SUGAR CANE JUICE AS AN ENERGY SOURCE FOR FATTENING PIGS

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24 pigs in the last stages of fattening were used to investigate the use of sugar cane juice as a source of energy (72% of the diet on a dry matter basis)' supplemented with fish mealal (7%) soyabean meal (21%) and minerals/vitamin5 (1%). The animals were divided between 3 treatments according to their initial weight of 40,50 or 60 kg, and the animals were slaughtered at 90 kg. The daily liveweight gains were 614, 729 and 776 g/d, and the feed conversions 3.55, 3.30 and 3.42 (kg of dry matter/kg liveweight gains) respectively for the three treatments.

Key words: pigs, fattening, sugar cane juice, by-products

A serious problem confronting pig producers in tropical areas is that cereal grains are not produced in large quantities in this zone. It is therefore necessary to import concentrates based on cereal grains from outside, with the loss of foreign exchange that this implies.

The use of waste bananas has been tried as a substitute, or partial substitute,for cereal grains in pig diets (Zaragoza 1977). However, it would seem that the most practical work of this type was carried out in Cuba using integral molasses and combinations of final molasses and sugar (MacLeod et al 1968).

Integral molasses is prepared from the extracted juice of sugar cane, which has been clarified and then concentrated and partially hydrolyzed to avoid the crystalization of sucrose. In this process none of the sugars are extracted, and for this reason the integral molasses has a higher concentration of sugar and a lower concentration of minerals than final molasses. The production of integral molasses however requires a high energy input to concentrate it to a Brix of 75° which is carried out to stop fermentation . At the present time, with the high cost of fuel, this process is uneconomic.

A second possibility for the use of sugar cane as an energy source for pigs is to use freshly pressed cane juice, immediately after its extraction from the cane. The high water content of the juice is not detrimental to its nutritive value, but it does imply that the juice must be used within 24 hours of its preparation, or that it should be conserved with a preservative.

At its simplest level the extraction of sugar cane juice from cane stalk requires the use of a simple cane press of the type which has been used over many generations for the preparation of crude sugar and brown sugar, particularly in the less developed tropical countries of Latin America.

The experiment which is reported in this paper was the first in a series of studies concerned with pig production based on the use of sugar cane juice as a tropical feed

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resource.

The objective was to study the effect of initial weight on liveweight gain throughout the final stages of fattening, assuming that adaptation to a diet of this nature would be easier at that stage of growth.

Materials and Methods

Treatment and design: Three treatments were compared. These were initial weights of 40, 50 or 60 kg. There were two groups of 4 pigs on each treatment and each group consisted of two males and two females.

Diets: Sugar cane juice was given ad libitum, being fed three times daily at 0800, 1200 and 1700 h. The protein supplement consisted of 75% soya meal and 25% fish meal, this being given in restricted quantities, according to protein requirements established by the NCR (1968). The quantities were adjusted every 15 days on the basis of animal liveweight, A commercial mixture of minerals and vitamins was given at the constant level of 25g/d/ animal throughout the experimental period,

Sugar cane juice was extracted daily using a simple cane press with 3 rollers, with which an extraction rate of approximately 55% (of the weight of the cane m the form of juice) was achieved, The !Brix of the juice averaged 13! during this experiment. The juice was given in fresh liquid form, immediately after its extraction from the cane.

The supplement was mixed with a small part of juice (approximately 5 litres/group of 4 animals), and was given as the first food of the day so that it would be completely consumed.

Measurements: The pigs were weighed every 15 days and the daily live weight gains were calculated using linear regression of weight against time. Daily food consumption was recorded, The pigs were slaughtered individually as they reached 20 kg liveweight. The carcasses were weighed and the width and depth of the L dorsi muscle was measured at the level of the 10th rib. Measurements were also made of the thickness of the back fat at the level of the rump and shoulder, For purposes of comparison the same measurements were made on animals from the production unit of the faculty, these being fed on traditional cereal-based diets.

Results

Health: No digestive or metabolic disorders were reported during the experiment. There were cases of slight diarrhoea in the first few days after the initiation of feeding with cane juice, but these disappeared in a very short time without the need for veterinary treatment,

Performance: No significant differences were observed between treatments for liveweight gain, consumption or feed conversion (Table 1).

Carcass characteristics: The most surprising result with respect to the carcasses (Table 2) was the very high yields, apparently better even than those pigs fed on a traditional cereal diet, Moreover there were indications that the area of the L dorsi muscle was greater, the pH of the muscle lower, the subcutaneous fat thinner and the liver heavier when the pigs were fed with sugar cane juice.

