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Effects of Forage Species and Preparations on the Growth and Feeding Performance of Sheep

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Abstract

Sheep production is very minimal in the Philippines amidst its better economic performance than goat. Lack of researches on this livestock is seen as one factor affecting its lack of acceptance by local livestock raisers. Also, available feed resources and efficient utilization by sheep is constraint in the country despite the abundance of forage. Here, we investigate the effect of forage species, namely napier grass (*Pennisetum purpureum*) and star grass (*Cynodon dactylon*), and the type of preparation, namely soilage and silage, on the efficient utilization of forage and its effect on the growth performance of sheep. Forage species did not significantly affect the gain in weight and feed conversion ratio of sheep but acted differently on the feed intake of sheep wherein napier grass was 50% greater than star grass. On the other hand, preparations of forage played significant role on the feed conversion ratio of sheep as silage resulted to an increased weight gain and augmented efficiency in converting feed into weight gain. Though interaction of species and preparations of forage did not show significant results, napier grass silage showed the highest weight gain and the best feed conversion ratio. The results suggest that the preference of sheep for unpalatable forage could be encourage through inclusion (mixing) of napier grass in the diet. Similarly, silage could be added (mixed) with other feed preparations (soilage and hay) to encourage high weight gain and better feed conversion ratio.

KEYWORDS

Star grass
Napier grass
Soilage
Silage

Introduction

In the Philippines, sheep production is not being given much emphasis amidst several experts advertising for its better economic performance compared to goat production. In fact, sheep raisers in the country, though relatively few, are openly admitting and encouraging the public to go to sheep production due to its lucrative potential and easier management (Davao, 2015). According to Statistica (2019) and Philippines Statistics Authority (2019), sheep production in the country is around 30,000 heads only compared to 3.71 million heads for goat in 2017. This is a glaring

gap amidst the claims of experts that sheep are easier to be raised, more resistant to parasites, can better withstand inclement weather and produce more meat than goats. Additionally, Oscar Barzaga claimed that, "*sheep is one of the most productive and economical animals that Filipinos can raise!*" (Davao, 2015).

This beg the question, "*What are the reasons for the underdevelopment of sheep industry in the Philippines despite the animal's enormous economic potential?*" A study conducted by University of the Philippines Los Baños revealed the indifference of Filipinos to sheep raising mainly due to lack of marketing system and appropriate technology. Additionally, Dr. Patricio Faylon, the former director of Philippines Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD), explained that sheep in the country has very low priority in research and development (Davao, 2015). Thus, more study on sheep production is needed to realize its economic potential for farmers and contribute to the country's development.

The Philippine government is now aiming the sheep industry to be as profitable as goat production. However, feed resources with its inefficient utilization is still the major constraints nowadays which was already identified by the PCARRD in 1989. Many animal husbandmen use commercially available concentrates such as grains, legumes, and pelletized feeds to improve the inefficient utilization of available forages; however, this practice requires a lot of money. Utilization of quality forage such as napier grass and good preparation of forage such as silage may provide better feed source and promotes efficient utilization of feed. Thus, an assessment on the effects of forage species and preparations on the performance of sheep is necessary to maximize sheep production efficiency in the country. Silage also offers nonnutritive function. Leeuwen et al. (2005) and Laffan and Neeson (2016) stated that roughage preparation such as silage and hay processing will usually kill the eggs and larvae of internal parasites during the storage period ensuring that these will not be reintroduced into the stock.

This study was conducted to determine the daily feed intake, daily weight gain, and feed conversion ratio of sheep as affected by species and preparations of locally available forage using the comparative growth trial method. The study promotes the utilization of napier grass (*Pennisetum purpureum*) and star grass (*Cynodon dactylon*) as roughage for sheep under highland condition of Benguet, Philippines. At the same time, the experiment aimed to provide ideas on the impact of air drying (soilage) and fermentation (silage) on the chemical properties and consumption of forage; and on the feeding behavior and growth pattern of sheep. Moreover, the study hopes to guide animal husbandmen on which species and forms of napier and star grass have better impact on the feed utilization and growth performance of sheep.

