The Importance of Poultry Gut Health in Achieving Optimum Value Through the Production Chain

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About Danisco Animal Nutrition

- Danisco Animal Nutrition, part of DuPont Industrial Biosciences
- Offers value-driven, science-based solutions for gut health
- Many solutions are industry "firsts"- unparalleled investment in developing of unique technologies (Enzymes, Essential Oils, Betaine and Probiotics)
- Global and local collaboration with customers, leading industry, government and academic partners.
Today’s Presentation: Three Main Topics

1. Background
   - The Challenge: importance to consumers and producers
   - Gut Health and Efficient Production
     - Consequences of Dysbacteriosis
     - Sub-Clinical Diseases
     - Food Safety
   - Antibiotic Growth Promoter (AGP) Withdrawal

2. Maintaining Efficient Production – Four Alternative Solutions
   - Enzymes
   - Essential Oils
   - Probiotics or Direct Fed Microbials (DFMs)
   - Enzyme + DFM Combinations

3. Summary and Conclusion
Importance Of Poultry Market To China

- Leading egg producer
- World’s 2nd largest producer of poultry meat

<table>
<thead>
<tr>
<th>Poultry meat</th>
<th>Eggs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 USA</td>
<td>100</td>
</tr>
<tr>
<td>2 China</td>
<td>72</td>
</tr>
<tr>
<td>3 Brazil</td>
<td>58</td>
</tr>
<tr>
<td>4 EU</td>
<td>40</td>
</tr>
<tr>
<td>5 Russia</td>
<td>18</td>
</tr>
</tbody>
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Sources: FAO stat 2014 and Rabobank/USDA, 2014
Why Is Feeding The World With Safe, Nutritious Food Still A Challenge?

In the case of poultry:

- All these issues relate to gut health.
- Antibiotic Growth Promoters (AGPs) are going away.
Commercial Production Conditions Can Make Birds More Susceptible To Clinical & Sub-clinical Disease

Post hatch/week one
- Mortality
- Colibacillosis

2 weeks onwards
- Necrotic Enteritis (NE)
- Footpad dermatitis (Pododermatitis)
- Coccidiosis

3 weeks
- *Campylobacter*
- Dysbacteriosis

4-6 weeks
- Enterococcal spondylitis
- Endemic colibacillosis
Which Diseases Specifically?

- **Necrotic Enteritis (NE)**
  - Overgrowth of *Clostridium perfringens*
  - 2-5 week old broiler chickens
  - ~40% of broiler flocks worldwide
  - Profit reduced by 33%
  - Treatment of NE ~5¢ per broiler

- **Podo Dermatitis (Foot Pad Lesions)**
  - Ammonia burns on foot pads
  - Caused by poor litter quality
  - High pH, ammonia produced by bacteria in litter
  - Ammonia inhalation is bad for bird’s health

- **Avian coccidiosis**
  - Caused by intracellular parasite *Eimeria*
  - Predisposes birds to bacterial diseases
  - Estimated annual loss of more than $3 billion worldwide
  - Subclinical cases account for 70% of this cost.
There Is No “Silver Bullet”

Antibiotics do not correct unfavourable microbial conditions caused by poor husbandry, nutrition or genetics.
Small Intestine ….. BIG Job

A Delicate Balancing Act of Conflicting Objectives

Pathogen Defense and Nutrient Absorption

✿ VFA (butyrate) provides 70% energy

✿ Produce nutrients, such as vitamin K & B.

✿ Water re-absorption

✿ Improve bone mineralization

✿ and much more

✿ Decreased nutrient digestibility

✿ Non-specific

✿ Stimulation of immune response

 Increased absorptive cell turnover and mucus production.

✿ Undesirable shifts in the gut microbiota, negatively affecting Feed Conversion Ratio (FCR) and bird health
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Alternative Solution #1: **Enzymes**

*Carbohydrase and protease enzymes could be part of the solution*

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**Small Intestine**

- De-polymerisation of soluble NSPs
- Reduction in viscosity
- Increase nutrient digestibility
- Digest transit time is better regulated
- Lesser microbial overgrowth
- Better nutrient absorption

**Large Intestine**

- De-polymerisation of soluble NSPs produce smaller oligomers which are utilized by healthy microflora
- Increased energy availability by higher VFA production
- Lower pathogen pressure
Enzymes and Gut Health

Enzymes help maintain gut health by reducing available substrate and improving GIT mucous membrane layers.

