

Dried Poultry Manure as Non-Protein Nitrogen Additive of Napier Grass (*Pennisetum purpureum* Schumach) Silage Fed to Sheep

Clarita Ecleo Morbos¹, Sulpecio C. Bantugan² and Lolito C. Bestil^{2*}

ABSTRACT

The study was conducted to describe the physical characteristics of napier grass silage added with dried poultry manure (DPM) as non-protein N source, and to assess its acceptability and digestibility in sheep. Three types of silages were evaluated: T1 - napier grass alone, T2 - napier grass + DPM (at a ratio containing 10% crude protein), and T3 - napier grass + DPM (at a ratio containing 12% crude protein). These were stored in airtight plastic drum silos for 45 days at room temperature. After evaluation, the silages were tested with 9 male growing sheep for intake and digestibility measurements arranged in completely random fashion.

Physical evaluation in terms of color, smell, and texture of the 3 silages showed no significant differences, and all showed good quality silage characteristics. However, significantly higher pH level ($p < 0.05$) approaching normal rumen pH was observed in silages containing DPM (T2 and T3) compared to that without (T1). Chemical analysis showed significantly higher dry matter (DM) and crude protein (CP) contents in T2 and T3 silages than in T1. The OM content, however, was significantly reduced with the addition of DPM (T2 and T3) than without (T1) while acid detergent fiber (ADF) and neutral detergent fiber (NDF) contents showed no significant differences. Nutrient intakes significantly increased with silages containing DPM (T2 and T3) while increases in nutrient digestibility by sheep for the 3 silages showed no significant differences in all parameters measured. The addition of DPM to napier grass silage to contain 10 to 12% CP is recommended to increase CP and DM contents and improve nutrient intakes without affecting nutrient digestibility.

Keywords: Napier grass silage, dried poultry manure additive, intake and digestibility

¹ Department of Agriculture, College of Agriculture and Allied Sciences, Eastern Samar State University-Salcedo Campus, Salcedo, Eastern Samar.

² Department of Animal Science, College of Agriculture and Food Sciences, Visayas State University, Visca, Baybay City, Leyte.

*Corresponding Author. Address: Department of Animal Science, College of Agriculture and Food Science, Visayas State University, Baybay City, Leyte 6521 - A Philippines. E-mail: litobestil@vsu.edu.ph
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INTRODUCTION

Ensiling is the process of conserving forages, crop residues such as corn stover, sugarcane tops, or ramie tops, as well as banana and pineapple peelings with sufficient moisture through anaerobic fermentation (Tacio 1994). This method of conservation retains about 85% or more of the nutritive value of the grass (Ensminger 1978). According to Oldfield (1972), ensiling does not only conserve the nutritive value of the forage crops but can also result in biochemical changes that enhance the availability of nutrients. The silage produced is a better source of protein and of certain vitamins, especially carotene, and perhaps some of the unknown nutritive factors than dried forages. The biggest advantage of processing the feed into silage is that excess growth of forages beyond what the animal population needs during the rainy season, a period of lush vegetation, can be gathered and stored, and then fed to livestock during the dry season when supply of grasses is scanty. By producing silage, a farmer could stabilize feed supply on-farm and abundantly feed his livestock year-round.

Maize, sorghum, pearl millet, oats, *Brachiaria* species, and napier grass (*Pennisetum purpureum* Shumach) are ideal silage crops because of their high soluble carbohydrates which tend to produce a silage high in energy content (Ranjhan 1993). These crops, however, contain low protein or nitrogen (McDonald 1996) and the silage produced will be deficient in protein as well. For example, corn silage contains about 8.3% crude protein on dry matter basis which is far from the 12% crude protein requirement of growing and finishing cattle (Ensminger 1978). Consequently, when grass silage is used as basal diet, it would require supplementation of protein nitrogen (eg, soybean meal) or non-protein nitrogen (eg, urea) sources that provide ammonia (NH₃) needed for rumen microbial protein synthesis to optimize weight gain in growing and fattening cattle.

