Effect of gruel and Tonisity Px™ on feed intake and weight gain at weaning

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Introduction

The transition to weaning and dry food intake is a well-documented problem in pig management. Weight gain in the first week post-weaning has a large impact upon subsequent performance and economics of the pig.[1] Decreased feed intake after weaning results in a post-weaning growth check that causes significant production losses and has negative impacts on gut health.[2] The immediate post-weaning period may also see a significant proportion of pigs that have subnormal water intake for up to 48 hours.[3]

Increased post-weaning diarrhea also results in increased antibiotic usage requirements. As producers aim to better manage their antibiotic usage, it is appropriate to investigate whether or not the use of semi-liquid feed supplementation in the period immediately before and after weaning is beneficial.

A novel isotonic protein-electrolyte solution (Px) has recently been developed and has the characteristics of being highly palatable as well as providing key amino acids for support of intestinal function. It was hypothesised that using Px solution to make a gruel with creep feed could result in improved feed intake post-weaning and improved health.

Materials and methods

The study was performed on a 400 sow (Landrace × Large White/Pietrain) farrow-to-finish operation with batch farrowing and regular weaning at 3 weeks of age. The farm was positive for PRRS and APP. The farm had a low incidence of scours in farrowing, but the most recent surveillance sample had documented *E. coli* (strains F41 and *gad*) as well as *Clostridium difficile*. Surveillance samples were negative for rotavirus A and PEDV on PCR.

52 sows and their litters (608 piglets) were enrolled in the study and randomized to one of two groups, control (group A) or supplementation with 3% Px solution (group B). Groups were balanced by sow's parity, number of piglets and piglets' weight. Cross-fostering was permitted only within the treatment group and within the first 24 hrs. All piglets were weighed at day 2 of age. Starting approximately 24 hours after birth (Day 2 of age), group B litters were given 500 mL of 3% Px solution daily in an open pan, in their farrowing crate. Group B litters continued to receive 500 mL of Px daily until day 8 of age. Control litters (group A) were given no extra supplementation. All litters had access to fresh water through a drinker nipple and were allowed to suckle the sow normally.

The pre- and post-weaning feeding plan is summarized in Table 1. Four days before weaning (approximately 15 days of age, study day -4), all pigs were weighed and litters were allocated to one of 3 new treatment groups - dry creep feed (D), water-gruel (WG) or Px-gruel (PG). Group A and B pigs were allocated equally across the 3 new treatment groups. These new groups were again balanced by sow's parity, number of piglets and piglets' weight on SD -4. On SD -4, D litters received dry creep feed, WG litters received 500 mL of water and PG litters received 500 mL of 3% Px solution. All feeds and liquids were served in an open pan.

On SD -3, SD -2, and SD -1, D litters continued to receive dry creep feed. WG litters received a gruel of creep feed mixed with water and PG litters received a gruel of creep feed mixed with Px solution. All gruel was made using the ratio of 1 kg of dry feed to 1.5 L of liquid (water or 3% Px solution), i.e., a 1:1.5 w/v ratio.

On SD 0 (19 days of age), pigs were weaned, weighed and sorted into 53 pens of 10-11 pigs each. Pigs were also sorted into pens by bodyweight (heavy (H), medium (M), light (L)) while still remaining within their feed groups. Heavy was defined as > 5.8 kg, medium 4.1 – 5.8 kg and light < 4.1 kg.

Both WG and PG pigs continued to receive their gruel ad libitum for at least 1 day after weaning and were then tapered off gruel over another 3-4 days according to body weight. Light and medium pigs were tapered more slowly.

The quantity of dry creep feed and gruel to be delivered was calculated to achieve an ad libitum consumption. This calculation was based on the average bodyweight (BW) of the piglets in the litter/pen calculated from individual BW measured on SD-4 and SD 0, the expected dry matter intake (DMI) based on the average BW, the number of piglets in the litter/pen, and the % dry matter (DM) of the creep feed used. The DM of the creep feed was based on proximate analysis (moisture, crude protein, crude fat and ash) as measured by near infrared spectroscopy. A margin of +20% was added in order to ensure that there was enough gruel available. During the days that gruel/feed was administered ad libitum, if the leftover gruel/feed of a pen was 0, the quantity of gruel/feed delivered was increased by another 20% on the next day in that pen. The total quantity of gruel or dry creep feed in open pans was divided into two doses per day.

Additionally, creep feed was offered ad lib in separate feeders to all groups from SD1 to at least SD7. Pre-starter feed was offered to M and H pens from SD7 and to L pens from SD10.

