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Phytase in pig production

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Phytase in pig production

AGENDA
1. The Danish model for evaluation of phytase
2. Benchmarking phytases for swine
3. Inorganic P-free diets
4. Future expectations to the use of phytase

Page

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Before we start

- One Danish feed unit (FU) is 11.8-12.3 MJ ME in complete feed
  - use 12.2 MJ ME as reference - or 12.6 MJ DE.
- Feed unit for growing pigs (FUgp) and sows (FUsow)
- Nutrition standards are stated per FU and not per kg
- Typical energy levels:
  - < 10 kg = 1.12-1.18 FUgp/kg
  - 10-30 kg = 1.09-1.13 Fugp/kg
  - 30-115 kg = 1.02-1.08 FUgp/kg
  - Lactating sows = 1.04-1.10 FUsow/kg
  - Gestating sows = 0.98-1.04 FUsow/kg

Page 3

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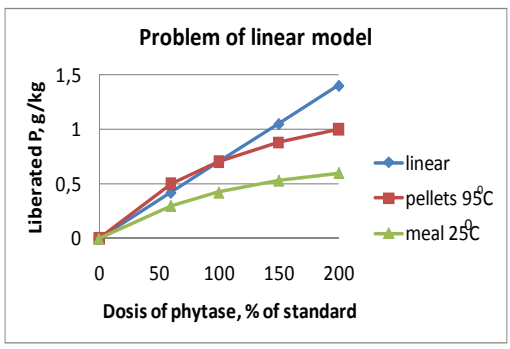

Page 4

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2005:Solution wanted

- Model to fit all different phytases
  - Existing and coming
- Non-linear
  - Implemented in programmes using linear programming
- Effect dependent on ingredients
  - Meal and heat-treated pellets
  - High and low phytate level
- Safe for the pig and the farmer
- Possible to make economically optimum solutions
- Possible to make solutions when phosphorus restrictions on land

Page 5

Problem:

- Dosing of different phytase products
- Used in same calculation system

Solution:

- Definition of a standard dose for all phytases

Page

Danish definition

- The standard dose of a given phytase product is the number of phytase units from this product (measured at pH 5.5) that is equal to 500 FTU Natuphos Phytase in typical feed
- **Standard dose = 100% dose**
  - 500 FTU Natuphos Phytase
  - 500 FTU Phyzyme XP
  - 500 FYT RONOZYME-HiPhos
  - 750 FYT RONOZYME-P
  - 1250 FYT RONOZYME-NP
  - 250 OTU / 500-750 FTU Optiphos
  - 400 FTU Axtra Phy
  - 400 FTU Quantum Blue

Page

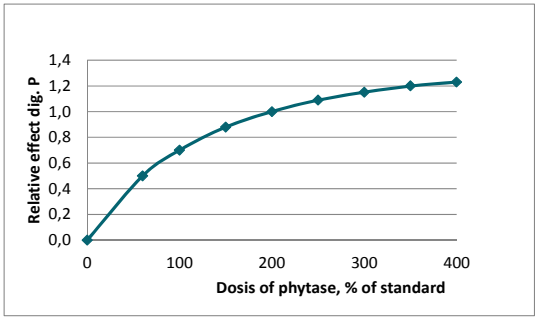
Phytase evaluation

Dose	Natuphos (FTU) Phyzyme XP (FTU) Ronozyme HiPhos (FYT)	Ronozyme NP (FYT)	Optiphos (OTU)	Axtra Phy (FTU) Quantum Blue (FTU)
60%	300*		150	250* (min)
100%	500	(1250) 1500*	250	400
150%	750	1875	375	600
200%	1000	2500	500	800
300%	1500	3750	750	1200
400%	2000	5000	1000	1600

*Minimum dose is 500 FYT for Hiphos and 1500 FYT for Ronozyme-NP

Page 8

Effect of increasing phytase dosis



Page 9

Danish calculation system, example

- 1. Digestibility without phytase
- 2. Digestibility with dosing of 400%
- 3. Standard curve in-between

Relative effect	**Wheat, heat treated, digestibility**	
0 = 0	28%	(defined by experiments)
60% = 0.5	42%	28+(62-28) x 0.5/1.23
100% = 0.7	47%	28+ (62-28) x 0.7/1.23
150% = 0.88	52%	28+ (62-28) x 0.88/1.23
200% = 1.0	56%	28+ (62-28) x 1,0/1.23
250% = 1.09	58%	28+ (62-28) x 1,09/1.23
300% = 1.15	60%	28+ (62-28) x 1,15/1.23
400% = 1.23	62%	(defined by experiments)

