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Nutritive Value and the Quality of Ensiled Napier Grass (*Pennisetum Purpureum* Schum.*)* and Banana (*Musa Acuminata)* Peelings

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Abstract. This paper aimed to evaluate the nutritive value and the quality of ensiled Napier grass (*Pennisetum purpureum* Schum) and banana (*Musa acuminate*) peelings. Different levels of banana peeling and Napier grass used in this study were as follows: 100% Napier Grass (NG), 75%NG + 25% Banana Peeling (BP), 50%NG + 50%BP, 25%NG + 75%BP and 100%BP. Napier grass and banana peeling were mixed, weighed and placed into empty jam bottle with weights ranging from 64.4 grams to 509.2 grams as a simulated laboratory silo. Physically, the color of silage were light yellow with a little greenish color for 100% napier grass, light to moderately yellow for the three combinations of napier and banana peel and yellow for 100% banana peel. Texture ranged from dry and coarse for napier grass, relatively dry for the combinations and moderately wet for the banana peel. The napier grass had a slightly acidic smell, the combinations had slightly sweet, acidic smell while the 100% banana peel had a sweeter, acidic smell. Likewise, pH before ensiling had ranged from 5.7 (25%NG + 75%BP) to 7.5 (100% BP) while after ensiling the pH changed from 4.575 (100% napier grass) to 5.75 (100% banana peel). There were significant differences on DM, Moisture, CP, EE, CF, and Ash before ensiling. Similar trend was observed after ensiling except the ash content of all the treatments. ADF and NDF did not show significant variations in all treatments. IVDMD and IVOMD before ensiling varied significantly, but after ensiling only IVDMD of the treatments differed significantly. In terms of physical attributes, nutritive value and digestibility, banana peel can be used as silage material. All treatments generated comparable acceptability when fed to the animal.
Key words: Napier grass, banana peelings, silage, quality

Abstrak. Tulisan ini bertujuan untuk mengevaluasi nilai gizi dan kualitas silase rumput gajah (*Pennisetum purpureum Schum*) dan kulit pisang (*Musa acuminata*). Perbandingan rumput gajah dan kulit pisang yang digunakan dalam penelitian ini bervariasi: Rumput Gajah 100% (RG), 75% (RG) + 25% Kulit Pisag (KP), 50% RG + 50% KP, 25% RG + 75% KP dan 100% KP. Rumput gajah dan kulit pisang dicampur berdasarkan kombinasi persentase perlakuan, ditimbang dan dimasukkan ke dalam botol selai kosong dengan berat mulai dari 64,4 gram sampai 509,2 gram sebagai laboratorium simulasi silo. Secara fisik, silase berwarna kuning muda dan sedikit kehijauan untuk rumput gajah 100%, ringan sampai agak kuning untuk tiga kombinasi rumput gajah dan kulit pisang dan kuning untuk kulit pisang 100%. Tekstur berkisar dari kering dan kasar untuk rumput gajah, relatif kering untuk kombinasi rumput gajah dan kulit pisang dan cukup basah untuk kulit pisang. Rumput gajah memiliki aroma yang sedikit asam, kombinasi rumput gajah dan kulit pisang sedikit manis dan berbau asam, sementara kulit pisang berbau manis dan asam. Demikian pula, pH sebelum proses silase berkisar antara 5,7 (25% RG + 75% KP) sampai 7,5 (100% KP) sedangkan setelah proses silase, pH berubah dari 4,575 (100% RG) menjadi 5,75 (100% KP). Ada perbedaan yang signifikan pada Bahan Kering, Kelembaban, Protein Kasar, Ekstrak Ether, Serat Kasar, dan Abu sebelum proses silase. Kecenderungan serupa diamati setelah proses silase kecuali kandungan abu dari semua perlakuan. ADF dan NDF tidak menunjukkan variasi yang signifikan dalam semua perlakuan. IVDMD dan IVOMD sebelum proses silase bervariasi secara signifikan, namun setelah proses silasi, hanya perlakuan IVDMD yang berbeda secara signifikan. Berdasarkan atribut fisik, nilai gizi dan kecernaan, kulit pisang bisa digunakan sebagai bahan silase. Semua perlakuan sama dikonsumsi saat diberikan pada ternak.
Kata kunci: Rumput gajah, kulit pisang, silase, kualitas

Introduction

Silage can be made from many different crops and may be a more manageable product than hay. Silage is naturally preserved by lactic acid fermentation of sugars by bacteria after the forage has been wilted and stored to exclude air. The main goal of silage making is to preserve as much of the nutritional value of the original crop as possible. The objective of silage preservation is conversion of moist, chopped forage with a short storage life to preserved silage that can be fed to livestock as needed. Yokota et al., (1994) stated that silage making is a method of forage preservation for animal production. According to Yokota et al., (1994) silage from a number of tropical herbage plants was stable against anaerobic decomposition, but its chemical characteristics were different from lactate-type silages of temperate forage.

