

PERFORMANCE TRAITS OF FINISHING PIGS FED MULBERRY AND TRICHANTHERA LEAF MEALS

Comportamiento productivo de cerdos en finalización alimentados con harina de hojas de morera y tricantera

Humberto Araque¹, Carlos González¹, Samkol Pok² and Julio Ly²

¹Institute of Animal Production, Faculty of Agronomy, Central University of Venezuela. El Limón, Maracay, Venezuela.

²Swine Research Institute. Punta Brava, La Habana, Cuba.

E-mail: araqueh@agr.ucv.ve and caraujo2@telcel.net.ve / samkolpok@yahoo.com and jlyca@yahoo.com

ABSTRACT

A total of 48 commercial crossbred pigs, weighing an average 50 ± 3 kg were allotted at random in groups of two into six treatments consisting of diets given *ad libitum* to the animals. There was a control diet (T1) mainly prepared with cereals and soybean meal, and five diets containing sweet potato root meal as the main energy source (40%) and either soybean meal (T2) or mulberry (*Morus alba*) and trichanthera (*Trichanthera gigantea*) leaf meals either alone or mixed in the proportion of 24+0 (T3), 16+8 (T4), 8+16 (T5) and 0+24 (T6) percent of the diet respectively. Water solubility and *in vitro* digestibility of N were best in mulberry as compared to trichanthera. There were no significant differences amongst treatments in feed intake, although a slight depression effect of tree leaf meal on this trait was noted (T3 to T6). Mean daily gain resulted significantly ($P < 0.05$) higher in treatments T1 to T3 than in those containing high proportions of trichanthera leaf meal (T4 to T6); likewise, a deterioration was observed ($P < 0.05$) in the food conversion for the treatments (T4 to T6). According to the results herein reported, it should be suggested that in diets for fattening pigs where sweet potatoes root meal is the main energy source, mulberry leaf meal and palm oil in levels of 24% and 6% respectively, determine similar performance traits to others where conventional protein sources are usually included. More research concerning the feeding value of trichanthera leaf meal, or even combinations of mulberry and trichanthera leaf meals should be encouraged to be conducted.

Key words: Pigs, sweet potatoes, performance traits, *Morus alba*, *Trichanthera gigantea*.

RESUMEN

Se utilizó un total de 48 cerdos híbridos comerciales con un peso promedio de 50 ± 3 kg distribuidos al azar en parejas (hembra y macho castrado), dentro de seis tratamientos o dietas suministradas *ad libitum* a los animales. La dieta control (T1) estuvo conformada por cereales y harina de soya, y las otras cinco contenían harina de raíces de batata como fuente principal de energía (40%) y harina de soya; (T2) harinas de hojas de morera (*Morus alba*) y tricantera (*Trichanthera gigantea*), solas o mezcladas en las proporciones de 24+0 (T3); 16+8 (T4); 8+16 (T5) y 0+24 (T6) por ciento de la dieta respectivamente. La solubilidad y la digestibilidad *in vitro* del N fue mejor en la morera que en la tricantera. No hubo diferencias significativas entre tratamientos para el consumo de alimento, aunque se notó un ligero efecto depresivo, cuando las dietas contenían harinas de hojas de árboles (T3 a T6). La ganancia diaria fue significativamente mayor ($P < 0,05$) en los tratamientos T1 a T3 que en los que contenían altas proporciones de harina de tricantera (T4 a T6); así mismo, se observó un deterioro ($P < 0,05$) en la conversión de alimento para los tratamientos (T4 a T6). De acuerdo con los resultados, se sugiere que en dietas para cerdos en finalización donde la harina de raíz de batata sea la principal fuente de energía, un 24% de harina de hojas de morera y 6% de aceite de palma determinan rasgos de comportamiento similares a los de otras en las que se incluyen fuentes convencionales de proteína. Debieran realizarse más investigaciones en las que se probaran harina de hojas de tricantera, o de tricantera y morera para determinar su valor alimentario.

Palabras clave: Cerdos, batata, rasgos de comportamiento, *Morus alba*, *Trichanthera gigantea*.

INTRODUCTION

Tropical ecosystems can provide a great variety of alternative feedstuffs, not only covering either protein or energy requirements for pigs, but having a high production of biomass [3, 18]. On the other hand, the scarcity of conventional sources in tropical areas, its low yield and competence of pigs and humans for the same food sources create a constraint for sustainability of pig production, thus enhancing even more efforts directed to the study and utilization of locally available food resources for pigs [18].