Meeting the protein needs of the ruminant livestock fed silage can also be achieved by adding urea into the silage mass to supply NH₃ for the growth of the fermenting bacteria and, consequently, produce good quality high-protein silage. While urea is locally available, its use as silage additive has been restricted by its price. This prompted silage producers to utilize poultry manure which, not only increases the crude protein content of the silage but may also serve as buffer to prevent too much drop in the pH of the silage mass (Zamora 1991). Using Napier grass as silage material which lacks soluble carbohydrates as substrate for microbial fermentation in the production of good quality silage, in comparison to grain-producing cereal crops, the use of dried poultry manure as non-protein nitrogen (NPN) additive warrants testing.

The study was conducted to assess the physical attributes of Napier grass silage added with dried poultry manure as non-protein nitrogen additive and determine the acceptability and digestibility of the Napier grass silage added with dried poultry manure as non-protein nitrogen additive in sheep.

MATERIALS AND METHODS

Preparation of silage materials

A stand of napier grass about 45 days old from the last cutting was harvested, collected, and chopped to about two cm long. The chopped napier grass was wilted

to contain approximately 30-35% dry matter.

Fresh broiler manure collected after end of production period or about 2-3 weeks old (a mixture of manure defecated after brooding period of two weeks until harvest at 30-35 days) from a commercial farm in Baybay, Leyte, Philippines was used in this study as NPN additive to supply NH_3 needed by fermenting bacteria. The manure was sun-dried for 24 hours and was ground before mixing with the chopped and wilted napier grass.

Treatments and Experimental Setup

The mixtures of napier grass and dried poultry manure for silage-making corresponded to the following treatments: T_1 – Napier grass alone (control), T_2 – Napier grass + chicken manure (containing 10% CP), and T_3 – Napier grass + chicken manure (containing 12% CP). Each treatment was replicated three times and arranged in completely random fashion.

Silage making

The proportion of chopped napier grass and dried poultry manure in the silage mass was computed to contain 10% and 12% crude protein (CP) levels using Pearson Square method based on 8.0% CP and 30.5% CP contents of napier grass and chicken manure, respectively. The mixtures, corresponding to the different treatments, were ensiled in 35-kg capacity plastic drum silos. The silage materials were then poured into the plastic drum silos and packed adequately with pressure to remove as much oxygen as possible and achieve anaerobic conditions, and the filled-up silos were then sealed with plastic cover and tied with rubber band to prevent entry of air. The silage materials were then stored and were allowed to ferment anaerobically for 45 days at room temperature before harvest.

Silage Evaluation

After 45 days, each treatment-silage was evaluated for physical attributes such as color, smell, and texture, including pH level. Then, a representative sample for each treatment-silage was collected and analyzed for dry matter (DM), organic matter (OM), crude protein (CP), neutral detergent fiber (NDF), and acid detergent fiber (ADF) contents.

Intake and Digestibility Trial

Prior to the start of the intake and digestibility trial, the metabolism cages, equipped with feeding and watering troughs, and the surrounding area were cleaned. Nine male crossbreed sheep (Suffolk x Philippine Native) aging about 6 to 7 months were dewormed, weighed, and fitted with harness for the collection of feces. They were placed individually inside the metabolism cages and were randomly assigned to the three dietary treatment-silages. The young rams were fed twice daily at 8am and at 4pm, while drinking water was made available at all times.

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The digestibility trial was conducted based on the following schedule:

Day 1-7 Adjustment/adaptation period. Experimental sheep were given the daily amount of silage with 20% allowance based on previous day's voluntary intake so as to determine *ad libitum* intake where diurnal variations become minimal. Initial weight of the experimental sheep was also determined.

Day 8-9 Feed (silage) offered was set at 90% of *ad libitum* to ensure that both leaves and stems are eaten and digestibility values are not biased on the leafy portion of the forage made into silage.

Day 10-14 Collection/sampling period. In addition to recording of silage intake levels, total fecal output was also measured. Then samples of feces, and silage offered and refused, were collected in plastic bags and stored in the freezer for subsequent analyses.

Experimental sheep were also given a mixture of salt and dicalcium phosphate (1 kg NaCl:100g dicaphos) at approximately one teaspoon/head at every feeding time (morning and afternoon).

The daily fecal samples collected were pooled together for each sheep, and approximately 25-gram sub-samples were taken and oven-dried at 55°C for 72 hours, then ground to pass the 1mm screen in a Wiley mill. These were then analyzed for DM, OM and CP contents following the standard procedures of AOAC (1990) and for fiber constituents (NDF and ADF) following the procedures of Goering and Van Soest (1970).

