RESEARCH REPORT
ANIMAL WELFARE

Title: How does drinking behavior influence feed intake and the development of behavior problems in newly weaned piglets? **NPB # 05-052**

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ABSTRACT

During the first few days after weaning, pigs often experience weight loss, which may be partly due to their substitution of drinking for feeding. Using drinker devices other than the standard nipple drinker may ease piglets' transition at weaning by facilitating initiation of feeding and preventing the development of behavior problems such as belly nosing. Two experiments were run to determine the effect of drinker type on water and food intake, growth rates and belly-nosing and to determine piglets' drinker preference at two different weaning ages. In the first experiment, piglets were given one of three drinkers (standard nipple, push-lever bowl or a float bowl), and their growth and behavior was examined through two weeks. When given only the nipple drinker, piglets wasted significant amounts of water. With only the float bowl drinker, water consumption was limited due to soiled water. With only the push-lever drinker, piglets consumed adequate amounts of water and spent less time belly nosing than other piglets. There was no effect of drinker type on growth rates.

In the second experiment, piglets were weaned at either 20 or 28 days of age and given access to all three drinker devices. Their preference for a drinker type and the influence of their preference on production and behavior was examined. Piglets at both weaning ages spent similar amounts of time at the nipple and push-lever drinkers during the first two days after weaning, while spending little time at the float bowl drinker. Younger weaned piglets that preferred the push-lever drinker gained more weight than those piglets that preferred the nipple drinker. Younger weaned piglets also spent more time at the push-lever drinker at days 8 and 9 after weaning than older weaned piglets. It appears that piglets are not averse to using the push-lever drinker at either weaning age, and this drinker device can minimize water wastage and behavior problems while not negatively affecting feed intake or growth rates.

INTRODUCTION

Drinker management is a mostly overlooked aspect of livestock production, even though water is the most important nutrient in an animal's diet. Studies in dairy cattle (Pinheiro Machado Filho et al., 2004) and horses (Nyman and Dahlborn, 2001) have examined animals' preferences for different drinker devices with the idea that the preferred drinking device will ensure proper fluid balance in the animal. Swine researchers have weaned pigs at four and five weeks of age and studied them for their drinker preferences (Phillips and Phillips, 1999; Horváth et al., 2000). However, past research shows that pigs weaned at earlier ages (three weeks of age and younger) often drink excessively (Fraser et al., 1990; Holub, 1991; Gonyou et al., 1998; Worobec et al., 1999) and show a delay in independent feeding following weaning (Bark et al., 1986; Metz and Gonyou, 1990). In addition, these young pigs are spending time at the feeder, but do not consume much feed, with the result being a vast discrepancy between feed intake and feeding duration (Bøe, 1993; Metz and Gonyou, 1990; Gonyou et al., 1998; Gardner et al., 2001; Torrey and Widowski, 2004), unlike pigs at any other stage of life, who generally have shown a strong relationship between feed intake and feeding behavior (Bigelow and Houpt, 1988). Therefore, preferences of older pigs for different drinker devices may not be relevant for the younger pig. In rat pups there is an age difference in ingestive behavior directed at different sources (review by Hall, 1990). It may be that piglets have different needs for oral-nasal outlets at different ages that correspond to developmental aspects of ingestive behavior.

Early weaning of piglets is also characterized by an increase in behavioral problems, specifically belly-nosing. Performance of belly-nosing has been negatively correlated with feed intake and postweaning average daily gains (Gonyou et al., 1998; Worobec et al., 1999; Straw and Bartlett, 2001). This suggests that there is, in fact, an interaction among the motivational systems for ingestive behavior that interfere with the piglet's ability to adapt to weaning. In previous studies in our laboratory, we have found that the presence of different drinker devices can result in different feed and water intake, and varying levels of belly-nosing (Torrey and Widowski, 2004). Piglets given access to a push lever bowl drinker, rather than a nipple drinker, performed significantly less belly-nosing while having higher feed intake during the first two days post-weaning, a critical period for early-weaned piglets (Torrey and Widowski, 2004). It appears then that piglets with nipple drinkers are spending more time drinking at the expense of eating. Since most piglets experience a growth check at weaning, the use of nipple drinkers may be exacerbating the problem by providing them with an easy outlet for oral behavior, resulting in gut-fill and a decreased motivation to feed. Therefore, drinker management in the young weaned pig may have important implications on initiation of feeding and the development of behavioral stereotypies. What was not determined in that study was whether the benefits derived from the push lever drinker were due to tactile stimulation of the snout by the surface of the drinker or to the oropharyngeal stimulation of ingesting water from a vessel. The same benefits may not hold true for other styles of bowl drinkers.

