Yeast cell wall immunomodulatory and intestinal integrity effects on broilers challenged with *Salmonella enteritidis*

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Alternative agents to replace antibiotic to fight against bacterial pathogens

• Essential oils
• Organic acids / Acidifiers
• Phytogenic / Herbal plants
• Probiotics
• Prebiotics
Yeast physiology

Different pH, temperature, fermentation conditions

Ethanol yeast

Brewer yeast

Baker yeast
Yeast cell wall anatomy

- Fibrillar Layer
- Mannoprotein
- β Glucan
- β Glucan-Chitin
- Mannoprotein
- Plasma Membrane
Yeast cell wall and yeast hydrolysate preparation
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Yeast cell wall (ImmunoWall)
- Mannan oligosaccharide
- Beta glucan

Yeast hydrolysate
- Peptides
- Nucleotides
## Major composition of yeast cell wall

<table>
<thead>
<tr>
<th>Composition</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude protein</td>
<td>35.0</td>
</tr>
<tr>
<td>Beta glucan</td>
<td>30.0</td>
</tr>
<tr>
<td>Mannan oligosaccharide</td>
<td>17.0</td>
</tr>
<tr>
<td>Crude fiber</td>
<td>3.1</td>
</tr>
</tbody>
</table>
Beta-(1,3)(1,6)-D-glucan
Beta-glucan enhance immune responses

- β Glucans
- Macrophage Recognizes β Glucans
- Activated Cell Releases Cytokines
- Phagocytic Action Against Microorganisms
- New Macrophage Production
Mannan oligosaccharide
Yeast

Salmonella

Gut epithelial lining cells

Mannan oligosaccharide

Yeast

Ekachai Jenwitheesuk (ekachai@iccbrazil.com)
Previous research findings

TABLE 1. Screening of bacterial isolates from clinical material for mannose-binding lectin

<table>
<thead>
<tr>
<th>Strain</th>
<th>No. of strains positive</th>
<th>No. of strains tested</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Escherichia coli</em></td>
<td>54</td>
<td>118</td>
</tr>
<tr>
<td><em>Salmonella typhi</em></td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td><em>Salmonella typhimurium</em></td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td><em>Salmonella enteritidis</em></td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td><em>Proteus morganii</em></td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td><em>Klebsiella pneumoniae</em></td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td><em>Citrobacter diversus</em></td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td><em>Citrobacter freundii</em></td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td><em>Serratia marcescens</em></td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td><em>Aeromonas hydrophila</em></td>
<td>5</td>
<td>7</td>
</tr>
</tbody>
</table>

* Mannose-binding activity determined by agglutination of *Saccharomyces cerevisiae* yeasts.

Previous research findings

Mannan oligosaccharide (MOS) significantly improved feed efficiency and performance in livestock and aquaculture, which likely were a result of bacterial (coliforms, vibrio, clostridia and salmonella) load reduction and increased total leukocyte levels.

Staykov et al., 2007; Amani Denji et al., 2015
Scanning electron micrograph of ImmunoWall

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Previous research findings

Yeast cell wall and mannan oligosaccharide agglutinate bacteria with type I fimbriae appendages

E.coli                       Salmonella

Previous research findings

Microscopic photos of the intestine 14 days post challenge with $10^8$ CFU/mL E.coli

No ImmunoWall

0.2% ImmunoWall

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Hypothesis of this study

Yeast cell wall could help **prevent gut leakage** and **promote immune response** in *Salmonella* challenged chicken.
Materials and Methods
Animal 2-day-old Cobb broiler
ImmunoWall 500 g/ton of feed
S. enteritidis $10^8$ CFU/chick PO
Gut leakage test 4 days after challenge
Specific IgA 14 days after challenge
Gut leakage test

Dextran-FITC

2 hr 30 min after PO
Salmonella specific IgA measurement

Tetra Methyl Benzidine (TMB)

Anti-chicken IgA - HRP

Salmonella-specific Ig in feces

Salmonella enteritidis LPS

450 nm
Results and Discussion
Gut leakage test in broiler on day 4 after challenge with $10^8$ *Salmonella enteritidis*
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$P < 0.05$
Specific immune responses on day 14 after challenge with $10^8$ *Salmonella enteritidis*

**IgA anti-*Salmonella***

![Graph showing specific immune responses](image)

- **Control**
- **ImmunoWall**
- **S. enteritidis**
- **S. enteritidis plus ImmunoWall**

**P = 0.053**

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Conclusion

1. Gut leakage prevention
Yeast cell wall (ImmunoWall) at the inclusion rate of 500 g/ton could significantly prevent gut epithelial lining damage from *Salmonella enteritidis* infection.
Conclusion

2. Stimulation of immune response

**Fecal secretory IgA** is secreted by mucosal tissue and represents the first line of defense of the GI mucosa and is central to the normal function of the GI tract as an immune barrier.

**Specific IgA in serum** is a good predictor of the release of specific IgA at intestinal surfaces after intragastric immunization.

Yeast cell wall (ImmunoWall) at 500 g/ton could **significantly increase IgA level** to fight against *Salmonella enteritidis* infection.
ImmunoWall

- Strengthening gut lining
- Efficient gut functions

Higher growth performance
Lower morbidity & mortality
Thank you