Royal palm nut meal for fattening pigs. Influence of body weight on rectal digestibility and faecal output of materials

J. Ly[1,3], J.L. Reyes[1], E. Delgado[2], Lázara Ayala[1] and M. Castro[3]

[1] *Instituto de Investigaciones Porcinas, Gaveta Postal No. 1, Punta Brava, La Habana, Cuba*

[2] *Universidad Nacional Autónoma de México, Tlalpan, Distrito Federal de México, México*

[3] *Instituto de Ciencia Animal, Apartado Postal 24, San José de las Lajas, Mayabeque, Cuba*

Email: jly@iip.co.cu

A 2 x 3 factorial arrangement was applied to measure rectal digestibility of nutrients and faecal output of materials, at the starting and finishing fattening stages (30 and 80 kg). Twenty four castrated Cuban Criollo x CC21 male pigs were used. Animals were fed *ad libitum* for 14 weeks with final molasses alone (80 %) or with raw sugar or ground royal palm nut (45 %). The body weight x diet interaction was significant ($P < 0.05$) for raw fiber digestibility, NDF and N, but not for DM and organic matter at rectal level. Final molasses and sugar made to decrease rectal digestibility with weight increase, while with royal palm nut the opposite occurred. In general, rectal digestibility of nutrients was significantly higher ($P < 0.001$) with sugar and lower with royal palm nut. Faecal output of materials was considerably low in animals fed the raw sugar contained in the diet. The inverse happened with the royal palm nut. If royal palm nut constitutes a substantial part of low protein diets for pigs, rich in sugar cane molasses, this local feeding source could raise the digestive indices during fattening.

Key words: *pigs, rectal digestibility, body weight, molasses, royal palm nut*

In the last years the digestive processes in pigs fed sugar cane final molasses and, particularly, with final molasses (Ly 2008 and Xandé 2008) have been studied. Nonetheless, not much is known about the nutritive value of royal palm nut, a fruit from the royal palm (*Roystonea regia* H.B.K.). The royal palm is very abundant in Caribbean countries, which are sugar cane producers. Perhaps since the introduction of the pig species in Cuba by the Spaniards, approximately half millennium ago, a natural association was established among pigs and Cuban royal palms, especially under extensive rearing conditions or in the natural environment. Presently there is not sufficient available knowledge on the nutritional aspects of this association, in fact, if dealing with performance traits of pigs fed royal palm nut (García *et al* 2001 and Santana *et al*. 2006).

The objective of this paper was to make a report on the influence of body weight on the digestive indices and faecal output of materials in pigs fed high proportions of final molasses or royal palm nut. The characterization of body weight on these indices is important. It has been stated that final molasses tends to be less digestible as fattening advances (Macías and Ly 1998), while the royal palm nut is inefficiently digested by young animals (Ly *et al* 2011).

Materials and Methods

Twenty four castrated male F1 (Cuban Criollo x CC21) pigs were randomly distributed in three treatments. These consisted of diets that had as energy source final molasses, alone or with royal palm nut or raw sugar, supplied *ad libitum* for 14 weeks. Final molasses represented, approximately, 80 % or 35 % of the diet, when the ground royal palm nut or the raw sugar constituted 45 % of the diet in dry basis (table 1). The royal palm nut came from wild palm groves in the vicinity of Punta Brava, close to the Institute of Swine Research, located in Havana. The characteristics of the diets are set out in table 1.

Animals were housed in individual corrals of an open stable, with free access to drinking water. Rectal sampling were carried out at the beginning, two weeks after the introduction of diets and at the end of the fattening (30 and 80 kg of body weight), at 12 week interval. The rectal digestibility indices were measured by the indirect method. The acid insoluble ash present in the feed and faeces was used, as digestibility indicators. Two rectal samplings in two consecutive days were made at 9:00 a.m. the first day and at 3:00 p.m. the following day. At sampling pH of the faeces was determined through a glass electrode. Later, fresh faeces of both days were mixed equally in fresh weight for obtaining a representative sample per animal. Chemical analyses were carried out by duplicate, in samples corresponding to the feed and faeces. The procedures established for DM, ash, raw fiber and N determinations were followed (AOAC 1995). The NDF was analyzed according to van Soest *et al*. (1991), while acid insoluble ash was measured by van Keulen and Young (1977).

