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Utilization of Cogon (*Imperata cylindrica* L.) Silage and Urea-Treated Corn (*Zea mays* L.) Stover as Affected by Supplementation

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ABSTRACT

Cogon grass, a weed occasionally used as livestock feed, has limited nutritive value. Improving the utilization of low-quality roughages could be by treatment with nitrogen sources, chemical, and physical treatment. Thus an experiment was conducted to assess the voluntary intake and digestibility *in vivo* of cogon silage and urea-treated corn stover as affected by varying ratios of concentrate: Ipil-Ipil leaf meal (ILM) supplementation in goats. The experiment was set-up in a Randomized Complete Block Design (RCBD) with four (4) blocks based on sex-period combination with a 2x3 factorial treatment design: factor A with two types of base forage (cogon silage, urea-treated corn stover), and factor B with three (3) ratios of concentrate: ILM as a supplement (1.25:0; 0.75:0.50 and 0.50: 0.75 %BW, DM basis). Results revealed a comparable voluntary intake and in vivo digestibility of cogon grass silage and urea-treated corn stover across three types of supplements, and among supplements across types of basal diet. Interaction between the kind of basal diet and type of supplement was not significant. It is, therefore, advantageous to mix ILM with concentrate at 0.75%:0.50% BW or 0.50:0.75% BW ratio, DM basis, as a supplement to either cogon silage or urea treated corn stover rather than given an all-concentrate supplement at 1.25% BW, DM basis, to save on feed cost.

Keywords: In vivo, urea-treated, silage, concentrate: Ipil-ipil supplement

INTRODUCTION

Ruminants in tropical countries are raised predominantly on pasture grasses and crop residues, which are inherently poor in nutritive value and digestibility, especially in the dry season (Babayemi and Bamikole, 2009). During the rainy season, natural pasture tends to be more succulent, highly nutritious, and more abundant. Still, during the dry season, the native vegetation becomes fibrous, scarce, and devoid of most essential nutrients which required for the increase in rumen microbial fermentation and improved animal performance (Sowande, 2004; Lamidi, 2009). The most common native vegetation is cogon grass (*Imperata cylindrica* L.), which grows all over the Philippines and is readily available all year-round in more than half of the 5 million hectares of grasslands. This species is traditionally used as a roofing material but could be used as feed for ruminants during periods of drought (Samson and Capistrano, 1982), especially at a stage of fine leaves through frequent burning and grazing, or cutting (Yunus et al. 2000). Its use as animal feed, however, could be limited because of low digestibility if grazed or harvested at a stage when its cell wall becomes highly lignified and, consequently, low voluntary intake.

Fibrous crop residues (e.g., rice straw and corn stover) are also abundant during the dry season when good quality forages are scarce. There are a lot of unutilized crop residues, but their quality is associated with lignified nature, which limits intake, digestibility, and overall utilization (Olafadehan and Adewumi, 2009). Some ways of improving digestibility and, consequently, intake have to be instituted, including physical, chemical, and biological treatments (Wanapat et al. 2013). The use of alkali, such as urea (McDonald et al. 2002; Nguyen et al. 2012), and supplementation, such as concentrates and high-quality forages (Jackson, 1979), or both (Bestil, 2009) have been used to improve the feeding value of crop residues.

Optimizing the use rather than improving the nutritive value of such feedstuffs in ruminants implies using treatments that will enhance digestibility and the quality of the roughage through appropriate supplementation and feeding techniques. The utilization of poor quality cogon that is nutritionally enhanced by ensiling, and corn stover (*Zea mays* L.) by urea treatment and supplementation has not been fully documented in Cebu Province. Hence, this study conducted to compare the voluntary feed intake and *in vivo* digestibility between cogon silage and urea-treated corn stover as affected by supplementation of pure concentrate or concentrate + ipil-ipil leaf meal (ILM); and determines the type of supplement of varying concentrate: ILM ratios fitting for cogon silage or urea-treated corn stover.

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MATERRIALS AND METHOD

Time and Place of the Study

The experiment was conducted at Cebu Technological University-Barili Campus, Cagay, Barili, Cebu, Philippines, while laboratory analyses were conducted at the Animal Nutrition Laboratory of Department of Animal Science - College of Agriculture and Food Science-Visayas State University, Visca, Baybay, City Leyte, Philippines from December 2018 to April 2019.

Preparation of Experimental Diets and Animals

In this study, corn stovers were collected from cornfields after the grains harvested at 100 days old, situated in Cagay, Barili, Cebu, Philippines. They were chopped to approximately 3-4 cm long and sprayed with urea solution (40-50 grams urea dissolved in 1 L water sprayed onto 1 kg corn stover). The treated corn stover was then covered for (3) three days to prevent the volatilization of ammonia, enabling it to act on the lignin-cellulose bonding.