Tropical grass biomass increases with maturity, but decreases in nutritive value. To overcome this problem these grasses are frequently ensiled at an early growing stage. However, young plants have a high moisture content, high buffering capacity and a low-level of soluble carbohydrates. Woolford (1984) explained that these factors have a negative influence on the fermentation process, preventing a rapid lowering of the pH and thus allowing unwanted secondary fermentation, consequently damaging the quality of the final product.

Banana is a large herbaceous plant and the fruit is a berry and protected by a cover known as peel. Banana peelings are abundant as waste materials that create negative impact to the environment if not properly disposed (Sabutan, 1996). Trunk, leaf and peelings are usually used for animal feed (Karto, 1995). Banana peelings are also used in various food and non-food applications serving as thickening agent, coloring and flavor, alternative source for macro and micronutrients, nutraceuticals, natural fibers, and sources of natural bioactive compounds and bio-fertilizers (Padam et al., 2014). In terms of pharmacological relevance, banana peel is known by its local and traditional use to promote wound healing mainly from burns and to help overcome or prevent a substantial number of illnesses, as depression (Paraeira & Maraschin, 2015).

Subramanian et al., (1998) reported that banana peel rich in polysaccharides thus they could be easily digested. Forty percent of fresh banana peel mixed with 10% of King Grass increased a body weight of PO cows (Wina, 2001). A solution to provide feed for animals by utilizing banana peelings through the silage making is important to reduce the environmental problems. It was considered as agricultural waste which almost all of the banana's parts could be used ad animal feed.

Silage additives include feedstuffs, urea, ammonia, inoculants and acids are available used for different reasons. Additives are used to improve nutrient composition of silage, to reduce storage losses by promoting rapid fermentation, to reduce fermentation losses by limiting extent of fermentation, and to improve bunk life of silage (increase aerobic stability). In other words, the reason for applying an additive was to prevent secondary fermentation and butyric acid silage.

Bolsen et al., (1996), categorized silage additives into fermentation inhibitors, fermentation stimulants and substrate or nutrient sources. Molasses, which included in substrate sources, has been used as a silage additive for many years. Molasses, unlike grain, provides fermentable carbohydrate; therefore, molasses addition can improve the fermentation of some hay crop forages. Other research also found that the applying of molasses improved fermentative quality, feed intake and digestibility of Napier grass (Bureenok et al., 2012).

There is an opinion that Napier grass ensiled without the additive was low in lactic acid and high in pH value, ammonia, nitrogen and VFA (Yokota *et al*., 1996). In summer session, fermentation quality of Napier grass was improved by the input of additives with the highest quality in lactic acid bacteria and Acremonium cellulose (LAB + AC) resulting in low pH and sum of the butyric, caproic and valeric acid (Fukugawa et al., 2016). It was also proved that the ensiling quality structural and nonstructural carbohydrate and enzymatic digestibility (ED) value of mature Napier grass silage improved through additives (Desta et al., 2016).

Assuming that the above problems are the main limitations to the ensilage of Napier grass, research was undertaken with the objective to find practical solutions to enable the production of good quality silage from the Napier grass. The experiment was designed to test the hypothesis and to evaluate the effects of banana peeling as of sugar sources that could replace the function of molasses which can increases the fermentable sugar content in silage. This study also wanted to probe at what level banana peeling will take the function of molasses as sugar source.

The study was conducted to evaluate the use of banana peeling as a feed material along with Napier grass in silage form, and particularly aimed to: (1) evaluate the physical characteristics of the different levels of banana peeling and Napier grass in silage form; (2) identify the nutritive value of the different levels of banana peeling and Napier grass in fresh and silage forms, and (3) measure the pH, ADF, NDF, IVDMD and IVOMD of the different levels of banana peeling and Napier grass in fresh and silage forms.

