THE IMPACT OF NUTRITION ON REDUCTION OF PHOSPHATE EXCRETION IN PIGS

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Description
In pig diets, P-reduction is possible by 1) precisely adjusting digestible P supply on P requirements (phase feeding), 2) adding more phytase to the diet, 3) improving P-digestibility of the raw materials and 4) increasing nutrient density of the diet.

Rationale, mechanism of action
Nutritional research in relation to environmental pollution has focused mainly on reducing the dietary P input, and on their more efficient utilization. To achieve this, it is important to supply dietary P in close accordance with the animals' requirement. This requires adequate knowledge about the digestibility of P in the feed used, and on the requirement for this nutrient. It has been recognized that the nutritional requirements in different countries may vary because of differences in housing conditions, genotype of the animals, level of feeding, major ingredients used in the diets and response criteria. Furthermore, it is possible to enhance the digestibility of P in feeds by using extrinsic enzymes. In addition, the excretion of P can be further reduced by exchanging less digestible feedstuffs by better digestible ones. By the introduction of (multi)phase feeding, also a reduction in P excretion can be obtained. Moreover, by improved performance (improved types of pigs) reduction of the excretion of P can be achieved. In this respect also optimal management with regard to housing and health status of the pigs and feeding strategy, which may improve feed conversion ratio, will be beneficial for the environment.

Digestible P in feedstuffs
The nutritive value of total P of a diet is evaluated by its apparent fecal digestibility. Table 1 shows that there are large differences in P digestibility among feedstuffs of plant origin. There are also substantial differences among those from animals and feed phosphates. The large variation among and within a feedstuff is attributed to differences in phytate P content, phytase activity, and processing [1]. The requirements for phosphorus are also expressed in terms of digestible P [2].

Table 1 Faecal digestibility of P (%) in some feedstuffs for pigs [3].

Feedstuff	**P**
Barley	39
Maize	20
Wheat	48[a]
Wheat middlings	30[b]
Soybean meal extr.	39
Rapeseed meal extr.	27
Sunflower seed extr.	15
Peas	45
Fishmeal (CP 580-630)	77

[a] wheat contains 1000 phytase units per kg
[b] wheat middlings contain 3000 phytase units per kg

Adjusting digestible P supply on P requirements

Based on the P-contents of different categories of pigs, digestible P-requirements per kg EW (1 EW equals 8.79 MJ NE or 12.55 MJ ME) are estimated by use of the factorial method. The estimated digestible P and Ca-requirements per pig category are shown in Table 2.

Table 2 Practical recommendations of digestible P en Ca in pig diets [2]

Category	Dig. P (g.kg EW^{-1})	Ca (g.kg EW^{-1})
Weanling pig until 2 wk after weaning	3.2	8.0
Weanling pig from 2 wk after weaning	3.4	9.5
Grower pig (25 to 45 kg)	2.4	6.9
Grower pig (45 to 70 kg)	2.1	6.3
Finisher pig (70 kg to slaughter)	1.9	5.7
Finisher pig (45 kg to slaughter)	2.0	6.0
Pregnant sow (until 70 d. of pregnancy)	1.5	5.0
Pregnant sow (from 70 d. of pregnancy)	2.2	7.3
Pregnant sow (whole pregnancy)	2.1	6.9
Lactating sow	2.7	7.7

The desired digestible P content of the diet highly depends on the physiological status of the pig category. As the recommended concentration of digestible P per kg feed decreases as LW of grower-finisher pigs increases, phase-feeding systems can be introduced to further reduce P excretion.

Adding more phytase to the diet

Plant ingredients used to formulate pig diets may contain from 0.7 to 3.5% of phytates [4]. They are of very limited digestibility for pigs. Therefore, feed manufacturers and farmers have to add inorganic P from feed phosphates to their pig diets. To enable dephosphorylation of the dietary phytates, intrinsic or extrinsic (microbial) phytases can be used. Since 1990, several experiments with exogenous microbial phytases were reported to quantify their effect on the apparent digestibility of P. A survey of a large part of these studies has been presented [5,6]. Most studies show an exponential dose-response curve (Figure 1).

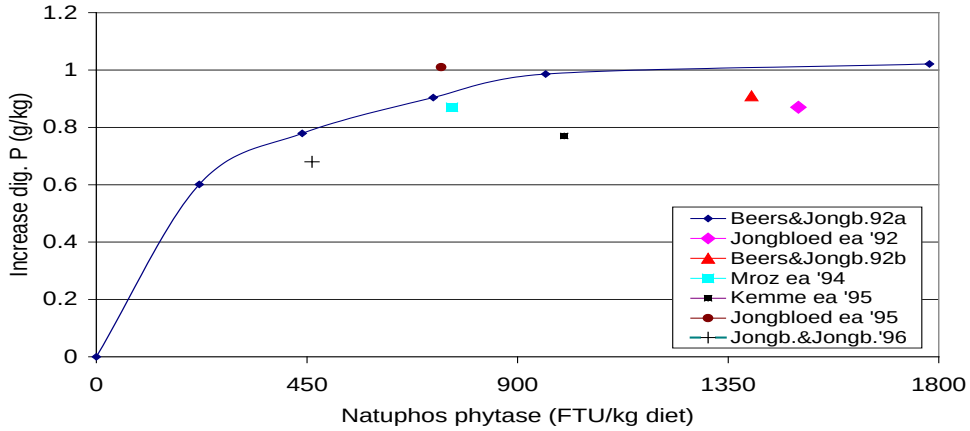

Figure 1 Dose-response effect of 3-phytase and of several other experiments by ID TNO on the amount of digestible P generated of diets with more than 50% maize and soybean meal

Applicability
Reducing phosphate excretion by phase feeding is especially applicable in gestating sows and grower – finisher pigs. Adding more phytase to the diet and improving P-digestibility of the raw materials is applicable in diets of all categories of pigs. The environmental perspectives of increasing the nutrient density of the diet are largest in grower – finisher pigs. Supplementing high energy diets to lactating sows, however, probably could also be a perspective option.

