Effect of mangosteen peel, garlic and urea pellet supplementation on rumen fermentation and nutrient digestibility of beef cattle

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ABSTRACT: The aim of this study was to determine the effect of mangosteen peel, garlic and urea pellet supplementation on rumen fermentation and nutrient digestibility of beef cattle. Four crossbred (Brahman x Holstein) beef cattle were randomly assigned according to a 4 x 4 Latin square design to study supplementation of different mangosteen peel pellets in concentrate. The treatments were as follows: T1) None supplementation; T2) Supplementation with mangosteen peel pellet at 200 g /head/day (Mago-pel); T3) Supplementation with mangosteen peel and garlic pellet at 200 g /head/day (Mago-lic); and T4) Supplementation with Mangosteen peel, garlic and urea pellet supplement at 200 g /head/day (Mago-ulic). Rice straw was available for *ad libitum* consumption. Concentrate was fed at 0.5% of BW. The results were found that total DMI and digestibility of DM, CP, and ADF were not significantly affected by pellets supplementation; however, digestibility of NDF, ADF were higher in the pellet supplementation than in the control (P<0.05), Rumen temperature, pH, NH_3-N and total VFA and C4 were similar among treatments although NH_3-N tended to be higher in supplemental treatments and highest in Mago-Ulic supplemental treatment. There was significant difference in C3 production (P<0.05) between treatments in which highest in Mago-Ulic supplementation. In addition, the C2, C2 to C3 ratio and methane production tended to be reduction. Bacterial population was increased and highest in Mago-Ulic treatment, but protozoal population was reduced while fungal zoospores were not affected by feed supplementation. In conclusion, supplementation Mago-Ulic at 200g/h/d could be improve rumen fermentation and should in lowering protozoal population in beef cattle.
Keywords: Mangosteen peel pellets, garlic, urea, rumen fermentation, beef cattle

Introduction

Ruminants establish a symbiotic relationship with rumen microorganisms. However, this symbiotic relationship has energy (losses of methane) and protein (losses of ammonia N) inefficiencies (Van Nevel and Demeyer, 1988). Utilization of feed additive has proved to be a useful strategy to improve the efficiency of energy and protein utilization in the ruminant. One of possible alternatives is using the secondary compound in natural plants such as saponins, tannins, and essential oils. Mangosteen peel contains high amount of secondary compounds, especially condensed tannin (15.8%) and saponin(9.8%) (Ngamseang et al., 2006). Which are also assumed to be responsible for anti-protozoa effects and decreased methane concentration in rumen atmosphere (Poungchumpoo et al., 2008) or in *in vitro* (Hess et al., 2003). Garlic is another kind of herb that has been used by humans as a source of antimicrobial agents for the gastrointestinal. Therefore, it could manipulate rumen fermentation. Busquet et al.(2005) reported that garlic supplementation decreased in the proportion of acetate and increased proportion of propionate and butyrate, inhibition of methanogenesis and decreased in the CH4:VFA ratio. Many researches have shown that urea treatment could be used to add ammonia nitrogen for ruminal microbes,

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increased nutritive value, particularly the crude protein content, digestibility and voluntary feed intake by ruminant (Wanapat, 1985). However, manipulating ruminal fermentation of dairy steers by using combination of mangosteen peel, garlic and urea still limit of data. Therefore, the objectives of this study were to determine effect of mangosteen peel, garlic and urea pellet supplementation on rumen fermentation and nutrient digestibility of beef cattle.

Materials and methods

Animals, treatments and experimental design

The experiment was conducted at Tropical Feed Resource Research and Development Center (TROFREC), Department Animal Science, Faculty of Agriculture, Khon Kean University, Thailand from January to April, 2011.

Four, ruminally fistulated crossbred steer (Brahman x Holstein Friesian) cattle with initial BW of 220 ± 15kg were randomly assigned to receive four dietary treatments according to a 4 x 4 Latin square design. Four treatments were T1) None supplementation; T2) Supplementation with mangosteen peel pellet at 200 (g /head/day) (Mago-pel); T3) Supplementation with mangosteen peel and garlic pellet at 200 (g /head/day) (Mago-lic); and T4) Supplementation with mangosteen peel, garlic and urea pellet supplement at 200 (g /head/day) (Mago-ulic). Feed ingredients and chemical composition of concentrate, pellets, and rice straw are shown in **Table 1**. All animal were kept in individual pens, mineral block, fresh water and rice straw were available for *ad libitum* consumption. Concentrate was fed for animals with 0.5% of BW.

Table 1 Ingredients and chemical compositions of diet

	Concentrates	Mago-pel	Mago-lic	Mago-ulic	Rice straw
Ingredients, %					
Cassava chip	65.0				
Cassava starch		0.5	0.5	0.5	
Rice bran	8.0				
Coconut meal	8.0				
Palm meal	3.0				
Soy bean meal	14.0				
Molasses	0.5	1.0	1.0	1.0	
Sulfur	0.5				
Mineral premix	0.5				
Salt	0.5				
urea		0.0	0.0	2.0	
Mangosteenpeel powder		98.5	93.5	91.5	
Galic powder		0.0	5.0	5.0	
Chemical composition, %					
DM	89.0	93.3	93.1	92.7	94.0
		---------------------------% DM---------------------------			
OM	93.3	96.5	96.4	96.5	87.2
CP	14.3	21.2	21.5	22.1	2.4
NDF	24.6	57.3	57.2	57.0	72.3
ADF	11.1	48.6	48.2	48.3	59.6
Condensed tannins	-	17.4	17.3	17.0	-
Saponins	-	11.3	11.3	11.1	-

