Role of Organic Acid in Poultry

By, Buis Ebbinge
MD Daavision BV, Holland
Place- CTICC Cape Town
Date- 6th December 2014
Topics Covered

- Introduction of Organic Acid
- Reason for antibiotic ban
- Usage, application, mode of action & efficacy of feed acidifiers
- Experimental Trial of Acidifiers
- Factor affecting consistency in results, Risk Factor & Solution
- Overview of global feed acidifiers market
- Summary & Conclusion
What is an Organic Acid
What is Organic Acid

- Organic Acid is an Organic Compound with Acidic properties associated with their Carboxyl group –COOH
In General Organic Acid are considered to be any carboxylic acid including fatty acid & amino acid. Organic Acids are weak Acid & do not disassociate completely in water.
• Organic Acid usage started initially for Oil & Gas well stimulation treatments because of their much less reactive properties with metal than the strong mineral acids like HCL & HF Acid, for this reason, organic acid are used at a high temperatures when long contact times between acid & pipe are needed.
Organic Acid

Oil & Gas

Food industry

Nutrition & Animal feed
EU, Banned Prophylactic use of AGP in January 2006
Reason behind ban of antibiotic in Animal Feed

- Indiscriminate use of antibiotic
- Bacterial resistance
- Environmental Concern
- Every class of antibiotic used
- International food trade
- Animal welfare

Animal welfare

Environmental Concern

International food trade

Bacterial resistance

Indiscriminate use of antibiotic

30/11/14
• In Germany 1,734 Mt. of Antibiotic used for animals in 2011 compare to 800 MT in humans
• In Netherlands- Antibiotic usage to treat disease has significantly increased after the ban.
• USA- in 2011, 80% of the antibiotic went to livestock production.
• China- China Producers consumes the most antibiotic
• India- in 2012, India manufactured about a third of the total antibiotics in the world.
Effect of growth-promoting antibiotics

Physiological
- Nutrient absorption.
- Feed intake.

Nutritional
- Energy retention.
- Nitrogen retention.

Metabolic
- Liver Protein synthesis.

Others
- Immunity.

Physiological
- Feed transit time.
- Gut Wall diameter.
- Gut wall length.

Nutritional
- Gut energy Loss.
- Vitamin Synthesis

Metabolic
- Ammonia production.
- Toxic amine production
- Fatty acid oxidation

Others
- Secondary disease by E coli
Reason behind Organic Acid introduction in Animal Feed

- Europe- 1980 first reported bacterial resistance to Vancomycin.
- CC398- Methicillin-resistant Staphylococcus aureus was produced by the use of antibiotic in livestock.
- The appearance of Carbapenem resistant enterobacteriaceae.
- Appearance of resistant E Coli causing blood stream infection.
- Study released by CSE India found antibiotic residue in chicken.
- Antibiotic resistant bacteria have been found in Brazilian Cattle.
Feed Acidifiers

- Usage
- Application

Classification

Mode of Action & efficacy
<table>
<thead>
<tr>
<th>Acidifier</th>
<th>g/mol</th>
<th>Form</th>
<th>$pK_a$</th>
<th>Solubility</th>
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<tr>
<td>Formic</td>
<td>46</td>
<td>liquid</td>
<td>3.75</td>
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<tr>
<td>Acetic</td>
<td>60</td>
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<td>4.76</td>
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<tr>
<td>Propionic</td>
<td>74</td>
<td>liquid</td>
<td>4.88</td>
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<tr>
<td>Butyric</td>
<td>88</td>
<td>liquid</td>
<td>4.82</td>
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<tr>
<td>Lactic</td>
<td>90</td>
<td>liquid</td>
<td>3.83</td>
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<tr>
<td>Sorbic</td>
<td>112</td>
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<td>4.76</td>
<td>-</td>
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<tr>
<td>Benzoic</td>
<td>121</td>
<td>solid</td>
<td>4.17</td>
<td>-</td>
</tr>
<tr>
<td>Fumaric</td>
<td>116</td>
<td>solid</td>
<td>3.02</td>
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<td></td>
<td></td>
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<td>4.38</td>
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<td>Malic</td>
<td>134</td>
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<td>Tartaric</td>
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<td>Citric</td>
<td>192</td>
<td>solid</td>
<td>3.13</td>
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<td>4.76</td>
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<td></td>
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<td>6.40</td>
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<tr>
<td>Phosphoric acid</td>
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<td>solid</td>
<td>2.15</td>
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<td>7.10</td>
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<td>12.32</td>
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</table>
Usage of various Acid & Salts

