FAECAL OUPUT AND CHARACTERISTICS IN PIGS FED DIETS BASED ON SUGAR CANE MOLASSES AND GRADED LEVELS OF BIOTRANSFORMED FILTER CAKE MUD (GARANVER)

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SUMMARY

A double 3x3 Latin square design was employed to study the faecal response in 30 kg Yorkshire castrate male pigs of the introduction of either none, 11.5 or 22.5% of treated, biotransformed filter cake mud (garanver) in diets based on sugar cane molasses type B and soybean meal.

A sharp, highly significant (P<0.001) decrease in faecal DM concentration and increase in faecal pH was encountered as a consequence of increasing garanver in the diet. Faecal output of fresh material, water and dry material were significantly (P<0.01) doubled when 11.5% of garanver was present in the feed, but no further differences were found when garanver constituted 22.5% of diet. Fresh faecal output was 227, 477 and 581 g/kg DM intake, and faecal DM concentration, 34.3, 29.5 and 26.3% with none, 11.5 and 22.5% garanver in the diet, respectively. Total SCFA and ammonia faecal output significantly (P<0.05) augmented from 21.8 to 52.6, and from 12.9 to 20.6 mmol/kg DM intake, respectively, with increasing levels of garanver in feed.

Data obtained in the herein described evaluation will contribute to information considering pig faeces as starting material for either production of compost or biogas as methods to neutralize environmental aggression of pig excreta, among other possible alternatives.

Key words: *pigs, faecal output, biotransformed filter cake mud, garanver*

Short title*: Faecal output in pigs fed treated treated filter cake mud (garanver)*

CARACTERISTICAS Y SALIDA FECAL DE CERDOS ALIMENTADOS CON MIELES DE CAÑA DE AZUCAR Y NIVELES VARIABLES DE CACHAZA BIOTRANSFORMADA (GARANVER)

RESUMEN

Se usó un cuadrado latino duplicado 3x3 para estudiar la respuesta fecal in cerdos Yorkshire machos castrados con 30 kg, de introducir ninguna, 11.5 o 22.5% cachaza biotransformada (garanver) en dietas preparadas con miel B de caña de azúcar y harina de soya.

Se encontró un marcado, altamente significativo (P<0.001) decrecimiento o crecimiento en la concentración de MS y el pH fecales como consecuencia de incrementar el garanver en la dieta. La salida de material fresco, agua y material seco se duplicó significativamente (P<0.01) con 11.5% de garanver en la comida, pero no se halló aún más diferencias cuando el garanver constituyó el 22.5% de la dieta. La salida fecal de materia fresca fue 227, 477 y 581 g/kg MS ingerida, y la concentración fecal de MS, 34.4, 29.5 y 26.3% con ninguno ó 11.5 ó 22.5% de garanver en la dieta, respectivamente. Los AGCC y el amoníaco emitidos fecalmente aumentaron significativamente (P<0.05) desde 21.8 hasta 52.6, y desde 12.9 hasta 20.6 mmol/kg MS ingerida, respectivamente, con el incremento del garanver en la comida.

Los datos que se obtuvieron en la evaluación aquí descrita contribuirán a la información a considerar sobre las excretas de cerdos como material inicial para la producción de composta o biogás como métodos para neutralizar la agresión ambiental de las excretas porcinas, entre otras posibles alternativas.

Palabras claves*: cerdos, salida fecal, cachaza biotransformada, garanver*

Título corto: *Salida fecal en cerdos alimentados con cachaza tratada (garanver)*

INTRODUCTION

The use of filter cake mud (FCM) or filter press mud (Göhl 1998) for feeding pigs has been assayed in different moments (Bautista 1987; Pérez and Patterson 1983; González and Mederos 1996; Ly 1998; Ly and García 2002), since a considerable amount of this material is originated at the sugar cane factory as a result of alkaline treatment of sugar cane juice (see Figueroa and Ly 1990). According to Cuban experiments, it has generally been found that FCM in natura

neither determine an improvement in digestive utilization of nutrients of the diet (Ly and García 2002), nor is in favour of good performance traits of growing pigs (Pérez and Patterson 1983), even in conditions of use of treated FCM such as that named luvagar (González and Mederos 1996), gicabú (Ly 1998), or garanver (Ly and García 2002; Almaguel et al 2008).

Since Cuban efforts for improving the nutritive value of FCM are in current progress (see Almaguel et al 2008), the main objective of the present investigation was to determine faecal parameters in order to provide engineering studies of characteristics of pig faeces fed with graded level of the biotransformed FCM, named garanver.

