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Effect of Nursing Frequency and Creep Feed Provision on the Milk and Feed Intake and Performance of Zero Day Weaned Piglets Reared on a Dummy Sow

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ABSTRACT : One hundred and forty-four piglets with an average birth weight of 1,672±13.4 g were used to evaluate different feeding strategies for piglets reared from birth on a dummy sow. A 3×2 factorial experiment compared three nursing frequencies (1, 3 or 6 h intervals) and two feeding regimes (milk only, or milk combined with access to creep feed and water). The piglets which were nursed at one hour intervals had the lightest body weights at all days, and the poorest combined milk and creep feed dry matter conversion efficiency to piglet body weight gain in the second week. Piglets which were nursed at 3 h intervals had the heaviest body weight at day 15 and 22, but those nursed at 6 h intervals achieved similar body weight by days 29 (milk withdrawal) and 36. Piglets offered creep feed were observed to wean themselves before cessation of milk availability, and the timing of this self-weaning depended on the nursing frequency. The piglets nursed at one hour intervals weaned themselves between day 22 and day 29, those nursed at 3 h intervals weaned themselves between day 15 and day 22, whilst those nursed at 6 h intervals weaned themselves between day 8 and day 15. The piglets which were nursed at 6 h intervals had the highest total dry matter intake in weeks 3 and 4 when fed with milk, creep feed and water but not when fed milk only. They consequently had the poorest dry matter conversion efficiency in the fourth week and overall when fed with milk, creep feed and water, but not when fed milk only. It is concluded that the optimal management routine under these conditions is a 3 h nursing cycle with provision of supplementary creep feed and water. (**Key Words :** Zero Day Weaning, Piglet, Nursing Frequency, Creep Feed)

INTRODUCTION

There are a number of situations which might require artificial rearing of piglets. For whole litters, these include circumstances where the sow dies after farrowing or shows agalactia. There are also increasing situations in which individual piglets are unable to obtain sufficient milk if left in their natal litters, as a result of selection for hyperprolificacy in sows and the consequence of litter sizes which exceed functional teat numbers. As hyperprolificacy becomes standard within herds, the scope for cross-fostering to alleviate such problems is often insufficient. It is therefore important to develop viable alternative methods for artificial rearing of piglets which would otherwise starve.

Suckling piglet performance usually depends mainly on the quantity of milk production, provided that no other health or management problems intervene. Natural milk composition is about 17-33% of dry matter content (Bowland, 1966), and the natural nursing interval of litters varies from about 44 minutes to 58 minutes for the 1st to 6th weeks of lactation respectively (Hartman et al., 1962). However, these has been little study of the optimum frequently and amount of milk which should be provided in situations of artificial rearing. The purpose of the present study was therefore to evaluate different feeding regimes for situations where piglets need to be artificially reared from birth. Such studies also provide insight into the factors which influence the transition from milk to solid feed intake in the piglet, and might assist in the development of better weaning strategies under normal nursing conditions.

MATERIALS AND METHODS

One hundred forty-four LYD piglets with an average of birth weight of 1672±13.4 g were purchased from the same

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farm and moved within 2-3 h after birth to an artificial rearing facility. This comprised three individual controlled-environment chambers, each containing an automatic dummy sow. Each chamber was 8 m wide, 7.5 m long and 3.5 m high, with a 7.5 Horse Power cooling compressor and 5,000 Watt heater. A digital temperature controller was used to keep the environmental temperature constant, and fully insulated walls, roof and floor reduced the heat loss. The sensitivity of the temperature control was ±0.1°C and the air movement was 0.1 m/s. 16×40 Watt fluorescent lights were used as the light source, and were controlled by a 24 h timer switch. The room temperature for piglets were 30, 28, 26, 24, and 24°C for 1, 2, 3, 4, and 5 weeks respectively. The Nursing dummy sow (Jen-Wan Co. Ltd., Taiwan), included a milk tank with temperature controlled water bath, an automatic on/off valve, two separate 0.5 inch diameter milk tubes with seven silicone baby teats on each, a motor-controlled up and down udder box with seven polymer rubber udder partitions on each side, a cassette player and a twenty-four hour timer controller. When the timer reached a set point, the udder box went down, the automatic valve opened the milk line and the radio cassette played a tape of sow nursing grunts. The nursing period was a minimum of 10 minutes each time, and the milking frequency could be set for any time in 24 h. The dummy sow lay between two adjacent pens, allowing two experimental litters to be nursed at the same time.

