# Giant Taro leaves

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Giant Taro (Alocasia macrorrhiza) leaves as partial replacement for soya bean meal in sugar cane juice diets for growing pigs in Colombia

The authors document the value of the leaves of Giant Taro as a protein source in pig diets based on sugar cane juice (with the permission of Livestock Research for Rural Development).

# Introduction

In industrialized countries to optimize pig production means to maximize weight gain with diets formulated on a least cost basis. It is generally assumed that improvements in economic performance will be associated with increased rate of animal productivity. However, in most developing countries this strategy is not appropriate because of the high costs of conventional feed ingredients (maize, soybean meal and fish meal), many of which are imported. This creates problems of balance of payments at national level and dependence on credit at the level of the producer. Attempts to produce the ingredients locally (principally maize and and soya beans) are constrained by high prices of machinery, seeds and agrochemicals, all of which usually have a content of imported components. Moreover, in most developing countries, cereal grains such as maize are utilized primarily in the human diet, which elevates the price and makes it difficult to include them in feed for animals. Another issue is that the climate and soils in tropical latitudes are not favorable for maize cultivation, which results in lower yields and higher costs of cultivation. The final point is that pig production is often not considered as a component of the farming system, but rather as a specialized activity producing only meat. . By contrast, in an integrated system, pigs are multipurpose animals producing fertilizer and energy as well as meat.

The implication of the above analysis is that in tropical latitudes there is a need to develop feeding systems which make maximum use of plant species which are adapted to, and exploit, local ecosystems. The use of sugar cane as a replacement for cereals as the energy component of the diet, for both ruminant and monogastric live stock (Preston and Leng 1987), is an example of such a strategy. However, the application of this feeding system to pig production, initiated in Colombia in the '80s (Sarria et al 1990), was constrained by the dependence on soybean meal (usually imported) as the source of protein.

The idea of using protein-rich foliages as a replacement for soya and fish meals in practical pig diets was first applied in Vietnam with the use of fresh duck weed ( *Lemna* spp) as the only protein source in pig diets in which sugar cane juice provided the energy (Rodríguez and Preston 1996). The leaves from the cassava plant ( *Manihot esculenta* ) , initially in sun-dried or ensiled form, were shown to have potential to replace up to 30% of the protein in diets for growing pigs based on cassava root meal (Bui Huy Nhu Phu et al 1996). Fresh foliage of water spinach ( *Ipomoea aquatica)* gave good results as the only source of supplementary protein in diets for young growing pigs in which the energy was from broken rice (Ly 2001), and was shown to have a synergistic effect on pig growth rates when mixed with fresh cassava leaves in broken rice diets (Chhay Ty and Preston 2005). Sweet potato leaves were used successfully as a protein source in pig diets in Vietnam (Le Van An et al 2003) as were the leaves of the mulberry tree ( *Morus alba* ) (Phiny et al 2003).

Two factors facilitate the use of leaves from tropical trees and shrubs as protein sources in pig diets. The first was the demonstration that the conventional protein requirements for pigs (eg: NRC 1988) could be reduced by up to 40% (Speer 1990) when the protein in the diet had the required balance of essential and non-essential amino acids, subsequently referred to as the "ideal protein" (Wang and Fuller 1989). Leaf proteins, being composed mostly of enzymes necessary for growth of plant tissue, have an amino acid balance that resembles the "ideal" protein. Thus diets in which the protein comes exclusively (basal diet of sugar cane juice) or mainly (cassava roots and broken rice) from leaves of plants can be compounded with lower protein levels (up to 40% less) than when cereal grains such as maize or sorghum are the source of energy, as more than 50% of the protein in such diets is from the cereal component with an imbalanced array of amino acids (Speer 1990). The second factor relates to the capacity of the pig to consume and digest fibre. Leaves from trees, shrubs and crop plants are relatively high in fibre hence the advantages of using energy sources, which are low in fibre (sugar cane juice, cassava roots, sweet potato tubers, banana fruit and broken rice all fall into this category). Use of these feeds as energy sources creates "space" in the diet for protein supplements relatively high in fibre as is the case of leaves from trees, shrubs and crop plants.

The Giant Taro (*Alocasia macrorrhiza*) is widely distributed in tropical latitudes. The leaves and roots of some of the wild varieties are reported to contain oxalate crystals which cause itchiness in the mouth. The cultivated variety is said not to have this characteristic (Göhl 1971). In Hue province in Vietnam the leaves and roots are used by farmers as animal feed (Le Duc Ngoan 2006, personal communication). In the farm where the present study was undertaken (6° 18" N, 73° 32" W, 1500 msl), the Giant Taro produces a high yield of above-ground biomass, growing naturally in moist areas and tolerating partial shade (Lylian Rodríguez, unpublished observations). Like the plantain and banana trees *(Musa* spp)*,* new leaves are produced at 2-3 week intervals, eventually dying and falling to the ground after some 15 days.