Materials and Methods

The experiment was carried out at the animal barn of Benguet State University (BSU) in Balili, La Trinidad, Benguet. Sixteen sheep were randomly distributed into different pen compartments – with one head per compartment for monitoring of individual responses and for even distribution of treatment diets. There were four treatment combinations replicated four times following 2x2 factorial experiment in a Completely Randomized Design (CRD) with one sheep serving as one replicate. The different treatments were presented in Table 1.

Table 1

Treatments used in the study

Treatment number	Treatments
1	Star grass (S_1) Soilage (P_1)
2	Star grass (S_1) Silage (P_2)
3	Napier grass (S_2) Soilage (P_1)
4	Napier grass (S_2) Silage (P_2)

The forage used were napier grass (*Pennisetum purpureum*) and star grass (*Cynodon dactylon*) which were locally abundant in the area. Soilage diets were offered to the experimental animal after 24-hour drying time (air-dry preparation), while silage diets were fed after 30-day fermentation period (molasses-based preparation). Treatment diets were given without limit. Left overs were collected every morning (7:00 AM) before offering new batch of treatment diet. All treatments were

subjected to the same management practices except for the type of diet offered for each treatment animal. Dry matter content, ash content, and fiber content treatment-diet samples were analyzed at the BSU Animal Science Nutrition Laboratory using the dry matter analysis, ash analysis, and 'Van Soest' scheme, respectively. Gain in weight, feed intake, and feed conversion ratio of treatment animals was also determined. Computed data were analyzed using the Analysis of Variance (ANOVA) for the Completely Randomized Design (CRD) by the Statistical Analysis System and were interpreted by comparing treatment means using ANOVA and LSD as post hoc.

Results

Nutrient Content

The nutrient content of the four treatments are presented in Figure 1. This include percent dry matter (DM), percent ash, percent neutral detergent fiber (NDF), and percent acid detergent fiber (ADF) of star grass and napier grass.

Dry matter (DM). Percent DM of silage (19.9) and soilage (19.2) were comparable in napier grass but not in star grass where percent DM of soilage (36.3) was significantly higher than silage (30.4). Data showed that ensiling has varying effect on the DM of forage. Between forage species, DM is consistently lower in napier grass either in silage or soilage preparation.

Ash. Percent ash of silage (13.9) and soilage (10.2) were comparable in star grass but not in napier grass. Percent ash of silage (22.5) was significantly higher than soilage (21.9). As shown in the data, ensiling influenced the ash content of star grass and napier grass differently as it appeared to be favorable only for napier grass. Between forage species, ash content is consistently lower in napier grass either in silage or soilage preparation.

NDF and ADF. On both star grass and napier grass, percent NDF was significantly higher in soilage (80.5 and 58.8) compared to silage (55.4 and 43.4). Similarly, percent ADF was significantly higher in soilage (61.5 and 51.9) than silage (41.1 and 27.4). Between forage species, NDF is consistently lower in napier grass either in silage or soilage preparation. But in terms of ADF, napier grass is higher than star grass at soilage preparation but lower at silage preparation. Moreover, it can be readily seen in Figure 1 that NDF and ADF of soilage is higher than in silage