Page

P digestibility, ingredients

Phytase, % of standard	0	60	100	150	200	250	300	400
Relative effect	0	0.50	0.70	0.88	1.00	1.09	1.15	1.23
P digestibility, % - depending on dose of phytase								
Spring barley, heat treat	30	41	46	50	53	55	56	58
Spring barley, Not HT	43	49	52	54	55	56	57	58
Wheat, heat treated	28	42	47	52	56	58	60	62
Wheat, Not HT	50	55	57	59	60	61	61	62
Maize	20	36	43	49	53	55	57	60
Soybean meal	39	51	56	60	63	66	67	69
Rapeseed meal	27	40	45	50	53	55	57	59
Sunflower meal	15	28	33	37	40	42	44	46

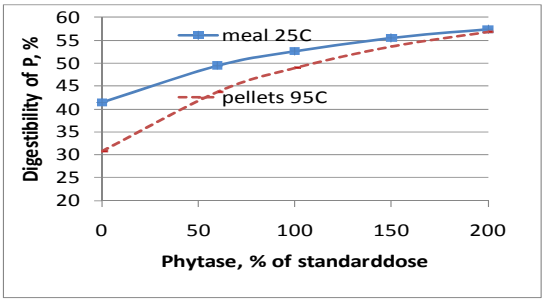
Page 11

How does this work in practice?

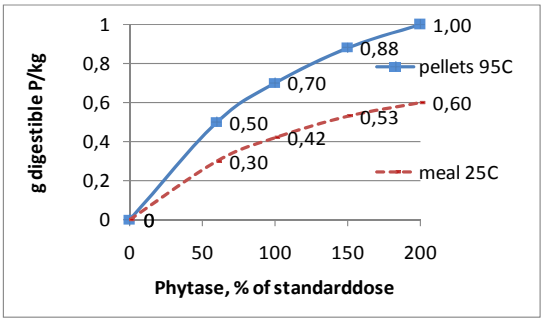
- All feed ingredients have 8 levels of digestible P
  - Like 8 different amino acids
  - Dig. P of 200% dose = one amino acid
- Grain in two versions, heat or not
- You choose level of dig. P in complete diet
- You choose the level of phytase you use
- The limit is eg. 2.5 g dig P per FU at 200% dose
- Price at150% or 250% phytase
- Other factors
  - Maximum acceptable level of P in feed
  - EPE (extra phosphoric effect)?

Typical Danish feed

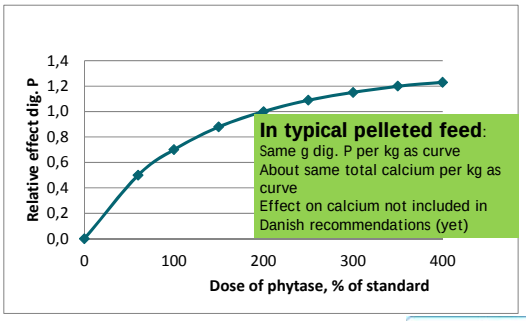
Calculated digestibility, Plant-P



Effect of phytase in a typical Danish diet



Effect of increasing dose of phytase

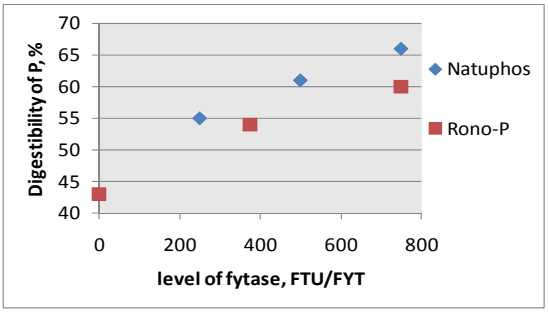


In typical pelleted feed:
Same g dig. P per kg as curve
About same total calcium per kg as curve
Effect on calcium not included in Danish recommendations (yet)

