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Effects of sweeteners on individual feed intake characteristics and performance in group-housed weanling pigs[1]

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ABSTRACT: To assess the effects of 2 high intensity sodium saccharine-based sweeteners on individual feed intake characteristics and performance of group-housed weaned pigs, one hundred ninety-eight 26-d-old weanling pigs were given ad libitum access to 3 dietary treatments containing: no additional sweetener (control), 150 mg of sweetener (Sucram C-150)/kg, or 150 mg of sweetener (Sucram 3D)/kg. At weaning, piglets were allocated to 18 pens (11 pigs/pen) based on BW, sex, and ancestry, and pens were randomly assigned to 3 treatments with 6 pens per treatment. The pens were equipped with computerized feeding stations. During the first 12 d, pigs were offered pelleted prestarter diets that were replaced at once by pelleted starter diets for the last 7 d of the 19-d experimental period. The individual feed intake characteristics consisting of latency time (interval between weaning and first feed intake), initial feed intake (intake during the first 24 h following the first feed intake), the number of total visits per day, and the number of visits in which feed was consumed, together with the time and the feed intake per visit, were determined for all piglets. Performance traits and fecal consistency were determined per pen for d 0 to 5, d 5 to 12, and d 12 to 19, as well as for the total period (d 0 to 19). The initiation of feed intake was not affected by the addition of high intensity sweeteners to the diet. From 12 d postweaning, dietary sweeteners caused the piglets to focus more on feed intake and less on exploratory behavior, as shown by the increased percentage of visits with feed intake in pigs fed the Sucram 3D diet compared with those fed the control diet ($P = 0.002$). The overall daily feed intake increased with time but was not affected by the addition of sweeteners. Nevertheless, dietary sweeteners prevented the depression of feed intake on d 8 and 10 postweaning (d 8, $P = 0.013$; d 10, $P = 0.014$), which seemed to coincide with an improved fecal consistency score (d 5 to 12, $P = 0.11$; d 12 to 19, $P < 0.001$). However, the changes in feed intake characteristics and fecal consistency only resulted in numerical effects on postweaning pig performance (ADFI, $P = 0.126$; ADG, $P = 0.140$). The results of the present study indicate that weanling pigs need a certain period of time before clear effects of dietary sweeteners on individual feed intake characteristics and pig performance can be observed.

Key words: feed intake, performance, piglet, sweetener, weaning

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INTRODUCTION

Taste plays a major role in feed consumption, and taste is especially important when appetite is suppressed for some reason, such as at weaning (Hellekant and Danilova, 1999). Some studies have shown that the dietary inclusion of sweeteners, such as sucrose, lactose, dextrose, or artificial high intensity sweeteners, increased feed intake and BW gain of newly weaned pigs (Lewis et al., 1955; Grinstead et al., 1961; Schlegel and Hall, 2006). A study of Munro et al. (2000), however, failed to demonstrate an effect of dietary sweeteners on performance of weaned pigs.

The development of early feed intake behavior of weanling pigs is highly variable among individuals within groups (Bruininx et al., 2001b). Nevertheless, an uninterrupted intake of nutrients immediately after weaning is considered essential for the performance and health of piglets (McCracken et al., 1995; Pluske et al., 1996; Verdonk, 2006). The effects of sweeteners on individually measured early feed intake characteristics in group-housed weanling pigs are unknown. It can be hypothesized that pigs offered sweetened feeds start eating sooner after weaning and also reduce the number of visits to the feeder, during which no feed

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is consumed. Furthermore, provision of a sweet taste combined with the supply of nutrients has been shown to enhance chewing behavior in growing pigs at the expense of exploratory behavior (Day et al., 1996). Therefore, it can be hypothesized that sweetened feed modulates feeding behavior by increasing the proportion of visits to the feeder, during which feed would be consumed.

The following study was carried out to evaluate the effects of 2 commercial high intensity sweeteners on individual feed intake characteristics and performance of group-housed weanling pigs. Individual feed intake characteristics were measured using computerized feeding stations.

MATERIALS AND METHODS

The care and treatment of the pigs were according to Dutch animal welfare legislation.

