RISK FACTORS FOR MORTALITY OF WEANED PIGLETS TRANSPORTED BY ROAD IN CANADA

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Presented by: Hauwa Bwala, DVM.

Saskatchewan Pork Industry Symposium
12th November 2019, Saskatchewan, Canada
Transportation of pigs in Canada.

Destination locations

Short journey (5mins to 6h)
Long journeys (≥ 36h)
**Background: Transport effects and regulations**

- Transport is associated with stress.
  - Handling, vibration, temperature changes

- Mortality records during transport.
  - Important index for animal welfare

- Regulations on livestock transport.
  - CFIA- *Health of Animals Regulations (Part XII).*
  - Max. time with no feed, water and rest: from 36h -28h in Feb. 2019.
  - Effective 2020.
  - What does this mean? Relevance of study?

Background: Why weaned piglets?

- Weaned piglets vs Market weight pigs.
  - Lower body reserves, tolerance of temperature fluctuations.
  - Limited information on weaned piglets transport.
  - What are the typical practices? How are piglets handling them?
  - Mortality figures?
  - Relationship between distance and mortality? Interactions with other transport factors?

**Study Objective**

- To identify risk factors for mortality in newly weaned piglets transported by road in Canada through retrospective analysis of transport records from commercial shipments.

![A pot-belly trailer used for pig transport in Canada.](image-url)
Transport records (N=6,692) from five companies, spanning 2014-2018.
- Integrated Company (X2)
- Livestock Transporter (X2)
- Cooperative Company (X1)

Transport journeys of 5mins – 36h.
- Potential risk factors for Dead on Arrival (DOA).

**Methodology: Data Collection**

<table>
<thead>
<tr>
<th>No.</th>
<th>Potential risk factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Maternity unit (Origin barn – OB)</td>
</tr>
<tr>
<td>2.</td>
<td>Receiving unit (Destination barn – DB)</td>
</tr>
<tr>
<td>3.</td>
<td>Total pigs per load (number of head – N)</td>
</tr>
<tr>
<td>4.</td>
<td>Batch weight of load (kg)</td>
</tr>
<tr>
<td>5.</td>
<td>Average piglet weight at transport (kg)</td>
</tr>
<tr>
<td>6.</td>
<td>Average ambient temperature at OB</td>
</tr>
<tr>
<td>7.</td>
<td>Average ambient temperature at DB</td>
</tr>
<tr>
<td>8.</td>
<td>Total distance travelled (km)</td>
</tr>
<tr>
<td>9.</td>
<td>Trucking company (N=8)</td>
</tr>
<tr>
<td>10.</td>
<td>Trailer type (Potbelly/Straight deck)</td>
</tr>
<tr>
<td>11.</td>
<td>Type of trip (Domestic/international)</td>
</tr>
</tbody>
</table>

Table 1. Potential risk factors that could influence piglet mortality during transport.
**Methodology: Data grouping**

- Temperature values from historical weather data (climate.weather.gc.ca).
  - Location coordinates to identify weather stations.

- Distance: calculated based on information received.
  - Coordinates to map distance (maps.google.com).

- Average temperatures and distances were categorized
  - Temperature categories based on Nora Lewis’ work (Lewis & Berry, 2006).

(*Estimated duration of transport in parenthesis)

**Table 2. Temperature categories and distance categories for data analysis.**

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Distance (Km*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very cold = &lt;-10</td>
<td>Short = &lt;500 (&lt;6h)</td>
</tr>
<tr>
<td>Cold = -10 to 5</td>
<td>Medium = 500 to 1250 (6-14h)</td>
</tr>
<tr>
<td>Mild = 5 to 20</td>
<td>Long = 1250 to 2500 (14-28h)</td>
</tr>
<tr>
<td>Warm = &gt;20</td>
<td>Very long = &gt;2500</td>
</tr>
</tbody>
</table>
Methodology: Data Analysis

- Piglet mortality (DOA counts).
  - Index of importance to pig welfare.

- Statistical software: Stata (Ver. 15.1).

- Regression analysis
  - Mixed Effects Negative Binomial (MENBREG).
  - Random effect = Origin Barn.
  - Fixed effects = Risk factors of interest.

