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Effect of Diatomite Filter Aid Residue in Feed on Feedlot Performance of Male Holstein x Thai-indigenous Crossbred Cattle*

Abstract

A study was conducted to determine the effect of diatomite filter aid residue (DFR) in feed on feedlot performance of male Holstein x Thai-indigenous crossbred cattle. Sixteen male Holstein x Thai-indigenous crossbred cattle averaging 230.48 ± 23.45 Kg initial body weight and 1.21 ± 0.14 years initial age, were randomly allocated to individual stalls and assigned to 4 groups. The animals in each group were randomly offered one of 4 isonitrogenous diets containing either 0, 30, 40 or 50% DFR and were fed *ad libitum* on both roughage and concentrate for 84 days. Average dry matter intake ($P<0.05$), dry matter intake as a percentage of body weight ($P<0.01$) and dry matter intake/$Kg^{0.75}$ ($P<0.01$) of concentrate were highest in cattle on 50%DFR. In contrast the average dry matter intake ($P<0.05$), dry matter intake as a percentage of body weight ($P<0.05$) and dry matter intake/$Kg^{0.75}$ ($P<0.01$) of roughage were highest in the control group cattle (0%DFR). Consequently, the concentrate to roughage intake ratio of the cattle fed 50 %DFR was highest ($P<0.01$). Organic matter and metabolisable energy intakes were not significantly different ($P>0.05$) among the treatment groups. However, the crude protein intake of total feed was highest ($P>0.05$) for the cattle on the 50% DFR. Total weight gain and average daily gains were not significantly different ($P>0.05$) whereas feed conversion ratio of total feed was highest in cattle on 50% DFR ($P<0.01$). Average gross margin considering feed cost as the only input cost for each group was 376.17, 616.92, 751.13 and 218.25 Baht[4]/head on the four groups respectively. Based on the findings from this study, 40% of DFR can be used in diets for fattening male Holstein x Thai-indigenous crossbred cattle.

1. Introduction

Diatomite, also called diatomaceous earth or kieselguhr, is a mineral from the fossils of the silica shell of the single cell eucaryotic algae diatoms. Diatomite is found widely in the world either in the earth (Eagle-Picher, 1988; Edwards, 1991) or accumulated on the bottoms of lakes (Sigurdsson, 1992). The world's resources have been estimated at 2 billion tonnes (Sigurdsson, 1992). In the diatomite production plants, about 1.8 - 2.2 million tonnes of diatomite is produced annually.

The main uses of diatomite are as filters, fillers, insulators and absorbers (Roskill Information Service Ltd, 1994). Diatomite used as filter aid mainly consists of silicic acid or silica dioxide (SiO_2) which account for 89.2 - 92.8 % of the components. Oxides of Aluminium, Iron, Calcium, Magnesium and Sodium and some other trace minerals are also found (Eagle-Picher, 1988). The flux calcined diatomite used as filter aid is normally white

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[4] Baht : Thai monetary unit (15.20 Baht were equivalent to 1 DM during the experimental time period).
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in colour, about 33 μ in diameter, with pH of 10.0, density of 220-320 g/l and specific gravity of 2.33 (Eagle-Picher, 1988).

Diatomite filter aids are used in Thailand widely in factories such as in brewery and in monosodium glutamate production. In monosodium glutamate production process, some undigested starch and sugar residues accumulate on the diatomite filter aid structure which is removed with the filters. The used diatomite gives diatomite filter aid residue (DFR). About 2.200 tonnes of DFR is released annually in Thailand (Ajinomoto, Thailand co. Ltd., Personal communication).This DFR contains crude protein, crude fibre, ether extract, ash and nitrogen free extract (NFE) in the proportions of 51.0, 31.4, 20.3, 470.4 and 426.9 g/kg on dry matter basis respectively (Feed analysis division, 1991). This quality profile makes it a potential animal feed resource. This study was conducted to evaluate the effect of DFR inclusion in feed on growth performance and economic returns under feedlot conditions of male crossbred Holstein x Thai-indigenous cattle.