Animals

One hundred ninety-eight 26-d-old weanling pigs (7.7 ± 0.6 kg) were used. The pigs originated from a commercial sow herd [Great Yorkshire × Dutch Landrace females (Topigs 20 sow line, Topigs, Vught, the Netherlands) × D-line males (Topigs D-line boar line, Topigs)]. During the suckling period, all pigs had free access to water, but to reduce variation in postweaning performance, creep feed was not provided. At d 3 after birth, male pigs were castrated. At weaning (d 0), pigs were transferred to the nursery room before 1100 h. Pigs were individually weighed on d −1, 0, 5, 12, and 19 after weaning, and ADG was calculated for d 0 to 5, 5 to 12, and 12 to 19.

Treatments and Experimental Design

Pigs were offered 1 of 3 dietary treatments: no additional sweetener (control), 150 mg of sweetener (**C-150**; Sucram C-150, Pancosma SA, Geneva, Switzerland)/kg, or 150 mg of sweetener (**3D**; Sucram 3D, Pancosma SA)/kg. The major differences between the 2 sweeteners were their concentration in sodium saccharine (less for 3D) and the inclusion rate of taste enhancers and texturizing agents. During the first 12 d, pigs were offered pelleted prestarter diets that were replaced at once by pelleted starter diets, which contained the same amount of added sweeteners, for the last 7 d of the 19-d experimental period (Table 1). The ADFI was determined per pen for d 0 to 5, 5 to 12, and 12 to 19.

Pigs were randomly assigned to 18 pens (3 trials of 6 pens) based on BW (d −1), sex, and ancestry. Each pen contained 11 pigs. Barrows and gilts, as well as littermates, were equally divided among pens. The experiment was repeated 3 times in a single room with 2 pens per dietary treatment per trial. Pigs were given ad libitum access to feed and water (1 nipple drinker per pen) during the whole experimental period.

Housing

The pens (3.35 × 1.80 m) had partially slatted floors, which consisted of 2-m metal slats and 1.35-m solid floor with heating. The pens were situated in a room with computer-controlled heating and mechanical ventilation systems. During the first 5 d, the room was continuously illuminated with artificial light, and after 5 d, the room was illuminated daily from 0800 to 1800 h. Each pen was equipped with 1 individual voluntary feed intake recording in group housing (**IVOG**)-feeding station (Insentec B.V., Marknesse, the Netherlands) for weanling pigs as described by Bruininx et al. (2001a). Briefly, one IVOG-feeding station for weanling pigs consists of a feeder placed on a load cell that records within a range of 0 to 50 kg. Body weights were recorded in 10-g increments. The single space feeder in the feeding station had a 220 × 200 × 290 mm feeding bowl. A small adjustable fence (0.2 m) in front of the feeder allowed competition among pigs and facilitated distinguishing separate visits. The entrance width to the feeding stations was set between 0.11 and 0.35 m, depending on the size of the pigs.

At weaning, each pig received an electronic ear transponder that was read by 2 antennas in the feeding stations. The feeding stations recorded feeder weight, time at the beginning and end of each visit to the feeder, and the electronic identification number of the pigs. Failed identification of pigs or incorrect recordings of feeder weight are main sources of errors in the data collected by computerized feeding stations (Eissen et al., 1998). Therefore, IVOG data were screened before calculations of feed intake characteristics. Screening was based on the recorded feed intake per visit (g), and the calculated feeding rate per visit (g/min) according to the method of Bruininx et al. (2001a).

Feed Intake Characteristics

The development of feed intake behavior of individual pigs during the first several days after weaning was studied by calculating latency time, the initial feed intake, and the daily feed intake behavior according to Bruininx et al. (2001b). Latency time is defined as the interval (h) between the start of the experiment, when all pigs were transferred to the nursery pens and were given access to the IVOG-feeding stations, and the first recorded feed intake. The initial feed intake (g) was the amount of feed consumed during the first 24 h after the first recorded feed intake. The feed intake characteristics were recorded from d 0 (start of the experiment) until d 19 (end of the experimental period). The whole experimental period was divided into: d 0 to 4 (start of experiment until end of d 4 at 0000 h), d 5 to 11 (start of d 5 at 0000 h until end of d 11 at 0000 h), and d 12 to 19 (start of d 12 at 0000 h until d 19). The number of total visits per day and the number of visits, in which feed was consumed, together with the time (s) and the feed intake per visit (g) were calculated.

