FAECAL OUTPUT IN GROWING PIGS FED HIGH-TEST OR FINAL SUGAR CANE MOLASSES

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SUMMARY

A double 5x5 Latin square was used to study in growing pigs from a commercial cross, 35 kg initial live weight on average, faecal output of undigested materials from diets where the energy sources were sugar cane high-test and final molasses mixed in the proportion of 75:0, 60:15, 45:30, 30:45 and 15:60 in dry basis respectively. Feed intake was ad libitum.

Faecal DM concentration decreased in a linear manner (R^2, 0.971; P<0.001) when final molasses increased in the diet. It was found that faecal output of fresh material and water significantly (P<0.05) decreased with increasing levels of final molasses in the diet.

It is considered that faecal output as determined by high-test molasses is similar to that determined by cereal based diets but the reverse is true when final molasses is given to the pigs. Faecal output of water is increased not only by a decrease in digestibility since DM concentration is lowered at the same time. Faecal output of water in pigs given sugar cane molasses could be explained as an osmotic consequence ot this dietary challenge.

Key words: *pigs, faecal output, mieles de caña de azúcar*

Short title: *Faecal output in pigs fed sugar cane molasses*

SALIDA FECAL EN CERDOS EN CRECIMIENTOS ALIMENTADOS CON MIEL RICA O MIEL FINAL DE CAÑA DE AZUCAR

RESUMEN

Se empleó un cuadrado latino 5x5 duplicado para estudiar en cerdos en crecimiento de un cruce comercial con un peso inicial promedio de 35 kg, la salida fecal de materiales indigeridos de dietas donde las fuentes energéticas son mieles de caña de azúcar, tanto rica como final mezcladas en la proporción de 75:0, 60:15, 45:30, 30:45 y 15:60 en base seca respectivamente. El consumo de alimento fue ad libitum.

El consumo diario de alimento fue el mayor con la miel rica y el menor con la miel final (2.4 y 1.9 kg MS por animal respectivamente. Todos los animales ganaron peso durante la prueba. La concentración de MS fecal decreció de una manera lineal (R^r, 0.971; P<0.001) cuando se incrementó la miel final en la dieta. Se halló que la salida fecal de material fresco y de agua disminuyó significativamente (P<0.05) con el aumento de la miel final en la dieta.

Se considera que la salida fecal determinada por la miel rica es similar a la ocasionada por las dietas basadas en cereales, pero lo contrario es cierto cuando se da miel final a los cerdos. La salida de agua fecal se incrementa no solamente por un descenso en la digestibilidad rectal puesto que la concentración de MS disminuye al mismo tiempo. La salida fecal de agua en los cerdos alimentados pudiera ser explicada como una consecuencia osmótica del desafío dietético.

Palabras claves: *cerdos, salida fecal, mieles de caña de azúcar*

Título corto: *Salida fecal en cerdos alimentados con mieles de caña de azúcar*

INTRODUCTION

Sugar cane is considered one of the best plant for efficiently capture solar energy (Alexander 1988), and many of sugar cane feeds which are obtained from its cultivation through the tropics are thought as a locally available source of energy for pigs (Figueroa and Ly 1990; Pérez 1997; Ly 2008). However, not all types of sugar cane are efficiently utilized by this animal species.

Since high-test molasses is the best of the different types of sugar cane molasses from the point of view of fattening pigs, it is well known since many years that final molasses appears

not to be convenient for using in an intensive system of pig production. Indeed, many investigations have been directed toward the characterization of digestion of molasses, envisaging as a goal the better use of final molasses. However, these efforts appear to be useless, due to the fact that perhaps the main constraint of sugar cane molasses, particularly final molasses, is inherent to its low energy density (Pérez 1997).

The aim of the present investigation was to determine some characteristics of faecal ouput in pigs fed either high-test or sugar cane molasses based diets, in order to contribute to increase the efficiency of utilization of molasses in diets for pigs..