Materials and Methods

Ensiling Material

The study is carried out to produce silages by using banana peelings and Napier grass as forage materials. An approximately two-months-old Napier grass (*Pennisetum purpureum* Schum.) from Dairy Training and Research Institute (DTRI) pasture at Los Baños, and fresh, ripe banana peelings from banana cue vendors at San Pablo were used as the materials of silage.

Treatments

Different levels of banana peeling and Napier grass were used in this study. The levels of Napier grass and banana peeling compared as treatments with four replications were as follows: 100% Napier Grass (NG), 75% (NG) + 25% Banana Peeling (BP), 50%NG + 50%BP, 25%NG + 75% BP and 100%BP.

Ensiling procedure

The forage materials were chopped into about 2 cm lengths. After chopping, Napier grass and banana peeling were mixed based on the percentage combination as treatments, weighed and placed into empty jam bottle with weights ranging from 64.4 grams to 509.2 grams as a simulated laboratory silo. All bottle silos were properly packed with the forage materials and closed as airtight as possible, sealed with masking tape. Samples were stored in eight weeks at the DTRI Forage Laboratory.

Physical and chemical analyses

Samples were taken at the time of silo filling and after ensiling and subjected to physical and proximate analyses. Physical evaluation of the ensiled materials after about 1½ months was made to characterize the smell/odor, texture, color and percent spoilage Samples in different weights were oven and sun-dried to determine the dry matter and moisture contents.

The remaining ensiled samples from each treatment were dried at 70°C up to constant dry weight. Dried samples were ground 40 mesh and subsequently analyzed for dry matter, ash, crude protein (CP), crude fiber (CF) following the AOAC (2005). Silage pH was measured using a digital pH meter. Concentration of neutral detergent fiber (NDF) was determined according to Van Soest and Wine (1967). Acid detergent fiber (ADF) was analyzed using Van Soest (1963). In vitro dry matter and organic matter digestibility were determined following the procedure of Tilley and Terry (1963).

Proximate analyses were done at Animal Nutrition Laboratory Institute of Animal Science while ADF, NDF, IVDMD, and IVOMD were done at the Animal Nutrition Division Laboratory at Dairy Training and Research Institute, UP Los Baños.

Statistical Analyses

Results of the physical and chemical analysis of dry matter (DM), crude protein (CP), crude fiber (CF), ash, in vitro dry matter digestibility (IVOMD) of the ensiled forage materials were statistically analyzed using a one way classification analyses of variance (ANOVA) in a completely randomized design (CRD) with five (5) treatments and four (4) replications.

The same statistical tool was used in comparing differences the results of proximate, IVDMD, IVOMD, pH and percent spoilage analyses of the un-ensiled materials. Comparison among treatment means was done using the Duncan's Multiple Range Test (DMRT). Descriptive comparison was used in comparing pH, ADF and NDF for the fresh materials.

Results and Discussion

Table 1 shows the physical evaluation of the different levels of combination between Napier grass and banana peeling. In terms of color, the 100% banana peeling had a yellowish color, relatively wet in texture and a sweet, slightly acidic smell. The 100% Napier grass on the other hand, had a light, little bit greenish in color, relatively dry and coarse in texture and had slightly acidic smell.

The combinations in varying levels of the banana peeling and Napier grass had light colors, relatively dry and coarse texture and range between slightly and moderately sweet smell. The physical performance of the silage indicated that increase in banana peeling percentage lead to the yellow color, wetter and sweeter smell of the silage. It was also observed that all levels of the silage were readily taken when fed to cattle in DTRI, UPLB.

The average spoilage of the ensiled Napier grass and banana peeling as well as both combinations at different levels are shown in Table 2; the moisture content of different treatments are presented in Table 3. Differences in the percent spoilage of the 100% Napier grass and 100% banana peeling with that spoilage of their combinations were not significant. Results showed less spoilage in the 50% NG + 50% BP treatment. For other treatments, spoilage was attributed to broken covers of the used laboratory silos.

The moisture contents among the combinations were significantly different. Apparently, moisture content was higher when levels of banana peel were greater in the silage. This can be attributed to the high moisture content of banana peeling.

