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Three-level Evaluation of Chopped Sugar Cane (*Saccharum officinarum* L.) Stems in the Diet of Pigs

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ABSTRACT

In order to integrate alternative plant sources of energy in the diet of swine weaned in the stages of growth and finishing, twenty, Landrace x Yorkshire castrated animals were used in this study. Their diets contained 15% and 13% crude protein. Fresh unpeeled sugar cane stems were chopped and included in the diet, at 15%, 20%, and 25% (growth stage); and 25%, 30%, and 35% (finish stage). The trial lasted 14 weeks. A completely randomized block design was used, with four treatments and five replicas; the Duncan´s significance test (5% probability) was also made. The inclusion of 30% sugar cane stalks from stems produced the highest mean weight values (83.80 kg $P < 0.05$). The highest weight gain value was observed in the pigs that consumed diets that included 20% sugar cane, whereas the best values for the finish stage was the 30% inclusion variant. The inclusion of 35% in the finish stage had the best feed conversion (2.19 kg/kg $P < 0.05$). The addition of 20-30% of chopped sugar cane stalks was recommended to fatten pigs.

Key words: *weaning, sugar cane, chopped, body weight, swine production*

INTRODUCTION

Pork production in areas with adequate soils for agriculture may become a particularly efficient and diversifying alternative for small and mid-sized farmers whose incomes can increase at less risks, leading to a more sustainable production (Brunori and Juárez, 2013).

Today, the world market prices have a rising tendency. The price of yellow corn from the Gulf of Luisiana (Export Elevators) underwent a 240% increase between 2000 and 2012 ($ 88 to 299 USD/MT, respectively) (Morillo and Zambrano, 2013).

Montaño, Quiñonez, Iglesias and Sagaró (2016) indicated that the livestock model in tropical areas is usually weak and unsustainable, due to its huge foreign dependency, rather than on the existing local resources. Besides, swine production on small private farms and in small and mid-sized commercial areas is one alternative to developing other agricultural activities with low productive and reproductive parameters, in which nutrition accounts for about 75% of costs.

Álava (2016) evaluated three levels of palm kernels in the growth and finish stages, and concluded that the pigs on 25% palm kernels weighed 90 kg in less time (70 days), followed by the 15% treatment (72 days), and the 35% treatment (77 days). The results indicated that a 25% inclusion of palm kernels produced the highest daily weight increase (0.93 kg). The highest feed consumption was 2.3 kg, in the 0% treatment, with an average feed conversion of 3.46, in the treatment using 0% palm kernels.

García (2004) evaluated three feedstuff diets with pigeon pea meal during the growth and finish stages. The pigs fed with 10 and 20% pigeon pea meal ended the trial in twelve weeks, with an average weight of 92 and 91.60 kg, respectively; whereas the animals that received the 0 and 30% inclusion values, ended the trial in twelve weeks, with average weight gains of 90.3 and 91.10 kg, respectively. The pigs in treatment 2 (10% pigeon pea meal) had the highest daily weight increase (0.82 kg). The highest average daily consumption of feed was observed in treatment 1 (0% pigeon pea meal), with 1.65 kg; the average feed conversion of 2.45 kg/kg was observed in treatment 4 (30% pigeon pea meal).

Sugar cane is a perennial crop with high a biomass production. Fishery and slaughterhouse wastes, and agricultural residues must be considered non-conventional resources for swine nutrition in tropical regions (Montaño, Quiñonez, Iglesias and Sagaró, 2016).

Animal food production from sugar cane has always been a real possibility to increase meat

and milk yields, without using imported grains (Villar-Delgado and Montano-Martínez, 2011).

Castro and Martínez (2015) found no significant differences with 0, 10, 20, and 30% sugar cane meal in the productive behavior of animals, with minimum mortality values during the trials and similar feed consumption in all the inclusion levels studied.

Various sugar cane derivatives have adequate nutritional values to feed swine, including the juice, rejected sugar, molasses, yeasts as protein sources, and several feeds developed through simple biotechnological techniques. All of them can enhance swine nutrition in combination with other products achieved by swine farmers (Castro and Martínez, 2015).

The aim of this research was to evaluate the effect of sugar cane stems as a source of energy instead of imported grains, in weaned pigs (growth and finish stages).