Data Gathered and Analysis

1. Physical attributes of the silages (color, smell, and texture)

Scores for physical quality attributes were based on the points system of Huang (1966) as cited by Bestil et al (1998) presented in Table 1.

Table 1. Description and allotment of points for silage quality evaluation

Character	Description	Points
Color	Forage remain in original color, or green leaves turn greenish yellow	30
	Green leaves lose green color	25
	Leaves turn brown in color	15
	Leaves turn black	Off grade (not advisable for feeding)
Smell	With alcohol smell	30
	No alcohol smell but pleasant acid	25
	With stink acid smell	15
	Very weak acid smell (incomplete fermentation)	10
	Bad smell (ammonia, rot)	Off grade
Texture	When released from the palm will separate to a loosen texture	10
	Moist but cannot squeeze moisture from the sample	7
	Material more or less in paste form	5

2. Silage pH - This was measured using pH meter.

3. Dry Matter content (%)

$$\% \text{ Dry matter} = \frac{\text{Dry sample weight}}{\text{Fresh sample weight}} \times 100$$

4. Organic Matter content (%)

This was obtained by first burning the samples in the furnace set at 600°C for 3 hours and calculating the percent ash, and the percent organic matter was computed as follows:

$$\% \text{ OM} = 100 - \% \text{ Ash}$$

$$\text{Where: } \% \text{ Ash} = \frac{\text{Ash weight}}{\text{Dry sample weight}} \times 100$$

5. Crude Protein content (%)

The percent nitrogen was determined in the micro-Kjeldahl setup, and the percent CP was calculated as follows:

$$\% \text{ CP} = \% \text{ N} \times 6.25$$

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6. Acid Detergent Fiber content (%)

$$\% \text{ADF} = \frac{\text{Acid detergent residue}}{\text{Oven dry sample weight}} \times 100$$

7. Neutral Detergent Fiber content (%)

$$\% \text{ADF} = \frac{\text{Neutral detergent residue}}{\text{Oven dry sample weight}} \times 100$$

8. Dry Matter Intake (DMI)

$$\text{DMI, grams} = \text{As-fed intake (g)} \times \% \text{ DM of silage}$$

$$\text{where: As-fed intake} = \text{Amount given (g)} - \text{Amount refused (g)}$$

DMI was also expressed as % of body weight to eliminate the effects of the differences in body size on voluntary intake of sheep. The formula used was:

$$\text{DMI, \% BW} = \frac{\text{Dry matter intake, grams}}{\text{Body weight}} \times 100$$

9. Intakes of other nutrients (OM, CP, ADF, NDF)

$$\text{Nutrient intake} = \text{DMI (g)} \times \% \text{ Nutrient in feed}$$

10. Nutrient Digestibility (DM, OM, CP, NDF, ADF)

Digestion coefficient for each nutrient was calculated using the following formula:

$$\% \text{ Nutrient Digestibility} = \frac{\text{Nutrient intake} - \text{Nutrient excreted}}{\text{Nutrient intake}} \times 100$$

$$\text{where: Nutrient excreted (g)} = \text{DM excreted (g)} \times \% \text{ Nutrient in feces}$$

$$\text{DM excreted (g)} = \text{Fecal output (g)} \times \% \text{ DM of feces}$$

The quality attributes of the silages were analyzed by using Kruskal–Wallis Test, while pH, nutrient contents, and intake and digestibility measurements were analyzed using one-way analysis of variance. Comparison of treatment means was done using the Least Significant Difference test.

RESULTS AND DISCUSSION

Physical Quality and pH of Silages

Table 2 presents the physical attributes and pH of silages containing different levels of dried broiler manure. Results showed no significant differences in the mean scores for color, smell, and texture among silages tested. Though

differences were not significant, the scores for silage quality indicated that the resulting silages added with dried poultry manure (DPM) were of good quality, not even significantly affecting the smell. The pH values of silages significantly differed among treatments; silages containing DPM had significantly higher pH values than without. In addition, pH increased as the level of DPM inclusion increased.