In general, the moisture content of the silage should be below 70 percent for bunker or trench silos, below 50 percent for gas-limiting silos, and approximately 60 percent for upright (tower) silos and silage bags (Grant and Stock, 1996). If the moisture content of the forage is too high, effluent will flow from the silage mass.

According to Uchida et al., (1989) ensiling crop with high moisture content usually lead to clostridia fermentation, low DM voluntary intake, and large volume of effluent with highly digestible nutrients. Much effort, therefore have been devoted to improve silage quality and feeding value by controlling moisture content prior to ensiling.

The pH of different levels of Napier grass and banana peel combinations before ensiling ranged between 5.7 and 7.5 (Table 4). The 100% banana peel silage had a higher pH value while the 75% NG + 25% banana peel had the lower pH value.

Table 1. Physical evaluation of ensiled Napier grass and Banana peelings

Silage	Color	Texture	Smell
100% NG	Light yellow, a little bit greenish	Relatively dry and coarse	Slightly acidic
75% NG + 25% BP	Light yellow	Relatively dry and coarse	Slightly sweet smell
50% NG + 50% BP	Light yellow	Relatively dry and coarse	Moderately sweet smell
25% NG + 75% BP	Moderately yellow	Less dry	Moderately sweet smell
100% BP	Yellowish	Relatively wet	Sweeter smell, slightly acidic

Table 2. Average % spoilage of ensiled Napier grass and Banana peelings

Silage treatments	% Spoilage ^{ns}
100% Napier Grass	14.54
75% Napier Grass + 25% Banana Peelings	24.45
50% Napier Grass + 50% Banana Peelings	13.02
25% Napier Grass + 75% Banana Peelings	11.78
100% Banana Peelings	7.95

^{ns} Not significant (P>0.05)

Table 3. Moisture content of the different silage treatments

Silage treatments	% Moisture Content$^{*)}$
100% Napier Grass	82.43^{cd}
75% Napier Grass + 25% Banana Peelings	80.47^{d}
50% Napier Grass + 50% Banana Peelings	83.91^{bc}
25% Napier Grass + 75% Banana Peelings	85.67^{ab}
100 % Banana Peelings	87.32^{a}

$^{*)}$ Means with same superscripts are not significantly different (P<0.05)

Table 4. Average pH of different treatment before and after ensiled

Silage Treatments	Before ^{ns}	After$^{*)}$
100% Napier Grass	6.1	4.575^{b}
75% Napier Grass + 25% Banana Peelings	5.7	4.625^{b}
50% Napier Grass + 50% Banana Peelings	6.0	4.9^{b}
25% Napier Grass + 75% Banana Peelings	6.95	4.775^{b}
100% Banana Peelings	7.5	5.75^{a}

$^{ns)}$ Not siginificant (P>0.05)

$^{*)}$ Same superscript values are not significantly different (P<0.01)

Similar trend was observed on the obtained pH value after ensiling except that the 100% Napier grass had the lowest pH value. The silage pH in this study was slightly different compared to the study of Yokota (1994) whom used Napier grass in different time of harvesting added by 4% molasses, which ranged between 4.03 and 4.29. The pH value of napier grass silage was influenced by additive treatments. Characteristics of napier grass silage after 21 fermentations using different percentage of inoculant and crude enzymes from *Trichoderma reesei* ranged between 3.53 and 3.62 (Nurjana *et al*., 2016).

The 100% banana peel silage had a higher pH (already alkaline) than that of the other silages, which in turn did not show significant differences on their pH values. This higher pH value of 100% banana peel can be attributed to its higher protein content and it also influenced the buffering capacity of banana peelings. According to Weiss and Underwood (2001) hay crops, on the other hand, have a high buffering capacity due to high protein and mineral content and relatively low concentrations of fermentable carbohydrates. Therefore, pH drop in hay crop silage is slow and final pH is comparatively high (approximately 4-4.5). However, Napier grass ensiled without the additive was low in lactic acid and high in pH value, ammonia nitrogen and VFA (Yokota et al., 1994).

Similar to the Ammonia N content of the silage, the pH will give a good indication of whether silage has a good fermentation and is likely to store satisfactorily. The desirable pH range for clamp silage is 3.8 - 4.2. Above pH 4.5, the risk of deterioration in store becomes increasingly apparent. However, high dry matter silage can be satisfactory at a higher pH, but values at 3.6 and below are very acidic (Kim et al., 2001).

