# Least-Cost Rations Containing Cassava Meal for Broilers and Growing Pigs

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## ABSTRACT

A least-cost formulation program using cassava meal at a price equivalent to 80% of the current price of sorghum indicates that cassava can be incorporated in practical rations at levels of 20% to 30% for broilers (0-8 weeks) and 30% to 40% for growing pigs (weaning to market weight). Cassava meal is used as a substitute for feed cereal grains, sorghum or maize. Results of feeding trials with broilers and growing pigs show that even cassava meal prepared from roots of high cyanide-containing varieties, such as M Col 1684, if properly dried, can be satisfactorily incorporated at the levels mentioned above in compound or balanced feeds for these species, producing results similar to those obtained with standard practical rations. Experimental data on bodyweight gain, feed consumption, feed conversion and economic evaluation are presented and discussed.

## Introduction

Although the literature on use of cassava as animal feed is extensive (Nestel and Graham, 1977) the actual inclusion of cassava meal in practical balanced poultry and swine feeds in tropical cassava-producing countries is limited. One reason is the relatively high market price of cassava roots, despite low prices obtained by farmers at the production site. This difference is a consequence of several factors, including the limitation of cassava production to the amount required to satisfy the fresh root market and also the short post-harvest life of the fresh root. A pilot project aimed at development of small scale agroindustries on the north coast of Colombia (Ospina et al., 1983) involving cassava processing and drying for the animal feed market is currently producing results showing that this type of enterprise is technically and economically feasible under the agricultural production systems of that area.

In most, and possibly all, tropical Latin American countries, the poultry industry consumes the largest proportion (up to 70%) of compound or balanced feed production (Pachico and Lynam, 1981). It therefore constitutes the most important potential market for cassava as an animal feed. In Brazil, Cuba, Mexico, Venezuela and elsewhere in Latin America, commercial scale swine production enterprises with a high level of technology are now increasing in importance as markets for balanced feeds.

Experimental results reported on use of cassava meal in broiler diets typically show large variability and lack of consistency; the recommended levels of cassava meal inclusion in broiler diets ranged from 10% (Vogt, 1966) and 30%

(Montilla et al., 1969, 1975; Armas and Chicco, 1973; Enriquez et al., 1977) to 50% of the diet (Olson et al., 1969; Tejada and Brambila, 1969; Enriquez and Ross, 1967; Chou and Müler, 1972; Armas and Chicco, 1973). Some discrepancies in these studies were due to differences in the experimental conditions and in the type of cassava root processing. The results of swine experiments were more consistent than those using poultry and have recently been summarized (Gómez et al., 1982); the inclusion of 30% to 40% of cassava meal in growing pig diets has given satisfactory results.

The amount of cassava meal used in balanced feeds is determined by quality, by price relative to other feedstuffs (cereal grains) which cassava is replacing and by cost of protein-supplying ingredients used to supplement low protein content of cassava meal. Cost of this last factor commonly reduces the price paid for cassava meal to 80% of the current price of sorghum or maize. Using a computarized linear program to formulate least-cost diets with this relative price of cassava meal and current prices of common feedstuffs, levels of inclusion of cassava meal range from 20% to 30% of the diet for both broilers and growing pigs. Based on these considerations, the present study was undertaken to evaluate least-cost diets containing 20% and 30% of cassava meal for feeding broilers (0-8 weeks) and growing finishing pigs (20 to 90 kg body weight).

## Materials and Methods

### Preparation of cassava meal

Cassava meals used in feeding experiments were prepared by sun-drying whole-root chips on a concrete floor at a loading rate of 10 kg of fresh chips per square meter. A high-cyanide (CMC-84) and several low- to medium-cyanide containing varieties were used for the poultry and pig feeding trials, respectively. Dried chips were ground through a hammer mill and the resulting cassava meal used as an ingredient of the experimental diets. The average total cyanide contents in the cassava meals used for poultry and pig experiments were 61 and 51 ppm (dry matter basis), respectively; approximately 75% of the total cyanide was present as the cyanogenic glucoside (linamarin) with the remainder as free cyanide.

### Poultry experiment

A total of 444 one-day-old Hubbard chicks were divided into 12 groups of 37 chicks each. Three dietary treatments (0%, 20% and 30% cassava meal) with four replicates each were assayed. In each dietary treatment two types of diets were prepared, the starter and the finisher, which were supplied from 0 to 4 and 4 to 8 weeks, respectively. Diets were fed ad libitum in self-feeders and water was available from automatic waterers. Management and sanitary programs used were the standards for raising broilers on floor. Body weight and feed consumption for each experimental unit (37 chicks) were registered at 4, 7 and 8 weeks, respectively.