2. Materials and Methods

2.1. Feeds : Four Isonitrogenous diets were formulated according to NRC (1980) recommendations to contain 148 g/kg crude protein on dry matter basis. Diatomite filter aid residue (DFR) was included at four levels varying from 0, 30, 40 and 50 per cent. The diatomite filter aid residue was dried in a hot air oven at 105°C for 24 hours before being used in the rations. The ingredient proportions and chemical composition of the experimental rations used is shown in Table 1.

2.2. Animals : Sixteen male Holstein X Thaiindigenous crossbred cattle averaging 230.48 ± 23.45 kg initial body weight and 1.21 ± 0.14 years initial age were used. All animals were vaccinated against Foot and Mouth disease and Haemorrhagic septicemia and were given anthelminthics and a Vitamin A, D_3 and E injection, before the experiment.

2.3. Experimental design : The cattle were allocated randomly to their diets in a completely randomized design (CRD). The animals were housed in individual stalls of 1.4 m length, 1.4 m width and 1.2 m height.

2.4. Feeding and Management : The animals were fed both concentrate and roughage *ad libitum*. Feeds were offered to the animals twice a day at 0730 and 1630 hours. Light was kept on during the night. Refusals of both roughage and concentrate were weighed daily before new feed was offered.

2.5. Measurements : The animals were weighed three times at an interval of 24 hours before the experiment. The average body weight was used as the initial live body weight. Thereafter, the animals were weighed every two weeks at 0700 hours. The final and initial weights were used to determine body weight changes. Net feed intake was calculated on a daily basis.

2.6. Statistical analysis.: Data was analysed using a model specific for a CRD using the ANOVA procedure of SAS (1988).

3. Results

3.1 Intake : Total dry matter, organic matter, crude protein and metabolisable energy intakes of concentrate, roughage and the total feed are shown in Table 2. The concentrate, roughage and total feed intakes and crude protein intakes were significantly

Table 1. Experimental diets (g/kg on dry matter basis)

Ingredient	Diet			
	0%DFR	30%DFR	40%DFR	50%DFR
Diatomite filter aid residue (DFR)	0.00	300.00	400.00	500.00
Broken rice	300.00	0.00	0.00	0.00
Palmkernel meal	629.30	625.80	523.20	420.40
Urea[1]	10.70	14.20	16.90	19.60
Soybean meal	30.00	30.00	30.00	30.00
Molasses	20.00	20.00	20.00	20.00
Vitamin-Premix[2]	5.00	5.00	5.00	5.00
Normal salt	5.00	5.00	5.00	5.00
Total	1000.00	1000.00	1000.00	1000.00
Crude Protein (calculated)	148.00	148.00	148.00	148.00
Chemical analysis (g/kg DM)				
Dry matter (DM)	884.73	866.55	852.41	842.75
Organic matter	953.77	758.38	707.36	627.12
Crude protein	156.86	167.09	161.24	151.37
Crude fiber	120.39	151.84	140.73	110.20
Ether extract	48.17	46.35	41.38	36.76
Crude ash	46.23	241.63	292.64	372.88
Nitrogen free extract	628.36	393.10	364.01	328.80
Calcium	3.61	7.83	8.88	10.87
Phosphorus	4.55	4.24	3.91	3.28
Sodium	1.89	4.38	4.47	4.10
Potassium	6.46	1.36	0.86	0.54
Organic matter digestibility[3]	657.06	495.80	497.52	444.24
Gas production (ml/200mg DM)	56.04	36.42	36.27	29.74
Gross Energy (MJ/Kg)	19.07	15.70	15.08	13.90
Metabolisable Energy (MJ/Kg)[4]	10.06	6.82	6.74	5.64

[1] Contained 46 % Nitrogen.
[2] Contained Vitamin A, 1.250.000 iu; Vitamin D_3, 250.000 iu; Vitamin E, 1.000 iu; Zinc, 5.200 mg; Iron, 2.250 mg; Manganese, 2.500 mg; Copper, 1.000 mg; Cobalt, 60 mg; Iodine, 80 mg; Selenium, 25 mg and Sodium, 20 mg.
[3,4] Calculated according to Close and Menke (1986).

