ผลของระดับมันสำปะหลังในอาหารโคนม ต่อการให้ผลผลิตนม

Effect of Cassava Chip Levels in Dairy Diet on Milk Production

ฉลอง วชิราภากร Chalong Wachirapakorn*
เมธา วรรณพัฒน์ Metha Wanapat**
นิโรจน์ ศรสูงเนิน Nirote Sornsungnern***
สุรชัย โค้วสุวรรณ Surachai Kowsuwan****

บทคัดย่อ

การทดลองครั้งนี้มีวัตถุประสงค์เพื่อศึกษาระดับมันสำปะหลัง (*Manihot esculenta*, Crantz.) ในสูตรอาหารข้นสำหรับโคนมและเพื่อเปรียบเทียบการให้นมของโคนมพันธุ์ผสมโฮลสไตน์ฟรีเซี่ยนสายเลือด 50% กับ 75% โดยทำการทดลองในโคนมพันธุ์ผสมโฮลสไตน์ฟรีเซี่ยน 50% จำนวน 4 ตัว และโคนมพันธุ์ผสมโฮลสไตน์ฟรีเซี่ยน 75% จำนวน 4 ตัว โคนมมีน้ำหนักเฉลี่ย 390 + 27.5 กก. และวันที่ให้นมเฉลี่ยเมื่อเริ่มทดลองที่ 141 + 43.5 วัน สุ่มเข้าทดลองตามแผนการทดลองแบบ 4x4 ลาตินสแควร์ โดยแต่ละช่วงมีระยะทดลอง 21 วัน สุ่มให้โคนมได้รับอาหารที่มีสัดส่วนของอาหารหยาบ (หญ้ารูซี่แห้ง) ต่ออาหารข้น 30 ต่อ 70 โดยอาหารข้นมีระดับมันสำปะหลังเท่ากับ 25%, 35%, 45%, และ 55% และปรับให้อาหารข้นมีโปรตีนเท่ากัน จากการทดลอง พบว่า โคนมที่ได้รับอาหารข้นที่มีระดับมันสำปะหลังต่างๆ มีปริมาณการกินได้ของวัตถุแห้ง ปริมาณน้ำนมปรับไขมันนมที่ 3.5% และองค์ประกอบน้ำนมไม่แตกต่างกันทางสถิติ ($p > 0.05$) ส่วนปริมาณน้ำนมปรับไขมันนมที่ 3.5% ของโคนมพันธุ์ผสมโฮลสไตน์ฟรีเซี่ยน 50% (10.0 ± 0.19 กก./วัน) สูงกว่าของโคนมพันธุ์ผสมโฮลสไตน์ฟรีเซี่ยน 75% (8.41 ± 0.19 กก./วัน) อย่างมีนัยสำคัญทางสถิติ ($p < 0.01$) แต่ระดับสายเลือดพันธุ์โฮลสไตน์ฟรีเซี่ยนไม่มีผลกระทบต่อปริมาณการกินได้วัตถุแห้งและองค์ประกอบน้ำนม ($p > 0.05$) จากการทดลองครั้งนี้ สรุปได้ว่าสูตรอาหารข้นสำหรับโคนมที่มีมันสำปะหลังในสัดส่วน 25 ถึง 55% ในสูตรอาหารข้นให้ผลคล้ายคลึงกันและโคนมพันธุ์ผสมโฮลสไตน์ฟรีเซี่ยน 50% มีผลตอบสนองในการให้นมดีกว่าโคนมพันธุ์ผสมโฮลสไตน์ฟรีเซี่ยน 75%

* *ผู้ช่วยศาสตราจารย์ ภาควิชาสัตวศาสตร์ คณะเกษตรศาสตร์ มหาวิทยาลัยขอนแก่น*
** *ศาสตราจารย์ ภาควิชาสัตวศาสตร์ คณะเกษตรศาสตร์ มหาวิทยาลัยขอนแก่น*
*** *นักวิชาการเกษตร ภาควิชาสัตวศาสตร์ คณะเกษตรศาสตร์ มหาวิทยาลัยขอนแก่น*
**** *นักศึกษาปริญญาโท สาขาวิชาสัตวศาสตร์ บัณฑิตวิทยาลัย มหาวิทยาลัยขอนแก่น*

