

Feeding of fresh cassava root with feed block containing high sulfur on digestibility, rumen fermentation and blood metabolites in Thai native beef cattle

Anusorn Cherdthong^{1*}, Benjamad Khonkhaeng¹, Anuthida Seankamsorn¹
and Chanadol Supapong¹

ABSTRACT: The aim of this study was to evaluate the effect of fresh cassava root (CR) with feed block containing sulfur (FBS) on feed intake, digestibility, rumen fermentation and blood thiocyanate concentration in Thai native beef cattle. Four Thai male native beef cattle, initial body weight (BW) of 130±20.0 kg were used in this study. The experiment was randomly assigned according to a 2×2 factorial arrangement in a 4×4 Latin square design. Factor A was the level of CR (1 and 1.5 % BW) and factor B was level of sulfur contain in FBS (2 and 4 %). Treatments combinations were as follows: T1: 1% CR + 2% FBS; T2: 1% CR + 4% FBS; T3: 1.5% CR + 2% FBS and T4: 1.5% CR + 4% FBS. Intake of rice straw and concentrate diet did not differ significantly among treatments ($p>0.05$) while CR total DM intake were significantly different among treatments. FBS intake was not different among treatments and ranging from 7.18 - 8.02 g/kg BW^{0.75}. Dry matter digestibility coefficient was significantly higher ($p<0.01$) in animals fed 4% sulfur than in those fed 2% sulfur. Feeding CR with FBS and their interaction were not affected rumen ecology. Cattle fed CR with FBS had no effect on BUN while increasing sulfur levels at 4% trended to be increase BUN. Blood thiocyanate concentration was increased when animal fed 4% FBS with CR and range from 19.17-20.85 ng/mg. Therefore, feeding of CR with 4% FBS could be alternative feeding regimes for ruminant production.
Keywords: fresh cassava root, feed block, sulfur, thiocyanate, cattle

Introduction

Use of cassava chip as a source of energy in ruminant feeding is well established. However, high feed prices in some parts of the world, and fluctuation in feedstuff production have raised interest in alternative feed sources for ruminant feeding. Use of fresh cassava root (CR) as an energy supplement is attractive in ruminant diets, because of its low cost compared with cassava chip, and the farmers can grow cassava in their area (Cherdthong et al., 2011). In addition, during the rainy season, it is difficult to sun-dry cassava to produce cassava chip. However, feeding of CR in ruminant is limited since it contains a high

level of hydrocyanic acid (HCN) which is responsible for chronic toxicity. Nguyen et al. (1997) reported that CR contains HCN at about 114 mg/kg fresh basis. In ruminants, HCN can be rapidly detoxified by rhodanese and β -mercaptopyruvate-sulfurtransferase by rumen microbes (Majak and Cheng, 1984). Rhodanese is a sulfur transferase that catalyzes the deformation of cyanide and thiosulphate or other suitable sulfur donor to less toxic thiocyanate which is excreted in the urine. The main source of sulfur for HCN detoxification is sulfur amino acid, cysteine and methionine or elemental sulfur (S). Promkot et al. (2007) found that higher rates of HCN concentration disappearance, thiocyanide appearance and percentage of

¹ Tropical Feed Resources Research and Development Center (TROFREC) Department of Animal Science, Faculty of Agriculture, Khon Kaen University, Khon Kaen 40002, Thailand

* Corresponding author: anusornc@kku.ac.th

thiocyanide incorporation into thiocyanide during *in vitro* fermentation were observed in 0.5% S supplemented fresh cassava foliage. This study confirms that HCN could be detoxified in the rumen and S is associated with HCN detoxification by rumen microorganism.

Feed block has been developed to contain local feed ingredients, particularly those from different energy sources (e.g. molasses, rice bran), essential minerals (S, Na, P) and non-protein nitrogen (NPN) source. Cherdthong et al. (2014) demonstrated that supplementation of feed block improved feed intake, N utilization, and blood biochemistry in Thai native beef cattle fed on rice straw.

Therefore, the aim of this study was to evaluate the effect of fresh cassava root (CR) with feed block containing sulfur (FBS) on feed intake, digestibility, rumen fermentation and blood thiocyanate concentration in Thai native beef cattle.

