Antimicrobial use in Ethanol Processing

Considerations for Coproducts
Antimicrobial Use
What you need to be familiar with.

- Why are antimicrobials used?
- Antimicrobial options
  - Antibiotics
  - Non-antibiotics
- History of use
- Regulatory Framework
- Product Stewardship
Why are antimicrobials used?
Infections
What do they cost

Production yield/ferm (actual):
- Average ferm size = 800,000 gallons
- 45,000 bushels of corn per ferm
- Corn value > $160,000 ($3.63/bushel)
- Ethanol produced ~ 130,500 gallons
  - EtOH value = $176,000 ($1.35/gal)
- DDG produced ~ 420 tons
  - DDG value ~ $54,600 ($130/ton)

Potential loss from infection/ferm
- A 1% loss in yield ~ 1,300 gallons
  - Estimated value > $1,700
- DDG value impact
  - Potential negative impact on quality
- Indirect impact
  - Fouled heat exchangers & columns

1% yield loss => $5,280/day or ~ $2 million/year (assumes 3 ferms/day)
(Equivalent to moving from 14.5 w/v% etoh to 14.35 w/v% etoh in fermentation)
Antimicrobial Options
General Categories

Non-antibiotic

- Hops acid

- Chlorine dioxide based precursors
  - $5 \text{NaClO}_2 + 4 \text{HCl} \rightarrow 5 \text{NaCl} + 4 \text{ClO}_2 + 2 \text{H}_2\text{O}$

- Formaldehyde based biocides
General Categories

Antibiotics

- **Viginiamycin**
  - Naturally produced from *Streptomyces virginiae* bacteria
    - Production bacteria is naturally occurring in soil
    - Produced in fermentation similar to ethanol production

- **Penicillin**
  - Naturally produced from *Penicillium* mold
    - Production in fermentation similar to ethanol production

- **Erythromycin, neomycin, oxytetracycline, tylosin**
History of Use - Antibiotics
FDA issues “Letter of No Objection” to SmithKline Beecham (SKB) for use of virginiamycin in ethanol production

1993

FDA provides new guidance on ethanol processing aids

2008-2009

ATF (now the ATTB) issues “Letter of No Objection” to SKB for use of virginiamycin in beverage alcohol production

2010

Phibro concludes GRAS affirmation of virginiamycin based Lactrol®

2011

Food Safety Modernization Act (FSMA) signed into law

2014

Phibro concludes GRAS affirmation of penicillin based Phibropen®
Ethanol Production Impact

- Section 103 – Hazard Analysis

“…………identify and evaluate known or reasonably foreseeable hazards…..”

• "(A) biological, chemical, physical, and radiological hazards, natural toxins, pesticides, drug residues, decomposition, parasites, allergens, and unapproved food and color additives; and
• "(B) hazards that occur naturally, or may be unintentionally introduced; and ............
FSMA Consistent Guidelines from FDA in 2009

Any additive, including antimicrobials, used in an ethanol plant must meet one of three criteria to be acceptable for use.

<table>
<thead>
<tr>
<th>AAFCO Definition</th>
<th>The product has a definition in the feed ingredient manual approved by the American Association of Feed Control Officials.</th>
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</thead>
<tbody>
<tr>
<td>Approved Food Additive</td>
<td>The product has an approved food additive petition that is listed in the Federal Registry.</td>
</tr>
<tr>
<td>Generally Recognized as Safe (GRAS)</td>
<td>The product has been determined to be generally recognized as safe by panel of experts qualified by scientific training and experience to evaluate the safety of substances directly or indirectly added to food.</td>
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</tbody>
</table>
Sec. 570.30 Eligibility for classification as generally recognized as safe (GRAS).

(a) General recognition of safety may be based only on the views of experts qualified by scientific training and experience to evaluate the safety of substances directly or indirectly added to food. The basis of such views may be either (1) scientific procedures or (2) in the case of a substance used in food prior to January 1, 1958, through experience based on common use in food. General recognition of safety requires common knowledge about the substance throughout the scientific community knowledgeable about the safety of substances directly or indirectly added to food.

(b) General recognition of safety based upon scientific procedures shall require the same quantity and quality of scientific evidence as is required to obtain approval of a food additive regulation for the ingredient. General recognition of safety through scientific procedures shall ordinarily be based upon published studies which may be corroborated by unpublished studies and other data and information.

Product Stewardship

Dosing and Residue Monitoring
Minimum Inhibitory Concentration (MIC) Definition: Indicates the lowest concentration of an antimicrobial that will inhibit the visible growth of a microorganism.
Technology Overview

Identification of over 2500 species of anaerobic and aerobic bacteria as well as yeasts and fungi

Widely used in many technological applications

Omnilog® by Biolog, Inc.
Presence of bacteria causes opacity and formation of solid mass which increases absorbance.

Higher bacterial load = higher absorbance.

Lack of bacterial growth results in clear broth and leads to low absorbance.

Low bacterial load = little to no absorbance.
Technology Overview

Note that bacteria should be tested prior to exposure to antimicrobial
DDGS Antimicrobial Residues

- Phibro Test Results from June 2010 to current
- Analyzing Virginiamycin Residues
- Sample types include:
  - DDG/S, WDG/S, MWDGS, Syrup, Corn Oil

Residual testing since June 2010

- >2,000 Samples with no detection
Summary

Processing Aids/Antimicrobials/Antibiotics

- **FSMA** –
  - Requires producers to “…………identify and evaluate known or reasonably foreseeable hazards…..”
  - FDA guidelines for Processing Aids use provide framework to meet FSMA
    - AAFCO definition
    - Approved Food Additive
    - GRAS – Generally Recognized as Safe for the application