MATERIALES Y METODOS

A double 3x3 Latin square design was employed to study the faecal response in 30 kg Yorkshire pigs of the introduction of none, 11.5 or 22.5% of biotransformed filter cake mud (garanver) in diets based on sugar cane molasses type B and soybean meal. Further information concerning housing, managing of animals and characteristics of the assayed diets are available elsewhere (Almaguel et al 2008). As a result of the chemical analyses conducted in the garanver (AOAC 1995), it was noted that ash, crude fibre and crude protein (Nx.6.25) content were 19.2, 27.6 and 13.4% in dry basis, respectively. In consequence, ash and crude fibre of the diets containing garanver were increased considerably (table 1). The rations were prepared in the moment to be supplied to the pigs at 9:00 am and 3:00 pm. Water was added to the molasses, dry components and garanver in the proportion of 2:1 in dry weight to facilitate feed handling and intake by the pigs.

Table 1. Details of the diets

	Garanver, % DM		
	None[1]	11.5	22.5
Dry matter	53.76	53.93	53.94
Ash	6.66	8.26	9.74
Crude fibre	2.02	4.81	7.52

[1] The basal diet (control) contained sugar cane molasses type B and soybean meal, 65.8 and 31.4% respectively. For details, see Almaguel et al (2008)

A faeces sample from every pig in every experimental period was obtained from a five-day pool, and analyzed by duplicate for dry matter content, following the AOAC (1995) gravimetric procedure. Fresh material of daily faeces output was recorded by direct weighing of the collected material, and from this, faecal water output was a result of substraction from the dry material. The pH value of fresh faeces was determined daily in the moment of sample collection by the aid of a glass electrode, then pooling the values of five successive days to achieve an average data per pig and per experimental period. A representative sample of the five-day period was stored frozen at -5°C until analysis. Thawed faeces were thoroughly homogeneized, then suspended in a solution of NaCl, 9 g/L, in the proportion of 1:4 by weight. The suspended slurry was homogeneized carefully and filtered through four layers of cheese cloth to obtain a faecal liquor which was assayed for total SCFA and ammonia, according to the methodology described by Phinmasan et al (2004), consisting essentially in a distillation procedure by using a tecator distilling unit, with the aid of either a strongly acid solution of $MgSO_4$ to distill the SCFA, or other solution consisting of NaOH 40% to recover ammonia in a boric acid solution.

The Harvey (1990) software was employed to manage the results in order to determine statistical significant differences if any ($P<0.05$), following Steel et al (1997) recommendations. In the proper cases means were separate by the Duncan multiple range and multiple F test.

RESULTS AND DISCUSSION

The chemical composition of the FCM named garanver was very high in crude fibre and ash, and relatively low crude protein (Nx6.25) content. In this case, these characteristics of garanver are not so different from other types of FCM, such as the liquid product assayed by Bautista (1987) in Venezuela (table 2) or another, the common Cuban material evaluated by Serrano and Iglesias (1988).

Table 2. Chemical composition of filter cake mud (FCM) products

	Composition, % DM			
	Ash	Crude fibre	Nx6.25	Source
In natura				
	23.9	12.9	10.4	Devendra and Göhl (1970)
	24.7	5.4	5.6	Ibáñez and González (1979)
	27.9	19.8	9.4	Pedroso and Hardy (1982)
	14.2	21.4	15.1	Göhl (1998)
	32.3	24.4	12.8	Ly and García (2002)
Treated				
Garanver[1]	26.8	26.9	18.3	Ly and García (2002)
	19.2	27.6	13.4	This experiment
Gicabú	24.0	23.3	10.0	Ly (1998)
Luvagar[2]	28.0	30.4	15.5	González and Mederos (1996)
Liquid[3]	17.5	10.7	13.9	Bautista (1987)

[1] For details, see Almaguel et al (2008)
[2] Fermented FCM plus bagasse pith (see González and Mederos 1996)
[3] Liquid (DM, 23.9%), preserved with 0.5% benzoic acid

In this connection, it has been claimed that silica accounts for some 43% of the ash fraction (Rodríguez and González 1973) in the mud, whereas NDF values could account for some 30% of the dry material. In this connection some FCM composition such as that of garanver, is not apart from the average composition of FCM in natura. Values otherwise published in foreign reviews (Parish 1965; Göhl 1998) or even in Cuba (Pedroso and Hardy 1982; Bejottes 1988; Serrano and Iglesias 1988), indicate a good accordance with that presented herein, except for crude fibre content, which was considerable high.

Fermentative indices

The SCFA and ammonia concentration in faeces, as well as faecal pH values, are listed in table 3. The garanver product

determined an alkaline reaction in the faeces of pig, and this effect was significant (P<0.05) when compared to faecal samples from pigs fed no garanver. On the other hand, faecal concentration of SCFA increased, and ammonia decreased, as increasing levels of garanver occurred in the diet. Nonetheless, the analysis of variance did not reveal other influence than a trend (P<0.10) in the status of faecal microbial metabolites.

