# *Inclusion of meal from* Artocarpus altilis *fruit in diets for pre-fattening pigs*

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## ABSTRACT

In the Baracoa and Maisí municipalities, Guantánamo province, the bromatological composition of the meal from *Artocarpus altilis* (breadfruit) fruit and its inclusion in diets for pre-fattening pigs was evaluated. Forty eight Yorkland x Duroc hybrid animals, 33 days old and with 6 kg of live weight as average, were used. The design was completely randomized, of simple classification and with four replications, each of them constituted by three animals. The treatments consisted in: a control in which only concentrate feed, composed by corn and soybean meal, was consumed (T1); inclusion of 10 % meal from *A. altilis* fruit (MFBT) in the concentrate as substitute of corn (T2); 20 % of MFBT (T3) and 30 % of MFBT (T4). It was found that the meal from *A. altilis* fruit is a source rich in starch, sucrose, glucose and fructose; in addition, it is very poor in lipids (0,71 %) and has a moderate protein (5,80 %) and fiber content (7,74 %). The tannin and saponin concentrations were high. Equal values of viability (100 %) and intake (34,5 kg) were obtained in all the treatments. Only the diet that included 10 % of the MFBT did not differ significantly with regards to the control in the other evaluated indicators. The economic impact obtained with this diet allowed to save US $23,19 per ton of live weight produced as compared with the control. To include 10 % of the MFBT as maximum limit in the diets for pre-fattening pigs is recommended.

Key words: *Artocarpus altilis*, fruit meal, pre-fattening pigs, bromatological composition

## INTRODUCTION

The world economic crisis has deepened the food situation even in developed countries. Likewise, the constant increase of the prices of cereals forces different states to take urgent measures to face the possible impacts (Del Toro, 2009). For such reason, the main problem faced at present by industrial livestock production in the world is feed securing for the diverse animal species of economic use for men, especially the rearing of poultry and pigs, which are highly dependent on grains and cereals.

In the Guantánamo province the benefits offered by the fruit of the breadfruit tree (*Artocarpus altilis*) could be exploited, because this species generates around 9 000 t of dried fruits every year; it can also be found in some municipalities of Santiago de Cuba and Holguín, as well as in home gardens of Sierra del Rosario –Pinar del Río– and in the Isle of Youth (Rodríguez and Sánchez, 2001).

The objective of this work was to make a bromatological characterization of the meal from the *A. altilis* fruit (MFBT) and to evaluate the effect of its inclusion as substitute for corn in diets for pre-fattening pigs.

## MATERIALS AND METHODS

*Determination of the chemical composition of the MFBT.* For the chemical analysis ten samples of *A. altilis* fruit were taken in different zones of the Baracoa and Maisí municipalities. The diverse ages of the plantations, the soil type and fruit size, were taken into consideration, in order to correct the effect of variability. Each sample was constituted by 5 kg of fresh fruit, which were dried and ground before analysis. Afterwards, the meals were homogenized to obtain a unique sample. Dry matter (DM), ethereal extract (EE), crude fiber (CF), neutral detergent fiber (NDF) and acid detergent fiber (ADF), as well as lignin, cellulose, ash, nitrogen (N), phosphorus (P) and calcium (Ca) were determined according to the AOAC (1995) at the laboratory of analytical chemistry of the Cuban Institute of Animal Science.

Potassium (K), magnesium (Mg), sulfur (S), zinc (Zn), copper (Cu), manganese (Mn) and vitamins were determined in the National Laboratory of Soil Fertility and Plant Analysis, in the city of Celaya –Guanajuato state, Mexico–, according to the AOAC (2000).

For the qualitative determination of the antinutritional factors the phytochemical screening was conducted in the laboratory of analytical chemistry of the Central University of Las Villas Martha Abreu, according to the methodology described by Miranda and Cuellar (2000). A cross system was used to specify the presence or absence of metabolites in the treatments. In all the analyses the following criteria were used: +++ abundant; ++ moderate; + presence; - absence.