The experimental design was a 3×2 factorial comparing three nursing frequencies (1, 3 or 6 h intervals) and two feeding regimes (milk only, or milk combined with access to creep feed and water). A commercial creep feed was used and a bowl drinker hung on the dividing side gate for the treatments with the supplementary creep feed and water. At the end of day 29, all the piglets were weaned by removing the milk and teats. Creep feed and water were then given to all piglets, including those on the treatments not previously providing them.

The six treatment combinations were replicated four times. For each replicate, 36 newborn piglets, with 18 males and 18 females, were selected at birth from six sows. Each experimental litter had six piglets, 3 male and 3 female, each coming from a different mother. After selection, the experimental litters were moved directly to the chambers for weighing, identification and regrouping. Two hours later, all piglets were first trained to suck from the dummy sow. At training, the mouth of each piglets was opened and pushed onto the teat, waiting for 15-20 swallows. After the training, the udder box was left in the low position for 20 minutes, however, the valve of the milk line was closed. Thus, the piglets were given the chance to make contact with the udder and get accustomed to the dummy sow, without getting too much milk. The piglets were trained for three days, and the training frequency was the same as the experimental design for the nursing frequency.

To maintain hygiene in the feeding system, an acid and sterilizing liquid, sold for use in cattle milking systems, were use to clean the milk tank, milk line, teats, udder box and floor every day. During this period, the piglets were moved to an adjacent pen for 30 minutes until the pen and equipment were dry. Fresh milk was mixed every six hours, and any leftover milk was removed and discarded. The milk was reconstituted from a full cream milk powder for humans (OAK regular full cream milk powder, Hunter OAK Industries Company Pty. Ltd., Queensland, Australia). The milk powder contained 26.2% milk fat, 27% protein, 38% lactose, 6% minerals and 5% moisture. The energy level was 20.75 kJ/g. The water temperature was 65-70°C. The milk powder to water ratio was 305/695 in weight, and the fat content of the mixed milk was therefore 8% for all treatments until weaning. The drinking system was a bowl drinker, which connected to an individual water tank. The water consumption was measured by weighing water into the filling tank and "wasted" water which was collected in a tray under the pens. The treatments that were designated to receive creep feed, were offered *ad libitum* an 18% CP concentrate diet in broken pellet form. Fresh diet was given four times a day; leftover feed was removed every morning and discarded.

The body weight of each piglet was measured at day 1, 8, 15, 22, 29 and 36. The milk consumption was also measured for each piglet during three consecutive sucklings on days 8, 15, 22 and 29 by using the weigh-suckle-weigh technique. Piglets were weighed and put into an individual bucket 1 minute before suckling; soon after suckling, the piglets were put back into their own bucket for weighing. The total amount of creep feed consumption was measured weekly from day 4 to day 36.

The GLM procedure of SAS was used to perform statistical analyses (SAS, 2004). Data were analyzed by analysis of variance with litter as the experimental unit. The factors included in the analysis were nursing frequency, creep feed provision and week, and their interactions. For investigation of the effects of sex, comparison of the male and female piglets within the litter was made by analysis of variance, incorporating the effects of nursing frequency, creep feed provision and their interactions.

RESULTS

Overall performance of the piglets reared by the dummy sow was comparable to natural rearing. Piglets were weaned at 29 days old, with an average body weight of 7,505±86.2 mg, and the body weight gain during one week post-weaning was 2,560±103.0 mg.

