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Original Article

Effects of dried cassava pulp as a main source of energy in concentrate on growth performance, carcass composition, economic return and some beef eating qualities of feedlot cattle

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Abstract

This study was conducted to determine the effects of feeding dried cassava pulp (DCP) as a main source of energy at a higher level in concentrate on growth performance, carcass composition, economic return and some beef eating qualities of feedlot cattle. Fifteen Brahman-native crossbred young bulls at an average age of 2 years and initial weight of 277±10.36 kg were randomly allocated to 3 groups in a completely randomized trial. The animals received either control concentrate (CTRL), concentrate in which cassava meal was replaced by DCP at 50 (DCP50) or 100% (DCP100) by weight. Experimental diets were fed to the animals *ad libitum* and supplemented with 3 kg of para grass (*Brachiaria mutica*). The feeding period was 150 days. The results indicated that feedlot cattle on CTRL showed the best feedlot performance and carcass quality as compared to the other groups. However, the difference was not statistically significant (p>0.05). The DCP50 had higher economic return compared to the CTRL and DCP100, while DCP100 can be potentially incorporated into the ration when the cassava price is too high to be used. Carcass composition (slaughtering weight, carcass weight, carcass percentage, lean weight and lean percentage) of the experimental feedlot cattle were not significantly different (P>0.05) among the cattle fed with CTRL, DCP50 and DCP100, respectively. Some beef eating qualities (shear force, tenderness, juiciness, meat flavor and overall satisfaction were not significantly different (P>0.05) among the cattle fed with CTRL, DCP50 and DCP100 total, respectively.

Keywords: dried cassava pulp (DCP), concentrate, carcass composition, economic return, beef eating quality, feedlot cattle

1. Introduction

Cassava pulp is the residue from cassava starch process (Araullo *et al.*, 1974) and it is estimated that 1.5 million tons is produced each year (Sriroth, 1997; Sriroth and Piyajomkwan, 2003). Local feed ingredients such as dried cassava pulp (DCP) is not used as an energy source in concentrate for feedlot cattle due to the price and higher nutritive value of cassava meal. Price of DCP as an animal feed depends on drying cost and transportation. Although dried cassava pulp contains a higher fiber, lower protein and energy content than cassava meal, DCP still has more potential to be use as a feed ingredient (Nilvisade, 2000). Therefore, this experiment was conducted to determine the effects of feeding DCP as a main source of energy at a higher level in concentrate on growth performance, carcass composition, economic

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return and some beef eating qualities of feedlot cattle (local quality beef). It is believed that 0.6-0.8 million heads of feedlot cattle are produced each year from approximate 0.4-0.6 million families of the small holders (Yimmongkol, 2002; Ungkulo, 2003). Reducing production cost by incorporating DCP in the ration is very important to the local feedlot producers especially when the cassava price is too high to be used.

2. Materials and Methods

Fifteen Brahman-native crossbred young bulls at average an age of 2 years and initial body weight of 277± 10.36 kg were used. They were treated for internal and external parasites with Ivomex-F intramuscularly, vaccinated against Foot and Mouth Disease and were kept individually in feeding stalls where feed and water was provided. This took place at the Buffalo and Beef Production Research and Development Center, Suwanvajokkasikit Animal Production Research and Development Institute, Kasetsart University, Kamphaeng Saen Campus, Nakhon Pathom. The feedlot cattle were randomly divided into 3 groups of 5 animals and were randomly allotted to receive one of three dietary treatments according to a Completely Randomized Design (CRD) (SAS, 2003; Chantalakkana, 2006). A 14-days adaptation period preceded the growth studies. The feeding period was 150 days. The control concentrate (CTRL) used cassava meal as an energy source. CTRL and dietary treatments were fed to the animals *ad libitum* and supplement with 3 kg of para grass (*Brachiaria mutica*). The other 2 treatments were concentrate in which cassava meal was replaced by dried cassava pulp (DCP) at 50 and 100% and were assigned as dietary treatments (DCP50, DCP100) (Table 1). Diets were formulated to contain the same level of crude protein (14%) to satisfy the requirements for feedlot cattle for 1-1.4 kg /day of weight gain (Kearl, 1982). Each animal had access to a mineral-vitamin lick and water at all times. Feed offered and refusals were weighed daily to measure feed intake. Samples of the feed were taken weekly and weekly samples were bulked for laboratory analysis and determined the bulk density (Khajarern and Khajarern, (1999). Live weight was measured monthly before morning feeding. Palatability study was conducted by evaluating the refusals of the morning feed before the next feeding time (afternoon) and ranged from 1 (poor) to 4 (excellence).