Table 1. Composition of the pelleted diets (% as-fed basis)

	Prestarter diets			Starter diets		
Item	Control	C-150	3D	Control	C-150	3D
Ingredient						
Barley	36.0	36.0	36.0	17.5	17.5	17.5
Wheat	15.5	15.5	15.5	43.0	43.0	43.0
Corn	5.0	5.0	5.0	—	—	—
Whey powder (low in lactose)	4.0	4.0	4.0	—	—	—
Soybean meal	7.8	7.8	7.8	6.2	6.2	6.2
Toasted soybeans	5.5	5.5	5.5	—	—	—
Extracted sunflower seed	—	—	—	7.8	7.8	7.8
Extracted rape seed	—	—	—	9.7	9.7	9.7
Wheat bran	2.5	2.5	2.5	7.8	7.8	7.8
Potato protein (Protastar)	3.5	3.5	3.5	—	—	—
Linseed	1.7	1.7	1.7	—	—	—
Corn treated	9.6	9.6	9.6	—	—	—
Fish meal	0.5	0.5	0.5	—	—	—
Fat (animal)	3.83	3.83	3.83	5.50	5.50	5.50
Soy oil	0.50	0.50	0.50	—	—	—
Limestone	0.91	0.91	0.91	0.92	0.92	0.92
Monocalcium phosphate	0.85	0.85	0.85	—	—	—
Citric acid	0.50	0.50	0.50	0.19	0.19	0.19
Fumaric acid	0.50	0.50	0.50	—	—	—
Salt	0.46	0.46	0.46	0.53	0.53	0.53
Phytase premix, 100 phytase units/g	0.10	0.10	0.10	0.55	0.55	0.55
L-Lysine-HCl	0.35	0.35	0.35	0.39	0.39	0.39
DL-Methionine	0.10	0.10	0.10	0.04	0.04	0.04
L-Threonine	0.04	0.04	0.04	0.07	0.07	0.07
L-Tryptophan	0.03	0.03	0.03	0.01	0.01	0.01
Vitamin and mineral premix[1]	0.20	0.20	0.20	0.19	0.19	0.19
Sweeteners,[2] mg/kg	—	150	150	—	150	150
Chemical analysis, %						
DM	87.9	87.8	87.8	87.9	87.9	87.9
CP	18.4	17.9	17.9	17.5	17.5	17.5
Crude fat	7.9	7.9	8.0	7.2	7.2	7.2
Crude fiber	3.2	3.0	2.9	5.5	5.5	5.5
Ash	4.7	4.7	4.8	5.2	5.2	5.2
Ca	0.65	0.65	0.65	0.65	0.65	0.65
P	0.57	0.57	0.57	0.50	0.50	0.50
Na	0.22	0.22	0.22	0.22	0.22	0.22
Calculated NE, MJ/kg	10.39	10.39	10.39	9.74	9.74	9.74

[1]Provided the following nutrients per kg of diet: calcium, 18 mg; phosphorus, 0.96 mg; sodium, 0.4 mg; potassium, 4.3 mg; chloride, 0.38 mg; copper, 160 mg; iron, 160 mg; zinc, 110 mg; manganese, 30 mg; iodine, 10 mg; selenium, 0.2 mg; sulfur, 255 mg; retinol, 9,999 IU; cholecalciferol, 2,000 IU; tocopherol, 85 IU; thiamine, 1 mg; riboflavin, 4 mg; niacin, 20 mg; pantothenic acid, 15 mg; pyridoxine, 2 mg; biotin, 0.03 mg; pteryl-hepta-glutamic acid, 0.5 mg; cobalamin, 0.02 mg; menadione, 2 mg; antioxidants, 60 mg [E310 Propylgallate, E320 BHA (butylated hydroxyanisole), and E321 BHT (butylated hydroxytoluene)].

[2]Provided in prestarter and starter diets; C-150 = Sucram C-150 (Pancosma SA, Geneva, Switzerland); 3D = Sucram 3D (Pancosma SA).

Fecal Consistency

Fecal consistency was recorded 3 times per week using a score of 1 to 3, in which 1 was identified as firm feces, 2 as soft feces, and 3 as liquid feces. The fecal consistency was judged per pen by recording the number of pigs within a category of fecal consistency scores. Data were pooled per category for d 0 to 5, 5 to 12, and 12 to 19, and expressed as a percentage of animals observed in each fecal consistency class.