Banana peel had relatively high nutritive value than Napier grass in terms of its Crude Protein, Crude Fat, NFE and ash (Table 5). The high nutritive value are supported the higher pH value of banana peeling than Napier grass. Before ensiling, we assumed banana peelings have significant different of sugar content than Napier grass, but the analyses showed that the sugar content (NFE) of both silage materials are really similar. We then therefore surmised this situation is due to the mixing of green and ripe banana peeling we use as a treatment.

Compared to the study of Sabutan (1996), CP, CF, EE and DM of banana peel are almost similar. However, ash and NFE value in Sabutan's study are higher than our findings. Difference results between two these studies may due to the different variety of banana used in both studies. The CP and CF of banana peel in this study were in the range of CP and CF values from the study by Karto (1995) 6.5 – 9.5 and 15.32 – 26.7. The nutrient composition of the napier grass in this study was lower compared to the study of Nurjana *et al*. (2016): CP 6.51%; EE 1.35% except for CF 29.51% - all in DM basis.

DM value of Napier grass was higher than banana peel. The CP and ash contents of the used banana peel were similar, but DM and crude fiber were higher in the used samples. Likewise, ether extract was also lower than the EE obtained by Sabutan (1996). The CP and ADF contents of the used Napier grass were lower than what were obtained by Del Barrio et al. (1998). Nutritive values of fresh Banana peel, Napier grass and their combinations in fresh and ensiled forms are shown in Table 6.

The ensiled DM, CP, CF and EE of the five treatments were different, that also observed in the fresh form. DM value of silage using molasses as additive was significantly high is in line with the observed lower NDF content of this silage (Bureenok et al., 2012). The 100% banana peel had a higher moisture, crude fat, and NFE, but had the lowest DM and ash values.

Table 5. Nutritive value of Napier grass and Banana peelings

Forage	Dry Matter	CP	EE	CF	Ash	NFE
	(Fresh Basis)			(Dry Matter Basis)		
Napier	97.68	5.96	1.28	33.92	14.68	43.87
Banana Peel	90.50	7.60	9.27	16.64	12.20	46.26

Table 6. Nutritive value*) of fresh and ensiled Napier grass and Banana peeling*include crude fat

	Fresh (Dry Matter Basis)					Ensiled (Dry Matter Basis)				
Treatment	DM	CP	EE	CF	ASH	DM	CP	EE	CF	ASH
100% NP	97.68^{ab}	5.99^{d}	1.28^{c}	34.68^{a}	12.55^{b}	95.42^{a}	5.96^{bc}	2.34^{d}	33.92^{a}	14.68
75% NG + 25% BP	97.66^{ab}	10.17^{a}	4.85^{b}	25.23^{b}	15.09^{a}	94.94^{a}	5.13^{d}	2.31^{d}	32.7^{a}	14.56
50% NG + 50% BP	95.9^{b}	7.08^{ab}	5.60^{b}	23.97^{d}	14.88^{a}	92.91^{ab}	6.83^{ab}	4.08^{c}	27.24^{b}	14.64
25% NG + 75% BP	97.79^{a}	9.21^{ab}	6.81^{b}	16.63^{c}	$14.6b^{a}$	92.29^{ab}	7.8^{a}	5.64^{b}	23.95^{c}	14.54
100% BP	90.5^{c}	7.94^{c}	9.27^{a}	13.71^{c}	13.36^{b}	90.11^{b}	7.6^{ab}	8.89^{a}	16.64^{d}	12.2

*) Means in the same column with the same letter are not significantly different (P> 0.01)

The 75% BP + 25% NG had the highest CP content among the treatments, but had similar nutritive values with the other treatments except 100% banana peel. Ash content in all of the fresh treatments was significantly different, though it was not similar but did not differ significantly after ensiling.

NFE content of the treatments were not different in fresh form, but differed significantly after ensiling with the 100% banana peel had higher NFE. It is however noted that nutrient contents in the ensiled form were lower than in fresh form. According to Widjastuti and Hernawan (2012), the use of fresh banana peel up to 20% in the ration of broiler suffering from heat stress can still support the good results in the final broiler weight, percentage of carcass and percentage of abdominal fat within normal limits. DM digestibility of silage using molasses as additive was significantly high is in line with the observed lower NDF content of this silage

IVDMD and IVOMD values before and after ensiling differed significantly (Table 7). IVDMD values of 100 % banana peeling before and ensiling were consistently higher than the 100% Napier grass and their combinations. Different trend was observed in the IVOMD value obtained before ensiling where the 100% Napier grass was higher than the other treatments.