The animals were weighed (at the end of the experiment), held overnight off feed and slaughtered the following day at a local standard slaughter house (J. Livestock Farm, Suphanburi) with the method of Kantapanit (1986) and National Livestock and Meat Board (Ziegler, 1977). After skinning and evisceration, the rumen was cut open and the walls inspected for ulcers and scaring. Warm carcass weight, hide weight, visceral weight, carcass composition and carcass percentage were recorded. The dressing percentage and meat composition were also determined.

Table 1. Feed ingredients and chemical composition of the experimental concentrate

Ingredient (kg)	CTRL	DCP 50	DCP 100
Cassava meal	46.6	25.4	-
Dried cassava pulp	-	25	46.4
Cassava leaf meal	15	15	15
Rice bran	12	10	12
Corn	12	10	12
Molasses	8	8	8
Urea	1.9	2.1	2.1
Zeolite	2.0	2.0	2.0
Salt	1.0	1.0	1.0
Dicalcium phosphate	1.0	1.0	1.0
Premix (trace mineral)	0.4	0.4	0.4
Sulphur	0.1	0.1	0.1
Total	100	100	100
Chemical composition (% of DM)			
Crude Protein (Prox. analysis)	14.25	14.40	14.50
TDN (by calculation)	79.43	75.50	71.46
Crude fiber	8.47	10.25	13.06
Ash	9.19	8.78	10.67
Fat	3.8	3.08	3.6
NDF	20.08	21.92	26.73
ADF	12.48	16.94	21.76
Lignin	3.14	3.32	4.32
Cal/g	4,116.7	4,016.77	4,090.05
Bulk density (g/ lit)	560.19	526.39	487.04
Price (baht / kg)	4.84	4.40	4.14

Loin samples (Longissimus dorsi muscle; LD) from both the right and left of each carcass were collected and chilled under 3°C for 7 days, then kept frozen waiting further analysis of the eating quality, appearance and tenderness. A study on some beef eating qualities was done at the Animal Produce Research and Development Center. Beef eating qualities, appearance and tenderness were determined and analyzed as follows.

1. Carcass percentage (Cole *et al*., 1968, Kantapanit, 1986) is calculated by

$$\text{Carcass percentage} = \frac{\text{Carcass weight}}{\text{Slaughtering weight}} \times 100$$

2. Loin eye area (cm^2) was measured at the area of the rib eye muscle (Longissimus dorsi muscle) between 12th and 13th rib by using semi transparence paper and/or real time ultrasound (Pie Medical 100 Falco, U.S.A.)(Kantapanit, 1986; Sretthakul and Opaspattanakij, 2005; Gresham, 2001; Smith *et al*., 2001)

3. Marbling (Score from 1 to 5; 1= no marbling and 5 = highest marbling) was measured at the rib interface of the rib eye muscle (Longissimus dorsi muscle) between 12th and 13th rib (National Bureau of Agricultural Commodity and Food Standards, 2005)

4. Fat Thickness (Rib Fat) (cm) External fat thickness was measured at the 12th / 13th rib interface, perpendicular to the outside surface of the carcass at a point ¾ of the length of the rib eye from its chine-bone end (Kantapanit, 1986; Smith *et al*., 2001).

5. Meat color was determined by using a Subjective Color Score which is divided into 7 levels (1=pale pink, 2= soft pink, 3=pink, 4=light red, 5=red, 6=medium dark red and 7=dark red) (Japan Meat Grading Association, 1990; Smith *et al*., 2001). Meat color which consumers prefer are range from soft pink to red color (from 2 to 4)

6. Fat color was determined by using a Subjective Color Score which is divided into 7 levels (Japan Meat Grading Association, 1990).

7. Tenderness (shear force; kg) was measured by using Warner Bratzler Shear device (Challion; G-H ELEC Co. Ltd., U.S.A.) (Kantapanit, 1986). Tenderness was measured by sampling 1 inch thick rib eye muscle and roasting it at 148.5°C until the center of the rib eye muscle is 70°C. After cooling down, the muscle was sampled by using a core (1.27 cm of radius) cut along the muscle fiber. The meat samples were put into the triangle hole of the Warner Bratzler Shear device and the device run. The data was recorded from scale and the average calculated.