The results coincided with the findings of (Trung et al 1985) wherein high pH values (5.8 - 6.9) were obtained in silages containing higher levels of chicken wastes. High pH values of silages containing higher proportion of broiler manure could be due to the greater amounts of NH_3 (being an alkali) released from the breakdown of urea in the manure. Furthermore, the subsequent formation of ammonium compounds that are formed during ensilage can partially neutralize organic acids and consequently reduce acidity (Grotheer et al 1990, Hadjipanayiotou 1984, Moriba et al 1982, as cited by Trung 1988).

Table 2. Physical attributes and pH of Napier grass silages with or without dried poultry manure.

Treatments	Point Score			pH
	Color	Smell	Texture	
T1 – Napier alone (8% CP)	30.00	30.00	10.00	4.94 ^c
T2 – Napier + DPM (10% CP)	28.33	26.67	9.00	5.55 ^b
T3 – Napier + DPM (12% CP)	28.33	26.67	8.00	5.92 ^a
Kruskall - Wallis Test at $\alpha = 5\%$	1.143 ^{ns}	3.200 ^{ns}	2.667 ^{ns}	0.000043 ^{**}

Means within a column of dissimilar letter-superscripts are significantly different. ^{ns} not significant (Kruskall-Wallis test); ^{**} highly significant (ANOVA F-test)

Nutrient Composition of the Silages

The nutrient composition of the silages with and without DPM is shown in Table 3. There were significant differences in the DM, OM, and CP contents of treatment-silages. DM and CP contents were significantly higher in DPM-containing silages (T2 and T3) than without (T1), with the silage containing higher amount of DPM (T3) consistently higher than T2. However, OM was significantly lower in silages with DPM (T2 and T3) than without (T1), indicating higher contamination of soil rich in ash or minerals in the broiler manure used. It appeared that DPM can be a good additive for the silage to achieve higher CP content and optimum DM content of 30-35%. Interestingly, the addition of DPM had no significant effects on NDF and ADF contents of the silage, indicating that DPM is less fibrous and does not limit the silage digestibility.

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Table 3. Nutritive characteristics of napier grass silage with or without dried poultry manure

Treatments	% DM	% CP	%OM	% ADF	% NDF
T1 – Napier alone (8% CP)	17.07 ^c	5.58 ^b	63.57 ^a	22.33	57.01
T2 – Napier + DPM (10% CP)	20.80 ^b	7.81 ^a	51.68 ^b	25.78	58.31
T3 – Napier + DPM (12% CP)	24.90 ^a	8.67 ^a	48.48 ^b	21.36	58.39
p-value	0.0007	0.0037	0.0001	0.3886	0.4805

Means within a column of similar letter-superscripts are not significantly different ($p < 0.05$)

The findings of Lavezzo (1993), as cited by FAO (2000), that poultry manure can be used to increase the CP and DM contents of the silage, provide support to the results of this study. The relatively high OM content in Napier-alone silage (T1) can be attributed to the low ash/inorganic content of Napier grass as in the findings of Bakrie et al (1996). Conversely, the lower OM contents in T2 and T3 silages could be due to the high ash content of the poultry manure especially when dropped directly into the soil as found by Bhattacharaya and Fontenot (1986) and Muller (1982).

Voluntary Feed Intake of Silages

Results on the nutrient intake as a measure of the nutritive value of the three silages tested are shown in Table 4. There was an increasing DMI in silages containing DPM, and the highest was with T3, even significantly higher than in T1. A similar pattern of differences was observed when voluntary DMI was expressed as percent of body weight as that of grams DMI, and both silages containing DPM (T2 and T3) had significantly higher values than T1; the highest was with T3 group. Though DPM-containing silages had higher values of DMI, such levels, however, did not meet the daily DMI requirement of approximately 3% of the body weight of sheep (NRC 1975).

Table 4. Daily Voluntary feed DM and nutrient intakes of napier grass silage with or without DPM

Treatments	Ave. BW (kg)	DM Intake		CP Intake (g)	OM Intake (g)	ADF Intake (g)	NDF Intake (g)
		(g)	(% BW)				
T1 – Napier alone (8% CP)	16.65	196 ^b	1.17 ^c	109 ^c	125	44 ^b	112 ^b
T2 – Napier + DPM (10% CP)	18.93	283 ^{ab}	1.49 ^b	221 ^b	146	73 ^{ab}	165 ^{ab}
T3 – Napier + DPM (12% CP)	18.08	402 ^a	2.22 ^a	348 ^a	195	86 ^a	235 ^a
p-value		0.0298	0.0186	0.0048	0.1407	0.0351	0.0264

Means in a column with the same letter superscripts are not significantly different; LSD Test $\alpha = 5\%$.

