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NUTRIENT DIGESTIBILITY OF FIBROUS FEEDSTUFFS IN HIGH-CONCENTRATE DIET WITH SODIUM-BICARBONATE ($NaHCO_3$) ADDITION IN RUMEN-FISTULATED BRAHMAN BULL

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ABSTRACT: Ruminants are given substantial quantities of concentrate diets full of quickly fermentable carbohydrates to increase output performance; however, it can also lead to digestive disorders. This study aimed to investigate the effect of adding $NaCHO_3$ to a high-concentrate diet on the nutrient digestibility of locally available fibrous feedstuffs in the Philippines. The experiment utilized a rumen-fistulated Brahman bull. The treatment diets were the following: Treatment 1 (T1): Untreated rice (*Oryza sativa* L.) straw; T2: Urea-treated rice straw; T3: Napier grass (*Pennisetum purpureum* Schumach); T4: Napier silage; T5: Sugar cane (*Saccharum officinarum* L.) tops; and T6: Cogon grass (*Imperata cylindrica* L.). The nylon bags containing the treatment diets were incubated in the rumen at two periods: first at a high-concentrate (70% level), and second at a high concentrate added with NaCHO3). The results showed that the nutrient digestibility of locally-available feedstuffs varies significantly ($p<0.05$) both with and without $NaHCO_3$. The addition of $NaHCO_3$ in a high-fiber diet improves the digestibility of locally available fibrous feedstuffs in terms of dry matter (DM), organic matter (OM), and neutral detergent fiber (NDF). Therefore, the addition of NaHCO3 to a high-concentrate diet has the potential to positively stabilize rumen pH and enhance the nutrient digestibility of locally available fibrous feedstuffs.

Keywords: Fibrous feedstuffs, *in situ* digestibility, Nutrient digestibility, Rumen, Sodium bicarbonate.

INTRODUCTION

The Philippines provides inexpensive sources of ruminant feeds based on its favorable climate for fodder and other fibrous feedstuffs (Van Hung et al., 2017). One agriculture by-product that can be utilized as feed is the rice straw (Van Hung et al., 2017; Zaghloul et al., 2018). Rice straw is known to have a low nutritional value (Vadiveloo, 2000), but when properly managed and supplemented, it can contribute to the diet of ruminants (Aquino, 2020). According to recent studies, rice straw contains on average 7-10% crude protein, 30-40% of digestible fiber, and provides about 6.7 MJ/kg of metabolizable energy (Devendra and Sevilla, 2002). The rice plant's (*Oryza sativa*) vegetative portion, cut during or after grain harvest, is known as rice straw. It can be incinerated and left on the rice field's surface before plowing, tilled into the ground to enhance the soil, or used as livestock feed (Kadam et al., 2000). In regions where rice is grown, rice chaff is a common forage. Rice straw's nutritional worth can be increased by treating it. These therapies aim to improve feed consumption and digestibility. Treatments involving mechanical, chemical, heat, and pressure can improve solubility. Napier grass, also known as Elephant grass (*Pennisetum purpureum*), is a prominent forage crop in the Philippines due to its high yield and resilience to various climatic conditions. Elephant grass, noted for its high fiber content, exhibits significant variations in neutral detergent fiber (NDF) concentrations ranging from 55% to 75% on a dry matter (DM) basis contingent on the stage of maturity. Due to its remarkable productivity, Napier grass is a crucial forage in the tropics. It is exceptionally well adapted for feeding buffalo and cattle. Napier grass is typically fed in stalls, made to silage or hay, or used in cut-and-carry methods (also known as "zero grazing"). A potential feedstuff for ruminants, especially areas with vast sugarcane plantations, is the sugarcane (*Saccharum officinarum* tops). A hectare of sugarcane can yield 11 to 21 tonnes of leaves and stalks, which are farm wastes (DA-Philmech). However, the majority of the crop residue from sugarcane fields is either burned or is allowed to decompose in the field, which may increase global warming.

