RATE & EXTENT OF WHEAT STARCH DIGESTION AND ITS IMPACT ON GRAIN AME & BROILER GROWTH

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Outline

• Introduction

• Experiment 1 - In vitro assessment of starch digestibility

• Experiment 2 - In vivo assessment of starch digestibility

• Conclusion/Implications
Importance of wheat in feed

- **Canadian feed industry** - Feed accounts for 60 to 75% of total cost of poultry production (Agriculture and Agri food Canada 2013)

- **Energy in feed** - 40% of cost of production for poultry industry (Scott et al., 1998)

- **Wheat** - main energy providing cereal in western Canada (Gutierrez del Alamo et al., 2008; Yegani et al., 2013)
• Wheat class/cultivar significantly different for AME
  - CWAD > CWES > HRS > CPS
  - CWAD – highest

• Feed conversion ratio (FCR)
  - HRS > CPS > CWAD  (Scott et al., 1998)
• In vivo Ileal starch digestibility
  ➢ Lowest - CPSR (0.836)
  ➢ Highest - CWAD (0.923)

• Ileal digestible energy (IDE)
  ➢ Lowest - CWSWS (11.3 MJ/kg)
  ➢ Highest - CWAD (13.4 MJ/kg)

• Apparent metabolizable energy (AME)
  ➢ Lowest – CWSWS (12.7 MJ/kg)
  ➢ Highest – CWAD (14.6 MJ/kg)  (Yegani et al., 2013)
Experiment 1 - In vitro assessment of starch digestibility
Objectives

- Determine the effect of class and cultivar on the rate and extent of in vitro starch digestibility of wheat
- Determine the relationship of starch characteristics to the rate and extent of starch digestion
**Materials & Methods**

Wheat samples \((n = 18; 4 \text{ samples per cultivar})\)

<table>
<thead>
<tr>
<th>Class</th>
<th>Cultivars</th>
</tr>
</thead>
<tbody>
<tr>
<td>CWES</td>
<td>CDC Rama</td>
</tr>
<tr>
<td>CWSWS</td>
<td>AC Andrew, Sadash</td>
</tr>
<tr>
<td>Spelt</td>
<td>CDC Zorba, CDC Origin,</td>
</tr>
<tr>
<td>CPS</td>
<td>5702PR, SY985, Conquer</td>
</tr>
<tr>
<td>CWHW</td>
<td>Snowstar, Snowbird</td>
</tr>
<tr>
<td>CWAD</td>
<td>Strongfield, CDC Verona, Transcend</td>
</tr>
<tr>
<td>CWRS</td>
<td>Glenn, CDC Stanley, CDC Utmost</td>
</tr>
<tr>
<td>GP</td>
<td>NRG003, Minnedosa</td>
</tr>
</tbody>
</table>
In vitro starch digestion

• Principle - establish two incubation periods to mimic chicken’s gastric and small intestine (SI) phases
  • Grind samples (0.5mm) to mimic chicken gizzard
  • Gastric phase (proventriculus and gizzard)
    ➢ 30 minutes
    ➢ pH 2.5; pepsin
  • SI phase
    ➢ 240 minutes
    ➢ Temperature 41°C; pH 5.6; pancreatin
• Measure glucose release
In vitro starch digestibility for wheat classes

![Graph showing the in vitro starch digestibility for different wheat classes over time. The x-axis represents incubation time (min) ranging from 0 to 240 minutes, while the y-axis represents starch digestibility (%) ranging from 0 to 120%. The graph includes lines for various wheat classes such as CWES, CWSWS, Spelt, CPS, CWHW, CWAD, CWRS, and GP.]
### Class range in digestibility values

<table>
<thead>
<tr>
<th>Incubation time (min)</th>
<th>Class (low)</th>
<th>% starch digestion</th>
<th>Class (high)</th>
<th>% starch digestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>Spelt</td>
<td>33.06</td>
<td>CWAD</td>
<td>49.12</td>
</tr>
<tr>
<td>60</td>
<td>CWRS</td>
<td>80.15</td>
<td>CWAD</td>
<td>93.29</td>
</tr>
<tr>
<td>120</td>
<td>CWRS</td>
<td>92.37</td>
<td>CWES</td>
<td>97.57</td>
</tr>
</tbody>
</table>
In vitro starch digestibility for wheat cultivars

Starch digestibility (%) vs. Incubation time (min)

- CDC Rama
- AC Andrew
- Sadash
- CDC Zorba
- CDC Origin
- 5702PR
- SY985
- Conquer
- Snowstar
- Snowbird
- Strongfield
- CDC Verona
- CDC Verona
- Transcend
- Glenn
- CDC Stanley
- CDC Utmost
- NRG003
- Minnedosa

www.usask.ca
## Cultivar range in digestibility values

<table>
<thead>
<tr>
<th>Incubation time (min)</th>
<th>Cultivar (low)</th>
<th>% starch digestion</th>
<th>Cultivar (high)</th>
<th>% starch digestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>CDC Zorba</td>
<td>32.62</td>
<td>Transcend</td>
<td>51.63</td>
</tr>
<tr>
<td>60</td>
<td>Glenn</td>
<td>77.26</td>
<td>CDC Verona</td>
<td>94.75</td>
</tr>
<tr>
<td>120</td>
<td>CDC Origin</td>
<td>90.97</td>
<td>Transcend</td>
<td>101.33</td>
</tr>
</tbody>
</table>
Starch analysis

- Amylose content
- Granule size
- Associated compounds (lipid, protein)
- Dietary fibre – arabinoxylans, β-glucans (Ahuja et al., 2013)
Wheat cultivar selection for in vivo trials

- CWAD - Transcend, Strongfield
- GP - Minnedosa, NRG003
- CWRS - CDC Stanley, Glenn
- CPS - 5702PR, Conquer
- CWHW - Snowbird, Snowstar
- CWSWS - Sadash, AC Andrew
Experiment 2 - In vivo assessment of starch digestibility
Objectives

- To determine the effect of wheat cultivar on the rate and extent of starch digestibility in broiler chickens
- To study the relationship between in vitro and in vivo digestibility assessment
- To determine the degree of starch fermentation by comparing starch digestion at the terminal ileum and in excreta
- To relate in vitro and in vivo digestibility to wheat apparent metabolizable energy (AME)
Materials & Methods

- Day old broiler chicks from a hatchery
- Experimental diet - 14 to 21 days of age
- Feed intake & body weight gain
  - Cage basis day 14 - 21
- Mortality- daily recording
- Feed conversion ratio
Sample collection

Caeca

Excreta
Conclusion

- Wheat class/cultivar affects on in vitro starch digestibility rate & extent of poultry.
Implications

- Develop better wheat varieties by plant breeding
- Accuracy of poultry diet formulation
- Undigested starch for energy requirements of animals
- Future research on starch digestibility rates
Questions