

NUTRIENT RECOMMENDATIONS FOR PIGS IN DENMARK

This publication provides an outline of the Danish nutrient recommendations per kg of feed for sows, gilts, piglets, growing pigs and finishers with energy levels calculated in DE, ME, NE, EW and Danish feed units in typical pig diets.

INSTITUTION: SEGES PIG RESEARCH CENTRE

AUTHOR: PER TYBIRK

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Summary

This publication provides an outline of the Danish nutrient recommendations for sows, prebreeding gilts, piglets, growing pigs and finishers. The Danish recommendations are expressed per Danish feed unit, and in this publication they are converted to recommendations per kg of feed. In addition, the publication includes examples of feed composition and energy levels in feed in different energy evaluation systems.

Nutrient recommendations and total amount of other minerals and vitamins are presented as digestible amino acids and digestible phosphorus per kg feed. The basis is typical international feed composition using Danish recommendations, and the energy content of the feed is calculated in DE, ME, NE, EW and Danish feed units for growing pigs (FU_{gp}) or sows (FU_{sow}).

Background

In Denmark, nutrient recommendations are expressed per Danish feed unit [1]: there is one feed unit for growing pigs (FU_{gp}) and a slightly different one for sows (FU_{sow}). The two units are calibrated so that FU_{gp} = FU_{sow} in barley. Low-energy diets contain more FU_{sow} than FU_{gp} and high-energy diets contain more FU_{gp} than FU_{sow}. The difference is attributed to a higher energy value of fibre for sows in the equations used to calculate energy content.

In other countries, where different feed evaluation systems are applied, it may be difficult to convert the Danish recommendations per Danish feed unit to the feed evaluation systems in question – a topic of increasing interest as sales of DanAvl genetics worldwide continue to soar. This publication will be a helpful tool in converting Danish recommendations to other evaluation systems.

Method

Danish pig feed is primarily based on wheat, barley and soybean meal, and to a smaller extent rapeseed expeller/meal and sunflower meal. Danish barley and wheat have very low protein concentrations due to years of restriction on nitrogen fertilization in order to minimize nitrogen leaching. It is therefore irrelevant to apply Danish feed composition in foreign countries where grain typically contains more protein.

This publication includes examples of how the Danish recommendations may be used in an average international scenario of available feedstuffs with typical content of protein in grain. The examples include corn even though this cereal is rarely used in Danish pig feed as Danish pig producers are fairly self-sufficient in energy from wheat, barley, rye and triticale.

Furthermore, it was decided to show energy content calculated with six different methods: DE, ME, NE from NRC 2012 table values of ingredients [2], Dutch EW from CVB Table booklet of feeding of pigs (2008) [3] and the two Danish feed units for growing pigs and sows. The relation between energy systems (e.g. MJ ME per FU_{gp}) depends on the feed composition, in particular on protein content.

One key factor is the energy content in feed as the Danish recommendations for protein, amino acids, minerals and vitamins are expressed on the basis of energy content. Consequently, nutrient content per kg depends on energy content per kg, i.e. recommendations per kg apply only to the specific energy content per kg feed shown in the individual example. The recommendations per energy content can be calculated as content per kg divided by energy per kg in the energy unit chosen (i.e. per MJ ME). Alternatively, the recommended content per kg of a nutrient in the Danish system can be calculated as (desired energy content in feed) / (energy content in Danish example) x amount of digestible nutrient per kg in the Danish example.

Danish amino acid recommendations are intended to be economically optimum at an average price scenario in Denmark. An increase in the amino acid profile to 5-10% above the recommendation may improve growth and feed conversion slightly, but the cost of doing so will normally exceed the benefit.

In 2014, we introduced new feeding standards for prebreeding gilts. These standards are far below the levels required for maximum growth as it is attempted to use nutrition to slow down growth in order to decrease mature size, increase leg strength and increase fat levels in per cent of body at breeding. The overall goal is to increase the longevity of sows.