A 2 x 3 factorial arrangement (Steell *et al*. 1997) was applied, where the factors were body weight and diets. The analysis of variance technique was utilized to determine significant effect ($P < 0.05$) in case there was. In that case, means were separated by Tukey's test. Infostat as statistics package for Windows (Balzarini *et al*. 2001) was used for the statistical manipulation of data.

Table 1 Characteristics of the diets (% in dry basis)

	Final molasses plus		
	Alone	Raw sugar	Royal palm nut
Composition			
Final molasses	80.0	35.0	35.0
Raw sugar	-	45.0	-
Ground royal palm nut	-	-	45.0
Complement[1]	20.0	20.0	20.0
Analysis			
Ash	14.39	7.58	10.38
Organic matter	85.61	92.42	89.62
Raw fiber	1.18	1.90	13.35
NDF	2.26	3.62	26.32
Ether extract	0.99	1.00	12.29
NFE	78.14	77.47	46.97
Nitrogen	1.79	1.79	2.08
Gross energy, kJ/g DM[2]	16.07	16.77	18.61

[1]Soybean meal plus vitamins and minerals, plus zeolite (10%). Vitamins and minerals were formulated according to NRC (1998)
[2]Calculated according to Nehring and Haenlein (1973)

Results and Discussion

The interaction body weight x diet was significant ($P < 0.05$) for rectal nutrient digestibility, in some cases. The royal palm nut tended to increase the digestive indices with the increase of the body weight, while final molasses and raw sugar had an opposite performance. Data related to DM digestibility showed the tendency to be influenced by this interaction ($P < 0.10$), while ash digestibility and the organic matter did not show this influence. These indices, as well as the rectal digestibility of raw fiber, NDF and N are set out in table 2. The statistical analysis is shown in table 3.

In this experiment it was not evidenced that the increase of body weight had a negative influence on organic matter digestibility in the diets with final molasses, alone or with sugar. The contrary occurred with royal palm nut (table 2). Macías and Ly (1998) previously found a decrease of organic matter rectal digestibility, as pigs increased weight when they were fed final molasses diets. This performance suggested that in diets rich in sucrose it seems that the criterion that on increasing pig weight, the digestive indices of the animals rose is not fulfilled (Noblet *et al*. 1993 and Le Goff and Noblet 2001).

The interaction between factors was significant ($P < 0.01$) for raw fiber and NFD digestibility, with the lowest values for final molasses and the highest for royal

Table 2. Rectal digestibility of nutrients in fattening pigs

Digestibility, %		Final molasses plus[1]		
	Weight, kg	Alone	Raw sugar	Royal palm nut
Dry matter	30	80.0	89.7	64.4
	80	76.7	82.1	67.7
Ash	30	67.1	66.3	44.6
	80	52.6	44.9	33.5
Organic matter	30	83.6	91.6	65.0
	80	80.6	86.6	70.8
Raw fiber	30	5.9^{c}	48.7^{a}	31.5^{b}
	80	0.2^{c}	36.0^{a}	48.0^{a}
NDF	30	31.2^{c}	60.9^{a}	42.5^{b}
	80	0.5^{d}	45.7^{b}	61.0^{a}
Nitrogen	30	41.9^{b}	65.3^{a}	51.4^{ab}
	80	40.2^{b}	59.1^{a}	53.6^{ab}

[abcd]Means with different letters in each index measured differ significantly at $P < 0.05$
[1]For details see table 1

Table 3 Analysis of variance for rectal digestibility

	Source of variation			
	Diet	Body weight, kg	D x BW	Error
Degrees of freedom	2	1	2	40
Mean square Digestibility				
DM	1 761.33***	103.62*	69.40+	25.66
Ash	3 536.04***	1 826.09***	237.42	172.87
Organic matter	1 736.14***	67.19	155.64	94.29
Raw fiber	7 153.55***	10.92	929.08**	159.53
NDF	6 810.48***	1 038.18*	2 432.18***	194.01
N	1 527.84***	10.92	929.08**	159.53

+ P < 0.10; * P < 0.05; ** P < 0.01; *** P < 0.001

palm nut. Even though, it is possible that in royal palm nut diets, and consequently, with high fiber content, the fact that no more than approximately half of the fiber fraction was digested, could negatively influence on the dry matter digestibility. However, energy digestibility would not have necessarily to follow a parallel behavior, since royal palm nut diet is also very rich in ether extract (table 1). This contributes to increase its energetic density, an aspect that is not reflected in the digestive indices (Ly *et al*. 2000). Rectal digestibility of NDF followed the same tendency that the raw fiber.