MATERIALS AND METHODS

This experiment was made at the Swine Project, Boliche Experimental Station, National Autonomous Agricultural Research Institute, on 2º 15´15´´ south latitude and 73º 38´4´´ west longitude, 26 km east of Guayaquil, via Duran-Tambo, Virgen Fátima parish, Yagua Chi canton, Guayas province, 17 meters above sea level. The average annual precipitation is 1 025 mm, 24 ºC annual mean temperature, and 83% relative humidity.

The sugar cane stems were collected from a 9-month old commercial plantation (approx. 2-5 mm). They were chopped every three days using a crushing mill powered by an electric motor. The other raw materials were bought in commercial facilities.

The experiment included the application of balanced diets using 13 and 15 % crude protein in the growth and finish stages, respectively (Tables 1 and 2). The feed was administered *ad libitum*, during the 14 weeks of the field trial.

A number of 20 Landrace x Yorkshire animals were used (10 males and 10 females), weighing 20 kg on average. The animals were lodged in groups of five in pens (13 m^2) featured with troughs for water (tub-like) and for feed (cup-like).

The animals were weighed weekly. Leftover collection and cleansing were made daily, between 06:00 and 08:00 h, respectively.

Experimental design

The trials consisted in the application of three administration levels of chopped sugar cane stems in the diets of pigs for the growth (0,15, 20, and 30%), and finish (0,25, 30, and 35%) stages. The experiment had four treatments with five replicas

A randomized block design was used. Variance analysis (ANOVA) was made for data analysis; the Duncan´s test (5% significance) was used for mean comparison.

RESULTS AND DISCUSSION

Table 3 shows the highest daily feed consumption during the growing stage without sugar cane (control), which was statistically superior to the other treatments. The lowest value observed was for the 25% inclusion level.

Weight gain was greater in the growth stage, using 20%; whereas it was lower with the 0, 15, and 25% inclusion.

In the growth stage, treatment 3 weighed 50.1 kg; whereas treatments 4, 2, and 1, weighed 48.70, 48.62, and 48.30 kg, respectively, in 49 days.

In the four treatments (seven weeks) for growth, feed conversion revealed that the 20 and 25% inclusions had the highest values (2.10 and 2.16 kg, respectively); whereas the 15% and 0% inclusions averaged 2.50 kg and 2.27 kg, respectively.

Table 4 shows that during the finish stage the inclusion levels were statistically significant; the control (0%) had the highest daily consumption average (1.84 kg); whereas the lowest consumption was observed in the 35% inclusion (1.54 kg). The variance analysis showed statistical differences between the inclusion levels in the finish stages. The highest weight gain was achieved with the 25%, far from the rest.

During the finish stage, treatment 3 weighed 83.80 kg, the highest; whereas treatments 4, 2, and 1, weighed 82.40, 79.50, and 75.80 kg, respectively, in 42 days.

In the four treatments (seven weeks) for finish, feed conversion revealed that the 35% inclusion had the best value (2.19 kg); whereas the 30% and 25% inclusions averaged 2.54 kg and 2.54 kg, respectively. The 0% inclusion had the highest feed conversion (2.98 kg).

García (2004) and Álava (2016) used different amounts of palm kernels in the growth and finish stages, and achieved weights of 90 kg between 70

and 77 days. Meanwhile, the pigeon pea meal experiment produced the same values in 84 days. However, using chopped sugar cane rations in the growth stage (0, 15, 20, and 25%), and the finish stage (0, 25, 30, and 35%), required 91 days.

The pigs in treatment 3 had an average weight of 83.80 kg; treatment 4 accounted for 82.40 kg; whereas treatments 2 and 1 averaged 79.50 and 75.80 kg, respectively.

Regarding the average daily weight gain using chopped sugar cane stems at 0, 15, 20, and 24% in the growth stage; and 0, 25, 30, and 35% in the finish stage, produced a lower weight increase (0.70 kg/day), compared to García (2004), with 0.82 kg/day, using pigeon pea meal; and Álava (2016), who achieved 0.93 kg/day using palm kernels.

The average daily feed consumption based on chopped sugar cane in the growth stage (0, 15, 20, and 25%), and in the finish stage (0, 25, 30, and 35%) (1.84, 1.68, 1.72 and 1, 54 kg/day), was inferior to the reports of Álava (2016), using palm kernels (2.70, 2.71, 2.75 and 2.93 kg/day), and superior to treatments 1, 2, and 3, but inferior to treatment 4, reports made by García (2004), using pigeon pea meal (1.44, 1.48, 1.60 and 1.65 kg/day).