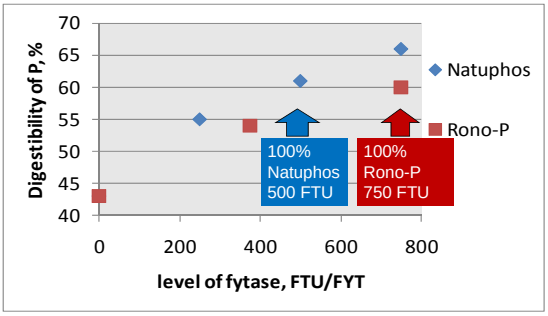
Benchmarking phytase for swine

- **We prefer**
  - Good comparative measures of phytases in same experiment
  - In Denmark or other places!
- **We have to live with**
  - New phytases with "many" experiments without benchmarking
  - Typically made in diets with high level of phytate and no natural phytase (eg. maize + 30% soybean meal)
  - Big variations between ingredients and research institutions!
  - Phytase sellers compete on matrix values – some selected from "best experiments"!
- **Phytase producers - in Denmark - have to live with**
  - Conservative evaluation until good comparative experiments
  - No risk for pigs or pig farmers!
  - We do not recommend use of matrix values for amino acids
  - Experiments defining requirement are made with phytase in feed

Danish experiment (Livest. Sci.,2007)



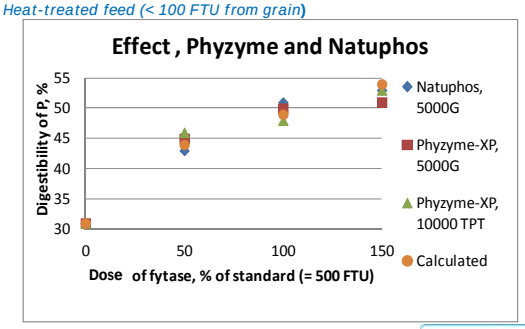
Danish experiment (Livest. Sci.,2007)



Page 18

Phyzyme and Natuphos phytase, 2010

Heat-treated feed (< 100 FTU from grain)



Page 19

Evaluation, phytases, Foulum 2011 unpublished

	Cont	Natuphos			Phyzyme XP			RON-NP		
FTU	0	300	750	1500	300	750	1500	600	1500	3000
Ana*	180	580	1240	2070	440	940	1800	1080	2230	4950
Add	0	400	1060	1890	260	760	1620	900	2050	4770
Add%	0	80	212	378	52	152	324	72	164	382
P-Dig	41	55	63	65	57	61	62	55	59	65

*Analysis Foulum Lab

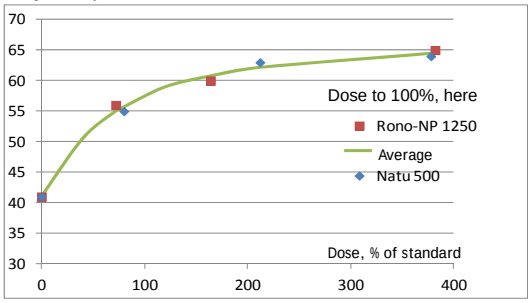
Standard dose used :

Natuphos 500
Phyzyme 500
Ron-NP 1250

Page

Response curve, Rono-NP and Natuphos, unpublished

P digestibility, no mineral-P



Page 21

Evaluation RONOZYME-HiPhos, Foulum

	Control	Natuphos			HiPhos	
Phytase, plan	0	400	750	1000	400	1000
Analysis of premix before mixing						
P-dig., %	42	54	59	62	56	63

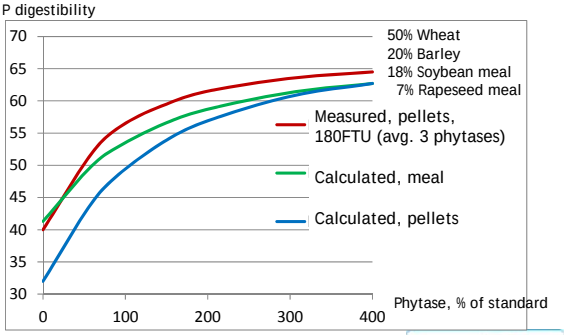
Wheat 47%, barley 25%, soybean meal 18%, rapeseed meal 9%
4,3 g P per kg, no mineral P
Heat treated at 90 degree, 180 FTU in control.