Looking at differences in voluntary intakes of CP, OM, ADF, and NDF, the pattern showed similarity as that of DMI where silages containing DPM, especially T3, had significantly higher values than without (T1), except for OM intake. The slight increases in OM intakes of T2 and T3 silages even with their significantly higher DMI levels could be due to the high ash or reduced OM contents of DPM-containing silages. As NDF and ADF contents of the different silages did not differ widely, the significant differences in the intake of NDF and ADF of the different treatment silages could be mainly due to differences in DMI levels, while the significantly higher CP intake of DPM-containing silages, especially in T3 group, could be due to the higher CP content of this silage.

Voluntary intake of nutrients of DPM-containing napier grass silage appeared to increase significantly when the level of poultry manure meets the minimum required nitrogen or protein content (Hume et al 1970, as cited by Bestil 1985). The findings of Trung et al (1985) also provided support when they found that voluntary DMI was significantly higher with rations containing DPM compared to the control. These results also conformed with the findings of Harmon et al (1975) who found that DM intake by sheep of maize silage with 15 or 30% poultry litter (DM basis) was higher than that of maize alone or with 0.5% urea. Therefore, the addition of broiler manure does not affect the acceptability and even improves dry matter and nutrient intakes of the napier grass silage.

Nutrient Digestibility of the Silages

Presented in Table 5 is the digestibility of nutrients in napier grass silages with or without DPM. As shown in Table 5, no significant differences in the digestibility of nutrients among silages were found. While the digestibility of DM, NDF, and ADF tended to decline with increasing levels of DPM addition in the napier grass silage (T2 and T3), that of CP and OM tended to increase, showing that poultry manure does not affect the digestibility of these nutrients.

The digestibility of a particular feedstuff usually declines when voluntary intake increases beyond the optimum rumen load as a consequence of a faster rate of passage or reduced exposure time to rumen microflora (Egan et al 1985). The results, however, showed that the increased voluntary intake of DPM-containing silages (Table 4) did not reduce the digestibility of the diet, indicating high acceptability that satisfies the optimum rumen DM load and the balance between rumen microflora and substrate.

Table 5. Digestibility of nutrients in napier grass silage with or without dried poultry manure

Treatment	Digestibility (%)				
	DM	CP	OM	ADF	NDF
T1 – Napier alone (8% CP)	79.95	50.97	51.64	30.88	72.93
T2 – Napier + DPM (10% CP)	77.21	54.50	53.75	29.64	68.89
T3 – Napier + DPM (12% CP)	73.11	60.41	56.20	26.12	60.59
p-value	0.2505	0.3045	0.8638	0.9276	0.3302

CONCLUSION

Napier grass silage added with dried poultry manure (DPM) shows the characteristic color, smell, texture, and pH typical of good quality silage. While the silage produced contains low organic matter especially that which contains higher DPM level (calculated to contain 12% CP), the addition of DPM as a source of non-protein nitrogen (NPN) increases the dry matter and crude protein contents, including minerals, of the silage produced, and consequently increases the overall intake of nutrients without significantly affecting digestibility. The increasing trend in OM and CP digestibility of DPM-containing napier grass silages may even outweigh the reduction in the OM content of such silages.

RECOMMENDATION

The addition of DPM to napier grass during silage production to contain up to 10 to 12% crude protein (CP) is recommended to increase CP and dry matter (DM) contents and nutrient intakes without affecting nutrient digestibility. However, DPM addition to contain 12% CP is highly recommended as DM and CP intakes of the silage produced are significantly increased at this level. The lack of significant improvement in nutrient digestibility even with improvements in nutrient contents and intakes calls for further studies of producing napier grass silage added not only with DPM but also a source of carbon (C) chain (eg, molasses) as C:N ratio is very critical in the fermentation reaction during silage production.

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