- Propionic acid
- Formic acid
- Citric acid
- Lactic acid
- Sorbic acid
- Malic acid
- Acetic acid
- Fumaric acid
- Benzonic acid
- Butyric acid
- Tartaric acid

- Ammonium propionate
- Calcium propionate
- Calcium formate
- Sodium propionate
- Calcium lactate
- Sodium benzoate
- Potassium propionate
- Sodium diacetate
- Not specified
Application in Poultry

Application

- Sprayed as a liquid directly into feedstuff & compound feed
- Powder form are added directly or via premix
- Liquid form via drinking water
Specific Target of Organic acid usage in Poultry

- **Disease Control**
  - E Coli, Salmonella, Clostredia, Entrococcus

- **Growth**
  - High growth, Low FCR, High Egg production, Homogenesity

- **Improved Metabolism**
  - Can be used for various metabolic pathways for energy generation

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# Effect of Acid

## Acid effect on various functions

<table>
<thead>
<tr>
<th>Acid</th>
<th>Antimicrobial gram-</th>
<th>Nutritive</th>
<th>pH lowering</th>
<th>taste</th>
<th>corrosivity</th>
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<tbody>
<tr>
<td>Formic Acid (C1)</td>
<td>+++</td>
<td>++</td>
<td>+++</td>
<td>----</td>
<td>---</td>
</tr>
<tr>
<td>Acetic acid (C2)</td>
<td>+++</td>
<td>+</td>
<td>+</td>
<td>±</td>
<td>-</td>
</tr>
<tr>
<td>Propionic acid</td>
<td>++++(Y+M)</td>
<td>+</td>
<td>+</td>
<td>±</td>
<td>-</td>
</tr>
<tr>
<td>Lactic acid</td>
<td>++</td>
<td>+++</td>
<td>++++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Fumaric acid (C7)</td>
<td>--</td>
<td>++</td>
<td>++</td>
<td>±</td>
<td>±</td>
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<tr>
<td>Sorbic acid</td>
<td>+++++</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benzoic acid</td>
<td>++++++</td>
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</tr>
<tr>
<td></td>
<td>Yeasts</td>
<td>Fungi</td>
<td>Gram–Bacteria</td>
<td>Gram+ Bacteria</td>
<td>Stafylo– / Streptococ</td>
</tr>
<tr>
<td>----------------</td>
<td>--------</td>
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<td>---------------</td>
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<td>-----------------------</td>
</tr>
<tr>
<td><strong>Formic acid</strong></td>
<td>+++</td>
<td>0</td>
<td>++++</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Acetic acid</strong></td>
<td>+</td>
<td>-</td>
<td>+++</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Propionic acid</strong></td>
<td>++</td>
<td>++++</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Sorbic acid</strong></td>
<td>++++</td>
<td>+++</td>
<td>++++++</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Benzoic acid</strong></td>
<td>+++</td>
<td>+++</td>
<td>++++++</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Lactic acid</strong></td>
<td>-</td>
<td>-</td>
<td>++?</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Caprylic- and caprinic acid</strong></td>
<td>++</td>
<td>++</td>
<td>+++</td>
<td>++++++</td>
<td>+++++</td>
</tr>
<tr>
<td><strong>Lauric acid – GML90</strong></td>
<td>++++</td>
<td>++</td>
<td>++</td>
<td>+++++</td>
<td>++++++</td>
</tr>
</tbody>
</table>
Effects beyond

- Improve digestive enzyme activity
- Growth of gastrointestinal mucose
- Microbial Phytase activity
- Increased pancreatic secretion
Purpose of adding acidifiers in poultry

To Lower the pH below 5

Inhibit the growth of harmful bacteria directly & indirectly

To reduce the buffering capacity of feed
Role of Acidifiers in Animal production

Role in Feed Hygiene
- Reducing pH
- Inhibit Microbial growth
- Reduction in BC

Role in Intestinal Tract
- pH reduction
- Antimicrobial Action
- Improves pepsin activity

Role in Metabolism
- Improve nutrient digestibility
- Improve Enzyme secretion
Which Acid to be used

- **Formic, Acetic, Propionic**. Reduces pH & affect directly gram- bacteria
- **Fumeric, Citric, Malic, Lactic**
  - Indirect effect on the b. population by pH reduction, acting mainly on stomach.