Table 1:
Performance of fattening pigs fed fresh sugar cane juice and protein supplements

-	Initial weight, kg			
	40	50	60	$SE_{\bar{x}}$
No. of pigs	8	8	8	-
Initial weight , kg	37.6	49.3	58.9	± 2.86
Final weight, kg	90.8	91.2	91.9	± 4.88
Duration, d	84	59	43	± 7.2
Gain,g/d	614	729	776	± 138
Consumption, kg/d				
Fresh juice	10.9	11.5	13.1	± 1.04
Supplement	.77	.81	.86	± .03
Total DM	2.25	2.35	2.63	± .13
Conversion[1]	3.55	3.30	3.42	± .81

[1] DM consumed/liveweight gain

Table 2:
Carcass characteristics of pigs fed with diets based on sugar cane juice or cereal grains

	Sugar cane juice, initial weight(kg)				
	40	50	60	$SE_{\bar{x}}$	Cereal
Yield [1]					
Warm carcass	81.8	82.1	81.9	±2.7	76.8
Cold carcass	79.3	79.6	79.6	±1.9	74.5
Area if L dorsi[2] (cm^2)	43.4	43.3	45.2	±8.3	30.3
pH of muscle	5.60	5.60	5.58	± .04	5.70
Liver (kg)	1.54	1.56	1.58	± .20	1.39
Back fat thickness (mm)					
Shoulder	38.6	38.4	45.4	±6.7	52.6
Rump	23.8	23.8	27.0	±5.6	26.0
Iodine[3] (%)	56.7	57.4	59.2	±3.51	60.0

[1] Yield on basis of liveweight taken in the morning without food
[2] Width and depth (Cuthbertson and Pease 1968)
[3] According to the method of Bateman (1970)

Discussion

Experiment 1: There is a paucity of literature on the use of auger cane juice as the basal diet for pigs, However, in Cuba a number of studies have been carried out on the feeding of pigs on integral molasses, wh ich is concentrated sugar cane juice.

The results obtained using sugar cane juice are similar to those report ed with integral molasses (Table 3).

Table 3:

Summary of results of liveweight gains, voluntary consumption and feed conversions of pigs fed with integral molasses and sugarcane juice (this work)

No of animals	Race	Final weight	Gain (g/d)	Consumption (DM kg/d)	Feed conversion Kg DM/kg gain	Source
-	D x Y	92	515	-	3.70	Preston et al (1970)
48	D x Y	90	528	1.80	3.43	Marrero et al (1976)
10	D x Y	100.7	537	2.39	4.45	Díaz et al (1978)
10	D x Y	90.7	575	1.76	3.10	MacLoed et al (1968)
32	D x Y	90	644	2.32	3.60	Velázquez et al (1970)
7	D x H	93.6	665	2.39	3.60	Dieguez (1974)
60	D x Y	90	696	-	3.35	Velázquez et al (1972)
35	D x Y	90.7	710	2.66	4.09	Lezcano et al (1975)
24	Y x H	91.3	703	2.41	3.42	This work

D = Duroc Jersey

Y = Yorkshire

H = Hampshire

Animal liveweight gain was very acceptable considering that even with grain-based diets liveweight gain very rarely exceeds 600 g/day and under tropical conditions it is always lower (Devendra and Fuller 1979). A summary of results taken from the literature on carcass yield and area of the L dorsi muscle for different diets is presented in Table 4.

Carcass yield is an important characteristic from the economic point of view. For this reason the high values obtained using sugar cane juice implied that this diet has important ,advantages.

It is interesting to note that Fernandez, Smith, Ellis, Clark and Armstrong (1979) reported higher carcass yields from pigs fed with solutions of glucose before slaughter.

According to the literature, the area of the L dorsi muscle is measured using two different methods: one method is to trace the muscle with a planimetre and the other method is to simply multiply the width (A) by the depth (B). However Smith et al (1965) found that the value (AxB) is always higher (by 39%) than that resulting from direct measurements using the planimeter. Using this proposal one can adjust values found in the the present work which should give higher values than those reported in the literature for animals fed diets based on cereals and molasses(Table 4).

It is well known that the quality of pig meat is affected by various conditions such as stress produced by poor management immediately before slaughter, nutrition, injuries and slaughter procedure. Any one of these factors can affect muscle pH. It is considered that good quality meat should have a pH between 5.4 - 5.8 (Fernandez, Smith and Armstrong 1979). A high pH tends to reduce the storage life and increase the possibility of bacterial attack.

