

Digestibility results from tests with a recovered feed phosphate

Magdalena Presto Åkerfeldt
Associate Professor

SLU, Department of Animal Nutrition and Management

Why are Phosphate Feed Additives Needed?

- **Phosphorus** is a vital ingredient for life
 - Restricted growth
 - Deteriorated appetite
 - Disrupted bone mineralization process
 - Decreased productivity with reduced consumption and digestion of feed; digestive disorders, moulting, feather loss
- Major part of diets to pigs and poultry include vegetable ingredients
 - Contain around 30% of the **phosphorus** that pigs and poultry need
 - Even then, only half of this amount is absorbed by the animal
- Typical form of feed grade phosphate - **monocalcium phosphate** (MCP) is added to the feed



Phosphate Feed Additives

- **MCP** is highly soluble, allowing for increased flexibility in diet formulation
- Easily digested by farm animals, meaning that less of the **feed additive** is wasted = lower impact on the environment

BUT

- Phosphorus raw material is a finite resource - mined in underground mines or open pits
 - **Critical Raw Material**
- **Recycled phosphate** – an important and promising option



Phosphorus Digestibility

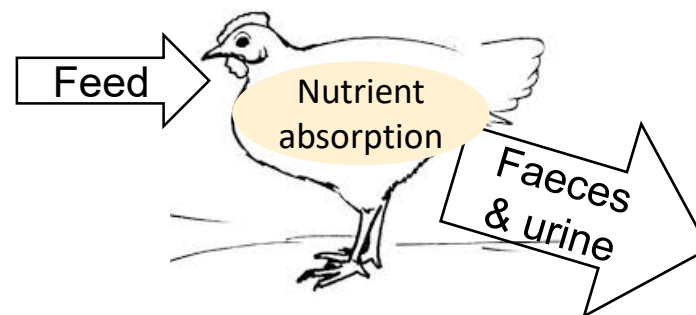
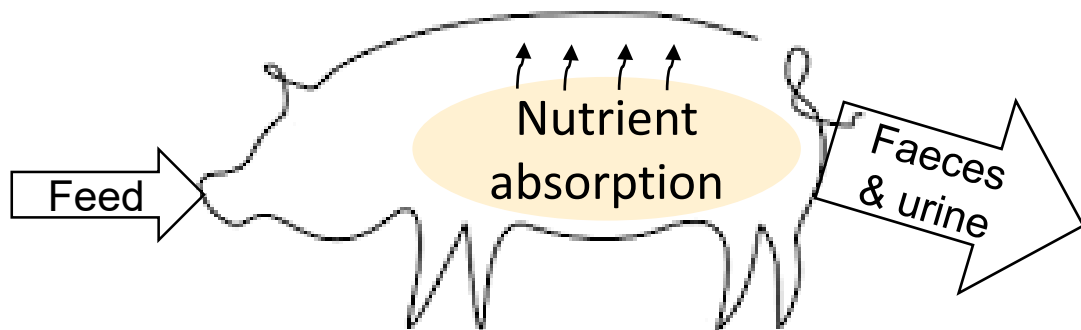
- Why is it Important?



Photo: M. Åkerfeldt

Digestibility of phosphorus

- Amount of **phosphorus** that can be **absorbed and utilized** by the animal
- **Compose feeds** with the right amount of phosphorus
- Optimize the animals' **performance** and **reduce excess of phosphorus** in the manure



Two Digestibility Studies

- **Growing pigs and chickens**
- Determine the phosphorus digestibility of recycled **precipitated calcium phosphate** (PCP)
- **Hypothesis:** PCP should have a similar phosphorus digestibility as monocalcium phosphate (MCP) in pigs and chickens



Chicken study

- 240 day old chicks (Ross 308) divided in 30 groups - 8 chickens/group
- At day 21: Five experimental diets (6 groups/diet)
 - **Basal** diet (*WPSA, 2013*)
 - Test diet **PCP low** (total P level 0.075%)
 - Test diet **PCP high** (total P level 0.15%)
 - Test diet **MCP low** (total P level 0.075%)
 - Test diet **MCP high** (total P level 0.15%)



Photo: E. Ivarsson

Chicken study

Day 21-28

Diet 1	Basal	Slaughter and collection of ileal digesta
Diet 2	PCP low	
Diet 3	PCP high	
Diet 4	MCP low	
Diet 5	MCP high	



Photo: E. Ivarsson

Pig study

- Eight (9-w old) gilts (YxH) from two litters
- Randomly divided within litter into two treatment groups
 - Test diet **PCP**
 - Test diet **MCP**
 - **Basal** P-free diet (prior to test diet for endogenous P-losses)