8. Sensory evaluation. Sensory evaluation was determined by using the rib eye muscle which was chilled for 7 days and roasted until the center of the rib eye muscle was 70°C. After cool down, the meat was cut into pieces at 1 cm^3 within the same muscle fiber. Tenderness, juiciness, meat flavor and overall satisfaction were determined by taste panelists and were divided into 5 levels (Larmond, 1970; Kantapanit, 1986).

3. Results

3.1 Growth performance

No significant difference was observed on final weight (388.40, 384.80 and 379.80 kg), weight gain (117.20, 102.00 and 104.50 kg), ADG (0.78, 0.68 and 0.70 kg/day) and FCR (8.80, 8.67 and 9.42) of the CTRL, DCP50 and DCP100, respectively. It was found that total DM intake (997.55, 854.68 and 976.73 kg), DM intake/day (6.65, 5.70 and 6.50 kg/day), DM intake (% BW) (3.02, 2.56 and 2.98%) had significant difference (P<0.05) of the CTRL, DCP50 and DCP100, respectively. Feed cost (4.84, 4.4 and 4.14 baht/kg) and feed cost/kg of gain (44.38, 39.58 and 41.54) were not significantly different (P>0.05) but feed cost/day (33.58, 26.02 and 28.72 baht/day) was significantly different (P< 0.01) among the cattle fed with CTRL, DCP50 and DCP100, respectively. Although, feed intake decreased in the feedlot cattle fed with DCP50, feedlot performances were not affected (weight gained, ADG and FCR) and was consistent with Sommart and Bunnakit (2004). However, more selective eating behavior of the feedlot cattle fed with DCP50 was observed as compared to CTRL and DCP100 as shown by the palatability score (Table 2).

3.2 Carcass composition

After the feeding trial, all feedlot cattle were sent to the slaughter house to study carcass quality and composition. From Table 4, carcass composition of the experimental feedlot cattle showed that slaughtering weight (393.2, 388.8 and 383.0 kg), carcass weight (213.8, 210.8 and 204.75 kg),

Table 2. Effects of DCP in concentrate on feedlot performance and feed cost of feedlot cattle.

Feedlot performance	CTRL	DCP 50	DCP 100	SEM	P
Initial wt. (kg)	271.2	282.8	275.3	2.7	0.22
Final wt. (kg)	388.4	384.8	379.8	4.8	0.80
Gain (kg)	117.2	102	104.5	6.4	0.60
ADG. (kg/day)	0.78	0.68	0.70	0.04	0.60
FCR	8.80	8.67	9.42	0.35	0.70
DM intake					
Total DM intake (kg)	997.55^a	854.68^b	976.73^a	26.8	0.039
($kg\ d^{-1}$)	6.65^a	5.7^b	6.5^a	0.18	0.04
($\%BW\ d^{-1}$)	3.02^A	2.56^B	2.98^A	0.08	0.01
(g./$BW^{0.75}$)	85.84^A	72.95^B	84.6^A	2.24	0.01
Feed cost (baht/kg)	4.84	4.40	4.14	-	-
Feed cost/day(baht/day)	33.58^A	26.02^B	28.72^B	1.15	0.006
Feed cost /kg of gain (baht/kg)	44.38	39.58	41.54	1.70	0.50
Palatability[1/]	2.80	2.50	2.60	0.72	0.14

[A,B] Means within rows with different superscripts differ significantly (P<0.01)
[a,b] Mean within rows with different superscripts differ significantly (P<0.05)
[1/] 4 = excellence, 3 = good, 2 = fair, 1= poor

Table 3. Effects of DCP in concentrate on economic return of feedlot cattle.

Carcass quality and profit	CTRL	DCP 50	DCP100	SEM	P
Slaughtering Weight (kg)	393.20	388.80	383.00	6.3	0.84
Carcass wt. (kg)	213.80	210.80	204.75	3.2	0.57
Total feed cost (baht)	5,037.50 ^{A}	3,903.70 ^{B}	4,307.40 ^{B}	173.12	0.006
Cost of feedlot cattle (baht)	11,661.60	12160.40	11,919.60	-	-
Cost of feedlot cattle (baht/kg)	43	43	43	-	-
Other production cost (baht)	1,030	1,030	1,030	-	-
Total production cost (baht)	18,667.50 ^{A}	17,533.70 ^{B}	17,937.40 ^{B}	173.12	0.006
Carcass price (baht)[/1]	19,146.80	18,871.90	18,442.60	293.80	0.67
Sale price/kg body wt. (baht/kg)	48.80	48.53	48.14	0.41	0.84
Profit / head (baht/head)	1,417.70	1,777.80	1,269.40	292.33	0.80
% Profit	8.05	10.48	7.38	1.73	0.74

