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Effect of Protein Level on Nutrient Digestion and Nitrogen Utilization in Beef Cattle

C. Yuangklang, K. Vasupen, S. Wongsuthavas and S. Bureenok
Department of Animal Science, Faculty of Natural Resources,
Rajamangala University of Technology Isan, Sakon Nakhon Campus,
Phangkhon, Sakon Nakhon, 47160, Thailand

Abstract: Four male purebred Brahman bulls about 2 years olds were used in a 4×4 Latin square design. Their initial body weight was 151+13 kg (mean±SD). Treatments were 8.0, 10.0, 12.0 and 14.0% crude protein in total diets. Rice straw was used as main roughage sources. Animals were offered in form of total mixed ration. Feed intake was linearly decreased ($p<0.05$) as increased protein level. Digestion of DM, OM, NDF, ADF and EE were not significantly difference ($p>0.05$) among treatments. Nitrogen intake was 81.95, 103.0, 115.5 and 147.2 g day^{-1} in 8.0, 10.0, 12.0 and 14.0% CP in diets, respectively ($p<0.05$). Fecal nitrogen excretion was linearly enhanced ($p<0.05$) as increased protein level. Urinary nitrogen and total nitrogen excretions were significantly difference ($p<0.05$) among treatments. Apparent N digestibility was 67.53, 72.97, 80.60 and 78.78 % in 8.0, 10.0, 12.0 and 14.0% CP in diets, respectively ($p<0.05$; quadratic). Plasma urea nitrogen was linearly elevated ($p<0.05$) as increased protein level. In conclusion, it can be concluded that CP level 12.0% did increase apparent total tract N digestibility without any adversely effect on feed intake.

Key words: Protein, nitrogen, digestibility, beef cattle, feed intake, Brahman

INTRODUCTION

The population of beef cattle is increasingly growing in the northeast of Thailand. There are many breeds of beef cattle raises in the northeast region such as Native, Brahman, Charolais and their crossbred. The most popular breed is Brahman and crossbred Brahman owing to they are easily to raise, good price, well adaptation and good posture. The key successful of raising beef cattle are based on nutrition and management which the nutrition is accounted for 60-70% of total cost (Yuangklang, 2007). Typically, beef cattle are reared on natural range in the northeast of Thailand. The main reason is to reduce the production cost. It is well know that the quality of grass and agricultural by-products are poorly nutritive value. There are many researcher have been attempted to improve performance of beef cattle. Various strategies such as high quality protein sources supplementation (cassava leaf, leucaena leaf, high quality feed block/pellet) (Wanapat, 1999). These strategies have been shown to increase feed intake and improve growth performance. However, these strategies are suitable for non-fattening beef cattle which they are gradually increased animal body weight. However, there is limited research on the protein requirement of beef cattle. There is needed to quantify the required protein for beef cattle. NRC (1996) reported the protein requirement for growing and finishing medium-frame steer calves with initial body weight of 250-300 kg and gain 1.0 kg day^{-1} are range from 720-755 g day^{-1}. While Kearl (1982) reported protein requirement of cattle with body weight of 250-300 kg and gain 1.0 kg^{-1} are 760-874 g day^{-1}. Chantiratikul *et al.* (2009) demonstrated that protein requirement for maintenance of Thai-indigenous heifers was <6.0% of dietary crude protein.

In addition, Chumpawadee *et al.* (2009) suggested that protein requirement of Thai-indigenous heifers should be >12.0% crude protein during accelerated growth periods. However, there is limited information on protein requirement for purebred Brahman. The objective of present experiment was aimed to investigate the effect of protein level on feed intake, nutrient digestion and nitrogen utilization in purebred Brahman cattle.