Photo: E. Ivarsson

Pig study

- Change-over study design

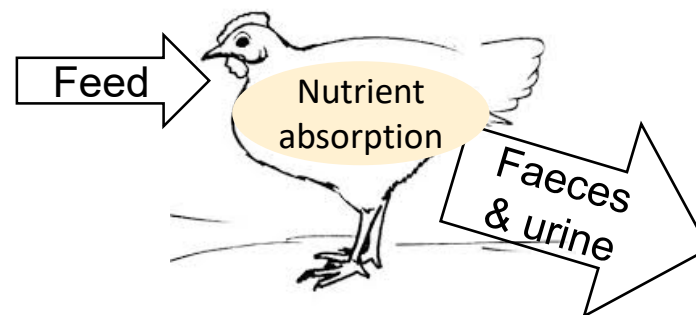
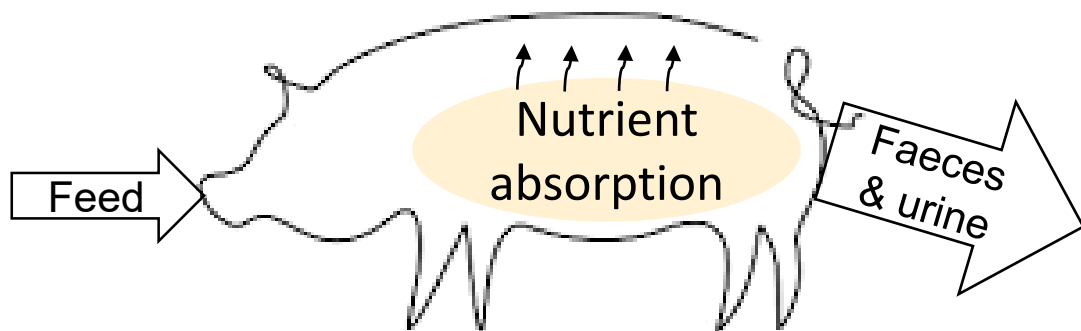
7 d adaptation + 4 d faecal collection for each experimental period

Group 1	Basal	PCP	MCP
Group 2	Basal	MCP	PCP



Digestibility of phosphorus

- TiO_2 – indigestible marker in the feed
 - Will be present in the ileal digesta and faeces
- Digestibility of nutrients can be calculated



Analyses and Calculations

- Feed, digesta and faeces were analysed for dry matter (DM), crude protein (CP), TiO_2 , Ca and P
- Ileal apparent digestibility (IAD) and total tract apparent digestibility (TTAD) for the diets:

$$\text{IAD/TTAD \%} = 100 - [100 \times (Ti_{\text{feed}} \times NC_{\text{digesta/faeces}}) / (Ti_{\text{digesta/faeces}} \times NC_{\text{feed}})]$$

- Content of pre-caecal digestible P (pcdP) in the diet:

$$\text{pcdP (g/kg of diet)} = \text{IAD (\%)} \times \text{P content diet} / 100$$

Statistics

- Mixed procedure in SAS to determine treatment effects by ANOVA
- Models included **Diet** (fixed factor), **Pen** or **Pig** (random factor)
- Chicken study included an intercept multiple regression analysis between **total phosphorus** contents and the **pcdP** in the diets with the GLM procedure
- Level of significance: **$P < 0.05$**

