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The influence of feeder type and the method of group allocation at weaning on voluntary food intake and growth in piglets

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Abstract

Two hundred and ten piglets weaned at 30 days of age and weighing 9 kg were allocated to a 3 × 2 factorial arrangement of treatments to examine the influence of feeder type ('wet and dry' single-space feeder (SSF), 'dry' SSF, or multi-space feeder) and method of group allocation (piglets from different litters were mixed together, or piglets were weaned with their littermates) on performance after weaning. The use of a 'wet and dry' SSF did not enhance growth rate or voluntary food intake (P > 0·05) in the 28 days after weaning. Piglets feeding from 'wet and dry' SSF grew proportionately 0·06 slower in the 28 days following weaning as a result of a 0·45 proportional decrease (P = 0·013) in growth in the 1st week. Piglets mixed together from different litters at weaning grew proportionately 0·34 faster (P = 0·010) in the first 14 days after weaning than piglets weaned as littermates. This initial difference resulted in a 0·14 proportional increase in growth rate from day 1 to 28 (385 v. 339 g/day, P < 0·001). Piglets from different litters mixed at weaning consumed proportionately from 0·06 to 0·16 more food (P = 0·096) than piglets weaned as entire litters. No interactions between feeder design and the method of group allocation at weaning occurred for any of the production parameters measured. Single-space feeders failed to increase the production of weaner piglets, whilst mixing non-littermate piglets into a new social group seemingly enhanced performance from weaning to 56 days of age.

Keywords: *feed dispensers, food intake, group housing, piglets, weaning.*

Introduction

The post-weaning growth check can be attributed to the inability of the newly weaned pig to eat sufficient food and hence grow at a maximum rate. Two factors that may have profound effects on voluntary food intake, particularly in the first few days after weaning, are the design of the feeder and the association between feeding behaviour and aggression. Mixing piglets from different litters is a common practice at weaning but this causes high levels of aggressive behaviour for 24 to 48 h as piglets fight to establish a dominance order (Ewbank, 1976; McGlone, 1986). Allocating littermate piglets to the same pen after weaning reduces aggression (Rushen, 1987; Rundgren and Löfquist, 1989) but may or may not improve food intake and growth (see Petherick and Blackshaw, 1987). In growing-finishing pigs most fighting between penmates occurs during feeding (Ewbank and Meese, 1971; Baxter, 1983), and this is exacerbated when feeding space and/or the amount of food on offer is restricted (Graves, Graves and Sherritt, 1978; Hansen, Hagelsø and Madsen, 1982; Vargas, Craig and Hines, 1987). This led Baxter (1991) to conclude that aggression displayed at the feeder may reduce the amount of time pigs spend eating and reduce voluntary food intake.

Using meal and/or pelleted diets, numerous workers have reported increases in growth rate, apparent voluntary food intake and/or food conversion ratio in growing-finishing pigs when 'wet and dry' single-space feeders were used in preference to 'dry' single-space feeders or conventional multi-space feeders (Patterson, 1989a and b; Walker and Overton, 1989; Walker, 1990a and b; Payne, 1991). Voluntary food intake might be stimulated by 'wet and dry' feeders in a number of ways. First, the findings of Bigelow and Houpt (1988), who reported that proportionately 0·75 of daily water intake occurred in conjunction

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with eating bouts in the young pig, and Barber, Brooks and Carpenter (1989), who recorded a direct correlation between water intake and food intake after weaning, suggest that 'wet and dry' single-space feeders may increase food intake because pigs prefer to eat their food in the presence of water. Second, the single-space feeder might protect the pig during feeding and reduce aggression because the two most vulnerable parts on the body for an aggressor to attack, the head and ears, are enclosed (Kelley, McGlone and Gaskins, 1980; McGlone, 1985; Baxter, 1989; Morrow and Walker, 1994). This may augment food intake as the pig feels more secure when it feeds and less inclined to relinquish its position at the feeder. Similar studies with weaner piglets have not been reported in the literature.