Table 1: Feeding plan

Age (days)	Study day	Individual weights	In LITTERS		
2		x	**Group A** Normal suckling control group		**Group B** Suckling + 500 mL Px solution/ litter/ day
8		x	↓	↓	
			In LITTERS		
15	SD -4	x	Dry creep feed	500 mL water	500 mL Px solution
16	-3		Dry creep feed ad lib	Water-Gruel ad lib	Px-Gruel ad lib
17	-2		Dry creep feed ad lib	Water-Gruel ad lib	Px-Gruel ad lib
18	-1		Dry creep feed ad lib	Water-Gruel ad lib	Px-Gruel ad lib
			Into PEN BLOCKS*		
19	Weaning SD 0	x	**Light**	**Medium**	**Heavy**
			Gruel ad lib	Gruel ad lib	Gruel ad lib
20	1		Gruel ad lib	Gruel ad lib	Gruel ad lib
21	2		Gruel ad lib	70% of the gruel intake on SD1	60% of the gruel intake on SD1
22	3		70% of the gruel intake on SD2	50% of the gruel intake on SD1	40% of the gruel intake on SD1
23	4		50% of the gruel intake on SD2	30% of the gruel intake on SD1	20% of the gruel intake on SD1
24	5		30% of the gruel intake on SD2	10% of the gruel intake on SD1	Dry creep feed only
25	6		10% of the gruel intake on SD2	Dry creep feed only	↓
26	7	x	Dry creep feed only	Prestarter diet	Prestarter diet
29	10		Prestarter diet	↓	↓
33	14	x	↓	↓	↓
40	21		Starter diet	Starter diet	Starter diet
55	36	x	↓	↓	↓

* All pens had dry creep feed available ad lib in feeders, alongside the gruel feeders.

Data collection

Pigs were individually weighed on day 2 and day 8 of age, then SD -4, SD 0, SD 7, SD 14 and SD 36. Feed intake was measured for each group and normalised to dry matter intake (DMI), which equalised differences between the volume and weight of the gruel and dry feed. Feed intake was calculated for the pre-weaning period, 7 days post-weaning and 14 days post-weaning. Average daily gain was calculated for the same periods. The number of pigs with positive ADG in the first week and second post-weaning was calculated.

The number of pigs requiring antibiotic treatment during the study period was also recorded. Antibiotic treatment for diarrhea was at the discretion of farm staff and consisted of Marbocyl 2% by injection.

The number of piglets per pen with diarrhea and their individual scour score was recorded daily from SD1 to SD14. The scale used was 0 = no scour, 1 = pasty faeces and 2 = liquid scour. The total scores per pen were then summed and divided by the number of pigs in the pen to create a pen faecal score.

Statistical analysis

The experimental unit was the litter until weaning, and the pen after weaning. Tests were two-tailed and carried out with a risk $\alpha = 5$ %. *P*-values of ≤ 0.05 were considered statistically significant, while $0.05 < P \leq 0.10$ was considered a near-significant trend. Least squares means (LSM) ± standard error (SE) were used to calculate 95% confidence intervals. Logistic regression was used to calculate the differences between treatment groups for positive and negative ADG. All statistical analyses were performed with R software†, using packages GLM and lme4 as appropriate.

Results

Day 2-8 consumption of Px

The mean consumption of Px solution was 38 mL/piglet on day 2 of age, which increased to a mean of 45 mL/pig at day 8, i.e., all 500 mL was consumed by the litter. The mean consumption per kg BW was 188 mL for the week.

Dry matter intake (DMI)

The PG litters had an average DMI of 75 ± 5 g/pig/day in the pre-weaning period (SD -3 to SD -1, which was significantly higher than the WG litters (58 ± 4.9 g/pig/day) or the D litters (54 ± 5.7 g/pig/day) ($P < 0.05$).

After weaning the DMI was tracked both by type of feed and weight class (Heavy, Medium, Light). Table 2 shows total DMI of gruel and creep feed consumed in the first week after weaning. The most marked differences were seen in the Light and Medium pigs in the first week after weaning. Both gruel groups in these weight classes had significantly higher DMI compared to the dry creep feed group. Light-weight Px-gruel pigs had an average DMI of 164 g/pig/day compared to 150 g/pig/day for water-gruel and 126 g/pig/day for dry creep in the first week post-weaning.

Average daily gain

When all weight groups of pigs were compared (Table 3), the PG group tended to have a higher percentage of pigs with positive ADG in the first week post-weaning compared to the D group (OR 1.66, 95CI 0.95 – 2.92, $P = 0.076$. The PG group also had a significantly higher percentage of pigs with positive ADG in the first week post-weaning compared to the WG group (OR 1.79, 95CI 1.05 – 3.04, $P = 0.031$). There was no significant difference between the WG and D group in this parameter (OR 0.93, 95CI 0.55 – 1.58, $P = 0.788$).

When analyzed by weight class (Table 4), the Medium and Light pigs in the PG group also out-gained their counterparts in the other feed groups. 88% of the Medium pigs and 92% of the Light pigs in the PG group had positive ADG in the first week post-weaning ($P < 0.05$). This difference was not seen in the Heavy pigs.

Odds ratios were also calculated for each group to assess the likelihood of an effect. Light pigs in the PG group were more likely to have positive ADG than the WG group (odds ratio 3.25, 95% CI 1.00 – 10.56, $P = 0.050$). Medium pigs in the PG group were more likely to have positive ADG than the D group (odds ratio 2.44, 95% CI = 1.08 – 5.52, $P = 0.032$).