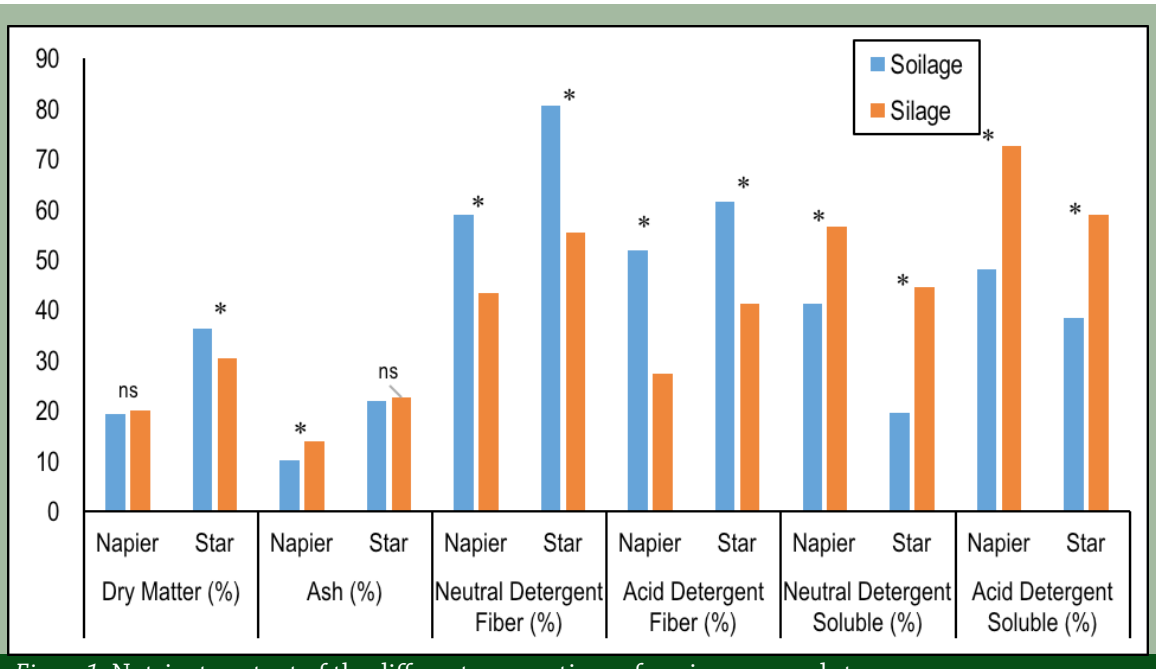

Figure 1. Nutrient content of the different preparations of napier grass and star grass
*(where: ns-no significant difference * - significantly different)*

but opposite in NDS and ADS, silage is higher than soilage.

Feed Intake

Table 2 shows the daily feed intake of the experimental sheep as affected by forage species (napier grass, star grass), preparations of forage (soilage, silage), and the interaction between forage species and forage preparations.

Effects of forage species (S). Forage species affected the daily 'as fed' intake of sheep wherein napier grass intake (2,914.19g) was significantly higher than star grass intake (1,455.81g). However, forage species did not differ significantly in the daily DM intake of sheep wherein napier grass intake (568.83g) is comparable to star grass intake (483.16g).

Effects of forage preparations (P). Forage preparation did not affect the daily 'as fed' intake of sheep wherein soilage intake (2,287.21g) was comparable to silage intake (2,082.79g). Similarly, the two forage preparation did not significantly affected the daily DM intake of sheep wherein soilage intake (581.22g) is comparable to silage intake (470.77g). This result implies that preparations did not significantly affected the 'as fed' and DM intake of the sheep.

Interaction Effect of Species x Preparation. As shown in Table 2, interaction of forage species and preparations neither significantly decrease nor increase the 'as fed' intake and DM intake of sheep. Result showed that the 'as fed' intake of napier grass soilage (S2P1), napier grass silage (S2P2), star grass soilage (S1P1), and star grass silage (S1P2) were 3,027.16g, 2,801.22g, 1,547.27g, and 1,364.35 grams, respectively.

Gain in Weight

Table 3 shows the weight gain of experimental sheep as affected by forage species (napier grass vs. star grass), preparations of forage (soilage vs. silage), and the interaction between forage species and forage preparations.

Effects of forage species (S). Result showed that the effect of two forage species on the daily gain in weight of sheep did not significantly differ. The average daily gain in weight of sheep feeding on napier grass was 81.94 grams which is higher, though not statistically significant, than the 68.06 grams average daily gain in weight of sheep consuming star grass.

Effects of forage preparations (P). Mean daily gain in weight of sheep feeding on silage

Table 2

Daily consumption of sheep during the 45-day growth trial (g)

Treatment	Feed intake	
	As fed	Dry matter
Species		
Star grass (*Cynodon dactylon*)	1455.81[b]	483.16[a]
Napier grass (*Pennisetum pupureum*)	2914.19[a]	568.83[a]
Preparations		
Soilage	2287.21[a]	581.22[a]
Silage	2082.79[a]	470.77[a]
S x F	ns	ns
CV (%)	23.82	23.87

Means with common letter in a column are not significantly different at 5% level of significance (LSD)

