Influence of bagasse versus rice straw with oil sources in a total mixed ration on feed intake, digestibility and blood chemistry of crossbred Thai Native x American Brahman cattle

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ABSTRACT

This study was aimed to analysis the effects of roughage sources and oil sources in a total mixed ration (TMR) on voluntary feed intake, digestibility and blood chemistry. The study was conducted using four crossbred Thai Native X American Brahman cattle, aged 1.5 years old and with a live weight of 177±34 kg, which were trialled by using a 2x2 factorial in 4x4 Latin square design. All cattle received TMR diets supplemented with bagasse and palm oil, bagasse and sunflower oil, rice straw and palm oil, rice straw and sunflower oil. Each period of feeding lasted for 21 days. During the experimental periods, all cattle were fed \textit{ad libitum} and with a water supply. The results revealed that roughage sources and oil sources did not affect voluntary feed intake, digestibility and blood chemistry. It was concluded from this experiment that using bagasse or rice straw as the roughage sources with palm oil and sunflower oil mixed in the TMR were suitable for use in beef cattle diets, especially using bagasse with palm oil because of the lowest price (0.28 USD/kg) when compared to the other treatments.

Keywords: roughage sources, oils resources, total mixed ration, beef cattle
INTRODUCTION

For the production of ruminants in tropical areas it is well known that huge quantities of low-quality feedstuffs such as rice straw and bagasse from biomass can be used as a potential roughage source for ruminants (Van Soest, 1994). Rice production in Asia is about 670 million tons per year (Nguyen et al., 2019) so ample sources are available, as after rice harvesting, rice straw can be produced as a feed for ruminants. In addition, bagasse is another by-product of the sugar industry used to feed ruminants and could be shown to be important for fibre utilisation in ruminants such as in buffaloes (Seshaiah et al., 2014) and goats (Baiti et al., 2013). Whereas by product from bulky nature of roughage sources restrict consumption so that livestock need additional energy supplementation according to Bauman et al. (2003) who finding sustainable sources of energy for ruminants is important and fat supplementation appears to be of benefit for increasing the diet's energy density. Moreover, the use of these kind of feedstuffs are possible to reduce operational feed cost and could increase the benefit of production.

The objective of this study was to investigate the effect of the addition of bagasse and rice straw with palm oil and sunflower oil in the TMR on voluntary feed intake, nutrient intake, digestibility and blood chemistry in crossbred Thai Native x Brahman bulls.

MATERIALS AND METHODS

Animals and Experimental Design

Four crossbred Thai native X Brahman bulls, with a live weight of 177±34 kg and aged about 1.5 years old were used in a 2x2 factorial in 4x4 Latin-square design with 21 days for each period. The bulls were treated for intestinal worms and were injected with an oily solution of A, D₃ and E vitamins before the start of the experiment. All animals were housed individually.

Experimental Diets

During each period (21 days for each period), all animal treatments were offered ad libitum. TMRs were roughage: concentrate in a 40:60 ratio, in which dry fodder, especially rice straw and bagasse were chopped into 3 cm sizes, mixed along with concentrate in proportion to make a chemical composition as presented in Table 1. The mixing of roughage and concentrate portions of the feed was then blended together to make the TMR. The treatment consisting of bagasse and rice straw were used as the roughage sources supplemented with sunflower oil (SFO) and palm oil (PO) as the oil sources. The diets were articulated isonitrogenous and iso-TDN (14% protein, 60%), and the price of feeds were 8.60, 8.80, 9.00 and 9.50 THB (Thai baht)/kg as shown in Table 1.

Feeds, Faeces Collection and Analysis

The experiment proceeded for 4 periods, in each period the first 14 days were an adaptation period and the last 7 days were an experimental period. The amount of TMRs offered was collected daily so that TMR refusals were weighed. All TMRs offered and refused were sampled through the experimental period and stored (at −20 °C) until chemical composition analyses were carried out: dry matter (DM), ash, crude protein (CP) and ether extract (EE) (AOAC, 1984), neutral detergent fibre (NDF) and acid detergent fibre (ADF) (Goering and Van Soest, 1970). Voluntary feed intake and apparent diet digestibility were determined by the method as described by Moloney and O'Kiely (1997).