Table 1 shows the means of the body weight at different weeks, for each of the treatments. As can be seen, piglets

Table 1. The means of the average body weight at different ages for different nursing frequencies and feeding regimes

Item	Milk			Milk & feed & water			SED	Sig. of		
	1 h	3 h	6 h	1 h	3 h	6 h		Freq	Fed	Freq×fed
Av. initial body weight (g)	1,655	1,672	1,711	1,671	1,645	1,682	46.7	ns	ns	ns
Av. body weight at day 8 (g)	1,920	2,372	2,355	1,907	2,439	2,336	58.2	***	ns	ns
Av. body weight at day 15 (g)	2,261	3,511	3,266	2,291	3,683	3,489	62.4	***	***	ns
Av. body weight at day 22 (g)	3,438^{d}	4,981^{b}	4,360^{c}	3,524^{d}	5,464^{a}	5,422^{a}	68.0	***	***	***
Av. body weight at day 29 (g)	6,251^{e}	7,711^{b}	7,003^{c}	6,590^{d}	8,662^{a}	8,817^{a}	94.1	***	***	***
Av. body weight at day 36 (g)	7,309^{e}	9,111^{c}	8,586^{d}	10,282^{b}	12,473^{a}	12,633^{a}	115.9	***	***	***

Sampled from 24 litters' data with 3 nursing frequencies and 2 feeding regimes, with 4 litters in each treatment and three female and three male LYD piglets in a litter.
Freq = Nursing frequency; Fed = Feeding regime. SED = Standard error of the difference between two means.
Means with the same letter are not significantly different. Sig.: ns = p>0.05; *** p<0.001.

were selected from the same pool with a similar initial body weight. The piglets which were nursed at one hour intervals had the lightest body weights at all subsequent days. Piglets which were nursed at 3 h and 6 h intervals had a similar, heavier body weight at day 8. Piglets which were nursed at 3 h intervals then had the heaviest body weight at day 15 and 22, before 6 h piglets re-established parity on days 29 and 36. Provision of creep feed increased piglet body weight from day 15 onwards. There was no significant interaction between nursing interval and feeding regime in the average body weight until day 22, after which piglets nursed at 6 h intervals had a lighter weight than those nursed at 3 h intervals when fed milk only, but had a similar weight when creep feed has available.

The average body weight gain is shown in Table 2. The piglets which were nursed at one hour intervals gained the least body weight in the first three weeks, and also in the week after milk withdrawal. Creep feed provision increased weight gain in all weeks after the first, and there were significant interaction effects between nursing interval and feeding regime in all weeks. The piglets which were nursed at 6 h intervals had a lower weigh gain in weeks 2-4 than those nursed at 3 h intervals when fed only milk, but not when also given creep feed and water.

Table 3 shows the means of the average milk intake per suckling at different ages for different nursing frequencies

Table 2. The means of the average body weight gain at different ages for different nursing frequencies and feeding regimes

Item	Milk			Milk & feed & water			SED	Sig. of		
	1 h	3 h	6 h	1 h	3 h	6 h		Freq	Fed	Freq×fed
1st week body weight gain (g)	265^{e}	700^{bc}	644^{cd}	237^{e}	794^{a}	654^{bcd}	26.2	***	ns	***
2nd week body weight gain (g)	342^{e}	1,139^{b}	911^{c}	384^{d}	1245^{a}	1,153^{b}	19.9	***	***	***
3rd week body weight gain (g)	1,177^{e}	1,470^{c}	1,094^{f}	1,233^{d}	1,781^{b}	1,933^{a}	23.4	***	***	***
4th week body weight gain (g)	2,813^{de}	2,730^{def}	2,643^{ef}	3,066^{c}	3,198^{b}	3,396^{a}	61.3	ns	***	***
5th week body weight gain (g)	1,058^{e}	1,400^{d}	1,582^{c}	3,692^{b}	3,810^{a}	3,816^{a}	40.8	***	***	***

Sampled from 24 litters' data with 3 nursing frequencies and 2 feeding regimes, with 4 litters in each treatment and three female and three male LYD piglets in a litter.
Freq = Nursing frequency; Fed = Feeding regime. SED = Standard error of the difference between two means.
Means with the same letter are not significantly different. Sig.: ns = p>0.05; *** p<0.001.

