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# Effect of cassava leaf pellet supplementation on growth performance, nutrient digestibility, and economic return in Chalorais crossbred cattle fed rice straw as basal diet

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**Abstract** The results showed that increasing the level of CLP supplement had not significantly affected on animal body weight and monthly growth rate (weight gain and average daily gain) but increased linearly in the overall period (P<0.05). Increasing the level of CLP supplement also had not significantly affected to intake daily dry matter (DM), nutrients including organic matter (OM), crude protein (CP), ether extract (EE), neutral detergent fiber (NDF) and acid detergent fiber (ADF). Increasing the supplementation levels were significantly increased in ADF digestibility (P<0.05). The nutrient (DM, OM, CP, and NDF) digestibility in the cattle, did not differ significantly. Increasing the level of CLP supplement increased net profit per head (THB) and profit (%) (P<0.05). It is concluded that CLP could be supplemented in concentrate up to 20% as protein soured in Charolais crossbred cattle.

**Keywords**: Feed security, Feeding trial, Ruminant, Alternate feed

## Introduction

By the year 2050, the world is expected to require 70 percent more food to supply a global population of approximately 9.1 billion. The growing population occurs in parallel with growing demand. Developing countries have a trend of increase that is greater than developed countries from 2015 to 2030, meat and milk consumption in developing countries will increase from 190 to 255 million tons (+ 30%) and from 359 million tons to 491 million tons (+65%), respectively (Steinfeld and Wassenaar, 2007). Global food security faces a challenge to support this growing demand and population number.

Livestock plays a vital role in food security as a protein-energy food supply for humans. Cattle are the most important ruminant population and are widely used throughout the world. Thailand is an agriculturally developing

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country. Beef cattle have long been associated with Thai culture and Thai society. They are raised by smallholders on approximately 1,096,616 cattle farms (99% of total beef farms in Thailand). The beef cattle population in Thailand is currently about 7.6 million head (DLD, 2021). In general, cattle feeding systems in Thailand are classified into two systems, extensive and intensive (Ogino *et al*., 2016). Most beef cattle are Thai native cattle (*Bos indicus*) kept under an extensive system. They graze on natural grasses and other plants in public areas, requiring less concentrated feed and less labor (Ogino *et al*., 2016). The other breeds are Brahman and Brahman crossbred cattle (*Bos indicus*), European cattle (*Bos taurus*) and European crossbred cattle (*Bos indicus x Bos taurus*) kept under intensive systems (Osothongs *et al.*, 2016). They require more feeding management compared to extensive systems, such as by using a highly concentrated feed and total mixed ration as well as feeding in individual pens. Meat production in Thailand, however, has not been able to meet the demand for meat consumption, which has increased rapidly since 2010 (OAE, 2021).

Most farmers usually used concentrates to improve the performance of beef cattle for many years. However, the concentrated cost has raised causing high prices of feed ingredients, especially protein sources for feeding aminal such as soybean meal. The high price of feedstuff is a very serious problem for farmers.

Approaches to use in cassava leaves which are large amounts in the locality (approximately 9% of the total weight of the whole plant) and are suitable for ruminant feeding, could solve the problem of expensive feed costs. The products of cassava leaves are 300 – 500 kg/rai and crude protein content is within a range of 17.7–38.1% dry matter (Chaiareekitwat *et al.*, 2022).

Inngarm *et al.* (2018) reported that cassava leaves could be used in the total mixed ration (TMR) at 15% dry matter did not affect on growth performance of Charolais crossbred beef cattle. Sath *et al.* (2008) reported that supplementation of sun-dried cassava foliage improved the growth performance of cattle and that the response was linear over the range from 0 to 1.6 g cassava crude protein/kg live body weight. Bernard *et al.* (2020) showed that cassava leaves were alternated protein sources for African short-horned Zebu heifers. It could be used in Range of grass up to 26% dry matter. However, Putra and Sinaga (2018) documented that cassava leaves could be used up to 50% dry matter in feed for male sheep with no effect on body weight gain, feed consumption, and feed conversion ratio.

The problem with the utilization of dried cassava leaves for feeding animal was light, dusty, and easily lost. According to previous research, pelleted feeds have been used successfully for the animal including ruminant animals and non-ruminants. The useful of pelleted feeds were prevented selective feeding, preventing the feed from separating causing varying and density and size, providing higher bulk density, which has advantages for shipping, and improving the utilization of nutrient (Wanapat *et al*., 2013). Furthermore, research on cattle feeding to improve animal productivity and performance for sustainable cattle production is urgently needed. The strategy for livestock development is the improvement of the efficient utilization of available feed resources and the use of suitable feeding systems (WTSR, 2010).