Abstract

This experiment was aimed at studying the effect of cassava chip (CC) levels in concentrate on milk yield between 50% and 75% Holstein Fresian (HF) crossbred dairy cows. Eight cows (4 hds for 50% HF and 4 hds for 75% HF), an average liveweight 390±27.5 kg and day in milk 141±43.5 days, were used in a replicated 4x4 Latin square design with 21-d periods. Cows were fed, ration consisted of dried Ruzi grass (*Brachiaria ruziziensis*) and concentrate at ratio 30 to 70, *ad libitum.* There were four levels of CC (25%, 35%, 45% and 55%) in concentrate. The results showed that levels of CC in concentrate did not have any effect (p>.05) on total dry matter intake, digestion coefficients of dry matter (DM) and organic matter (OM), 3.5% fat-corrected milk (3.5% FCM) and milk compositions. However, 3.5% FCM in 50% HF cows (10.0±0.19 kg/d) was significantly higher (p<.01) than that in 75% HF cows (8.41±0.19 kg/d), while total dry matter intake and milk compositions were not different (p>.05) between 50% HF cows and 75% HF cows. In conclusion, concentrate for lactating cows containing CC from 25 to 55% resulted similarly. Cows with 50% HF can produce more milk than cows with 75% HF as fed the same feed.

คำสำคัญ : มันสำปะหลัง อาหารโคนม การผลิตนม

Keywords : cassava chip, diart diet, milk production

Introduction

Dairy production in Thailand increases gradually, numbers of cows increase from 287,144 to 474,090 hds in five years with average milk yield 11.0 kg/d (Uraikul, 1998). However, most of dairy catttle raised are Holstein crossbred range from 65 to 75%. Division of Animal Breeding (1987) reported that 50% Holstein crossbred cows produce 1,811 kg per lactation (248 days), which is lower than that observed by Simarak (1989). The author found that 75 % Holstein crossbred cows produced 3,054 kg per lactation while cows with lower 75 % Holstein blood produced 2,873 kg per lactation averaging from 7 lactations. As an increase in Holstein blood, cows may need more nutrient to meet their potential milk production and thus feeding for high producing dairy cows need to be considered carefully, particularly when crop residues are used as roughage sources. Cassava (*Manihot esculenta,* Crantz.), which is widely grown in Thailand for many years, faces uncertain price. One option to increase its value is by use in dairy diet as an energy source for lowering concentrate price. Cassava chip (CC) contains 88-90% of dry matter (DM), 2.3-2.5% of crude protein (CP) and soluble carbohydrate 76-81% (Gomez and Waldivieso, 1983), which consists of starch 64-72% and the rest is sugar, sucrose, maltose, glucose and fructose (Rojanalitpichet, 1976). Sathapanosiri et al. (1990) observed that starch of cassava is highly degraded in the rumen (94%) and digested all in the whole tract. Similar result has been reported by Sommart et al. (1991). Although CC is known to be an energy source in dairy diet, an optimal level of CC has not been extensively study in lactating cows. Therefore, the objective of this experiment was to study levels of CC potentially used in dairy concentrate and to compare milk production between 50% Holstein Friesian (HF) crossbred cows and 75% HF crossbred cows.

Materials and Methods

Eight lactating HF crossbred cows (390±27.5 kg) in mid lactation (141±43.5 days) were assigned to receive one of four dietary treatments in a replicated experiment with a 4x4 Latin square design with 21-d periods. One square consisted of four 75% HF crossbred cows and the other square consisted of four 50% HF crossbred cows. Dietary treatments, CC levels in concentrate at 25% CC, 35% CC, 45% CC and 55% CC of concentrate, are shown in Table 1.