In Colombia the root has been used traditionally to feed chickens and pigs and it is usually chopped and cooked. Some farmers use the leaves to feed chickens and fish. In the mountainous areas in Colombia the Giant Taro is part of the farming systems and since 2003 it has been used in the TOSOLY ecological farm as part of the pig diet combined with other leaves such as cassava (*Manihot esculenta* Cranz), aro (*Trichanthera gigantea),* water spinach (*Ipomoea aquatica*) andwhole bean foliage. The proportion of leaves in the diet was dictated mainly according to the availability of the leaves. In this period of observations, the the Giant Taro was found to be one of the most promising forages for its re-growth capacity, high yield and palatability. In the beginning, the petioles as well as the leaves were fed but since 2005 the strategy was changed with the leaves being used for the growing pigs, while the petioles were considered to be more appropriate for feeding to pregnant sows, which need lower levels of protein in the diet as well being able to deal with bulky feeds.

Sugar cane and Giant Taro have a high potential for forming the basis of pig production within an integrated farming system in tropical latitudes. The juice from sugar cane, which contains neither fibre nor protein, is easily expressed from the stalks and is an ideal complement for protein-rich forages such as Giant Taro. Both are perennial plants with high biomass yield and are therefore good "sinks" for carbon. Giant Taro grows well in association with tree crops such as cocoa, coffee and citrus, which adds another dimension to these farming systems.

The present study is the first in a series aimed to document the value of the leaves of Giant Taro as a protein source in pig diets based on sugar cane juice.

# Materials and methods

## Location

The study was carried out in the "Finca Ecológica", TOSOLY, Morario, Guapota, Department of South Santander, Colombia (6° 18" N, 73° 32" W, 1500 msl) between July and November 2005. Air temperature ranges between 19 and 28°C in the day, falling to around 12°C during the night. Rainfall is between 2700 and 3000 mm/year.

## Treatments and design

The two treatments were degree of substitution of soybean meal by fresh leaves of Giant Taro as sole protein sources in diets of sugar cane juice for growing pigs:

- SB: Soybean meal 500 g/pig/day
- GT: Soybean meal 250 g/pig/day supplemented with fresh leaves of Giant Taro at levels of 4 kg/pig/day.

There were two repetitions of each treatment, with groups of 3 animals allocated to each of 4 pens according to a completely randomized design.

## Animals

The pigs were crossbreed (Yorkshie*Landrace) and at the start were 75 days old with an average weight of 24.8±1.26 kg. They had been vaccinated previously against swine fever and were treated with Estrongol (Diethylcarbamazine citrate; VICAR Co) to eliminate internal parasites. There was a period of adaptation of 1 week before beginning the recording of data which was terminated after a total trial period of 56 days.

## Feeds and management

Leaves plus petioles (Figure 1) of Giant Taro were harvested daily from plants of different ages located in the farm or in the grounds of neighbors (Photo 1). The leaves were separated from the petioles and passed through a mechanical forage chopper before being fed immediately to the pigs in treatment GT. The soybean meal was purchased from a commercial supplier in the nearby town of Socorro. Stalks of sugar cane, grown on the farm or purchased from neighbours, was passed once through a 3-roll mill (Photo2) to separate the juice from the residual fibre (bagasse). The juice was fed immediately after extraction in quantities that the pigs were able to consume completely before the next meal. A mineral mixture (salt 33.3, rock phosphate 33.3 and magnesium limestone 33.3, parts by weight) was fed daily in quantities equivalent to 1% of the daily DM intake.

The supply of protein was set at a fixed level of 200 g/day, based on the extensive experience with diets of cane juice fot growing-fattening pigs, carried out by commercial farmers in the Department of Valle, Colombia during the decade of the '90s (Sarria et al 1990). The soybean meal (SB) and the mixture of soybean meal and chopped taro leaves (GT) were given in two meals daily, at 07.00 and 13.00 hours. The cane juice was given at 10.00 and 16.00 hours. The objective of this feeding strategy was to ensure the total consumption of the protean component before offering the cane juice due to the high palatability of this ingredient. The quantities of cane juice that were fed were calculated on the basis of an expected total DM intake of 50 g per 1 kg of live weight of the pigs. As the offer level of the protein ingredients was fixed, this resulted in the cane juice supplying from 50 rising to 80% of the total diet DM during the course of the 56 days of trial.

The pig pens, which were washed every second day, were connected to a 5 m3 plastic biodigester, which produced biogas for cooking and nutrient-rich effluent to fertilize the crops.

## Measurements

The pigs were weighed at the beginning of the trial, in the morning before offering the new feed, and subsequently at 7-day intervals for a total of 8 weights in 56 days. The daily gain in live weight was determined from the linear regression of live weight (Y) on days in the trial (X). Feed offered was recorded daily. There were no refusals of any of the diet ingredients. The content of total sugars ("Brix" value) in the cane juice (assumed to be equivalent to the DM content) was measured daily with a hand refractometer. Samples of the taro leaves were taken at intervals during the trial for determination of DM by micro-wave radiation (Undersander et al 1993) and nitrogen according to the "Kjeldahl" procedure (AOAC 1990). Protein was calculated as N*6.25.

