Digestibility and Performance of Buffalo Fed Total Mixed Ration with Different Levels of Citric Waste

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ABSTRACT

The experiment was conducted to determine the utilization of citric waste (CW) in total mixed ration (TMR) for buffaloes. Sixteen swamp buffaloes (200.9 ± 3.1 Kg body weight) were randomly allotted into 4 treatments, 4 replications (one buffalo/one replication) according to the Completely Randomize Design Experiment (CRD). TMR diets were formulated to contain 14% crude protein and 2.6 Mcal/kg energy according to the requirement of buffaloes. The CW was substituted for cassava in TMR at 0, 10, 20 and 30%, respectively. The buffaloes were raised in individual cages for 2 months feeding trial. Growth and feed intake (FI) were recorded and determined for FI, average daily gain (ADG) and feed per gain (FCR). Feces were also recorded and collected to determine digestion coefficient using acid insoluble ash (AIA) marker. The results showed that the substitute of CW had no effect on ADG, FI and FCR of buffaloes ($P>0.05$). The digestion coefficient of dry matter, protein, and NDF were not different ($P>0.05$) among diets. Diet with 10% CW had the highest digestibility ($P>0.01$). The digestibility of ADF was decreased with the higher level of CW.

Keywords: digestibility, waste product, citric plant, buffalo

INTRODUCTION

Buffaloes are the important domestic animal, especially for small holder in the Northeast of Thailand. The numbers of buffaloes are rapidly decreased every year. To increase efficiency of buffalo production, several factors need to be improved especially the diets. The good quality diet can increase the efficiency of production such as weight gain, carcass quality and meat production. Waste products from cassava are cassava peel and cassava pulp which account for 3 and 6 % of fresh weight respectively (Rakshit, 2003). Both waste had high production but low cost (0.50 Baht to 1.5 Baht/Kg) and can be used for citric acid production by mixed with rice brand and inoculated with Aspergillus niger for 7 days. There is a lot of residue left after citric was harvested. These residues have high acidity but still have some protein (2.98) which can be used for animal feed. Previous research showed that CW can be used in cattle diet up to 16 % without any effect on feedlot performance. According to several researches, buffalo can use low quality roughage and high lignin feed ingredients than cattle. Then citric waste (CW) should be able to use as the feed ingredient in concentrate diet for buffalo. If CW can be used more in buffalo diet, it will be useful not only to reduce feed cost for buffalo production but also reduce waste from citric plant. The objective of this experiment is to study on digestibility of diet with several levels of CW in buffaloes.

Citric acid is an organic acid used in several industries such as food, beverage, medicine and cosmetics. Several crop residues can be used for citric production such as corn cob and cassava waste (Hossain et al., 1983). At least 2 plants in Thailand used cassava waste for citric acid production. One plant in Kalasin uses cassava pulp as the major sources in Solid State Fermentation process (SSF). The second plant in Samutsongkarm uses cassava chip as the major sources in the Submerge Fermentation process (SF). The SSF is more popular process due to more citric production and less waste (Pandey and Soccol, 1998). With an appropriate water (60 %

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moisture) and fermentation period, there will be a production of citric 26-27 g/100 of substrates (Grewal and Kalra, 1995; Prado et al., 2005). Uriyapongson et al. (2006) reported that waste product was high in moisture (77.63 %), acid (pH 4), fiber and lignin and 3-5% protein available.

Uriyapongson et al. (2006) and Prapunsil (2008) reported that CW had NDF, ADF and acid detergent lignin (ADL) at 86.13, 68.17 and 19.74 % of dry matte respectively. This high fiber waste can be used at low level in non-ruminant. Dnupatra and Todsapon (2007) used CW to replace cassava at 0, 5 and 10% in goat diet. They concluded that, concentrate intake of the goat was lower due to high acid of CW and recommend to supplement not more than 5 % in concentrate diet for weaning goat. Peeraporn et al. (2008) used CW and rice straw in the total mix ration (TMR) for dairy cattle. The ratio of roughage to concentrate was 40 to 60 and levels of CW in TMR were 0, 10, 20 and 30 %, respectively. The results showed that feed intake was higher due to more fiber in rice straw than in CW. Milk production (4 % fat collected milk) increased directly to the level of CW while milk fat and milk protein were directly decreased. This was due to rice straw was the better precursor for VFA production than CW. However, used 30% CW with rice straw reduce feed cost and made more profit to farmers. Prapunsil (2008) used CW in concentrate diet at 0, 10, 20 and 30% in 162 Kg. Brahman X Native crossbred cattle. The result showed that cattle fed 10 % CW had the highest feed intake and weight gain. More CW in the diet reduced digestibility of the cattle because of the higher fiber (68.17 %). He concluded that CW can be used up to 10 % without any effect on feedlot performance and carcass characteristics.