Materials and methods

The feed block containing sulfur (FBS) was prepared according to Cherdthong et al. (2011). All ingredients in the feed blocks were mixed together and then pressed into a block of about 10 kg by hydraulic compressor machine for 3 min per block then brought to dry under the sun for 3 days or incubate at 60°C in the incubator. Fresh cassava root (CR) (variety Kasetsart 50, bitter variety) was obtained from Ban Nonthong, Kho sub-district, Muang district, KhonKaen. It was harvested at a mature stage (1 year), washed and chopped for 3 to 5 mm before feeding. Ingredient of concentrate, FBS and CR used in the experiment are shown in Table 1.

Four Thai male native beef cattle, initial body weight (BW) of 130 + 20.0kg were used in this study. The experiment was randomly assigned according to a 2×2 factorial arrangement in a 4×4 Latin square design to evaluate the effect of CR with FBS on feed intake, digestibility, rumen fermentation and thiocyanate concentration. Factor A was the level of CR (1 and 1.5 % BW) and factor B was level of sulfur contain in FBS (2 and 4 %). Treatments combinations were as follows: T1: 1% CR + 2% FBS; T2: 1% CR + 4% FBS; T3: 1.5% CR + 2% FBS and T4: 1.5% CR + 4% FBS. A concentrate mixture was fed to animals at 5 g/kg of BW daily and offered in two equal meals daily at 7:00 and 16:00. Cattle were fed rice straw *ad libitum*. All animals were kept in individual pens. Clean fresh water and FBS were available at all times for the whole experiment. Individual intakes of rice straw, concentrate, CR and FBS were recorded daily by weighing the offered and refused feeds during the morning feeding. The experiment was conducted for 4 periods with 21 days per each. The first 14 days were for adaptation period and last 7 days were for samples collection as animals were moved to metabolism crates and fed the straw at 900 g/kg of the voluntary feed intake of straw from the adaptation period.

Feed offered and refusals samples were collected during the last 7 days of each period at morning and afternoon feedings. Fecal samples were collected during the last 7 days of each period by using total collection method as animal were on the metabolism crates to study on the nutrient digestibility. The fecal samples were collected about 5% of total fresh weight and divided into two parts; first part for DM analysis

every day and the second part was kept in refrigerator and pooled by cattle at the end of each period for chemical analysis and calculation for nutrient digestibility.

Feed and fecal samples were analyzed for DM, ash, CP (AOAC, 1990), NDF and ADF (Van Soest et al., 1991). Hydrocyanic acid contents in CR were analyzed by Bradbury et al. (1991). Rumen fluid and blood samples were collected at 0 and 4 h-post feeding on the last day of each period. About 100 ml of whole rumen fluid was collected by stomach tube from individual animals. Ruminal pH and temperature were determined immediately after collection using a glass electrode pH meter. Ammonia nitrogen ($\text{NH}_3\text{-N}$) concentration in rumen fluid was analyzed by methods of AOAC (1990). Blood samples were taken from a jugular vessel 12 ml into two parts. The first 6 ml blood portion was kept into EDTA tubes used later for blood urea nitrogen (BUN) analysis. The second portion of 6 ml blood was kept in tubes and centrifuged immediately to separate serum used later for blood thiocyanate analyzed using the method of Lambert et al. (1975).

All data were analyzed as a 2×2 factorial arrangement in a 4×4 Latin square design using the general linear procedure in PROC GLM of SAS (1996).

Results and discussion

The composition and chemical analysis of concentrate, FBS, CR and rice straw are shown in Table 1. FBS contains CP at 30.18-30.58 DM basis and could be related to urea inclusion. Hydrocyanic acid in CR was 9.14 mg/kg and was

lower than reported by Nguyen et al. (1997; 114 mg/kg fresh basis). This possibly is due to the differences variety of cassava and cassava preparation before feeding to cattle.

Effect of Thai native cattle fed CR with FBS on feed intake and digestibility of nutrients are shown in Table 2. Intake of rice straw and concentrate diet were did not significantly different among treatments ($p>0.05$) while CR total DM intake were significantly different among treatments. FBS intake was not different among treatments and ranged from 7.18 to 8.02 g/kg $\text{BW}^{0.75}$. Dry matter digestibility coefficient was significantly higher ($p<0.01$) in animals fed 4% sulfur than those in fed 2% of sulfur. It probably is due to sulfur could increase number of fibrolytic bacteria in animals fed with supplemental sulfur at 4% DM basis as compared with 2% sulfur in feed block, which could increase fiber digestibility leading to improve digestibility coefficient. This could be due to the action of urea and molasses in FBS. When more nitrogen from urea was released with molasses it will possibly be available for rumen fibrolytic bacterial synthesis. Another reason is the composition of sulfur contained in FBS which sulfur has long been recognized as an essential element for ruminant microorganism, for their growth and normal cellular metabolism and its metabolism is closely related to nitrogen metabolism (Cherdthong et al., 2011). The animal relies on microorganisms in the rumen to convert sulphate to hydrogen sulphite which is used to synthesize methionine and cysteine for microbial growth. In ruminants, sulfur is mainly required to optimize rumen cellulolytic bacterial synthesis. Therefore, the continuous availability of nitrogen with sulfur in FBS and could improve cellulolytic

