Effects of Pelleted Sugarcane Tops on Voluntary Feed Intake, Digestibility and Rumen Fermentation in Beef Cattle

C. Yuangklang[1, 2, *], M. Wanapat[2] and C. Wachirapakorn[2]

[1]Department of Animal Science, Faculty of Agriculture, Khon Kaen University, Khon Kaen 40002, Thailand

ABSTRACT : Four male crossbred beef steers about 2 years old were used in a 4×4 Latin square design to investigate the effect of pelleted sugarcane tops on voluntary feed intake, rumen fermentation and digestibility of nutrients. Experimental treatments were; Control (dried-chopped sugarcane tops (DCST)); PS1 (Pelleted sugarcane tops at 1 cm of diameter); PS2 (Pelleted sugarcane tops at 2 cm of diameter) and PS3 (Pelleted sugarcane tops at 3 cm of diameter). Roughage intake and total dry matter intake were 1.59, 1.62, 1.61, 1.63% BW and 2.09, 2.12, 2.11 and 2.13% BW in control, PS1, PS2 and PS3 treatments, respectively ($p<0.05$). Digestibility of DM, OM and CP were similar in control and PS3 treatment but there was significant difference ($p<0.05$) between control and PS1, PS2 treatments. Digestibility of neutral detergent fiber (NDF) and acid detergent fiber (ADF) were 52.89, 50.01, 50.05 and 50.56% and 41.91, 39.96, 39.91 and 39.69% in control, PS1, PS2 and PS3, respectively ($p<0.05$). Total volatile fatty acids concentrations in rumen contents was 67.68, 65.93, 66.15 and 66.67 mM in control, PS1, PS2 and PS3, respectively ($p<0.05$). Even though, concentrations of acetate and butyrate (%) were significant different ($p<0.05$) but concentration of propionate (%) was not affected by treatments ($p>0.05$). Rumen pH, ammonia nitrogen and plasma urea nitrogen were significantly different ($p<0.05$) among treatments. From this experiment, it was found that dried-chopped sugarcane tops increased digestibility of nutrients whereas pelleted sugarcane tops increased feed intake in beef cattle. However, pelleted sugarcane tops at 3 cm of diameter did similar result in digestibility and rumen parameters with DCST. Therefore, it could be concluded that pelleting sugarcane top is an alternative way to improve the quality of sugarcane tops for use as ruminant roughage source. ***(Asian-Aust. J. Anim. Sci. 2005. Vol 18, No. 1 : 22-26)***

Key Words : Sugarcane Tops, Digestibility, Rumen Fermentation, Beef Cattle

INTRODUCTION

In Thailand, agricultural crop-residues are commonly used as roughage sources for ruminants in the dry season because there is not enough available green forages (Wanapat, 1995). There are many agricultural crop-residues such as rice straw, sugarcane-tops, whole-corn stover and cassava leaf, are available in the area of their production. Sugarcane (*Saccharum officinarum*) is widely grown in the tropical and subtropical areas by which the main purpose is to produce sugar. During harvesting season, sugarcane-tops are plenty left in the field. It is known that sugarcane tops are one of usable crop-residues as animal feeds because of its components are suitable for ruminants. But the use of sugarcane tops is negligable due to low nutritive values. However, some researchers have reported that feeding sugarcane-tops with protein supplementation for ruminants in dry season did maintain their body weight (Kutty and Prasad, 1980). In accordance with Snitwong et al. (1983) who found that feed intake and feed/gain in buffaloes fed sugarcane-tops were shown similar performance as those buffaloes fed napeir grass (*P. purpureum*). Moreover, ensiling sugarcane-tops with urea increased feed intake and digestibility of nutrients in sheep (Reddy and Prasad, 1982). Preston and Leng (1987) reported that ensiling chopped sugarcane-tops with urea improved digestibility of nutrients but was not affected voluntary feed intake. Other researcher concluded that sugarcane-tops silage was contained similar nutritive value to dried sugarcane-tops (Sritakoonpech, 1990). In feeding trial from Gendley et al. (2002) demonstrated that supplementation of wheat bran and Lentil chuni in crossbred cattle fed chopped green sugarcane tops improved nutrient intakes and digestibilities. In accordance with Kawashima et al. (2002b) who concluded that chopped sugarcane tops can be utilized as roughage source during dry season, but it is necessary to be properly added with protein and energy sources. In dairy cattle trial, Wanapat et al. (1999) reported that feeding sugarcane tops with urea-treated rice straw was improved feed intake and nutrient digestion in dairy cattle. Similar resulted with Kawashima et al. (2002a) who found that chopped sugarcane tops improved energy supply when compared with rice straw in diary cows. There is, however, very few literature focusing on alternative way to use sugarcane-tops as ruminant feeds. Thus, this present experiment was studied the effects of pelleted sugarcane-tops on voluntary feed intake, digestibility and ruminal fermentation in beef cattle.

