Water Quality Impacts on the Economics of Nursery Pig Production

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Background and Objectives:

Although water is a critical resource for profitable swine production, there has been surprisingly little research on how various aspects of water relate to pig performance. There is a growing number of pigs being raised in areas where good quality ground water is unavailable, and surface (dugout) water must be used. However, there is very little information on the use of surface water for pigs in general and nursery pigs in particular. Compared to well water, surface water is at a much higher risk of contamination and therefore its quality is likely to be an issue for its use in pig production.

Various water treatment methods are available to the pork industry, but their impact on pig performance is largely unknown. These include chlorination, coagulation, filtration, and pH adjustment. Chlorination is now an accepted practice within the swine industry, at least as it relates to nursery pigs. However, the impact of different levels of chlorination on water intake and pig performance remains a key concern that needs to be investigated.

Therefore the objectives of the project were:

1. To compare the performance of newly weaned pigs provided surface water compared to those provided ground water.
2. To determine the effect of coagulation and filtration of surface water on the performance of newly weaned pigs.
3. To determine the effect of chlorine levels in the drinking water on the performance of newly weaned pigs.
4. To determine the impact of acidification on the performance of newly weaned pigs.
5. To determine the economic impact of surface water quality on pork production.
Procedure and Project Activities:

The project was carried out at the Triad Nursery Facility located near Kolla, Manitoba. The facility consisted of 4 barns, each with a capacity of about 2,600 to 2,700 head. Within each barn, there were 4 identical rooms, each consisting of a central alleyway with 13 pens on each side of the alleyway.

Only two barns were used in the study thus providing a total of 8 rooms. This provided two room turns on each treatment in each of two seasons: spring and summer. Within each room, the water delivery system was modified such that one half of the room received the control water while the other half of the room received the designated treatment water. In each water line, a water meter was installed to facilitate monitoring of water usage. Two room fills were assigned to each treatment; in such a manner that the sides of the room assigned to control and treatment differed in the two rooms. Normal management involves putting all females along one side of the room and all males along the other side. However, this was modified such that one half of each side housed females while the other housed males. There were 6 observations (6 pairs of pens, as one feeder supplied two pens) per treatment per room thus giving 12 observations (600 pigs) per treatment per season.

Treatments Tested

- Treatment 1 (surface vs. ground water)
  - Barn 1, room 1: Control vs. Elkhorn pipeline water (source of well water)
  - Barn 1, room 2: Control vs. Elkhorn pipeline water (source of well water)
- Treatment 2 (Surface vs. treated surface)
  - Barn 2, room 1: Control vs. coagulated filtered water
  - Barn 2, room 2: Control vs. coagulated filtered water
- Treatment 3 (Chlorine levels)
  - Barn 1, room 3: Control vs. water with elevate chlorine
  - Barn 1, room 4: Control vs. water with elevated chlorine
- Treatment 4 (Acidification)
  - Barn 2, room 3: Control vs. acidified water
  - Barn 2, room 4: Control vs. acidified water

Three trial runs were completed. The first trial run was conducted in the spring of 2001 while the second and third trials were conducted during the summer. The spring trial compared untreated (except the normal chlorination at 0.5 ppm free chlorine) surface water with acidified (pH 6.0 to 6.2) surface water and well (ground – from a city pipeline) waters (Treatments 1 and 4). This was repeated again in the summer. The second summer run compared untreated surface water to coagulated surface water and to surface water with elevated (2 ppm free chlorine) chlorine levels (Treatments 2 and 3).

Parameters Measured

Pigs were weighed as a group per pen on day 1, end of week 1, 3 weeks later and at the end of the nursery cycle. Feed intake (disappearance) per pen was monitored and together with growth data used to calculate feed conversion efficiency.

Samples of untreated (dugout water collected prior to the cistern; pipeline water as delivered) and treated water were tested for the following as indicators of water quality:

- total dissolved solids
- nitrate/nitrite nitrogen
- iron
- manganese
- pH
Effect of Water Source on Piglet Performance

Feeding the surface water used in the study had no effect on piglet performance (i.e. average daily feed intake, average daily gain, and feed conversion efficiency) compared to feeding well water in both the spring and summer trials (Figure 1). Overall, in the spring trial, ADFI averaged 573 and 573 g per day for pigs fed well water and surface water, respectively. Respective values for average daily gain and feed conversion efficiency were 406 and 396 g per day and 1.43 and 1.36, respectively. In the summer, average daily feed intake was 524 and 530 g per day for well and surface water, respectively. Respective values for average daily gain and feed conversion efficiency were 384 and 393 g per day and 1.39 and 1.36, respectively.

The results of the two trials demonstrate that the surface water tested supported nursery pig performance comparable with that supported by well water. However, as the use of surface water in nursery pig production has not been studied extensively, care should be taken in extending the results of the study to all surface water sources.