The objective was to determine the effect of the supplementation level of cassava leaf pellet (CLP) on growth performance such as dry matter intake, nutrient intake (organic matter, neutral detergent fiber, acid detergent fiber, and ether extracts intake), live body weight, weight gain, average daily gain, nutrient digestibility, and economic return.

## Materials and methods

This experiment was conducted at San Keaw village, Prangku District Sisaket Province, Thailand from March 10 to December 12, 2021.

### *Animals and experimental design*

Twelve Charolais crossbred steers with an average body weight of 250 ± 50 kg (mean±SD) were analyzed in a randomized complete block design (3 groups with 4 replications), each group received the use of cassava leaf pellet (CLP) as a protein source to replace concentrate at 0% 10% and 20% respectively. The animals were housed individually in pens ($2.5 \times 3.0$ m$^2$) with feeding at 09.00 am and 5.00 pm each day and provided with clean water. The vitamin supplement AD$_3$E (Phoenix, Belgium: vitamin A 3000,000 IU, vitamin D3 100,000 IU, vitamin E acetate 50 mg; administered at 1 mL per 50 kg live weight) was given intra-muscularly to all animals at the beginning of the experiments. All animals fed concentrate at 2.0% of BW (DM), twice daily at 07.00 h and 16.00 h. Rice straw was fed to cattle *ad libitum*.

### *Experimental diet preparation*

All ingredients of the experimental diet were shown in Table 1. The CLP was prepared from the cassava leaf collected in the NonKhoon district, Sisaket province. The ingredients of CLP were mixed in a horizontal feed mixer. After mixing well, all ingredients were added to water to adjust moisture to 30%, accordingly made pellets using a pellets machine and then sun-dried for 24-30 hours.

The concentrate was formulated to meet the nutrient requirements of beef cattle for an average daily weight gain of 1,000 g/day (WTSR, 2010). It was prepared using feedstuffs obtained from the local market in Sisaket province, Thailand, as shown in Table 1. A formulated ingredient ratio of 200 kg of fresh matter per batch was mixed in a horizontal feed mixer and loaded into a plastic silo tank (200 L). The silo tanks were stored in an outside room for at least 7 ensiling days.

**Table 1.** The ingredients of concentrate, cassava leaf pellet, and roughage

| Items | Ratio | | |
|---|---|---|---|
| | Concentrate | Cassava leaf pellet | Roughage |
| Ingredients (%DM) | | | |
| Rice straw | - | - | 100 |
| Dried Cassava leaf | - | 70.00 | - |
| Fresh cassava pulp | 40.00 | - | - |
| Dried cassava pulp | - | 29.20 | - |
| Cassava ship | 9.80 | - | - |
| Palm kernel meal | 14.00 | - | - |
| Soybean meal | 20.35 | - | - |
| Rice bran | 14.00 | - | - |
| Urea | 0.90 | 0.80 | - |
| Mineral | 0.25 | - | - |
| Premixed | 0.03 | - | - |
| Total | 100.00 | 100.00 | 100 |

***Data and sample collection***

**Animal weight and feed intake**

Cattle were monthly weighed and recorded in the morning (07:30 am), to determine body weight and metabolic body weight for each group. The offered feed was weighed daily and the animal fed after the refused feed was removed. The refused feed from the previous day was recorded daily. Feed intake was calculated as the difference between the amount offered and the amount of refused feed.

### Nutrient digestibility

The AIA marker technique, as described by Van Keulen and Young (1977), was used to estimate the digestibility. Fecal grab samples were obtained (200 g/animal) daily for 5 d, before feeding, by rectal palpation. They were pooled at the end of the sampling period, thus producing a composite sample/animal. The offered feed refused feed, and feces were stored at −18 °C until analysis.

At the end of the experimental period, all samples (offered feed, refused feed, and feces) were thawed and mixed thoroughly and the sample (1% aliquot) was oven-dried (65 ℃) for 72 hours and ground to pass through a 1-mm screen. The dry samples of feed and feces were analyzed using AOAC (1995) procedures for dry matter, organic matter, crude protein, and ether extracts. Neutral detergent fiber assayed with a heat-stable amylase and expressed inclusive of residual ash, and acid detergent fiber, expressed inclusive of residual ash, were analyzed by the method of Van Soest *et al.* (1991).