**Xylanase, Amylases** reduces xylans, NSPs

**Proteases** breaks down indigested protein

**AGPs prevent microbial overgrowth in small intestine by antimicrobial activity**

**Enzymes prevent microbial overgrowth in small intestine by substrate reduction**
Enzymes (XAP combination) And Necrotic Enteritis Challenge

**BWG, d0-42, g/bird**

- Unchallenged control: $1988^a$
- Challenged Control: $1790^b$
- Challenge + Enzyme: $1902^c$

**FCR, d0-42, g/g**

- Unchallenged control: $1.96^b$
- Challenged Control: $1.75^a$
- Challenge + Enzyme: $1.87^c$

**Mortality by NE*, %**

- Unchallenged control: $0^a$
- Challenged Control: $11^b$
- Challenge + Enzyme: $6.7^c$

**Lesions scores**

- Unchallenged control: $0^a$
- Challenged Control: $0.54^b$
- Challenge + Enzyme: $0.29^c$

Romero et al. 2012, unpublished
Enzymes (XAP) And Salmonella Challenge

S. enteritidis-positive birds (birds with >10^5 cfu/g), %

Salmonella enteritidis inoculation, cfu/bird

- Control
- + Enzyme

Study done at Bristol University, UK
Alternative Solution #2: **Essential Oils**

Success In Use Where AGP Reductions/Bans Are Already In Place

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**Reduced Salmonella (% positive)**

- **Control**: 32.5
- **Challenged control**: 0
- **Enviva® EO (0.1 kg/t)**: 7.5

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EO US B 11.08

* 8.4 - 26 kg

* Values without a common superscript are significantly different (P<0.1)

** Salmonella positive caecal samples
Alternative Solution #3: **Probiotics**

**Benefits of using probiotics:**
- Promotes villus (gut cell) formation
- Reduction in meat contamination
- Improved overall performance
- Prevention of inflammatory reactions
- Alternative to AGPs

**Benefits of using *Bacillus* spores:**
- Stable during distribution, feed processing and storage
- Long shelf life
- In the chicken GI tract, germinate rapidly
- Active in the GI tract

Ref: Ohimain and Ofongo, 2012, Ref: Kiarie *et al.*, 2013
Probiotics And Gut Health Restoration

Scanning electron microscopy of ileal villus of 21-day old poult's

*Probiotic = Lactobacillus casei and Lactobacillus acidophilus

Rahimi et al., 2009
Probiotics And Necrotic Enteritis Challenge (0-28d)

Body Wt gain g

Control: 738
Challenged Control: 508
CC+ Antibiotic: 726
CC+Probiotic: 700

FCR

Control: 1.63
Challenged Control: 2.04
CC+ Antibiotic: 1.70
CC+Probiotic: 1.72
Probiotics: *Bacillus* and Egg Quality

- Shell Strength: -12.2
- Shell thickness: 1
- Yolk color: 1.6
- Haugh Unit: 3.1
- Yolk Cholesterol: 10.6

Li *et al*, Poultry Sci, 2006
Probiotics And Meat Quality

![Bar chart showing differences in moisture, protein, fat, and ash percentages between control and probiotic treatments for leg and breast meat, with p-values less than 0.05.](Image)
Alternative Solution #4: Probiotics + Enzymes Combined

Combination of 3 strains of *Bacillus* + xylanase, amylase and protease enzymes
Probiotics: Synergy with enzymes

AMEn (kcal/kg DM)

Control  Bacillus  XAP  Bacillus +XAP

2960<sup>c</sup>  2995<sup>c</sup>  3042<sup>b</sup>  3093<sup>a</sup>

Ileal IE lymphocytes

Un-challenge  Challenge

Control  Test

35<sup>b</sup>  40.8<sup>ab</sup>  48<sup>a</sup>  34.3<sup>b</sup>

Foot pad scores

Negative control  Syncra® AVI  BMD  Virginiamycin

<sup>a,b</sup> Indicates significant difference at P<0.05

Romero et al., 2013
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- Healthy Nutrition large part of solution with genetics, husbandry and environmental control.

- Alternative solutions of enzymes, EOs, probiotics and combination are backed by scientific studies.
Thank You!

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