The study of the tannin and saponin concentration was conducted in the Laboratory of Natural Product Chemistry belonging to the Research Center of Advanced Studies of the National Polytechnic Institute, Guanajuato Campus, Mexico. The condensed tannins were determined in triplicate through the vanillin-HCl method, proposed by Price *et al*. (1978); and saponins, by the vanillin-sulfuric acid method, suggested by Hiai, Oura and Nakajima (1976).

The analysis of sucrose, fructose and glucose was made, simultaneously, through enzymatic essays, by a commercial kit (Boehringer Mannheim), described by Mancilla (2006); and starch, with the commercial kit Total Starch Assay Procedure (Megazyme), adopted by the AOAC (1995) in the method 996.11 (McCleary and Monaghan, 2002).

*Evaluation of the MFBT with pre-fattening pigs*. The trial with pre-fattening pigs lasted 42 days and was conducted at the Pig Integral Enterprise Maqueicito, Guantánamo province. Forty-eight newly-weaned Yorkland x Duroc hybrid animals, 33 days old and with 6 kg of live weight as average, were used. The design was completely randomized (simple classification), with four treatments and four repetitions; each repetition was constituted by three animals, for a total of 12 per treatment. The pigs were placed in sheds, in a Flat Deck housing system, where they received water and feed *ad libitum*.

The treatments consisted in the inclusion, in the concentrate feed, of 10, 20 and 30 % of meal from *A. altilis* fruit as substitute of corn; plus a control in which only concentrate feed, composed by corn and soybean, was consumed. Table 1 shows the inclusion level of each raw material per treatment, as well as their nutritional contribution. To obtain the meal from the *A. altilis* fruit the technology described by Leyva and Valdivié (2007) was followed.

Table 1. Raw materials used in each treatment and their nutritional contribution.

| Raw material | Level of inclusión of the MFBT (%) | | | |
|---|---|---|---|---|
| | 0 (control) | 10 | 20 | 30 |
| Corn meal | 57,48 | 46,97 | 36,45 | 25,94 |
| Soybean meal | 39,49 | 40,0 | 40,52 | 41,03 |
| MFBT | 0,0 | 10,0 | 20,0 | 30,00 |
| Calcium carbonate | 1,13 | 1,13 | 1,13 | 1,13 |
| Monocalcium phosphate | 1,0 | 1,0 | 1,0 | 1,00 |
| Common salt | 0,35 | 0,35 | 0,35 | 0,35 |
| Mineral-vitamin pre-mixture | 0,45 | 0,45 | 0,45 | 0,45 |
| Choline chloride | 0,10 | 0,10 | 0,10 | 0,10 |
| Total (%) | 100,0 | 100,0 | 100,0 | 100,00 |
| Calculated contribution | | | | |
| CP (%) | 21,00 | 21,06 | 21,13 | 21,20 |
| ME (Kcal/kg) | 2 904,00 | 2 896,00 | 2 870,00 | 2 855,00 |
| Ca (%) | 0,75 | 0,80 | 0,83 | 0,90 |
| P (%) | 0,31 | 0,31 | 0,32 | 0,32 |
| Cost of the diet (US$/t) | 379,21 | 354,21 | 329,17 | 304,10 |

The diets were formulated taking into consideration the requirements of the category, according to the NRC norm (1998). At 42 days of pre-fattening the viability (%), final live weight (kg), mean daily gain (g), intake (kg) and feed conversion (kilogram of consumed feed per kilogram of obtained LW), were determined.

*Economic analysis*. In each treatment the feeding cost was evaluated, expressed in dollars (US $), and the feed cost per ton of live weight was analyzed.

## RESULTS AND DISCUSSION

The chemical composition of the meal from *A. altilis* fruit is shown in table 2. This meal contains 88,79 % of dry matter and low crude protein levels (5,8 %), as compared with those of corn, wheat, sorghum and other cereals and pseudocereals (FAO, 1999); however, they are higher than those of the meal from cassava root (Buitrago, Gil and Ospina, 2001) and are close to the ones of the meal from sweet potato root (Rostagno, 2005).