Table 4:

Summary of results of the carcass yield and L.dorsi muscle area for pigs fed different energy sources (including this work)

No of animals	Race	Energy source	Final weight (kg)	Carcass yield,%	Area[a] L dorsi (cm^2)	Fat depth of shoulder (mm)	Source
43	D x Y	Molasses	90.7	80.5	23.6	39.7	Marrero et al (1976)
35	D x Y	Molasses	91.5	81.5	24.8	41.3	Lezcano et al (1975)
12	D x Y	Molasses	90.0	77.9	24.9	56.0	Velâzquez et al (1972)
26	P x H x Y	Molasses	80.0	-	26.1	31.0	Brooks (1972)
10	D x Y	Molasses	91.0	72.7	27.5	39.7	MacLoed et al (1968)
8	D x Y	Molasses	91.4	78	27.7	41.3	Velâzquez et al (1970)
26	P x H x Y	Cereals	80.0	-	25.7	34.4	Brooks (1972)
24	D x H	Cereals	101.5	-	29.3	-	McConnell et al (1975)
392	LW x L	Cereals	100.0	-	30.5[b]	32.5	Smith et al (1965)
-	-	Cereals	-	75.4	-	-	Zert (1979)
26	P x H x Y	Sugar	80.0	-	25.2	35.5	Brooks (1972)
24	Y X H	Sugarcane juice	91.3	81.9	31.7[c]	24.8	This work

[a] Measured with planimeter
[b] Width x depth
[c] A x B adjusted using the factor suggested by Smith and Ross (1965)
D = Duroc jersey; Y = Yorkshire; H = Hampshire; P = Poland; LW = Large White; L = Landrace

The muscle pH of pigs fed with juice was between 5.5-5.6. These results are slightly below those reported by Gallwey and Tarrant (1978), when they fed pigs with sugar before slaughter,

Muscle pH was lower ($P < 0.01$) in those pigs fed juice than in those fed cereals, although muscle pH of those pigs fed cereal was within the range which is considered to be satisfactory.

Fernandez et al (1979) fed pigs on diets rich in sugar before sacrifice and they observed a reduction in the muscle pH of 0.2 to 0.4 units. The explanation for this was that the content of glycogen in the muscle was considerably increased and this was converted to lactic acid after death.

Liver weight, according to Zert (1979) is normally within the range 1.2 to 2.0 kg. Cane juice fed pigs had livers weighing over 1.5 kg, these being greater than those of animals fed cereal based diets.

Gallwey et al (1978) reported that the liver weight of those animals fed sugar for 1 night before slaughter increased by 34%.

Babatunde et al (1975) also reported that the weight of the liver increased as the level of molasses in the diet increased. It would appear that any source of sugar in pig diets increases the level of glycogen in the liver resulting in heavier livers (Fernandez et al 1979). A part of this effect is attributable to the enzyme synthesis of glycogen, whose activity increases markedly when there is an increase of consumption of sugar by the animals (Fernandez et al 1979).

Fernandez and Smith (1979) noted that the consumer acceptability of the livers from pigs fed sucrose was better than those pigs which had not been fed sugar before slaughter. The reason for this was that the livers of those pigs fed sugar were more tender and were juicier, even though there was no difference in terms of taste. In the case of this work there was no testing at consumer level but the characteristics reported by the above researchers were noted.

From Table 4 it can be seen that the depth of fat of pigs fed sugar cane juice is thinner that for pigs fed molasses and cereals as energy sources.

The nature of the deposited fat can be markedly affected by the type of feedstuff used. The hardness of the fat can be quite different according to the feedstuff, and this is a factor which affects the commercial value of carcass of animals to be sold for meat.

A measure of muscle grade is the level of saturation of the fat deposit. This is called the Iodine Index. This Index for pig fat can vary between 46-66% (MacDonald et al 1975). No significant differences were found in this work, either between sex or treatments for the Iodine Index; nor were there any differences between pigs fed juice and pigs fed cereal grains.

Anderson and Mendel (cited by Maynard et al 1975) found that the iodine indices for the body fat of pigs fed with various carbohydrate protein sources vary between 55-70%. Carbohydrates tended to give a saturated body fat and for this reason the fat was harder than that produced by the majority of fat contained in animal diets (Maynard et al 19752, Values reported here, where the basic diet wee one of carbohydrate, were within the range of values reported for carbohydrate diets in the literature,

Conclusions

Fresh sugar cane juice can be used to substitute cereal grains completely in diets for pigs in the final stages of fattening starting at 40 kg liveweight. Moreover this type of diet appears to have nutritional and economic advantages in terms of the carcass characteristics, when compared to traditional cereal based diets.