- Descriptive statistics and summaries
  - Distribution of data
  - Averages and mortality rates
Results: Distribution of journeys by distance and temperature

- Short journeys accounted for 70% of all transport (N=6692).
- Transport in mild conditions (5 to 20°C) 67% of all transport (N=6692).

Figure 1. Distribution of transport records (N) by distance: short (<500km), medium (500-1250km), long (1250-2500km) and very long (>2500km).

Figure 2. Distribution of transport records (N) by temperature: very cold (<-10°C), cold (-10 to 5°C), mild (5 to 20°C) and warm (>20°C).
Results: Distribution of mortalities (%) by distance travelled

Figure 3. Distribution of transport records (N) by distance: short (<500km), medium (500-1250km), long (1250-2500km) and very long (>2500km) and reported mortality (0 or >=1 DOA).
Results: Total pigs (N) transported by distance travelled

Figure 4. Total number of pigs transported from (N) by distance: short (<500km), medium (500-1250km), long (1250-2500km) and very long (>2500km).
Results: Piglet mortality rate (%) by distance travelled

Figure 5. Piglet mortality rates (%) by distance: short (<500km), medium (500-1250km), long (1250-2500km) and very long (>2500km). Total N =6692.
Variables that remained in final Model:
- Distance (km)
- Temperature at Origin Barn (°C)
- Trailer type (PB/SD)
- Average piglet weight (confounding variable)

Average load size = 1,119 piglets/load

Average total DOA per load = 1 DOA/load.

Average temperature at Origin Barn (°C) = 6.8 °C
- Minimum: -30.3 °C, Maximum: 28.5 °C
Results: Effect of distance on mortality (DOA).

Figure 6. Mean predicted DOA (N) during short (<500km), medium (500-1250km), long (1250-2500km) and very long (>2500km) distance transport. Error bars indicate ± Standard error of mean. Variables within and across season with no shared letters indicate significant difference at the 5% level. G.
Results: Interactive effect of distance and temperature on mortality (DOA).

Figure 7. Mean predicted DOA (N) during short (<500km), medium (500-1250km), long (1250-2500km) and very long (>2500km) distance transport in very cold (<-10 °C), cold (-10 to 5 °C), mild (5 to 20 °C) and warm (>20 °C) conditions. Error bars indicate ± Standard error of mean. Variables within and across season with no shared letters indicate significant difference at the 5% level.
Results: Interactive effect of trailer type and temperature on mortality (DOA).

Figure 8. Mean predicted DOA (N) during short (<500km), medium (500-1250km), long (1250-2500km) and very long (>2500km) distance transport in very cold (<-10°C), cold (-10 to 5°C), mild (5 to 20°C) and warm (>20°C) conditions. Error bars indicate ± Standard error of mean. Variables within and across season with no shared letters indicate significant difference at the 5% level.
Conclusions.

- Distance does impact DOA:
  - Increased risk with increasing distance travelled.

- Distance interacts with environmental conditions.
  - Colder weather increases risk of DOA’s than warmer temperature.

- Trailer type interacts with temperature to influence DOA.
  - Pot belly trips in colder temps increase risk of mortality.

- Future Studies:
  - Impact of transport on piglet behaviour – Data collected and being analysed.
  - Loading density, on-board watering, compartment temperatures and management practices at origin barns may be important to distance.
Industry implications.

- Presents much needed knowledge on piglet mortality during commercial transport.
  - Fills a knowledge gap – provides science-based data on mortality figures.

- Improves our understanding of current practices.

- Identifies areas of focus to decrease piglet mortality.
  - Aid in re-evaluating management practices.

- Uncovers relationships that are likely impacting piglet welfare during transport.

That's all folks!
Thank You!

- Funding: Saskatchewan Agriculture Development Fund (ADF).