While a few studies have focused on different drinker devices for piglets, they have examined pens on a group basis (Phillips and Phillips, 1999; Horváth et al., 2000), measured only water usage and not water intake (Torrey and Widowski, 2004), used pigs at ages different from those of newly weaned pigs (Phillips and Fraser, 1991; Brumm et al., 2000), or housed piglets individually (Torrey and Widowski, 2006). Therefore, there is a gap in the knowledge of individual pig ingestive behavior immediately post-weaning. The objective of this study is to determine individual piglets' preferences for drinker devices when they are weaned at different ages, and the relationship between drinking and the onset of independent ingestion and abnormal oral-nasal behavior patterns. Two separate experiments were run to meet these objectives.

OBJECTIVES

1. To determine the impact of the different drinker devices on overall performance, water intake and belly nosing (Experiment 1)
2. To determine the preferred drinker style for piglets weaned at two different ages and to identify the relationships between a piglets' drinker preference and their initiation of feeding (Experiment 2)

MATERIALS AND METHODS

A. Experiment 1

The experiment followed a complete block design with three treatments (drinker devices) in each of six replicates (n = 18 pens). Within replicate, pens were blocked by weaning weight, litter and gender. In each replicate, 45 piglets were weaned at 18.1 ± 0.1 days of age into each of 3 pens (15 piglets/pen) containing one of three drinker devices: a standard nursery pig bite nipple drinker (S.M. Bauman Mfg., 3/8" stainless steel Piggy Drinker, Model XYZ, Wallenstein, ON, Canada; referred to as "nipple"), a stainless steel nursery push-lever bowl drinker (Drik-O-Mat® weaner bowl drinker Egebjerg, Hovedgade 27, Denmark; referred to as "push-lever bowl"), or a plastic automatic float bowl drinker (Jeffers Pets, Auto-Wata® Automatic Waterer, 16-Al, Dothan, AL, USA; referred to as "float bowl"). The nipple and push-lever bowl drinkers were attached to the pen wall ca. 15 cm above the floor while the float bowl was at floor level. To eliminate pre-weaning drinking experience, all piglet-drinking devices were removed from farrowing crates. Sows were able to drink from nipple drinkers that were inaccessible to the piglets. Therefore, piglets only had access to drinkers post-weaning. At weaning, piglets were transferred from standard farrowing crates to an on-site nursery room containing eight raised-deck pens. Each nursery pen measured 1.2m x 2.4m and contained one drinker, two four-hole stainless steel feeders and one heating pad measuring 0.61m x 0.91m. Heating pads were placed at the front of the pens and were adjusted with rheostats to control temperature to meet the needs of the piglets. Lights remained on continuously to aid video-recording.

Pen feed intake was determined on a daily basis and was adjusted for the number of piglets in the pen (accounting for any mortality). Water usage was measured at each drinker using pre-calibrated ABB Positive Displacement Water Meters (C-700 Polymer). Piglet body weight was measured on the day of weaning and on days 7 and 14 after weaning. Average daily gain was calculated from the weight data. Mortality was recorded as it occurred throughout the experiment and feed and water intakes adjusted for the number of piglets per pen.