## Statistical analysis

The data (feed intake, weight gain and feed conversion) were analyzed according to the General Linear Model option of the ANOVA of the Minitab (2000) software. The sources of variation were: treatments and and error.

# Results and discussion

The fresh weight of the taro foliage (leaf plus petiole) ranged from 450 to 650 g, of which about 40% corresponded to the leaf component. The average value of DM in fresh leaf was 110 g/kg. This value and those for crude protein and crude fibre (Table 1) are similar to those (90, 240 and 125 g/kg DM, respectively) reported in Tropical Feeds (Göhl 1971) for Giant Taro leaves in

Malaysia. The levels of crude fibre and NDF in the leaves (Table 1) are lower than for most leaves presently being studied as protein supplements for pigs. High values for calcium and low values for phosphorus were also reported by Göhl (1971) and emphasize the need to provide additional sources of phosphorus when the leaves are to be fed to pigs.

**Table 1:**
Composition of the leaves of the Giant Taro (g/kg DM)

| | CP | Ash | NDF | ADF | CF | Ca | P | K | Mg |
|---|---|---|---|---|---|---|---|---|---|
| Taro | 248 | 133 | 255 | 198 | 142 | 17.7 | 2 | 32.3 | 2.2 |

The balance of the first-limiting essential amino acids (Table 2) in the taro leaves appears be closer to the "ideal" protein than in typical samples of soybean meal (Figure 1).

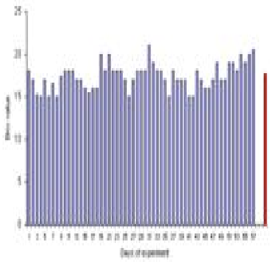
**Table 2:**
Composition (g/kg crude protein) of the leaves of the Giant Taro compared with soybean meal

| | Lysine | Methionine | Cystine | Met+Cys | Threonine |
|---|---|---|---|---|---|
| Taro | 46.0 | 27.1 | 12.2 | 26.9 | 49.5 |
| Soybean | 63.2 | | | 28.3 | 38.9 |

*Data for taro from samples in the present experiment;*

*Data for soybean from analyses of 900 samples in USA (Martin M 1999)*

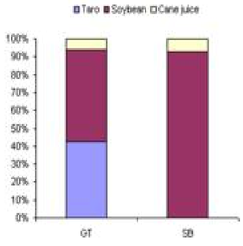
The "Brix" (approximates to the content of total sugars) of the sugar cane juice ranged from 15 to 20.5 during the trial, with an average value of 17.7 (Figure 2).



There were no differences between treatments in any of the recorded parameters (Table 3). The curves of growth (Figure 3) show that the gains in weight were uniform throughout the trial and parallel for the two treatments.

| | **GT** | **SB** | **SEM** | **Prob.** |
|---|---|---|---|---|
| **Live weight, kg** | | | | |
| Initial | 22.4 | 25.9 | 1.8 | |
| Final | 56.4 | 59.8 | 3.8 | |
| Daily gain | 0.524 | 0.519 | 0.079 | 0.97 |
| **Intake, kg/d** | | | | |
| Cane juice | 6.86 | 8.22 | 0.60 | 0.19 |
| Fresh Taro leaves | 3.78 | 0.00 | | |
| Soybean meal | 0.250 | 0.472 | 0.013 | |
| Total DM | 1.85 | 1.88 | 0.180 | 0.86 |
| Crude proteín | 0.195 | 0.204 | | |
| **DM conversion** | 3.67 | 3.76 | 0.222 | 0.81 |

The Giant Taro leaves contributed 50% of the protein in the GT treatment (Figure 3). There were no refusals of the Taro leaves which is a measure of their high palatability. The live weight gains of 524 and 519 g/day for the diets GT and SB were slightly lower than the average of 588 g/day recorded in 8 trials with growing pigs carried out in the Department "Valle" of Colombia (Sarria et al 1990), using comparable diets to the control (fresh cane juice ad libitum and 500 g/animal/day of soybean meal). The feed conversion data (3.67 and 3.76 kg DM/kg live weight gain) were also similar to those (3.4 and 3.8) reported by Sarria et al (1990). The intakes of protein of 195 and 204 g/animal/day in diets "GT" and "SB" are equivalent to concentrations of 10.5 and 10.9% in the DM of the diet, and approximate to the the levels recommended for this system (Preston 1995) of 200 g/day of protein and 10% crude protein in the diet DM .




A preliminary report on the use of Giant Taro foliage for pigs (Basta 2002) indicated that it could replace 40% of the conventional "concentrate" diet of pregnant sows. However, the Taro foliage was the leaf plus petiole which it is estimated would have an average of 15% crude protein in DM. Assuming the commercial concentrates also contained 15% crude protein in DM, then the Taro foliage would be supplying 40% of the total protein offered, which can be compared with the 50% of the dietary protein supplied by the Taro leaves in the present study.

# Conclusions

The results of this preliminary study indicate that the growth performance of pigs is not affected when 3 - 4 kg/day of the fresh leaves of Giant Taro are fed as replacement of 50% of the normal allowance of soybean meal in a diet based on fresh sugar cane juice.

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