bacterial population and increased DM digestibility. These result was agreed with Promkot et al. (2007) who shown that the rate of gas production and digestibility increased ($p < 0.01$) with the level of sulfur inclusion in the substrate of fresh cassava foliage.

CR supplementation with FBS and their interaction were not affected rumen ecology, namely rumen pH which ranged from 6.95 to 7.04 and temperature about 38.75 to 38.92°C (Table 3). A similar finding by Promkot et al. (2007) who shown that the pH value of the inoculum was very similar in all treatments (6.5-6.75) in rumen fluid of beef cattle fed sulfur on fresh cassava foliage and cassava hay incubated. Similarly, Cherdthong and Wanapat (2014) also indicated that these ranging of rumen pH and temperature conditions were optimum level for microbial digestion. The ruminal $\text{NH}_3\text{-N}$ values did not adversary affected among treatments. A similar result was reported by Qi et al. (1993) who found that $\text{NH}_3\text{-N}$ was not affected by adding sulfur in growing goat diet. Promkot and Wanapat (2009) had been also demonstrated that cassava foliage, supplementation of sulfur and their interaction did not affect $\text{NH}_3\text{-N}$. However, the result from this show was an increasing trend when increase in the CR diets. It could be due to providing higher levels of readily fermentable N from urea might be increased $\text{NH}_3\text{-N}$ concentrations in the rumen.

Cattle fed CR with FBS had no effect on BUN while increasing sulfur levels at 4% trended to be

increase BUN. This could be due to higher ruminal $\text{NH}_3\text{-N}$ resulted in higher BUN which indicated that BUN concentration is positively correlated with ruminal $\text{NH}_3\text{-N}$ (Promkot and Wanapat, 2009). In contrast, blood thiocyanate concentrations was significantly ($P < 0.01$) different between sulfur levels in feed block (Table 3). The concentration of blood thiocyanate was increased when animal fed high sulfur with CR and range from 19.17 to 20.85 ng/mg. It could be relatively increase of cyanide consumption and sulfur inclusion in FBS. NRC (2001) reported that the animals received hydrocyanic acid in diets (such as fresh cassava root or sorghum) might require a high sulfur supplement, in order to activate sulfur for detoxification into thiocyanate form. Hydrocyanic acid can be rapidly detoxified by rhodanese and β -mercaptopyruvate-sulfurtransferase by rumen microbes (Majak and Cheng, 1984). Rhodanese is a sulfur transferase that catalyzes the deformation of cyanide and thiosulphate or other suitable sulfur donor to less toxic thiocyanate which is excreted in the urine. Similarly, Promkot et al. (2007) demonstrated that inclusion of 0.5% sulfur in fresh cassava foliage could reduce hydrocyanic acid concentration while percentage of thiocyanide concentration during *in vitro* fermentation was increased. Onwuka et al. (1992) also found that percentage of sulfur in the diet was correlated with serum thiocyanate concentration when sheep were fed a dried cassava-based diet.

Table 1 Ingredient of concentrates and chemical composition used in the experiment (% dry matter (DM)).

| Item | Con ^a | FBS ^b 2 | FBS ^b 4 | CR ^c | RS ^d |
|-----------------------------|------------------|--------------------|--------------------|-----------------|-----------------|
| Ingredients, (% DM). | | | | | |
| Cassava chip | 55 | - | - | | |
| Rice bran | 11 | 30 | 30 | | |
| Palm kernel meal, solvent | 13.5 | - | - | | |
| Coconut meal, solvent | 12.9 | - | - | | |
| Molasses, liquid | 2 | 42 | 40 | | |
| Urea | 2.6 | 10 | 10 | | |
| Cement | - | 11 | 11 | | |
| Pure sulfur | 1 | 2 | 4 | | |
| Mineral premix | 1 | 2 | 2 | | |
| Salt | 1 | 1 | 1 | | |
| Tallow | - | 2 | 2 | | |
| Chemical composition | | | | | |
| Dry matter, (%) | 87.42 | 79.11 | 76.27 | 27.61 | 90.10 |
| Organic matter (%) | 94.77 | 90.00 | 90.10 | 92.60 | 91.77 |
| Crude protein (%) | 14.16 | 30.58 | 30.18 | 2.08 | 2.61 |
| Neutral detergent fiber (%) | 53.19 | 18.94 | 22.71 | 53.13 | 85.34 |
| Acid detergent fiber (%) | 29.78 | 8.01 | 10.03 | 31.19 | 47.62 |
| Hydrocyanic acid, mg/kg | - | - | - | 9.14 | - |