The cogon grass was gathered early in the morning from the pasture area about 20-25 days after the last cutting. Freshly-cut Cogon was wilted to 60-75% dry matter (DM) and chopped to 2–3 cm long. Urea-molasses was used as silage additive to the cogon grass at 2.1% of silage mass, with molasses added at five (5) times higher than that of urea (Ubod and Bestil 2018). The silage material was compacted, then the air was withdrawn from the plastic silage bags, and stored in a room temperature of about 27-30°C inside a 200-litre plastic drums, with clamp lid, and harvested after 21 days.

The supplemental concentrate was formulated to contain 14% CP, composed of 37.5% cassava meal, 15% rice bran, 25% corn grits, 22% soybean meal, and 0.5% of salt. Ipil-ipil leaves were freshly harvested at the flowering stage, sun-dried for a day to contain about 86-90% DM or 10-14% moisture content, ground, and stored in sacks.

Twelve (12) healthy grower hybrid goats, six (6) females and six (6) males, aging 4-5 months, and weighing 8-11 kg live weight, were used in this study. They were dewormed with Ivermectin and administered with B-complex vitamins beforehand and were randomly assigned to the dietary treatments in two runs with two blocks per run. The experiment was laid out in Randomized Complete Block Design (RCBD), replicated four (4) times with four (4) blocks based on a sex-period combination, for the following treatment in a 2x3 factorial design: Factor A (Types of Forage): A1- Cogon Urea-Molasses Silage and A2 – Urea-Treated Corn Stover; Factor B (Types of Supplementation): B1 - Concentrate (1.25% BW, DM basis), B2 - Concentrate: ILM (0.75:0.50% BW, DM basis) and B3-Concentrate: ILM (0.50:0.75% BW, DM basis).

Collection and Measurements of Fecal Output

Feces were collected manually from each animal throughout the day during the collection period and were kept in individual nylon bags to avoid the loss of volatile nitrogen and contamination of dirt and urine. Feed offered and refused were recorded daily during the duration of the experiment. Refusals were removed and weighed before the morning feeding. During the digestibility trial, refusals were removed daily, weighed, sampled, and bulked in individual bags. The total quantity of feces voided was weighed and recorded in every animal. About 10% of feces were mixed every day from each animal. At the end of the collection period, the fresh feces were compiled together, and oven-dried and were used for percent dry matter analysis.

In vivo Digestibility Trial

The digestibility trial was conducted at 90% ad libitum intake to prevent bias of digestibility measurements towards the leafy portion of the base diets as follows: Day 1 to 5 gradual shifting from the previous diet to treatment diets; Day 5 to 25 (Adjustment period), this is the period the treatment diets fed at ad libitum (free choice) by giving 20% allowance based on the previous day's voluntary intake, initial weight determined on Day 5 before feeding and weekly monitoring of weight changes and Voluntary Feed Intake (VFI); Day 26 - 29 (Digestibility Trial), reduce basal diet offering to 90% of Ad libitum intake to prevent bias of digestibility measurements towards the leafy portion of the corn stover and cogon grass; and day 30-35 (Collection period), recording of fecal output, feed intake, sampling of feces, and feeds for analysis in Days.

Chemical Analysis

Feed and fecal samples were analyzed for its dry matter (DM), organic matter (OM) contents, and neutral detergent fiber (NDF) according to the methods of the Association of Official Analytical Chemists (AOAC 1990) at the Animal Nutrition Laboratory of the Department of Animal Science - College of Agriculture and Food Science-Visayas State University, Visca, Baybay, City, Leyte, Philippines.

Data gathered and analyzed included:

1. Voluntary DM Intake

For concentrate, ILM and urea-treated corn stover: DMI=Feed Intake x % DM of feed

For silage:

$$\text{DMI} = (\text{Feed Given x \%DM of feed given}) - (\text{Feed Refused x \%DM of feed refused}$$

2. Dry Matter Degradation (DMD)

$$\text{DMD (\%)} = \frac{(\text{Dry Matter Intake} - \text{Dry Matter Excreted}}{\text{Dry Matter Intake}} \text{ x100}$$

Where: DM Excreted=Fecal Output x % DM of feces

3. Organic Matter Intake

$$\text{OMI} = \text{DM Intake x \% OM of feed}$$

4. Organic Matter Digestibility

$$\text{OMD (\%)} = \frac{\text{Organic Matter Intake} - \text{Organic Matter Excreted}}{\text{(Organic Matter Intake)}} \text{x100}$$

Where: Organic Matter Excreted=Fecal DM Output x % OM of feces

5. Neutral Detergent Fiber Intake

NDFI=Dry Matter Intake x % NDF of feed

6. Neutral Detergent Fiber Digestibility

$$\text{NDFD (\%)} = \frac{\text{(NDF intake} - \text{NDFI excreted)}}{\text{(NDF intake)}} \text{ x 100}$$

Where: NDF Excreted=Fecal DM output x % NDF of feces

DATA ANALYSIS

Data were analyzed by two-way Analysis of Variance (ANOVA) for a Randomized Complete Block Design, and comparison of treatment means was done using the Honestly Significant Difference (HSD) Test with the Statistical Package for Social Sciences (SPSS) version 20 software.