### Production cost and economic return

The production cost and economic return were determined using equations (1) to (6), respectively:

| | | | |
|---|---|---|---|
| cattle cost | = | initial live weight x animal price | (1) |
| feed cost | = | feed intake x feed price | (2) |
| management cost | = | wages + housing + medicine + water + electric | (3) |
| total cost | = | cattle cost + feed cost + management cost | (4) |
| total income | = | final live weight x animal price | (5) |
| profit | = | total income (5) - total cost (4) | (6) |

### *Statistical analysis*

All data were analyzed using the general linear model procedure of SAS (1998) according to a randomized complete block design. The mean values were compared by Duncan's test. Significant differences were $P < 0.05$ unless otherwise noted. Linear and quadratic contrast of the treatment means were estimated.

## Results

### *Growth performance*

The results showed that the weight gain and average daily gain of cattle fed the experimental diet with different levels of CLP supplementation were 87.0 to 93.3 kg and 0.96 to 1.04 kg/day, respectively. Increasing the level of CLP supplementation had no influence (P>0.05) on live weight, but linearly increased overall weight gain and overall average daily gain (P<0.05) as shown in Table 2.

**Table 2.** Body weight, weight gain, and average daily gain of cattle fed the experimental diet with different levels of CLP supplementation

| **Items** | **level of CLP supplementation** | | | **SEM** | **P –value** | |
|---|---|---|---|---|---|---|
| | 0 | 10 | 20 | | L | Q |
| Live weight (kg) | | | | | | |
| Initial | 218.3 | 225.7 | 188.0 | 16.67 | 0.268 | 0.332 |
| Final | 305.3 | 315.0 | 281.3 | 17.26 | 0.381 | 0.363 |
| Weight gain (kg) | | | | | | |
| Day 0 - 30 | 27.0 | 32.0 | 29.3 | 1.50 | 0.334 | 0.106 |
| Day30 - 60 | 30.0 | 28.0 | 30.0 | 1.78 | 1.000 | 0.411 |
| Day 60 - 90 | 30.0 | 29.3 | 31.7 | 1.33 | 0.427 | 0.410 |
| Overall | 87.0[b] | 89.3[ab] | 93.3[a] | 1.50 | 0.041 | 0.674 |
| Average daily gain (kg/day) | | | | | | |
| Day 0 - 30 | 0.90 | 1.07 | 0.98 | 0.05 | 0.345 | 0.108 |
| Day30 - 60 | 1.00 | 0.93 | 1.00 | 0.06 | 0.970 | 0.423 |
| Day 60 - 90 | 1.00 | 0.98 | 1.13 | 0.06 | 0.165 | 0.272 |
| Overall | 0.96[b] | 1.00[ab] | 1.04[a] | 0.02 | 0.033 | 0.755 |

[a b] Mean with different superscripts within columns significantly differed (P < 0.05), SEM = Standard error of the mean, L = linear; Q = quadratic. CLP = Cassava leaf pellet

***Feed intake and digestibility***

The daily feed intake and nutrient intake were not significantly affected by increasing the level of CLP supplementation (P>0.05) as shown in Table 3. The mean values of dry matter intake were similar between treatments, ranging from 6.7 to 6.9 kg, 2.7 to 2.7 %BW, and 63.9 to 65.09 g/kg 0.75, respectively. The intake (kgDM/day) of organic matter, crude protein, ether extracts, neutral detergent fiber, and acid detergent fiber were in the range 6.7 to 6.9, 2.7 to 2.7, and 62.5 – 65.09, respectively.

Additionally, increasing the level of CLP supplementation resulted in increasing the digestibility of ADF (*P*<0.05), whereas the digestibility of DM CP EE and NDF were not significantly increased in the level of CLPsupplementation (*P*>0.05), ranging from 80.7 to 82.7 %, 86.1 to 87.5 %, 68.6 to 70.5 %, 70.1 to 80.3 %, and 60.9 to 74.2 %, respectively.

**Table 3.** Feed intake and digestibility of cattle fed an experimental diet with different levels of CLP supplementation