Sugarcane tops can be used raw, dried, or ensiled for feeding animals. They have a wide range of nutritional value, which is affected by pre-harvesting methods, the stage at which the stem is removed, plant maturation, and the volume of dry leaves (McKenzie et al., 2007). Sugarcane forage, characterized by its high energy content, tends to offer optimal nutritional value during dry periods (Archimède et al., 2011). However, its nutritional profile is marked by low protein, mineral, and vitamin contents, making it a fibrous material of considerable bulkiness. Cogon grass (Imperata cylindrica) is a widespread weed that thrives throughout the Philippines. Cogon grass (*Imperata cylindrica*) can support an effective extensive livestock production system if they are given sources for energy, urea, and minerals (Falvey, 1981). Subsistence farmers keep the majority of the ruminant stock in the Philippines. So, feeding is mainly dependent on fibrous crop

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residues that are readily accessible or on any grasses on the farm, as well as grazing on unused land or shared pastures. Because concentrate is infrequently used in the country, animal productivity could be much higher. Increasing the number of concentrates in ruminant diets might improve production efficiency while utilizing the locally and economically available for ages.

Ruminants such as beef and dairy cattle are frequently given substantial quantities of concentrate diets full of quickly fermentable carbohydrates to increase output performance and financial returns (Klevenhusen and Zebel, 2021; Wang et al., 2023). In contrast to forages, concentrates feature low-fiber, high-energy diets with variable protein levels (Gallo et al., 2019). They are typically given to dairy cattle to increase the feed energy level and compensate for any deficiencies not covered by the forage part of the diet. While concentrated feed can significantly increase overall production, it also has adverse health effects. If the proper measures are not taken, a high-concentrate diet can cause digestive disorders like subacute ruminal acidosis (SARA) in cattle. Due to the buildup of the VFA and lactic acids in the rumen, a large amount of concentrate typically results in a temporary drop in the ruminal pH after feeding (Nocek and Rusell, 1998).

Sodium bicarbonate, represented by the chemical symbol NaHCO3, serves as a standard exogenous buffer. It plays a crucial role in normalizing the ruminal pH in cattle that might be susceptible to ruminal acidosis. In feedlots, the inclusion of sodium bicarbonate in diets is a response to the drastic dietary shift from highly fibrous feed to high-grain (carbohydrate) diets, which is associated with a decline in rumen pH, leading to rumen acidosis. However, sodium bicarbonate's effect on nutrient digestibility and buffer in the rumen environment varies. Additionally, it was not recorded how $NaHCO_3$ affected the intestinal digestibility of locally available feedstuffs in high-concentrate feeding. Therefore, the objective of this study was to investigate the effect of the addition of $NaCHO_3$ to a high-concentrate diet on the digestibility of dry matter (DM), organic matter (OM), and neutral detergent fiber (NFD) of locally available fibrous feedstuffs.

MATERIALS AND METHODS

Ethical consideration

All the procedures in caring for animals in this study followed the Animal Welfare Act 8485 of the Philippines. The methods of this study were approved by the Institutional Animal Care and Use Committee (IACUC) of the Visayas State University.

Experimental animal

All the procedures in caring for animals in this study followed the Animal Welfare Act 8485 of the Philippines. A rumen-fistulated Brahman Bull was dewormed using Ivermectin at a dose of 1ml/ 33kg LW prior to the conduct of the study. The bull was fed with the test diets for ten days as the adjustment period to allow the build-up of specific rumen microorganisms.

Treatments and experimental design

The experiment comprised six locally feedstuffs selected based on their fiber contents. The treatment diets were as follows: T1: Untreated rice (*Oryza sativa* L.) straw; T2: Urea-treated rice straw; T3: Napier grass (*Pennisetum purpureum* Schumach); T4: Napier silage; T5: Sugar cane (*Saccharum officinarum* L.) tops; and T6: Cogon grass (*Imperata cylindrica* L.).