Antibiotics and diarrhea

Though no significant differences were seen in scour scores between treatment groups or weight classes in either the first or second week post-weaning, PG pigs tended to be less likely to be treated with antibiotics in the post-weaning period compared to D pigs (odds ratio 0.59, 95% CI 0.33 – 1.04, $P = 0.068$). Similarly, WG pigs were significantly less likely to be treated with antibiotics in the post-weaning period compared to D pigs (odds ratio 0.51, 95% CI 0.28-0.93, $P = 0.028$). There was no significant difference in the incidence of antibiotic treatment between WG and PG pigs (odds ratio 1.16, 95% CI 2.13, $P = 0.645$).

Discussion

This study again showed that newborn piglets less than one week old will consume substantial volumes of 3% Px solution. It was also clear that piglets found Px-gruel more palatable than water-gruel or dry creep feed, especially in the immediate pre-weaning period. Feeding Px-gruel and water-gruel in the peri-weaning period had a significant impact on the DMI and ADG of medium-weight and light-weight pigs, which comprised 75% of the population. Light-weight Px-gruel pigs consumed 30 g/kg BW/day more food than the same water-gruel pigs and 74 g/kg BW/day more food than the same dry creep pigs in the first week post-weaning. This was reflected in the overall trend towards increased ADG in the Px-gruel pigs. Further studies are planned to investigate how best to optimise the effect of Px on heavy-weight pigs.

The reduction in antibiotic use suggests that gruel may be a useful strategy for decreasing antibiotics in the post-weaning period and should be investigated further. Feeding semi-liquid food may also ameliorate the possible dehydration associated with weaning and moving into pens.

Future studies are required to investigate whether or not gruel feeding can increase the percentage of pigs that are 'eaters' of creep feed, encouraging more suckling pigs to eat that will be better adapted to weaning.[4]

References

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† R Core Team (2015). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL `http://www.R-project.org`.

Table 2: Average daily DMI of gruel and/or creep feed per piglet (g/pig/day), by feed group and size

		Dry creep (D)		Water-gruel (WG)		Px-gruel (PG)	
Size	**Days post-weaning**	**LSM (SE)**	**CI 95%**	**LSM (SE)**	**CI 95%**	**LSM (SE)**	**CI 95%**
H	0 to 6	142 (9.3)	124 - 161	149 (9.6)	130 - 168	148 (8.7)	131 - 165
M	0 to 6	**120^{b} (5.3)**	**109 - 130**	**150^{a} (4.6)**	**141 - 159**	**141^{a} (4.4)**	**133 - 150**
L	0 to 6	**126^{b} (9.8)**	**107 - 145**	150^{ab} (9.3)	132 - 168	**164^{a} (8.2)**	**148 - 180**

H: heavy (pens with average BW > 5.8); M: medium (pens with average BW of 4.1 to 5.8 kg); L: light (pens with average BW < 4.1 kg). T1: dry feed; T2: gruel with water; T3: gruel with 3% PX solution. a, b different superscript in the same row indicates statistical differences ($P \leq 0.05$). t in the same row indicates statistical tendency ($P \leq 0.10$).

Table 3: Number and percentage of piglets with positive ADG in the first week post-weaning, by treatment group

	Dry creep (D)	Water-gruel (WG)	Px-gruel (PG)
ADG ≤ 0	31 (22%)	41 (23%)	28 (14%)
ADG > 0	113$^{ab\,t}$ (78%)	139^{b} (77%)	**170$^{a\,t}$ (86%)**

^{a,b} different superscript in the same row indicates statistical differences (P≤0.05). t in the same row indicates statistical tendency ($P \leq 0.1$).

Table 4: Number and percentage of piglets with positive ADG in the first week post-weaning, by treatment group and size (H, M and L).

Size		**D**	**WG**	**PG**	**Comparison**	**Odds ratio**	**CI 95%**	***P*-value**
H	ADG ≤ 0	9 (24%)	15 (31%)	11 (30%)	D vs. WG	0.70	0.27 – 1.84	0.474
	ADG > 0	29 (76%)	34 (69%)	26 (70%)	D vs. PG	0.73	0.26 – 2.05	0.555
					WG vs. PG	1.04	0.41 – 2.64	0.930
M	ADG ≤ 0	17 (25%)	17 (19%)	12 (12%)	D vs. WG	1.45	0.68 – 3.11	0.338
	ADG > 0	**51 (75%)^{b}**	74 (81%)^{ab}	**88 (88%)^{a}**	**D vs. PG**	**2.44**	**1.08 – 5.52**	**0.032**
					WG vs. PG	1.68	0.76 – 3.75	0.202
L	ADG ≤ 0	5 (13%)	9 (23%)	5 (8%)	D vs. WG	0.52	0.16 – 1.73	0.287
	ADG > 0	33 (87%)^{ab}	**31 (78%)^{b}**	**56 (92%)^{a}**	D vs. PG	1.70	0.46 – 6.30	0.430
					WG vs. PG	**3.25**	**1.00 – 10.56**	**0.050**

^{a,b} different superscript in the same row indicates statistical differences ($P \leq 0.05$).