Alternatives to in-feed antibiotics and their impact on the safety of animal products

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ANTIBIOTICS

- Penicillin: A. Fleming, 1929
- First „Clinical trial“
- 29. 11. 1942

- The most destructive fire accident in USA since 1903
- Penicillin has been given to patients with burn wounds
- Better skin grafts acceptance – prevention of infection in burned patients and its spreading to their system – the best results achieved so far
- „Miracle drug“

Levy, 2002
„There may be a danger, though, in underdosage. It is not difficult to make microbes resistant to penicillin in the laboratory by exposing them to concentrations not sufficient to kill them, and the same thing has occasionally happened in the body. “

A. Fleming, Nobel Lecture, 1945
ATB resistance, Europe

Proportion of Fluoroquinolones Resistant (R) *Escherichia coli* Isolates in Participating Countries 2002

Proportion of Fluoroquinolones Resistant (R) *Escherichia coli* Isolates in Participating Countries 2007
Antibiotics in animal nutrition

- Prevention of GIT infections (mainly after weaning)
- Lowering of the risk of contamination of animal products
- Production traits enhancement
Antibiotics in animal nutrition

- Prevention of GIT infections (usually after weaning)
- Lowering of the risk of contamination of animal products
- Production traits enhancement
Antibiotics in animal nutrition

- Worldwide since 50-ies of the last century
- **Resistance**: reduction in their use
- January 2006: restricted in EU (based on the EU Regulation no. 1831/2003)
Phasing Out Certain Antibiotic Use in Farm Animals

December 2013
• In-feed ATB restriction:
  
  – ↓ production
  
  – ↓ health (GIT infections around weaning in particular)
  
  – ↑ risk of bacterial contamination of animal products
  
  – ↑ costs
## Alternatives to in-feed ATB

- Probiotics, prebiotics
- Bacteriocins
- Enzymes
- Plant extracts, essential oils
- Antibodies
- Organic acids
Organic acids

- Feed & food preservatives

- Animal nutrition:
  - Growth & performance enhancers
  - Antibacterial properties
Organic acids

• Feed & food preservatives

• Animal nutrition:
  – Growth & performance enhancers
  – Antibacterial properties

MCFA \((C_{8:0} \text{ – } C_{12:0})\)
Antibacterial effect of fatty acids in vivo

The natural feed additive caprylic acid decreases *Campylobacter jejuni* colonization in market-aged broiler chickens

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*Poultry Science Department, University of Arkansas, Fayetteville 72701; †Poultry Production and Product Safety Research Unit, Agricultural Research Service, USDA, Fayetteville, AR 72701; and ‡Department of Animal Science, University of Connecticut, Storrs 06269

-Experimental infection of chickens with *C. jejuni*
-Caprylic acid (C₈:₀)
-Concentrations 0.35 % - 1.4 %
-Last week of the fattening period (7 days or 3 days)
Antibacterial effect of fatty acids
in vivo

Figure 1. Cecal *Campylobacter jejuni* counts in 42-d-old broiler chickens (n = 10 birds/treatment per trial) fed caprylic acid 3 d (trial 1 and 2) or 7 d (trial 3 and 4) before necropsy. **Columns with no common letters differ significantly (P < 0.05).**

*S. de los Santos a kol., Poultry Science 2009*
Antibacterial effect of fatty acids in vivo

- *Cuphea lanceolata* a *C. ignea* seeds
  - Rich in MCFA
  - 5% addition to feed
  - Combined with exogenous lipase
- The effect on performance and GIT microflora
- Improvement was not statistically significant
Antibacterial effect of fatty acids in vivo: IAS Prague

- Experimental infections of rabbits & chickens
- Effect of MCFA on GIT microbiota
- Field experiments
### Antibacterial effect of fatty acids *in vivo*: IAS Prague

- Experimental infections of rabbits & chickens
- Effect of MCFA on GIT microbiota
- Field experiments
I. Experimental infections

Effects of caprylic acid and triacylglycerols of both caprylic and capric acid in rabbits experimentally infected with enteropathogenic Escherichia coli O103

Eva Skřivanová, Zuzana Molatová, Milan Marounek

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Received 8 June 2007; received in revised form 9 July 2007; accepted 10 July 2007
I. Experimental infections

- 88 broiler Hypuls rabbits, weaned at 35D
- Individual cages

- Negative control
- Positive control
- 0.5 % C8 FA
- 1 % C8 + C10 TAG

- Bacterial shedding
- Performance
- Health status

*E. coli* O103
The effect of C\textsubscript{8} and Akomed R on \textit{E. coli} shedding in terms of experimental infection of broiler rabbits

![Graph showing Log10 CFU/g over days post-infection with different treatments and superscripted letters indicating significant differences (p < 0.05)].

