

ผลของการเสริมเปลือกมังคุดและกระเทียมผงอัดเม็ดต่อการเปลี่ยนแปลงนิเวศวิทยาเรูเมน และการผลิตก๊าซเมเทนในโคเนื้อ

Effect of mangosteen peel-garlic powder pellet supplementation on rumen ecology and methane gas production in beef cattle

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บทคัดย่อ: การศึกษาครั้งนี้มีวัตถุประสงค์เพื่อศึกษาผลของการเสริมเปลือกมังคุดและกระเทียมผงอัดเม็ด ต่อปริมาณการกินได้ การย่อยได้ กระบวนการหมักในกระเพาะเรูเมน และการผลิตก๊าซเมเทนในโคเนื้อ โดยใช้โคเนื้อเพศผู้ลูกผสมเจาะกระเพาะ (rumen fistulated) จำนวน 4 ตัว ใช้ฟางข้าวเป็นแหล่งอาหารหยาบหลัก เสริมด้วยอาหารข้น 0.5 % ของน้ำหนักตัว โดยสุมโคเนื้อแต่ละตัวให้ได้รับอาหารทรีทเมนต์ในแผนการทดลองแบบ 4x4 ลาตินสแควร์ โดยมีทั้งหมด 4 ทรีทเมนต์ ได้แก่ 1) กลุ่มควบคุมที่ได้รับอาหารข้นตามปกติ(ไม่มีการเสริม) 2) การเสริมด้วยเปลือกมังคุดอัดเม็ด 3) เสริมเปลือกมังคุดและกระเทียมผงอัดเม็ด และ 4) เสริมด้วยเปลือกมังคุดกับกระเทียมผงและยูเรีย 2 % ที่ระดับการเสริม 200 กรัม/ตัว/วัน ในทุกๆกลุ่มการทดลอง ผลการทดลองแสดงให้เห็นว่า การเสริมเปลือกมังคุด กับกระเทียม และ เปลือกมังคุดกับกระเทียมที่ผสมยูเรียอัดเม็ด ไม่ทำให้ปริมาณการกินได้ การย่อยได้ของวัตถุดิบ อินทรีย์วัตถุ และโปรตีนแตกต่างกันทางสถิติ ($P>0.05$) ผลจากการเสริมทำให้เพิ่มสัดส่วนของ propionate (C3) ลด acetate (C2) และลดการผลิตก๊าซเมเทนได้ ($P<0.05$) ในขณะที่ butyrate (C4) ไม่มีความแตกต่างเมื่อเทียบกับกลุ่มควบคุม

คำสำคัญ: เปลือกมังคุด, กระเทียม, กระเพาะเรูเมน, ก๊าซเมเทน, โคเนื้อ

ABSTRACT: The objective of this study was to investigate the effect of mangosteen peel and garlic powder supplementation on the intake, digestibility, ruminal fermentation and methane production in beef cattle steers fed on rice straw base of diet. Four, 2 year old rumen fistulated male crossbred beef cattle were randomly assigned in a 4x4 Latin square design to receive four dietary treatment; mangosteen peel pellet (Mago-pel), mangosteen peel with garlic powder pellet (Maga-Lic), mangosteen peel pellet with urea and garlic powder (Maga-ulic) 200g/h/d and non-supplemented (control). All animals were fed with rice straw *ad libitum* while of addition concentrate was fed 0.5 % body weight (BW). It was found that supplementation of mangosteen peel and garlic with or without urea had no effect on daily feed intake (FI), digestibility of dry matter (DM), organic matter (OM) and crude protein (CP) and was not significantly affected. Supplementation resulted in significantly lower overall NDF and ADF digestibility when compared with the control. Ruminal pH, concentration of ruminal $\text{NH}_3\text{-N}$ and blood urea nitrogen (BUN) concentrations were not significantly different among treatments. The proportion of C2 and methane gas production were decreased, while C3 proportion was increased by the supplementation.

Keywords: Mangosteen peel, Garlic, Rumen, Methane, Beef cattle.