Statistical Analyses

The ADFI, BW, ADG, and G:F were evaluated by ANOVA using the GLM procedure (SAS Inst. Inc., Cary, NC). The model used was

$$Y_{ijk} = \mu + \text{trial}_i + \text{dietary treatment}_j + \text{interaction}_{ij} + e_{ijk},$$

where Y_{ijk} = response of a specific trait per pig; μ = overall mean; trial_i = fixed effect of trial i (i = 1, 2, 3); $\text{dietary treatment}_j$ = fixed effect of dietary treatment j (j = 1, 2, 3); interaction_{ij} stands for the interaction between the dietary treatment and the trial; and e_{ijk} denotes the error term.

Feed intake characteristics were analyzed according to a split plot design, in which pen was the whole plot and pigs within pens were the subplots. Trial and dietary treatment were whole plot factors, and sex (barrows vs. gilts) was a subplot factor. Number of daily visits (total and with feed intake), % of visits with feed

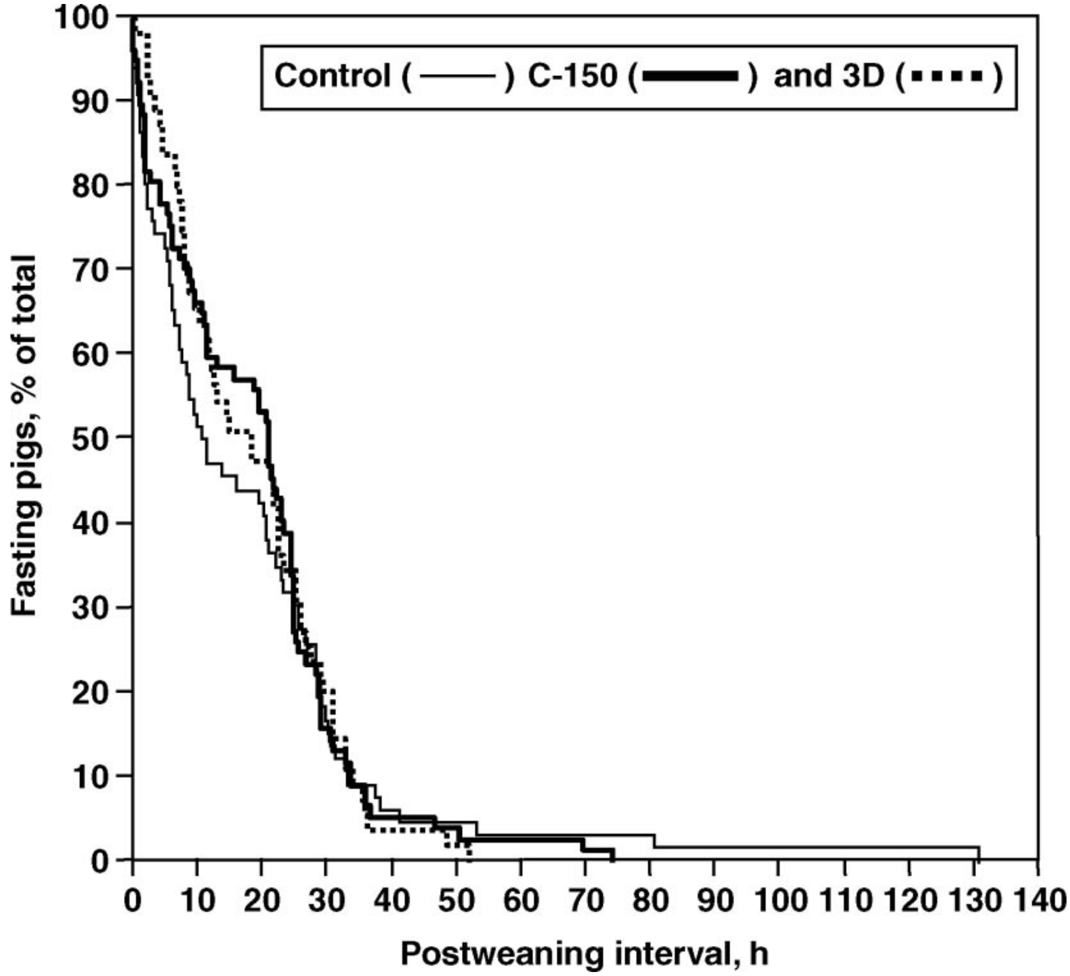

Figure 1. Percentage of weanling pigs that had not eaten after weaning (n pens = 6; n pigs = 66). Control = containing no additional sweetener, C-150 = 150 mg of sweetener (Sucram C-150; Pancosma SA, Geneva, Switzerland)/kg, and 3D = 150 mg of sweetener (Sucram 3D; Pancosma SA)/kg.