- Industry partners for providing data.
The effect of field pea and enzyme supplementation of swine diets on animal performance and nutrient digestibility

Jismol Jose, Agbee Livingstone, Atta Agyekum, Denise Beaulieu
University of Saskatchewan

Saskatchewan Pork Industry Symposium
Nov 12-13, 2019
FIELD PEAS, ENZYMES AND SUSTAINABILITY

- Feed production constitutes 60% of total GHG emissions from pig sector
  
  *Macleod et al., 2013*

- 17% of the total emissions from pork production is accounted by the application of inorganic and organic nitrogenous fertilizers for crop production
  
  *Macleod et al., 2013*

- Canada is the largest pea producer and exporter in the world
  
  *Food and Agriculture Statistics database, United Nations, 2016*

- Enzyme addition improves nutrient digestibility and reduces manure output in terms of amount and nutrients
  
  *Ravindran, 2013*
STUDY 1
EFFECT OF HIGH INCLUSION OF FIELD PEAS SUPPLEMENTED WITH ENZYMES ON GROWTH PERFORMANCE OF GROWER PIGS

STUDY 2
EFFECT OF HIGH INCLUSION OF FIELD PEAS SUPPLEMENTED WITH ENZYMES ON NUTRIENT DIGESTIBILITY IN GROWER PIGS
Study 1: Background

- The growth performance and meat quality of grower/finisher pigs was not affected when 20% field peas was included in the diet, replacing 58% of the soybean meal. 
  *Gatta et al., 2013*

- Feeding grower pigs a diet with 66% field peas had no negative impact on growth performance and carcass parameters, provided all the nutrient requirements are met. 
  *Stein et al., 2006*

- Overall ADG and G:F in the nursery was maintained when 40% field peas replaced SBM, although a reduction in ADG and G:F was observed during the first week of the trial. 
  *Landero et al. 2014*
Objective

- Determine the effect of 40% field pea inclusion with and without enzymes on growth, days to market and carcass qualities of grower-finisher pigs
## Methodology

- 180 pigs; 90 males and 90 females (60 ± 2.2 kg BW)
- 5 pigs/pen
- Feed and water was provided ad libitum

<table>
<thead>
<tr>
<th></th>
<th>0% Peas</th>
<th>40% Peas</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ Enzyme</td>
<td>0% Peas + Enzyme</td>
<td>40% Peas + Enzyme</td>
</tr>
<tr>
<td>- Enzymes</td>
<td>0% Peas – Enzyme</td>
<td>40% Peas – Enzyme</td>
</tr>
</tbody>
</table>
Multicarbohydrase enzyme used: Superzyme®-W¹

- Glucanase: minimum 300 GLU units/g
- Xylanase: minimum 1,000 XYL units/g
- Cellulase: minimum 1,900 CMC units/g
- Amylase: minimum 4,200 FAA units/g
- Invertase: minimum 150 INV units/g

- Used 1,000 grams per tonne of complete feed

¹CANADIAN BIO-SYSTEMS INC. CALGARY, ALBERTA
### Ingredient composition of diets for Study 1 (% as fed)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Phase 1</th>
<th>Phase 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DM%</td>
<td>CP%</td>
</tr>
<tr>
<td>Control</td>
<td>88.0</td>
<td>16.4</td>
</tr>
<tr>
<td>Peas</td>
<td>88.8</td>
<td>17.7</td>
</tr>
<tr>
<td>Field peas</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>Wheat</td>
<td>61.8</td>
<td>21.9</td>
</tr>
<tr>
<td>Barley</td>
<td>24.8</td>
<td>29.5</td>
</tr>
<tr>
<td>Canola oil</td>
<td>1.5</td>
<td>1</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>L-Lysine</td>
<td>0.34</td>
<td>0.00</td>
</tr>
<tr>
<td>DL-Methionine</td>
<td>0.03</td>
<td>0.08</td>
</tr>
<tr>
<td>L-Threonine</td>
<td>0.08</td>
<td>0.08</td>
</tr>
<tr>
<td>Limestone</td>
<td>1.20</td>
<td>1.20</td>
</tr>
<tr>
<td>Others</td>
<td>1.20</td>
<td>1.30</td>
</tr>
</tbody>
</table>
Data Collection

Animals and the amount of feed offered were weighed every two weeks

- \( \text{ADG (kg.d}^{-1}) = \frac{(\text{final weight} - \text{initial weight})}{\text{days on feed}} \)

- \( \text{ADFI (kg.d}^{-1}) = \frac{(\text{total feed offered (kg)} - \text{total feed left (kg)})}{\text{days on feed}} \)

- \( \text{G:F} = \frac{\text{ADG}}{\text{ADFI}} \)

Animals were marketed when they attained a target body weight of 127 kg
## Results