A digital recording system (Kodicom i31808WM, Toronto, ON, Canada) was used to video record the piglets' behavior at 30 frames per second. One camera per pen (Panasonic WV-CP240, Mississauga, ON, Canada) was mounted on the ceiling above the pens. Pens were continuously video recorded for forty-eight hours on days 9 and 10. Behavior was instantaneously scan sampled every 5 minutes from 0600-0800, 1200-1400 and 2000-2200 for lying, feeding, drinking, belly nosing, pen-mate directed nosing and other behavior.

B. Experiment 2

104 piglets from 21 litters were split-weaned at either 20 or 28 days of age into pens of 8 piglets over seven replicates. Each pen contained each of the three drinker devices described in Experiment 1. The positions of the drinkers relative to one another was varied and blocked across pens and ages. At each feeding and drinking bout, food and water intake were calculated. Drinkers were attached to digital water meters, which in turn were attached to a Hoboware data logger (Hoskin Scientific Limited, Hobo Weather Station, Burlington, ON) able to record minute changes in water (i.e., individual drinking bouts). To measure waste water, collection troughs were placed under the flooring below each drinker. The troughs were put on digital scales recording any changes in trough weight which reflected water wastage. The difference between the volumes of water dispensed and waste-water collected was used to determine daily water intake. Each pen was equipped with two single-piglet feeders (Single-door single-side Grow-Fast Hog Feeder (Nasco Farm and Ranch, Product Z29927N, Fort Atkinson, WI, USA), allowing two pigs to eat simultaneously.

The video recording system was the same as in Experiment 1. Pens were continuously video recorded for the forty-eight hours after weaning and again on days 8, 9 and 10. Piglets were individually identified by stripes dyed on their backs using black hair dye. All occurrences of feeding and drinking behavior were observed during the first forty-eight hours on a sub-sample of piglets (n = 22). On days 8-10, behavior of all piglets was instantaneously scan sampled every 5 minutes from 0600-0800, 1200-1400 and 2000-2200 for lying, feeding, drinking, belly nosing, pen-mate directed nosing and other behavior.

RESULTS

A. Experiment 1: Performance with one drinker device

There was no difference between treatments in feed intake through the first forty-eight hours after weaning ($P = 0.79$) or overall ($P = 0.64$). Piglets with access to a float bowl drinker consumed 99 ± 13 g/pig/d during the first two days and 225 ± 13 g/pig/d overall. Those with a nipple drinker ate 103 ± 13 g/pig/d during the first two days and 230 ± 13 g/ pig/d through two weeks after weaning. With the push-lever drinker, piglets consumed 107 ± 13 g/pig/d during the first two days and 233 ± 13 g/pig/d overall. There was a significant effect of day on feed intake ($P < 0.0001$) but no interaction between treatment and day ($P = 0.99$).

There was a significant difference between treatments in water intake ($P < 0.0001$), with piglets given the float bowl consuming significantly less water than piglets with the other two drinker devices (float < nipple, $P < 0.0001$; float < push-lever, $P < 0.0001$) (Figure 1). There was also a significant difference in water wasted throughout the experiment ($P < 0.0001$). Piglets with the nipple drinker wasted more water than piglets with either the float bowl ($P < 0.0001$) or the push-lever bowl ($P < 0.0001$) (Figure 2). There was also a significant effect of day after weaning ($P < 0.0001$) and an interaction between drinker type and day ($P < 0.005$) (Figure 2).

Piglets weighed 5.80 ± 0.07 at weaning. There was no effect of treatment on body weights ($P = 0.43$) or average daily gain ($P = 0.16$). Piglets with nipple drinkers gained 85 ± 18 g/d during the first week and 228 ± 18 g/d during the second week. With push-lever bowls, piglets gained 80 ± 18 g/d and 243 ± 18 g/d during the first and second weeks respectively. Piglets with the float bowl gained 75 ± 18 g/d during the first week and 219 ± 18 g/d during the second week after weaning.