intake, duration of daily visits, feed intake per visit, and the initial feed intake were analyzed with the following model:

$$Y_{ijklm} = \mu + \text{trial}_i + \text{dietary treatment}_j + e_{1,ijk} + \text{sex}_l + \text{interaction}_{jl} + e_{2,ijklm},$$

where Y_{ijklm} = response of a specific trait per pig; μ = overall mean; trial_i, $\text{dietary treatment}_j$, and sex_l, denote the fixed effects for the corresponding treatment factors; interaction_{jl} stands for all 2-factor interactions between the treatment factors; $e_{1,ijk}$ and $e_{2,ijklm}$ denote random errors for pen k in replicate i and for pig n in pen k in replicate i, respectively. Whole plot factors were tested against the error term 1. Subplot factors and interactions were tested against the error term 2. Estimates of model parameters and components of variance were obtained using the REML procedure in Genstat (Genstat release 8.1, VSN International, Hertfordshire, UK). Fixed effects were assessed using chi-square tests for the Wald statistics (GenStat). Whole plot and sub plot errors were considered to be random and normally distributed with mean 0 and variances equal to σ^2_{pen} and σ^2_{pig}, respectively. After a significant overall test, pairwise differences between treatment means were tested using a *t*-test without further protection. To study the development of daily feed intake behavior in time, the mixed model (REML procedure; Genstat) was extended with fixed effects of day and 2-factor interactions between day and an additional random error for differences between days within a pig. The extended model was fitted to the daily measurement data using the method of REML. To assess differences between treatments within days, an additional day-by-day analysis was performed using the REML procedure. After a significant overall test, the pairwise differences were tested using a *t*-test without further protection.

As in an earlier study (Bruininx et al., 2001b), preliminary analysis showed that all data except latency time followed a normal distribution. Therefore, Kaplan-Meier curves (Kalbfleisch and Prentice, 1980) were constructed for latency time, which is affected by dietary treatments, trial, and sex.

Table 2. Feed intake characteristics of weanling pigs as affected by the addition of C-150 or 3D to the diet[1]

Item	Control	C-150	3D	SEM	P-value
No. of pens	6	6	6		
No. of pigs	66	66	66		
Weaning weight	7.5	7.5	7.5		
Initial feed intake, g	99	83	107	10	0.242
d 0 to 4					
Daily visits					
Total number	34	31	32	2	0.623
Time per visit, s	79	90	89	6	0.321
Visits with feed intake	8.5	7.5	8.1	0.8	0.724
% visits with feed intake	24.3	24.6	26.0	2.0	0.815
Visits with feed intake					
Time per visit, s	204	251	236	17	0.122
Feed intake per visit, g	14	15	15	1	0.660
Feeding rate, g/min	4.7	4.2	4.4	0.4	0.767
d 5 to 11					
Daily visits					
Total number	41	36	34	5	0.607
Time per visit, s	116	131	141	12	0.349
Visits with feed intake	10.3	10.0	11.9	0.7	0.159
% visits with feed intake	29.0	32.2	37.3	2.9	0.122
Visits with feed intake					
Time per visit, s	306	343	309	21	0.379
Feed intake per visit, g	25	29	27	2	0.352
Feeding rate, g/min	5.2	5.3	5.4	0.3	0.892
d 12 to 19					
Daily visits					
Total number	39	35	31	3	0.169
Time per visit, s	124	136	149	10	0.209
Visits with feed intake	13.8	12.7	14.6	0.7	0.179
% visits with feed intake	37.8[a]	40.8[ab]	49.1[b]	2.8	0.014
Visits with feed intake					
Time per visit, s	281	302	271	14	0.300
Feed intake per visit, g	42	44	39	3	0.424
Feeding rate, g/min	9.0	8.8	8.8	0.4	0.950

[a,b]Within a row means without a common superscript differ, $P < 0.002$.