<table>
<thead>
<tr>
<th></th>
<th>Peas</th>
<th>Enzyme</th>
<th>P-Value</th>
<th>Peas*</th>
<th>Enzyme</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>SEM</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>AVERAGE DAILY GAIN</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 14</td>
<td>No: 1.13</td>
<td>Yes: 1.14</td>
<td>No: 1.19</td>
<td>Yes: 1.08</td>
<td>0.049</td>
</tr>
<tr>
<td>15 - 28</td>
<td>No: 1.14</td>
<td>Yes: 1.17</td>
<td>No: 1.12</td>
<td>Yes: 1.20</td>
<td>0.031</td>
</tr>
<tr>
<td>29 - 42</td>
<td>No: 1.09</td>
<td>Yes: <strong>1.17</strong></td>
<td>No: 1.13</td>
<td>Yes: 1.13</td>
<td>0.027</td>
</tr>
<tr>
<td>43 - 56</td>
<td>No: 0.98</td>
<td>Yes: 1.03</td>
<td>No: 1.00</td>
<td>Yes: 1.01</td>
<td>0.025</td>
</tr>
<tr>
<td>0 - 56</td>
<td>No: 1.09</td>
<td>Yes: <strong>1.13</strong></td>
<td>No: 1.11</td>
<td>Yes: 1.11</td>
<td>0.027</td>
</tr>
</tbody>
</table>
### Results

<table>
<thead>
<tr>
<th>AVERAGE DAILY FEED INTAKE</th>
<th>Peas</th>
<th>Enzymes</th>
<th>P-Value</th>
<th>Peas* Enzyme</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>Yes</td>
<td>SEM</td>
<td>Peas</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>Yes</td>
<td>SEM</td>
<td>Peas</td>
</tr>
<tr>
<td>0 - 14</td>
<td>2.24</td>
<td>2.28</td>
<td>0.085</td>
<td>0.72</td>
</tr>
<tr>
<td>15 - 28</td>
<td>2.84</td>
<td>3.00</td>
<td>0.054</td>
<td>0.05</td>
</tr>
<tr>
<td>29 - 42</td>
<td>2.87</td>
<td>2.98</td>
<td>0.048</td>
<td>0.13</td>
</tr>
<tr>
<td>43 - 56</td>
<td>3.25</td>
<td>3.25</td>
<td>0.087</td>
<td>0.97</td>
</tr>
<tr>
<td>0 - 56</td>
<td>2.80</td>
<td>2.88</td>
<td>0.041</td>
<td>0.09</td>
</tr>
</tbody>
</table>

G:F (0.40 ± 0.03) was not affected by treatment (P>0.1)
## Results – Carcass

<table>
<thead>
<tr>
<th>Carcass Data</th>
<th>Peas</th>
<th>Enzyme</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>Yes</td>
<td>SEM</td>
</tr>
<tr>
<td>Carcass Wt</td>
<td>105.8</td>
<td>105.6</td>
<td>0.524</td>
</tr>
<tr>
<td>Fat</td>
<td>16.7</td>
<td>16.4</td>
<td>0.790</td>
</tr>
<tr>
<td>loin</td>
<td>66.9</td>
<td>67.2</td>
<td>0.933</td>
</tr>
<tr>
<td>Yield</td>
<td>61.8</td>
<td>62.0</td>
<td>0.408</td>
</tr>
<tr>
<td>Dressing %</td>
<td>79.9</td>
<td>79.7</td>
<td>0.307</td>
</tr>
<tr>
<td>Days to Market</td>
<td>67.9</td>
<td>66.0</td>
<td>2.142</td>
</tr>
</tbody>
</table>
Results

- Tendency for improved ADG, ADFI and days to market was observed with high inclusion of field peas

- Carcass parameters (carcass weight, yield, loin area, back fat thickness and dressing percent) were comparable among treatments.
Conclusion

- Performance of grow-finish pigs was maintained with the inclusion of 40% field peas in the diet

- Addition of carbohydrase enzyme had no effect on performance in this study
Study 2: Background

- The proportion of non-starch polysaccharides (NSP) in peas is high, but they are highly fermentable
  
  Canibe et al., 1997

- In comparison with soybean meal the fiber content in field peas is high thereby diets formulated with field peas replacing soybean meal will be higher in fiber
  