**Short Chain Fatty acid**
- **Capric, Caprylic, Lauric acid**
  - Direct & strong antimicrobial effect on Gram+ and Gram- bacteria.
Or the Combination

SCFA
1-Formic Acid
2-Acetic Acid
3-Propionic Acid

MCFA
1-Capric Acid
2-Caprylic acid
3- Lauric Acid

ESSENTIAL OIL
1-Oregano
2-Cinnamon
3-Thuymol
Unique approach of combining SCFA & MCFA to control both Gram+ & Gram- bacteria

Two year scientific study of literature

PL Dawson, GD Carl, JC Acton, and IY Han (1 May 2002).

Study of 2 years in Vivo, In Vitro study

Equivalence of Lauric Acid and Glycerol Monolaurate as Inhibitors


Accenture Nomination

Nominated for 2 category (2013),
1- Green Sustainability.
2-Consumer goods & services.
Combination effect of scfa & GML 90 against Gram- & Gram+ bacteria.
Mode of Action

• At low pH un-dissociated acid are lipophilic and can diffuse across cell membranes including bacteria & molds.
• Once in the bacterial cell, the higher pH of cytoplasm cause dissociation of the acids, and the resulting reduction in pH due to the release of H+ disrupt the enzymatic reactions & nutrient transport system.
• Molecule of organic acid also attacks the DNA of bacteria resulting it to death.
Organic Acid (at low pH)

RCOO⁻ + H⁺

Essential Oils
Increasing membrane permeability

DNA

Bacterial Cell Wall

Mode of action

RCOO⁻

R-COOH

H⁺

pH↓

Energy

H⁺
Antibacterial activity & growth promoting effect of acid in poultry

- Inhibit growth of pathogenic microbes
- Improving gut health by the promoting beneficial bacterial growth
- Reduction of the buffering capacity of the feed
- Improving pancreatic secretion, increases digestibility, absorption & retention of protein & amino acid
- Reduce the formation of Biogenic Amines
Acid Effect on growth

Reduction of pH.
Inhibit bacterial growth.
Improve gut health.

Increase the Digestion, absorption of the Nutrients.
Increase the retention of protein, amino acid & minerals.
Improvement in gut Morphology.

Reduction in the formation of biogenic amines, particularly in high protein and containing added synthetic amino acid.

Growth promoting effect
Experimental Trial
Daacid is a special mixture of acidifiers to ensure a broad anti-microbial spectrum in the gut of poultry.

**Plate counts of C. Perferenges after 24 hours in Daacid**

**Conclusions:**
Daacid reduces the C. Perferenges effectively in vitro.
Overview 11 broiler farms with chronic Salmonella problems (1 mil. broiler places) using Daacid

- Total approach, including Daacid® and management measures (HACCP)
- Continuous care leads to success

Daavision 2009 + Veterinair service
A total of 200,000 broilers was tested in 4 identical rooms. Birds were on feed with 2kg/ton, 1kg/ton and 1kg/ton Daacid in starter, grower resp. finisher feed; the other room were on control feed without growth promoter. Data are for period 0–40 days.

Conclusion:
In field trials proven efficiency
Daacid and pH reduction

The graph shows the effect of different dosages of Daacid on BC (mEq/kg) and pH. The control group and the low dosage Daacid group have higher BC levels compared to the mid and high dosage groups. The pH levels decrease as the dosage of Daacid increases, indicating a reduction in pH with increasing Daacid dosage.
Broiler trials with Daacid® (and Daacid® + Daafit® plus) in different countries

Trial duration: 7-42 days
Feed: standard commercial feed
Control: average data generated from KWIN-V 2011-2012

Dosage Daacid®:
Total period D0-D42: 2 kg/ Mt dry feed (88% DM)