MATERIALS AND METHODS

The experiment was conducted in the Institute of Animal Science, San José de las Lajas. A double 5x5 Latin square design was used to study in growing, castrate male pigs from a commercial cross, 35 kg initial live weight on average, faecal output of undigested materials from diets where the energy sources were sugar cane high-test and final molasses mixed in the proportion of 75:0, 60:15, 45:30, 30:45 and 15:60 in dry basis respectively. High-test molasses was particularly manufactured for experiments to be conducted at the Institute of Animal Science, and final molasses, otherwise properly named sugar cane molasses type C, was of commercial origin. As it is known (Figueroa and Ly 1990), final molasses is the by-product resulting from the extraction of sucrose from sugar cane juice at the factory, High-test molasses is the sugar cane juice treated in so a manner that sucrose has been partially hydrolyzed to prevent crystallization during storage, then concentrated to attain the standard appearance of sugar cane molasses. Some details of the experimental diets are exposed in table 1. In this case the feeds were practically devoid of plant cell wall.

Table 1. Characteristics of the diets (per cent in dry basis)

	High-test:final molasses ratio[1]				
	5:0	**4:1**	**3:2**	**2:3**	**1:4**
Ingredients					
Sugar cane molasses					
High-test type	75.0	60.0	45.0	30.0	15.0
Final, type C	-	15.0	30.0	45.0	60.0
Fishmeal	21.0	21.0	21.0	21.0	21.0
Saccharomyces yeast	2.5	2.5	2.5	2.5	2.5
Vitamin premix[1]	0.5	0.5	0.5	0.5	0.5
Mineral premix[1]	1.9	1.0	1.0	1.0	1.0
Analysis					
DM	82.5	83.0	83.2	83.3	83.5
Ash	7.3	8.5	9.8	11.0	12.3
Nx6.25	16.7	17.0	17.4	17.7	18.1

[1] Vitamins and trace elements according to NRC (1998) recommendations

Any experimental period consisted of 14 days, from those the first seven days was of adaptation to the experimental diet, and the remaining time was divided into two days of adaptation of the pigs to the metabolism cages, and five other days used in quantitative collection of feed refusals and faeces. Every day, feed refusal and 24 hours excreted faeces were collected, recorded and then a faecal aliquote was stored frozen at – 5°C until analysis. DM in feed and faeces was determined by recognized procedures (AOAC 1998).

The metabolism cages were of the Shinfield type which allowed the quantitative, separated collection of faeces and urine, and were placed in a well ventilated room.

Analyses of variance and regression were conducted according to a standard technique (Steel et al 1997). When the analysis of variance revealed significant ($P<0.05$) among treatments, means were separated by the multiple range and multiple F test of Duncan. The Minitab software (Ryan et al 1992) was used in the biometrical approach of data.

RESULTS AND DISCUSSION

No animal discomfort symptoms were apparent during the conduction of the trial. Pigs appeared to be in good health and there were no abnormal characteristics of animal behaviour. Daily feed intake was highest with high-test molasses and lowest with final molasses (2.4 and 1.9 kg DM per animal respectively). All animals gained live weight during the trial.

Faecal DM concentration decreased in a linear manner (R^2, 0.971; $P<0.001$) when final molasses increased in the diet (figure 1). These relationship strongly suggests that there is not secondary influence of importance, if any, between this cause-effect phenomenum in the origin of faecal DM percentage disminution in growing pigs fed sugar cane final molasses.

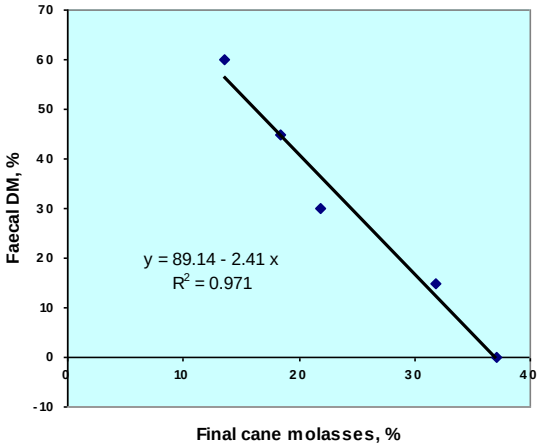

Figure 1. Correspondence between final cane molasses in diet and faecal DM concentration in growing pigs

Concomitantly, the analysis of variance revealed that a significant ($P<0.01$) difference existed among the evaluated treatments, with lowest faecal DM concentrations as a consequence of the increased level of final molasses included in the diet (table 2). Interestingly, the effect of final molasses resembled that of the presence of fibrous products in the diets, which was characterized very early by Cooper and Tyler (1959).