Table 3. The means of the average milk intake per suckling at different ages for different nursing frequencies and feeding regimes

Item	Milk			Milk & feed & water			SED	Sig. of		
	1 h	3 h	6 h	1 h	3 h	6 h		Freq	Fed	Freq×fed
Av. milk intake at day 8 (g/suckle)	24.0	61.8	135.8	26.4	67.2	138.0	2.29	***	*	ns
Av. milk intake at day 15 (g/suckle)	18.9^{d}	78.0^{b}	147.7^{a}	21.8^{d}	61.3^{c}	0^{e}	1.74	***	***	***
Av. milk intake at day 22 (g/suckle)	29.7^{c}	77.8^{b}	151^{a}	23.7^{d}	0^{e}	0^{e}	1.67	***	***	***
Av. milk intake at day 29 (g/suckle)	52.6^{c}	167.1^{b}	302.5^{a}	0^{d}	0^{d}	0^{d}	2.16	***	***	***

Sampled from 24 litters' data with 3 nursing frequencies and 2 feeding regimes, with 4 litters in each treatment and three female and three male LYD piglets in a litter.
Freq = Nursing frequency; Fed = Feeding regime.
SED = Standard error of the difference between two means; Means with the same letter are not significantly different.
Sig.: ns = p>0.05; * p<0.05; *** p<0.001.

Table 4. The means of the average milk intake in 24 h at different ages for different nursing frequencies and feeding regimes

Item	Milk			Milk & feed & water			SED	Sig. of		
	1 h	3 h	6 h	1 h	3 h	6 h		Freq	Fed	Freq×fed
Milk intake at day 8 (g/d)	577	495	543	634	537	552	21.8	***	**	ns
Milk intake at day 15 (g/d)	454^{c}	624^{a}	519^{a}	523^{b}	490^{b}	0^{d}	17.1	***	***	***
Milk intake at day 22 (g/d)	712^{a}	622^{bc}	604^{bcd}	569^{bd}	0^{e}	0^{e}	22.3	***	***	***
Milk intake at day 29 (g/d)	1,262^{bc}	1,337^{a}	1,210^{c}	0^{d}	0^{d}	0^{d}	18.5	***	***	***

Sampled from 24 litters' data with 3 nursing frequencies and 2 feeding regimes, with 4 litters in each treatment and three female and three male LYD piglets in a litter.
Freq = Nursing frequency; Fed = Feeding regime.
SED = Standard error of the difference between two means; Means with the same letter are not significantly different.
Sig.: ns = p>0.05; ** p<0.01; *** p<0.001.

and feeding regimes, and Table 4 shows the means of the average milk intake in 24 h at different ages, extrapolated from the average milk intake per suckling. Whilst piglets offered only milk increased their intake over time, those offered supplementary creep feed consumed less milk after the first week and were all observed to wean themselves in the experiment. However, the timing of this self-weaning depended on the nursing frequency. The piglets that were fed with milk, creep feed and water and nursed at one hour intervals, weaned themselves between day 22 and day 29. Those nursed at 3 h intervals weaned themselves between day 15 and day 22, and those nursed at 6 h intervals, weaned themselves between day 8 and day 15.

Table 5 shows the average total of milk plus creep feed dry matter intake at different ages for different nursing frequencies and feeding regimes. The dry matter of milk and feed were 29.0% and 90.0%, respectively. The total milk intake for each week was calculated as the mean of the measured intakes on the first and last days, times 7, whilst the total creep feed intake was measured directly. There may thus have been some error for the total milk intake. There were significant interaction effects between nursing interval and feeding regime from the second week of age in dry matter intake. The piglets which were nursed at 6 h intervals had the highest amount of dry matter intake in weeks 3, 4 and 2-4 when fed with milk, creep feed and water but not when fed milk only.

The combined milk and creep feed dry matter conversion efficiency to piglet body weight gain is shown in Table 6. The piglets which were nursed at 1 h intervals had poorer dry matter conversion efficiency in the second week when fed by both feeding regimes. The piglets which were nursed at 3 h intervals had better dry matter conversion efficiency in the third week when fed by both feeding regimes. The piglets which were nursed at 6 hour intervals had worse dry matter conversion efficiency in the fourth week and overall when fed with milk, creep feed and water, but not when fed milk only.