Conclusion: same standard dose for Natuphos and HiPhos

Page

Danish experiment 45 kg pigs, Foulum

P digestibility

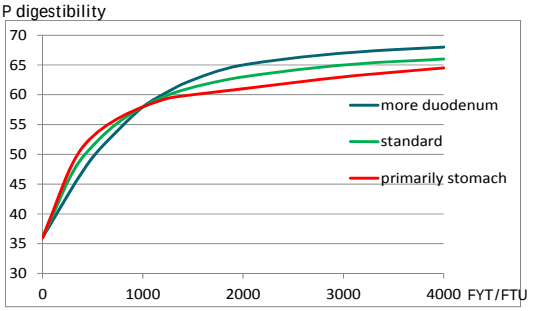


Page 23

Good questions, benchmarking

- Do all phytases fit the same standard curve ?
  - Same maximum digestibility
  - Same response curve
  - We, until now, assume this
- If not, could different shape of response curve be included in the digestibility system ?

Theoretical example, response curves



Good questions, benchmarking

- Different response curve could be included in the system, example:

Dose	% dig.	standard	only stomach	more duodenum F4
0	36	FTU	FTU	FTU
1	47	300	200	400
2	51	500	400	600
3	55	750	650	850
4	58	1000 (200%)	1000	1000
5	60	1250	1500	1150
6	61	1500	2000	1300
7	63	2000 (400%)	3000	1600

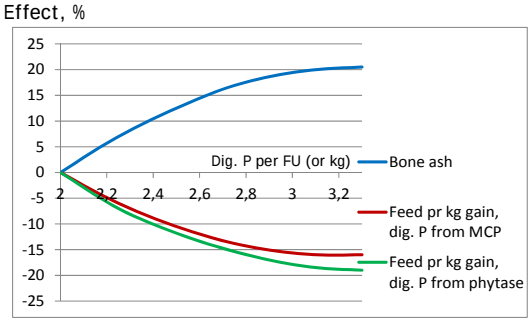
Possible, but more confusing!

Conclusion, Danish system

- **The system is conservative**
  - Experiments often show higher digestibility
  - "Goal": 70% of experiments find higher digestibility
- **We use same response curve for all phytases**
  - Up to 400% dose from September 2016
  - We do not find sufficient evidence to discriminate
- **If needed and documented, we could use the same basic system for phytases with different response curve**
  - Every level of digestibility could correspond to a specific phytase dose

EPE (extra phosphoric effect) and super dosing

The principle of super dosing/EPE



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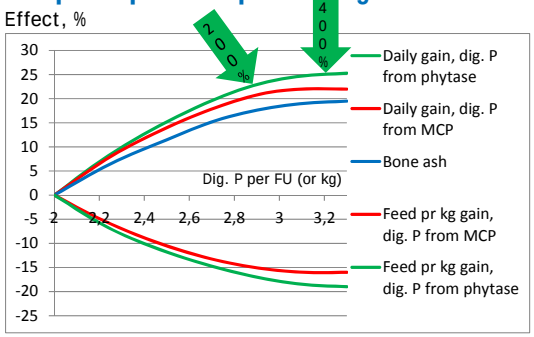
F4 Er der ikke lig kludder i rækkerne i denne tabel?
Forfatter; 17-02-2017

The principle of super dosing/EPE



EPE, super dosing, matrix

- Some effects are documented
  - Amino acid digestibility (1-3%), < 50% of experiments
  - Micromineral digestibility, eg zinc (every time!)
  - Less endogenous loss (energy and AS-dig.)
  - Growth and feed conversion, same dig. P (1-5%)
  - Greatest EPE-effect in piglet feed
- EPE effect should follow phytate degradation
- Main effect is reached at 200% dosis
- Danish experiments defining amino acid requirements are made with feed containing 200% phytase

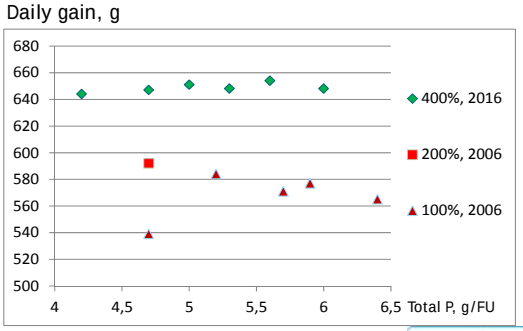
Future and low-P diets

- **Denmark will meet a maximum from P in manure, when disposed to farmland**
- Minimizing P in feed = less farmland needed and less N has to be supplied as fertilizer
- **Optimum Phytase dose**
  - Only P and Ca : 150-250%
  - P, Ca and EPE: 200-400%
  - P, Ca, EPE and slurry disposal: 250-400%
- It is very difficult to show extra EPE from 200 -> 300% dose
- An improvement of only 0.2-0.3% in weight gain and feed conversion ratio would make 300% best