The sweet potato (*Ipomoea batatas* Lam) root is a valuable energy source for pigs, with short cycle of vegetative life and average yields of 30 t/ha [6], whereas some tree leaves may be used as protein source for pigs. Amongst tree leaves, it has been claimed that mulberry (*Morus alba*) yields may be 10 t DM/ha per year, having between 15 and 18% raw protein [19] and a digestibility in pigs of around 83% [2]. Furthermore, mulberry leaf meal has been used as protein source in diets for growing and finishing pigs [15, 21] and gestating sows [13] with not adverse effects in productive traits. On the other hand, trichanthera (*Trichanthera gigantea*) foliage yields around 15 t DM/ha per year [23], has a crude protein content of 20% [5] and a digestibility of 80% [14].

The aim of this research was the evaluation of balanced diets for finishing pigs, when some 70% of cereals and soybean were replaced by sweet potato roots and graded levels of tree leaf meals.

MATERIALS AND METHODS

Tree leaves and sweet potato root sources

Mulberry and Trichanthera leaves were harvested from fully grown trees at intervals of 60 days until the needed amount for the experimental diets was obtained. Subsequently, leaves and petioles were separated from stems and then chopped and sun dried. Sweet potatoes were purchased locally from a commercial retailer, freshly chopped with a Thai chopper, and dried at 60°C for 48 hours in a tray under an opaque glass roof. Once dried, the roots were ground in a hammer mill through a 0.5 mm mesh before mixing them with the other components of the diet.

Diets and treatments

Six treatments were used in the trial. Diets were formulated by using a low cost software (NUTRIONR) taking into account nutrient and energy requirements for pigs [16]. There was a controlled, conventional diet prepared with cereals, soybean meal and other ingredients (TABLE I), and another five diets containing sweet potato root meal as the main energy source (40%) and mulberry and trichanthera leaf meals either alone or mixed in grade levels. Palm oil was added in enough

amounts in order to keep fairly constant the metabolizable energy content of diets.

Animals

A total of 48 commercial crossbred pigs, weighing approximately on average 50 ± 3 kg were used. Animal crosses were from Landrace, Yorkshire, Hampshire, Duroc and Pietrain genotypes. The animals were allotted at random in groups of two into six treatments consisting of the diets previously described. The pigs were housed in number of two, one female and one castrate male, in pens of 3.2 m².

General management

Feed was given *ad libitum* to the animals every day in the morning, at 9:00, as well as water using drinking nipples. Daily meal refusals were recorded. Animals were weighed at the beginning and at the end of the trial.

Analytical procedures

Four representative samples from both batches of mulberry and trichanthera leaf meals were subjected to proximate chemical analysis [1], physico-chemical characteristics and nutritive evaluation. Samples were obtained at random from the entire batch of the tree leaf meals. *In vitro* digestibility of the tree leaf meals was assayed in terms of DM, organic matter and N disappearance during incubation with pepsin and pancreatin using the two-steps technique of Dierick *et al* [4] with some slight modifications. In addition, tree leaf meals were assayed for water holding capacity by filtration following Kiryazakis and Emmans [9] and water solubility according to Ly *et al*. [13]. All analyses were done at least twice.

Statistical procedures

The analysis of variance technique was applied to the different variables through a GLM procedure of SAS [24]. The model included the effects of diet and replication. In the appropriate cases, means were separated by the Tukey's test. In the case of the comparison of the nutritive value of mulberry and trichanthera leaf meals, the statistical discrimination was conducted according to the Student t test. All statistical analyses were conducted in accordance with Steel and Torrie [25].

RESULTS AND DISCUSSION

Nutritive value of tree leaf meals

The results related to some physico-chemical characteristics of the examined samples are listed in TABLE II. Mulberry leaf meal had significantly less ash ($P < 0.01$), and therefore, more organic matter ($P < 0.01$) content than trichanthera leaf meal. Similarly the raw protein content of mulberry leaf meal was significantly higher ($P < 0.05$) than trichanthera leaf meal. A non significant trend ($P < 0.10$) for higher values of NDF and

TABLE I
CHARACTERISTICS OF THE EXPERIMENTAL DIETS (PERCENTAGE IN DRY BASIS)