Drinker type influenced feeding behavior ($P = 0.022$) and had a tendency to influence drinking behavior ($P = 0.058$), belly nosing ($P = 0.099$), and all piglet directed behavior ($P = 0.055$) (Table 1). There was an effect of day on pen-mate directed nosing ($P < 0.001$) and drinking behavior ($P = 0.03$), but there were no interactions between drinker type and day for any behavior observed.

B. Experiment 2: Individual preference among the three drinker devices

Through the first forty-eight hours after weaning, there was no difference between the two weaning ages in time spent at any of the three drinker devices (push-lever: $P = 0.31$; nipple: $P = 0.69$; float: $P = 0.92$), nor was there a difference in time spent at the feeder ($P = 0.55$) (Table 2). Of the 22 piglets observed for individual behavior, 18 spent more than 50% of their drinking time at one drinker device (11 piglets preferred the nipple drinker, while 7 preferred the push-lever bowl drinker) (Table 3). The remaining four piglets did not have a clear preference for a drinker type. There was no difference in weaning weights between the piglets that preferred the nipple or push-lever drinker. However, there was a weaning age by drinker preference interaction ($P = 0.10$); piglets weaned at 20d of age grew faster when they preferred the push-lever bowl but those weaned at 28d of age grew faster when they preferred the nipple drinker (Table 3). In addition, piglets that preferred the push-lever drinker tended to spend more time at the feeder one day after weaning than those piglets that preferred the nipple drinker ($P = 0.06$) (Table 4)

On days 8 and 9 after weaning, piglets weaned at the two different ages differed in their time spent at the push-lever drinker ($P < 0.03$); piglets weaned at 20d of age spent twice as much time at this drinker than those weaned at 28d of age (Table 5). Younger weaned piglets also belly nosed more ($P < 0.07$) and spent less time lying ($P < 0.01$) than older weaned piglets (Table 5). There was no effect of piglet preference for drinker type during the first 48 hours on belly nosing ($P = 0.43$; push-lever preference: 1.3 ± 1.1% of time belly nosing; nipple preference: 2.4 ± 0.8% of time belly nosing).

Over the course of the experiment, piglets weaned at 20d of age consumed significantly less water than those weaned at 28d of age ($P < 0.001$; 20d: 360 ± 44 ml/pig/d; 28d: 590 ± 46 ml/pig/d). Younger weaned piglets also wasted significantly less water than older weaned piglets ($P < 0.001$; 20d: 300 ± 40 ml/pig/d; 28d: 498 ± 41 ml/pig/d). Piglets weaned at 20d of age consumed equal amounts of water from the nipple and push-

lever drinkers but wasted significantly more water from the nipple drinker ($P < 0.001$; Figure 3) (Because of the low volume of water used and consumed from the float bowl drinker, it was excluded from these analyses). Those weaned at 28d of age consumed and wasted more water from the nipple drinker ($P < 0.001$; Figure 4).

DISCUSSION

In the first experiment, drinker type significantly affected water consumption, water wastage and behavior in the newly weaned piglet. With the push-lever bowl and nipple drinkers, water consumption increased with time, reflective of increasing feed intake with age. Water consumption was significantly lower when piglets were given the float bowl drinker rather than the other drinker types, especially after the first two days. This result is not surprising since, even with daily cleanings, the float bowl drinker became soiled with urine and feces, and piglets will choose not to drink from an unclean drinker (Phillips and Phillips, 1999). Water wastage was significantly higher in pens with the nipple drinker than those with the other two drinkers and accounted for over half of the water used in those pens. However, this high rate of water wastage may be partly due to the high flow rate (1 L/min) used in this experiment, as increasing water flow rates for both weanling (Nienaber and Hahn, 1984) and growing pigs (Li et al., 2005) increases the water wastage to water usage ratio. There was also a significant effect of drinker type on belly nosing, with piglets given the push-lever drinker spending less time belly nosing than other piglets. This finding is similar to our previous study (Torrey and Widowski, 2004), and is further evidence that piglets derive tactile satisfaction from this style of drinker.