[1]C-150 = Sucram C-150 (Pancosma SA, Geneva, Switzerland); 3D = Sucram 3D (Pancosma SA).

Fecal consistency scores were analyzed using ordinal regression analysis according to the method described by McCullagh (1980) using Genstat. The fecal scores on a pen basis were analyzed for each period with dietary treatment as the independent variable and trial as the block.

RESULTS

Effects of Sweeteners on Feed Intake Characteristics

The pattern of the Kaplan-Meier curves for latency time was not affected by the addition of high intensity sweeteners to the diet of pigs (Figure 1). During the first 4 d postweaning, feed intake characteristics were not affected by the dietary treatments (Table 2), although for the C-150 treatment, the average duration of a visit, in which feed was consumed, seemed to be about 23% greater than in the control treatment. From d 5 to 11, feed intake characteristics were not affected by the addition of sweeteners. Nevertheless, there were numerical differences among the 3 treatments in the proportion of visits during which feed was consumed (P = 0.122). The proportion of successful visits to the feeder by the pigs in the 3D treatment was about 29% greater than the control.

During the third period of the study (d 12 to 19) the percentage of visits with feed intake was affected (P = 0.014) by the addition of sweeteners. Pigs receiving the 3D diet had a greater proportion of successful visits to the feeder than pigs on the control treatment (P = 0.002), but the proportion of their successful visits did not differ from those receiving the C-150 treatment. Other feed intake characteristics during d 12 to 19 did not differ among the 3 treatments.

Effects of Sweeteners on Time-Related Changes in Feed Intake

Daily feed intake was time-dependent (Figure 2) and increased with time. The addition of a sweetener did not affect the overall time-related development in feed intake. Nevertheless, on d 8 and 10, differences between treatments (d 8, P = 0.013; d 10, P = 0.014) were observed. The control pigs showed a typical de-

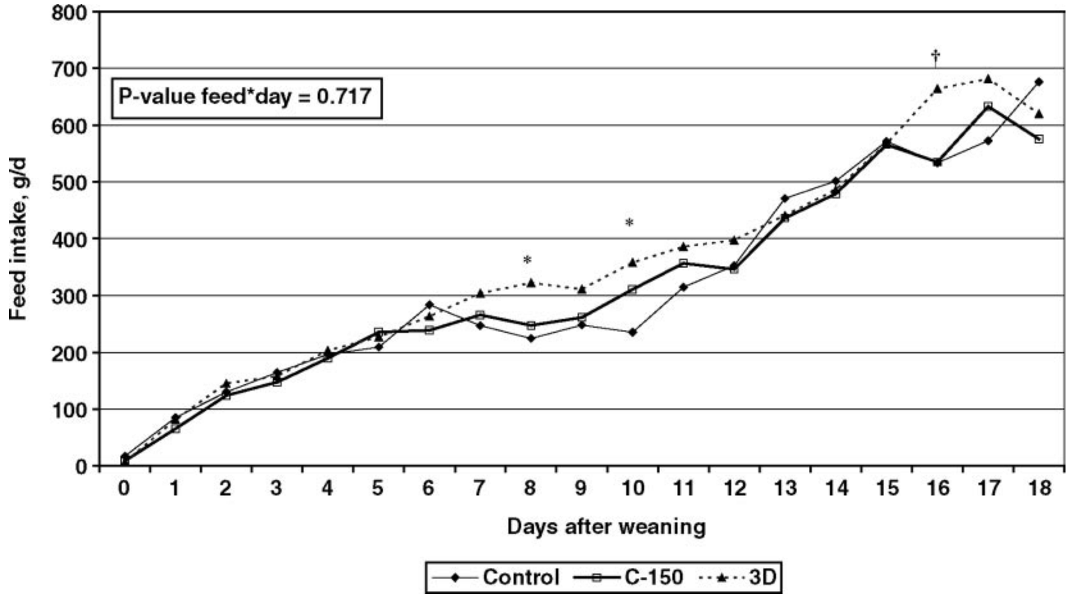

Figure 2. Daily feed intake during the total experimental period. Control = containing no additional sweetener, C-150 = 150 mg of sweetener (Sucram C-150; Pancosma SA, Geneva, Switzerland)/kg, and 3D = 150 mg of sweetener (Sucram 3D; Pancosma SA)/kg. Treatment effects within days (* and †): d 8, $P = 0.013$; d 10, $P = 0.014$; and d 16, $P = 0.074$.

pression in feed intake on those days and pigs receiving 3D showed a steady increase in feed intake (control vs. 3D: d 8, $P = 0.002$; d 10, $P = 0.003$). The feed intake pattern of the C-150 pigs was intermediate. On d 16, a tendency toward a treatment effect ($P = 0.074$) was observed. Feed intake in pigs fed the 3D diet was greater than those fed the control and the C-150 diets.