Table 3

Weight gain of sheep during the 45-day growth trial

Treatment	Gain in weight (g)	
	Total Gain	Daily Gain
Species		
Star grass (*Cynodon dactylon*)	3,062.50[a]	68.06[a]
Napier grass (*Pennisetum pupureum*)	3,687.50[a]	81.94[a]
Preparations		
Soilage	3,062.50[a]	68.06[a]
Silage	3,687.50[a]	81.94[a]
S x F	ns	ns
CV (%)	21.60	21.60

Means with common letter in a column are not significantly different at 5% level of significance (LSD)

preparation was 81.94g which is higher than the 68.06g average daily gain in weight of sheep consuming soilage prepared grass. However, data showed that preparations of forage did not affect the daily gain in weight of sheep.

Interaction effect (S x P). The data shows that interaction of forage species and preparations neither significantly decrease nor increase the weight gain of sheep. Result showed that the total gain in weight of sheep consuming napier grass silage (S2P2), napier grass soilage (S2P1), star grass silage (S1P2), and star grass soilage (S1P1) were 4,125g, 3,250g, 3,250g, and 2,875g, respectively.

Feed Conversion Ratio

Table 4 shows the feed conversion ratio (FCR) in the experimental sheep as affected by forage species (napier grass vs. star grass), preparations of forage (soilage vs. silage), and the interaction between forage species and forage preparations.

Effects of forage species (S). FCR between forage species did not differ significantly. FCR in star grass was 7.5 which is comparable with the 7.1 FCR in sheep consuming napier grass.

Effects of forage preparations (P). On the other hand, the preparations of forage significantly affected the FCR of sheep. The experimental sheep feeding on silage had 8.9 FCR which is significantly higher than the 5.7 FCR of sheep consuming soilage. This result implies feed conversation was higher in sheep feed with silage than soilage.

Interaction effect (S x P). The interaction of forage species and preparations neither significantly decrease nor increase the FCR of sheep. Result showed that the FCR of sheep consuming star grass soilage (S1P1), napier grass soilage (S2P1), napier grass silage (S2P2), and star grass silage (S1P2) were 9.5, 8.4, 5.9, and 5.6, respectively.

Table 4

Feed conversion ratio of sheep during the 45-day growth trial

Treatments	Feed Conversion Ratio
Species	
Star grass (*Cynodon dactylon*)	7.5[a]
Napier grass (*Pennisetum pupureum*)	7.1[a]
Forms	
Soilage	8.9[b]
Silage	5.7[a]
S x F	ns
CV (%)	17.8

Means with common letter in a column are not significantly different at 5% level of significance (DMRT)

Discussion

Nutrient Content

Chemical compositions dictate the nutritive value of forage. McDonald et al. (2010) stated that one of the guaranteed measure of nutritive value of forage is the digestibility of the organic matter as affected by the anatomic features of plants. In the study, there's a noticeable difference between nutrients present in star grass and napier grass.

DM is generally accepted as one important nutrient required by ruminants since they eat as much as they can to satisfy their DM content. DM satisfaction is greatly affected by the species of forage, preparation of forage, feeding duration, and amount of feed offered. Heuze et al. (2015) stated that the DM of star grass soilage is 30.6%, while the DM of napier grass soilage and silage are 17.9% and 19.5%, respectively. These results are comparable with the findings of the study. DM represents the non-moisture component of a feedstuff and therefore holds the necessary nutrient within the forage. Between napier grass and star grass, the later retains greater amount of DM after oven drying at 105°C for 12 hours – this means that sheep given with napier grass are expected to consume more forage than those sheep given with star grass. Moreover, forage preparations such as air drying and ensiling affect the DM content of forage – ensiling promotes moisture in feed that should keep sheep consuming more silage than soilage. McDonald et al. (2010) mentioned that silage dry matter intakes tend to be low and are strongly influenced by a number of factors, particularly pH, concentration of organic acids, buffering capacity and ammonia nitrogen content. This was also

observed in the study wherein silage dry matter intakes were lower compared to soilage.

Ash represents the mineral components of feeds. Heuze et al. (2016) published that the ash contents of napier grass as soilage and silage are 13.8% and 12.6%, respectively – these results are comparable but lower compared with the findings of this study. Also, Heuze et al. (2015) published earlier that the ash level of star grass soilage is 7.3% which is lower than napier grass soilage. Our result is much higher which recorded 21.9-22.5% ash in star grass.