Table 7 shows the average total creep feed intake in the first week after weaning for different nursing frequencies and feeding regimes. Piglets which had not previously received creep feed ate less after weaning. There was an

Table 5. The means of the total milk plus creep feed dry matter intake at different weeks of age for different nursing frequencies and feeding regimes

Item	Milk			Milk & feed & water			SED	Sig. of		
	1 h	3 h	6 h	1 h	3 h	6 h		Freq	Fed	Freq×fed
2nd week milk dry matter intake (g)	1,046^{b}	1,135^{a}	1,150^{a}	1,173^{a}	1,043^{b}	0^{c}	29.3	***	***	***
3rd week milk dry matter intake (g)	1,182^{abc}	1,264^{ab}	1,212^{abc}	1,107^{bc}	0^{d}	0^{d}	53.9	***	***	***
4th week milk dry matter intake (g)	2,002^{a}	1,987^{a}	1,840^{b}	0^{c}	0^{c}	0^{c}	40.9	*	***	*
1st week feed dry matter intake (g)	0	0	0	69	169	424	-	-	-	-
2nd week feed dry matter intake (g)	0	0	0	195	1,022	1,425	-	-	-	-
3rd week feed dry matter intake (g)	0	0	0	1,150	2,205	2,819	-	-	-	-
4th week feed dry matter intake (g)	0	0	0	2,726	4,013	4,733	-	-	-	-
2nd week milk and feed dry matter intake (g)	1,046^{d}	1,135^{c}	1,150^{c}	1,369^{b}	2,065^{a}	1,425^{b}	67.7	***	***	***
3rd week milk and feed dry matter intake (g)	1,182^{c}	1,264^{c}	1,212^{c}	2,257^{b}	2,205^{b}	2,819^{a}	86.0	***	***	***
4th week milk and feed dry matter intake (g)	2,002^{d}	1,987^{d}	1,840^{d}	2,726^{c}	4,013^{b}	4,733^{a}	120.1	***	***	***
2nd to 4th week milk and feed dry intake (g)	4,230^{d}	4,386^{d}	4,202^{d}	6,352^{c}	8,283^{b}	8,978^{a}	246.5	***	***	***

Sampled from 24 litters' data with 3 nursing frequencies and 2 feeding regimes, of which 4 litters in each treatment and three female and three male LYD piglets in a litter (n = 4).
Freq = Nursing frequency; Fed = Feeding regime. SED = Standard error of the difference between two means.
Means with the same letter are not significantly different. Sig.: * p<0.05; *** p<0.001.

Table 6. The means of the milk plus creep feed dry matter conversion efficiency in different weeks of age for different nursing frequencies and feeding regimes

Item	Milk			Milk & Feed & Water			SED	Sig. of		
	1 h	3 h	6 h	1 h	3 h	6 h		Freq	Fed	Freq×fed
2nd week milk and feed dry matter conversion efficiency	3.09^{b}	1.00^{d}	1.26^{d}	3.57^{a}	1.66^{c}	1.23^{d}	0.133	***	***	**
3rd week milk and feed dry matter conversion efficiency	1.01^{de}	0.86^{e}	1.11^{cd}	1.83^{a}	1.24^{c}	1.46^{b}	0.068	***	***	***
4th week milk and feed dry matter conversion efficiency	0.71^{d}	0.73^{d}	0.70^{d}	0.89^{c}	1.25^{b}	1.39^{a}	0.039	***	***	***
2nd to 4th week milk and feed dry matter conversion efficiency	1.29^{b}	1.05^{d}	1.15^{c}	0.87^{e}	1.16^{c}	1.38^{a}	0.040	***	ns	***

Sampled from 24 litters' data with 3 nursing frequencies and 2 feeding regimes, of which 4 litters in each treatment and three female and three male LYD piglets in a litter (n = 4).
Freq = Nursing frequency; Fed = Feeding regime. SED = Standard error of the difference between two means.
Means with the same letter are not significantly different. Sig.: ns = p>0.05; ** p<0.01; *** p<0.001.

interaction between feeding regime and nursing frequency, whereby the piglets nursed at 1 h intervals ate least creep feed after weaning when fed with milk only before weaning, but not when they had experienced creep feed during lactation.