Effectiveness, including certainty
The impact of different feeding strategies on phosphorus excretion in grower – finisher pigs are summarized in Table 3. Starting point is based on the average performance and P-content in the Dutch grower - finisher husbandry of 2007.

Table 3 The impact of different feeding strategies on phosphorus excretion in grower – finisher pigs, based on the average Dutch performance in pig husbandry of 2007

Grower – finisher pigs from 25 kg to 110 kg		**Control**	**Phase feeding**	**More phytase**	**Control energy diet**	**High energy diet**
Starting points	Unit	**2007**	**2007**	**2007**	**2009**	**2009**
Days to slaughtering	d	117	117	117	114	111
Starter weight	kg	25.6	25.6	25.6	23.3	23.3
Slaughter weight	kg	116.6	116.6	116.6	115.4	117.1
Feed conversion		2.75	2.75	2.75	2.62	2.00
Daily gain	g/d	779	779	779	808	844
P-content starter diet	g/kg	**4.8**	**4.8**	**4.6**	**4.6**	**4.4**
P-content grower diet	g/kg	**4.7**	**4.7**	**4.5**	**-**	**-**
P-content finisher diet	g/kg	**4.7**	**4.5**	**4.3**	**4.8**	**3.8**
Total feed intake	kg	250.3	250.3	250.3	241.3	187.6
Per year						
Conversion factor to year		3.12	3.12	3.12	3.20	3.28
Total P-intake	kg	3.69	3.62	3.46	3.68	2.43
P-retention in meat	kg	1.53	1.53	1.53	1.58	1.65
P-excretion	kg	2.17	2.09	1.94	2.09	0.77
Relative P-excretion	**%**	**100**	**96**	**89**	**100**	**37**
P-retention	**%**	**41.3**	**42.2**	**44.1**	**43.1**	**68.1**

Phase feeding could reduce P-excretion of grower – finisher pigs by 4%, whereas the mixture of phase feeding and additional phytase in the diet could reduce P-excretion by 11%. Results of 2009 are showing that the use of high energy diets could reduce P-excretion even by 63%.

The impact of different feeding strategies on phosphorus excretion in breeding sows and piglets are summarized in Table 4. Starting point is based on the average performance and P-content in the Dutch breeding pig husbandry of 2008.

Table 3 The impact of different feeding strategies on phosphorus excretion in breeding sows and piglets, based on the average Dutch performance in breeding pig husbandry of 2008.

Breeding sow and piglet to 25 kg		**Control**	**Phase feeding**	**More phytase**	**Increased P-digest.**
Starting points	**Unit**	**2008**	**2008**	**2008**	**2008**
Live born piglets/sow/year		30.9	30.9	30.9	30.9
Weaned piglets/sow/year		26.9	26.9	26.9	26.9
P-content piglet diets	g/kg	**5.4**	**5.4**	**5.2**	**5.1**
P-content lactation diet	g/kg	**5.5**	**5.5**	**5.2**	**5.0**
P-content gestation diet < 80 d gestation	g/kg	**5.0**	**4.4**	**4.4**	**3.0**
P-content gestation diet > 80 d gestation	g/kg	**5.0**	**5.0**	**4.7**	**4.4**
Per sow per year					
P-intake					
Piglet diets	Kg	4.26	4.26	4.11	4.01
Lactation diets	Kg	2.28	2.28	2.16	2.07
Gestation diet < 80 d gestation	Kg	2.44	2.15	2.15	1.46
Gestation diet > 80 d gestation	Kg	1.31	1.31	1.23	1.16
Total P-intake	**Kg**	**10.30**	**10.00**	**9.64**	**8.71**
P-retention in growth sow, piglets, mortality piglets	Kg	3.94	3.94	3.94	3.94
P-excretion	Kg	6.35	6.06	5.70	4.76
Relative P-excretion	**%**	**100**	**95**	**90**	**75**
P-retention	**%**	**38.3**	**39.4**	**40.9**	**45.3**

Phase feeding could reduce P-excretion of breeding sows by 5%, whereas the mixture of phase feeding and additional phytase in the diet could reduce P-excretion by 10%. The use of raw materials with a low content of indigestible P might reduce P-excretion even by 25%.

Time frame
The different feeding strategies that might reduce P-excretion can be implemented in pig husbandry in the short-term. Data from practical farms show that some pig farmers already are realizing significant reductions in P-excretion without negatively affecting technical or economical performance.

Environmental side-effects / pollution swapping
There is a growing concern about the exhaustibility of our natural P-resources. Reducing the P-content of pig diets will contribute to a well-balanced use of P-resources.

Relevance, potential for targeting, administrative handling, control
Before delivering the feed to the farmer, the feed producer has to determine the P-content of the pig diets regularly. Analytical data should be registered in a control system, which will be inspected at random. Phosphate content of manure should be determined before transport.

Costs: investment, labor

Additional costs or savings of P-low diets depend on the market prices of raw materials and inorganic phosphorus sources and are fluctuating over time. To realize (multi-)phase feeding, farmers need to invest in additional equipment, like feed silo's. Feeding systems, however, differ in the level of sophistication, so no general statement about additional costs can be made.

References

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