In our second experiment, we found that piglets weaned at 20d of age spent more time at the push-lever drinker than those weaned at 28d of age, and those that preferred the push-lever drinker spent more time at the feeder and grew better than other piglets.

When given three drinker devices, more piglets preferred the nipple drinker than the other drinkers, a result which agrees with our previous finding with individually-housed piglets (Torrey and Widowski, 2006), and may be because of the ease of use of the nipple drinkers. However, water wasted from the nipple drinker was significantly higher than that wasted from the other drinkers for all pigs, and, as in the first experiment, accounted for more than half the water used.

Piglets' age at weaning influenced drinking behavior and water intake at the different drinker devices through nine days after weaning. Piglets weaned at 28d of age consumed increasing amounts of water from the nipple drinker with time, while decreasing their water consumption from the push-lever drinker. Their water consumption from the nipple drinker appears to mimic their growth and feed intake, which agrees with the idea that older piglets perform most drinking around meal times (Kraly, 1984; Bigelow and Houpt, 1988). Piglets weaned at 20d of age consume similar amounts of water from both the nipple and push-lever drinkers, but appear to gradually increase their water consumption from the push-lever drinker. This gradual increase may be related to increasing feed intake or increasing motivation to perform belly nosing, which generally peaks between seven and ten days after weaning (Metz and Gonyou, 1990; Gardner et al., 2001). Regardless, younger weaned piglets appear to obtain more benefit from the push-lever drinker than those weaned at older ages, and this benefit does not carry over to other bowl style drinkers.

LAY INTERPRETATION

Drinker style affects multiple aspects of production and behavior of the newly weaned piglet. Nipple drinkers contribute to high levels of water wastage, regardless of weaning age. Float bowl drinkers limit water consumption due to soiled water, and result in higher levels of behavioral problems such as belly nosing. The push-lever drinker keeps water wastage in check while still ensuring that piglets consume adequate amounts of water. This style of drinker also appears to benefit younger weaned piglets through their initial feeding behavior and overall growth.

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Figure 1. Effect of drinker type on water intake through two weeks after weaning.

