# High-test molasses or maize as energy source for growing pigs. Performance traits and rectal digestibility

J. Ly<sup>1,2</sup> R. Almaguel<sup>2</sup> P. Lezcano<sup>1</sup> and E. Delgado<sup>2,3</sup>

<sup>1</sup>Instituto de Ciencia Animal, Apartado Postal 24, San José de las Lajas, Mayabeque, Cuba <sup>2</sup>Instituto de Investigaciones Porcinas, Punta Brava, La Habana, Cuba <sup>3</sup>Facultad de Medicina Veterinaria y Zootecnia, Universidad Nacional Autónoma de México Tlalpan, Ciudad de México, México Email: jly@ica.co.cu

For studying productive and digestibility indices, 16 female and castrated male pigs in equal proportion from a commercial cross were distributed randomly in two groups. For six weeks, animals were fed *ad libitum* from 30 kg with high-test molasses maize diets as the only energy source and torula yeast as the only protein source. Animals fed high-test molasses showed better performance (feed conversion, 4.59 and 3.45 kg DM/kg gain, P < 0.01) and rectal energy digestibility traits (83.7 and 88.1 %, P < 0.01) than those consuming maize. According to results obtained, growing pigs fed *ad libitum* high-test molasses diet as the only energy source can exhibit better performance traits than those receiving maize. Also, there are differences in rectal digestibility favoring the high-test molasses diet.

Key words: pigs, high-test molasses, maize, performance, digestibility

The use of sugar cane molasses diets, particularly with high-test molasses, has been studied in Cuba with interest because sugar cane culture is largely practiced and for many years has constituted the main feeding source for livestock production in the country, mainly for pigs (Figueroa and Ly 1990, Pérez 1997 and Ly 2008). Also in other Caribbean regions has been topic of attention (Renaudeau et al. 2011 and González et al. 2012). Thus, all research studies destined to identify the indices of economic interest are important as well as for providing information contributing to the knowledge of the digestive processes of pigs (Ly 1996, 2008, Xandé 2008 and Xandé et al. 2010). The use of yeasts as main protein source in diets, mainly with molasses, is also a subject that has been examined for a long time (Lezcano 1976, 2005).

The objective of this evaluation was studying jointly the performance traits and digestibility indices of pigs fed high-test molasses or maize, as only energy source during the growth phase that in Cuba is defined between 30 and 60 kg of body weight.

# **Materials and Methods**

The experiment was carried out between March and April, with an average daily temperature of 25° C. Sixteen Yorkshire x Landrace x Duroc, female and castrated male pigs in equal proportion were used with 30 kg live weight approximately, distributed randomly in two groups to which corresponded the treatments with maize or high-test molasses. Animals, between 30 and 55 kg, were fed *ad libitum* with high-test molasses or maize diets as only energy source. Maize meal came from a lot of imported grains conveniently ground. The torula yeast and the high-test molasses were Cuban. The high-test molasses used in the experiment (DM 87.21 %) contained: 23.5 % sucrose and 54.6 % of reducing sugars (glucose plus fructose) in dry basis. Details related to the diet evaluated are shown in table 1. It must be underlined that the crude fiber was almost absent in the high-test molasses diet, since the cell wall was only contributed by torula yeast.

Animals were housed in individual corrals with cement floor provided each one with feeding and water troughs. Corrals were placed in open-sided stable. Feeding troughs were cleaned daily at 8:00 a.m. and the left over of the feed was registered. Later, enough feed was distributed for guaranteeing a surplus for the 24 h period. Water was always available for the pigs. The maize and torula yeast diet was prepared once in order to use the lot during the whole experiment. The high-test molasses and torula yeast diet was prepared daily. Salts and the premix were combined with the torula yeast. Later, the dry ingredients were mixed with the high-test molasses. The feed was afterwards diluted with water in a 1:2 proportion in weight for facilitating management and consumption. The final DM concentration in this diet was of 36 % as average. All days sufficient feed was mixed for distributing among the eight animals fed with this diet.

At the beginning and end of the experiment, animals were weighed. Pigs had one week for adaptation to lodging and the experimental diets. On concluding this week, they were weighed and the experimental period started. Six weeks after the test started, when animals reached 55 kg as average, fecal samples were taken by rectal stimulation, at 8:00 a.m., at the time when they were weighed and before slaughter. This was made for measuring the rectal digestibility by the indirect method (van Keulen and Young 1977).