The paddy rice straw (*Oryza sativa* L.) or the untreated straw for T1 was collected at Barangay Pangasugan, Baybay City, Leyte Rice Field. The collected feedstuff has undergone chopping using a mechanical chopper at approximately 3-4cm in length. For T2, the urea-treated rice straw has undergone (46%N) treatment. The straw was cut into 4cm lengths. The straw was moistened with a 3% urea solution. Forty to fifty grams of urea were dissolved in one liter of water and sprayed unto the rice straw for each kilogram. The treated rice straw was incubated for three days and dried for four to six hours for extended storage (Wanapat et al., 2009). The Napier grass (*Pennisetum purpureum* Schumach) for T3 was harvested at the Department of Animal Science at Visayas State University Forage Area. They were harvested at 45 days maturity and were chopped at approximately 3-4 cm length. Three weeks prior to rumen incubation is the preparation of Napier silage for T4. Napier grass was harvested after 45 days of re-growth and underwent chopping into 3-4 cm lengths. The small-scale silage was prepared by adding 4% molasses per fresh weight basis (Yokota et al., 1991) and was stored in a polyethylene bag. The silage was harvested at least three weeks (21 days) after the ensiling. The sugarcane (*Saccharum officinarum* L.) tops for T5 were collected at a plantation site at Ormoc City, Leyte. For animal consumption, the sugar cane tops were roughly chopped to a size of 3–4 centimeters, dried in the shade on a sheet of plastic, and then placed in a jute bag. For T6, Cogon (*Imperata cylindrica* L.) grass was harvested at the heading stage and has undergone drying to reduce moisture content, the chopped at 2-3 cm sizes.

The experiment was set up where the Nylon bags containing the test diets in six replicates each was incubated in a single rumen environment of a Brahman bull. This study was conducted using the Completely Randomized Design (CRD). The study was divided into two phases, phase 1 was the feeding of a high-concentrate diet (without $NaHCO_3$), and phase 2 was with the addition of $NaHCO_3$. The Brahman steer was fed ad libitum (5% feed allowance). The animal was fed a diet consisting of seventy percent (70%) commercial concentrate supplementation and thirty percent (30%) test diets at a dry

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matter DM basis. The test diets constituting 30% of the total ration comprised 5% Napier silage, 5% Napier grass, 5% urea-treated rice straw, 5 % untreated rice straw, 5% Sugar cane tops, and 5% Cogon grass.

Addition of $NaHCO_3$ to the diet

For the second phase of the study (Phase 2), 0.75% feed-grade sodium bicarbonate (NaCHO3) was added to the diet on a DM basis. The 0.75% addition on a DM basis was based on the recommendation of the study of Zinn, 1991.

Nylon-bag/In-situ/In-sacco experiment

The digestibility and degradability through in situ technique are widely used in several types of research to measure digestibility and evaluate feedstuffs (Hoffman et al., 2001). This method involves using small dacron/nylon bags and then inserted into the fistulated rumen of the experimental animal. The difference in the number of nutrients before and after incubation in the rumen is compared to the amount digested. The nylon bag experiment followed the schedule below:

Table 1- The *in-situ* digestibility schedule

Concentrate level	Day	Activity
Phase I (w/o $NaHCO_3$)	1-9	Adjustment period. Animal given basal diet, Napier grass soilage at *ad libitum* (giving 5% allowance for that day based on previous days voluntary intake), together with 70% commercial concentrate mixed with the test diets (constituting 30%).
	8-10	Daily monitoring of rumen pH at 2 hours after the morning feeding.
	9	Reduction of the total amount of feed given to 50-60% to accommodate the nylon bags containing the test diets.
	10	Incubation period. After being placed inside a lingerie bag with weights, the nylon bags containing the test diets were placed in the rumen for twenty-four (24) hours.
	11	Nylon bags were recovery from the rumen
Phase 2 (w/$NaHCO_3$)	11-17	Adjustment period. The animals were given the same type of diet, but with 0.75% $NaHCO_3$ in the diet.
	16-18	Rumen pH is measured every day two hours after the morning feeding
	18	Reduction of the total amount of feed given to 50-60% to accommodate the nylon bags containing the test diets.
	19	Incubation period. After being placed inside a lingerie bag with weights, the nylon bags containing the test diets were incubated in the rumen for 24 hours.
	20	Nylon bags were recovered from the rumen

To determine the initial DM and OM, the feed samples were oven-dried at 105°C at 16hr and then weighed to determine the DM. The oven-dried sample was placed in a muffle furnace to determine the ash. The ash was subtracted from the DM content to obtain the OM. The feeds were ground into 2mm approximate sizes using the Wiley Mill by Thomas Scientific at the Department of Animal Science-Animal Nutrition Laboratory, VSU. The ground feedstuff samples were distributed into three replicates, weighing 5g each. The samples were placed in a nylon bag with a 5 × 10 cm dimension and pore size of + 53μ (Bar Diamond Lane, Parma, ID, USA). The nylon bags were incubated in the rumen of a cannulated Brahman steer with a body weight of 300kg for digestibility determination. After incubation, the nylon bags undergo 30-min washing in the running water and manual scrubbing until the water becomes clear. The washed nylon bags will be oven-dried under 65℃ for 48 hours and will be weighed to obtain the DM content.

