The future of poultry nutrition: Achieving more with less!
Agenda

• Introduction
• Challenges in the future
• Complexity of nutrition
• Nitrogen retention
• Summary and conclusion
Poultry Nutrition – A challenge - I

Microflora → Interactions → Host

Requirement

Maintenance → Performance

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Poultry nutrition – A challenge - II

Microflora

Interactions

Requirement

Host

Housing Management

e.g. ban of AGP, 2006

e.g. ban of animal by products, 2004

Selection of ingredients

e.g. ban of cage systems, 2012

e.g. ban of AGP, 2006

e.g. ban of cage systems, 2012

Balanced protein (% CP)

Feed conversion ratio

Eits et al., 2005

NE-lesion score at days 15-17 (dark) and day 22 (light)

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Sustainability

- **Use of soybean products**
  - **Hungary** plans ban of GMO raw materials. With SBM → about 95% is GMO. A “Protein Program” is announced and will be discussed.
  - **Germany**: 4 Mill. € per year will be invested into protein-strategy-program until 2017.
  - **United Kingdom**: A new pea plant with lower protease inhibitors and a higher content of digestible proteins has been developed. It could make peas a more viable protein replacement for soya.
  - **France**: A 5 years research program has been launched. Objective is to increase the production and quality of vegetable protein sources as alternatives to soy: lupine, faba bean, flax, ... Budget is 17 million EURO for 5 years.
  - **Germany**: Company KTG Agrar AG increased SBM sawing by 60%.

Current and future challenges

Info picked up in media:

- Initiatives to reduce / replace use of SBM
- Initiatives to establish other protein sources
  - Protein will be reduced

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Sustainability

- **Use of soybean products**
- **Animal welfare**

- Consumers / (N)GOs / retailers / slaughter houses request animal welfare related improvements
  - e.g. introduction of foot pad lesion scoring systems by several slaughter houses in various countries
  - e.g. report on possibilities for animal production which is better accepted by the society by German ministry of agriculture
  - e.g. Tierwohl-Initiative (Germany)

Current and future challenges

- **Stocking density**
- **Management of manure etc.**
- Concentrations of ammonia in animal houses
  - Protein will be reduced

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Current and future challenges

Sustainability
- Use of soybean products
- Animal Welfare
- Emission reduction

- Best Available Techniques Reference Document document submitted to the European Commission by the Joint Research Center of the EC (JRC)
  - Max nitrogen excretions/animal place/year proposed
  - Use of AA as one best available technique proposed

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Key elements of future nutrition

- Use of soybean products
- Animal welfare
- Emission reduction

Resource efficiency

- Optimising nitrogen utilisation
- Reducing dietary nitrogen / maintaining performance
- Increasing availability of dietary nitrogen / increasing performance

or both!

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How successful are we with protein reduction?

- Use of soybean products
- Animal welfare
- Emission reduction

Resource efficiency

Optimising nitrogen utilisation

Reducing dietary nitrogen / maintaining performance

Increasing availability of dietary nitrogen / increasing performance

or both!
2007: AMINONews 8 (1)

- "Crude protein levels in broiler diets can be reduced by 3-4 percentage points provided supplemental amino acids are used to maintain the levels found in conventional diets."

Impact of protein reduction on average daily gain (difference)

- Despite differences were often not statistically significant different, there was a numerical tendency of performance reduction.
To be able to reduced dietary nitrogen while maintaining performance we need to better understand:

- Amino acid requirement – optimal dietary level
  - Interaction host – microflora
  - E.g. microbial fermentation ➔ feed evaluation

Various interactions between amino acids and other factors need to be considered.
To be able to reduced dietary nitrogen while maintaining performance we need to better understand:

- Amino acid requirement – optimal dietary level
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  - Interactions between nutrients
    - E.g. amino acids – energy

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Balanced protein (%) vs ME (kcal)

Broiler 21-37 d, Evonik, 2015
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- Interactions between nutrients
  - E.g. amino acids – energy
- Interactions with health issues
  - E.g. requirement for immune responses (Performance / maintenance)

Klasing, 2007; Klasing and Calvert, 2000

<table>
<thead>
<tr>
<th>Process</th>
<th>Production (mg/kg)</th>
<th>Normal Cost (μmol lys/kg)</th>
<th>Normal LPS-challenged Production (mg/kg)</th>
<th>Normal LPS-challenged Cost (μmol lys/kg)</th>
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<tbody>
<tr>
<td>Leukopoiesis in all tissues</td>
<td>6.50</td>
<td>45.5</td>
<td>1360</td>
<td>90.9</td>
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<td>Ig synthesis</td>
<td>1.14</td>
<td>66.6</td>
<td>121</td>
<td>69.6</td>
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<td>Acute-phase protein synthesis</td>
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<td>-0</td>
<td>710</td>
<td>386</td>
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<td>Total for immunocompetence</td>
<td>7.64</td>
<td>111.1</td>
<td>2131</td>
<td>546.5</td>
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<td>Body weight gain</td>
<td>85.000</td>
<td>56.950</td>
<td>72.446</td>
<td>5212</td>
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<tr>
<td>Lysine intake</td>
<td>-</td>
<td>9520</td>
<td>-</td>
<td>8311</td>
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<tr>
<td>% of intake used for immune processes</td>
<td>1.17</td>
<td></td>
<td>6.71</td>
<td></td>
</tr>
<tr>
<td>% of intake used for growth</td>
<td>62.50</td>
<td></td>
<td>62.70</td>
<td></td>
</tr>
</tbody>
</table>
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  - Interactions with environmental factors
  - E.g. heat stress, stocking density

* Brake et al., 1998
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    - E.g. requirement for immune responses (Performance / maintenance)
  - Interactions with environmental factors
    - E.g. heat stress, stocking density
  - Impact of feed / ingredient related factors
    - E.g. ANF, heat damage, variation
  - Etc.