* Corresponding Author: Chalermpon Yuangklang. Tel: +66-42-771-460, Fax: +66-42-771-460, E-mail: cyuangklang@yahoo.com

[2] Sakon Nakhon Agricultural Research and Training Center, Rajamangala Institute of Technology, Phangkhon, Sakon Nakhon 47160 Thailand.

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Table 1. The composition of concentrate diet

Ingredients	% (as fed basis)
Cassava chip	21.90
Corn meal	9.80
Kapok meal	41.10
Rice bran	4.00
Sunflower meal	3.40
Cottonseed	11.50
Molasses	3.30
Cement	1.50
Minerals	3.50
Total	100.00

MATERIALS AND METHODS

Animals and experimental treatments

Four crossbred beef steers about 2 years old were used in a 4×4 Latin square design. Their initial body weight was 155.8±1.9 kg (mean±SD). Each period was lasted for 21 days; 14 days was used to measure feed intake and last 7 days was used to measure digestibility by using total collection method (Schnieder and Flatt, 1975); 2 days for adaptation on the crate and last 5 days for sample collection. Experimental treatments were; Control (Dried-chopped sugarcane tops (DCST)); PS1 (Pelleted sugarcane-tops (1 cm diameter)); PS2) Pelleted sugarcane-tops (2 cm diameter) and PS3 (Pelleted sugarcane-tops (3 cm diameter). The DSCT and all pelleted sugarcane tops were mixed with 40% molasses, 16% cassava meal and 4% cement.

Sugarcane tops were chopped about 2-3 inches and sun-dried for 3-4 days. Dried-chopped sugarcane tops were ground pass through a 3 mm screen and mixed with other compositions and the mixtures were pelleted by pellet instrument (Orietal Electric Industry Model Super Line 15 HP 4 POLE TYPE SE-J, Thailand) for different size of diameters according to experimental treatments. Pelleted sugarcane-tops were sun-dried for 2-3 days before use.

All animals received concentrate diet at 0.5% BW to ensure the activity of rumen microorganism. The composition of concentrate is shown in Table 1. Animals were offered roughage *ad libitum* and feed refusals being measured once daily. During total collection periods, animals were housed on the metabolism crates and feces samples were collected in the last five consecutive days. Feed samples were collected weekly and pooled for analysis. At the end of each total collection period, rumen samples were collected by stomach tube at 4 h post feeding. Then, pH of rumen samples were measured immediately by pH/Temperature meter. The portion of 20 ml sub-samples were acidified with 2 ml 6 N HCl to inhibit microbial activity and frozen at -20°C. Subsequently, individual rumen samples were thawed for volatile fatty acids analysis using HPLC (Waters, Model Water 600; UV detector, Millipore Corp.) (Samuel et al., 1997) and ammonia-nitrogen (NH_3-N) using Kjeltec Auto 1030 Analyzer (Bremner and Keeney, 1965). On the same occasion as rumen sampling, 10 ml of blood was taken from jugular rena-puncture. After centrifuging, the plasma sample was taken and then frozen for subsequent analysis for plasma urea nitrogen (PUN) (Crocker, 1967).

Feed and feces samples were dried at 60°C for 72 h; ground and analyzed for dry matter (DM), crude protein (CP) and ash by the method of AOAC (1990). Neutral detergent fiber (NDF), Acid detergent fiber (ADF) and Acid detergent lignin (ADL) were measured by the method of Goering and Van Soest (1970). Digestibility of nutrient was calculated as nutrient intake-nutrient in feces×nutrient intake^{-1}×100 (Schneider and Flatt, 1977).

Data were subjected to analysis of variance using GLM procedure (SAS, 1996). Treatment means were compared using Duncan's new multiple range test (Steel and Torries, 1960). The statistical significant was considered at $p<0.05$.

