson and Lindgren, 1990; Yokota *et al.*, 1992). Good quality silage is standardized as pH value being less than 4.2, and VBN/TN 11% or below, LA between 3 and 13%, and BA less than 0.2% (Catchpoole and Henzell, 1971; McDonald *et al.*, 1991).

According to the results of the present experiment, the application of slower N releasing compounds (O and GU) to napiergrass silage improved quality until 60 days of storage with or without glucose addition, except for O only. Slower N releasing additives increased nutrients quality and would not promote ammonia releasing activity of napiergrass silage. It is necessary, therefore, to conduct a future experiment measuring the digestibility and feed intake in animals in order to establish practical silage making with these slow N releasing additives.

REFERENCES

AOAC 1984 Official Methods of Analysis. Association of Official and Analytical Chemists 14th ed.

Arlington, Virginia – 22201

Acorda, J. A., M. Okamoto and N. Yoshida 1992 Upgrading of processed rice straw for feeding. *J. Japan. Grassl. Sci.*, **37**: 405–411

Barker, S. B. and W. H. Summerson 1941 The colorimetric determination of lactic acid in biological material. *J. Biol. Chem.*, **138**: 535–554

Bolsen, K. K., G. Ashbell and Z. G. Weinberg 1996 Review. Silage fermentation and silage additive. *Asian-Aus. J. Anim. Sci.*, **9**: 483–493

Catchpoole, V. R. and E. F. Henzell 1971 Silage and silage making from tropical herbage species. *Herb. Abstr.*, **41**: 213–219

Davies, D. R., R. J. Merry, A. P. Williams, E. L. Bakewell, D. K. Leemans and J. K. S. Tweed 1997 Proteolysis during ensilage of forages varying in soluble sugar content. *J. Dairy Sci.*, **81**: 444–453

Henderson, N. 1993 Review. Silage additives. *Anim. Feed Sci. Technol.* **45**: 35–56

Humphreys, L. R. 1991 Tropical Pasture Utilisation. Cambridge University Press., Cambridge., pp.143–148

Jayasuriya, M. C. N. and G. R. Pearce 1983 The effect of urease enzyme on treatment time and the nutritive value of straw treated with ammonia as urea. *Anim. Feed Sci. Technol.*, **8**: 271–281

McDonald, P., A. R. Hunderson and S. J. E. Heron 1991 The Biochemistry of Silage. 2nd ed. Cambrian Printers Ltd., Aberystwyth, pp. 184–236

Nakashima, Y., K. Ambo, K. Yamada and T. Matuura 1991 Rumen degradation characteristic of rice straw treated with urea and ammonia. *J. Japan. Grassl. Sci.*, **36**: 416–425

Ohshima, M. and P. McDonald 1978 A review of the changes in nitrogenous compound of herbage during ensilage. *J. Sci. Food Agric.*, **29**: 497–505

Pancholy, R., P. C. Mali and D. Mathur 1994 Effect of urea-molasses and lactic culture on silage fermentation of *Cenchrus ciliaris*. *Annal Arid Zone.*, **33**: 147–150

Pettersson, L. L. and S. Lindgren 1990 The influence of the carbohydrate fraction and additives on silage quality. *Grassl. Forage Sci.*, **45**: 223–233

SAS. 1985 SAS User's Guide: Statistics (SAS Institute, Cary).

Soebarinoto, S., Chuzaimi, J. V. Bruchem, Hartutik and Mashudi 1997 The nutritive value of rice straw in relation to variety, urea treatment, location of growth and season, and its prediction from in sacco degradability. *Asian-Aus. J. Anim. Sci.*, **10**: 215–222

Yokota, H., J. H. Kim, T. Okajima and M. Ohshima 1992 Nutritional quality of wilted napiergrass (*Pennisetum purpureum* Schum.) ensiled with or without molasses. *Asian-Aus. J. Anim. Sci.*, **5**: 673–679

Yunus, M., N. Ohba, M. Shimojo, M. Furuse and Y. Masuda 2000 Effects of adding urea and molasses on napiergrass silage quality. *Asian-Aus. J. Anim. Sci.*, **13**: 1542–1547

Wilkinson, J. M 1983 Silage make from tropical and temperate crops. *World Anim. Rev.*, **45**: 36–40