Rumen pH

The rumen pH was determined by collecting a rumen fluid sample from the cannulated rumen and reading the pH value through a digital pH meter.

In situ nutrient degradation, %

The *in-situ* degradability of nutrients such as DM, OM, NDF from the samples incubated was calculated using the following formula:

$$\%\text{Nutrient Degradation} = \frac{\text{Amount before incubation} - \text{Amount after incubation}}{\text{Amount before incubation}} \times 100 \quad (1)$$

Where: Amount of nutrient before incubation = dry weight inside nylon bag after incubation x % nutrient of residue

Statistical Analysis

The collected data were analyzed by one-way analysis of variance (ANOVA), and treatment means were compared by Tukey's HSD test using the Statistical Package for Social Sciences (SPSS) version 26 software. A paired sample T-test was used to determine differences in treatment means between with and without $NaHCO_3$ addition.

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RESULTS AND DISCUSSION

Changes in the Rumen pH

The rumen pH from both treatments with and without $NaHCO_3$ gradually increases along with the sampling day (Table 2). It was clear that adding $NaHCO_3$ to a high-concentrate feed in a Brahman bull mitigates its effects. The diet without adding $NaHCO_3$ yields a pH of 5.75 which inclines to the acidity level, while the diet with $NaHCO_3$ has a mean of 6.49. Generally, the rumen pH under a high concentrate diet w/out the $NaHCO_3$ addition was 5.75, which falls below the optimum pH level for fiber digestion between 6.0-6.4 (Antanaitis et al., 2020). In a 2016 study by Sato, feeding Holstein cattle a high-concentrate diet reduced rumen pH and increased VFA concentration, indicating a negative correlation among rumen pH and VFA content. Rapidly increasing the proportion of concentrate in the feed (from 40% to 90% on a dry matter basis) led to a low pH level (Bevans et al., 2005). In this study, adding $NaHCO_3$ resulted in a pH level of 6.24, which falls to the optimal level for fiber digestion. At this pH level, cellulolytic microbes can digest fibre effectively. They are, however, inhibited at pH levels below 6.0 (AlZahal et al., 2009). However, the result in this study was contrary to the study of Rogers et al., 1985 by which the NaCHO3 addition has the lowest ruminal pH. The result was due to a higher feed intake and higher concentration of volatile fatty acids (VFA). These reactions might cause the rumen pH to decrease.

Table 2 - Changes in Rumen pH under a high-concentrate diet with and without $NaHCO_3$ addition

Day of sampling	w/o $NaHCO_3$	w/ $NaHCO_3$	Difference[1] (p-value)
1	5.90	6.12	0.427
2	5.73	6.25	0.385
3	5.62	6.36	0.049
Mean	5.75	6.24	0.259

[1]Paired-samples T-test; p<0.05=significant, p>0.05=not significant

Dry matter digestibility

The percentage of dry matter in the feed that an animal digest is known as dry matter digestibility. Table 3 presents the dry matter digestibility in the rumen under a high-concentrate diet with and without $NaHCO_3$ addition. It can be observed that Napier grass (T3) has the highest DMD of 43.67 under a higher concentrate diet alone. The urea-treated rice straw followed it with a DMD of 26.30, sugarcane tops at 22.87%, Napier silage at 21.53%, rice straw at 21.42%, and the least digested fiber was the cogon grass at 19.20%. On the other hand, the urea-treated rice straw has the highest DMD under the addition of $NaHCO_3$ in a high-concentrate diet. The addition of $NaHCO_3$ has generally increased the DMD across all fiber treatments. This means that adding $NaHCO_3$ improved DMD digestibility for locally able fiber feedstuffs. Moreover, significant differences (p<0.05) were observed in urea-treated rice straw (T2) and Napier silage (T3).