Table 2.. Faecal output in pigs fed sugar cane molasses

	High-test:final molasses ratio[1]					
	5:0	**4:1**	**3:2**	**2:3**	**1:4**	**SE ±**
n	10	10	10	10	10	-
DM, %	37.1[a]	31.9[ab]	21.8[ab]	18.4[ab]	13.6[b]	1.9**
Faecal output, g/kg DM intake						
Fresh material	240[a]	298[a]	468[ab]	609[ab]	897[b]	105*
Water	151[a]	203[a]	366[ab]	497[ab]	775[b]	150*
DM	89	95	102	112	122	45[+]

[1] Total sugar cane molasses in diet, 75% in dry basis
[+] P<0.10; * P<0.05; ** P<0.01
[ab] Means in the same row without letter in common differ significantly (P<0.05)

A summary considering the effect of different sugar cane products on faecal output of pigs is presented in table 3.

Table 3. Faecal output (in g/kg DM intake)[1] and DM concentration (in per cent) in pigs fed sugar cane products as the only source of energy in the diet

Product in diet[2]	**Fresh material**	**DM**	**Source**
Sucrose, raw	191	40.7	Velázquez et al (1969)
Sucrose			Bayley et al (1983)
Sucrose, refined	182	33.7	Ly et al (1995)
Sucrose, refined	193	34.7	Ly (1992)
Fructose	203	29.5	
Glucose	155	34.1	
Sugar cane juice	109	42.1	Xandé (2008)
High-test molasses	168	46.9	Velázquez et al (1969)
	220	38.6	Ly (1977)
	186	39.3	Ly (1984)
Syrup off[1]	163	25.4	Ly et al (2000)
	250	25.1	
Molasses type A[1]	85	-	Maylin et al (1987)
	100	-	
Molasses type B	227	34.3	Ly and Almaguel (2007)
	293	22.5	Ly et al (1997)
	390	22.3	Domínguez and Ly (1997)
Molasses type C[1]	1 496	12.4	Díaz et al (1990)
	1 084	13.0	
	1 227	16.3	Ly(1984)

[1] In any case, faeces corresponded to a 24 hr-pool
[2] For identification of the sugar cane products, see Figueroa and Ly (1990) and Pérez (1997)

In fact, a very few fresh material is excreted via faeces when pigs are fed high levels of either sucrose or glucose and fructose, the main components of the soluble fraction of sugar cane, as it was observed by Ly (1992). Interestingly, when fructose represented 69% of the diet, faecal DM was below 30%. The same overall trend which was found to be determined by pure carbohydrates, does occur in sugar cane juice (Xandé 2008), which is considered to be an aqueous, diluted sucrose solution (Binkley y Wolfrom 1953). In contrast, sugar cane molasses type B and particularly the type C, or final molasses, usually provokes a marked increase in faecal output of fresh material, together with a decrease of DM concentration.

It has been considered that faecal output of high-test molasses is similar to that determined by cereal based diets, and the reverse is true when final molasses is given to the pigs (Pérez 1997). In fact, this assumption remains true, as it was found in the current investigation. Besides, a marked difference in the rate of passage along the gastrointestinal tract, slow in high-test molasses, and fast in final molasses, takes place as a result of the ingestion of great amount of these molasses by pigs (Ly 1984).

On the other hand, faecal output of water is increased not only by a decrease in digestibility since DM concentration is lowered at the same time. Faecal output of water in pigs given sugar cane molasses could be explained as an osmotic consequence of this dietary challenge, as suggested by Christon and Le Dividich (1978). More research to test this hypothesis is needed to be conducted.

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