NDF is the plant fiber left after the forage have been digested using neutral detergent solutions. This represents the non-soluble portion of forage such as lignin, hemicellulose, and cellulose. Apparently, the results of the study imply that ensiling decreases NDF content of both napier grass and star grass. This supports the findings of Tufan et al. (2016) that NDF content of fresh forage is lower than silage. Van Saun (2018) stated that within a given feed, NDF is a good measure of feed quality and plant maturity. For legume forages, NDF content below 40% would be considered good quality, while above 50% would be considered poor. For grass forages, NDF <50% would be considered high quality and >60% as low quality. In the study, napier silage, napier soilage, and star grass silage appeared to be good quality forages in terms of NDF but not star grass soilage.

ADF is the plant fiber left after the breakdown of NDF by an acid detergent solution, represented by the lignin and cellulose. Apparently, ensiling decreased the ADF content in napier grass and star grass which supports the findings of Tufan et al. (2016) that ADF of silage is lower than fresh forage and hay. Van Saun (2018) stated that the goal for a quality legume and forage would be to have <35% ADF. Among the treatments, only napier grass silage was of good quality forage in the terms of ADF.

Feed Intake

Aside from being the basis for feedstuff's acceptability, palatability, and digestibility, feed intake also expresses the rumen capacity and feed requirement or feed allocation of sheep. Earlier studies showed that star grass has greater DM content over napier grass. McDonald et al. (2010) mentioned that ruminants do eat to maintain a constant amount of dry matter in the rumen – this explains the comparable DM intake of different treatment diets despite differences in the 'as fed' intake.

McDonald et al. (2010) also mentioned that though roughages are voluminous, food like silage do not promote as great a fill as other foods – this explains the lower intake of silage over soilage. Even so, silage did not negatively affect the feed intake of sheep resulting to similar intake as soilage. In the study, species of forage is one influencing factor in the increased intake of sheep. Regardless of preparations, napier grass was more preferred by the sheep in terms of 'as fed' intake.

Kieser (2018) found that each goat is able to consume 3% up to 5% of its body weight in dry matter daily. The study showed that the experimental sheep require lesser daily dry matter allowance as goats – sheep consumed about 2.6% to 3.7% DM of its body live weight regardless of treatment diets.

Gain in Weight

In general, weight gain is an indicator of physiological progress in the animal, for instance growth and feed efficiency. In the study, there may be variations in the nutrient contents of forage as affected by species and types of preparation, but species and preparations were shown not to significantly differ in the growth of sheep in terms of weight gain. Though not significantly different, higher gain in weight was observed in napier grass vs star grass and in silage vs. soilage. This is consistent with the study of Sormunen-Cristian and Jauhiainen (2001) who observed that ewes fed with silage under restricted feeding before and after breeding have higher gain in weight. Higher weight from silage could be attributed to its low NDF level. Rasby and Martin (2018) stated that low NDF values are desired. This may also explain the higher weight gain in the sheep under silage preparation.

Feed Conversion Ratio

Feed conversion ratio denotes the feed consumption of animals per unit of their body weight gain. In addition to gain in weight, feed conversion ratio is one important factor that need to be well known as it manifest the animal's ability to transform feed into its digestible form. Lower FCR is better. Silage preparation showed

better FCR than soilage preparation, while napier grass and star grass have similar FCR efficiency. Van de Vyver et al. (2013) studied the effects of different levels of silage to 40 finishing merino lambs and have concluded that merino lambs with increased silage consumption (50% to 70%) have the best FCR. Higher FCR from silage could be attributed to its desired low NDF level as emphasized by Rasby and Martin (2018). This is consistent with the study where star grass silage and napier grass silage consumption of sheep resulted to lower or better FCR.

Conclusions

The study documented the performance of sheep in terms of growth and feed efficiency using forage species and preparations of forage as factors. Regardless of species, whether it be star or napier grass, silage preparation enhances nutritive value of forage (43.40% NDF, 55.41% NDF), increases daily gain in weights (81.94 g), and improves FCR (5.7). The data may facilitate the preparation of appropriate diets for sheep production in the locality.

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