Table 3 - DMD (%) in rumen under a high-concentrate diet with and without $NaHCO_3$ addition

Treatment	$NaHCO_3$ -	$NaHCO_3$ +	Difference[2] (p-value)
T1 Rice Straw	$21.42\underline{+}1.12^{b}$	$28.01\underline{+}1.25^{c}$	0.571
T2 Urea-treated Rice Straw	$26.30\underline{+}2.02^{ab}$	$62.81\underline{+}0.25^{a}$	<0.001
T3 Napier grass	$43.67\underline{+}0.56^{a}$	$38.53\underline{+}0.37^{ab}$	0.400
T4 Napier Silage	$21.53\underline{+}0.17^{b}$	$62.70\underline{+}1.85^{a}$	<0.001
T5 Sugarcane Tops	$22.87\underline{+}2.78^{b}$	$47.57\underline{+}0.34^{ab}$	0.093
T6 Cogon grass	$19.20\underline{+}0.65^{b}$	$31.30\underline{+}2.01^{c}$	0.244
p-value[1]	0.16	0.003	

[1]One-way Analysis of Variance; p<0.05=significant, p>0.05=not significant; [2]Paired-samples T-test; p<0.05=significant, p>0.05=not significant

Although the Napier grass has the highest DMD among all fibrous feedstuffs at a high-concentrate level experiment (w/o $NaHCO_3$), it still appears to be lower than the DMD value of Napier which is 66% (Benedetti et al., 2008). Surprisingly, the Napier grass is higher than the Napier silage in terms of DMD, which contrasts with the study of Bureenok et al. (2012). The inclusion at an amount of 4% of molasses for silage making was insufficient to have an impact on digestion. Interestingly, when NaHCO3 was added in the high-concentrate diet, the Napier grass digestibility has reduced. Cogon grass (*Imperata cylindrica*) is a widespread weed that thrives throughout the Philippines. The inclusion of $NaHCO_3$ can help stabilize rumen pH, but its impact on DMD may be minimal, especially when it comes to high-quality forages like Napier grass. The inherent digestibility of Napier grass might not be significantly enhanced by the addition of $NaHCO_3$ or rumen pH alteration (Van Soest, 1994).

It can be observed that the urea-treated rice straw has a higher dry matter digestibility than rice straw alone for both treatments with or without $NaHCO_3$. The same results were also observed in the study of Asoy and Aban (2022), by which urea treatment on rice straw improves dry matter digestibility in goats. Rice straw's hemicelluloses-lignin complex swells

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due to ammonium hydroxide (NH4 OH) produced in UTRS (Mapato et al., 2010). These outcomes could explain how urea treatment improved rice straw rumen microbial degradation by increasing the accessibility of both cellulose and hemicellulose to the rumen microbes (Shen et al., 1999). Meanwhile, cogon grass had the lowest DMD due to its low DM content. *Imperata cylindrica*'s nylon bag digestibility was found to be 2/3 poorer than that of elephant grass (Pennisetum purpureum), buffel hay (*Cenchrus ciliaris*), and *Setaria sphacelata* (Holmes et al., 1980). Patiga et al. (2020) emphasized that to maximize utilization of cogon grass, it must be harvested early.

The improved dry matter digestibility (DMD) observed across various feedstuffs when high-concentrate diets are supplemented with sodium bicarbonate ($NaHCO_3$) can be attributed to the buffering capacity of $NaHCO_3$, which helps maintain optimal rumen pH levels. Rumen pH plays a crucial role in the activity and growth of different microbial populations involved in fiber and carbohydrate breakdown.

Fiber-digesting microbes, such as cellulolytic bacteria and protozoa, thrive optimally in a ruminal pH range of 6.0-6.4 (Antanaitis et al., 2020). These microbes are responsible for breaking down complex fiber components like cellulose and hemicellulose into simpler compounds that can be further fermented and utilized by the animal. By buffering the rumen pH, $NaHCO_3$ helps create an environment that is favorable for the growth and activity of these fiber-digesting microbes, thus enhancing the breakdown and utilization of fibrous feedstuffs (Nagaraja and Titgemeyer, 2007). By ensuring that the rumen pH remains within the appropriate ranges for both fiber and carbohydrate breakdown, $NaHCO_3$ supplementation promotes efficient fermentation and digestion of feedstuffs. This, in turn, leads to improved dry matter digestibility across various feedstuffs in high-concentrate diets.