RESULTS AND DESCUSSION

Dry matter Intake and Digestibility

Table 1 presents the dry matter intake and dry matter digestibility from both the basal diet (cogon silage and urea-treated corn stover) and different levels of concentrates. DMI is expressed as % BW in terms of the types of diet and types of concentrate. As shown in the table, there were no significant differences in Dry matter intake (DMI, grams) and dry matter digestibility of goats in terms of the type of forage and type of supplementation. This means that cogon grass silage and urea-treated corn stover and the different types of supplementation have a comparable effect in terms of the dry matter intake. The highest DM intake was achieved by goats supplemented with cogon silage added with 0.75% concentrate and 0.5% Ipil-ipil leaf meal. Clearly, the results show that the addition of 75% commercial concentrates compounded to contain complete nutrients, and the additional legume meal improved the DM intake. The combination of a higher amount of commercial concentrates and a lesser amount of Ipil ipil leaf meal given to the animals directly correlates to the DM intake.

The results are in consonance with the study about nutrient digestibility of ensiled sweet corn hob. The digestibility coefficients in ESCH were low (p-value > 0.05) in all the nutrients, and supplementation of Ipil - Ipil leaves in ESCH increased digestibility coefficients. Total digestible nutrients (TDN) and digestible energy were higher in the silages supplemented with ipil - ipil leaves (Sruamsiri et al. 2007). This might be due to the supplement of ipil – ipil leaves in the silages, which provided more nutrients, especially nitrogen, for microbial growth and activities. Ipil-ipil (*Leucaena leucocephala* L.) feed, due to its excellent palatability, digestibility, the balanced chemical composition of protein and minerals, low fiber content, and moderate tannin content can promote to achieve better by-pass protein value ipil-ipil can be a suitable replacement for expensive concentrate ingredients in feed. It is rich in all kinds of nutrients required by goats to provide a goat with better DM intake, weight gain, and reproductive performance (Akingbade et al. 2002 and 2004; Kanani et al. 2006).

The fiber component is also a significant fraction of the dry matter (DM). In many instances, the fiber content of leaf meals may equal or exceed CP concentrations. Consequently, the digestibility of the CP fraction of many leaf meals is low, which tends to depress overall CP digestibility when leaf meals constitute a significant proportion of the diet (Tangendjaja et al. 1990).

Dietary inclusion rates will depend to a significant extent on the protein sources they are intended to replace.

Table 1

Voluntary Intake and Nutrient Digestibility of Cogon Grass Silage and Urea-Treated Corn Stover with Varying Types of Supplementation in Goats

TREATMENTS	DMI (g)	DMI (%BW)	DMB (%)	OMI (g)	OMD (%)	NDFI (g)	NDFD (%)
Factor A (Types of diet)							
A1 - Cogon Silage	388	4.03	21.39	423	83.57	291[a]	43.70
A2 - Urea-treated Corn Stover	331	4.24	20.96	361	84.09	241[b]	51.85
p-value	*0.056*	*0.650*	*0.598[ns]*	*0.058*	*0.616[ns]*	*0.030*	*0.295[ns]*
Factor B (Types of supplementation)							
B1 – Concentrate: ILM (1.25:0% BW,DM)	344	4.01	19.23	375	85.31	241	48.15
B2–Concentrate:ILM(0.75:0.5% BW,DM)	373	4.43	22.37	404	82.67	284	45.86
B3-Concentrate:ILM(0.5:0.75%BW,DM)	362	3.97	21.93	398	83.50	272	49.30
p-value	*0.827*	*0.323*	*0.118[ns]*	*0.890*	*0.117ns*	*0.500*	*0.761[ns]*
Interaction (AxB)							
p-value	*0.294*	*0.316*	*0.110[ns]*	*0.293*	*0.085[ns]*	*0.416*	*0.517[ns]*

Means within a column of the same letter-superscripts are not significantly different.

Thus the replacement value of leaf meal is relatively low in diets based on good quality protein sources such as soybean and fish meal.