Table 2. Chemical composition of the MFBT (dry basis).

| Nutrient (%) | Concentration |
|---|---|
| DM | 88,79 |
| CP | 5,80 |
| EE | 0,71 |
| CF | 7,74 |
| NDF | 27,82 |
| ADF | 17,7 |
| Lignin | 6,17 |
| Cellulose | 11,13 |

The content of crude fiber (7,74 %) ADF, NDF, lignin and cellulose is higher than that of corn, sorghum, wheat, barley, triticale, broken rice, cassava meal, sweet potato meal and banana meal (Dale, 2006), and it is slightly lower than oat and paddy rice, for which no difficulties should appear in pig feeding when the fiber level does not exceed 10 % (NRC, 1998).

The content of ethereal extract of the MFBT is extremely low (0,71 %), for which this feedstuff in practice does not contribute fatty acids to the animals; yet, it is an excellent source of starch (56,43 %), sucrose, glucose and fructose (table 3). Valdivié and Álvarez (2003) obtained 58 % of starch in this feedstuff, which coincides with the findings in this work.

The value of carbohydrates in the MFBT was 77,25 %, in correspondence with the report by Acero (1995), who stated that the concentration of this nutrient in the MFBT is higher than that of potato, cassava and banana, and similar to corn, rice and wheat.

The meal from the *A. altilis* fruit makes a good contribution of minerals (table 4), because it exceeds corn regarding Fe, Cu and Zn, it is equal in Mg and is slightly lower in Ca, K and Mn (Dale, 2006); for which, the pre-mixtures of traditional minerals should work well in concentrate feeds with high contents of meal from *A. altilis* fruit.

The composition of vitamin A, vitamin C, thiamin and riboflavin of the MFBT is shown in table 4. This fruit, according to Leyva and Pohlan (2005), contributes important quantities of thiamin, vitamin C and vitamin A.

On the other hand, Ragone (1997) determined the nutrient content of the *A. altilis* fruit in different forms of elaboration (crude, roasted, boiled, fermented and as pulp), destined to human consumption in Polynesia, and stated that it is rich in carbohydrates and constitutes a good source of vitamins and minerals.

The results of the phytochemical screening performed on the meal from *A. altilis* fruit are shown in table 5. This meal has neither triterpenes nor flavonoids, but shows tannins and saponins.

Several authors (Albert, 2006; Trompiz *et al*., 2007; Pedraza, 2000) have stated that the tannins and saponins present in the diets of pigs have several undesirable effects, such as: reduction in the dry matter digestibility, damage in the intestinal mucosa, astringency, bitter taste, foam formation and hemolysis. This reduces feed intake and, consequently, decreases the growth rate.

Table 6 shows the productive indicators evaluated in the pre-fattening pigs. Regarding viability and feed intake, there were no significant differences among the treatments. The final live weight and mean daily gain did not differ from the control or the treatment with 10 % of MFBT; however, they

Table 3. Concentration of carbohydrates in the MFBT (% DM).

| Carbohydrates | Starch | Sucrose | Glucose | Fructose |
|---|---|---|---|---|
| 77,25 | 56,43 | 13,66 | 14,5 | 13,0 |

Table 4. Contribution of minerals and vitamins in the MFBT (dry basis).

| Nutrient | Concentration |
|---|---|
| Calcium, % | 0,98 |
| Total phosphorus, % | 0,14 |
| Potassium, % | 1,63 |
| Magnesium, % | 0,09 |
| Sulfur, % | 0,07 |
| Iron, ppm | 120,00 |
| Zinc, ppm | 6,00 |
| Manganese, ppm | 0,44 |
| Copper, ppm | 3,03 |
| Vitamin A, UI/mg | 283,00 |
| Thiamin, mg/100 g | 0,12 |
| Riboflavin, mg/100 g | 0,30 |
| Vitamin C, mg/100 g | 6,50 |

differed significantly ($p < 0,01$) with regards to those of 20 and 30 % of inclusion, which did not show significant differences between themselves.

The feed conversion was different among all the treatments, except in the control and the one with 10 % of inclusion of the MFBT that showed the most acceptable values in this indicator, which was reflected in the highest body weight of the animals at the end of the experiment.