Measurement of Body Weights and Blood Analysis

The animals were weighed before and after each experimental period. In the morning before feeding, the cattle were restrained and blood was collected by puncturing the jugular vein. Blood collections were made using evacuated tubes containing anticoagulants and centrifuged at 2,500 g for 15 min. All plasma samples were evaluated in commercial kits (Labtest®Diagnóstica S.A.,Lagoa Santa, MG, Brazil) to analyse plasma glucose, blood urea nitrogen (BUN), triglycerides, and cholesterol concentrations.

Statistical Analysis

All data were analysed using SAS, software version 8.0 (SAS, 2000). The PROC general linear model (GLM) procedure was used for the analysis of variance (ANOVA). Means were compared by Duncan's new multiple range test (DMRT) (Steel and Torrie, 1980).
RESULTS AND DISCUSSION

Chemical Composition of Experimental Diets
The chemical compounds of the diets are shown in Table 2. Chemical compositions of the TMR in each dietary treatment were similar. The percentages of EE contents in the TMRs were 4.50, 5.11, 5.20 and 4.95, while CP contents were 14.35, 14.40, 13.92 and 13.81% respectively.

Daily Dry Matter and Nutrient Intakes
Generally, the high intake of fats certainly depresses feed intake as a result of the inhibition of rumen movement (Chilliard, 1993). In the current experiment, feed intake was unaltered, and ruminant nutrition recommends total fat should not be extreme i.e. 6–7% of dietary dry matter without a negative effect on the nutrient digestion (Jenkins, 1993). Therefore, it was found that fat source supplementation was not affected by the total dry matter intake (kg/day and g/kgBW0.75) of cattle (Table 3) which is confirmed by Thanh et al. (2018), who fed goats with Guinea grass with concentrate including 25 g/kg of SFO with total fat in the feed being 4.63% in diet and this did not affect feed intake. All treatments did not affect DM intake/kgW0.75 and DM intake as a % of BW and this agrees with Otaru et al. (2011) who suggested an addition of 4% palm oil in concentrate for goats.

Intakes of DM, OM, CP, EE and NDF were not significantly different across the diets (P>0.05) according to Markus et al. (1996) who suggested that, when supplemented with 7.1% whole sunflower seeds (4.2% total fat) in the diet of Holstein cows, this did not influence the intakes of NDF and ADF. Additionally, Thanh et al. (2018) suggested that replacing SFO with fish oil (FO) with total fat 4.5% approximately in the diet of growing goats did not significantly affect the intakes of DM, OM, CP and EE. Nevertheless, the ADF intake of bagasse was higher (P<0.01)
than in the rice straw of the bulls due to ADF in TMRs with bagasse supplemented with PO and SFO which contained higher ADF than TMRs with rice straw supplemented with PO and SFO (Table 3). Apparent Digestibility of Nutrients

No significant differences were observed for
the digestibility of DM, CP, EE and NDF and ADF in beef cattle being fed either bagasse or rice straw with PO or sunflower SFO based TMR (Table 4). In the present experiment, the oil supplementation was almost 5.0% and that is not high enough to sufficiently depress the feed intake because it is less than the safe level for microbial activity in the rumen (Morsy et al., 2015). Normally, the ruminant nutritionists recommend the total fat in the diet to be below 6% of the DM. Moreover, the digestibility of DM and CP in this present experiment was lower than Thanh et al. (2018) who supplemented 25 g/kg DM sunflower oil in growing goats, DM digestibility was 70.29%, and CP digestibility was 80.77%, respectively. Additionally, Wachirapakorn et al. (2016) reported that cows fed ground corn cobs (33%) and rice straw (7%) in TMR, NDF digestibility was 63.40% and 52.60% respectively. However, for EE digestibility this experiment was approximately 86.36% lower than Polviset et al. (2015) who suggested that 97.50% EE digestibility in Thai native bulls fed with sunflower seed. It might be reasoned that oil seeds may not negatively affect nutrients’ digestibility.