Organic Matter Intake and Digestibility

Table 1 also presented the effects on the organic matter (OM) digestibility values. OM digestibility is defined as the proportion of organic matter in the feed that is apparently digested in the total ruminant digestive tract. OM digestibility can be used to measure the energy available and to estimate the microbial protein synthesis in the rumen (Anam et al. 2017). Data shows that there were no significant differences found in all treatments, meaning their effects are comparable.

Supplementation is strongly recommended to mitigate the nutritional weaknesses of roughage. In ruminants, when milk or meat production is desired, the low nutritive value of roughage must be supplemented with both protein and energy sources for better growth and improves consumption and increases energy intake (Jackson, 1979); thus, the comparable effects of pure commercial concentrate supplementation plus ensiling and urea treatment of the experimental diets.

Feeding protein or non-protein nitrogen (NPN) in concentrate could increase feed intake, digestibility, microbial protein production, and rumen fermentation efficiency; thereby, improving the performance of ruminant fed low-quality roughages (McGuire et al. 2013; Khattab et al. 2013).

Urea is a good source of NPN that can effectively be used as a source of supplemental N to ruminants consuming low-quality roughages with increasing of voluntary feed intake, nutrient digestibility, a passage from the rumen, and rumen ecology (Cappellozza et al. 2013; Sweeny et al. 2014; Benedeti et al. 2014; Holder et al. 2015; Kang et al. 2015; Ampapon et al. 2016). Urea is used as the building block for the production of protein by rumen microbes, thus its comparable effects with other treatments.

Moreover, urea is commonly added to the ruminant diet as a source of non-protein nitrogen that is rapidly hydrolyzed to ammonia in the rumen. Therefore, it is apparent that the nutritional quality of maize stover is poor, and maize stover should be fed along with the concentrate to maintain the health and increase the milk production potential of milch animals. The concentrates will provide the required concentration of protein as well as other nutrients. Urea treatment on the nutritive value of roughage is the result of two processes that occur within the treated forage: Firstly, the ureolysis, which turns urea into ammonia through an enzymatic reaction that requires the presence of the urease enzyme and secondly, the effect of ammonia on the cell walls on the forage. Several factors, such as urea doses, moisture, temperature, affect the effectiveness of urea treatment. The nutritional quality of urea treated maize stover is drastically enhanced compared to normal stover. The increased microbial biomass in the treated stover may contribute significantly towards higher crude protein content (Elias and Fulpagare, 2015), wherein results revealed that urea treatment of maize stovers seems to be useful to improve the crude protein content of maize stover.

Supplementation of locally available leguminous forages with commercial concentrate mixture can be a good option for successful goat farming as legumes can be a good source of protein.

Neutral Detergent Fiber Intake and Digestibility

Table 1 presents the results of the neutral detergent fiber (NDF) analysis. Neutral detergent fiber digestibility is a good indicator of fiber content in forages. It does not, however, measure how digestible that fiber is. In vitro NDF digestibility gives us more accurate estimates of total digestible nutrients (TDN), net energy (NE), and feed intake potential. In general, increased NDF digestibility will result in higher digestible energy and forage intakes.

The table shows that there a significant difference in terms of the kinds of diets. However, there were no significant differences observed in terms of types of

IMPLICATIONS

The experiment on intake and in vivo digestibility of cogon grass silage and urea-treated corn stover supplemented with varying ratios of concentrates, and Ipil-ipil leaf meal implies the following: the utilization of cogon and corn stover as ruminant feed should be maximized, especially in the Province of Cebu where soil characteristics cannot support the production of high-quality grasses/forages for a vibrant and booming livestock industry because of better markets; the maximum utilization requires alkali treatment (e.g., urea) of fibrous feeds (e.g., corn stover) and processing (e.g., silage-making) of native grasses (e.g., cogon) harvested at an age when digestibility is highest to prevent further lignification; and the maximum utilization of cogon grass silage and urea-treated corn stover can be stretched further with supplementary feeding, utilizing locally available concentrated ingredients and legume leaf meals (e.g., ILM) in appropriate ratios to minimize feed cost and prevent "substitution effect."

CONCLUSION

Cogon grass in silage form is comparable to urea-treated corn stover in terms of intake and digestibility. Mixing ipil-ipil legume leaf meal with concentrate at 0.75:0.5 ratio or 0.5:0.75 % BW, DM basis, as a supplement to either cogon silage or urea treated corn stover, was comparable to an all-concentrate supplement at 1.25% BW, DM basis.

RECOMMENDATION

It is recommended to process cogon into silage, treat corn stover with urea, and supplement with a mixture of concentrate and Ipil-ipil leaf meal rather than all-concentrates to reduce supplement cost.

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