MATERIALS AND METHODS

Animals and diets: Four yearling purebred Brahman bulls about 2 years old were used in a 4×4 Latin square design. Their initial body weight was 151±13 kg (mean±SD). Each period was consisted of 28 days;

Corresponding Author: C. Yuangklang, Department of Animal Science, Faculty of Natural Resources, Rajamangala University of Technology Isan, Sakon Nakhon Campus, Phangkhon, Sakon Nakhon, 47160, Thailand

Table 1: Ingredient and nutrient compositions of the treatment ration (DM basis)

Items	Dietary protein level (CP%) 8.0	10.0	12.0	14.0
Ingredients (%)				
Cassava chip	37.00	35.50	33.00	32.50
Soybean meal	-	2.00	4.00	6.00
Dried tomato pomace	15.00	14.00	14.00	12.00
Dried brewer's grain	10.00	10.00	10.00	10.00
Molasses	8.00	8.00	8.00	8.00
Urea	-	0.50	1.00	1.50
Salt	0.90	0.90	0.90	0.90
Sulfur	0.20	0.20	0.20	0.20
Dicalcium phosphate	0.40	0.40	0.40	0.40
Calcium carbonate	0.50	0.50	0.50	0.50
Oyster meal	0.50	0.50	0.50	0.50
Mineral premix[2]	0.50	0.50	0.50	0.50
Tallow	2.00	2.00	2.00	2.00
Pangola hay	25.00	25.00	25.00	25.00
Nutrients (%)				
DM	95.00	95.90	95.40	95.60
CP	7.97	10.00	12.20	14.10
NDF	34.50	34.00	33.90	32.90
ADF	22.80	22.40	22.50	21.70
Ca	0.75	0.75	0.75	0.76
P	0.49	0.51	0.52	0.54
TDN	72.90	72.80	72.50	72.40
ME[2] (Mcal kg^{-1})	2.64	2.64	2.63	2.62
Pangola hay (% DM)				
DM[1]%	98.20	-	-	-
Ash	8.00	-	-	-
CP	7.88	-	-	-
NDF	63.30	-	-	-
ADF	35.70	-	-	-
Ca	0.44	-	-	-
P	0.20	-	-	-

[1]DM = Dry Matter, CP = Crude Protein, NDF = Neutral Detergent Fiber, ADF = Acid Detergent Fiber, Ca = Calcium, P = Phosphorus, TDN = Total Digestible Nutrients; [2]TDN = 3.62 Mcal of ME

21 days was used to measure feed intake and last 7 days was used to measure digestibility by using total collection method (Schneider and Flatt, 1975); 2 days for adaptation on the crate and last 5 days for sample collection.

Treatments were 8.0, 10.0, 12.0 and 14.0% CP in total diet. Steers were fed *ad libitum* twice daily at 0700 and 1700 h. Cleaned water was fully supplied. Steers received Total Mixed Ration (TMR) at 3.0% BW. The composition of TMR is shown in Table 1. During the collection periods, animals were housed on the metabolic crates and feces samples were collected in the last five consecutive days. Urine samples were quantitatively collected in the last 5 consecutive days.

Feed samples were collected weekly and pooled for analysis. At the end of each total collection period, blood samples were taken from jugular rena-puncture. After the plasma sample was take and then frozen for subsequently analysis for Plasma Nitrogen (PUN) (Crocker, 1967).

Feed and feces samples were dried at 60°C for 72 h; ground and analyzed for Dry Mater (DM), Crude Protein (CP) and ash by the method of AOAC (1990). Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) were measured by the method of Goering and Van Soest. Digestibility of nutrient was calculated as nutrient intake-nutrient in feces x nutrient intake^{-1} ×100 (Schneider and Flatt, 1975). Urine samples were analyzed for nitrogen by the method of AOAC (1990). Nitrogen balance was calculated as nitrogen intake-nitrogen in feces-nitrogen in urine (Schneider and Flatt, 1975).

Statistical analysis: All data were statistically subjected to ANOVA and analyzed as a 4×4 Latin square design using the PROC MIXED (SAS, 1996). Significant differences between treatments were determined using Duncan's News Multiple Range Test (DMRT) (Steel and Torries, 1960).

RESULTS AND DISCUSSION

The protein contents of experimental diets were 7.97, 10.0, 12.2 and 14.1% as shown in Table 1. Dry matter, ash, crude protein, NDF and ADF of pangola hay was 98.2, 8.0, 7.88, 63.3 and 35.7%, respectively. Angthong *et al.* (2006) reported that protein content of pangola hay at 45 and 82 days cutting times were 4.04 and 10.46%, respectively. In this trial, pangola grass was cut at 45th day of growth and then grass was sun-dried for 3-4 days. Feed intake (expressed as kg DM day^{-1}) was linearly decreased ($p<0.05$) as increased protein level (Table 2).