RESULTS AND DISCUSSION

The chemical composition of concentrate and pelleted dried-chopped sugarcane tops are presented in Table 2. The chemical compositions of experimental treatments were similar in the percentage of DM, CP, Ash, NDF, ADF and ADL. The percentages of NDF and ADF of PS1, PS2 and PS3 were likely suitable to use as roughage source in ruminants, but the percentage of CP was low.

Total feed intakes expressed as kg/d was not affected by pelleting, but pelleted sugarcane tops (PS1 and PS3) expressed as % BW were significantly different ($p<0.05$) as compared to the control treatment (Table 3). This result is in according with Preston and Leng (1987) who reported that

Table 2. Chemical composition of concentrate diet and experimental treatments

Items	Concentrate	Experimental treatments			
		Control[1]	PS1	PS2	PS3
Dry matter	91.8	90.6	90.6	90.6	90.6
Crude protein	20.2	4.1	4.1	4.1	4.1
Ash	14.7	15.3	15.3	15.3	15.3
NDF	25.5	41.3	41.3	41.3	41.3
ADF	15.8	23.2	23.2	23.2	23.2
ADL	2.3	3.4	3.4	3.4	3.4

[1] Control: Dried-chopped sugarcane tops (DCST), PS1: Pelleted sugarcane tops (1 cm diameter), PS2: Pelleted sugarcane tops (2 cm diameter), PS3: Pelleted sugarcane tops (3 cm diameter).

Table 3. Feed intake and digestibility of dry matter (DM), organic matter (OM), crude protein (CP), neutral detergent fiber (NDF) and acid detergent fiber (ADF)

Items	Control[1]	PS1	PS2	PS3	SEM
Roughage intake,					
kg/d	2.58	2.65	2.70	2.70	0.04
g/kgBW$^{0.75}$	56.67^{b}	58.01^{a}	57.71^{ab}	58.54^{a}	0.29
% BW	1.59^{b}	1.62^{a}	1.61^{ab}	1.63^{a}	0.01
Total intake,					
kg/d	3.39	3.47	3.47	3.53	0.05
g/kg BW$^{0.75}$	74.52	75.88	75.61	76.46	0.33
% BW	2.09^{b}	2.12^{a}	2.11^{a}	2.13^{a}	0.01
Digestibility, %					
DM	68.80^{a}	63.37^{b}	64.64^{b}	68.57^{a}	0.65
OM	71.04^{a}	66.19^{b}	67.30^{b}	70.37^{a}	0.56
CP	66.99^{a}	63.55^{b}	63.80^{b}	66.85^{a}	0.48
NDF	52.89^{a}	50.01^{b}	50.05^{b}	50.56^{b}	0.34
ADF	41.91^{a}	39.96^{b}	39.91^{b}	39.69^{b}	0.30

$^{a, b, c, d}$ Value in the same row with different superscript differ ($p<0.05$).

[1] Control: Dried-chopped sugarcane tops (DCST), PS1: Pelleted sugarcane tops (1 cm diameter). PS2: Pelleted sugarcane tops (2 cm diameter), PS3: Pelleted sugarcane tops (3 cm diameter).

Table 4. Ruminal total volatile fatty acid (TVFA), pH, ammonia nitrogen (NH_3N) and plasma urea nitrogen (PUN)

Items	Control[1]	PS1	PS2	PS3	SEM
TVFA, mM	67.68^{a}	65.93^{b}	66.15^{b}	66.67^{ab}	0.42
Acetic acid, %	70.75^{a}	67.84^{b}	68.72^{b}	68.93^{b}	0.41
Propionic acid, %	22.74	23.36	23.18	23.05	0.20
Butyric acid, %	6.52^{b}	8.81^{a}	8.10^{a}	8.02^{a}	0.34
Acetate:propionate	3.13	2.96	2.97	2.99	0.04
Rumen pH	6.70^{a}	6.65^{b}	6.66^{b}	6.69^{a}	0.05
Rumen NH_3N, mg/dl	9.61^{a}	9.33^{b}	9.32^{b}	9.55^{a}	0.01
PUN, mg/dl	8.44^{a}	8.38^{b}	8.39^{b}	8.43^{a}	0.01

$^{a, b, c, d}$ Value in the same row with different superscript differ ($p<0.05$).