### Pig experiment

Thirty-six weaned-crossbred pigs with an average body weight of 20.0 ± 1.2 kg and an average age of 60 days were allocated on the basis of weight and sex to six pens with three barrows and three gilts per pen. Three dietary treatments (0%, 20%, and 30% cassava meal) with two replicates each were assayed. Diets for the growing phase were fed until pigs reached approximately 50 kg, after which the finishing diets were fed. The trial lasted 13 weeks. Diets were fed ad libitum

Table 1. Composition (%) of least-cost diets containing 0, 20% and 30% cassava meal* for broilers.

| Price** | Ingredient | Starting diets (0-4 wk) 0 | 20 | 30 | Finishing diets (4-8 wk) 0 | 20 | 30 |
|---|---|---|---|---|---|---|---|
| Col.$/kg | | | | | | | |
| 15 | Sorghum | 67.09 | 44.32 | 32.94 | 70.94 | 48.17 | 36.79 |
| 12 | Cassava meal | ..... | 20.00 | 30.00 | ..... | 20.00 | 30.00 |
| 29 | Soybean meal | 21.52 | 22.68 | 23.25 | 19.55 | 20.70 | 21.28 |
| 35 | Fish meal | 8.00 | 8.00 | 8.00 | 5.00 | 5.00 | 5.00 |
| 38 | Tallow | .44 | 1.89 | 2.62 | 1.07 | 2.53 | 3.25 |
| 14 | Bone meal | 2.24 | 2.38 | 2.45 | 2.65 | 2.79 | 2.85 |
| 10 | Salt, iodized | .25 | .25 | .25 | .32 | .32 | .32 |
| 168 | Commercial premix | .20 | .20 | .20 | .20 | .20 | .20 |
| 280 | Methionine | .11 | .13 | .14 | .13 | .15 | .16 |
| 300 | Coccidiostat | .10 | .10 | .10 | .10 | .10 | .10 |
| 228 | Antibiotic | .05 | .05 | .05 | .05 | .05 | .05 |
| | Calculated nutrients, % | | | | | | |
| | Crude protein | 22.13 | 21.18 | 20.70 | 19.67 | 18.72 | 18.25 |
| | Calcium | .93 | .97 | .99 | .88 | .92 | .94 |
| | Phosphorus, total | .50 | .50 | .50 | .48 | .48 | .48 |
| | Phosphorus, available | .24 | .25 | .26 | .28 | .29 | .30 |
| | Lysine | 1.20 | 1.20 | 1.20 | 1.00 | 1.00 | 1.00 |
| | Methionine | .50 | .50 | .50 | .45 | .45 | .45 |
| | Metabolizable energy, Mcal/kg | 2.95 | 2.95 | 2.95 | 3.00 | 3.00 | 3.00 |
| | Cost, Col.$/kg | 20.67 | 20.62 | 20.59 | 19.98 | 19.92 | 19.89 |

*Sun-dried whole-root chips of variety CMC-84, a high-cyanide cultivar.

**Exchange rate at time of experiment: US$ ~64 Colombian pesos.

in self-feeders and water was available from automatic nipples. Body weight and feed consumption for each pen were periodically registered throughout the experimental period.

Economic assessment of feeding trials

An economic evaluation of feeding trials used current feedstuffs and live broiler and pig prices (Col.$) in Cali as of June 1982. Actual cost of diets was estimated by adding a 12% charge to the overall calculated average price of all diets in each trial; this charge amounted to 2.43 and 1.91 pesos per kilogram of poultry and pig diets, respectively. These amounts covered cost of labor in different operations required for diet preparation as well as depreciation of equipment used. Fixed costs for each trial included estimated costs of labor, administration, vaccines and drugs, utilities, and depreciation of housing and equipment.

Table 2. Composition (%) of least-cost diets containing 0, 20% and 30% cassava meal* for growing-finishing pigs.