Organic Matter Digestibility

The percentage of organic material in the feed that appears to have been digested in the entire ruminant digestive system is known as organic matter digestibility. Measurements of the amount of energy available and an estimation of the microbial protein production in the rumen can be made using the digestibility of organic matter. In table 4, the addition of $NaHCO_3$ improved the OMD of all fibrous feedstuffs and resulted in significant differences ($p<0.05$) to the urea-treated rice straw (T2) and Napier silage (T4).

The high-concentrate diet without $NaHCO_3$ addition resulted in a significant difference ($p<0.05$) among all feedstuffs. The Napier silage (T4) had the highest OMD (71.40%), which is slightly higher than that Napier grass (T3) at 70.80% OMD. The urea-treated rice straw has an OMD of 60.02%, higher than the untreated rice straw (T1) of 54.38%. Moreover, almost the same results were observed when $NaHCO_3$ was added. Significant differences were also observed ($p<0.05$).

It is possible that the addition of $NaHCO_3$ to a high-concentrate feed improved the digestion of OM because more cellulolytic bacteria and ciliate protozoa were present overall (Santra et al., 2003). This would have improved the rumen's ability to process fibrous feedstuffs. Santra et al. (2003) found that groups given feed with high levels of $NaHCO_3$ (2.25 and 1.5%) exhibited higher levels of total protozoa in the rumen (P0.01) than those fed diets with a lower level (0.75%) of $NaHCO_3$. These findings are in line with the understanding that cellulolytic bacteria and protozoa play a significant role in fiber degradation and utilization in the rumen. By increasing their populations through the addition of NaHCO3, the breakdown and digestion of complex carbohydrates, such as cellulose and hemicellulose, are enhanced. This, in turn, improves the overall digestibility of organic matter in the rumen. The result of this study was in contrast with Philip (1983), who reported that treatment with $NaHCO_3$ at a dosage of 3% of the diet was unaffected by DM. However, the bioavailability of nitrogen did show some improvement.

Table 4 - OMD (%) in rumen under a high-concentrate diet with and without NaHCO3 addition

Treatment	$NaHCO_3$		Difference[2] (p-value)
	-	+	
T1 Rice Straw	54.38 ± 2.38^{cd}	63.40 ± 1.67^{c}	0.367
T2 Urea-treated Rice Straw	60.02 ± 3.12^{bc}	72.13 ± 4.12^{abc}	0.041
T3 Napier grass	70.80 ± 2.67^{a}	80.90 ± 2.57^{ab}	0.359
T4 Napier Silage	71.40 ± 3.94^{ab}	83.47 ± 5.34^{a}	0.005
T5 Sugarcane Tops	58.12 ± 2.01^{bc}	67.12 ± 2.12^{bc}	0.246
T6 Cogon grass	40.12 ± 1.02^{d}	58.03 ± 2.42^{c}	0.052
p-value[1]	<0.001	0.001	

[1]One-way Analysis of Variance; p<0.05=significant, p>0.05=not significant; [2]Paired-samples T-test; p<0.05=significant, p>0.05=not significant

Neutral Detergent Fiber Digestibility

Neutral detergent fiber digestibility (NDFD) accurately measures rumen microbes' capacity to ferment fiber. NDF digestibility more accurately predicts feed intake capability, net energy from metabolism (NE), and total digestible nutrients (TDN). Greater NDF digestibility will generally lead to higher forage and digestible calorie intakes. Table 2 shows that $NaHCO_3$ had increased NDFD of the fibrous feedstuffs than a higher-concentrate diet alone. The data showed significant differences ($p<0.05$) of NDFD with and without $NaHCO_3$ addition for rice straw (T1), Napier silage (T4), and Cogon grass.

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Significant differences ($p<0.05$) among fibrous feedstuffs were observed for both experiments with and without $NaHCO_3$ addition. The urea-treated rice straw (T2) was the highest on a high-concentrate diet, with an NDFD of 25%. At a high-concentrate level with $NaHCO_3$ addition, the Napier silage has the highest NDFD of 60.53%. Since the rumen pH was altered by $NaHCO_3$ addition, it directly affects NDFD. Because ruminal pH significantly affects microbial populations, it is believed to be a crucial element in the rumen's regular and stable operation.