	Soybean meal + Mulberry:trichanthera ¹					
	Maize	Sweet potato	1:0	2:1	1:2	0:1
Ingredients						
Sweet potato roots meal	-	40.0	40.0	40.0	40.0	40.0
Trichanthera leaf meal	-	-	-	8.0	16.0	24.0
Mulberry leaf meal	-	-	24.0	16.0	8.0	-
Yellow maize meal	58.8	20.7	9.6	9.6	9.6	9.6
Wheat bran	14.4	11.5	-	-	-	-
Soybean meal	13.0	14.0	9.3	9.2	9.3	9.3
Palm oil	3.0	3.0	6.1	6.2	6.2	6.1
Sorghum	4.3	4.3	4.3	4.3	4.3	4.3
Fish meal	4.0	4.0	4.0	4.0	4.0	4.0
Vitamins and minerals ²	1.0	1.0	1.0	1.0	1.0	1.0
CaPO ₄ H ₂ .2H ₂ O	0.4	0.6	1.1	1.1	1.1	1.1
NaCl	0.3	0.3	0.3	0.3	0.3	0.3
DL-Lysine hydrochloride	-	-	0.11	0.11	0.11	0.11
DL-Methionine	-	0.02	0.16	0.16	0.16	0.16
CaCO ₃	0.6	0.32	-	-	-	-
Calculated analysis						
Raw fibre	3.64	3.99	5.25	4.83	4.42	4.00
NDF	7.77	4.46	10.10	10.28	10.52	10.77
Raw protein (N × 6.25)	15.99	15.77	15.75	15.70	15.68	15.60
DL-Lysine	0.81	0.73	0.61	0.67	0.71	0.77
DL-Methionine	0.30	0.24	0.35	0.35	0.37	0.38
Linoleic acid	0.95	0.95	0.85	0.86	0.84	0.85
Calcium	0.58	0.50	0.92	1.04	1.16	1.28
Available phosphorous	0.32	0.32	0.35	0.35	0.35	0.35
ME (KJ/g DM)	13.61	13.67	13.68	13.67	13.63	13.59

¹ Tree leaf meals. For details see text. ²According to recommendations [16].

TABLE II
PHYSICO-CHEMICAL CHARACTERISTICS OF THE TREE LEAF MEALS

	Tree leaf meals		
	Mulberry	Trichanthera	
Composition, % dry basis			
Ash	16.77	23.91	2.12**
Organic matter	83.23	76.09	2.21**
NDF	26.18	32.15	4.11+
Raw fibre	20.05	25.13	3.60
N × 6.25	20.38	15.63	2.14*
WHC (g H ₂ O/g DM) ¹	8.19	7.72	0.50

¹ Water holding capacity determined by filtration. +P < 0.10. *P < 0.05. **P < 0.01.

raw fibre was seen in the trichanthera foliage, as compared to mulberry. There was no significant difference in water holding capacity between the two examined types of tree leaf meals, although mulberry leaves showed high values in this category. These data agree in accordance to a similar comparison between both tree species made in Cambodia in different circumstances [14].

Water solubility and *in vitro* digestibility indices of N from the examined samples were the best in mulberry leaf meal, as compared to trichanthera leaf meal (TABLE III). In the case of *in vitro* N digestibility, the difference was more obvious ($P < 0.001$) than in N solubility ($P < 0.05$). In two comparisons, these data agree with others obtained previously for these two types of tree foliages [13, 14].

Performance traits

Live weight measurements are shown in TABLE IV. Average pig's initial live weight was 50,1 kg. There was a significant

($P < 0.01$) effect of treatment on final live weight of the animals. The results indicated that there was no effect of the source of carbohydrate on final live weight when the animals were fed diets based on maize or sweet potatoes when soybean meal was used as the main protein source. On the other hand, total body weight gain was significantly ($P < 0,01$) higher with the two soybean containing diets compared with the Mulberry and Trichanthera diets. However, the diet with sweet potato and mulberry leaf meal (24%) did not affect significantly the final live weight as compared to the other two mentioned diets. Feed intakes of pigs fed sweet potatoes were not different from those that were fed corn meal when soybean meal was the protein source of both diets (TABLE V). The data are in agreement with others [7]. On the other hand, although in less magnitude, feed intake of pigs was not significantly depressed when tree leaf meals were introduced in the ration, as compared to this same index from animals fed on diets containing soybean meal instead of foliage meal. Nevertheless, this effect was not significant.

TABLE III
WATER SOLUBILITY AND *IN VITRO* (PEPSIN/PANCREATIN) DIGESTIBILITY OF THE TREE LEAF MEALS

	Tree leaf meals		SE ±
	Mulberry	Trichanthera	
Water solubility (%)			
Dry matter	42.22	43.49	3.33
N	47.78	37.80	2.50*
<i>In vitro</i> digestibility (%) ¹			
Dry matter	55.21	40.21	4.62**
Organic matter	57.44	42.22	3.00**
N	59.10	46.34	2.63***

¹*In vitro* N digestibility of casein used as standard was 98.53 ± 0.72%. * $P < 0.05$. ** $P < 0.01$. *** $P < 0.001$.