| **Items** | **level of CLP supplementation** | | | **SEM** | **P –value** | |
|---|---|---|---|---|---|---|
| | 0 | 10 | 20 | | L | Q |
| Daily feed intake | | | | | | |
| Dry matter (kg) | 6.7 | 6.9 | 6.7 | 0.24 | 0.213 | 0.771 |
| Dry matter (%BW) | 2.7 | 2.7 | 2.7 | 0.07 | 0.720 | 0.917 |
| Dry matter (g/kg $^{0.75}$) | 63.9 | 65.09 | 62.5 | 2.29 | 0.699 | 0.552 |
| Nutrient feed intake (kgDM/day) | | | | | | |
| Organic matter | 6.3 | 6.2 | 6.1 | 0.31 | 0.780 | 0.974 |
| Crude protein | 0.6 | 0.7 | 0.7 | 0.04 | 0.517 | 0.337 |
| Ether extracts | 0.2 | 0.2 | 0.2 | 0.01 | 0.736 | 0.698 |
| Neutral detergent fiber | 3.5 | 3.6 | 3.7 | 0.16 | 0.491 | 0.866 |
| Acid detergent fiber | 2.2 | 2.4 | 2.5 | 0.12 | 0.211 | 0.778 |
| Digestibility (%) | | | | | | |
| Dry matter | 82.7 | 81.0 | 80.7 | 0.68 | 0.097 | 0.428 |
| Organic matter | 87.5 | 86.1 | 86.7 | 2.38 | 0.828 | 0.764 |
| Crude protein | 68.9 | 70.5 | 68.6 | 2.55 | 0.828 | 0.764 |
| Neutral detergent fiber | 70.1 | 72.7 | 80.3 | 3.34 | 0.100 | 0.580 |
| Acid detergent fiber | 60.9[b] | 65.6[ab] | 74.2[a] | 2.29 | 0.048 | 0.552 |

[a b] Mean with different superscripts within columns significantly differed ($P < 0.05$), SEM = Standard error of the mean, L = linear; Q = quadratic. CLP = Cassava leaf pellet

**Table 4.** Production cost, income, and profit of cattle fed the experimental diet with different levels of CLP supplementation

| Items | level of CLP supplementation | | | SEM | P –value | |
|---|---|---|---|---|---|---|
| | 0 | 10 | 20 | | L | Q |
| Total production cost (Baht) | 28,524.00 | 27,562.00 | 23,312.30 | 1,624.10 | 0.086 | 0.455 |
| Animal cost (Baht) | 23,287.00 | 22,567.00 | 18,800 | 1695.80 | 0.135 | 0.504 |
| Total feed cost (Baht) | 4,000.20 | 3,758.40 | 3,275.70 | 303.25 | 0.466 | 0.762 |
| Total management cost (Baht) | 1,237.00 | 1,237.00 | 1,237.00 | - | - | - |
| Total income (Baht) | 36,160.00 | 37,800 | 33,760 | 1,920.56 | 0.427 | 0.294 |
| Economic return | | | | | | |
| Net Profit (Baht/head) | 7,636.00[b] | 10,237.80[ab] | 10,447.20[a] | 642.57 | 0.037 | 0.206 |
| Profit (Baht/day) | 84.84[b] | 113.75[ab] | 116.08[a] | 7.20 | 0.037 | 0.206 |
| Profit (%) | 27.40[b] | 37.79[a] | 49.79[a] | 3.14 | 0.005 | 0.553 |

[a b] Mean with different superscripts within columns significantly differed ($P < 0.05$), SEM = Standard error of the mean, L = linear; Q = quadratic. CLP = Cassava leaf pellet

### *Economic return*

The results showed that total production costs as animal cost, total feed cost, and total management cost were similar between beef cattle groups fed the experimental diet with different levels of CLP supplementation, ranging from 23,312.30 to 28,542.00 baht, 18,800 to 23,287.00 baht, 3,275.70 to 4,000.20 baht, and 1,237.00 to 1,237.00 baht, respectively.

The increasing of the level of CLP supplementation resulted in linearly increasing profit (P<0.05) in Table 4.

## Discussion

Vongsamphanh and Wanaapt (2004) showed that increasing the level of dried cassava leaf in the experimental diet did not increase the dry matter intake of beef cattle. In addition, Wanapat (2009) documented that dried cassava leaf could be supplemented in dairy feed at 20% with no effect on dry matter intake (P>0.05). Similarly, Gitiyanuphap *et al*. (2020) reported that increasing cassava leaf pellet did not affect on feed intake of cows (P>0.05). Paengkoum *et al.* (2017) concluded that cassava leaf pellets could replace soybean meal 50% CP (or up to 30% in concentrate) as a protein source in growing goats. However, a highly increasing level of CLP could reduce feed intake due to the higher NDF content of the cassava leaf.

The results agreed with Gitiyanuphap *et al.* (2020), who found that cows fed CLP 26% in concentrate were not significantly different from the control group (CLP 0% in concentrate). However, increasing the level of CLP supplementation could reduce the digestibility of crude protein. This may be explained by the by-pass protein effect of condensed tannins which protect the proteins from rumen activity (Wanapat, 2002; Gitiyanuphap *et al*., 2020).

The use of leaves from local plants in the pelleted form helps to supplement high crude protein for the animal (Wannapat *et al*., 2013). CLP was the alternated feed for improving nutrient utilization and so increasing the feed conversion rate. In this study, the results showed that CLP could be added up to 20% in concentrate for beef cattle.

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