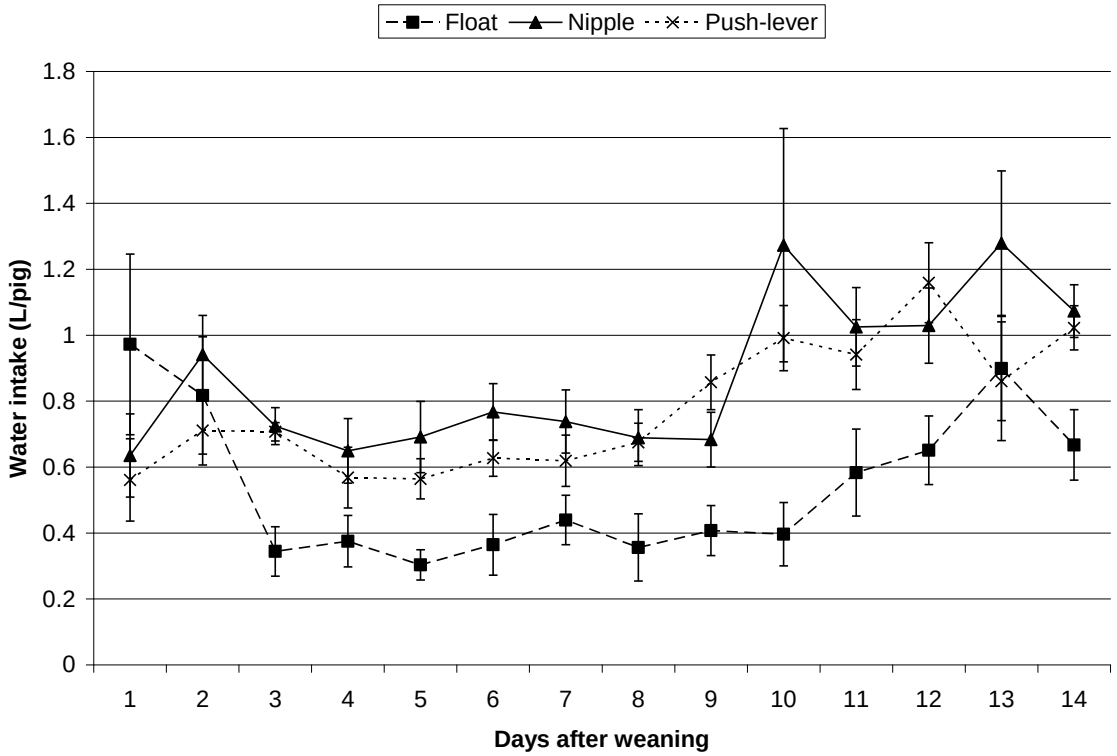

Figure 2. Effect of drinker type on water waste through two weeks after weaning.

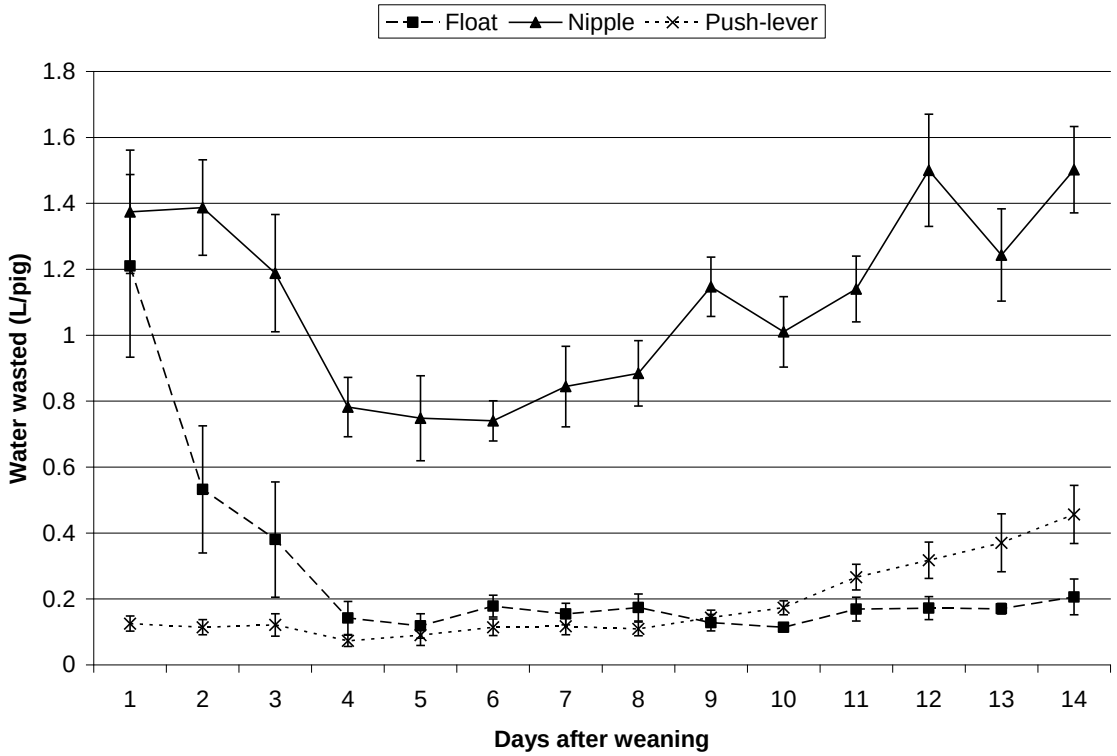

Table 1. Effect of drinker type on the frequency of different behavior patterns on days 9 and 10 (mean ± SEM). Means within a row with different subscripts differ ($P_{a,b} < 0.05$, $P_{c,d} < 0.10$).