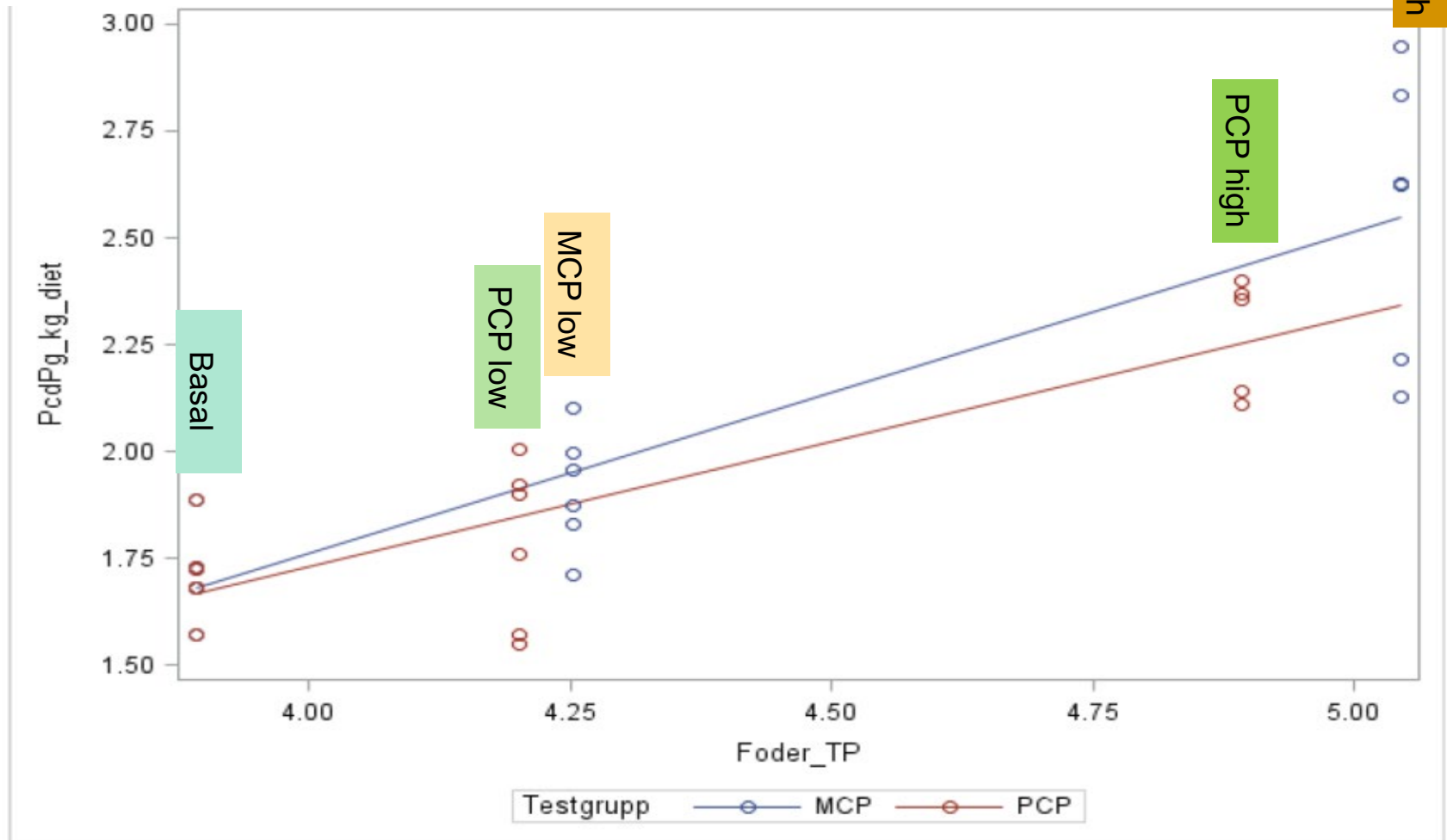
Results Chicken Study

– ileal apparent digestibility % of nutrients in diets

	Basal	PCP Low	MCP Low	PCP High	MCP High	SE	P-value
OM	73.43	73.73	74.41	75.76	75.60	0.770	0.150
Ca	59.03	55.13	58.13	54.71	55.34	2.196	0.535
P	41.91 ^{ab}	40.28 ^b	42.64 ^{ab}	44.16 ^{ab}	48.27 ^a	2.007	0.022
PcdP	1.61 ^b	1.67 ^b	1.79 ^b	2.16 ^a	2.43 ^a	0.094	0.001

Results Chicken Study

- Linearly relationship between pcdP content and total P



Results Chicken Study

- Ileal Apparent Digestibility of P

	Regression equation	SE of slope	SE intercept	r ²	Ileal digestibility %
MCP	Y=0.751-0.638	0.142	0.620	0.770	75.1
PCP	Y=0.584-0.603	0.110	0.475	0.770	58.4



Photo: E. Ivarsson

Results Pig Study

– total tract apparent digestibility %
of nutrients in diets

	PCP	MCP	SE	P-value
OM	94.0	94.2	0.24	0.348
Ca	58.5	71.3	2.29	0.001
P	60.4	83.8	2.59	0.001



Conclusion

- **P digestibility of MCP** in the present studies **within expected range**
- **Digestibility of P** was **lower for PCP** than for MCP for both chickens and pigs
- Linearly relationship between content of **pre-caecally digestible P** and **total P** for chickens
- **Digestibility of Ca** similar in the diets with MCP and PCP in the chicken study but lower for PCP than MCP in the pig study



Conclusion

- **First time** P digestibility of PCP **determined *in vivo***
- **Hypothesis:** PCP should have a similar phosphorus digestibility as MCP in pigs and chickens **could not be supported**

To fully explore the potential of PCP as feed ingredient:

- More **digestibility studies** and **feeding and growth studies** needed
- **Benefits** of closing the phosphorus cycle, having **domestic production** and **decreasing CO₂ emissions** should be considered



Acknowledgements

Financial support:

Lantmännen Research Foundation, Ragn-Sells

Feed production:

Lantmännen Lantbruk

Center for feed technology, Fortek

Project group:

SLU – Emma Ivarsson, Magdalena Åkerfeldt

Easy Mining – Sara Stiernström, Yariv Cohen, Daniel Boman

Reference group:

Lantmännen - Kerstin Sigfridson, Maja Möller, Anna Björnberg

Swedish Board of Agriculture – Division of Feed and animal by-products

Thank you for your attention!

Magdalena.Akerfeldt@slu.se
Emma.Ivarsson@slu.se

SLU, Dept. of Animal Nutrition and Management