After ensiling however, the 100% banana peel had a higher IVOMD value than the other treatments although differences were not significant. The IVDMD values of fresh Napier grass were similar to the values obtained by Del Barrio et al. (1998) in both local and hybrid varieties during dry, dry-hot, dry-cold climate.

Table 7. In vitro dry matter digestibility and in vitro organic matter digestibility of Napier grass and Banana peeling before and after ensilage

Treatment	IVDMD (% / DM)		IVOMD (% / DM)	
	Before	After	Before	After
100% NG	44.00^{b}	42.23^{d}	90.39^{ab}	79.47^{ns}
75% NG + 25% BP	45.01^{a}	44.74^{d}	88.52^{ab}	74.07
50% NG + 50% BP	47.81^{a}	50.67^{bc}	84.81^{b}	79.23
25% NG + 75% BP	47.06^{a}	53.60^{ab}	94.33^{a}	85.87
100% BP	51.84a	56.41^{a}	83.94^{b}	80.44

Dry matter and organic matter digestibility determined by in vitro technique showed and IVDMD and IVOMD of 42.23% and 79.47% respectively for napier. Our finding is lower for IVDMD and higher for IVOMD compared to the results of Yokota *et al*. (1994) that ranged from 49.4% to 69.2% for IVDMD and 48.6% to 71.9% for IVOMD.

Results we obtained in this study obviously showed the difference between the IVDMD and IVOMD values of our treatment after ensiling. It maybe because IVOMD analysis is not include lignin component analysis, however IVDMD analysis covered all component materials include lignin. ADF and NDF contents of the treatments are shown in Table 8. Along with the tendency of increasing in NDF contents after ensiled, evidently showed that our treatments have high fiber content, and it will decrease the digestibility. Differently, the NDF content of Napier grass was clearly affected by the fermentation with the addition of molasses and cassava meal (non-fiber sources) lowered the content of NDF compared to untreated and fermented juice of epiphytic lactic acid bacteria – FLJB silages (Bureenok et al., 2012). Yokota et al. (1994) reported that lignin is a chemical component in forage cell walls, increases with the development of the grass and is most associated with reduced digestibility of fiber.

Differences in ADF and NDF contents of the treatments after ensiling were not significant, however, the NDF content of the treatments had increased after ensiling. In contrast, ADF of the treatments did not follow the same consistent trend after ensiling.

Conclusions

Physically, the color of silage were light yellow with a little greenish color for 100% napier grass, light to moderately yellow for the three combinations of napier and banana peel and yellow for 100% banana peel. Texture ranged from dry and coarse for napier grass, relatively dry for the combinations and moderately wet for the banana peel. The napier grass had a slightly acidic smell, the combinations had slightly sweet, acidic smell while the 100% banana peel had a sweeter, acidic smell. Likewise, pH before ensiling had ranged from 5.7 (25%NG + 75%BP) to 7.5 (100% BP) while after ensiling the pH changed from 4.575 (100% napier grass) to 5.75 (100% banana peel).

There were significant differences on DM, Moisture, CP, EE, CF, and Ash before ensiling. Similar trend was observed after ensiling except the ash content of all the treatments. ADF and NDF did not show significant variations in all treatments. IVDMD before ensiling varied

Table 8. Average ADF and NDF of different treatment before and after ensiled

Silage Treatments	Before		After	
	ADF	NDF	ADF	NDF
100% Napier Grass (NG)	24.00	68.06	38.34	74.23
75% NG + 25% BP	27.56	68.82	26.27	64.40
50% NG + 50% BP	30.94	80.24	26.54	63.69
25% NG + 75% BP	23.27	57.37	32.12	63.05
100 Banana Peelings (BP)	32.84	42.54	26.37	64.17

significantly, but after ensiling only IVDMD of the treatments differed significantly.

In terms of physical attributes, nutritive value and digestibility, banana peel can be used as silage material. All treatments generated comparable acceptability when fed to the animal. It is suggested that further study, specifically *in vivo* trial, will be conducted to validate the feeding and nutritional value of banana peel as alternative silage for ruminants.

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