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Introduction

Manipulation of the rumen microbial ecosystem to enhance fibrous feed digestibility, reduce methane emission and reduce nitrogen excretion by ruminants such as to improve their performance are some of the most important goals for animal nutritionists (Patra et al., 2006). Plant secondary compounds such as condensed tannins and saponins have been shown to inhibit protozoa and methanogens presumably by lowering methanogenic activity of protozoal-associated methanogens (Guo et al., 2008). Mangosteen peel (*Garcinia mangostana*), contains of tannins and crude saponins, which exerts a specific effect against rumen protozoa and reduced methane gas emissions, while the rest of the rumen biomass remains unaltered (Ngamsaeng et al., 2006). Currently, the use of plant herbs has resulted in improving rumen ecology (Kamra, 2005; Wanapat et al., 2008). Garlic (*Allium sativum*) is an herb or spice plant that has been used by humans as a source of antimicrobial agents for the gastrointestinal. It has a complex mixture of many secondary plant products (Lawson, 1996) that could manipulate rumen fermentation such as decreased in the proportion of acetate and increased in proportion of propionate and butyrate, inhibition of methanogenesis and decreased in the CH₄:VFA ratio (Busquet et al., 2005). However manipulation of ruminal fermentation of beef cattle by the use of mangosteen peel and/or garlic powder with or without urea by pelleting is quite limited. Therefore, the objective of this study was to investigate the effect of mangosteen peel and garlic powder supplementation on the intake, digestibility, ruminal fermentation and methane production in steer beef cattle.

Materials and Methods

Animal, diets and experimental design:

Four- fistulated male crossbred beef cattle (228±45 kg of BW) were randomly assigned according to a 4x4 Latin square design to investigate the effect of mangosteen peel and garlic powder supplementation on FI, digestibility of nutrients, rumen fermentation and methane production. The dietary treatments were as follows: T1 = control (non-supplementation), T2 = supplementation of mangosteen peel pellet (Mago-pel) 200g/day, T3 = supplementation of mangosteen peel with garlic powder pellet (Maga-lic) 200g/day and T4 = supplementation of mangosteen peel pellet with urea and garlic powder (Maga-ulic) 200g/day. The ration compositions were shown in **Table 1**. All animals were kept in individual pens and received free access to water and mineral blocks. The animals received concentrate diet at 0.5 % of BW and while rice straw was offered *ad libitum* as basal roughages source. FI of concentrate and roughage were measured separately and refusals were recorded. The experiment lasted for four periods, each period lasted for 21 days. During the first 14 days FI was measured, while the last 7 days feed, feces and feed refusals were sampled for chemical analyses. Feed and fecal were collected by total collection when animals were on metabolism crates during the last 7 days of each period. Dietary treatment, concentrate, rice straw and feces were sampled and analyzed chemical compositions of DM, Ash, CP and NH₃-N by the method of AOAC (1990) and NDF, ADF by Van Soest et al. (1991).

Table 1 Ingredients and supplemental pellet diets used in the experiment

Items	Mago-pel	Maga-lic	Maga-ulic
Mangosteen peel	98.5	93.5	91.5
Garlic powder	-	5.0	5.0
Molasses	1.0	1.0	1.0
Urea	-	-	2.0
Cassava starch	0.5	0.5	0.5
Total	100.0	100.0	100.0
CP	21.3	19.6	25.2
TDN*	70.0	64.4	63.7

*By calculation, CP = Crude protein.

At the end of each period rumen fluid and jugular vein blood samples were collected 0, 2, 4 and 6 h after feeding. A blood sample (about 10 ml) was analyzed of BUN according to the method of Crocker (1976). Rumen fluid was collected via rumen fistular and immediately measured for pH and temperature (HANNA, Instruments HI 8424 microcomputer, Singapore). Rumen fluid samples were used for NH_3 -N and VFAs analysis. NH_3 -N analysis using the Kjeltech Auto 1030 Analyzer and Volatile fatty acids (VFAs) were analyzed using High pressure liquid chromatography (HPLC).

Statistical analyses were performed using the general linear procedure in proc GLM of SAS (1996). The results are presented as mean values and standard error of the means. Differences between treatment means were determined by Duncan's New Multiple Range Test (DMRT) (Steel and Torrie, 1980).

Result and Discussions

FI and apparent digestibility of nutrients:

FI and digestibility of nutrients are presented in **Table 2**. Total FI, intake of rice straw and concentrate, digestibility of DM, OM and CP were not affected by feed supplementation ($P > 0.05$); however, fiber digestibility (NDF, ADF) were changed as influenced by supplementation ($P < 0.05$). Supplementation of Mago-pel, Maga-lic and Maga-ulic as resulted in lower NDF and ADF digestibility when compared with control group ($P < 0.05$). This result was consistent with Ngamseng et al. (2006) and Pongchompu et al. (2009) who reported that feeding dietary tannins and saponins decreased apparent digestibilities. While in others reports (Kongmun et al., 2011; Wanapat et al., 2008) have found that supplementation of garlic powder had no effect on NDF and ADF digestibilities but tended to increase CP and NDF digestibilities.