Results and discussion

The following tables are examples of feed composition when Danish recommendations are applied. Tables 1-3 concern nutrient content and the following three tables provide examples of feed composition used to calculate digestible content and energy content in different energy evaluation systems. Typical feed will often have a higher concentration of several amino acids compared to minimum recommendations. Consequently, the examples include both the minimum recommendation and the level achieved for digestible amino acids.

Phytase was included with 1000 FTU in all examples of feed composition - as in typical Danish feed – and xylanase is included in feed for piglets and growing-finishing pigs, but not for sow feed.

Many feed formulators around the world use matrix values for phytase and xylanase to increase the calculated content of digestible amino acids and energy. In this publication, matrix values were not applied to increase digestibility of amino acid or energy content expressed in DE, ME, NE or EW. In the Danish system, we include a 0.5-1.0% “uplift” of energy content from xylanase, because the calculated energy value includes the effect of xylanase on the in vitro digestibility. In Denmark, the “uplift” for phytase is not used on energy or digestibility of amino acids partly because this cannot be documented with the Danish methods for control of energy in pig diets and partly because recommendations for digestible amino acids are based on trial activities with feed containing phytase.

Table1. Nutrient content of piglet feed.¹

Piglet weight	6-9 kg		9-15 kg		15-30 kg	
Mcal / MJ DE/kg feed (NRC)	3.42 / 14.30		3.39 / 14.20		3.35 / 14.00	
Mcal / MJ ME / kg feed (NRC)	3.28 / 13.74		3.26 / 13.64		3.21 / 13.44	
MJ NE / kg feed (NRC)	2.48 / 10.40		2.46 / 10.31		2.40 / 10.05	
EW / kg feed, NL	1.14		1.13		1.09	
FUgp / kg, DK	1.17		1.15		1.11	
MJ DE / ME per FUgp	12.2 / 11.7		12.3 / 11.9		12.6 / 12.1	
Total gram per kg, achieved in the examples (table 4)						
Crude protein	198		194		195	
Phosphorus	6.2		6.0		5.6	
Calcium	7.6		9.3		8.9	
Lysine	14.4		13.4		13.1	
Methionine	4.6		4.2		4.1	
Met + cys	7.8		7.5		7.5	
Threonine	9.0		8.5		8.3	
Tryptophan	2.9		2.8		2.7	
Isoleucine	8.3		7.9		7.8	
Leucine	15.4		15.1		15.0	
Histidine	4.7		4.7		4.8	
Phenylalanine	9.4		9.3		9.2	
Phenylalanine + tyrosine	16.4		16.2		16.0	
Valine	9.9		9.4		9.2	
Standardized digestible gram per kg for protein and amino acids, apparent digestible P, g / kg						
	Minimum	Achieved	Minimum	Achieved	Minimum	Achieved
Crude protein	170	172	161	168	158	167
Phosphorus	3.9	3.9	3.7	3.7	3.3	3.3
Lysine	12.9	12.9	12.1	12.1	11.7	11.7
Methionine	4.1	4.2	3.9	3.9	3.7	3.7
Met + cys	6.9	6.9	6.6	6.6	6.3	6.5
Threonine	7.9	7.9	7.4	7.4	7.1	7.1
Tryptophan	2.6	2.6	2.4	2.4	2.3	2.3
Isoleucine	6.8	7.3	6.4	6.9	6.2	6.7
Leucine	12.9	13.6	12.1	13.3	11.7	13.0
Histidine	4.1	4.1	3.9	4.1	3.7	4.2
Phenylalanine	7.0	8.3	6.5	8.2	6.3	8.0
Phenylalanine + tyrosine	12.9	16.4	12.1	14.2	11.7	13.9
Valine	8.6	8.6	8.1	8.1	7.8	7.8

¹ Feed composition is shown in table 4.