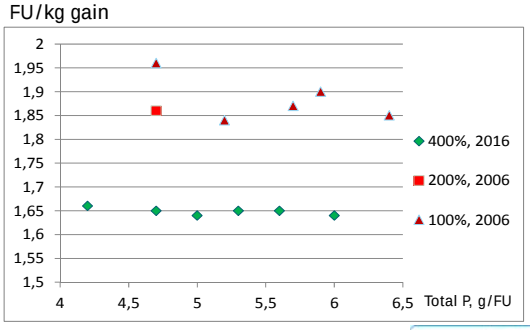
Danish experiments with piglets and growing/finishing pigs

- 2006: piglets, Ronozyme-P (100-200%)
- 2016: piglets, RONOZYME HiPhos, 400%
- 2008: 30-105 kg Ronozyme-P, (100-200%),
  - Grain + soybean meal
- 2010: 30-106 kg Ronozyme-P (0-200%),
  - 8% sunflower, 6% rapeseed
- New experiments 2017: Hiphos

Piglets, 10-30 kg, P and Phytase



Piglets, 10-30 kg, P and Phytase



P and Phytase, low P diet, 30-105 kg

Total-P analysis, g/FEsv	3.4	3.9	4.4	4.9
FYT Rono-P	1500	1500	750	750
Phytase, analysed	2210	2060	1290	1250
Dig. P, calculated, 2010	1.94	2.35	2.46	2.76
Daily gain, 30-105 kg	883	898	909	902
FU/kg, 30-105 kg	2.87	2.81	2.81	2.81
Meat, %	59.5	59.9	59.7	59.9
Production value, index	92	100	100	100
P per ha, 2010 DK-rules	15 kg	19 kg	23 kg	29 kg

Page 36

Effect of P and phytase, high natural P
(6% rapeseed, 8% sunflower)

Total-P, g/FU, ana	4.0	4.0	4.0	4.45	4.45	4.9
FYT added (Ron-P)	0	750	1500	750	1500	750
FYT, analysed	500	1200	2100	1200	2200	1200
Dig P, calcul. 2010 (as home-mixed)	1.7	2.0	2.1	2.3	2.4	2.6
Results 30-106 kg:						
FU/day	2.61	2.60	2.65	2.64	2.65	2.64
Daily gain, g	940	950	972	975	982	987
FU/kg gain	2.78	2.74	2.73	2.71	2.70	2.68
Meat %	60.1	60.2	60.3	60.3	60.2	60.4

Page 37

Inorganic P-free diets?

- Age group
- Diet natural P level and phytase dose

- Diets for gestating sows can be without inorganic P
- We expect diets for pigs > 75 kg can be inorganic-P free with no or very little negative effect

- **Experiment ongoing**
- 6 levels of P in diets with 250% phytase, 30-115 kg
  - (3.8-5.4 g total-P, 5% rapeseed meal. 5% sunflower meal)
- **In development:**
- 4 groups for slaughter pigs, 250% phytase, starts "very soon"
- Positive and negative control
- 2 strategies of phase feeding

Page 38

Total-P needed, 250% dose, typical feed

Dig. P		Digestibility	Total-P
2,0	Gestating	56	3.6
2.1 (?-2017)	75-110	56	3.7 (?-2017)
2.3	65-110	57	4.0
2.5	30-110	58	4.3
2.6	30-55	59	4.4
3.0	15-30, sow	62	4.8
3.2	9-15 kg	63	5.1

High natural levels = rapeseed meal and sunflower meal, wheat bran – and/or high protein level (more soybean meal).

Gestating sows = natural
> 75 kg is waiting for experiment

Page 39

Conclusions

- Danish phytase evaluation system is unique
  - Can handle nearly all phytase issues - except EPE
- We recommend choosing the higher dose, if economy on P and Ca is neutral or close to neutral
- The near future is
  - 150-250% meal
  - 200-300% pellets
  - EPE : 300% for piglets

- More emphasis on P-reduction by phytase and phase feeding because of P restrictions on farmland

Page 40