  Landero et al., 2014

- Enzymes like cellulases, glucanases, pectinases and xylanases which are capable of cell wall disruption can enhance NSP digestibility
  
  Zijlstra et al., 2010
Objective

- To determine the nutrient digestibility and effect of multicarbohydrase supplementation on fiber digestion in high pea diets
Methodology

- 48 crossbred barrows (60.9 ± 2.6 kg BW) were selected and assigned to pens and treatments.
- Pigs were housed individually in metabolism crates (1.42m x 1.49m).
- Animals were fed three times their maintenance requirement which approximates 95% of ad libitum intake.
- Water was provided ad libitum using a nipple drinker.
Methodology

- Three levels of peas (0, 20 and 40%), with or without a carbohydrazo enzyme.
- Celite was added as a marker to calculate digestibility

<table>
<thead>
<tr>
<th></th>
<th>0% Peas</th>
<th>20% Peas</th>
<th>40% Peas</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ Enzyme</td>
<td>0% Peas + Enzyme</td>
<td>20% Peas + Enzyme</td>
<td>40% Peas + Enzyme</td>
</tr>
<tr>
<td>- Enzymes</td>
<td>0% Peas – Enzyme</td>
<td>20% Peas – Enzyme</td>
<td>40% Peas – Enzyme</td>
</tr>
</tbody>
</table>
### Ingredient composition of diets for Study 2 (%as fed)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>0% Peas</th>
<th>20% Peas</th>
<th>40% Peas</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM%</td>
<td>88.0</td>
<td>88.5</td>
<td>88.8</td>
</tr>
<tr>
<td>CP%</td>
<td>16.4</td>
<td>16.7</td>
<td>17.7</td>
</tr>
<tr>
<td>NE (Kcal/kg)</td>
<td>2422</td>
<td>2400</td>
<td>2379</td>
</tr>
<tr>
<td>Ingredients</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field peas</td>
<td>0.0</td>
<td>20.0</td>
<td>40.0</td>
</tr>
<tr>
<td>Wheat</td>
<td>61.8</td>
<td>41.5</td>
<td>21.9</td>
</tr>
<tr>
<td>Barley</td>
<td>24.8</td>
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<td>29.5</td>
</tr>
<tr>
<td>Canola oil</td>
<td>1.5</td>
<td>1.2</td>
<td>1.0</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>9.0</td>
<td>6.0</td>
<td>5.0</td>
</tr>
<tr>
<td>L-Lysine</td>
<td>0.34</td>
<td>0.19</td>
<td>0.00</td>
</tr>
<tr>
<td>DL-Methionine</td>
<td>0.03</td>
<td>0.05</td>
<td>0.08</td>
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<tr>
<td>L-Threonine</td>
<td>0.08</td>
<td>0.08</td>
<td>0.08</td>
</tr>
<tr>
<td>Limestone</td>
<td>1.20</td>
<td>1.20</td>
<td>1.20</td>
</tr>
<tr>
<td>Others</td>
<td>1.20</td>
<td>1.25</td>
<td>1.30</td>
</tr>
</tbody>
</table>
Sample collection

- The experiment utilized a 7-day adaptation period, followed by 4-days of collections

- A sample of feces was collected twice daily, while urine was collected continuously for 24 hours for the 4 days
Data Analysis

- Chemical analyses were conducted at the General Nutrition Laboratory of the Department of Animal and Poultry Science at the University of Saskatchewan and Central Testing Laboratories in Winnipeg, Manitoba.

- Apparent total tract digestibility was calculated using the equation:

\[
\text{ATTD, } \% = 100 - \left[ \left( \frac{\% \text{Marker Diet} \times \% \text{Nutrient Feces}}{\% \text{Marker Feces} \times \% \text{Nutrient Diet}} \right) \times 100 \right]
\]
## Results

<table>
<thead>
<tr>
<th></th>
<th>Peas</th>
<th>Enzyme</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>DM</td>
<td>87.9</td>
<td>86.2</td>
<td>86.7</td>
</tr>
<tr>
<td>GE</td>
<td>87.4</td>
<td>85.9</td>
<td>86.1</td>
</tr>
<tr>
<td>NDF</td>
<td>50.0</td>
<td>45.3</td>
<td>53.0</td>
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<tr>
<td>ADF</td>
<td>34.6</td>
<td>38.0</td>
<td>47.6</td>
</tr>
<tr>
<td>N</td>
<td>86.3</td>
<td>84.3</td>
<td>83.3</td>
</tr>
<tr>
<td>P</td>
<td>52.9</td>
<td>44.5</td>
<td>45.2</td>
</tr>
</tbody>
</table>
Results