DISCUSSION

The experiment demonstrated that it was feasible to rear piglets artificially from birth, and to achieve acceptable health and growth in these animals. However, there were marked differences in the early performance of these piglets depending on the feeding regime they experienced. Once cyclical suckling is established in piglets, the regular intervals under natural conditions range from 21-96 minutes in 1 to 51 days of lactation (Barber et al., 1955; Ellendorf et al., 1982; Newberry and Wood-Gush, 1984; Auldist and King, 1995; Arey and Sancha, 1996; Wechsler and Brodmann, 1996; Spinka et al., 1997). It is therefore surprising that in this experiment the piglets which were nursed at one hour intervals had the lightest body weight from day 8 onwards. This may have been because the piglets were nursed in a nearly *ad libitum* situation, rather than receiving a very transient period of milk ejection, and at 1 h intervals seemed not hungry enough to have another suckling. There is also the possibility that too much milk may have reduced the HC1 concentration in the stomach, and therefore reduced the utilization of the milk (Cranwell, 1985). The poor DM conversion efficiency of 1 h piglets in the first weeks may support this. Furthermore, during the training procedure, the piglets which were nursed at 1 h intervals had some diarrhea problems, but these were not seen at 3 and 6 h intervals. As they became older, the milk utilization of the 1 h piglets improved and matched that of the other treatments. In the fourth and fifth weeks, all the piglets gained the same body weight, however, the piglets which were nursed at one hour intervals were still lighter and did not compensate for the lower growth before day 22.

As might be expected, the 1 hour interval piglets which sucked milk more often had a higher daily milk intake at day 8, 15 and 22. As nursing frequency decreased, the intake per meal increased and, in the case of piglets fed milk only, they achieved full compensation for the reduced feeding frequency. However, 6 h interval piglets consumed less and less milk as they become older. This was attributable only to those piglets given creep feed; when this was not available, the milk intake of 6 h interval piglets was as high as all other groups. It therefore seems that although the piglets had the ability to compensate for reduced nursing frequency, when alternative food was available they chose not to do so. Piglets with less frequently available milk, even though not limited in amount, compensated from an early age by eating more creep feed.

Providing creep feed and water did not improve the piglets' body weight at day 8 and day 15, however, these piglets had a heavier body weight at days 22, 29 and one

Table 7. The means of the average total creep feed intake in the first week post-weaning for different nursing frequencies and feeding regimes

Item	Milk			Milk & Feed & Water			SED	Sig. of		
	1 h	3 h	6 h	1 h	3 h	6 h		Freq	Fed	Freq×fed
5th week total creep feed intake (g/piglet)	2,294^{e}	2,940^{d}	3,078^{d}	6,094^{ac}	5,623^{bc}	5,887^{abc}	142.2	*	***	***
Feed conversion efficiency in one week post-weaning	2.17^{a}	2.10^{a}	1.95^{b}	1.65^{c}	1.48^{d}	1.54^{d}	0.037	***	***	**

Sampled from 24 litters' data with 3 nursing frequencies and 2 feeding regimes, with 4 litters in each treatment and three female and three male LYD piglets in a litter.
Freq = Nursing frequency; Fed = Feeding regime. SED = Standard error of the difference between two means.
Means with the same letter are not significantly different. Sig.: * p<0.05; ** p<0.01; *** p<0.001.

week post-weaning. This may be because the piglets did not effectively develop the digestive system to cope with the different form of energy and protein presented by the creep feed ingredients before 3 weeks of age (Sangild et al., 1991; Sangild, 1993). By the second week, the total dry matter intake of piglets offered creep feed and water exceeded that of piglets fed milk only, and the differential increased with time. However, the DM conversion efficiency was poorer throughout lactation. This indicated that although the piglets developed the ability to digest increasing amounts of solid feed, it was still an inferior nutrient source to the artificial milk. It is known that the digestibility of milk products exceeds that of the vegetable based ingredients typically incorporated in compound pig feeds (Braude and Newport, 1977).