In the feed as in the digesta, DM, total ash and acid

1	5	/				
Ingredients	Maize	High-test molasses				
Maize meal	79.3	-				
High-test molasses of sugar cane	-	65.5				
Torula yeast	18.0	32.5				
CaCO <sub>3</sub>	1.3	1.3				
CaPO <sub>4</sub> H.2H <sub>2</sub> O	0.8	-				
NaCl	0.1	0.1				
Vitamins and minerals <sup>1</sup>	0.5	0.5				
Analysis						
Dry matter	89.90	87.86				
Ash	4.87	6.62				
Organic matter	95.13	93.38				
Crude fiber	2.50	0.33				
N x 6.25	16.03	16.05				
Energy, kJ/g DM	18.45	18.50				
According to the requirements of NPC $(2012)$						

	Table 1.	Composition	of the diets (	(% in	dry basis	5)
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1According to the requirements of NRC (2012)

insoluble ash (AIC) concentration were determined in that order and in the same sample. For that, samples were dried in an oven with air circulation at 60° C, incineration in muffle at 550° C and digestion of the sample with HCl 2 N (van Keulen and Young 1977). The N content was measured by the macro-Kjeldahl procedure (AOAC 1995), while the caloric content was determined by pump adiabatic calorimeter. Fecal pH was measured through a glass electrode connected to a digital pHmeter. All analyses were made by duplicate.

Data were manipulated according to the technique of variance analysis, according to a simple classification (Steel et al. 1997). An adequate statistical package was used (Minitab 2009). No sex effect was considered in the evaluations.

### Results

All animals were apparently healthy throughout the whole performance test. However, at slaughter, the two pigs from the high-test molasses treatment that showed best performance traits, a female and castrated male, died unexpectedly, with acute symptoms of anoxia, when moved from their corrals, after weighing. These two animals showed generalized cyanosis and symptoms equivalents to those that suffered metabolic acidosis. The meat was pale, soft and exudative. Data corresponding to these two pigs, relative to performance traits and digestive indices, measured ante-mortem, were used for the biometric evaluation. Nonetheless, after the postmortem examination herein reported, no morphological analysis was carried out of the digestive organs. In the treatment with high-test molasses, only data of six animals were used for the macroarchitecture and the gastrointestinal environment (Ly et al. 2014 a,b).

In table 2 are shown the information related to the performance traits of the animals. Pigs fed high-test molasses exhibited better performance traits than those fed the maize diet. In fact, the high-test molasses

	Maize	High-test molasses	SE±
n	8	8	-
Days on trial	42	42	-
Initial weight, kg	29.9	29.1	0.5
Final weight, kg	52.0	55.6	1.00*
Weight difference, kg	22.1	26.5	0.55*
Consumption, kg DM/D	2.51	2.25	0.06**
Gain, kg/d	0.547	0.653	0.026**
Feed conversion			
In kg DM/kg increase	4.59	3.45	0.44**
In MJ GE/kg increase	84.69	83.25	0.03**
In kg protein/kg increase	0.735	0.554	0.050**

Table 2. Performance traits of growing pigs fed maize or high-test molasses diets

\* P < 0.05; \*\* P < 0.01

Cuban Journal of Agricultural Science, Volume 48, Number 3, 2014. treatment determined, with lower DM daily consumption (P < 0.01), greater daily gain and lower DM feed conversion and of crude protein (P < 0.01).

Data corresponding to rectal digestibility of nutrients, as well as the fecal exit of materials are set out in table 3. In this experiment it was found that the pH and fecal concentration of DM was significantly higher (P < 0.001) in the animals consuming high-test molasses, in comparison with those receiving maize. The rectal digestibility of nutrients in the high-test molasses diet was considerably high and significantly (P < 0.01) higher than that of maize, except for the N, where the opposite occurred (P < 0.05). Consequently, fecal exit of fresh material and water was higher (P < 0.01) in pigs fed maize, in comparison with those consuming high-test molasses. The fecal exit of DM was also higher (P < 0.05) in those fed maize meal, regarding the animals from the high-test molasses treatment.

carbohydrate components of the feed. Although it was not calculated, the adjustment of the diets in order that they were isoprotein, determined the unfavorable amino acid balance in the high-test molasses/yeast diet, since there was probably deficit of sulfurated amino acids or a lysine superavit, available in the protein supplied to the animals (Lezcano 2005). It is known that the amino acid unbalance could negatively influence on the performance traits of the animals, among them, the voluntary feed intake (Sugahara et al. 1969, Henry 1988 and Henry et al. 1992). However, the protein conversion was evidently higher in the treatment with high-test molasses that could suggest that the amino acid unbalance, due to the fact of using only torula yeast as protein source, was not the cause of the differences found between treatments regarding voluntary feed consumption.