Single-space feeders should reduce aggression between piglets while they are feeding and might allow them to eat more food. We tested this hypothesis by measuring how much food piglets ate from single-space feeders or conventional, multi-space feeders. Providing water in addition to food in a single-space feeder might stimulate voluntary food intake further, so we investigated this by placing a nipple drinker inside the feeder. Aggression between piglets, particularly in the first 24 h after weaning, may also be a cause of low food intake. We investigated the importance of aggression either by weaning piglets as littermates or mixing them into new social groups.

Material and methods

Piglets were weaned at an average age of 29·9 (s.e. 0·27) days when they weighed 9·0 (s.e. 0·14) kg, and were housed in groups of nine in pens of asbestos construction with full wire-mesh floors that had a measured area of 1·62 m^2. A single 150-W lamp hung over a corner heated each pen. During the experiment (April to October 1990) the ambient temperature in the weaner room ranged from a minimum of 15·2 (s.e. 1·5)°C to a maximum of 23·8 (s.e. 1·6)° C. A 'bite-action' nipple drinker provided water *ad libitum* in each pen. The experiment was a 3 × 2 factorial arrangement of treatments, with piglets allocated on the basis of litter, sex and live weight to one of three feeders: (1) a single-space feeder with the nipple drinker in the bowl connected to water ('wet and dry') (SSF+); (2) a single-space feeder not connected to water ('dry') (SSF–); and (3) a conventional multi-space feeder (MULTI); and to one of two methods of allocation at weaning: (1) three piglets from each of three litters were mixed together (+); (2) piglets were kept with their littermates (–).

Piglets were offered pelleted diets *ad libitum*. A starter diet (diet 1, Table 1) was offered for the first 2 weeks after weaning and then diet 2 (Table 1) was offered from day 15 to 28 after weaning. Diets were provided from either conventional multi-space or from single-space feeders. The multi-space feeders were 1140 mm in length and contained 11 feeding spaces. The single-space feeders (Verbakel™, Vereyken Brothers Pty Ltd, Grafton, NSW) had a feeding bowl that was 210 mm wide, 190 mm high and 230 mm deep. To obtain food the piglets had to knock a latch mechanism with their snout that allowed food to drop into the bowl of the feeder. 'Blinkers' of stainless steel construction that were 245 mm high and extended 120 mm from the front of the feeder were added to the single-space feeders because the opening of the feeder was too wide and allowed more than one piglet to feed at a time. The 'blinkers' ensured that only one piglet could feed at a time and that the feeders were truly 'single-space'. Single-space feeders were connected either to a water supply via a drinking nipple located inside the feeder ('wet and dry') or were left unconnected to water ('dry'). Piglets were weighed at weekly

Table 1 *The composition (g/kg) of diets offered to weaner pigs*

Ingredient	Diet 1	Diet 2
Wheat	276	500
Barley	200	
Oat groats	150	222
Skim-milk powder	250	
Lupins		50
Full-fat soya-bean meal		50
Meat meal		100
Blood meal		25
Fish meal	70	35
Vegetable oil	30	12
Limestone	7	
Dibasic calcium phosphate	8	
L-lysine	2	1·5
DL-methionine	1	
L-threonine	1	
Vitamin and mineral pre-mix†	5	4·5
Dry matter (g/kg)‡	889	892
Crude protein (g/kg)‡	213	207
Ether extract (g/kg)‡	128	115
Digestible energy (MJ/kg)§	15·0	14·6
Total lysine (g/kg)§	14	12
Available lysine (g/MJ DE)§	0·89	0·67
Calcium (g/kg)§	12	11
Phosphorus (g/kg)§	8	8

† Provided the following nutrients (per kg of air-dry diet): vitamins: retinol 1500 μg, cholecalciferol 20 μg, α-tocopherol 10 mg, riboflavin 2·5 mg, niacin 16 mg, pantothenic acid 10 mg, pyridoxine 2 mg, choline chloride 140 mg, cyanocobalamin 10 μg; minerals: NaCl 3·5 g, Cu 10 mg, Zn 100 mg, Mn 20 mg, Fe 60 mg, Co 0·2 mg.
‡ Determined from proximate analysis of complete diet.
§ Calculated for each diet from average analysis of ingredients.