Effect of Water Treatment on Indicators of Water Quality

The three water treatment methods tested in the project were acidification, high chlorination and coagulation. As expected, adding the acidifying agent to surface water reduced the pH to between 6.0 and 6.2. Coagulation, which involves lumping together the fine particles into large particles, which are in turn settled and then removed from the water, offers a viable means for treating water with high turbidity. Clearly, coagulating the surface water used in the study reduced the level of most contaminants measured.
Table 1. Effect of coagulating surface (dugout) water on the amount (ppm) of selected dissolved mineral elements as indicators of water quality.

<table>
<thead>
<tr>
<th>Period / Parameter</th>
<th>Surface Water Treatment</th>
<th>None</th>
<th>Coagulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkalinity</td>
<td></td>
<td>389</td>
<td>225</td>
</tr>
<tr>
<td>Total dissolved solids</td>
<td></td>
<td>833</td>
<td>527</td>
</tr>
<tr>
<td>Dissolved organic carbon</td>
<td></td>
<td>7.3</td>
<td>4.3</td>
</tr>
</tbody>
</table>

Raw water (both well and surface water) during the trial contained only minor bacterial loading. Levels of fecal and *E. coli* bacteria were typically below 10 organisms per 100 mL. Once the water was subjected to base chlorination treatment, all samples showed zero indicator organisms.

*Effect of Water Treatment on Piglet Performance*

Acidifying the surface water used in the project did not influence piglet performance at any point during the study in both the spring and summer trials (Figure 2). High chlorine level and coagulation of the surface water used in the study did not affect piglet performance (Table 2). Over the 42-day study period, average daily feed intake, average daily gain and feed conversion efficiency were 537 g per day, 353 g per day and 1.44 for piglets fed untreated surface water. Corresponding values for those fed surface water with elevated chlorine were: 542, 370 and 1.48, respectively.

Table 2. Performance of nursery pigs fed surface water with standard or elevated chlorine level during the summer.

<table>
<thead>
<tr>
<th>Period / Parameter</th>
<th>Surface Water Chlorine Level</th>
<th>Standard</th>
<th>High</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 42 days</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avg. daily feed intake, g/d</td>
<td></td>
<td>536.8</td>
<td>541.8</td>
<td>7.2</td>
</tr>
<tr>
<td>Avg. daily gain, g/d</td>
<td></td>
<td>352.6</td>
<td>370.3</td>
<td>24.2</td>
</tr>
<tr>
<td>Feed conversion efficiency</td>
<td></td>
<td>1.44</td>
<td>1.48</td>
<td>0.03</td>
</tr>
</tbody>
</table>

1 Number of observations (pens) per water type = 24; Standard = 0.5 free chlorine and High = 2 ppm free chlorine.
The result of the study suggests that young pigs can tolerate water with 2 ppm free chlorine, which is about four times the recommended amount. For practical pork production, there is no merit for increasing the free chlorine level in water, but rather to add a sufficient amount of chlorine to ensure effective water disinfection.

An important observation from the study is that coagulating surface water is able to remove contaminants, thus improving the quality of water. However, this improvement did not lead to improved piglet performance (Table 3). There are two possible explanations to this observation. Firstly, the level of contaminants in the untreated surface water may not have been high enough to affect piglet performance such that any reduction in the levels of these compounds could not lead to any measurable benefits. Secondly, pigs seem to handle water of variable quality reasonably well, depending on the presence of other factors as evidenced by various studies. The greatest benefits of coagulating water for pig production will likely be realized in situations where the raw water has very high levels of contaminants.

Table 3. Performance of nursery pigs fed untreated or coagulated surface water during the summer.

<table>
<thead>
<tr>
<th>Period / Parameter</th>
<th>Surface Water Treatment</th>
<th>SEM²</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>Coagulation</td>
<td></td>
</tr>
<tr>
<td>0 – 42 days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avg. daily feed intake, g/d</td>
<td>513.9</td>
<td>532.0</td>
</tr>
<tr>
<td>Avg. daily gain, g/d</td>
<td>364.1</td>
<td>342.0</td>
</tr>
<tr>
<td>Feed conversion efficiency</td>
<td>1.42</td>
<td>1.47</td>
</tr>
</tbody>
</table>

¹ Number of observations (pens) per water type = 24.
² SEM = pooled standard error of the means.

The response of nursery pigs to water type was similar in all three trials for barrows and gilts regardless of water type. Clearly, at this stage of growth and under the conditions of the study, it can be concluded that gender has no effect on piglet response to water type.

Conclusions:

The following conclusions can be derived from the data obtained in the project:

- Surface water supported piglet performance similar to that of well water.
- Treating water used in the present study had no effect on piglet performance.
- Coagulation improved the quality of surface water.
- Surface water can be used for commercial nursery pig production.
- Since piglet performance in terms of average daily feed intake, average daily gain and feed conversions efficiency were similar among treatments in both the spring and summer trials, it would seem that treating water for nursery pigs may not always translate into improved performance.
- However, it can be speculated that barn environment (in particular pathogen load) may play a major role in piglet response to water treatment. Hence water treatment will likely have greater benefits in situations where nursery conditions are less than optimal.