Feed conversion using a diet based on sugar cane chops in the growth stage (0, 15, 20, and 25%), and the finish stage (0, 25, 30, and 35 %), averaged 2.98, 2.54, 2.45, and 2.19 kg/kg, respectively. The highest values were observed in treatment 1, but they were lower than Álava (2016), using palm kernels; and higher in treatments 1, 2, and 3. These values were lower than the reports by García (2014) in treatment 4, using pigeon pea meal (2.27; 2.29; 2.40, and 2.45 kg/kg).

CONCLUSIONS

The inclusion of 20-30 % chopped sugar cane stems for the growth and finish stages as an alternative to high volumes of imported corn in feedstuffs (15 and 13% crude protein, respectively) increased the average daily gain to 0.702 kg/day.

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Table 1 Estimated composition of feedstuffs based on chopped sugar cane in the growth stage

Ingredients (%)	Control	Inclusion		
		15 %	20 %	25 %
Sugar cane stem	0	15	20	25
Corn meal	46.25	42	36.50	37
Rice polish	33	18.50	18	10.5
Soy beans	15.25	17.50	18	20
Fish meal	1	2.5	3	3
Feedstuff pre-mixture *	2	2	2	2
Ca and P	2	2	2	2
Salt	0.5	0.5	0.5	0.5
Total	100	100	100	100
Chemical analysis				
Crude protein (%)	15.02	14.99	15	15.01
E.M. (kcal/kg)	3290.83	3313.30	3303.27	3323.52
Crude fiber (%)	2.98	4.05	4.50	4.92
Relative humidity (%)	11.45	20.21	23.14	26.09
Dry matter (%)	88.61	79.79	76.86	73.91

*: pre-mixture used for every 100 kg of feed, containing 850 g of corn, 100 g of loa fac, and 50 g of flavomycin.

Table 2. Estimated feedstuff composition based on chopped sugar cane in the finish stage

Ingredients (%)	Control	Inclusion		
		25 %	30 %	35 %
Sugar cane stem	0	25	30	35
Corn meal	47.50	38	36.75	29.00
Rice polish	39.50	16.25	11.00	12.50
Soy beans	7.50	14.25	15.25	16.50
Fish meal	1	2	2.5	2.50
Feedstuff pre-mixture *	2	2	2	2
Ca andP	2	2	2	2
Salt	0.5	0.5	0.5	0.5
Total	100	100	100	100
Chemical analysis				
Crude protein (%)	12.99	12.96	13.01	12.99
E.M. (kcal/kg)	3271.94	3311.79	3320.79	3304.90
Crude fiber (%)	6.06	4.83	5.23	6.24
Relative humidity (%)	11.42	26.19	29.06	32.01
Dry matter (%)	88.58	73.81	70.94	67.99

Table 3. Behavior of pigs that consumed different volumes of chopped sugar cane included in the diet during the growth stage

Variables	Inclusion levels			
	0 %	15 %	20 %	25 %
Number of pigs	5	5	5	5
Duration of the experiment (days)	49	49	49	49
Initial average weight (kg)	19.30	19.25	19.90	19.10
Final average weight in the growth phase (kg)	48.30 c	48.62[b]	50.10[a]	68.70[b]
Daily weight gain (kg)	0.590[b]	0.600[b]	0.626[a]	0.604[b]
Average daily feed consumption (kg)	1.481[a]	1.36[b]	1.358[b]	1.270
Feed conversion (kg/kg)	2.505[a]	2.276[b]	2.169[b]	2.102 c

Averages with equal letters have no statistical differences, according to Duncan ($P < 0.05$)

Table 4. Behaviour of pigs that consumed different volumes of sugar cane in the finish stage

Variables	Inclusion levels			
	0 %	25 %	30 %	35 %
Number of pigs	5	5	5	5
Duration of the experiment (days)	42	42	42	42
Initial average weight (kg)	48.30	48.62	50.10	48.70
Final average weight in the finish stage (kg)	75.80 c	79.50[b]	83.80[a]	82.40[b]
Average daily weight gain (kg)	0.620 c	0.662[b]	0.702[a]	0.702[a]
Average daily feed consumption (kg)	1.84[a]	1.68[b]	1.72[b]	1.54 c
Feed conversion (kg)	2.98[a]	2.54[b]	2.45[b]	2.19

Averages with equal letters have no statistical differences, according to Duncan ($P < 0.05$)