| Price** | Ingredient | Growing diets 0 | Growing diets 20 | Growing diets 30 | Finishing diets 0 | Finishing diets 20 | Finishing diets 30 |
|---|---|---|---|---|---|---|---|
| Col.$/kg | | | | | | | |
| 15 | Sorghum | 65.49 | 42.37 | 29.34 | 70.55 | 46.81 | 35.13 |
| 12 | Cassava meal | ..... | 20.00 | 30.00 | ..... | 20.00 | 30.00 |
| 7 | Molasses, cane | 9.08 | 12.65 | 14.47 | 9.26 | 13.04 | 14.93 |
| 21 | Cottonseed meal | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 |
| 29 | Soybean meal | 8.58 | 6.21 | 7.55 | 4.85 | 3.15 | 1.95 |
| 35 | Fish meal | 1.94 | 4.18 | 3.77 | ..... | 1.85 | 2.98 |
| 14 | Bone meal | 1.70 | 1.07 | .95 | 1.97 | 1.39 | 1.07 |
| 2 | Calcium carbonate | .51 | .53 | .59 | .60 | .63 | .64 |
| 10 | Salt, iodized | .46 | .41 | .42 | .50 | .46 | .44 |
| 50 | Vegetable oil | ..... | .33 | .64 | .02 | .42 | .61 |
| 160 | Commercial premix | .20 | .20 | .20 | .20 | .20 | .20 |
| 228 | Antibiotic | .05 | .05 | .05 | .05 | .05 | .05 |
| 280 | Methionine | ..... | ..... | .014 | ..... | ..... | ..... |
| | Calculated levels, % | | | | | | |
| | Crude protein | 17.16 | 15.89 | 15.38 | 14.63 | 13.37 | 12.73 |
| | Calcium | .80 | .80 | .80 | .80 | .80 | .80 |
| | Phosphorus | .60 | .60 | .60 | .60 | .60 | .60 |
| | Lysine | .70 | .70 | .70 | .50 | .50 | .50 |
| | Methionine | .26 | .26 | .26 | .20 | .20 | .20 |
| | Digestible energy, Mcal/kg | 3.15 | 3.15 | 3.15 | 3.15 | 3.15 | 3.15 |
| | Cost, Col.$/kg | 16.87 | 16.22 | 16.02 | 15.94 | 15.31 | 14.98 |

*Sun-dried whole-root chips of several low and medium cyanide-containing varieties.

**Exchange rate at time of experiment: US$ ~64 Colombian pesos.

Interest on working capital was estimated by pro-rating the 30% annual interest rate on the capital invested (cost of animals at the beninning of trials, fixed and feeding costs). In the case of poultry, a total of at least four lots of broilers (7-8 weeks periods) could be raised throughout the year on the same premises, whereas for pigs only three lots (~3 months periods) could be fattened per year. Therefore, interest on the working capital used was 7.5% (30 ÷ 4) and 10% (30 ÷ 3) for poultry and pig feeding trials, respectively.

Actual results of feeding trials, expressed as the number and live weight of animals and feed consumption, have been used in the economic evaluation. Calculations were performed on the basis of lots or groups of 1,000 chicks or 10 pigs because these size groupings are frequently found at the level of small scale enterprises.

Net returns were obtained by sustracting total expenses from the income represented by the sale of live animals and in the case of poultry the value of the litter sold as fertilizer was also considered. Net return was also expressed as a percentage of total investment or expenses.

## Results and Discussion

Results of the broiler feeding trial are summarized in Table 3. The mortality of chickens, which mainly occurred during the first 2 weeks, was slightly higher for the group fed diets containing 30% cassava meal although it was near the normal range (~5%) (North, 1978). There were no significant (P>.05) differences among the biological results of the three experimental groups for any of the parameters studied; the average body live weights at 7 and 8 weeks were similar to those found normally in commercial broiler enterprises (North, 1978). The feed coversion (units of feed consumed per unit of body weight gain) was similar for all three groups especially at 7 weeks, but it tended to be slightly better for the group fed the 20% cassava meal diet than for the other two groups; thus, the data indicated that to obtain 100 kg of live broiler weight at 7 weeks, 215 kg of diet containing 20% cassava meal were required whereas for the same amount of gain, 220 and 224 kg of diets with 0% and 30% cassava meal, respectively, were necessary.

Table 3. Performance of broilers fed least-cost diets containing varying levels of cassava meal.

| Parameter | Cassava meal (%) in diets 0 | 20 | 30 | SD* |
|---|---|---|---|---|
| Chicks at end of trial (no.)** | 141 | 140 | 137 | .... |
| Mortality (%) | 4.7 | 5.4 | 7.4 | .... |
| Avg. body wt/chicken (kg) | | | | |
| at 7 wk | 1.69 | 1.75 | 1.63 | .05 |
| at 8 wk | 2.01 | 2.08 | 1.97 | .08 |
| Feed consumed/chicken (kg) | | | | |
| 0-7 wk | 3.64 | 3.69 | 3.58 | .13 |
| 0-8 wk | 4.61 | 4.74 | 4.57 | .18 |
| Feed conversion*** | | | | |
| 0-7 wk | 2.20 | 2.15 | 2.24 | .04 |
| 0-8 wk | 2.34 | 2.33 | 2.36 | .04 |

*Pooled standard deviation = Error mean square.