TABLE IV
CHANGES IN LIVE WEIGHT OF FINISHING PIGS FED *AD LIBITUM* SWEET POTATOES AND TREE LEAF MEALS

	Soybean meal + Mulberry:trichanthera ¹						
	Maize	Sweet potato	1:0	2:1	1:2	0:1	
Initial live weight (kg)	49.88	49.55	50.85	49.75	50.45	49.95	2.32
Final live weight (kg)	84.57 ^a	85.15 ^a	80.22 ^{ab}	72.50 ^b	75.50 ^b	72.65 ^b	6.23**
Live weight increase (kg)	34.85 ^a	36.01 ^a	28.75 ^b	23.00 ^b	24.75 ^b	22.79 ^b	5.12**

¹Tree leaf meals. For details see text. ** $P < 0.01$. ^{ab}Means without letter in common in the same row differ significantly ($P < 0.05$).

TABLE V
PERFORMANCE TRAITS OF FINISHING PIGS FED *AD LIBITUM* SWEET POTATOES AND TREE LEAF MEALS

	Soybean meal + Mulberry:trichanthera ¹						
	Maize	Sweet potato	1:0	2:1	1:2	0:1	
Meal intake (kg/day)	2.40	2.48	2.10	2.27	2.11	2.24	0.34
Mean daily gain (g)	670 ^{ab}	692 ^a	553 ^{ab}	442 ^b	475 ^b	438 ^b	100*
Meal conversion (kg/kg)	3.58 ^a	3.58 ^a	3.79 ^b	5.13 ^c	4.44 ^b	5.11 ^c	0.42*

¹For details see Table 1. * $P < 0.05$. ^{abc}Means without letter in common in the same row differ significantly ($P < 0.05$).

Meal intake in pigs has been reported to be influenced [20, 22, 27] or not [11, 19] by the inclusion of tree leaves in the diet. Particularly, when either mulberry leaf meal [2, 10] or trichanthera leaf meal [23] were used for finishing pigs, this depressive effect of tree foliage has been evident. Overall, it has been claimed that bulking characteristics of the diet determines the voluntary feed intakes of animals fed ad libitum fibrous feeds [9]. In the case of this research, it is possible that the relatively small population size avoided any clear evidence of depression of voluntary feed intake due to diet's bulkiness, if any.

Mean daily gain, as calculated from total live weight increment during the trial (TABLE IV) resulted significantly higher ($P < 0.05$) in treatments where tree leaf meals were not given to the animals, than in those including trichanthera leaf meal. In this matter, the treatment containing the highest amount of mulberry in the diet (mulberry:trichanthera, 1:0) determined similar daily gains in pigs as compared to those from animals fed with soybean meal and fishmeal as the only source of protein. Overall, this effect could be attributed to a certain decrease in nutrient availability in diets containing non digestible fibre fractions, such as those formulated with tree leaf meals. This negative effect of fibre on performance traits of pigs has often been observed [12], including diets with high levels of mulberry [17, 26] or trichanthera [23]. It is probable that a not significant differences in daily gains amongst the diet with 24% mulberry meal (565 g/day) and the diets with a major contribution of soybean meal (667 and 685 g/day) could be explained by the high variability encountered for this performance trait.

The deterioration in feed conversion as caused by the introduction in the dietary formula of tree foliage was probably due to a consequence of the increased presence of the fibrous fraction in the meal. This very well known, negative effect on animal's feed conversion, has been reported elsewhere [12]. In this matter, all diets evaluated in the current study were calculated to contain a similar energy density in terms of metabolizable energy (TABLE I), assuming that since mulberry and trichanthera leaf meals contained a relatively low energy density, an increased level of raw palm oil in the diet would be necessary as a compensatory dietary ingredient. In this way, it has been recently found [8] a rather low energy digestibility of raw palm oil for pigs. Accordingly, it is assumed that this could determine in some degree, an increase in feed conversion values for treatments designed to contain high levels of tree foliage meal, and at the same time, a relatively high proportion of raw palm oil in feed.

CONCLUSIONS

According to the results herein reported, it should be suggested that in diets for fattening pigs where sweet potatoes root meal is the main energy source, mulberry leaf meal and palm oil in levels of 24% and 6% respectively, determine similar performance traits to others where conventional protein

sources are usually included. More research concerning the feeding value of trichanthera leaf meal, alone or in combination with Mulberry and Trichanthera is clearly needed.

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