2001

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TECHNICAL NOTE

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Phillips, P.A. and Fraser, D. 2001. **Modifying water nipples for newborn pigs**. Canadian Biosystems Engineering/Le génie des biosystèmes au Canada **43**:5.1-5.4. The use of bite nipples by piglets during the first six days after birth was monitored by time-lapse video recording. Simple bite nipples, mounted at a downward angle, were not discovered by most piglets within the six days, even after the nipple had been modified to drip water continuously. However, two modifications resulted in most piglets discovering the nipple within three days. These modifications were (1) mounting the nipple close to the floor with an upward angle and (2) adding a short length of chain to the valve lever. **Keywords**: piglets, water dispenser, drinking, nipple, learning behaviour.

On a observé à l'aide d'un enregistrement video accéléré comment des porcelets utilisaient des abreuvoirs à tétines dans les six jours suivant leur naissance. Durant cette période, la plupart des porcelets n'ont pas réussi à trouver les tétines installées avec un angle vers le bas, même après qu'elles aient été modifiées pour couler en permanence. Cependant, deux modifications ont permis aux porcelets de découvrir les tétines dans les 3 jours suivant la naissance: 1) la tétine a été installée à proximité du plancher avec un angle vers le haut, et; 2) on a ajouté une petite chaîne au levier de la valve.

INTRODUCTION

Many piglets drink substantial amounts of water in the first few days after birth (Phillips et al. 1990), but the animal's need for water at this age is a matter of some debate. It has often been assumed that young piglets do not require drinking water because of the high moisture content of milk. Calculations suggest that this is probably true of piglets receiving enough milk for normal growth (Fraser et al. 1990). However, a minority of piglets receive little milk, either because they fail to establish normal suckling behaviour or because the sow fails to lactate normally. If these animals are housed in a warm environment where evaporative water loss occurs, dehydration may become a problem (Fraser et al. 1990). Provision of drinking water may keep such piglets alive until they can be fostered or raised artificially.

Because of their low cost and reliability, bite nipples are the most common water dispensers used by Canadian pig producers. However, our earlier research (Phillips and Fraser 1991) suggested that newborns are slow to use this type of dispenser, presumably because of the time required to learn how to operate the valve. After three days, litters had made little use of a bite-nipple compared to a water bowl with an exposed water surface which was discovered by most piglets in under 24 h. Other work demonstrated that modifications in water bowl design could accelerate discovery even before 24 h. However, water bowls have drawbacks including their higher initial cost and susceptability to fouling. The objective of this study was to see if bite-nipple discovery could be accelerated by small changes in design. To accomplish this objective, an apparatus was developed which allowed us to record each time piglets activated the dispenser valve with their mouth. These records were used as an indirect behavioural measure to compare the effect of the nipple design changes.

EXPERIMENT

The experiment consisted of two parts. In the first part, a commercial nipple was modified to drip water continuously to determine if this would attract piglet attention compared to a control that did not drip. The continuous drip adjustment was achieved by installing a 3 mm diameter threaded hole in the barrel directly above where the valve was seated against the orifice. A 5 mm long screw was threaded into the hole allowing the end of the screw to touch the edge of the valve and, hence, the valve to be displaced very slightly as the screw was turned. This permitted small amounts of water to escape past the valve. The drip rate was adjusted to 35 mL/min (± 10 mL/min) and the open nipple flow rate to 0.4 L/min (±0.1 L/min). The nipples were mounted on a 45° downward slope with the terminal end of the nipple 140 mm above the floor (Fig. 1) following recommended practice (Connor 1993).

During the first part of the experiment, eight litters were assigned alternately to the continuous drip and control treatments (four litters per treatment). Because the treatment differences were negligible, this comparison was ended and two new variations of the continuous drip treatment were tested. In one variation, a 60 mm length of 5 mm width, link chain (sash chain) was attached to the terminal end of the valve lever (Fig. 1). This "chain-added" modification was expected to arouse the curiosity of the newborns, become a focus for oral play, increase the chance of oral contact with water, and facilitate learning the association between activating the valve lever and receiving

water. The mounting angle and height for this treatment remained as before. The second "floor-mounted" variation involved changing the mounting angle and height of the dripping nipple by placing the base of the nipple as close to the floor as possible with the barrel angled up at 25° above horizontal (Fig. 1). This mounting position offered two possible advantages. First, the upward sloping barrel acted as a small catchment for the dripping water, holding about 3 mL surrounding the valve lever. Second, because piglets are primarily attentive to objects at floor level, they were expected to discover the nipple end 25 mm above the floor more easily than when the nipple was mounted at the higher (recommended) height. The drip rate was left unchanged for both modifications. In the second part of the experiment, ten litters were assigned to the chain-added, ten to the floor-mounted, and six additional litters to the control treatment to bring the total litters for each of these three treatments to ten.