intervals. Voluntary food intake was measured weekly by disappearance of food from the feeders. In the week following weaning a porridge-like mixture formed in the bowl of 'wet and dry' feeders. This was removed, oven-dried (100° C for 24 h), and subtracted from the food offered. Treatment effects and interactions were analysed by least-squares, two-way analysis of variance using SYSTAT© (Wilkinson, 1990) for the main effects of type of feeder and method of allocation of pigs at weaning. Since no interactions were present between the independent variables, pairwise comparisons were made between main-effect means using Fisher's-protected least significant difference (LSD) procedure (Maindonald, 1992). Statistical significance was accepted at $P < 0.05$. Voluntary food intake was expressed as 'apparent voluntary food intake' due to unavoidable food wastage.

Results

Piglets feeding from the 'wet and dry' single-space feeders grew slower in the 1st week after weaning than pigs weaned onto either 'dry' single-space feeders or multi-space feeders (102 *v.* 143 and 153 g/day, $P = 0.013$). Apparent voluntary food intake for pigs eating from multi-space feeders was proportionately 0·27 higher during this week than for pigs eating from either of the single-space feeders (254 *v.* 204 and 198 g/day) but the variation in intake between pens was too high for statistical difference ($P = 0.116$). Live-weight gain between days 1 and 28 was similar ($P > 0.05$) between feeders. There was no significant effect of feeder design on apparent voluntary food intake or food conversion efficiency in the experiment, although piglets eating from 'dry' single-space feeders showed a 0·07 proportional improvement (1·5 *v.* 1·6, $P = 0.064$) in the apparent conversion of food to live-weight gain in comparison with other feeders from day 1 to 28 (Table 2).

Discussion

Our hypothesis that 'wet and dry' single-space feeders would increase piglet growth rate after weaning because they would eat more food than piglets fed from either 'dry' single-space or multi-space feeders was not supported since performance was similar between feeder types. The failure of 'wet and dry' single-space feeders to increase performance after weaning in this study suggests that providing water in association with dry food does not stimulate an increase in apparent voluntary food intake. These results differ from the work conducted in growing-finishing pigs where water connected to the single-space feeder was thought to

Table 2 *Performance of pigs for 28 days after weaning fed from one of three feeder types: SSF+ ('wet and dry' single-space feeder), SSF– ('dry' single-space feeder), and MULTI (multi-space feeder), and either mixed (+) or kept as littermates (–) at weaning*

	Feeder type (F)			Mixing at weaning (M)			Level of significance		
	SSF+	SSF–	MULTI	+	–	s.e.d.	F	M	F × M
Live weight at weaning (kg)	9·1	9·0	9·0	9·1	9·0	0·22			
Live weight after 28 days (kg)	19·2	19·8	20·0	20·0[b]	19·3[a]	0·42		*	
Daily live-weight gain (g/day)									
days 1-7	102[a]	143[b]	153[b]	151[b]	113[a]	18·5	*	**	
days 8-14	310	343	344	367[b]	298[a]	21·8		***	
days 15-21	432	422	462	436	441	22·2			
days 22-28	589	606	576	590	590	23·2			
days 1-28	347	365	374	385[b]	339[a]	15·2		***	
Apparent voluntary food intake (g per pig per day)									
days 1-7	204	198	254	235	203	27·7			
days 8-14	428	442	465	475[b]	415[a]	29·0		*	
days 15-21	664	658	728	717	650	39·7			
days 22-28	1008	986	1038	1041	980	76·4			
days 1-28	578	571	628	616	569	36·7			
Food : gain ratio (g food : g live-weight gain)									
days 1-7	1·9	1·6	1·7	1·6[b]	1·9[a]	0·14		*	
days 8-14	1·4	1·3	1·4	1·3	1·4	0·13			
days 15-21	1·6	1·5	1·6	1·7	1·5	0·14			
days 22-28	1·7	1·7	1·8	1·8	1·7	0·16			
days 1-28	1·6	1·5	1·6	1·6	1·6	0·05			

[a,b] Within main effects, values in rows not followed by a common superscript differ ($P < 0.05$).

be responsible for an increase in food intake (Payne, 1991). Walker (1990b) reviewed a number of trials comparing single-space feeders, both 'wet and dry' and 'dry', with multi-space feeders and found that 'wet and dry' feeders increased voluntary food intake and improved growth rate by proportionately about 0·10 for meal diets and 0·03 for pelleted diets, respectively, over the other feeders. Similarly, Payne (1991) found a 0·10 proportional increase in food intake and a 0·06 increase in growth rate when finishing pigs of the same genotype as those used in this study were fed from 'wet and dry' feeders.