Effects of Sweeteners on Fecal Consistency and Performance

During the first 5 d after weaning, the proportion of firm feces was greater than 90% in all treatment groups, and the fecal consistency score was not affected by dietary treatments (Table 3). However, during d 5 to 12 and d 12 to 19, fecal consistency score seemed to be affected by dietary treatments ($P = 0.11$ and <0.001, respectively). The distribution of fecal consistency score in both the C-150 ($P = 0.002$) and 3D ($P = 0.001$) groups consisted of a greater proportion of firm feces and less soft feces compared with the control group.

The ADFI, ADG, and G:F were not affected by the addition of high-intensity sweeteners to the diet (Table 4). Nevertheless, there were numerical differences in ADFI for periods d 5 to 12, d 12 to 19, and d 0 to 19 ($P = 0.122$, 0.131, and 0.126, respectively). During the total 19-d period, pigs on the C-150 and 3D treatments consumed (respectively) 5 and 12% more feed than the pigs on the control treatment. Similar numerical differences were observed for ADG ($P = 0.140$) during the 19-d period. Pigs on the C-150 and 3D treatments gained 6 and 15% more, respectively, than the pigs in the control treatment.

DISCUSSION

The results of the present postweaning study showed that the addition of high intensity sweeteners to diets for weanling pigs can affect feed intake characteristics to a limited extent. Intake responses of pigs (Lewis et al., 1955; Grinstead et al., 1961; Munro et al., 2000; Schlegel and Hall, 2006), cattle (Murphy et al., 1997; Broderick et al., 2000; Brown et al., 2004; McMeniman et al., 2006), and rats (Smith and Sclafani, 2002) to added sweeteners are variable. However, research on the effects of dietary sweeteners or other flavoring agents on feed intake characteristics of pigs or even other species has been very limited.

Gardner et al. (2001) demonstrated that offering weaned pigs a diet without milk products and a relatively high content of soybean meal seemingly caused a delay in the initiation and development of feed intake behavior. Assuming that their results are taste-related, those are in contrast with the results of the present study. We were not able to demonstrate any effect of dietary sweeteners on the initiation of feed intake (latency time). Nevertheless, as the study proceeded, the proportion of visits during which feed was consumed increased with the use of 3D. Therefore, the intake behavior of the pigs, meaning the efficiency of consuming feed, was improved with sweetened diets. Pigs are thought to spend considerable time engaged in exploratory behavior directed at feed and troughs, which is associated with information gathering (Day et al., 1996; Gardner et al., 2001). Day et al. (1996) proposed that nutritional feedback could stimulate feeding-motivated chewing in growing pigs (initial BW, 63.9 ± 5.8 kg) and showed that a sweet taste combined

Table 3. Fecal consistency (scores in % of animals observed in each consistency class) of weanling pigs as affected by the addition of C-150 or 3D to the diet[1]

Item	Control	C-150	3D	*P*-value[2]
No. of pens	6	6	6	
d 0 to 5				0.822
Firm feces	93.43	92.42	93.94	
Soft feces	6.57	7.58	6.06	
Liquid feces	0.00	0.00	0.00	
d 5 to 12				0.115
Firm feces	74.24	82.32	81.31	
Soft feces	25.76	16.67	18.18	
Liquid feces	0.00	1.01	0.51	
d 12 to 19[3]				<0.001
Firm feces	76.77	88.38	88.38	
Soft feces	22.22	10.10	11.62	
Liquid feces	1.01	1.52	0.00	

[1]C-150 = Sucram C-150 (Pancosma SA, Geneva, Switzerland); 3D = Sucram 3D (Pancosma SA).