Various interactions between amino acids and other factors need to be considered.
To be able to reduce dietary nitrogen while maintaining performance we need to better understand:

- Amino acid requirement
- Ideal protein concept

Most of the above mentioned interactions also apply here.

- Interactions between maintenance and performance
  - e.g. interaction with age
  - e.g. interaction with health status
- Interactions within amino acids
  - e.g. lysine – arginine
  - e.g. threonine – glycine – serine
  - e.g. methionine - cysteine
  - e.g. branched chain amino acids
  - e.g. NEAA – EAA (low protein)
- Interactions between amino acids and other nutrients
  - e.g. methionine – choline – betaine
  - e.g. amino acids – energy
Various interactions within amino acid nutrition need to be considered, too

To be able to reduced dietary nitrogen while maintaining performance we need to better understand

- Amino acid requirement
- Ideal protein concept → most of the above mentioned interactions also apply here
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Siegert et al. (2015a)
Various interactions within amino acid nutrition need to be considered, too

To be able to reduced dietary nitrogen while maintaining performance we need to better understand

• Amino acid requirement
• Ideal protein concept ➔ most of the above mentioned interactions also apply here
• Interactions between maintenance and performance
  • e.g. interaction with age
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• Interactions within amino acids
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  • e.g. amino acids – energy

Siegert et al. (2015b)
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To be able to reduced dietary nitrogen while maintaining performance we need to better understand

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For successful protein reduction a better understanding of requirements and interactions of various factors is needed.
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Fate of N during meat production
Losses of N along the way ➔ example pig

35% utilisation
40% utilisation of dig. N
(88% digestibility)

Galloway et al., 2006
What can we expect from today’s broilers with respect to nitrogen utilisation?
Nitrogen utilisation in broilers
Example 1 – University trial

- Two strains, male broilers
- 3 feeding phases
  - Starter: 1-10 days
  - Grower: 11-21 days
  - Finisher: 22-36 days
    - 5 balanced protein levels in finisher feed: 80, 90, 100, 110, 120% of recommendation
- Feed
  - Analysis → nitrogen, amino acids
  - Consumption
- Animals
  - Body weights
  - Whole body analysis, incl. Feathers → nitrogen
Nitrogen utilisation in broilers
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Nitrogen utilization – classical estimation
N-retention / N-intake

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- Animals
  - Body weights
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Two strains, male broilers

3 feeding phases
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Feed
- Analysis → nitrogen, amino acids
- Consumption

Animals
- Body weights
- Whole body analysis, incl. Feathers → nitrogen

Nitrogen utilisation in broilers
Example 1 – University trial

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Nitrogen utilisation in broilers
Example 2 – commercial trial

- Two repeated commercial trials
  - Each trial with 4 houses
    - 2 per treatment,
    - 60,000 birds per treatment
- Feeding programme (5 phases, data available for 2-wk-periods)
  - Starter: 1 - 14 days
  - Grower: 15 - 28 days
  - Finisher: 29 - 39 days
- Treatments
  - Standard
  - Protein reduced
- Feed
  - Analysis $\rightarrow$ nitrogen, amino acids
  - Consumption $\rightarrow$ 2-wk-periods
- Animals
  - Body weights
  - Protein content of body $\rightarrow$ 17.5% as determined in previous trial

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  - Protein content of body ➔ 17.5% as determined in previous trial
Two repeated commercial trials
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Treatments
  - Standard
  - Protein reduced

Feed
  - Analysis → nitrogen, amino acids
  - Consumption → 2-wk-periods

Animals
  - Body weights
  - Protein content of body → 17.5% as determined in previous trial
High performing broilers...
• retained about 55% of ingested nitrogen
• retained about 75% of ingested dig. AA-nitrogen
• increased retention of dig. AA-nitrogen to >80% with protein reduced diets, suggesting <15% N-losses by turn-over

Can we further improve utilisation?
Nitrogen utilisation in broilers
Example 1 – Impact of phase lengths

- Two strains, male broilers
- 3 feeding phases
  - Starter: 1-10 days
  - Grower: 11-21 days
  - Finisher: 22-36 days / 43 days
    - 5 balanced protein levels in finisher feed: 80, 90, 100, 110, 120% of recommendation
- Feed
  - Analysis -> nitrogen, amino acids
  - Consumption
- Animals
  - Body weights
  - Whole body analysis, incl. Feathers -> nitrogen

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Utilisation of available N by broilers is high ➔ increase / optimise availability of N!

Increasing digestible, utilisable nitrogen

- Using highly digestible ingredients
  - Use of additives (enzymes)
- How much of non-AA nitrogen is available to the animal?
  - E.g. creatine, etc.
- Raw material / feed processing
  - Avoiding heat damage
    - (Detecting and counterbalancing)
- Raw material management
  - Better understanding of nutrient contents / variation
  - Reducing safety margins

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Summary

• In future sustainability aspects will play an increasingly role
  • One key topic is pollution reduction (N, P, CO₂equiv, ..)
    • N excretion ↓
      • Knowledge on requirements and interactions with various factors to be increased
      • Low protein diets not always successful but a lot is possible already today even under practical conditions
    • N utilisation ↑
      • In well balanced diets utilisation of dig. AA-N can go up to >80%
      • Overall N-utilisation can be improved by
        • … higher digestibility / availability (e.g. additives)
        • … reduced / optimised safety margin
        • … better understanding of nutrition (see above)
        • …raw material management (not discussed)
Can we achieve more with less?

- For optimising sustainability deeper knowledge of various aspects related to poultry production is required
- Increased complexity
- There is good opportunities to improve the whole process including and linking all steps of production