**Initial number of chicks per treatment: 148 with an overall average body weight of 36.3 ± .5 g.

***Units of feed consumed per unit of body weight gain.

Data on the performance of growing-finishing pigs are in Table 4. The results of all three experimental groups were also similar (P>.05) but pigs fed diets containing 20% and 30% cassava meal reached a final live weight with

practically 5 and 1 kilogram more, respectively, than the group fed the diet without cassava meal; these differences were reflected to a lesser extent in the average daily gain per pig throughout the entire experimental period. The feed conversion tended to improve as the level of cassava meal in the diets was increased; pigs fed the control diet (0% cassava meal) required 339 kg of feed per 100 kg of live weight gain whereas the ratios for the pigs fed diets containing 20% and 30% cassava meal were 337 and 331, respectively.

Table 4. Performance of growing-finishing pigs fed least-cost diets with varying levels of cassava meal*.

| Characteristic | Cassava meal (%) in diets | | | SD** |
|---|---|---|---|---|
| | 0 | 20 | 30 | |
| Pigs/group (no.) | 11*** | 12 | 12 | .... |
| Avg final wt/pig (kg) | 89.9 | 94.7 | 91.1 | 2.20 |
| Avg daily gain (kg) | .77 | .82 | .78 | .02 |
| Avg daily feed (kg) | 2.55 | 2.77 | 2.54 | .06 |
| Feed conversion | 3.39 | 3.37 | 3.31 | .10 |

*Overall avg initial weight: 20.0 ± 1.2 kg. Experimental period: 91 days.

**Pooled standard deviation = Error mean square.

***One pig was eliminated during the first two weeks of the experiment.

Table 5 presents results of the economic assessment of poultry and pig feeding trials. Least-cost broiler diets containing 20% cassava meal produced the largest returns at 7 weeks, but diets containing 30% cassava meal led to the lowest economic performance despite the apparently similar biological results; for this group to reach an economic output equivalent to that of the control diet (0% cassava meal) the mortality occurring in that group (7.4%, Table 4) would have to be reduced to practically 0%. The economic evaluation of the poultry trial at 8 weeks, not shown in Table 5, gave returns of 17.5%, 20.2% and 14.7% of the total expenses for groups fed diets with 0, 20% and 30% cassava meal, respectively.

On the other hand, results of the pig feeding trial (Table 5) showed profitability increased as level of cassava meal in diets was incremented from 0% through 20% to 30%; these results were a consequence of the slightly higher body growth rate and the improvement of feed conversions (less units of feed required per unit of gain) observed when the inclusion of cassava meal was increased. The most economic results were obtained with the group fed the 30% cassava meal diet.

Although this type of evaluation may be greatly effected by such factors as actual fixed costs, variable interest rates on capital invested, price of ingredients and fluctuation of live animal marketing prices, results suggest that under current conditions in Colombia the use of cassava meal, at 80% of the price of sorghum, produced the most economical and productive broiler and growing-finishing pig performance at levels of 20% and 30% of the diets, respectively. It is assumed that similar or better results could be obtained under practical, commercial

conditions and evaluations at this level will be required to reconfirmed these experimental results.

Table 5. Economic assessment of poultry and pig feeding trials*.

| Item | Cassava meal (%) in diets 0 | 20 | 30 |
|---|---|---|---|
| | --------Colombian Pesos-------- | | |
| Poultry trial - Lot of 1,000 chicks at 7 weeks | | | |
| Chicks and fixed costs** | 48,600 | 48,600 | 48,600 |
| Feed cost | 74,310 | 77,060 | 74,580 |
| Interest on working capital*** | 9,218 | 9,425 | 9,239 |
| Total expenses | 132,128 | 135,085 | 132,419 |
| Live broilers at $100/kg + litter ($1,220) | 161,770 | 167,470 | 152,810 |
| Net return | 29,642 | 32,385 | 20,391 |
| Return, % of expenses | 22.4 | 24.0 | 15.4 |
| Pig trial - Lot of 10 pigs | | | |
| Weaned pigs at $170/kg | 33,830 | 34,170 | 34,000 |
| Fixed costs, estimated | 7,550 | 7,550 | 7,550 |
| Feed cost | 42,270 | 44,239 | 39,983 |
| Interest on working capital*** | 8,365 | 8,596 | 8,153 |
| Total expenses | 92,015 | 94,555 | 89,686 |
| Live pigs at $120/kg | 108,000 | 114,000 | 109,200 |
| Net return | 15,985 | 19,445 | 19,514 |
| Return, % of expenses | 17.4 | 20.6 | 21.8 |

*Results of biological evaluations have been used in these calculations.

**Includes $28,800 and $19,800 for cost of 1,000 one-day-old chicks and fixed costs for raising them, respectively.

***See text for explanations.

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