[2]This analysis follows from the ordinal regression analysis according to the method described by McCullagh (1980). The fecal consistency is quantified on an underlying continues scale. In this way the differences between the treatment averages are differences in treatment effects on this underlying constructed scale. Therefore, the *P*-values and superscripts are given for the distribution of the fecal score classes. For each treatment the distribution of fecal scores (firm, soft, liquid) = 100%.

[3]Fecal consistency distribution between treatments: control vs. C-150, $P = 0.002$; control vs. 3D, $P = 0.001$.

with a source of nutrients (sucrose solution) strongly reinforced chewing behavior, whereas sweet taste in the absence of nutrients (saccharin solution) reinforced chewing behavior only slightly. It seems that the sweetened diets in this study had a greater reinforcing value than the control.

The results of Bruininx et al. (2002a) showed that creep feed intake before weaning also resulted in a greater proportion of successful visits, but much earlier (d 1 to 8 postweaning) than the effects of the sweeteners in the present study. Bruininx et al. (2002a) concluded in their study that familiarity with solid feed at weaning causes the weanling pig to focus more on feed intake and less on exploratory behavior. Because the diets were provided only after weaning in the present study, perhaps the positive effects of the sweeteners were not observed sooner. This delayed response was indeed confirmed in the study of Schlegel and Hall (2006), who indicated only a positive effect of the addition of dietary sweeteners to the diet on pig performance in feeding phase 2 (12 to 25 d after weaning) and 3 (26 to 46 d after weaning). These pigs were also not fed before weaning. In a study of Brown et al. (2004), beef calves receiving high-intensity sweeteners in their diet had 17% greater DM intake, which was particularly evident after 14 d of receiving treatments. Therefore, it appears that a certain adaptation period is needed before effects of high-intensity sweeteners are expressed on performance, such as feed intake or growth.

The increased efficiency in consuming feed of the pigs receiving high-intensity sweeteners in the present study could also be demonstrated by the development in daily feed intake. Although the overall feed intake behavior was not affected by the addition of sweeteners, pigs received the 3D diet did not show the typical decline in daily feed intake between d 7 and 11. This lack of a feed intake depression coincided with an improved fecal consistency in the pigs receiving dietary sweeteners. The variation in feed intake between (Makkink, 1993) or even within days (Bruininx et al., 2002b) is considered to be an important determinant for the digestive and absorptive function of the gastrointestinal

Table 4. Performance results of weanling pigs as affected by the addition of C-150 or 3D to the diet[1]

Item	Control	C-150	3D	SEM	*P*-value
No. of pens	6	6	6		
d 0 to 5					
BW at d 0, kg	7.7	7.7	7.7		
ADG, g	61	83	85	15	0.449
ADFI, g	127	138	142	10	0.601
d 5 to 12					
BW at d 5, kg	8.0	8.1	8.1	0.1	0.430
ADG, g	171	178	204	12	0.158
ADFI, g	221	238	260	12	0.122
G:F, g/g	0.78	0.75	0.79	0.03	0.657
d 12 to 19					
BW at d 12, kg	9.2	9.3	9.5	0.13	0.228
ADG, g	254	261	277	12	0.404
ADFI, g	409	415	445	12	0.131
G:F, g/g	0.62	0.63	0.62	0.02	0.977
d 0 to 19					
BW at d 19, kg	10.9	11.2	11.4	0.17	0.142
ADG, g	173	184	199	9	0.140
ADFI, g	265	277	297	10	0.126
G:F, g/g	0.65	0.66	0.67	0.01	0.375

[1]C-150 = Sucram C-150 (Pancosma SA, Geneva, Switzerland); 3D = Sucram 3D (Pancosma SA).

tract. Therefore, the present data may indicate that high intensity sweeteners in weanling pig diets can be used to modulate feed intake patterns to prevent digestive disorders.

The present study showed, however, only numerical effects of the inclusion of high intensity sweeteners in the diet of weanling pigs on feed intake and BW gain. Bruininx et al. (2002a) demonstrated clear effects of improved feed intake efficiency, resulting from creep feed intake before weaning on average feed intake and performance after weaning. Their results indicate that weanling pigs need a certain period of time before clear effects of dietary sweeteners on performance can be observed. This is in agreement with the findings of Schlegel and Hall (2006) in pigs and Brown et al. (2004) in calves. The provision of a sweetened feed before and after weaning may minimize the exploratory phase after weaning and improve the efficiency of the feed intake and pig performance even further.

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