Dosage Daacid® + Daafit plus®
Starter: Daacid: 2 kg/ Mt dry feed (88% DM)
Grower: Daacid: 1 kg/ Mt dry feed (88% DM)
Finisher: Daafit Plus plus: 0.5 kg/ Mt dry feed (88% DM)

Set point = 100%

ADG
Feed conversion
Mortality
Factor’s contrubutes inconsistency
<table>
<thead>
<tr>
<th>Substrates</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Buffering capacity</strong></td>
<td><strong>Type/pKa/dose of supplemented acid</strong></td>
</tr>
<tr>
<td>Composition of diets</td>
<td>Colonization &amp; activity resulting in acid production</td>
</tr>
<tr>
<td>Qty of fermentable carbohydrates</td>
<td>Receptors for bacterial colonization on the epithelial villi</td>
</tr>
<tr>
<td>Presence of toxic metabolites such as biogenic amines</td>
<td>Immunity level</td>
</tr>
</tbody>
</table>
Risk factor of using Acidifiers
Diet Palatability

- When added at excessive level

Lower feed intake or feed refusal

- Due to the strong odor & flavor

Corrosive

- Corrosive to cement & steel equipment
Solution’s

Evaluate the natural BC of feeds to determine the minimum amount of acid required

Use of slow release form of acid

Use of organic acid with fatty acid and mono- and diglycerides mixes to form micro granules
Overview of Global Market

Current Status

Growth Drivers
Acid Market

1,949.9 Million USD

2,616.7 Million USD

Projected

CAGR 5.2%

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Growth Drivers

Cost effective & eco-efficient solution

- Increased demand in developing economies
- Stable demand from developed economies
- A growing global population

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Conclusion
1. Organic Acid are arguably are the most effective & eco-efficient feed additives to date.
2. Short chain & MCFA have specific antimicrobial activity.
3. Antimicrobial activity of the acidifiers is pH dependent, Acidifiers plays definite role in the pH reduction and inhibition of the harmful pathogens.
4. Reduction in the bacterial population are associated with feeding organic acid which are effective against acid in-tolerent species, E coli, Salmonella etc.
5. Organic acid improve protein & energy digestibility by reducing microbial competition with the host.
6. Effect of organic acid go beyond those of antibiotic, includes reduction of BC, increased pancreatic secretion, effect on mucosa.
7. Lack of consistency in the benefits is related to uncontrolled variables, eg BC of the Strata, presence of other antimicrobial compound, cleanliness of the production environment & heterogeneity of the gut microflora.
### Scheme for poultry with recommended Daavision products

#### Functional groups

<table>
<thead>
<tr>
<th>Functional Group</th>
<th>Grand parent stock</th>
<th>Parent stock</th>
<th>Broilers (starter)</th>
<th>Broilers (grower)</th>
<th>Broilers (finisher)</th>
<th>Laying hens</th>
<th>Turkeys</th>
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<tbody>
<tr>
<td>E. coli</td>
<td></td>
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<tr>
<td>Salmonella control</td>
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<td></td>
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<tr>
<td>Streptococci, Staphylococci</td>
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<td>Water quality optimalisation</td>
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<tr>
<td>Clostridia (NE)</td>
<td></td>
<td></td>
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<td>Campylobacter</td>
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<tr>
<td>Resistance improvement (immuno modulation)</td>
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<tr>
<td>Enterococci</td>
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<tr>
<td>Calcium absorption, Eggshell strength</td>
<td></td>
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<td>Coccidiosis</td>
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</tbody>
</table>

#### Species

- **Grand parent stock**: Daavit® Plus P (2 kg/1000 kg) through feed (88% DM)
- **Parent stock**: Daavit® (3-5 kg/1000 kg) through feed (88% DM) Salmonella protocol available
- **Broilers (starter)**: Daavit® P (1 kg/1000 kg) through feed (88% DM)
- **Broilers (grower)**: Daavit® Aqua (0.7 kg-2 kg/1000 litre) through drinking water
- **Broilers (finisher)**: Daavit® Aqua (1.2 kg/1000 litre) through drinking water
- **Laying hens**: Daavit® Aqua (0.1 kg/1000 litre)
- **Turkeys**: Research projects

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Thank You