There was significant effect (P < 0.01) for the interaction between factors in N digestibility. Also, it was shown that this index was considerably poor, perhaps owe to the really low level of the dietetic protein, and that of true protein was undoubtedly even more low, due to be absence of digestible protein in the final molasses (Ly 2008).

In table 4 are presented data on the different indices measured in the faecal output of materials. The analysis of variance is set out in table 5.

The lowest pH values and highest fecal DM concentrations were found in animals fed the ground royal palm nut (P < 0.01). There was no significant effect (P > 0.05) in any of the two cases for the body weight x diet interaction. Kerr *et al*. (2006) found that on varying the cellulose and N concentration in the diet, faeces composition changes. In accordance with the data of Kerr *et al*. (2006), the royal palm nut diet, rich in cellulose, favored the increase of DM faecal concentration and the decrease in the pH value. It is typical when molasses diets are consumed that faeces' pH of pigs tend to be close or equal to 7, and that faecal concentration be rather low, especially with C or final

Table 4. Faecal output of materials in fattening pigs

		Final molasses plus[1]		
	Weight, kg	Alone	Raw sugar	Royal palm nut
Faecal indices				
Dry matter, %	30	16.23[a]	27.21[b]	32.59[c]
	80	19.28[a]	24.54[b]	28.18[c]
N, % in dry basis	30	4.38	4.81	2.85
	80	4.00	4.41	2.98
pH	30	6.11[b]	6.32[b]	5.54[a]
	80	6.19[b]	6.62[c]	5.50[a]
Output, g/kg DM ingested				
Fresh material	30	12322.00	3782.00	1092.00
	80	12082.00	7292.00	1146.00
Dry material	30	2002.00	1032.00	356.00
	80	2332.00	1792.00	323.00
Water	30	10322.00	275.00	736.00
	80	9752.00	550.00	823.00
Nitrogen	30	8.66[ab]	5.00[a]	10.12[b]
	80	9.09[ab]	7.93[ab]	8.52[ab]

[abcd]Means with different letters in each index measured differ significantly at P < 0.05)

[1]For details see table 1

Table 5. Analysis of variance for faecal output of materials

	Source of variation			
	Diet	Body weight, kg	D x BW	Error
Degrees of freedom	2	1	2	40
Mean square				
Faecal indices				
DM	719.33***	0.11	65.80	11.35
N	12.43***	0.57	0.37	0.35
pH	3.64***	0.15+	0.12	0.06
Rectal output				
Fresh material	2473620.33***	38025.02	120550.08	82 139.85
Dry material	123650.58***	2976.75	19911.00***	2 190.76
Water	1829118.94***	13200.33	63967.02	65 808.80
N	42.95***	2.63	17.44**	3.15

** P < 0.01; *** P < 0.001

molasses (Ly 2008). In this sense, pH decrease in the faecal material released by the animals could be better interpreted as lower ammonia influence contained in that material, than as a reflex of the fermentative activity in the large intestine of animals (Miller and Varel 2003 and Kerr *et al*. 2006). This aspect was not contemplated in this research.

N concentration in the rectum was lower with the sugar diet, in accordance with greater rectal N digestibility, and lower faecal flow of nitrogenous compounds. This interdependency has been found to occur in this way in diets with variable cellulose and N levels (Cahn *et al*. 1998 and Kerr *et al*. 2006). In contrast, Mroz *et al*. (2000) did not find this proportionality in finishing pigs. Evidently, more studies in this direction, with the inclusion of non-conventional diets as those of molasses and royal palm nut are required.

Regarding faecal output of materials, the molasses diet containing raw sugar determined lower output (P < 0.001) regarding the other two, with or without royal palm nut, where the fresh material released by the pigs was considerable. These results confirm what was obtained in other studies. As a molasses or final molasses is sucrose enriched, rectal digestibility of nutrients increases and faecal output of materials decreases (Ly *et al*. 2008). Results of this paper agree with what was previously reported by Ly and García (2010), who indicated greater faecal output of materials in pigs fed high levels of fibrous materials.

Data derived from this experiment also confirm those of other studies realized in Cuba, regarding final molasses and sugar. It seems that both make to decrease rectal digestibility of nutrients, as pig fattening advances, measured in time and by the increase of body weight. If ground royal palm nut is a substantial part of diets low in protein for pigs, abundant in sugar cane molasses, it could contribute to raise the digestive indices throughout fattening. However, due to its high fiber content, it cannot be expected a high digestive utilization in this feed

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