The 34 litters were used from the minimum-disease Yorkshire and Landrace herd at the Centre for Food and Animal Research, Ottawa. The litters ranged from 9 to 14 pigs. For the different treatments, litter size averaged 11.1 to 11.8 at the start of the experiment; average initial mass ranged from 1282 to 1404 g and were within one standard error of the overall mean initial mass.

Sows were housed in temperature-controlled rooms (23 ±4°C) in 0.6 x 2.1 m farrowing crates placed 0.15 m off-centre in pens measuring about 2.1 x 1.5 m. Sows received water from a nipple drinker 0.6 m above the floor, well out of reach of the piglets. Pens had porous floors in the area of the sow's dispenser to ensure that water spilled by the sow would drain away rapidly and not be available to the piglets. Radiant heaters, suspended over 0.5 m^2 rubber mats, were provided for piglet comfort and were located about 0.3 m from the water dispensers.

Trials commenced between 8:00 and 10:00 on the first morning after the litter was born. At this time (start of day 1), piglets were weighed, marked with large ink numbers on their backs for identification, and provided with one of the water dispensers. The piglets were weighed again and re-marked after 72 h (end of day 3) and at 144 h (end of day 6) the pigs were weighed and the trial was stopped.

In earlier methodological research, we determined the actual daily water intake of individual piglets from a bowl, and also used time-lapse video recording to monitor the amount of time that each piglet spent drinking (Phillips et al. 1990). In five of six litters studied, the behavioural measure was an extremely good predictor of actual intake (r^2 = 0.85 to 0.96); in a sixth litter, the piglets drank very little and the two measures were less well correlated (r^2 = 0.58). On that basis, we have used behavioural measures of drinking instead of the much more time-consuming measures of actual intake (Phillips and Fraser 1989, 1990). A similar approach was used in the present study.

The piglet water dispensers were mounted on portable plywood panels positioned vertically at the same location of the farrowing pen in an area accessible to the piglets but not to the sow. Connected in-line with the nipple water supply and mounted on the panel above the nipple was a polysulfone, direct-reading, variable-area flowmeter with PVC float (flow range 0.1 to 1.0 L/min; Blue-White Industries, Westminster, CA). Time-lapse video recording of closed circuit television images was used to simultaneously monitor piglet mouth contact with the valve of the dispenser, flowmeter activation, and surrounding area. Recording continued throughout the trial at approximately 1 frame per second. To protect the flowmeter from external fluctuations in supply line pressure, a regulator (Watts, Model M, Woodbridge, ON) was installed to reduce the 410 kPa line pressure to 140 kPa.

Treatment response was determined from the video recordings for each member of a litter. An "oral activation" was recorded if the piglet's mouth was positioned over the end of the nipple and the flowmeter indicated that the valve was activated. A log was kept of the time of each event in which a piglet met these conditions. Because piglets could accidentally activate the valve by touching it with some other part of the body, records were also kept of these "body activations".

RESULTS

For statistical analysis, the median number of oral activations and body activations was calculated for each member of each litter for days 1 - 3 and for days 1 - 6. These litter medians were then compared by the Extension of the Median Test, and pairwise comparisons of treatments by the Median Test (Siegel 1956). Data were ignored for 10 piglets that died during the experiment.

Piglet mass gains averaged 117 and 187 g/d on days 1-3 and 4-6, respectively, and the mean daily mass gains for each treatment were within the range of normal sampling error. The control treatment had the smallest mean litter size, the highest average mass gains, and the highest mortality (5 pigs) during the experiment. The chain-added treatment had the lowest average mass gain due to 3 poor performing litters but had the lowest mortality (1 pig) during the experiment. The highest dispenser activation seen over the entire experiment occurred with one of these litters.