Table 3. Faecal microbial metabolites in pigs fed biotransformed filter cake mud (garanver)

	Garanver, %			
	None[1]	11.5	22.5	SE ±
n	6	6	6	-
pH	5.96[a]	7.21[b]	7.08[b]	0.15***
Faecal metabolites, mmol/100 g DM				
SCFA	26.71	28.28	33.51	6.08[+]
Ammonia	16.15	15.87	13.68	0.73[+]

[1] The basal diet (control) contained sugar cane molasses type B and soybean meal, 65.8 and 31.4% respectively
[+] P<0.10; *** P<0.001
[ab] Means in the same row without letter in common differ significantly (P<0.05)

As it was observed in the current investigation, Varel et al (1984) found a lower ammonia concentration in caecum, colon and faeces of pigs fed a high amount of crude fibre in the diet. On the other hand, the reverse appeared to be true for the status of organic acid concentration (Varel et al 1984). In this particular case, Varel et al (1984) suggested that these findings could be associated to either a higher ammonia utilization by microbial population or less protein catabolism which could be taking place there. Schneider and Bolduan (1985) and Bolduan et al (1986) claimed that ammonia arising from bacterial activity in the digestive tract of pigs is a negative factor in pig production, and should be kept as low as possible in animals and environment too.

Münchow and Hãger (1988) suggested that SCFA production, excretion and absorption in the large intestine of pigs should be greatly influenced by the type of substrate to be arriving to caecum and colon of animals. In the experiment of Münchow and Hãger (1988), partly hydrolyzed straw, as compared to the same untreated material, strongly favoured SCFA production and absorption in caecum and colon of the animals, and faecal excretion of these acids then evidently decreased. Accordingly, in the current study it could not be known if garanver, as a modified FCM which was introduced in the diet, determined an increase in SCFA production and absorption, and at the same time a major faecal output of acetate and similar organic acids could be taking place there.

Faecal output of materials

A sharp, highly significant (P<0.001) decrease in faecal DM concentration was observed as a consequence of the introduction of garanver in the diet (table 4).

Faecal output of fresh material, water and dry material were significantly (P<0.01) doubled when 11.5% of garanver was present in the feed, but no further differences were found when garanver accounted for 22.5% of diet. From the point of view of microbial metabolites, an increase output of SCFA and ammonia was evident when pigs were given increasing amounts of garanver in the diet. This effect was significant (P<0.05) in both cases. Overall, it is considered that these finding were a consequence of a higher faecal output of fresh materials, since concentration of these metabolites was either high or low according to the introduction of garanver in the diet, as a probable result of a modification of microbial metabolism in the large intestine of pigs fed high levels of a crude fibre product such as FCM. In this connection, it has long been recognized the role of fibrous materials as modulators of microbial fermentation in the gastrointestinal tract of pigs (Noblet and Le Goff 2001; Wenk 2001; Bindelle et al 2008). These results merit more research to be done.

Table 4. Faecal output in pigs fed biotransformed filter cake mud (garanver)

	Garanver, %			
	None[1]	11.5	22.5	SE ±
n	6	6	6	-
Faecal DM, %	34.35[a]	29.59[b]	26.32[c]	1.1***
Faecal output				
In g/kg DM intake				
Fresh material	227[a]	477[b]	581[b]	100***
Water	149[a]	336[ab]	428[b]	88***
DM	78[a]	141[b]	153[b]	15***
In mmol/kg DM intake				
SCFA	21.8[a]	40.1[ab]	52.6[b]	9.0*
Ammonia	12.9[a]	21.9[b]	20.6[b]	2.4*

[1] The basal diet (control) contained sugar cane molasses type B and soybean meal, 65.8 and 31.4% respectively
* P<0.05; *** P<0.001
[abc] Means in the same row without letter in common differ significantly (P<0.05)

The increased faecal output of fresh and dry faeces has been observed in previous experiments where other type of FCM was supplied to pigs (Ly 1998), and the hypothesis has been put forward that the high content of cell wall in FCM would be one of the main factors determining a high faecal output of materials. In addition, since faecal DM concentration tends to be lowered as determined by the presence of FCM in the feed, this second factor should be suggesting that either an increase in rate of passage through the large intestine, or certain impairment in the rate of water absorption in the colon of pigs could contribute to this phenomenum to occur too.

Data obtained in the herein described evaluation will contribute to information considering pig faeces as starting material for either production of compost or biogas as methods to neutralize environmental aggression of pig excreta, among other possible alternatives (Preston 2000; San Thy 2003)..

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