Predicted glycemic index and hydrolysis index in former food products intended for pig nutrition


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Carbohydrates/starch in animal nutrition

Major nutrient in farm animals diets

IMPORTANT

• Kinetics of carbohydrate/starch digestion of cereal-based feeds

• Different approach for pig nutrition
  – Glycemic Index (GI) classification

Pig diet

- NFC
- Protein
- Fiber
- Ash
- Fat
Carbohydrates digestion and glycemnic index

WHAT IS GLYCEMIC INDEX (GI)?

• A figure representing the relative ability of a carbohydrate food to increase the level of glucose in the blood.
Carbohydrates sources can affect FI

Figure 2: Effect of the five experimental diets on the incremental postprandial plasma glucose concentration in jugular-catheterized pigs. Values are means (n = 5 ± s.e.). CTR = corresponding area for the reference diet.

(van Kempen 2007; Menoyo et al. 2011; Giuberti et al., 2012a; Giuberti et al., 2012b; Dotti et al., 2014;
Aim

Evaluation of the predicted glycemic index (pGI) and hydrolysis index (HI) in selected FFPs intended for pig nutrition
Materials _feed samples

• Six FFPs samples

• Two control samples
  – Maize
  – Flacked wheat

• One reference sample
  – White bread
Methods

**In vivo cumulation of starch digestion**

**ORAL PHASE**

800mg ± 0.1 FFPs (milled 1-mm)

**GASTRIC PHASE**

25mg Pepsin in HCl 0.05M, 39°C, 30min

**INTESTINAL PHASE**

Small intestine

Enzyme mixture amylase activity
7000U/mL; pancreatic + amyloglucosidase + invertase
pH 5.2, 39°C, 240 min

**D-Glucose determination**

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120min
Calculations & statistics

- Digested carbohydrates
- Area under the curve

\[
A_3 = \frac{(C_{P_2} + C_{P_3}) \times (t_3 - t_2)}{2}
\]

- Hydrolysis index

\[
HI = \frac{AUC_{sample}}{AUC_{white \ bread}} \times 100
\]

- Predicted glycemic index

\[
pGI = 1.013 \cdot HI
\]

- \( C_0 \), \( C_\infty \), and \( k \)

\[
C_t = C_0 + C_\infty \cdot (1 - e^{-kt})
\]

→ Marquardt method PROC NLIN (SAS statistics, 2003)

- One way ANOVA (SAS statistics, 2003)

- MSD tukey’s test
## Results

<table>
<thead>
<tr>
<th>Item</th>
<th>$C_0$</th>
<th>$C_\infty$</th>
<th>$k$</th>
<th>$HI$</th>
<th>$pGI$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unprocessed maize</td>
<td>1.04</td>
<td>74.86</td>
<td>0.05</td>
<td>81.05</td>
<td>82.10</td>
</tr>
<tr>
<td>Heat processed wheat</td>
<td>1.77</td>
<td>80.79</td>
<td>0.12</td>
<td>93.59</td>
<td>94.81</td>
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<tr>
<td>FFP1</td>
<td>4.13</td>
<td>97.65</td>
<td>0.12</td>
<td>113.41</td>
<td>114.89</td>
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<td>FFP2</td>
<td>4.73</td>
<td>91.67</td>
<td>0.19</td>
<td>109.53</td>
<td>110.96</td>
</tr>
<tr>
<td>FFP3</td>
<td>5.37</td>
<td>87.00</td>
<td>0.09</td>
<td>100.08</td>
<td>101.38</td>
</tr>
<tr>
<td>FFP4</td>
<td>0.92</td>
<td>78.87</td>
<td>0.09</td>
<td>86.01</td>
<td>87.13</td>
</tr>
<tr>
<td>FFP5</td>
<td>2.86</td>
<td>87.11</td>
<td>0.13</td>
<td>104.70</td>
<td>106.06</td>
</tr>
<tr>
<td>FFP6</td>
<td>2.87</td>
<td>99.75</td>
<td>0.12</td>
<td>113.45</td>
<td>114.92</td>
</tr>
<tr>
<td>P</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>MSD</td>
<td>1.48</td>
<td>10.93</td>
<td>0.099</td>
<td>9.78</td>
<td>9.91</td>
</tr>
</tbody>
</table>

$C_0$ – carbohydrates digested at 0 min (g/100 g dry carbohydrates); $C_\infty$ – potential digestibility of carbohydrates (g/100 g dry carbohydrates); $k$ – rate of carbohydrates digestion (/min); HI – calculated by using white bread as reference (HI = 100); $pGI$ – predicted glycemic index calculated by using the equation proposed by Giuberti et al. (2011b); MSD – minimum significant difference.
Hydrolysis index & predicted Glycemic Index

![Graph showing the hydrolysis index and predicted glycemic index for different foods. The graph compares the HI and pGI for FFP1 to FFP6, flacked wheat, and maize. White bread is highlighted as a high glycemic index food.](image-url)
$k$ – rate of carbohydrates digestion (rate/min)
Results: glucose release over the time

Cumulative

Absolute
Summary

• FFPs are excellent energy/carbohydrates source

• Indexes like pGI and HI are accurate in defining FFPs nutritional features
  – FFPs are Rich in “ready to use” carbohydrates,
  – FFP’s pGI & HI are higher than in common cereals grains
Next step

• Further evaluation inclusion in a **compound feed**/complete diet
  – Inclusion level effect
Inclusion of 30% of FFP in a pig compound feed

CTR vs. FFPs

- At similar pGI
- $K$ – rate of carbohydrates digestion (/min) were:

  CTR = 0.121; FFP30% = 0.207

Ottoboni et al., unpublished results
Thank you for your attention

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