References

Babatunde G M, Fetuga B L & Oyenuga V A 1975 Effects of feeding graded levels of cane molasses on performance and carcass characteristics and organ weights of Yorkshire pigs in a trop ical environment Journal of Animal Science 40:632-639

Bateman J V 1970 Nutricion Animal Manual de Metodos Analiticos Primera Edicion Editorial Herrero Amos Sucesorea A S Buenos Aires Argentina

Brooks C C 1972 Molasses Sugar (sucrose), corn, tallow, soyabean oil and mixed fate as sources of energy for growing swine Journal of Animal Science 34:217-224

Cuthbertson A & Pease A H 1968 The interrelationship of various measurements, visual assessments and dissection results of pigs of 200 lb liveweight Animal Production 10:249-255

Devendra C 6 Fuller M F 1979 Pig production in the tropics Oxford Tropical Handbooks J P Maule (ed)

Diaz C P & Marrero L 1978 Ceba de cerdoa con cabecilla de arroz y miel final Revista Cubana de Ciencia Agrtcola 12:165-172

Dieguez F J 1974 Apuntes sobre las interrelaciones entre razgos de crecimiento en puercos alimentados con maiz y miel rice Revista Cubana de Ciencia Agricola 8:227-231

Fernandez T H, Smith W C & Armstrong D G 1979 The administration of sugar solutions to pigs in mediately prior to slaughter I Effect on carcass yield and some muscle and liver characteristics Animal Production 29:213~221

Fernandez T H, Smith W C, Ellis M, Clark J B K K & Armstrong D G 1979 The administrations of sugar solutions to pigs immediately prior to slaughter 3 Effect on bacon yield Animal Production 29: 315-320

Fernandez T H & Smith W C 1979 A note on consumer acceptability of liver from pigs fed a auger solution immediately prior to slaughter Animal Production 29:419-422

Gallwey W & Tarrant P V 1978 Sugar feeding of pigs during overnight lairage improves bacon quality Farm and Food Research 7:117-118

Lezcano P & Elias A 1975 Comportamiento de puercos alimentados con diferentes niveles de levadura saccharomyces en sustitucion de la harina de pescado en dietas de mieles Revista Cubana de Ciencia Agricola 9:311-317

MacLeod N A, Preston T R, Lassota L A, Willis M B A Velazquez M 1968 Miel y azucar como fuentes energeticas pare puercos Revista Cubana de Ciencia Agricola 2:205-210

Marrero L & Ly J 1976 Efecto de diferentes proporciones de miel rice y miel final en dietas pare cerdos en crecimiento 1 Comportamiento y composicion de la canal Revista Cubana de Ciencia Agricola 10:45-66

Maynard L, Loosli J 1975 Nutrition Animal Tercera Edicion Editorial Hispano Americano

McConnell J C, Skelley C C, Handlin D L & Johnston W E 1975 Corn, wheat, milo and barley with soybean meal or roasted soybean meal or roastbean and their effect on feedlot performance, carcass traits and pork acceptability Journal of Animal Science 41:1021-1029

McDonald P, Edwards R A & Greenhalgh J F 1975 Nutricion Animal Segunda Edicion Editorial Acribia Zaragoza Espana

NRC 1968 Nutrient requirements of domestic animals 2 Nutrient requirements of swine National Academy of Science National Resources Council Washington Publication 1599

Preston T R & Willis H B 1970 A new look at molasses for livestock feeding Feedstuffs March 28 1970 20-23

Smith C 6 Ross G J S 1965 Genetic parameters of British landrace Animal Production 7:291-301.

Velazquez M, Preston 7 R, MacLeod N A 1970 La sustitucion de la proteina por fosforo diamoniaco en dietas de miel rice pare puercos en crecimiento Revista Cubana de Ciencia Agricola 4:113~118

Velazquez M, Preston 7 R & Willis H 8 1972 La eficiencia de producir grass y came magra en puercos Yorkshire y Duroc Jersey , alimentados con dietas basadas en miel haste los 150 kg de peso vivo I Comportamiento a diferentes pesos vivos Revista Cubana de Ciencia Agricola 6: 177-183

Zaragoza L 1977 Different rations of bananas: Molasses for growing pigs Tropical Animal Production 2:227 (abs)

Zert P 1979 Vademecum del Productor de Cerdos Editorial Acribia Zaragoza Espana

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