Table 2 Effect of mangosteen peel-garlic powder pellet supplementation on feed intake and nutrient digestibilities.

Items	T1	T2	T3	T4	SEM	P-value
Kg/d	3.86	3.60	3.62	3.67	0.14	0.550
%BW/d	1.90	1.78	1.83	1.85	0.07	0.640
Rice straw DMI						
Kg/d	2.79	2.53	2.56	2.56	0.14	0.540
% BW/d	1.38	1.22	1.30	1.26	0.08	0.560
Concentrate DMI						
Kg/d	1.07	1.07	1.07	1.11	0.02	0.460
% BW/d	0.54	0.54	0.54	0.56	0.01	0.460
Apparent digestibility,%						
DM	56.9	55.5	51.6	52.8	5.10	0.510
OM	60.4	58.9	53.2	57.3	4.59	0.450
CP	44.6	34.3	33.7	31.2	7.64	0.640
NDF	52.5 ^a	43.5 ^b	41.2 ^b	42.6 ^b	3.94	0.045
ADF	50.4 ^a	42.3 ^b	40.7 ^b	41.8 ^b	3.67	0.043

^{a,b} Means in the same row with different superscripts differ (P<0.05). DMI; Dry matter intake, T1 = control (non-supplementation), T2 = supplementation of mangosteen peel pellet (Mago-pel) 200g/day, T3 = supplementation of mangosteen peel with garlic powder pellet (Mago-lic) 200g/day and T4 = supplementation of mangosteen peel pellet with urea and garlic powder (Mago-ulic) 200g/day.

Table 3 Effect of Mangosteen peel-garlic powder pellet supplementation on blood urea nitrogen and rumen fermentation.

Items	T1	T2	T3	T4	SEM	p-value
Temperature, °C	38.6	38.6	38.4	38.4	0.15	0.747
NH ₃ -N, mg/dL	6.0	7.1	6.2	8.6	1.06	0.027
BUN, mg/dL	8.3	7.5	8.0	8.8	1.25	0.911
VFA, mmol/L	107.6	98.9	105.1	103.5	3.29	0.225
Acetate (C2), %	65.4 ^a	59.8 ^b	60.6 ^b	58.5 ^b	1.71	0.458
Propionate(C3), %	18.6 ^b	24.3 ^a	23.5 ^a	25.6 ^a	0.86	0.038
Butyrate(C4), %	16.0	15.9	15.8	15.9	1.06	0.472
C2:C3	3.5	2.5	2.6	2.3	0.24	0.797
CH ₄ , mmol/L	30.1 ^a	26.8 ^b	25.4 ^b	27.8 ^b	0.83	0.035

^{a,b} Means in the same row with different superscripts differ (P<0.05)

$$CH_4 = 0.5C_2 - 0.25C_3 + 0.5C_4 \text{ (Ørskov, 1992)}$$

Rumen fermentation characteristics and methane gas production

Rumen pH (6.7 to 6.9), temperature (38.4 to 38.6 °C) and concentration of ruminal NH_3 -N (Table 3) were not significantly different among treatments, the values were in normal ranges and optimal for microbes to digest fiber and protein (Firkin, 1996). The total VFA production and BUN were not affected by feed supplementation ($P > 0.05$). However supplementation of Maga-ulic was slightly increased when compared with others groups. Supplementation increased C3 and decreased C2 concentration when compared with the control. This result of methane gas production was reduced significantly differences ($P < 0.05$) as influenced by dietary treatments. Garlic powder had no effect on ruminal NH_3 -N (Carilejos et al., 2006; Wanapat et al., 2008). The proportion of C2 was decreased, while C3 proportion was increased by supplementation. These results were similar with Pongchompu et al., 2009; Pilajun and Wanapat, 2011. This study did not find a difference on C4 proportion. The results were consistent with Kongmun et al. (2011).

Conclusions

Based on this study, it could be concluded that supplementation of Magosteen peel and garlic pellets could improve ruminal fermentation especially increased propionic proportion and reduced methane gas production.

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