Also it is known that an acid-base unbalance, as those

molasses			
	Maize	High-test molasses	SE ±
n	8	8	-
Fecal indices			
pH	6,25	7.25	0.30***
DM, %	30.4	38.0	3.5***
Rectal digestibility, %			
Dry matter	85.3	90.6	2.5**
Organic matter	87.3	94.0	2.4**
Ν	83.0	79.0	1.8*
Energy	83.7	88.1	2.1**
Fecal exit, g/kg DM ingested			
Fresh material	418	250	54**
Dry material	127	95	10*
Water	291	155	15**
Ν	4.36	5.39	0.20*

Table 3.	Indices of rectal	digestibility	and fecal	exit of	growing	pigs <sup>1</sup> fe	ed maize o	or high-	test
	molasses								

<sup>1</sup>Measurements made when animals weighed as average 55 kg

P < 0.05 \*P < 0.01 \*P < 0.01

### Discussion

The duration of the experiment (42 d) with growing animals surpassed the limit of time proposed, as minimum of 28 d for adequate measurements of voluntary feed consumption and of 35 d in test for measuring daily gain, according to Arthur *et al.* (2008).

Data of this study, which was developed with growing animals, confirm those of other studies with fattening pigs in which it was found that animals fed sugar cane molasses can display low voluntary feed consumption (Ly and Castro 1984), although high-test molasses, as energy component of the diet, determines better performance traits than those attained with maize, regarding daily gain and DM conversion. The decrease of voluntary feed consumption could have been influenced, to a certain extent, by the protein or occurring in pigs fed sugar cane molasses (Ly 2010), could lead to an inhibition of voluntary feed consumption, and to changes in the consumption pattern, as those originated in pigs fed diets with sugar cane molasses, as main energy source (Ly and Castro 1984). This has been associated to adjustments in the intermediary metabolism of the animals (Ly 2010, 2011 and Ly and Torres 2011). In fact, the peculiar way of the consumption pattern of the molasses diets (Ly and Castro 1984) could have negatively influenced, on daily feed consumption. It is interesting that the two pigs consuming amounts of the high-test molasses/yeast diets, above the average consumption value, had sudden death, apparently by anoxia. The topic of voluntary feed consumption in pigs fed molasses, originating high fructose deposits in the intermediary metabolism of pigs (Ly 1996, 2011 and Ly and Torres 2011) requires further investigation.

# Pigs fed diets in which the only energy source is an enriched molasses of sugar cane, usually show higher rectal indices than those of animals fed maize or the same final molasses (Pérez 1997). As known, final molasses is commonly identified as sugar cane molasses and it is relatively poor in sucrose and reducing sugars. The opposite occurs with high-test molasses (Ly 1996, 2008). In piglets weaned with maize or high-test molasses, for example, rectal digestibility of organic matter was from 71.1 to 83.1 % (Díaz and Ly 1979) or from 87.7 to 91.4 % (Mederos *et al.* 1990). Similarly, rectal DM digestibility in pigs fattened with high-test molasses is higher than that of final molasses (Ly *et al.* 2009). This experiment tends to confirm this fact.

The decrease in the rectal N digestibility in the hightest molasses diet will confirm other previous data from a molasses type A/torula yeast diet that showed the same situation regarding other of yucca starch/torula yeast (Maylin *et al.* 1987). On the matter, Maylin *et al.* (1987) suggested from his ileal and rectal N digestibility data that there is yeast x molasses interaction in the large intestine that will cause decrease in the N disappearance in cecum and colon. This effect will be rather beneficial, since there are no possibilities of amino acid absorption, but of amines and ammonia in the large intestine of pigs (Zebrowska 1973, 1975).

In this experiment it was also evidenced that a greater rectal digestibility, together with a greater concentration of fecal DM, contributes to a lower fecal exit of materials. This was shown in pig fed ad libitum during the growth stage. These results must be considered when fecal material of pig cattle is used as raw matter which is recycled in the farm through compost or biodigestors (Ly 2008). On the other hand, high rectal digestibility indices, especially of energy, can compensate at least partially the decrease in the voluntary feed consumption under the conditions of this experiment, due to more energy available for the animal by the increasing digestive processes. The digestive indices of young pigs, fed with the maize/yeast diet were generally lower to those of the high-test molasses/yeast diet. However, these figures were higher than those corresponding to fattening pigs with similar maize/torula yeast diets, but with lower protein content (Ly and Almaguel 2007). It has been found that the feed consumption level could influence on rectal digestibility of nutrients and energy in the maize/yeast diets (Ly and Almaguel 2007), as in others (Parker and Clawson 1957 and Smits et al. 1994), although there has not been always coincidence with this tendency (Morel et al. 2006). In a same study, Renaudeau et al. (2006) found effect of the consumption level, between 0.7 and 1.0, under ad libitum condition for the energy digestibility, but not for the different nutrients measured. In that regard, Morel et al. (2006) suggested that the inverse effect of the consumption level on the rectal digestibility of organic matter and energy depend on the type of diet supplied to the pigs. Evidently, more

Cuban Journal of Agricultural Science, Volume 48, Number 3, 2014. information is required on this topic.

According to the results herein exposed, growing pigs fed *ad libitum* with high-test molasses diets, as only energy source, exhibited better performance traits regarding to those fed maize. Similarly, there were differences in rectal digestibility that favored the hightest diet.

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