[/1] Carcass wt. > 190 kg = 90 baht/kg ; Carcass wt. < 190 kg = 88 baht/kg

^{A,B} Means within rows with different superscripts differ significantly (P<0.01)

^{a,b} Means within rows with different superscripts differ significantly (P<0.05)

carcass percentage (54.5, 54.2 and 53.5%), lean weight (170.8, 168.8 and 165.0 kg), lean percentage (44.3, 43.5 and 43.1%), hide weight (44.81, 45.39 and 42.92), hide percentage (11.30, 11.69 and 11.36%), bone weight (52.74, 51.2 and 50.65 kg), bone percentage (13.42, 13.19 and 13.41%), weight of abdominal fat (14.42, 12.39 and 13.08 kg) and abdominal fat percentage (6.68, 5.86 and 6.48%) were not significantly different (P>0.05) among the cattle fed with CTRL, DCP50 and DCP100, respectively. Carcass qualities of the experimental feedlot cattle showed that marbling (1.2, 1.2 and 1.0), fat thickness (0.28, 0.28 and 0.24 cm), meat color (3.4, 3.5 and 3.0), fat color (3.80, 3.75 and 4.0), total loin eye area (57.3, 55.08 and 50.81 cm^2) and loin eye area/ 100 kg of carcass weight (26.81, 26.34 and 24.81 cm^2/100 kg) were not significantly different (P>0.05) among the cattle fed with CTRL, DCP50 and DCP100, respectively.

3.3 Shear force and sensory evaluation

The overall satisfaction of the consumers on beef are general appearance, colour, price and some beef eating qualities such as tenderness, juiciness, marbling, smell and taste (Kantapanit, 1986). Results from the Warner Bratzler Shear device indicated that shear force (2.26, 1.99 and 2.12 kg), tenderness (3.42, 2.94 and 3.50), juiciness (3.40, 3.46 and 3.35), meat flavor (3.36, 3.02 and 3.20) and overall satisfaction (3.4, 2.94 and 3.41) were not significantly different (P>0.05) among the cattle fed with CTRL, DCP50 and DCP100, respectively (Table 4). The result from this experiment revealed that the use of DCP as a main energy source in concentrate did not influence beef eating qualities of the feedlot cattle.

3.4 Economic return of the feedlot cattle

The total feed cost and total production cost of the cattle fed with CTRL was higher than DCP100 while DCP50 has the lowest production cost (Table 3). The total feed costs were 5,037.5, 3,903.7 and 4,307.4 baht and total production costs were 18,667.5, 17,533.7 and 17,937.4 baht for the cattle fed with CTRL, DCP50 and DCP100, respectively. The production cost of the experimental feedlot cattle was studied to determine the economic return. The feedlot cattle fed with CTRL had the highest carcass price than DCP50 and DCP100 (19,146.80, 18,871.90 and 18,442.60 baht) due to the carcass weight. Carcass price was varied from 88 to 90 baht/kg and depended on carcass weight. As compared to the production cost, feedlot cattle on DCP 50 had a higher profit (10.48%) than those on CTRL (8.05%) and DCO100 (7.38%).

4. Discussion

Growth performance, carcass composition of the feedlot cattle showed no differences. The results revealed that diet containing DCP replaced of cassava meal at 50% and up to 100% as energy source did not influence growth performance, carcass weight, carcass percentage, lean weight and lean percentage. Even though ADG tended to be lower than cassava meal diet, DCP still had enough potential to be use as an energy source in feedlot ration especially for the small farmers who produced feedlot cattle around cassava starch and sweetener factories.

Sensory evaluation on some beef eating qualities showed no differences and confirmed the potential use of DCP. The economic return of each group of feedlot cattle was satisfactory and can help saving production cost. However, this experimental period was too long (150 days) while the feedlot production for local market should not exceed than 120 days (Yimmongkol, 1990; Yimmongkol *et al*., 2002). Compensatory growth at the early stage of feedlot helps saving cost of production and also group feeding of on a farm

Table 4. Effects of DCP as a main source of energy in concentrate on carcass composition and some beef eating qualities of feedlot cattle.

