Supplementation of pig diets with live yeast increases rate and extent of fermentation of non-digested feed ingredients and improve pig performance
Introduction

• World population (UN)
  - From >7 billion in 2010 to >9 billion in 2050
  - >90% in developing countries
Food price will also increase by ~20% - 70% between 2010 and 2050
Impact of food/feed price increase on pig farmers

- 2/3 of the total swine farm expense is accounted as feed cost
  - Pig Farmers will be forced to:
    - Reduce cost and Increase feed efficiency
  - Pig farmers will turn into other feed alternatives
    - Vegetable food residues
      • Cassava leaves, Sweet Potato vines, Tofu residues etc
    - Industrial byproducts
      • Wheat DDGS, Corn DDGS, Rice bran, Wheat bran
  - These cheap feed ingredients are rich in fibre content
    - Less digestible in the SI: less energy value
    - Anti-nutritional factors: less digestibility and nutrient utilization
Physiological Significance of Dietary Fibers

• Additional energy source
  ▪ 15% to 30% maintenance energy

• Enhances animal welfare
  ▪ Increase satiety and decrease aggressive behavior in sows

• Improve gut health
  ▪ Decrease GIT pH & suppress growth of harmful bacteria
  ▪ Support growth of beneficial microbiota
  ▪ Stimulate gut proliferation and maintenance
  ▪ Decreases negative effect of protein fermentation
DF decreases the production of harmful metabolites from protein fermentation

- Shift in N excretion pathway from urine to feces

![Graph showing the relationship between NSP (g/kg diet) and N-urine/N-feces ratio. The equation is $y = 178.1x^{-0.83}$ with $R^2 = 0.79$.](Jongbloed, 2001)
Methods to improve fiber utilization in swine

Choosing the right fibre type
- Soluble DF
- Insoluble DF

Feed processing techniques
- Grinding
- Pelleting, Extrusion

Exogenous Enzymes
- Xylanase
- Phytase
- β-glucanase

Pre and Probiotics
- Bacteria, Yeast and Yeast cell wall

Improve fibre fermentation and feed energy value
Objective

• To investigate the effect of live yeast (Actisaf®) supplementation on the rate and extent of in vitro fermentation of feed residues by fecal microbiota of pigs

• To Determine the effect of probiotic yeast (Actisaf®) supplementation on the in vivo fermentation and energy recovery of fibre rich feedstuffs in growing pigs.
Materials and Methods

- In vitro Digestion of Feed Ingredients

  - 2 g ingredient (1 mm size) in phosphate buffer

    - Pepsin digestion,
      - 2 hours, pH 2 buffer
    - Pancreatin digestion
      - 4 hours, pH 6.8 buffer

    - Filtered on nylon mesh (45μm)
    - Oven dried at 60°C
    - Ground through 0.5mm screen
Dry matter content and in vitro DM digestibility of ingredients used for in vitro fermentation

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Dm (%)</th>
<th>SD</th>
<th>CV (%)</th>
<th>IVDMD (%)</th>
<th>SD</th>
<th>CV (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>92.28</td>
<td>0.2499</td>
<td>0.2708</td>
<td>82.83</td>
<td>2.1515</td>
<td>2.5976</td>
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<tr>
<td>Barely</td>
<td>92.53</td>
<td>0.2438</td>
<td>0.2635</td>
<td>76.76</td>
<td>1.5029</td>
<td>1.9579</td>
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<tr>
<td>Corn</td>
<td>91.56</td>
<td>1.0235</td>
<td>1.1178</td>
<td>74.77</td>
<td>1.2110</td>
<td>1.6196</td>
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<tr>
<td>SBM</td>
<td>94.58</td>
<td>0.1809</td>
<td>0.1913</td>
<td>81.84</td>
<td>0.8107</td>
<td>0.9907</td>
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<tr>
<td>Canola</td>
<td>93.05</td>
<td>0.3044</td>
<td>0.3271</td>
<td>63.08</td>
<td>0.9808</td>
<td>1.5550</td>
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<tr>
<td>CDDGS</td>
<td>94.36</td>
<td>0.0694</td>
<td>0.0735</td>
<td>55.13</td>
<td>0.6256</td>
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<td>WDDGS</td>
<td>95.22</td>
<td>2.6081</td>
<td>2.7392</td>
<td>77.03</td>
<td>0.6896</td>
<td>0.8952</td>
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<tr>
<td>Grass</td>
<td>96.75</td>
<td>0.1862</td>
<td>0.1925</td>
<td>57.11</td>
<td>0.9605</td>
<td>1.6820</td>
</tr>
</tbody>
</table>

SE 0.5259 0.4079
p val <.0001 <.0001
Yeast supplementation and in vitro fermentation

S. cerevisiae Sc 47 (Actisaf®) Phileo-Lesaffre Animal Care

10% Slurry in bicarbonate buffer

Fermentation at 39°C, anaerobic

0, 3, 4 wks

Culture

+ 0.2g ingredient residue

Gas kinetics

SCFA

Menke, 1988; Bindelle et al, 2007

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Gas production kinetics

Gas production (ml/gDM)

A = final gas volume, \( t \to \infty \)

\( \textbf{R}_{\text{max}} \) = max rate of gas production (\( \text{mL g}^{-1} \text{ DM. h}^{-1} \))

\( \textbf{T}_{\text{max}} \) = time to \( \textbf{R}_{\text{max}} \)

- Pectin
- Starch
- Inulin
- Xylan
- Cellulose
Results

1. Gas accumulation curves

- Gas accumulation refers to gasses (CO$_2$, H$_2$, CH$_4$) produced during fermentation.
Results