different across treatments (P<0.05).Also when the intake of concentrate was expressed on a percentage body weight (%BW) and metabolic body weight ($Kg^{0.75}$) basis, there were highly significant (P<0.01) treatment differences. With increasing DFR content in the diet, the dry matter intake increased (P<0.05) for concentrate, whereas the roughage intake decreased (P<0.05), but not proportionately. Total feed intake increased (P<0.05) with increasing DFR in the diet. The ratio of concentrate to roughage intake also increased with increasing DFR in the diet.

The organic matter intake for concentrate and total feed were not significantly different (P> 0.05) across treatments, whereas for roughage this was significant (P<0.05). Metabolisable energy intake of concentrate and total feed were not significantly different (P>0.05) across treatments, whereas the metabolisable energy intake from roughage was different (P<0.05). The ratio between crude protein and metabolisable energy intake ranged between 14.60 to 25.61 (gm CP/Kg : MJ ME/Kg) and widened with increasing DFR in diet.

Table 2 . Performance of male Holstein x Thai-indigenous crossbred cattle receiving diets varying in diatomite filter aid residue (DFR).

Parameter	Diet				
	0%DFR	30%DFR	40%DFR	50%DFR	SEM
Number of animals	4	4	4	4	
Feeding Period (days)	84	84	84	84	
Concentrate intake					
Total dry matter (Kg)	408.76^{c}	509.45^{bc}	626.31^{ab}	700.46^{a}	53.93
Dry matter/day (Kg)	4.87^{c}	6.06^{bc}	7.46^{ab}	8.34^{a}	0.64
Dry matter as %BW	1.71^{C}	2.44^{B}	2.85^{AB}	3.21^{A}	0.20
Dry matter/Kg$^{0.75}$/d (gm)	70.08^{C}	96.63^{B}	114.33^{AB}	128.49^{A}	7.46
Roughage intake					
Total dry matter (Kg)	72.86^{a}	46.26^{a}	49.42^{b}	37.65^{b}	6.48
Dry matter/day (Kg)	0.87^{a}	0.55^{b}	0.59^{b}	0.45^{b}	0.08
Dry matter as %BW	0.30^{a}	0.22^{b}	0.23^{b}	0.18^{b}	0.02
Dry matter/Kg$^{0.75}$/d (gm)	12.38^{A}	8.77^{B}	9.11^{AB}	7.10^{B}	0.86
Total intake					
Total dry matter (Kg)	481.62^{b}	555.72^{ab}	675.72^{a}	738.11^{a}	56.82
Dry matter/day (Kg)	5.73^{b}	6.62^{ab}	8.04^{a}	8.79^{a}	0.68
Dry matter as %BW	2.01^{C}	2.67^{B}	3.08^{AB}	3.39^{A}	0.20
Dry matter/Kg$^{0.75}$/d (gm)	82.47^{C}	105.40^{BC}	123.44^{AB}	135.59^{A}	7.61
Cocentrate : roughage ratio	5.81	11.92	12.82	18.50	1.26
Organic matter intake (gm/day)					
Concentrate	4641.39	4599.64	5274.40	5229.24	432.83
Roughage	766.75^{a}	486.86^{b}	520.06^{b}	396.22^{b}	68.16
Total	5408.14	5086.50	5794.46	5625.46	464.16
Crude Protein intake (gm/day)					
Concentrate	763.50^{b}	1013.45^{ab}	1201.91^{a}	1262.49^{a}	99.96
Roughage	32.18^{a}	20.43^{b}	21.82^{b}	16.63^{b}	2.86
Total	795.68^{b}	1033.90^{ab}	1223.73^{a}	1279.12^{a}	101.17
Metabolisable energy intake(MJ/day)					
Concentrate	48.95	41.36	50.25	47.03	3.98
Roughage	5.52^{a}	3.51^{b}	3.75^{b}	2.86^{b}	0.49
Total	54.48	44.87	54.00	49.89	4.19
Crude Protein : Energy intake (gm CP/Kg : MJ ME/Kg)	14.60	25.61	22.67	23.06	0.13

$^{a, b, c, A, B, C}$ Means in the same with differing superscript differ significantly : $^{a, b, c,}$ $P < 0.05$, $^{A, B, C}$ $P < 0.01$; SEM=Standard error of mean, BW= Live body weight in Kg.