Cows were fed individually twice daily (0700 and 1500 h) in an equal allotments in amounts to achieve *ad libitum* intakes (about 10% orts). Diets were adjusted as necessary to maintain the 30:70 ratio of dried Ruzi grass *(Brachiaria ruziziensis)* to concentrate. The isonitrogenous concentrate diets were formulated to meet NRC (1989) requirement for 400 kg cows and yieldling between 7 to 13 kg/d of milk. Amounts fed were recorded daily and sampled weekly for component analysis. Composites of weekly samples were determined for DM (105°C for 24 h), ash (550°C for 8 h), CP by Kjeldahl procedure using Tecator Kjeltec (Tecator, Inc., Herndon, VA) as described by AOAC (1985), and neutral-detergent fiber (NDF) and acid-detergent fiber (ADF) according to the method of Goering and Van Soest (1970). Digestibilities of DM, organic matter (OM) and NDF were determined using acid-insoluble ash (AIA) as an internal unabsorbable marker (Van Keulen and Young, 1977). Feces were grab sampled during the last 4 d of each experimental period and then composited for component analysis as feed samples.

Rumen fluid, taken (4 h, post feeding) by stomach tube at the last day of each period, was measured immediately for pH and then preserved by 6 N HCl for later determination for ammonia-nitrogen (NH_3-N) concentration (Bremner and Keeney, 1965). Body weights were recorded immediately following the a.m. milking at the beginning and the end of each period.

Milk production was recorded at each milking. Milk was sampled on two consecutive milking for composition analysis. Milk fat, protein, lactose, solid-not-fat (SNF) and total solid contents were determined by Milko scan 33 (Foss Electric, Denmark).

Data were summarized and analyzed as a replicated 4x4 Latin square using the general linear model procedure of SAS (1985). The model included diet, period, cows within square and the interaction of square by treatment were sources of variation. The linear model used is described by the following equation:

$$Y_{ijk} = \mu + S_i + C_{j(i)} + P_k + T_l + (ST)_{il} + E_{ijkl}$$

where

μ = overall mean,

S_i = effect of square i,

$C_{j(i)}$ = effect cows j,

P_k = effect of period k,

T_l = effect of treatment l,

$(ST)_{il}$ = square x treatment interaction, and

E_{ijkl} = experimental error.

The effect of dietary treatments was expressed as least square means. Duncan's multiple range test was tested to compare dietary effects. Significance was at $p < 0.05$. Pooled standard errors are reported for all data.

Results and Discussion

Chemical composition of dried Ruzi grass and concentrates used in the experiment is shown in Table 1. The CP content of concentrates was similar among dietary treatments, from 19.9 to 21.1%. The total DMI (kg/d) of cows fed 35%CC was slightly higher ($p < .05$) than that of cows fed 25%CC, but was not different when compared to cows fed 45%CC and 55%CC. Daily intake of all dietary treatments was not significantly different ($p > 0.05$) when expressed as % BW or g/kgW$^{0.75}$. The total DMI of 50% HF cows was also not different when compared to that of 75% HF cows (Table 2). Digestion coefficients of DM and OM tended to be decreased as CC in concentrate was increased, but the differences were not significant ($p > 0.05$), averaging 69.7 and 72.4%, respectively (Table 2). The use of CC as an energy source in dairy diet has been reported previously by Sommart et al. (1996). Although total DMI (3.0% BW) of cows in this experiment was lower than that (3.6% BW) reported by Sommart et al. (1996), the difference may be due to different type of roughage used or roughage to concentrate ratio. As observed in the experiment, CC can be added upto 55% in concentrate or 38% of total diet which was higher than previously reported by Sommart et al. (1996). These authors suggested that an optimal levels of cassava between 27 to 40 percent in concentrate (approximately 20-30% in the total diets). Recently, Wanapat et al. (1996) found that beef cattle fed diet containing cassava pellet at 33-41% of concentrate had shown the highest ADG (0.71 kg/d). In this study CC can used at high level in concentrate it was due probably to adjusting rumen degraded nitrogen (RDN) and undegraded nitrogen (UDN) of concentrate to meet the requirements for microbial growth and for animals.