- An improved digestibility of DM, energy, N, and P was observed for pigs fed the control (0% peas) diet

- NDF and ADF digestibility was improved with 40% field peas

- Enzyme inclusion improved ADF digestibility
Conclusion

- Inclusion of 40% field peas had a negative impact on DM and energy digestibility

- Field pea fibers were more digestible

- Addition of carbohydrate enzymes improved fiber digestibility
Industry Implications

- Field peas can be considered as an alternative energy as well as protein source for pigs

- Addition of enzymes can improve the fiber digestibility

- Further research is required to determine if this will reduce the GHG output from pork production
Acknowledgement

- The project was funded by Saskatchewan Agriculture Development Fund (ADF) program, under the Canadian Agricultural Partnership.
Questions?
Effect of supplemental threonine above requirement on growth performance of *Salmonella typhimurium* challenged pigs fed high fiber diets

**M.O. Wellington**†*, A.K. Agyekum*, K. Hamonic*, J.K. Htoo‡, A.G. Van Kessel* and D.A. Columbus†*

†Prairie Swine Centre, Inc. Saskatoon, SK Canada
*Department of Animal and Poultry Science, University of Saskatchewan
‡ Evonik Nutrition & Care GmbH, Hanau-Wolfgang, Germany
Introduction

• Alternative feedstuff use in swine diets has increased in the last decade
  – DDGS, wheat bran, wheat shorts, soybean hulls

• Cheaper and readily available to producers but high in fiber and variable in composition (Woyengo et al., 2014)
  • Increased mucous secretion (Libao-Mercado et al., 2007)
  • Reduced nutrient digestibility (Mathai et al., 2016)

• High fiber increases Thr requirement for growth (Mathai et al., 2016; Wellington et al., 2018)
Introduction

• Restriction on antibiotic use by new regulations
  • Elimination of antibiotic use for growth promotion
  • Increased enteric immune challenge

• Immune challenge increases amino acid requirements (de Ridder et al., 2012; Litvak et al., 2013)
  • Nutrient partitioning towards immune response (Reeds et al., 1994)
  • Reduced amino acid availability for growth (Li et al., 1999, Zhang et al., 2007)
Introduction

Systemic LPS Challenge ABSENT

- Low-fiber diet estimate at
  - 0.68% SID Thr for maximum protein deposition

- High-fiber diet estimate
  - 0.78% SID Thr for maximum protein deposition

Systemic LPS Challenge PRESENT

- Low fiber diet estimate at
  - 0.76% SID for maximum protein deposition

- High fiber diet estimate
  - 0.72% SID Thr for maximum protein deposition

Wellington et al., 2018; J. Anim. Sci. 96:5222-5232
Objective

• To investigate whether supplementing Thr (0.78%) to meet requirements for high fiber and systemic LPS would maintain performance of pigs exposed to an enteric immune challenge when fed high fiber diets

Hypothesis

• Growth performance of pigs fed high fiber diets and challenged with Salmonella would be maintained when fed supplemental Thr.
Materials and Methods

- 128 growing pigs
- 22.6 ± 1.6 kg initial BW
- 4 pigs per pen
- 4 dietary treatments (8 pens/trt):
  - Low \((\text{LF})\) or high \((\text{HF})\) dietary fiber
  - Standard \((\text{STD}; 0.65\% \text{ SID})\) or supplemented \((\text{SUP}; 0.78\% \text{ SID})\) dietary Thr

- After 7 d adaptation, the experimental protocol was initiated for 21 d

- On d 1, all pigs were orally inoculated with \(2.3 \times 10^9\) CFU/ml of *Salmonella typhimurium var Copenhagen (Nov+/Nal+)\(^R\)
# Experimental Diets