3.2. Weight change, Feed conversion ratio, Feed Cost value and Gross margin : Data on weight change, feed conversion ratio, feed cost and gross margin obtained is shown in Table 3. The initial weight, final weight, weight gain and average daily gain of the animals were not significantly different ($P>0.05$) across treatments. Feed conversion ratio for concentrate and total feed was significantly different ($P<0.01$), whereas for roughage, this was not significantly different ($P>0.05$). The gross margin, considering feed cost as the only input cost for each group was highest on 40% DFR inclusion followed by 30% DFR, 50% DFR and lastly on the control diet.

Table 3. Economic assessment of male Holstein x Thai-indigenous crossbred cattle offered diets varying in diatomite filter aid residue (DFR).

Parameter	Diet				
	0%DFR	30%DFR	40%DFR	50%DFR	SEM
Number of animals	4	4	4	4	
Feeding Period (days)	84	84	84	84	
Weight change (kg)					
Initial weight	250.00	217.08	224.67	230.17	23.45
Final weight	345.25	302.00	324.75	313.50	25.24
Weight gain	95.25	84.92	100.08	83.33	8.62
Average daily gain	1.13	1.01	1.19	0.99	0.10
Initial value[1](B)	250.00	5427.00	5616.75	5754.25	
Final value[1] (B)	8631.25	7550.00	8118.75	7837.50	
Change in value[2]	2381.25	2123.00	2502.00	2083.25	
Feed conversion ratio					
Concentrate	4.31[C]	6.16[B]	6.28[B]	8.59[A]	0.53
Roughage	0.77	0.58	0.49	0.48	0.10
Total feed	5.08[B]	6.74[B]	6.77[B]	9.07[A]	0.61
Feed cost /Kg (B)					
Concentrate	4.17	2.45	2.29	2.14	
Roughage	1.25	1.25	1.25	1.25	
Total value of feed consumed (B)					
Concentrate	1906.20	1443.30	1683.80	1813.90	
Roughage	98.88	62.78	67.07	51.10	
Total	2005.08	1506.08	1750.87	1865.00	
Gross margin[3] (B)	376.17	616.92	751.13	218.25	

[A, B,C] Means in the same row with differing superscript differ significantly (P<0.01).
[1] Assumed 25 Baht /Kg of live weight. [2]Final value - initial value. [3]Change in value - value of feed consumed.
B (Baht : Thai monetary unit, 15.20 Baht were equivalent to 1 DM during the experimental time period).

3. CONCLUSIONS

The chemical and physical properties of diatomite filter aid residue (DFR) makes it of particular interest as a feed resource. The crude protein content of the DFR is low at 5.1 per cent but the content of readily available carbohydrate, in terms of nitrogen free extract (NFE) is high with a proportion of 46.20 per cent. The high mineral content in the DFR can present problems to its utilisation. However, incorporation of DFR in diets for pen-fattening Holstein x Thai-indigenous crossbred male cattle did not lead to any depression in performance up to 50 % inclusion. In fact, DFR inclusion led to increased dietary intakes. The diet with 40% DFR inclusion lead to the highest economic return, whereas incorporation of DFR at 50 % led to depressed economic performance. This could be attributed to imbalanced crude protein and energy supply which might lead to uncoupled fermentation and inefficient diet utilisation at tissue level (Perry, 1980). At higher levels of DFR inclusion therefore, incorporation of readily fermentable energy sources might be necessary. Under the conditions in this study, the optimum level of DFR inclusion was found to be 40 %. The study show that, DFR should find ready application in fattening rations for cattle in terms of reduction in feed costs and as one way of disposal.

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