Crude protein, digestible organic matter (DOM) and metabolizable energy (ME) intakes were calculated as shown in Table 5. Estimated ME and CP intakes of cows were similar for all dietary treatments, averaging 28.9 Mcal ME/d (2.37 Mcal ME/kgDM) and 1.8 kg/d (16% CP), respectively, which were met the nutrient requirement (2.35-2.53 Mcal ME/kgDM and 12-15% CP) for 400 kg cows milking 7-13 kg/d as recommended by NRC (1989). Recently, Promma et al. (1998), estimated that nutrient requirement for Holstein crossbred cows, averaging 400 kg, cows need diet containing 2.32 Mcal ME/kgDM and 14%CP for producing 10 kg milk per day. Intake of protein in this study is likely to be above the requirement for milk production while energy intake is similar to the requirement and consequent growth as observed.

Increase in CC in concentrate did not affect ($p>0.05$) rumen pH and NH3-N concentration in rumen fluid measured at 4 h post feeding when compared among dietary treatments (Table 3). However, rumen pH was an optimal level for activity of cellulolytic bacteria (Wanapat, 1990). Although concentration of NH3-N was lower than that reported by Sommart et al. (1996), NH3-N concentration found in this study was slightly higher than the minimum concentration (50 mg NH3-N/l) required for microbial growth in the rumen as reported by Satter and Slyter (1974). However, increase in urea in concentrate as CC was increased did not effect rumen NH3-N concentration, it was due probably to balancing between readily degradable carbohydrate and non-protein nitrogen (NPN). In addition, estimated N requirement for microbial growth expressed as g N/kgDOMR was slightly higher than value recommended by ARC (1984) (32 g N/kgDOMR). It clearly indicated that intake of protein of cows in this experiment was slightly higher than that requirement as suggested by NRC (1989) and Promma et al. (1998), as mentioned above.

Milk production and milk composition were not different ($p>0.05$) among CC levels, but milk production and 3.5%FCM were significantly higher ($p<0.01$) in 50% HF cows than in 75% HF cows (Table 4). This result was in accordance with Division of Animal Breeding (1987). The lower milk production of 75% HF cows might be due to an environmental impact. As high temperature (30-40°C) and humidity (65-79%) during the experiment conducted were prevalent, this may lead to develop mild heat stress in 75% HF crossbred cows (Armstrong, 1994) and then decrease in intake, digestibility and consequent milk production as observed in this experiment when compared to 50% HF cows.

Increasing CC levels in concentrate for lactating cows from 25 to 55% resulted similarly. The result indicated that CC can be used as an energy source in dairy diet at very high level (55% in concentrate or 38% of total diet). However, 50% HF cows produced more 3.5% FCM than in 75% HF cows when cows fed the same diet under hot condition.

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Table 1 Ingredients of concentrates used in the experiment (% DM basis).

Ingredient	Dried Ruzi grass	Cassava chip levels 25%	35%	45%	55%
Cassava chip		25.00	35.00	45.00	55.00
Soybean meal		13.00	10.00	8.00	0.00-
Cotton seed meal		14.00	14.00	14.00	14.00
Dried brewery grains		0.00	5.00	10.00	15.00
Corn meal		19.00	16.50	13.00	10.00
Urea		0.00	0.50	1.00	2.00
Dicalcium phosphate		1.00	1.00	1.00	1.00
Limestone		1.00	1.00	1.00	1.00
Salt		1.00	1.00	1.00	1.00
Premix mineral AD_3E		1.00	1.00	1.00	1.00
Total		100.00	100.00	100.00	100.00
Chemical composition, % DM basis					
DM	93.4±0.30[1]	94.6±0.01	94.6±0.01	95.1±0.01	95.4±0.50
Ash	5.7±0.70	9.6±0.01	9.5±0.01	8.7±0.02	9.4±0.10
CP	6.1±0.10	19.9±0.01	20.9±0.01	21.1±0.70	20.7±0.10
NDF	81.4±3.60	20.8±0.80	24.9±0.70	28.6±0.80	34.9±0.70
ADF	48.1±1.10	11.7±0.01	11.9±0.01	13.3±0.50	15.8±0.10

DM = dry matter; CP = crude protein, NDF = neutral-detergent fiber, ADF = acid-detergent fiber

[1] SE, replication of 4 periods

Table 2 The total DM intake and digestion coefficients of cows fed concentrate with different CC levels.