Item	CTRL	DCP50	DCP100	SEM	P
No. of Animals (heads)	5	5	5	-	-
Slaughtering Weight (kg)	393.20	388.80	383.00	6.3	0.84
Carcass Weight (kg)	213.80	210.80	204.75	3.2	0.57
Dressing (%)	54.50	54.20	53.50	0.51	0.78
Lean Weight (kg)	170.80	168.80	165.00	2.9	0.76
Lean (%)	44.30	43.50	43.10	0.44	0.53
Hide (kg)	44.81	45.39	42.96	1.37	0.78
Hide (%)	11.30	11.69	11.36	0.29	0.86
Bone (kg)	52.74	51.20	50.65	0.82	0.59
Bone (%)	13.42	13.19	13.41	0.21	0.89
Abdominal Fat (kg)	14.42	12.39	13.08	0.51	0.27
Abdominal Fat (%)	6.68	5.86	6.48	0.21	0.27
Marbling [1]	1.20	1.20	1.00	0.09	0.62
Rib Fat (cm)	0.28	0.28	0.24	0.01	0.24
Meat Color [2]	3.40	3.50	3.00	0.41	0.90
Fat Color [3]	3.80	3.75	4.00	0.19	0.88
Loin Eye Area $(cm)^2$					
- Total $(cm)^2$	57.3	55.08	50.81	1.03	0.25
- Per 100 kg of Carcass Weight $(cm)^2$/100 kg	26.81	26.34	24.18	0.78	0.36
Shear Force (kg)	2.26	1.99	2.12	0.33	0.95
Tenderness [4]	3.42	2.94	3.50	0.14	0.25
Juiciness [5]	3.40	3.46	3.35	0.11	0.95
Meat Flavor [6]	3.36	3.02	3.20	0.08	0.26
Overall Satisfaction [7]	3.40	2.94	3.41	0.11	0.15

[A,B] Means within rows with different superscripts differ significantly ($P<0.01$)
[a,b] Mean within rows with different superscripts differ significantly ($P<0.05$)
[1] Marbling score from 1 to 5; 1= no marbling and 5 = highest marbling
[2] Meat color score from 1-7; 1= pale pink, 2= soft pink, 3= pink, 4= light red, 5= red, 6= medium dark red and 7= dark red
[3] Fat color score from 1-7; 1= turbid white, 2= medium turbid white, 3= light turbid white, 4= white, 5=light pinky white, 6= medium pinky white, 7= pinky white
[4] Tenderness score from 1-5; 1= excellence, 2= good, 3= medium, 4= fair, 5= poor
[5] Juiciness score from 1-5; 1= excellence, 2= good, 3= medium, 4= fair, 5= poor
[6] Meat flavor score from 1-5; 1= excellence, 2= good, 3= medium, 4= fair, 5= poor
[7] Overall satisfaction score from 1-5; 1= excellence, 2= good, 3= medium, 4= fair, 5= poor

feedlot production system usually has better ADG and results in more weight gain due to feeding behavior (Prucsasri, 1990). On the other hand, DCP as an energy source in feedlot feed for prime quality beef production can be applied especially at the early stage of feedlot. Helping the feedlot producers to reduce the production cost is very important because more than 90% of meat consumed in Thailand comes from the small holders (Yimmongkol, 1990; Yimmongkol *et al*., 2002). This is especially important when the price of feed ingredients rises.

5. Conclusion

1. Dried cassava pulp still has enough potential to be used as a feed ingredient in feeding rations especially for the small farmers who raise feedlot cattle around the cassava planting area, cassava starch and cassava sweetener factories.

2. Growth performances of the feedlot cattle fed with concentrate which used dried cassava pulp instead of cassava meal (100 % instead) showed no differences.

3. Carcass qualities, carcass composition and some beef eating qualities of the feedlot cattle fed with concentrate which used dried cassava pulp instead of cassava chips showed no differences.

4. Helping the feedlot producers to reduce the production cost is very important, especially when the cassava price is too high to be used. It is estimated that more than 90% of meat consumed (the local quality beef) comes from

the small holders.

5. Using of DCP as feed ingredient can solve the problem of adulterating DCP into cassava meal or pellet which is unfair to the farmers in terms of quality and supply of feed ingredient.

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