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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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ABSTRAK

Tujuan penelitian ini adalah menganalisis efek sumber serat dan sumber minyak dalam ransum campuran total (RCT) pada asupan pakan sukarela, kecernaan dan kimia darah. Penelitian dilakukan menggunakan empat sapi hasil persilangan Thai native x American Brahman, berumur 1,5 tahun dengan bobot badan 177 ± 34 kg yang diujicobakan dengan menggunakan factorial 2x2 dalam desain bujur sangkar latin 4x4. Semua ternak memperoleh diet RCT yang dilengkapi ampas tahun dan minyak kelapa sawit, ampas tahun dan minyak bunga matahari, jerami padi dan minyak kelaapa sawait, jerami padi dan bunga matahari. Setiap periode berlangsung selama 21 hari, semua sapi diberi makan ad libitum dan persedian air yang tidak terbatas. Hasil penelitian menunjukkan bahwa sumber serat dan sumber minyak tidak mempengaruhi asupan pakan sukarela, kecernaan dan kimia darah. Disimpulkan bahwa ampas tahu atau jerami sebagai sumber serat dengan minyak kelapa sawit dan bunga matahari yang dicampur dadalam TMR cocok digunakan dalam pakan sapi potong, terutama ampas tahu dengan minyak kelapa sawit karena menunjukkan harga terendah (0,28 USD/kg).

Kata kunci : sumber serat, sumber minyak, pakan campuran total, sapi potong

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 4×4 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 *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. Therefore, by considering vegetable oils, this can be obtained from palm or sunflower oil. Additionally, another energy source in tropical areas always uses is cassava chips that a good source of ruminal degradation (Sommart *et al*., 2000).

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, D_3 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).

Table 1. Ingredients and Chemical Composition of Experimental Diets

Ingredients(kg)	Bagasse		Rice Straw	
	PO	SO	PO	SO
Ingredients (based on 100% DM)				
Bagasse	40.00	40.00	-	-
Rice straw	-	-	40.00	40.00
Palm kernel cake	10.00	-	17.00	-
Sunflower meal	-	11.00	-	12.00
Soy bean meal 44% CP	7.00	7.00	7.00	6.50
Cassava chip	35.50	35.50	29.50	35.00
Palm oil	1.50	-	1.00	-
Sunflower oil	-	1.00	-	1.00
Urea	3.50	3.00	3.00	3.00
Dicalcium phosphate	1.00	1.00	1.00	1.00
Limestone	1.00	1.00	1.00	1.00
Premix	0.30	0.30	0.30	0.30
Salt	0.20	0.20	0.20	0.20
Total	100.00	100.00	100.00	100.00
Price(USD)/kg	0.28	0.29	0.30	0.31

PO= Palm oil; SO=Sunflower oil

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/kgBW$^{0.75}$) 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)

Table 2. Chemical Compositions of TMR (DM Basis)

Chemical Composition (%)	Bagasse		Rice straw	
	PO	SO	PO	SO
DM	91.20	92.55	89.94	90.67
OM	89.83	90.78	88.36	89.65
EE	4.50	5.11	5.20	4.95
CP	14.35	14.40	13.92	13.81
NDF	51.33	53.50	54.78	56.86
ADF	25.96	28.77	21.89	20.45
Crude ash	10.17	9.22	11.64	10.35
TDN	66.50	63.26	65.18	64.83

PO= palm oil; SO= Sunflower oil; DM= Dry matter; OM = Organic matter; EE= Ether extract; CP= Crude protein; NDF = Neutral detergent fibre; ADF= Acid detergent fibreTDN = Total digestible nutrient

Table 3. Daily Dry Matter Intake (kg/d) and Nutrient Intake (kg/d) in Bulls Fed Different Diets

Items	Diets				SEM	P-value		
	Bagasse		Rice Straw			RS	OILS	RS*OILS
	PO	SO	PO	SO				
Total DM Intake								
kg/d	4.60	4.91	4.66	4.69	0.22	ns	ns	ns
g/kgBW$^{0.75}$	54.11	55.37	54.40	53.27	1.94	ns	ns	ns
%BW	2.24	2.33	2.26	2.34	0.04	ns	ns	ns
Nutrient Intake (kg/day)								
OM	4.20	4.55	4.19	4.25	0.20	ns	ns	ns
CP	0.66	0.71	0.65	0.65	0.03	ns	ns	ns
EE	0.21	0.25	0.24	0.23	0.01	ns	ns	ns
NDF	2.36	2.63	2.55	2.67	0.12	ns	ns	ns
ADF	1.19	1.42	1.02	0.96	0.05	**	ns	ns

PO= palm oil; SO= Sunflower oil; OM= Organic matter; CP= Crude protein; EE= Ether extract; NDF = Neutral detergent fibre; ADF= Acid detergent fibre; PO= palm oil; SO= Sunflower oil; RS= roughage sources; SEM = standard error of the mean; ns = not significant.**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 cholesteryl 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

Table 4. Apparent Digestibility of Nutrients

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= roughage sources; SEM = standard error of the mean; ns = not significant

Table 5. Blood Chemistry Parameters in Bulls

Items (mg/dl)	Diets				SEM	P-value		
	Bagasse		Rice straw			RS	OILS	RS*OILS
	PO	SO	PO	SO				
Plasma glucose	91.50	92.00	86.25	85.50	5.24	ns	ns	ns
BUN	19.63	18.28	17.63	15.85	3.55	ns	ns	ns
Cholesterol	111.75	134.75	104.75	88.00	13.71	ns	ns	ns
Triglycerides	28.00	37.00	19.25	28.00	6.62	ns	ns	ns

PO= palm oil; SO= Sunflower oil; RS= roughage sources; BUN= Blood urea nitrogen; SEM = standard error of the mean; ns = not significant

range of BUN (2.9 to 22.4 mg/dl.) (Lane and Campbell, 1966).

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 sun flower 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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