Providing creep feed and water during lactation depressed milk intake. It was clearly shown that both the milk intake per suckling and the total milk intake in 24 h were getting less and less each week when the piglets were provided with creep feed and water. All of the piglets offered creep feed weaned themselves prematurely by ceasing to take milk from the dummy sow, even though it continued to be on offer. This is a surprising result since, as already discussed, the milk was a superior source of nutrients to the creep feed. It is known that natural weaning occurs as a result of a gradual decrease in suckling frequency, which stimulates the piglets to seek out and ingest other food sources (Edwards, 1987; Bøe, 1991; Jensen and Stangel, 1992). However, in this case the reduction in frequency is imposed by changes in the willingness of the sow to nurse, and the amount of milk which the piglets can obtain is limited by factors outside their control. This was not true for the dummy sow, where *ad libitum* milk was available at each nursing. It therefore seems that it is nursing frequency, rather than milk availability, which triggers the behavioral changes in the piglets which result in weaning.

The age at which self-weaning occurred depended on the nursing frequency- the greater the interval between nursings, the younger the piglets were at self-weaning. Piglets on the 6 h nursing interval had already weaned themselves before 2 weeks of age. These piglets were already consuming a significant amount of creep feed within the first week of life; much more than reported for piglets suckling the sow (Okai et al., 1976; Aherne et al., 1982; Barnett et al., 1989; de Passillé et al., 1989; Gatel and Guion, 1990; Pajor et al., 1991; Appleby et al., 1992; Pluske, 1993). Despite failing to take any milk, their total dry matter intake exceeded that of the milk only piglets throughout lactation. However, the time of weaning did not seem to be regulated by a critical level of solid food intake, since piglets on the different nursing frequencies were eating very different amounts of solid feed at the time self-weaning occurred.

Access to the solid food during lactation gave the benefit of improved solid food intake after weaning. The piglets which were fed with milk only, had dramatically lower body weight gain in the first week post-weaning. This was a consequence of the much lower intake of previously unfamiliar solid food. Such an effect may reflect unfamiliarity with the solid feed as a source of nutrients, and/or the absence of previously induced enzymes to efficiently digest its ingredients. For example, several studies have shown that the provision of solid food containing complex carbohydrates to suckling piglets increases acid and pepsin secretion in the stomach (Cranwell, 1977, 1985; Cranwell and Stuart, 1984) and activity of some stomach and pancreatic enzymes (Friend et al., 1970; Corring et al., 1978; Corring, 1980; de Passillé et al., 1989). This latter effect may have contributed to the poorer feed conversion ratio which was seen in these pigs, although much of this will be explained by their lower growth rate relative to their maintenance requirement. In naturally suckling piglets, the effect of offering creep feed during lactation on weaning weight and post weaning performance has varied between experiments. Evidence to support the notion that supplying pigs with creep food during lactation will increase weaning weight is equivocal. Friend et al. (1970) observed a significant increase between 21 and 35 days of age in the daily gain of pigs offered creep from 7 days of age, a result supported by Aherne et al. (1982) who found an increase in weaning weight at 5 weeks of age of 0.8 kg for litters offered creep food. In contrast Okai et al. (1976) reported that piglets fed creep food and weaned at 3 or 5 weeks of age did not have a higher weaning weight, whilst Hampson and Kidder (1986) found no difference in weaning weight at 21 days of age between sow-suckled piglets and those offered creep feed from 10 days of age. Effects of prior experience of creep feed on post weaning growth are equally inconsistent (Pluske et al., 1995), although experiments under natural suckling conditions seldom show the premature self-weaning seen in this experiment.

It can therefore be concluded that the optimal management routine under the artificial rearing conditions applied in this experiment is a 3 h nursing cycle with provision of supplementary creep feed and water. With careful attention to piglet training, feed management and hygiene, it is possible to artificially rear piglets from birth and to achieve successful growth and transition to solid food.

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