Table 2. Nutrient content for growing-finishing pigs.¹

Pig weight	30-45 kg	45-65 30-105²	65-105 kg			
Mcal / MJ DE/kg feed (NRC)	3.22 / 13.49	3.19 / 13.36	3.16 / 13.23			
Mcal/ MJ ME / kg feed (NRC)	3.11 / 13.01	3.09 / 12.92	3.063 / 12.82			
Mcal / MJ NE/ kg feed* (NRC)	2.35 / 9.83	2.34 / 9.79	2.34 / 9.79			
EW /kg feed, NL	1.06	1.05	1.05			
FUgp/kg, DK	1.08	1.07	1.07			
MJ DE / ME per FUgp	12.5 / 12.0	12.5 / 12.1	12.4 / 12.0			
Total, gram per kg, achieved in the examples (table 5)						
Crude protein	169	154	142			
Phosphorus	5.0	4.8	4.5			
Calcium	7.5	6.9	6.4			
Lysine	10.8	9.4	8.6			
Methionine	3.2	2.8	2.6			
Met + cys	6.3	5.8	5.4			
Threonine	7.1	6.5	6.0			
Tryptophan	2.2	2.0	1.8			
Isoleucine	6.3	5.6	5.1			
Leucine	12.1	10.9	10.2			
Histidine	4.1	3.7	3.4			
Phenylalanine	7.6	6.8	6.3			
Phenylalanine + tyrosine	12.9	10.5	10.5			
Valine	7.7	7.0	6.5			
Standardized digestible gram per kg for protein and amino acids, apparent digestible P, g / kg						
	Minimum Achieved		Minimum Achieved		Minimum Achieved	
Crude protein	140	143	129	129	118	118
Phosphorus	2.8	2.8	2.5	2.5	2.4	2.4
Lysine	9.6	9.6	8.3	8.3	7.5	7.5
Methionine	2.9	2.9	2.5	2.5	2.2	2.2
Met + cys	5.4	5.5	4.9	5.0	4.3	4.5
Threonine	6.1	6.1	5.5	5.5	4.9	4.9
Tryptophan	1.9	1.9	1.66	1.66	1.5	1.5
Isoleucine	5.1	5.4	4.4	4.7	4.0	4.2
Leucine	9.6	10.4	8.3	9.2	7.5	8.6
Histidine	3.1	3.5	2.7	3.1	2.4	2.8
Phenylalanine	5.2	6.6	4.5	5.8	4.1	5.3
Phenylalanine + tyrosine	9.6	11.1	8.3	9.7	7.5	8.8
Valine	6.3	6.3	5.6	5.7	5.0	5.2

¹Feed composition is shown in table 5. The Danish publication offers detailed recommendations for other weight intervals.

² In Denmark, a large percentage of all growing-finishing pigs are fed the same feed from 30 kg until slaughter at 110 kg.

