Performance response of piglets to acid-preserved, high-moisture wheat as alternative to in-feed acidification

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Background

Pigs do not secrete sufficient amounts of hydrochloric acid (HCl) in their stomachs at the time of weaning to effectively digest protein and maintain gut health. Previous decades of research have established that adding acid to the feed of weanling pigs will lower pigs' gastric pH and so increase their digestive efficiency and health. For instance, pigs' stomach acid provides a barrier to pathogenic microorganisms, since low pH conditions control those populations. And acid can also improve the digestion of protein, and other nutrients. Typically, when weanling pig diets are supplemented with dietary acids to enhance digestion, piglet growth rates increase by 6 to 12% (Tung and Pettigrew, 2006).

Wheat, one of the main cereals used on the Canadian Prairies as an energy source in pig feed, is typically harvested at < 15% moisture to maintain its quality during storage. However, when environmental challenges to farming result in high moisture, low quality wheat crops, producers often resort to drying grain artificially or storage in oxygen limiting silos. But these processes can jeopardize nutrient value and increase producers' costs for fuel, power and specialized drying structures. As an alternative, high moisture, low quality wheat can be preserved by acidification for use as piglet feed, which simultaneously can improve weanling digestive growth and health.

Whether the benefits of diet acidification are maintained when piglets are fed acid-preserved high-moisture wheat is not known and requires further investigation. Therefore a nursery feeding trial was conducted to evaluate the efficacy of feeding acid-preserved, high moisture wheat as an alternative to in-feed acidification.

Experiment Method

Wheat was reconstituted to 20% moisture content and then either a commercial, phosphoric acid-based feed acidifier or propionic acid was added. The mixture was then stored in polyethylene barrels for 34 days. Carbon steel and galvanized steel coupons were embedded in the treated grain to measure the effects of acids on corrosion rate in storage silos and bins.

As Table 1 indicates, galvanized steel was more prone to corrosion than carbon steel. Propionic acid was more corrosive than phosphoric acid.

Grains were additionally monitored for mould growth and, when found high, were analyzed for a complete mycotoxin profile. (See Table 2.) Throughout the trial, the amount of mycotoxin in the wheat fell below the maximum allowable level.

A total of 160 newly weaned pigs (21 days of age, approx. 6.5 kg in body weight) were weighed and randomly distributed to 40 pens with 4 pigs per pen. Pens were assigned to 1 of 5 treatments in a randomized complete bock design. Treatments were arranged to measure the effect of each type of acid (phosphoric vs propionic) and the two methods of application (acid-preservation of moist wheat vs direct acidification of dry wheat), plus a non-acid control.

To summarize: piglets were fed with a wheat based diet without acid (the control), an acid-preserved wheat with phosphoric acid (APW-Phos), an acid-preserved wheat with propionic acid (APW-Prop), an acidified diet with phosphoric acid (AD-Phos), or an acidified diet with propionic acid (AD-Prop).

A phase 1 diet was provided between days 0 to 7 and the phase 2 diet was given from days 8 to 21 post-weaning, followed by a common phase 3 diet from days 22 to 35.) The average daily gain (ADG) and average daily feed intake (ADFI) were collected at days 7, 21 and 35 and were used to calculate feed efficiency (G:F=ADG/ADFI).

Table 1: Corrosion rate of carbon steel and galvanized steel exposed to either phosphoric or propionic acid when used as preservatives for high moisture wheat

Acid	Coupon Type	Average corrosion rate, mils per year	Classification
Phosphoric	Carbon Steel	0.16	low
Phosphoric	Galvanized Steel	7.00	severe
Propionic	Carbon Steel	2.94	mod
Propionic	Galvanized Steel	7.46	severe

Table 2: pH and mould measurements in acidified, high moisture wheat

Acidified High Moisture Wheat			
Item	*Initial*	*Finl*	*Mould Count, colony forming unit/gram*
Phosphoric Acid (Phos)	*4.27*	*5.72*	*7,000*
Propionic Acid (Prop)	*4.56*	*4.85*	*20*

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Results

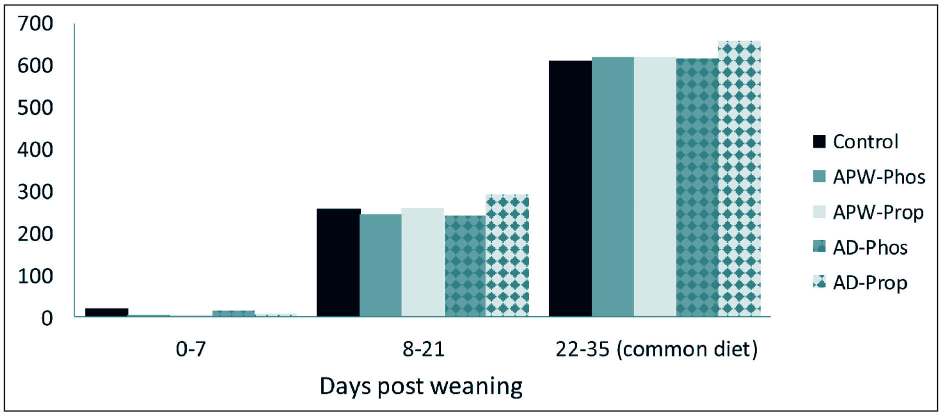
Grain quality, grain pH, mycotoxin levels, and corrosion rate. When the grain was in storage, the mould count of the phosphoric acid-preserved wheat (APW-Phos) was higher than the propionic acid-preserved wheat (APW-Prop). However, toxin analysis consistently found that the mycotoxin levels in phosphoric acid occurred at levels lower than the maximum allowable limits. The pH in phosphoric acid-preserved wheat (APW-Phos) increased from pH 4.27 to pH 5.72, while the pH in propionic acid-preserved wheat (APW-Prop) increased from pH 4.56 to pH 4.85. (Again, as Table 1 above indicates, galvanized steel was more prone to corrosion than carbon steel; and propionic acid was more corrosive than phosphoric acid.) Overall, the trend after the addition of acid to the wheat was for pH to rise over time, most notably for wheat preserved with phosphoric acid. The pH may rise due to issues such as the production of ammonia by microorganisms, the reaction of grain components to the acid and the evaporation of the acid, itself. The benefits of using wheat preserved by phosphoric acid (including enhanced gut health for piglets) may be gained without producers having to manage the corrosiveness of propionic acid.