Sample collection and analysis

The experiment was conducted for 4 periods, each lasted for 21 days. Concentrate and rice straw were sampled daily during the collection period and pooled prior to analyses. During the last 7 days of each period, feed, fecal samples were collected every day for chemical analysis fecal samples were divided into two parts, first part was analyzed for DM and Ash, the second part was kept and pooled at the end of each period for analyzing CP according to AOAC (1997), NDF, ADF according to Van Soest (1991). Rumen fluid were collected from fistulated rumen at 0, 2, 4, and 6 h post feeding in the end of each period. Rumen fluid was immediately measured for pH using a portable pH temperature meter (HANNA, instruments HI 8424 microcomputer, Singapore) and rumen ammonia- nitrogen by Kjeltech-Auto 1030 Analyzer (AOAC, 1090). Volatile fatty acids were analyzed using High Pressure Liquid Chromatography (Instruments by controller water model 600E; water model 484 UV detector; column Novapak C18; column size 3.9 mm×300 mm; mobile phase 10 mM $H2PO4$ [pH 2.5]) according to procedure of Samuel et al. (1997). Rumen fluid was determined for direct count of bacteria, fungi and protozoa using the methods of Galyean (1989).

Statistical analysis

All data obtained from the experiment were subjected to ANOVA for a 4 x 4 Latin square design using the General Linear Models (GLM) procedures of the Statistical Analysis System Institute (SAS, 1996). Treatment means were statistically compared using the Duncan's New Multiple Range Test (DMRT)

Result and discussion

Dry matter intake, apparent digestibility

The effects of pellets supplementation on total dry mater intake (DMI) and nutrients digestibility are presented in **Table 2**. It was found that total DMI intern of kg/d and %BW were not significantly affected ($P>0.05$) by pellet supplementation.

Apparent digestibility (%) of DM, OM and CP were not significantly different among treatments; however, apparent digestibility of NDF and ADF was higher in pellet supplementation than control treatment ($P<0.05$), although it was not significantly different among the supplement groups.

Table 2 Effect of different pellet supplementation on feed intakes and digestibility

Items	Control	Mago-pel	Mago-Lic	Mago-Ulic	SEM
kg/day	3.6	3.3	3.6	3.4	0.20
%BW/day	1.8	1.6	1.9	1.7	0.13
Apparent digestibility, %					
DM	58.2	60.8	58.4	58.4	4.06
OM	59.8	61.2	60.1	61.2	3.28
CP	66.5	65.4	67.3	65.7	0.95
NDF	52.6^{a}	64.7^{b}	61.9^{b}	62.5^{b}	2.04
ADF	55.2^{a}	61.5^{b}	60.4^{b}	60.9^{b}	1.02

$^{a, b}$ Means in the same row with different superscripts differ ($P<0.05$), SEM: Standard error of the mean

Table 3 Effect of different pellet supplementation on rumen ecology

Items	Control	Mago-pel	Mago-Lic	Mago-Ulic	SEM
Ruminal pH	6.8	6.8	6.8	6.9	0.04
Ruminal temperature, ^{0}C	38.6	38.5	38.3	38.4	0.17
NH_3-N, mg/dL	14.8	14.8	15.0	15.5	0.34
Total VFA, mmol/l	112.28	111.59	113.82	112.77	2.21
Acetate(C2), %	63.36^a	61.23^b	61.28^b	60.62^b	0.54
Propionate(C3), %	23.14^b	25.26^a	24.9^a	25.62^a	0.51
Butyrate(C4), %	13.48	13.51	13.81	13.76	0.36
C2:C3	2.77^a	2.42^b	2.47^b	2.40^b	0.07
CH_4 (mmol/l)	27.55^a	26.03^b	26.28^b	25.75^b	0.62
Bacteria (x 10^{10} cell/ml)	9.1^b	9.8^{ab}	9.8^{ab}	11.7^a	0.62
Protozoa (x 10^5 cell/ml)	6.4^a	3.9^b	4.3^b	4.0^b	0.25
Fungal zoospore(x 10^5 cell/ml)	7.9	8.0	7.9	8.3	0.95

[a, b] Means in the same row with different superscripts differ (P<0.05), SEM: Standard error of the mean, $CH_4 = 0.45C_2 - 0.275C_3 + 0.4C_4$ (Moss et al., 2000)

Rumen fermentation

Effect of pellet supplementation on rumen fermentation characteristic in beef cattle is shown in **Table 3.** Ruminal pH, temperature and NH_3-N were not altered by feed supplementation and the values were stable at pH 6.8 and temperature 38.3 -38.6°C. Rumen NH_3-N was ranged between 14.77 and 15.53 mg/dl, which were in optimal range (15-30mg/dl, Wanapat and Pimpa, 1999) for increasing microbial protein synthesis in ruminant fed low-quality roughages, although rumen NH_3-N tended to be higher in supplemental treatments and was highest in Mago-Ulic supplemental treatment. Total VFA and butyrate (C4) were not significantly different (P>0.05) among treatments. However, propionate (C3) increased with supplemental treatment (P<0.05) and was highest in Mago-Ulic treatment. Acetate (C2), C2 to C3 ratio and methane production tended to be reduced with pellet supplementation (P<0.05).

Pellet supplementation affected on microorganism population. Which increased bacteria population and promoted highest in Mago-Ulic treatment, reduced protozoa population; however, fungal zoospores were not effected.

Conclusions and recommendations

Based on these results, it could be concluded that supplementation of mangosteen peel, garlic and urea pellet could improve efficiency of feed utilization through increased NDF and ADF digestibility. Improved rumen ecology by increasing propionate concentration and deceasing protozoal numbers. Mago-ulic pellet supplementation should be the best result.

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