Item	Cassava chip levels 25%	35%	45%	55%	±SE	Holstein Crossbred 50%	75%	±SE
Total DM intake, /d								
Kg	12.0^{a}	12.4^{b}	12.3^{ab}	12.2^{ab}	0.13	12.3	12.2	0.09
%BW	2.98	3.05	3.06	3.03	0.02	3.06	2.99	0.18
$g/kgW^{0.75}$	139	135	134	135	3.07	137	134	2.17
Digestion coefficients, %								
DM	70.7	70.1	69.3	68.5	1.57	70.6	68.6	1.11
OM	73.1	72.8	71.9	71.8	1.50	73.5	71.4	1.06
NDF	62.9	64.8	63.4	66.7	1.89	66.1	62.8	1.34
Change in BW, kg/d	0.32	0.31	0.63	0.33	0.17	0.32	0.48	0.12

DM = dry matter, OM = organic matter, NDF = neutral-detergent fiber, BW = body weight

Means with different superscripts in the same row are significantly different ($p<0.05$).

SE = standard errors of means

Table 3 Effect of CC levels in concentrate on pH, and ammonia-nitrogen (NH_3-N) in rumen fluid.

Item	Cassava chip levels					Holstein Crossbred		
	25%	35%	45%	55%	±SE	50%	75%	±SE
Rumen pH	6.76	6.60	6.56	6.69	0.06	6.76	6.55	0.04
NH_3-N, mg/l	53.4	54.2	52.0	46.5	3.00	53.7	49.4	2.12

SE = standard errors of means

Table 4 Effect of CC levels in concentrate on milk yield and milk composition.

Item	Cassava chip levels					Holstein Crossbred		
	25%	35%	45%	55%	±SE	50%	75%	±SE
Milk yield, kg/day	9.48	9.69	9.31	9.43	0.22	10.4	8.58	0.15
3.5% FCM, kg/day	9.14	9.43	8.98	9.32	0.26	10.0^a	8.41^b	0.19
Milk composition								
Fat, %	3.28	3.33	3.28	3.43	0.11	3.28	3.37	0.08
Protein, %	3.13	3.08	3.14	3.10	0.02	3.06	2.99	0.03
Lactose, %	4.48	4.54	4.65	4.59	0.13	4.58	4.54	0.90
Solids-not-fat, %	8.05	8.13	8.22	7.91	0.19	8.19	7.97	0.14
Total solids, %	11.2	11.5	11.7	11.5	0.21	11.6	11.4	0.15

Means with different superscripts in the same row are significantly different ($p<0.05$).

SE = standard errors of means

Table 5 The nutrients intake of cows fed concentrate with different CC levels.

Item	Cassava chip levels					Holstein Crossbred		
	25%	35%	45%	55%	±SE	50%	75%	±SE
Nutrient intake								
OM, kg/d	8.17	8.46	7.99	7.37	0.17	8.08	7.92	0.12
CP, g/d	1.77	2.00	2.04	2.01	0.06	2.00	1.91	0.05
Estimated energy intake								
Mcal ME/d	26.9	28.4	29.5	30.9	1.46	30.3	27.6	1.03
Estimated N requirement for microbial growth								
g N/kgDOMR	53.1	55.3	56.5	55.9	0.19	55.0	55.3	0.14

ME = metabolizable energy, DOM = digestible organic matter, DOMR = apparently digestible OM in the rumen, OM = organic matter, CP = crude protein

SE = standard errors of means