Generally, there was a close correspondence between the number of oral and body activations for each treatment (Table 1), presumably because treatments that attracted the piglets to drink also resulted in the animals spending more time near the nipples and, hence, being more likely to activate them accidentally by movements of the body. The number of oral activations differed significantly between treatments ($P<0.001$;Table 1). The control and continuous drip nipples received negligible use throughout the 6 days. Both the chain-added and floor-mounted nipples received significantly higher use ($P<0.01$). In these treatments, median values were greater than zero for 17 of 20 litters after 3 days, indicating that the majority of the piglets had activated those nipples within that time. By day 6, all litters with chain-added and floor-mounted nipples had median values above zero and the median number of activations for day 1-6 had increased threefold over the total up to day 3. By day 6, the floor-mounted treatment received significantly higher use ($P<0.01$) than the chain-added or control treatments.

It was assumed that events where piglets used their mouth to successfully activate the nipple valve and create water flow represented a significant behavioural step in the learning process of discovering a nipple water dispenser. Actual water consumption was not measured. However, some water consumption would have been difficult to avoid as an activated

Fig. 1. From left to right, the floor-mounted, chain-added and control nipples. A continuous drip adjustment screw was installed on all nipples to allow the continuous drip feature to be used as required (arrow on 'CONTROL' nozzle shows screw location).

nipple tends to inject water into the open mouth. The chain-added and floor-mounted nipples appeared to facilitate piglets learning to operate the nipple valve. By itself, the continuous drip feature appeared ineffective in attracting the piglets. Because piglets tend to focus attention at floor level, the raised location of the nipple may have reduced the likelihood of early contact. Also, the rapid disappearance of the drops of water through the slotted floor may have given little chance for the piglets to investigate the water and discover the nipple in that way. The chain-added and floor-mounted variations were two ways of placing the valve lever closer to the level that piglets are likely to investigate. In these cases, the continuous dripping may have increased the chance of a piglet getting water into its mouth and, presumably, making the association between water and the valve lever.

The use of continuous dripping water, a feature on some commercially available bowl-type water dispensers, will increase water use and will create additional waste which must be stored and disposed of. The drip rate that was used in this study would require about 50 L/d of water per litter, roughly twice that for the sow. However, a much lower drip rate might provide much the same benefits with less cost. With the floor-mounted nipple, a drip rate of 6 mL/min would refill the catchment area around the valve stem at least every 30 s and require only 8 L/d; 3 mL/min would refill every minute and would require only 4 L/d. With the chain-added nipple, a lower drip rate would wet the chain to much the same degree as seen in this experiment. Alternatively, the dripping action could be used only for a few days after birth to assist the learning process and thereafter be discontinued. Using either or both of these measures, the additional water use would be relatively small compared to the total water requirement for lactation and room clean-up.

CONCLUSION

To summarize, our previous studies indicated that bite-nipples are relatively ineffective in making water easily accessible to suckling pigs compared to water bowls. The results here confirm that a regular bite nipple received little use by piglets up to 6 days age. However, the findings indicate some small changes in nipple design such as mounting the nipple close to the floor with an upward angle and adding a short length of chain to the valve lever could speed up discovery of the nipples and help bring accessibility more in line with that of water bowls. Further study is required on piglet water consumption and its benefits for individual piglets.

ACKNOWLEDGEMENTS

The authors thank B. Pawluczuk for his assistance with the experiment.

Table 1. Median number of valve activations (expressed as the median and range of litter medians) by piglets after 3 and 6 days, divided according to oral or other body contact.

Nipple treatment	Number of litters	Median number of activations			
		Days 1 - 3		Days 1 - 6	
		Oral*	Body	Oral	Body
Control	10	0^{a} (0)	0.3^{a} (0-3)	0^{a} (0-2)	2.5^{a} (0-8)
Continuous drip	4	0^{ab} (0)	0^{ab} (0-1)	0^{abc} (0-1)	1^{ab} (0-3)
Continuous drip and chain-added	10	1^{b} (0-11)	1.5^{ab} (1-17)	3.3^{b} (1-30)	1^{ab} (0-3)
Continuous drip and floor-mounted	10	2.8^{b} (0-8.5)	3.8^{b} (1-15)	13.5^{c} (5-24.5)	15^{b} (2.5-40.5)

* Within a column, results that do not have a common superscript are significantly different ($P<0.01$).

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