**Blood Chemistry**

In this experiment (Table 5) plasma glucose concentrations ranging between 85.50-92.00 mg/dl were higher than reported from Kholif et al. (2018) who fed goats with 20 ml of flaxseed oil in concentrate (blood glucose was 68.90 mg/dl) and Civelek et al. (2011) suggested serum glucose ranging from 49.79-59.00 mg/dl. However in a study, plasma glucose did not find any effect when the beef cattle were supplemented with different diets.

In this experiment, the range of plasma cholesterol concentrations did not differ significantly (P>0.05) from the treatments. The range in between 88.00-134.75 mg/dl were lower than Otaru et al. (2011) who reported the range of serum cholesterol concentrations of 122.30–186.15 mg/dl when an increased level of palm oil were included in goats. On the other hand, Tudisco et al. (2019) who fed TMR supplemented with hydrogenated palm oil in dairy goats, cholesterol concentration was 70.16 mg/dl in agreement with our results, when fed TMR with rice straw and sunflower oil, cholesterol concentration was 88 mg/dl. In the other studies with dairy cows the mean concentration of cholesterol esters was 175.40 mg/dl supplemented with TMR (formula is not shown) (Bitman et al., 1990) agree with Wheeler et al. (1987) who reported cholesterol concentration in British crossbred cattle as 162.3 mg/dl.

Plasma BUN is a by-product of protein metabolism in animals. In our study, the treatments were not significant, and 15.85-19.63 mg/dl lower than Javaid et al. (2008) who suggested that for medium ruminally, degradable protein fed buffalo bulls the BUN concentration was 22.77 mg/dl, and Tudisco et al. (2019) reported that when fed hydrogenated palm oil at 50 g/day in dairy goats the BUN concentration was 38.96 mg/dl. However, the BUN concentration in this study was in the normal

| Items | Diets | SEM | P-value |
|-------|-------|-----|---------|
|       | Bagasse | Rice Straw |       | RS | OILS | RS*OILS |
|       | PO | SO | PO | SO | | |
| DM    | 67.74 | 65.77 | 69.00 | 64.37 | 1.67 | ns | ns | ns |
| CP    | 62.09 | 62.58 | 65.13 | 61.54 | 1.14 | ns | ns | ns |
| EE    | 83.32 | 87.63 | 87.17 | 87.33 | 1.25 | ns | ns | ns |
| NDF   | 64.52 | 53.52 | 66.16 | 60.84 | 1.73 | ns | ns | ns |
| ADF   | 53.57 | 56.23 | 58.09 | 54.37 | 1.70 | ns | ns | ns |

PO= palm oil; SO= Sunflower oil; DM= Dry matter; CP= Crude protein; EE= Ether extract; NDF = Neutral detergent fibre; ADF= Acid detergent fibre; RS= roughtage sources; SEM = standard error of the mean; ns = not significant
Additionally, feed supplementation with the type and amount of dietary fat was an influence on the value of triglycerides in plasma (Clemens et al., 1974; Ghoreishi et al., 2007). The range of triglycerides concentration was 19.25-37.00 mg/dl in this experiment, higher than Civelek et al. (2011) who recommended serum triglycerides from 10.17-12.42 mg/dl, and Tudisco et al. (2019) who fed TMR supplemented with hydrogenated palm oil in dairy goats with triglycerides concentration was 20.12 mg/dl. Nevertheless, Kholif et al. (2018) reported that triglycerides concentration was 131.80 mg/dl when fed 20 ml of flaxseed oil in goats. However, overall the circulating lipids in ruminants were fluctuating depending on the feed supplementation.

CONCLUSION

The results of this experiment indicated that the addition of roughage sources from either bagasse or rice straw (40%) in the TMR containing concentrate (60%) with palm oil or sunflower oil were carried out without any effect on DMI, digestibility and blood chemistry. However, using bagasse with palm oil was suitable in beef cattle diets due to the lowest price (0.28 USD/kg).

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