Total tract apparent digestibility of Dry Matter (DM), Organic Matter (OM), Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) and Ether Extract (EE) were not significantly difference ($p>0.05$) among treatments. Gabler and Heinrichs (2003) studied four different protein levels (11.9, 16.7, 18.1 and 20.1% CP) in dairy heifers. They demonstrated that apparent total tract dry matter digestibility was similar for all diets. Chantiratikul *et al.* (2009) found that DM, NDF and ADF digestibilities were not significantly difference in Thai-indigenous heifers fed different protein level. Increasing CP level was significantly greater ($p<0.05$) in N intake. Fecal, urinary and total N excretion were significantly difference ($p<0.05$) among treatments. Gabler and Heinrichs (2003) showed that increased CP level increased urinary N and total N excretion but was not affected fecal N excretion. Apparent total tract N digestibility was quadratically significant difference ($p<0.05$) among treatments. Marini and Van Amburgh (2001) reported increased CP level enhanced total tract apparent N digestibility.

Table 3 plasma Urea Nitrogen (PUN) was linearly increased ($p<0.05$) as increased protein level. This finding is in accordance with Gabler and Heinrichs (2003);

Table 2: Effect of dietary protein level on feed intake and nutrient digestibility

	Protein levels (%)					Contrast		
Items	8.0	10.0	12.0	14.0	SEM	L	Q	C
Feed intake (kgDM day^{-1})	7.37	7.26	7.15	6.96	0.06	*	NS	NS
BW%	3.00	3.00	3.00	3.00		-	-	-
g $\text{kg}^{-1}\text{BW}^{0.75}$	138.50	136.50	134.40	125.80	4.16	NS	NS	NS
Digestion (percentage of intake)								
Dry matter[1]	79.90	80.60	80.80	80.90	1.68	NS	NS	NS
Organic matter	74.50	74.80	75.20	74.60	0.34	NS	NS	NS
Neutral detergent fiber	68.00	72.10	76.10	73.50	0.55	NS	NS	NS
Acid detergent fiber	57.80	59.80	59.60	58.40	0.65	NS	NS	NS
Ether extract	82.10	83.10	84.30	83.50	0.49	NS	NS	NS

[1]Total tract apparent digestibility; *p<0.05; NS = not significant

Table 3: Effect of dietary protein level on nitrogen utilization and plasma urea nitrogen

	Protein levels (%)					Contrast		
Items	8.0	10.0	12.0	14.0	SEM	L	Q	C
N intake (g day^{-1})	81.95	103.00	115.90	147.20	1.20	*	NS	NS
Fecal N excretion (g day^{-1})	26.99	28.33	22.51	31.63	0.01	*	NS	NS
Urinary N excretion (g day^{-1})	7.74	7.74	12.04	24.48	1.57	*	NS	NS
Total N excretion (g day^{-1})	34.71	36.06	34.57	56.11	0.01	*	NS	NS
Apparent N digestibility (%)	67.53	72.97	80.60	78.78	1.16	NS	*	NS
PUN (mg, %)	5.50	7.47	9.34	11.56	0.03	*	NS	

Total tract apparent digestibility, *p<0.05; NS = Not Significant

Chantiratikul *et al.* (2009) and Chumpawadee *et al.* (2009) who demonstrated that increased CP level was elevated PUN concentration. The high concentration of PUN was associated with great N intake. When protein diet reaches the rumen, microbes degrade protein into peptides, amino acid and ammonia nitrogen (Church, 1972). Then ammonia nitrogen is absorbed into blood stream circulation. Then ammonia nitrogen is eliminated by urea cycle, led to more ammonia nitrogen re-circulates into the blood. Thus, PUN concentration is highly related with nitrogen intake, nitrogen digestion and nitrogen utilization (Church, 1972; Yuangklang *et al.*, 2004).

CONCLUSION

In purebred Brahman bulls with body weight between 150 and 200 kg consuming a diet at 3.0% BW as DMI containing a CP level at 12.0% (2.6 Mcal ME kg^{-1}) achieved a greater apparent total tract N digestibility than at other levels in the present experiment.

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