Table 5. NDFD (%) in rumen under a high-concentrate diet with and without NaHCO3 addition

Treatment	$NaHCO_3$ -	$NaHCO_3$ +	Difference[2] (p-value)
T1 Rice Straw	9.12±0.70[a]	33.35±2.76[c]	<0.001
T2 Urea-treated Rice Straw	25.13±1.45[c]	50.94±3.78[b]	0.024
T3 Napier grass	20.50±0.63[c]	31.69±2.45[c]	0.417
T4 Napier Silage	22.20±1.67[c]	60.53±2.46[a]	0.002
T5 Sugarcane Tops	14.12±0.98[b]	25.21±1.03[cd]	0.036
T6 Cogon grass	9.03±0.05[a]	24.37±0.12[cd]	0.001
p-value	0.002	.007	

[1] One-way Analysis of Variance; p<0.05=significant, p>0.05=not significant; [2]Paired-sample T-test; p<0.05=significant, p>0.05=not significant

Dietary fiber digestibility in ruminants is influenced by various factors, including ruminal pH, the amount of concentrate in the diet, and the addition of sodium bicarbonate. When high concentrate diets are fed without sodium bicarbonate supplementation, lower digestibility rates have generally been observed. This finding is consistent with a recent study conducted by Niepes et al. (2023), which showed that increasing the amount of concentrate in the diet from 20% to 40% resulted in a decrease in ruminal pH, making it more challenging for neutral detergent fiber (NDF) to be effectively digested.

On the other hand, improvements in dietary fiber digestibility have been occasionally noted and have been attributed to the maintenance of a pH level in the rumen that is more favorable for cellulolytic microbes. Zebeli et al. (2008) suggested that variables influencing ruminant conditions, such as ruminal pH and the amount of digesta exiting the reticulorumen, can impact the extent of fiber degradation. A study by Yang et al. (2002) demonstrated that reducing the mean ruminal pH level to a range of 6.18 to 5.78, along with an increase in the rate of nutrient disappearance through the reticulorumen, led to a reduction in NDF breakdown in the intestines and overall digestive tract. Specifically, the breakdown of NDF decreased from 40% to 37% and from 52% to 41%, respectively.

However, there are contrasting results in the literature regarding the effect of sodium bicarbonate on fiber digestibility. Marden et al. (2008) found that the addition of NaHCO3 to the diet resulted in a decrease in fiber digestibility. This finding aligns with the claims made by Mould and Orksov (1983), suggesting that in animals fed a high-concentrate diet, pH buffering with bicarbonate only partially restored ruminal cellulolytic activity.

CONCLUSION

This study investigated the effect of adding sodium bicarbonate ($NaHCO_3$) to a high-concentrate diet on the digestibility of locally available fibrous feedstuffs in ruminant animals. The results showed that NaHCO3 supplementation had a positive impact on rumen pH, dry matter digestibility (DMD), organic matter digestibility (OMD), and neutral detergent fiber digestibility (NDFD) of the tested feedstuffs. The addition of $NaHCO_3$ helped stabilize rumen pH, which is essential for maintaining optimal microbial activity in the rumen. The improved rumen pH led to increased DMD, OMD, and NDFD, indicating enhanced nutrient utilization and digestibility of the fibrous feedstuffs. This finding suggests that $NaHCO_3$ supplementation can effectively improve the utilization of locally available feed resources, which is particularly beneficial in areas where fibrous crop residues and grasses are the primary feed sources for ruminant animals. Among the tested feedstuffs, urea-treated rice straw and Napier silage showed the highest improvements in DMD, OMD, and NDFD when $NaHCO_3$ was added to the high-concentrate diet. These results highlight the potential of these feedstuffs as valuable sources of nutrients for ruminant animals when supplemented with $NaHCO_3$.

The findings of this study suggest that $NaHCO_3$ supplementation in high-concentrate diets can play a significant role in improving the digestibility and utilization of fibrous feedstuffs in ruminant animals

DECLARATIONS

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Authors' contribution
Richelle A. Niepes performed the experimental trial, analysis, and writing of the manuscript while supervised by Lolito C. Bestil.

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Conflict of interests
The authors have not declared any conflict of interests.

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