Behavior, %	Nipple	Push-lever	Float	SEM	P value
Belly nosing	4.67	4.19^{c}	5.65^{d}	0.49	0.099
Pen-mate directed nosing	2.12	1.50	2.13	0.59	0.109
All pig directed nosing	6.79	5.70^{a}	7.78^{b}	0.77	0.055
Feeding	9.67^{a}	8.53^{bc}	9.47^{d}	0.73	0.022
Drinking	0.47	0.31	0.71	0.16	0.152
Lying	71.61^{c}	75.76^{d}	72.02	2.39	0.058
Other	11.46	9.71	10.02	1.27	0.201

Table 2: Ingestive behavior during the first 48 hours after weaning at 20 or 28 days.

	20 d wean (n = 10)	28 d wean (n = 12)	All piglets (n = 22)
Push-lever			
Total drinking time, min	15.9 ± 5.6	10.1 ± 2.9	12.7 ± 3.0
% of all drinking	45.4 ± 5.5	36.1 ± 5.9	40.8 ± 4.6
% of day	0.55 ± 0.02	0.35 ± 0.01	0.44 ± 0.01
Nipple			
Total drinking time, min	15.1 ± 3.1	14.5 ± 2.3	14.8 ± 1.8
% of all drinking	43.3 ± 5.7	51.7 ± 7.1	47.4 ± 4.6
% of day	0.53 ± 0.01	0.50 ± 0.01	0.51 ± 0.01
Float			
Total drinking time, min	4.0 ± 0.6	3.4 ± 0.9	3.7 ± 0.5
% of all drinking	11.3 ± 4.6	12.2 ± 3.1	11.8 ± 2.6
% of day	0.14 ± 0.02	0.12 ± 0.03	0.13 ± 0.02
Feeding			
Total feeding time, min	68.4 ± 16.3	58.4 ± 8.5	62.9 ± 8.6
% of day	2.38 ± 0.57	2.03 ± 0.30	2.18 ± 0.30

Table 3. Effect of drinker preference and drinker preference by weaning age on weights (kg) and growth (g/d). Preference was determined if an individual piglet spent more than 50% of its drinking duration at one of the three drinkers during the first 48 hours after weaning

	Nipple preference		Push-lever preference		P values		
	20d (n=4)	28d (n=7)	20d (n=3)	28d (n=4)	Age	Pref	Age*Prf
Wean wt	5.53 ± 0.49	8.18 ± 0.37	5.09 ± 0.56	7.52 ± 0.49	0.002	0.31	0.30
Final wt	6.43 ± 0.71	10.50 ± 0.54	6.65 ± 0.82	8.85 ± 0.71	0.003	0.49	0.26
ADG	90 ± 36	231 ± 27	155 ± 42	133 ± 36	0.09	0.89	0.10

Table 4. Relationship between Drinker Preference and Initiation of Feeding Behavior through 48 hours (expressed in minutes)

Feeding	Nipple preference		Push-lever preference		P values		
duration	20d (n=4)	28d (n=7)	20d (n=3)	28d (n=4)	Age	Pref	Age*Prf
0-24hr	43.0 ± 18.5	20.2 ± 4.2	20.5 ± 3.5	26.3 ± 9.1	0.41	0.44	0.18
24-48hr	49.7 ± 22.5	26.0 ± 5.9	72.2 ± 13.0	55.4 ± 8.0	0.13	0.06	0.79
0-48hr	92.7 ± 16.1	46.2 ± 12.2	92.7 ± 18.6	81.7 ± 16.1	0.11	0.31	0.31

Table 5. Effect of weaning age on general behavior of piglets at days 8 and 9 after weaning.