^aConcentrate diet^bFeed block sulfur^cFresh cassava root^dRice straw**Table 2** Feed utilizations of Thai native cattle fed fresh cassava root (CR) with feed block sulfur (FBS)

| Item | CR-1 | | CR-1.5 | | SEM | Interaction | | |
|-----------------------------------|---------------------|---------------------|---------------------|---------------------|------|-------------|------|--------|
| | FBS-2 | FBS-4 | FBS-2 | FBS-4 | | CR | FBS | CR*FBS |
| DM intake g/kg BW ^{0.75} | | | | | | | | |
| Rice straw | 57.99 | 57.52 | 57.62 | 52.53 | 4.45 | 0.56 | 0.55 | 0.61 |
| Concentrate | 16.86 | 16.83 | 16.83 | 16.89 | 0.37 | 0.96 | 0.97 | 0.91 |
| CR | 33.72 ^a | 33.66 ^a | 50.57 ^b | 50.72 ^b | 0.98 | 0.01 | 0.96 | 0.92 |
| FBS | 7.41 | 8.02 | 7.71 | 7.18 | 1.48 | 0.86 | 0.98 | 0.70 |
| Total DM intake | 115.96 ^a | 116.04 ^a | 132.73 ^b | 127.26 ^b | 4.86 | 0.01 | 0.59 | 0.58 |
| Apparent digestibility | | | | | | | | |
| Dry matter (%) | 65.15 ^a | 73.30 ^b | 66.37 ^a | 75.60 ^b | 1.43 | 0.24 | 0.01 | 0.71 |
| Organic matter (%) | 79.47 | 31.08 | 83.11 | 82.39 | 1.97 | 0.23 | 0.82 | 0.56 |
| Crude protein (%) | 66.06 | 71.50 | 68.62 | 63.52 | 3.80 | 0.48 | 0.96 | 0.18 |
| Neutral detergent fiber (%) | 72.58 | 74.16 | 76.47 | 74.95 | 2.47 | 0.36 | 0.99 | 0.54 |
| Acid detergent fiber (%) | 68.25 | 69.71 | 72.55 | 70.85 | 2.91 | 0.37 | 0.97 | 0.60 |

^{a,b,c} Means in the same row with different superscripts differ (P<0.01)

Table 3 Feeding of fresh cassava root (CR) with feed block sulfur (FBS) in Thai native beef cattle on rumen ecology.

| Item | CR-1 | | CR-1.5 | | SEM | Interaction | | |
|---------------------------|--------------------|--------------------|--------------------|--------------------|------|-------------|------|--------|
| | FBS-2 | FBS-4 | FBS-2 | FBS-4 | | CR | FBS | CR*FBS |
| Ruminal pH | 6.95 | 7.01 | 7.04 | 6.75 | 0.15 | 0.59 | 0.43 | 0.26 |
| Ruminal temperature, °C | 38.82 | 38.92 | 38.91 | 38.75 | 0.27 | 0.89 | 0.90 | 0.64 |
| NH ₃ -N, mg/dl | 15.65 | 15.97 | 17.62 | 17.13 | 1.23 | 0.23 | 0.95 | 0.75 |
| BUN, mg/dl | 11.50 | 12.25 | 12.75 | 13.38 | 0.89 | 0.20 | 0.46 | 0.95 |
| Thiocyanate, ng/ml | 14.72 ^a | 20.85 ^b | 15.77 ^a | 19.17 ^b | 1.51 | 0.84 | 0.01 | 0.40 |

^{a,b,c} Means in the same row with different superscripts differ (P<0.01)

Conclusion

In summary, feeding of CR with 4% FBS could increase thiocyanate concentration in the blood and enhanced DM digestibility. Moreover, animals fed CR with FBS did not adverse effect on roughage intake, rumen fermentation and BUN. Therefore, feeding of CR with 4% FBS could be alternative feeding regime for ruminant production.

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