2. Parameters of gas production kinetics

\[ A = \text{Total Gas Production, } t \rightarrow \infty \]
Results

2. Parameters of gas production kinetics

B = Time to T/2

Half time to asymptote (h)

<table>
<thead>
<tr>
<th></th>
<th>Wheat</th>
<th>Barley</th>
<th>Corn</th>
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<th>Canola</th>
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<th>CDDGS</th>
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<tbody>
<tr>
<td>Cont</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yeast</td>
<td>15</td>
<td>18</td>
<td>20</td>
<td>18</td>
<td>16</td>
<td>24</td>
<td>30</td>
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</tbody>
</table>

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**Results**

2. Parameters of gas production kinetics

\[ R_{\text{max}} = \text{Rate of Gas Production} \]

<table>
<thead>
<tr>
<th></th>
<th>Maximum rate of gas production (ml/g DM/h)</th>
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<tbody>
<tr>
<td>Wheat</td>
<td>8</td>
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<tr>
<td>Barley</td>
<td>4</td>
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<td>Corn</td>
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<tr>
<td>CDDGS</td>
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</tbody>
</table>

R\(_{\text{max}}\) = Rate of Gas Production

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### Results

#### 3. SCFA production, average of all ingredients

<table>
<thead>
<tr>
<th>Time (h)</th>
<th>Yeast (yes/no)</th>
<th>Total SCFA (mg/ g DM)</th>
<th>Acetic (%)</th>
<th>Propionic (%)</th>
<th>Butyric (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>No</td>
<td>164.4&lt;sup&gt;d&lt;/sup&gt;</td>
<td>64.7&lt;sup&gt;d&lt;/sup&gt;</td>
<td>23.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10.5&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>194.4&lt;sup&gt;c&lt;/sup&gt;</td>
<td>66.8&lt;sup&gt;c&lt;/sup&gt;</td>
<td>21.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>9.4&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>72</td>
<td>No</td>
<td>325.6&lt;sup&gt;b&lt;/sup&gt;</td>
<td>70.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>17.3&lt;sup&gt;d&lt;/sup&gt;</td>
<td>7.8&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>356.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>69.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>17.9&lt;sup&gt;c&lt;/sup&gt;</td>
<td>8.6&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>
Similar result from another in vivo experiment

![Bar chart showing VFA production and proportions of acetate, propionate, and butyrate for control and Actisaf Sc 47 groups.](image)

- **VFA prod., mg/g**
- **Acetate, %**
- **Propionate, %**
- **Butyrate, %**

* *p<0.05*
Total SCFA production for each ingredient

12 hours

<table>
<thead>
<tr>
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<th>Control</th>
<th>Yeast</th>
</tr>
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72 hours

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Control</th>
<th>Yeast</th>
</tr>
</thead>
<tbody>
<tr>
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Acetic Molar Percentage

12 hours

72 hours

Acetic molar percent

Wheat  Barley  Corn  SBM  Canola  WDDGS  CDDGS

Control  Yeast

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Actisaf improves fiber digestibility and feed energy extraction

Actisaf effect on digestibility in piglets

- NDF and hemicellulose digestibility are significantly improved by Actisaf®
- Higher VFA production in Actisaf® group
Actisaf improved zootechnical performance in growing pigs feed high fiber low energy diet

Performance results (28-64 days)

<table>
<thead>
<tr>
<th></th>
<th>High energy control</th>
<th>Low energy Actisaf®</th>
<th>Low energy control</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADG, g/d</td>
<td>536</td>
<td>539</td>
<td>482</td>
</tr>
<tr>
<td>ADFI, g/d</td>
<td>757</td>
<td>736</td>
<td>661*</td>
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<tr>
<td>FCR</td>
<td>1.41</td>
<td>1.37</td>
<td>1.40</td>
</tr>
</tbody>
</table>

* P < 0.05

Probiotic impacts on pig production

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Actisaf improved zootechnical performance in growing pigs feed high fiber low energy diet
Summary

• Live yeast (Actisaf®) supplementation enhanced the extent and rate of *in vitro* fermentation of variety of feed residues
  ▪ Ranking of ingredient residues for response to yeast varied between experiments
  ▪ Lowest enhancement for soybean meal and canola meal

• Live yeast (Actisaf®) supplementation significantly increased *in vitro* total SCFA production
  ▪ Greatest effect in wheat, barley and corn
  ▪ Molar percentage shifts from increased Acetate at 12 hours to increased Propionate and Butyrate at 72 hours

• Live yeast (Actisaf®) improves pig performance by improving fiber digestibility and energy recovery
Conclusion

- Daily supplementation with a live yeast probiotic (Actisaf®) may favor increased fermentative activity in the hindgut of the pig, increasing the energy value of feed ingredients, maintain gut health and improve animal performance.

- Therefore, Live yeast (Actisaf Sc 47) may allow the use of high fiber/low energy diets to formulate feed with both lower energy and low cost ingredients.
Actisaf® increased fermentation activity of swine manure for biogas production
Acknowledgments

• The Van Kessel lab
  Jason Marshall
  Jing Wang
  Tomohiro Hamaoka

• Phileo-Lesaffre Animal Care

THANK YOU ALL FOR YOUR ATTENTION
WHAT BREWERY YEAST? LET'S ENJOY THE REAL STUFF!
Actisaf Sc 47 effect on piglets microflora

Caecum

- Excellent discrimination between control and Actisaf Sc 47-supplemented piglets