	20 d wean (n = 48)	28 d wean (n = 48)	P value
Lying	71.9 ± 2.7	75.3 ± 2.7	0.01
Feeding	6.1 ± 0.5	5.4 ± 0.5	0.16
Drinking	0.5 ± 0.08	0.5 ± 0.08	0.98
At push-lever	0.2 ± 0.07	0.1 ± 0.07	0.03
At nipple	0.3 ± 0.08	0.4 ± 0.08	0.27
At float	0.03 ± 0.03	0.05 ± 0.03	0.39
Belly nosing	2.1 ± 0.6	0.9 ± 0.6	0.07
Pen-mate nosing	2.0 ± 0.3	2.2 ± 0.3	0.46
Object nosing	5.7 ± 1.3	5.8 ± 1.3	0.89
Other	10.4 ± 1.3	8.8 ± 1.3	0.02

Figure 3. Water intake and waste at nipple and push-lever drinkers for piglets weaned at 20 d of age. There was no difference in overall water intake between the nipple and the push-lever drinkers ($P = 0.52$); however, piglets wasted significantly more water from the nipple drinker ($P < 0.001$).

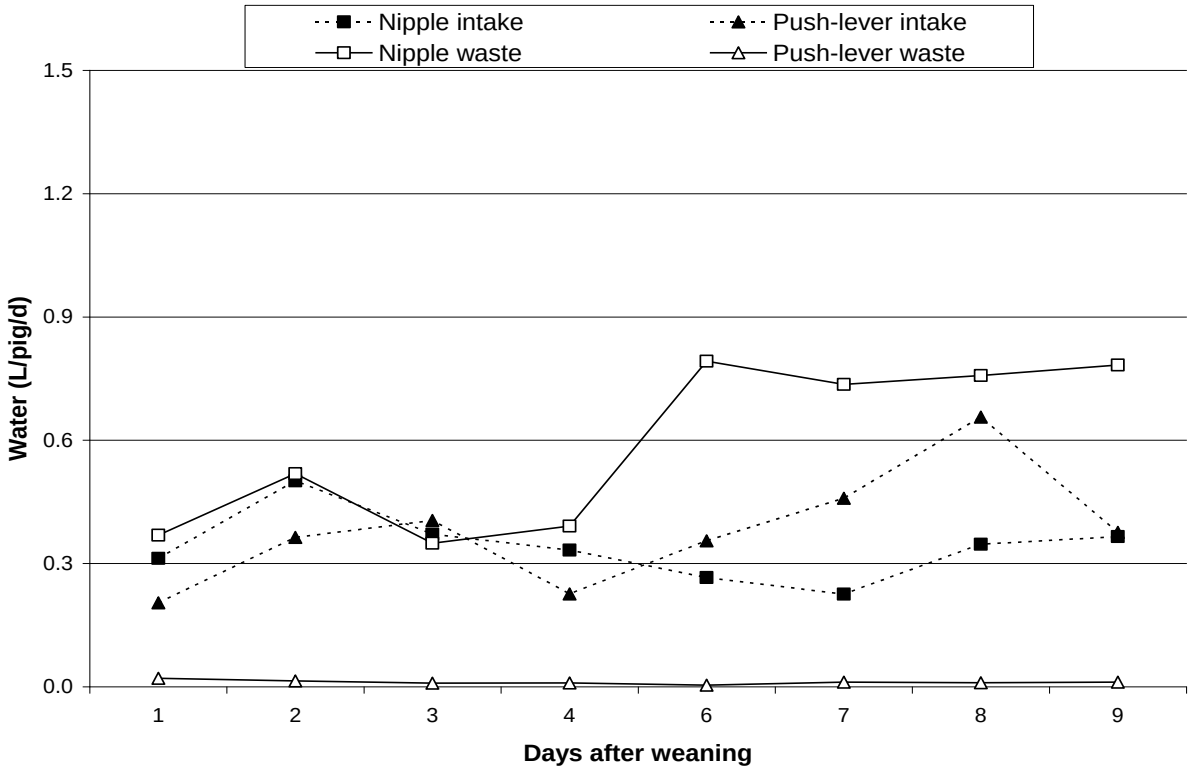

Figure 4. Water intake and waste at nipple and push-lever drinkers for piglets weaned at 28d of age. Overall, piglets consumed ($P < 0.0001$) and wasted ($P < 0.0001$) more water from the nipple drinker than from the push-lever drinker.