Table 3. Nutrient content for sows and prebreeding gilts.¹

Category	Lactating sows + Gilts 30-65 kg		After weaning ² + Gilts 65-105 kg		Gestating sows + Gilts >105 kg	
Mcal/MJ DE/kg feed (NRC)	3.21 / 13.45		3.10 / 12.95		3.06 / 12.81	
Mcal/ MJ ME / kg feed (NRC)	3.10 / 12.97		3.01 / 12.60		2.98 / 12.47	
Mcal / MJ NE/ kg feed (NRC)	2.35 / 9.83		2.31 / 9.67		2.27 / 9.51	
EW / kg feed, NL	1.07		1.05		1.05	
FUsow / kg, DK	1.08		1.05		1.02	
MJ DE / ME per FUsow	12.4 / 11.9		12.3 / 12.0		12.5 / 12.2	
Total, gram per kg, achieved in the examples (table 6)						
Crude protein	165		124		117	
Phosphorus	5.6		4.4		3.9	
Calcium	8.1		6.9		6.7	
Lysine	9.6		6.3		5.2 ²	
Methionine	3.0		2.1		2.0	
Met + cys	6.1		4.6		4.5	
Threonine	6.5		4.4		4.1	
Tryptophan	2.0		1.45		1.35	
Isoleucine	6.3		4.4		4.1	
Leucine	12.0		9.0		8.5	
Histidine	4.0		3.0		2.9	
Phenylalanine	7.6		5.5		5.1	
Phenylalanine + tyrosine	12.9		9.3		8.7	
Valine	7.7		5.8		5.5	
Standardized digestible gram per kg for protein and amino acids, apparent digestible P, g / kg						
	Minimum Achieved		Minimum Achieved		Minimum Achieved	
Crude protein	125	129	100	100	92	92
Phosphorus	3.2	3.2	2.4	2.4	2.0	2.0
Lysine	8.4	8.4	5.3	5.3	4.1	4.1 ³
Methionine	2.7	2.7	1.7	1.8	1.6	1.7
Met + cys	5.0	5.3	3.4	3.9	3.3	3.7
Threonine	5.5	5.5	3.4	3.4	3.1	3.1
Tryptophan	1.7	1.7	1.05	1.1	1.0	1.0
Isoleucine	4.7	5.3	3.1	3.5	3.0	3.2
Leucine	9.7	10.3	6.1	7.5	2.7	6.9
Histidine	3.3	3.4	2.1	2.4	1.2	2.5
Phenylalanine	4.6	6.5	3.2	4.6	2.0	4.2
Phenylalanine + tyrosine	9.5	11.0	6.1	7.7	3.7	7.0
Valine	6.3	6.3	4.0	4.5	3.6	4.2

¹ Feed composition is shown in table 6.

² From weaning to breeding – normally 2-4 weeks after weaning depending on housing system.

³ If only used for gestating sows until day 108 of gestation, the recommendation is 17% lower for lysine.

Table 4. Example of feed composition, piglet feeding - used in table 1.

Piglet weight	6-9 kg	9-15 kg	15-30 kg
Barley, 10 % crude protein	21.0	20.0	20.0
Wheat, 11.5 % crude protein	30.6	29.9	26.0
Corn	15.0	20.0	20.0
Whey powder	5.0	0	0
Palm oil	3.0	3.0	2.0
Sugarbeet molasses	1.0	1.0	1.0
Soybean meal	10.0	14.0	19.9
Soy protein concentrate, enzyme treated	4.3	3.0	0
Potato protein concentrate	3.0	2.5	1.7
Fishmeal	3.0	2.0	0
Rapeseed expeller	0	0	5.0
Limestone, 36% Calcium	1.10	1.70	1.74
MCP (16 / 22.7)	1.05	1.05	0.85
Salt	0.4	0.40	0.40
Lysine, HCl, 98.5	0.49	0.45	0.44
Methionine, 99	0.12	0.10	0.11
Threonine 98.5	0.14	0.13	0.12
Tryptophan, 98	0.05	0.04	0.03
Benzoic acid	0.5	0.5	0,5
Vitamins + micro minerals	0.2	0.2	0.20
Phytase + xylanase	0.02	0.02	0.02

Table 5. Example of feed composition, growing-finishing pigs – used in table 2.

Pig weight	30-45 kg	45-65 kg 30-105 kg	65-105 kg
Barley, 10% crude protein	25.0	25.0	26.8
Wheat, 11.5% crude protein	32.2	35.7	30.0
Corn	15.0	15.0	20.0
Wheat bran	1.0	2.5	5.0
Palm oil	1.3	1.0	1.0
Sugarbeet molasses	1.0	0	1.0
Soybean meal	12,6	6.7	4.3
Rapeseed expeller	4.0	5	4.5
Sunflower meal, 18% CF	4.0	5	4.5
Limestone, 36% Calcium	1.55	1.4	1.35
MCP (16 / 22.7)	0.58	0.5	0.35
Salt	0.40	0.4	0.40
Lysine, HCl, 98.5	0.46	0.44	0.42
Methionine, 99	0.06	0.03	0.02
Threonine 98.5	0.14	0.145	0.13
Tryptophan, 98	0.02	0.014	0.02
Benzoic acid	0.50	0	0
Vitamins + micro minerals	0.20	0.2	0.2
Phytase + xylanase	0.02	0.02	0.02

Table 6. Example of feed composition, gilts and sows – used in table 3.