There are two possibilities why 'wet and dry' single-space feeders failed to improve performance and, initially in the first few days after weaning, actually reduced performance of piglets which was contrary to our prediction. The first involves the complexity of operation of the single-space feeder from the piglet's perspective. To operate the feeder piglets had to learn to co-ordinate the flow of food from the hopper into the bowl with the flow of water from the nipple drinker that was located inside the bowl. For the first few days after weaning piglets had difficulty with this co-ordination and often managed to fill the bowl with a porridge-like, unpalatable gruel. We suggest that water flow to the feeder might be important during this learning period. The flow of water to the feeders in this study was = 1·1 l/min and, because of technical difficulties, could not be reduced. There is evidence that lower flow rates might maximize food intake in weaner piglets. For example, Barber *et al.* (1989) found maximum levels of food intake at flow rates of 750 ml/min, and Partridge, Fisher, Gregory and Prior (1992) reported that when water was added to a dry diet in a 1 : 1 ratio to form a 'slurry', there was a 0·13 proportional increase ($P < 0·05$) in food intake and a 0·11 increase ($P < 0·01$) in growth after weaning. In situations where the rate of water flow to the drinker in the bowl cannot be controlled, 'dry' single-space feeders may be more suited to weaner piglets as they appeared to reduce food wastage (a proportional improvement in food conversion ratio of 0·07) without a substantial decrease in performance.

Secondly, growing-finishing pigs have higher levels of voluntary food intake and water intake than weaned piglets. Given that the rate of water flow in our study was the same as that used in the work of Payne (1991), since both experiments were conducted in the same piggery, the larger pigs may have been able to cope with the higher rate of water flow than the piglets used in this experiment. Alternatively, older pigs are accustomed to novel methods of food presentation and dry food whereas newly weaned piglets must, for the first time, make psychological adaptations to the unfamiliar presentation and different sensory perceptions associated with eating dry food and drinking water.

Although quantitative estimates of aggressive behaviour were not made in this study, the mixing of non-littermate piglets caused vigorous fighting in the first few hours after weaning and occasional fights were still observed after 48 h. As anticipated, no fighting was seen in groups of piglets weaned as littermates. Piglets mixed together from three different litters at weaning grew proportionately 0·34 faster ($P = 0·010$) in the first 14 days after weaning than piglets weaned as littermates. This initial difference resulted in a 0·14 proportional increase in growth rate from day 1 to 28 (385 *v.* 339 g/day, $P < 0·001$). Piglets mixed at weaning consumed more food than piglets weaned as entire litters (range 0·06 to 0·16), but statistical significance was found only in the 2nd week after weaning. Food conversion ratio did not differ between mixing treatments over the 28-day period of the study ($P > 0·05$), although the ratio was proportionately 0·19 higher (1·9 *v.* 1·6, $P = 0·030$) in the first 7 days after weaning for piglets weaned as litters (Table 2). There were no significant interactions between feeder design and the method of allocating piglets to weaner groups at weaning for growth rate, apparent voluntary food intake and the conversion of apparent voluntary food intake to live-weight gain. Furthermore, our results suggest that time spent feeding was not increased by the use of single-space feeders provided with 'blinkers' to reduce aggression at the feeder. Although quantitative estimates of aggressive behaviour were not made, it was evident that any reduction in fighting that may have occurred as a result of using single-space feeders was of a magnitude too insignificant to augment food intake.