## Ingredients, %

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>STD Thr</th>
<th>SUP Thr</th>
<th>STD Thr</th>
<th>SUP Thr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>47.0</td>
<td>47.0</td>
<td>47.0</td>
<td>47.0</td>
</tr>
<tr>
<td>Barley</td>
<td>10.0</td>
<td>10.0</td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Corn</td>
<td>21.8</td>
<td>21.7</td>
<td>4.0</td>
<td>3.8</td>
</tr>
<tr>
<td>Sugar beet pulp</td>
<td>-</td>
<td>-</td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Wheat bran</td>
<td>-</td>
<td>-</td>
<td>5.0</td>
<td>5.0</td>
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<tr>
<td>Soybean meal</td>
<td>17.0</td>
<td>17.0</td>
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<tr>
<td>L-Threonine</td>
<td>0.15</td>
<td>0.28</td>
<td>0.16</td>
<td>0.29</td>
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<tr>
<td>Other ingredients</td>
<td>4.05</td>
<td>4.02</td>
<td>6.84</td>
<td>6.91</td>
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</tbody>
</table>

## Analyzed nutrients, %

<table>
<thead>
<tr>
<th>Analyzed nutrients</th>
<th>STD Thr</th>
<th>SUP Thr</th>
<th>STD Thr</th>
<th>SUP Thr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude protein</td>
<td>18.6</td>
<td>18.5</td>
<td>18.1</td>
<td>18.6</td>
</tr>
<tr>
<td>Total dietary fiber</td>
<td>13.0</td>
<td>13.7</td>
<td>20.9</td>
<td>19.9</td>
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<tr>
<td>Soluble dietary fiber</td>
<td>1.8</td>
<td>1.9</td>
<td>3.6</td>
<td>3.7</td>
</tr>
<tr>
<td>Insoluble dietary fiber</td>
<td>11.2</td>
<td>11.8</td>
<td>17.3</td>
<td>16.2</td>
</tr>
<tr>
<td>Net energy, kcal/kg</td>
<td>2488</td>
<td>2489</td>
<td>2486</td>
<td>2484</td>
</tr>
</tbody>
</table>
Materials and Methods

Sampling protocol

- Rectal temperature
  - Every 24 h for 6 d post-challenge.

- Blood Analysis
  - Samples collected on d -1, 4, and 7 post-challenge.

- Rectal swabs collected on d 1, 2, 4, 6, 14, and 20 post challenge and cultured on brilliant green agar and incubated overnight at 37°C
  - Colonies > 30 were given shedding score of 3.
  - Colonies < 30 were given shedding score 2.
  - Shedding score of 1 was assigned to swabs that were negative for ST following direct plating but positive after enrichment

- Body weight and feed intake were recorded
  - d -7, d 0, d 7, 14, and 21 post-challenge.
Statistical Analyses

• Growth performance data analyzed as a 2×2 factorial in a randomized complete block (Proc Mixed SAS 9.4)
  ➢ Main effects were a) fiber level and b) Thr level and their interactions.

• Blood data was analyzed as repeated measures ANOVA to determine the effect of day

• Significance at $P < 0.05$ (Tukey mean separation test)
Salmonella challenge induced a febrile response

- Serum haptoglobin increased d4 post-challenge and remained elevated on d7
Results - Pre-inoculation Growth Performance

No significant differences in ADG were observed.

HF reduced feed intake but no effect of Thr was observed.

HF improved G:F due to lower ADFI, but no effect of Thr was observed.
**Result - Post-Inoculation performance (day 0-7)**

- HF reduced ADG and SUP Thr improved ADG
- Both HF and SUP Thr reduced ADFI
- SUP Thr improved G:F while HF reduced G:F
Result - Post-Inoculation performance (day 8-21)

- SUP Thr improved ADG and HF reduced ADG
- No significant effects of fiber and Thr on feed intake
- SUP Thr improved G:F while HF reduced G:F
Conclusion

• Supplemental Thr above estimated requirement (NRC, 2012) improved growth performance in both LF and HF fed pigs.

• HF reduced both ADG and ADFI in Salmonella challenged pigs.

• Thr supplementation to meet previously estimated requirements for HF and LPS challenge was not sufficient to maintain growth performance in pigs fed HF and challenged with an enteric pathogen.

  • Are the endogenous Thr losses associated with mucin secretion greater with Salmonella challenge than LPS???
Acknowledgements

- Animal Care Unit staff, WCVM
- Prairie Swine Centre technicians
- Swine nutrition research group, U of S
Thank You