These productive results were influenced by the presence of tannins and saponins in the meal from *A. altilis* fruit, because, when included in doses of 20 and 30 % in the pig diet, it significantly increased the intake of these antinutritional factors, which determined that a lower daily gain was obtained and thus, a lower final weight in both experimental treatments.

Table 5. Phytochemical screening conducted on the MFBT.

| Antinutritional factor | Presence/ Absence | Quantification (g/100 g DM) |
|---|---|---|
| Condensed tannins | + | 4,24 |
| Saponins | + | 0,33 |
| Triterpenes | - | - |
| Flavonoids | - | - |

In this regard, Huisman *et al*. (1990) conducted experiments in which a high sensitivity to tannins was observed in piglets. This coincides with the results reported by Jansman (1993), who also obtained low productive values in this category by subjecting the animals to diets with tannin-moderate concentrations.

In this sense, Gutiérrez *et al*. (2003) stated that condensed tannins can produce depressive effects on the dry matter intake and digestibility, because they cause satiety and limit DM utilization. On the other hand, González and Díaz (1997) observed, in pigs, a negative effect of saponins on the concentrate intake and the digestibility of the nutrients that compose it.

The highest feed cost per ton of live weight was reached in the control (US $537,72); this was due to the highest inclusion of corn in the diet and to its high price in the international market. On the other hand, in the treatment that contained 10 % of MFBT the cost was reduced in US $23,19; in addition, it did not differ from the control in the bioproductive indicators.

Table 6. Productive indicators in pre-fattening (since 34 until 75 days of age).

| Indicator | MFBT (%) | | | | SE ± |
|---|---|---|---|---|---|
| | 0 (control) | 10 | 20 | 30 | |
| Initial live weight, kg | 6,0 | 6,0 | 6,0 | 6,0 | 0,04 |
| Final live weight, kg | 24,33[a] | 23,75[a] | 22,25[b] | 21,66[b] | 0,37** |
| Viability, % | 100,0 | 100,0 | 100,0 | 100,0 | - |
| Mean daily gain, g/day | 436,0[a] | 422,5[a] | 387,0[b] | 372,0[b] | 6,93** |
| Intake, kg | 34,5 | 34,5 | 34,5 | 34,5 | - |
| Conversion, kg feed/kg LW | 1,88[a] | 1,94[a] | 2,12[b] | 2,21[c] | 0,03** |
| Feed cost/t of live weight, US $ | 537,72 | 514,53 | 510,40 | 484,36 | - |
| Profit *vs.* control, US $ | - | 23,19 | 27,32 | 53,36 | - |

[abc] Means with different letters differ at $p < 0,05$ (Duncan, 1955) **$p < 0,01$

In this study it was proven that the meal from *A. altilis* fruit is an energy source rich in starch, sucrose, glucose and fructose; and that although it is very poor in lipids and has a moderate content of protein, fiber and its fractions, it has an important quantity of condensed tannins and saponins which should be considered when it is used in pig feeding.

To use 10 % of meal from *A. altilis* fruit in the concentrate feeds for pigs in the pre-fattening stage is recommended, because their productive performance is not altered and the feeding cost is reduced.

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## Reseñas de Publicaciones

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Este libro, que consta de 200 páginas bien ilustradas, ofrece al lector la posibilidad de profundizar en el conocimiento de la diversidad de árboles que existen en la región atlántica y en la región mediterránea de España.

En él se hace una descripción de las categorías taxonómicas de los árboles y su clasificación. Aparece una guía de las especies, donde se describen las características morfológicas, el hábitat natural donde se desarrollan y su distribución en el país.

Además, se dedica un acápite a los árboles monumentales, los cuales constituyen un patrimonio natural y cultural, y se incluye la descripción de las clases más habituales.

El libro termina con un índice alfabético de las especies, con su correspondiente nombre científico.

Se recomienda la lectura de este material a todo aquel que se interese en conocer más sobre los árboles y su uso.

*Dra.C. Marta Hernández Chávez*