The unexpected result in this study was the 0·08 proportional reduction in apparent voluntary food intake per pen (569 *v.* 616 g/day, $P = 0·141$) in piglets weaned as littermates compared with those mixed at weaning. This caused a lower growth rate (339 *v.* 385 g/day, $P < 0·001$) and a reduction in live weight of 0·7 kg ($P = 0·027$) at 56 days of age. This outcome contrasts with the comments of McGlone (1986) who studied the behaviour of piglets for 48 h after weaning, in the presence or absence of food and water, and concluded that piglets do not fight for the control of these resources but for their position in the dominance hierarchy. McGlone (1986) did not continue his studies beyond 48 h, but it is possible that effects on performance are the consequence of the less intense, chronic aggression and competition for food once the social order is established.

This increase in growth that occurred when piglets were mixed at weaning differs from previous reports

in the literature showing that mixing of previously unacquainted piglets at weaning either decreases growth, food intake and/or food : gain ratio (Teague and Grifo, 1961; cited by Friend, Knabe and Tanksley, 1983; McGlone and Curtis, 1985; Björk, 1989, Rundgren and Löfquist, 1989) or has no effect on performance after weaning (Hines and Thulan, 1979; cited by McConnell, Eargle and Waldorf, 1987; Friend *et al.*, 1983; Gonyou, Rohde and Echeverri, 1986; Blackshaw, Bodero and Blackshaw, 1987; McConnell *et al.*, 1987; McGlone, Stansbury and Tribble, 1987). The failure to detect an interaction between the multi-space feeder and the method of allocating piglets at weaning suggests that reducing psychological stress at weaning by grouping piglets as littermates did not increase the amount of time piglets spent eating, but may have actually decreased the duration of feeding. A possible explanation for this finding comes from the work of Algers, Jensen and Steinwall (1990) who examined relationships between weight change and behaviour after weaning. At weaning piglets from different litters were mixed together and, in the week after weaning, those gaining more weight were found to be the most aggressive, while piglets gaining least eight were submissive. These findings suggest that promoting aggression within a pen by mixing unfamiliar piglets may, in fact, cause an increase in food intake. This could occur by one, or both, of two mechanisms. First, stimulation of the adrenal gland to release catecholamines and glucocorticoids is reduced in dominant pigs of the social hierarchy (McGlone, 1984; Fitko, Kowalski and Zielinski, 1992) following mixing. These pigs may, in turn, suffer less from the stress-induced suppression of feeding (Vergoni, Poggioli, Marrama and Bertolini, 1990) and therefore eat more food after weaning than subordinate pigs. The increase in food intake of dominant pigs (relative to that of the submissive pigs) may be greater than that in pigs that do not fight at all and effect an increase in overall food intake. Second, Baxter (1991) suggested that reducing aggression in a group of pigs may decrease food intake because it inadvertently reduces the level of social interaction, or social facilitation, in a pen. The corollary to this is that in pens of pigs displaying more aggression where a dominance hierarchy has been formed, food intake increases. For example, Hsia and Wood-Gush (1982) studied the feeding behaviour of a previously satiated pig following the introduction of a hungry pig. If the satiated pig was the dominant of the two it fed for about 2 min out of the 10-min test period, whereas if it was subordinate then it did not continue to feed for more than a few seconds. Since no fighting was observed between littermate piglets after weaning in this study, it is possible that reducing psychological stress decreased performance because pigs failed to interact with each other. In this regard the formation of a social hierarchy after weaning may promote social facilitation of feeding (Hsia and Wood-Gush, 1983). Clearly further research is required to elucidate these propositions, and evidence to support this notion in weaner pigs is equivocal since McConnell *et al.* (1987) found no production differences between piglets kept as littermates or those mixed at weaning, and McGlone (1986) commented that pigs do not fight after weaning for the control of food and water, even when supplied in restricted quantities. Our results clearly show that (a) 'wet and dry' or 'dry' single-space feeders offer no production advantage over a conventional multi-space feeder for weaner piglets, and (b) mixing previously unacquainted piglets at weaning promoted increases in voluntary food intake and live-weight gain in the 4 weeks following weaning. We suggest that this unexpected result may be related to dominance/subordination relationships within a pen of piglets and/or social facilitation of feeding, and warrants further research.

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