[1] Control: Dried-chopped sugarcane tops (DCST), PS1: Pelleted sugarcane tops (1 cm diameter). PS2: Pelleted sugarcane tops (2 cm diameter), PS3: Pelleted sugarcane tops (3 cm diameter).

pelleting increased feed intake. The authors explained that pelleting improved the palatability and decreased the bulkiness of feed. Digestibilities of DM, OM and CP were not significant different between control and PS3 treatments but were significantly lower in PS1 and PS2 treatments than in control. Pelleting sugarcane tops was lowering digestibilities of NDF and ADF. It might be explained that ingredients must be ground before they are mixed and pelleted. It has been known that grinding changed the property of roughage by decreasing the particle size of the roughage, which has been know to increase rate of passage and decrease rumen retention time (Church, 1972). However, pelleted sugarcane tops treatment at 3 cm of diameter was showed similar in digestibility of dry matter, organic matter and crude protein when compare to control treatment ($p>0.05$). Church (1977) reported that pelleting of hay decreased digestibility of nutrients in sheep. He was explained that pelleting was rapidly degraded in rumen and increased the rate of passage. Led to decrease the retention time of diets, which less nutrient digestion by microbial flora in rumen. Gendley et al. (2002) was demonstrated that supplemented wheat bran and lenti chuni in crossbred cattle fed chopped green sugarcane tops was improved nutrient intake and digestibility of CP and EE. In accordance with Kawashima et al. (2002a,b) who suggested that feeding sugarcane stalk to cattle as roughage source can be conceivable with supplemented protein and energy source.

Rumen VFA, rumen pH, NH_3N and PUN are shown in Table 4. Total VFA was higher in control treatment than in other treatments ($p<0.05$). It could be attributed that control treatment was slowly degraded and raised rumen retention time of feed. Therefore, there were increased total volatile fatty acids by microbial activity in rumen. Concentration of acetate was decreased in pelleted sugarcane tops treatments ($p<0.05$). It could be explained that pelleting was changed the property of roughage, which raised rate of passage and decreased rumen retention time of feed so that lack of time for microbial flora to degrade feed in the rumen. From this experiment, concentration of propionate was not affected by treatments ($p>0.05$). It could be explained that the most of propionate was obtained from concentrate diet. As mention before, all animals were offered the same level of concentrate at 0.5% BW. Church (1972) concluded that concentration of propionate increased by pelleting of

roughage. Moreover, decreasing rumen pH has been known to increase concentration of propionate by rumen bacterial activity (Van Soest, 1994). In this experiment, it was showed that pelleted sugarcane tops decreased rumen pH when compared with control treatment, but concentration of propionate was not changed (Table 4). Concentration of butyrate was higher in pelleted sugarcane tops treatments than in control treatment ($p<0.05$). There was, however, found that acetate to propionate ratio was decreased in pelleted sugarcane tops treatments when compared with control treatment ($p<0.05$). It might be implied that pelleting was improved the utilization of energy from rumen volatile fatty acids. Because the concentration of propionate was increased in pelleted sugarcane tops treatments which has been known that propionate is a precursor for gluconeogenesis in ruminants (Church, 1977).

Rumen pH was decreased in pelleted sugarcane tops treatments ($p<0.05$). It could be explained that pelleting was rapidly degraded in rumen which has been known to decrease rumen pH (Chruch, 1977). It was an interaction between rumen pH and ammonia-nitrogen. It was found that ammonia nitrogen was high in pelleted sugarcane top treatments when compare to control treatment. Church (1977) reported that high ammonia nitrogen in rumen was increased pH of rumen. Concentration of plasma urea nitrogen (PUN) was increased in pelleted sugarcane tops treatment when compare to control treatment. There was interaction between rumen pH, NH_3N and PUN. Increasing of rumen pH was increased rate of absorption of NH_3N from rumen wall through blood. Led to increase plasma urea nitrogen (Church, 1977).

CONCLUSION

Dried-chopped sugarcane tops (DCST) increased digestibility of nutrients whereas pelleted sugarcane tops increased feed intake in beef cattle. However, it was found that digestibility of nutrients and rumen fermentation end products in pelleted sugarcane tops at 3 cm of diameter did similar with DCST. Therefore, pelleting should be conceivable way to improve the quality of agricultural crop residues for ruminants.

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