Determination of phosphorus availability in poultry

–The view of the European Working Group No. 2 of WPSA–

Markus Rodehutscord
First steps in P evaluation systems

- Differentiation by chemical analyses (NRC 1994, GfE 1999)
  - Total P
  - Phytate P (InsP$_6$)
  - Non phytate P (NPP), calculated as the difference

- Presumptions on efficiency of utilisation
  - Phytate P: 0%
  - NPP: 70% (or “high”)
  - Not more than rough approximations

This simple differentiation was an improvement, but not close enough linked to the digestive capacity of the animal.
Framework

- Increasing awareness about limited global raw phosphate stores
- High cost of feed phosphates
- Relevance of P excretion for the environment
- Great variability in P availability of feed raw materials
- Diversity of available P systems/requirements/determination

WPSA Working Group No 2: Nutrition initiated a sub-committee to standardise and suggest an available P system (ESPN 2009 in Edinburgh)
Available P is the part of dietary total P that, at marginal level of P supply, can be utilised to cover the P requirement of an animal.

- It is a feed quality criterion and describes the potential of a diet or a raw material.
Available Phosphorus System

- A standard system of available P links raw material evaluation, phytase evaluation, and requirement modelling

- The three working packages of the P sub-committee
  1. Suggest harmonisation of P evaluation and develop a standard protocol for the determination of available P
  2. Compile a feeding table of available P of feed raw materials
     - based on published literature
     - identification of need for further experiments
  3. Model the requirement of available P of different poultry species/categories
Members of the P sub-committee of the Working Group No. 2

- Mike Bedford, UK
- Machiel Blok, The Netherlands
- Franco Calini, Italy
- Evelyn Delezie, Belgium
- Dieter Feuerstein, Germany
- Maria Francesch, Spain
- Pierre-André Geraert, France
- Agnès Narcy, France
- Yael Noy, Israel
- Markus Rodehutscord, Germany
- Sanna Steenfeldt, Denmark
Standard protocol for the determination of available P

- Completed

**Working Group Report**

**Determination of phosphorus availability in poultry**

*Working Group No 2: Nutrition of the European Federation of Branches of WPSA*

- **Recommendation:** determination of precaecal P digestibility (pcdP) as the measure of P availability

- **Principle:**
  - pcdP of a given feedstuff tested by a linear regression approach
Standard protocol for the determination of available P

- Technical details of the protocol
  - Animals (broilers)
  - Pre-experimental and experimental feeding, including limitations for P and Ca
  - Examples for test diets and favourable feed ingredients
  - Duration of experiments
  - Digesta collection details
  - Calculations
  - etc.

- Specific details for testing of supplemented phytase

- Unresolved questions
Standard protocol for the determination of available P

■ Relevance
  ● End of *confusio lingarum* about P availability
  ● Standard for the evaluation of feed raw materials, effects of technological treatment and/or feed additives
  ● Results from different labs will be better to compare
  ● Limited global research resources can be used more effectively

■ Consideration by the scientific community and in the editorial work of scientific journals

■ Protocol is open for improvement/adjustment to new findings (no “closed shop”)

Do Research!
Feeding table of available P of feed raw materials

- Working steps
  - Comprehensive review of the literature
  - Selection of data based on standards set with the new protocol or similar to it
  - Precaecal digestibility or retention

- 68 references were eventually considered, providing data for approximately 40 raw materials

- Still the data set is very heterogeneous
### Literature data on P utilisation of broilers (%)

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Min.–Max.</th>
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</thead>
<tbody>
<tr>
<td>Maize (n=7)</td>
<td>42</td>
<td>27 – 73</td>
</tr>
<tr>
<td>Soybean meal  (n=20)</td>
<td>56</td>
<td>27 – 71</td>
</tr>
<tr>
<td>CaNaPO₄ (n=3)</td>
<td>60</td>
<td>55 – 63</td>
</tr>
<tr>
<td>CaHPO₄ anh.   (n=4)</td>
<td>51</td>
<td>29 – 65</td>
</tr>
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</table>

*WPSA–Working Group (unpublished)*

This can only be understood by looking at phytate degradation and factors affecting it.
Broiler’s potential for phytate hydrolysis

Broiler study

- 2 types of diet:
  - Maize-based: <100 FTU/kg
  - Wheat-based: 702 FTU/kg

- No mineral P supplement
- Measurements in the terminal ileum

Shastak et al. (2014)
Effects of P supplements

Data pooled across Vit. D levels

Mitchell & Edwards (1996)
Feeding table of available P of feed raw materials

- Very high variability for some raw materials
  - Care in using mean values in feed formulation
  - Need for understanding the reasons of variability and for the development of prediction approaches

- Can the data set be extended by consideration of bone data (relative bioavailability)?
Working steps

- Only tibia, toe and foot ash data were used (since 1980)
- Selection criteria for studies similar to the other data set
- 109 publications were considered

Recalculation (transformation)

- Relative bioavailability of the test P source
- Availability of the reference P source taken from the quantitative data set (if existent)
- Calculation of availability of the test P source based on both

Comparison of raw materials that have both recalculated data and quantitative data
Can the data set be extended by consideration of bone data (relative bioavailability)?

No
Working package 3: Model of requirement of available P

- Awaits to be started
- Initial model will be on broilers and based on published information on growth, body composition, bone development
Summary

- Important milestones have been reached
  - Agreement on what “available P” is
  - Standard protocol for the determination developed
  - Literature survey on relevant data completed

- Requirement modelling still needs to be done before the whole system can be implemented

- Expected benefits
  - More and comparable information for the industry both on raw materials and requirements
  - Better use of limited research resources
  - Contribution of the sector to sustainable food production through saving limited global resources