Growth rate (ADG). Acidification, the type of acid and the method of acid application, or a combination of all three, had no effect on the growth rate of pigs during days 0 to 7 after weaning, and days 22 to 35 after weaning. However, during days 8 to 21 after weaning (phase 2), there was a tendency for pigs fed diets with propionic acid, regardless of the method of application, to grow at higher rates compared to those fed diets with phosphoric acid.

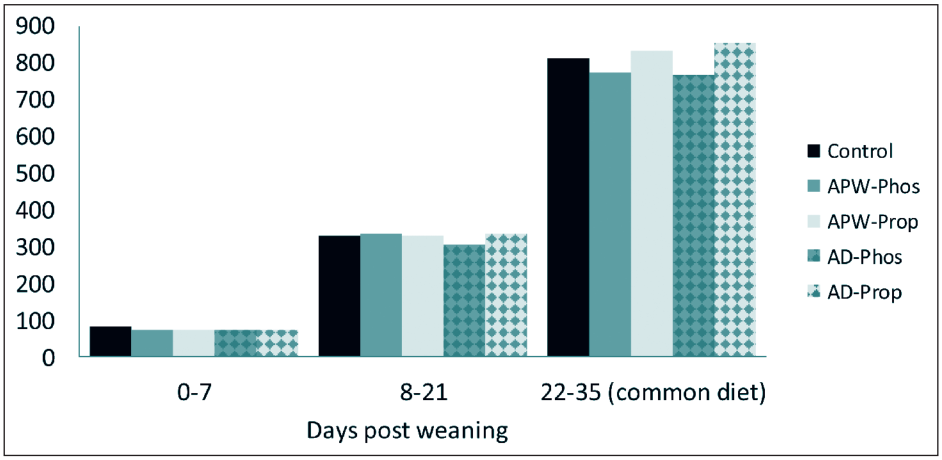
Feed intake (ADFI). Acidification, the type of acid and the method of acid application or a combination of all three had no effect on feed intake of pigs during days 0 to 7 after weaning, and days 8 to 21 after weaning. However, during days 22 to 35 (phase 3, when pigs were fed a common diet), pigs fed propionic acid during phases 1 and 2 had higher feed intake compared to those fed phosphoric acid, suggesting a potential for a carry-over effect (for propionic acid).

Feed efficiency (G:F). Acidification, type of acid and the method of acid application or a combination of all three had no effect on the feed efficiency of pigs during days 0 to 21, after weaning. During days 8 to 21 (phase 2), pigs fed propionic acid had improved feed efficiency compared to pigs fed the non-acid control ($P<0.05$); and compared to pigs fed diets with

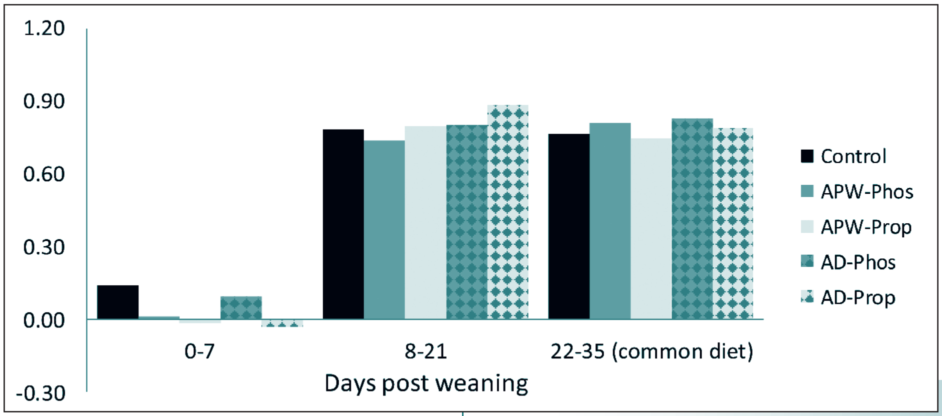
Graph 1: Average daily gain (ADG; grams/day)



Graph 2: Average daily feed intake (ADFI; grams/day):



Graph 3: Feed Efficiency (G:F; gram/gram/day):



phosphoric acid ($P<0.01$). However, during days 22 to 35 (phase 3), pigs fed phosphoric acid during phases 1 and 2 had higher feed efficiency compared to those fed propionic acid, again suggesting a potential for a carry-over effect (for phosphoric acid).

The Bottomline

One objective of this trial was to determine the effectiveness of feeding acid-preserved, high moisture wheat as an alternative to directly supplementing acid to the wheat diet of weanling pigs. Acidification of wheat with propionic acid resulted in a significant improvement in feed

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