MATERIALS AND METHODS

Sixteen culled water buffaloes (200.9±3.1 kg. body weight) were randomly allotted into 4 treatments and 4 replications according to Completely Randomized Design experiment. All buffaloes were fed daily with total mix ration (TMR) at 3 % of body weight while water was available at all times. The TMR diets were formulated to provide 14% crude protein and 2.67 Mcal/kgDM gross energy according to NRC (1984) as showed in Table 1. The CW was supplemented for cassava at 0, 10, 20 and 30% in the TMR. Feed intake was daily recorded. Feed and feces samples were collected to determine for dry matter (DM) crude protein (CP), ash and ether extract, EE) according to procedure of AOAC (1985). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were determined according to procedure of Goering and Van Soest (1970). Acid insoluble ash (AIA) was determined according to procedure of Van Keulen and Young (1977) and used as an indicator to evaluate digestion coefficient. The digestion trial was run for 2 months feeding period. All data were determined for Analysis of variance. Treatment means were compared using Duncan's New Multiple Range Test SAS, 1990 .

RESULTS AND DISCUSSIONS

The chemical composition of experimental diets showed higher NDF and ADF when higher percentage of CW was supplemented (Table 2). Supplementation of CW had no effect on feed intake final weight, weight gain and feed conversion ratio ($P>0.05$) as showed in Table 3. Weight gain buffalo was 0.44 kg/day and buffaloes from T1 showed the higher weight gain compared to other treatments. Weight gain from this experiment was lower than those reported by Wanapat and Wachirapakorn (1990) in buffalo fed 500 g concentrated per day and gain 0.8 kg/day. Uriyapongson et al. (2003) also showed higher weight gain (approximately 0.8 kg/day) when used broken rice substituted for corn in culled buffaloes. Prapunsil et al. (2008) concluded that cattle had more FCR when used more CW in the concentrate diets.

Digestion coefficient using AIA as an indicator showed that buffaloes had similar digestibility of DM, protein (CP), crude fiber and NDF ($P>0.05$) as showed in Table 4. However, digestibility of OM of buffaloes fed 10% CW was higher than other treatments. The digestibility of ADF decrease lower as the level of CW increased. Prapunsil et al. (2008) studied in beef cattle also showed that digestibility of protein was higher in 10% CW than without CW. The higher level of CW reduced digestibility of ADF and feed intake in cattle. Therefore, utilization of CW to supplement for cassava had no effect on feed intake, weight gain, feed conversion ratio in

buffaloes (P>0.05). The digestion coefficient of nutrient (DM, CP and NDF) were similar among treatments but digestibility of OM in diet with 10% CW had the highest value (P<0.01) while digestibility of ADF in non-supplemented group had the highest value (P<0.01).

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Table 1. Feed ingredient of total mixed ration.

Feed ingredient ( )	Total Mixed Ration			
	T1	T2	T3	T4
Citric waste	0	10	20	30
Cassava	40	30	20	10
Rice straw	30	30	30	30
Soybean meal (44%CP)	12.1	12	12.2	12.5
Rice bran	2.3	2.05	1.5	1
Palm oil meal	3.2	3.2	3.2	3.2
Palm oil	2	2.4	2.8	3.1
Molasses	5	5	5	5
Di-calcium	1	1	1	1
Mineral	1	1	1	1
Salt	0.5	0.5	0.5	0.5
Urea	2.1	2.05	2	1.9
Lime	0.5	0.5	0.5	0.5
Sulfur	0.3	0.3	0.3	0.3
Total	100	100	100	100
Price / kg (Baht)	5.7	5.2	4.8	4.4

Table 2. Nutrient composition of Total Mixed Ration.

Nutrient %	T1	T2	T3	T4
Dry matter (DM), %	88.37	88.80	87.33	86.47
	% Dry matter			
Organic matter (OM)	90.25	89.54	88.23	86.24
Ash	9.74	10.45	11.76	13.75
Crude protein	14.32	14.74	14.56	14.16
Ether extract (EE)	2.34	3.00	3.93	3.19
NDF	31.96	37.94	41.87	47.58
ADF	27.38	28.53	31.66	36.25
Total Energy (GE), Mcal/kg	3.80	3.85	3.80	3.80

Note T1, T2, T3, T4 means diet with CW at 0, 10, 20 and 30 %

Table 3. Effect of citric waste in concentrate diet on growth performance in buffaloes.

Characteristics	Treatments				SEM	P-value
	T1	T2	T3	T4		
Initial weight (kg)	207.00	191.25	207.00	198.67	5.78	0.22
Final weight (kg)	239.75	220.50	229.50	221.67	8.42	0.40
Weight gain (kg)	0.55	0.49	0.38	0.37	0.05	0.17
Feed intake (kg/d)	5.94	5.14	4.56	4.82	0.43	0.19
Feed conversion ratio	11.07	11.11	12.04	13.56	1.39	0.64

Note T1, T2, T3, T4 means diet with CW at 0, 10, 20 and 30 %

Table 4. Digestibility of nutrient in buffaloes fed different level of CW.

Characteristics	Treatment				SEM	P-value
	T1	T2	T3	T4		
Dry matter digestibility (%)	54.11	60.44	54.60	53.23	2.11	0.21
Organic matter digestibility (%)	63.65^{b}	65.42^{a}	63.84^{b}	62.00^{c}	0.17	<0.01
Digestibility of protein (%)	67.23	70.55	68.58	67.13	1.00	0.19
Digestibility of NDF (%)	53.61	51.85	51.05	50.81	1.50	0.59
Digestibility of ADF (%)	52.62^{a}	50.31^{b}	49.66^{b}	47.33^{c}	0.57	0.01

Note T1, T2, T3, T4 means diet with CW at 0, 10, 20 and 30 %
^{abc} within row were difference ($p<0.05$)