\textsuperscript{a,b,c}Columns with a different superscript are significantly different within the group (p < 0.05)
Inhibitory activity of rabbit milk and medium-chain fatty acids against enteropathogenic *Escherichia coli* O128

Eva Skřivanová, Zuzana Molatová, Věra Skřivanová, Milan Marounek*  
*Institute of Animal Science, Přírůstek 815 CZ-104 00, Prague, Czech Republic
The effect of $C_8$ and Akomed R on *E. coli* shedding in terms of experimental infection of broiler rabbits

Columns with a different superscript are significantly different within the group ($p < 0.05$)

*Skřivanová et al., Veterinary Microbiology 2009*
I. Experimental infections

ORIGINAL ARTICLE

Effect of coated and non-coated fatty acid supplementation on broiler chickens experimentally infected with Campylobacter jejuni

Z. Molatová¹, E. Skřivanová¹, J. Baré², K. Houf², G. Bruggeman³ and M. Marounek¹

¹ Institute of Animal Science, Prague, Czechia,
² Department of Veterinary Public Health and Food Safety, Ghent University, Merelbeke, Belgium, and
³ Nutrition Sciences N.V., Drongen, Belgium
I. Experimental infections

- 48 broiler chickens
- Individual cages

- Negative control
- Positive control
- C8 + C10 free, 0.5%
- C8 + C10 coated, 0.5%

- Bacterial shedding
- Performance
- Health status

Campylobacter jejuni
Experimental timeline

- Hatching
- Inoculation
- Sampling
- Inoculation
- Slaughter
The effect of free and coated MCFA on *C. jejuni* shedding in terms of experimental infection of broiler chickens

<table>
<thead>
<tr>
<th>Age of chickens (days)</th>
<th>Treatment group</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<tr>
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<td>Basal diet</td>
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<td>No infection</td>
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<tr>
<td>No infection</td>
<td>Infection</td>
<td>&lt;DL&lt;sup&gt;a&lt;/sup&gt;</td>
<td>&lt;DL&lt;sup&gt;a&lt;/sup&gt;</td>
<td>&lt;DL&lt;sup&gt;a&lt;/sup&gt;</td>
<td>&lt;DL&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>Protected acids</td>
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<tr>
<td>No infection</td>
<td>Infection</td>
<td>3.41 ± 0.67&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.38 ± 0.66&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.73 ± 0.68&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td>Infection</td>
<td>3.09 ± 20&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.37 ± 0.90&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.25 ± 0.45&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.09 ± 20&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td>Infection</td>
<td>3.67 ± 0.58&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.37 ± 0.60&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>3.67 ± 0.58&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td>Infection</td>
<td>5.31 ± 0.62&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.09 ± 0.29&lt;sup&gt;c&lt;/sup&gt;</td>
<td>7.27 ± 0.65&lt;sup&gt;d&lt;/sup&gt;</td>
<td>5.31 ± 0.62&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>Free acids</td>
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<tr>
<td>Infection</td>
<td>6.97 ± 1.06&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.39 ± 1.65&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8.20 ± 0.49&lt;sup&gt;c&lt;/sup&gt;</td>
<td>6.97 ± 1.06&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>Infection</td>
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<td>5.89 ± 1.55&lt;sup&gt;b&lt;/sup&gt;</td>
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**The potential use of caprylic acid in broiler chickens: effect on Salmonella Enteritidis**

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<th>Journal</th>
<th>Foodborne Pathogens and Disease</th>
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<td>Manuscript ID</td>
<td>FPD-2014-1833.R1</td>
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<td>Date Submitted by the Author</td>
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<td>Complete List of Authors:</td>
<td>Skrivanova, Eva; Czech University of Life Sciences Prague, Department of Microbiology, Nutrition and Dietetics; Institute of Animal Science, Department of Physiology of Nutrition and Quality of Animal Products Hovorkova, Petra; Czech University of Life Sciences in Prague, Department of Microbiology, Nutrition and Dietetics; Institute of Animal Science, Department of Physiology of Nutrition and Quality of Animal Products Cermak, Ladislav; Institute of Animal Science, Department of Physiology of Nutrition and Quality of Animal Products Marounek, Milan; Czech University of Life Sciences in Prague, Department of Microbiology, Nutrition and Dietetics; Institute of Animal Science, Department of Physiology of Nutrition and Quality of Animal Products</td>
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<td>Keyword</td>
<td>Antimicrobials, Antimicrobial Susceptibility, Food Microbiology, Poultry, Salmonella</td>
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Salmonella enterica var. Enteritidis

- **Dietary supplementation** of \( C_{8:0} \)
  - 0.25 % and 0.5 %
  - reduction of salmonellas in crop and caecum

- **Surface treatment** of chilled chicken carcasses
  - 0.125 % and 0.25 %
  - reduced salmonellas on a surface by 1 – 2 \( \log_{10} \) CFU/g of skin
  - sensory traits
Fatty acids in animal nutrition

- Effective in young animals or during the entire fattening
- Prevention of GIT infections
- Lower bacterial shedding
- Lower risk of contamination of animal products
- Can be used as a surface-treatment (with some limitations)
- Broiler rabbits, chickens, pigs
Thank you for your attention!
Consumption of veterinary chemotherapeuticals in the Czech Republic: ANTIBIOTICS (Hera et al., 2009)

[Bar chart showing the consumption of various antibiotic classes: Amfenikoly, Aminoglykosidy, Ansamyciny, Cefalosporiny, Diterpeny, Linkosamidy, Makrolidy, Penicilinová, Penicilinová + CL, Polypeptidy, Tetracykliny, Různá ATB over the years 2003 to 2009.]