Category	Lactating sows + Gilts 30-65 kg	After weaning* + Gilts 65-105 kg	Gestating sows + Gilts >105 kg
Barley, 10% crude protein	30,0	30	30.0
Wheat, 11.5% crude protein	27.1	27.3	22.7
Corn	15.0	20.0	20.0
Wheat bran	1.0	7.0	8.0
Palm oil	2.0	1.0	1.0
Sugarbeet molasses	1.0	3.0	1.0
Soybean meal	12,5	2.0	0
Rapeseed expeller	4.0	3.0	3.5
Sunflower meal, 18% CF	4.0	3.0	3.5
Limestone, 36% Calcium	1.60	1.43	1.35
MCP (16 / 22.7)	0.86	0.40	0.18
Salt	0.4	0.40	0.4
Lysine, HCl, 98.5	0.31	0.24	0.14
Methionine, 99	0.04	0	0
Threonine 98.5	0.08	0.03	0.02
Vitamins+ micro minerals	0.2	0.2	0.2
Phytase	0.01	0.01	0.01

Table 7. Danish recommendations, micro minerals and vitamins expressed per Danish feed unit (FU).

Category Nutrient	Gestating sows + Gilts > 105 kg	Lactating sows	Piglets 6-9 kg	Piglets 9-30 kg	Pigs 30-105 kg
Sodium, g/FU	1.5	1.5	1.5	1.5	1.5
Chloride, g/FU	2.5	2.5	2.5	2.5	2.5
Potassium, g/FU	2.5	2.5	2.5	2.5	2.5
Magnesium, g/FU	0.4	0.4	0.4	0.4	0.4
Iron, mg/FU	80	80	150	150	80
Cobber, mg/FU	6	6	6	6	6
Manganese, mg/FU	40	40	40	40	40
Zink, mg/FU	100	100	100	100	100
Iodine, mg/FU	0.2	0.2	0.2	0.2	0.2
Selenium, mg/FU	0.2	0.2	0.35	0.35	0.2
Vitamin A, IU / FU	8000	8000	8000	5000	4000
Vitamin D3, IU, FU	800	800	800	500	400
Vitamin E, IU / FU	40	165	140	140	40
Vitamin K3, mg / FU	2	2	2	2	2
Thiamin (B1), mg/FU	2	2	2	2	2
Riboflavine (B2), mg/FU	5	5	4	4	2
Pyridoxine (B6), mg/Fu	3	3	3	3	3
Niacin, mg/FU	20	20	20	20	20
Biotine, mg/FU	0.2	0.2	0.2	0.2	0.05
D-pantothenic acid (B5), mg/FU	15	15	10	10	10
Folic acid, mg/FU	1.5	1.5	0	0	0
Vitamin B12, mg/FU	20	20	20	20	20
Typical FU per kg*	1.02	1.09	1.17	1.15 / 1.11	1.07

*With feed composition as above. Recommendations per kg in typical feed = recommendation per FU x FU/kg.

Conclusion

The Danish nutrient recommendations per Danish feed unit for sows, breeding gilts, piglets and growing-finishing pigs are converted to recommendations per kg in typical international feed composition. Using the calculated level of energy per kg in the examples, the Danish recommendations can be recalculated as requirement per unit of energy in the chosen energy evaluation system. The recommendations per kg only apply to the energy content used in the examples.

References

- [1] Tybirk, P; Sloth, N.M.; Kjeldsen, N.J; Shooter, L.: (2016): Normer for næringsstoffer, SEGES Videncenter for Svineproduktion, 23. udgave.
- [2] NRC, 2012. NUTRIENT REQUIREMENTS of SWINE. 400 pp.
- [3] CVB, 2008. CVB table Booklet Feeding og Pigs. CVB-series no. 44.

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VIDENCENTER FOR SVINEPRODUKTION

Tlf.: 33 39 45 00

Fax: 33 11 25 45

vsp-info@seges.dk

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