OVN VITAMIN CONCEPT FROM DSM IMPROVES PRODUCTION VALUE IN FEED FOR PIGLETS

TRIAL REPORT NO. 1148

The high vitamin levels recommended by DSM led to improved productivity and higher production value compared to the official Danish vitamin standards.

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Abstract

The effect of DSM's Optimum Vitamin Nutrition concept (OVN) was studied at SEGES Danish Pig Research Centre's trial station Grønhøj in a trial comprising two groups of pigs: one group fed according to DSM's OVN concept and one fed according to the Danish vitamin standards. The trial comprised approximately 1,250 pigs in each group and 102 replicates.

The results revealed that:

- DSM's recommendation for vitaminisation in feed for piglets referred to as "The Optimum Vitamin Nutrition (OVN)" significantly improved all production traits as well as the production value compared to the Danish standards
- Some but not the entire difference in productivity was due to an unintentional high amino acid concentration in the OVN diets
- There were no differences in the health status or mortality between the two groups
- The vitamin content in blood plasma and liver tissue over time and the difference in vitamin content between the two groups evolved differently from vitamin to vitamin.

Background and aim

The optimum vitamin levels in feed for piglets reared under commercial production conditions are not as clearly established in the literature as is currently the case for many other nutrients [1, 2]. This may be due to the many challenges associated with designing dose/response trials with vitamins.

The official Danish nutrient standards include two sets of standards for vitamins: one that applies to the weaning period from around 6-9 kg and one that applies during the 9-30 kg period. The two differ only in the content of vitamins A and D, which is higher in the 6-9 kg period.

The OVN concept differs from the official Danish vitamin standards by the addition of Hy-D instead of vitamin D, the addition of vitamin C and higher levels of vitamins K and A, and all vitamins in the vitamin B complex. The content of vitamin E is identical in the two recommendations.

In a previous trial conducted by SEGES Danish Pig Research Centre, the Danish minimum standard for vitamins was compared to two higher vitamin levels, of which the highest was from DSM and known as the Nutritional Products Concept. The results of that trial revealed no significant differences between the production values in the three groups [3].

In the trial described in this report, the OVN concept is compared to a vitamin level referred to as the Danish standard. The Danish standard is based on Danish recommendations, but with a higher content of certain vitamins. The difference between the official Danish minimum standard and the Danish standard can be seen by comparing the values in appendices 2a and 2b.

The Danish standard is used in most Danish diets for piglets regardless of whether the feed is home mixed or purchased as ready-mixed feed.

The aim of this trial was to determine whether the addition of vitamins to feed for piglets, as recommended in DSM's OVN concept, would significantly improve the production value compared to the Danish vitamin standards.

The official Danish minimum standard for the 9-30 kg range, the Danish standard and the OVN concept are detailed in appendices 2a and 2b, respectively. The declared content of vitamins in the feed for the two groups – the Danish standard and the OVN concept, respectively – is shown in appendix 2a.

Materials and method

The trial was carried out at the Grønhøj trial station and comprised two groups. Pigs purchased for the trial at 6-8 kg were accommodated in pens holding 9-15 piglets per pen depending on the size of the pen. Each pen contained a feed dispenser and one drinking bowl.

The pigs were withdrawn from the trial when they weighed around 30 kg. Each group comprised roughly 1,250 pigs, corresponding to 101 and 102 pens (replicates) in the two groups.

Table 1. Trial design

Group	
1	2
Control Danish standard	**OVN concept** DSM recommendation

Feed

The feed used in the weaning period (6-9 kg) and the feed used in the piglet period (9-30 kg) were identical in vitamin content to keep the number of premixes required for the feed production to a minimum. Thus, in the control group both diets (6-9 kg and 9-30 kg) complied with the Danish vitamin standard. The composition of all four diets used in the trial is shown in appendix 1. The declared vitamin content in the control diets and the two OVN diets is shown in appendix 2a. The official Danish minimum standards are shown in appendix 2b.

The two premixes were manufactured by DSM and shipped to Danish Agro's feed factory in Sjølund where the four diets used in the trial were produced.

The feed for both groups was optimised so that all nutrients, except for the vitamin content, were at the same level.

Feed for the trial was produced on five occasions during the period 23 February 2016 to 6 June 2016: weaning feed was produced on three occasions, whereas piglet feed was produced on all five occasions. With each production, samples of the feed were taken using the automatic sampling equipment for subsequent chemical analysis. The samples were then sub-divided with a sample divider according to the Theory of Sampling (TOS) principles [4] by a technician from SEGES Danish Pig Research Centre and forwarded for chemical analysis at Eurofins Steins Laboratory A/S and DSM's laboratory.

For each feed production, a sample of each of the four diets was forwarded to DSM for vitamin analyses. In addition, one sample of each diet was taken at every production of feed, and these

samples were pooled into one large sample containing feed from all productions and stored at Grønhøj. Following the trial, five feed samples per diet from this sample were then forwarded to Eurofins Steins Laboratory A/S for chemical analysis. The samples were sub-divided according to the TOS principles using a sample divider.

Feed analyses

Feed samples were analysed for vitamin content by DSM, and for content of energy (feed units = FUgp), amino acids, zinc, calcium, phosphorus and phytase by SEGES Danish Pig Research Centre at Eurofins Steins Laboratory A/S. Energy content (FUgp) was analysed five times for each of the four diets. Samples were also subject to 14 protein analyses and 12 amino acid analyses, and the remaining parameters (zinc, phosphorus and phytase) were analysed three times.

The purpose of the analyses was to determine whether there were any significant differences in nutrient content between the diets in group 1 and group 2. This might result in productivity differences between the two groups that would not be due to the trial treatment (increased content of certain vitamins). In addition, the average FUgp in the individual diets was used to calculate the feed conversion ratio (FUgp/kg daily gain).

Collection of blood and liver samples

Blood samples were taken from the same 30 piglets from each group three times during the trial: on d 0, 25 and 47 after transfer to the trial. Liver samples were taken from another 30 piglets in each group: 15 samples per group on d 0 and 48 after transfer to the trial.

Recordings/production traits

All recordings were made at pen level and include the following parameters: entry and exit weight, feed intake, disease treatments, the number of dead and culled pigs.

Calculations and statistics

The pigs' production results, daily gain and feed conversion were pooled in a production value based on:

- Value of daily gain
- Feed costs
- Feeding days

For the feed cost calculations, a 5-year pricing was included for weaning and piglet feeds as well as the value of 1 kg daily gain. Consequently, when calculating the production value of the individual diets, the same feed prices were used.

Definition of the individual variables:

- Value of daily gain = a pig's daily gain (kg) during the trial period x value of 1 kg daily gain
- Feed costs = (exit weight ÷ entry weight) x FUgp per kg daily gain x price per FUgp.

The production value (PV) per pig per day was calculated in the following way:

- Production value in DKK per pig per day (value of daily gain ÷ feed costs) / feeding days
- Feeding days = the number of days that the average pig was included in the trial.

The economic assumptions for calculating the production value are shown in table 2.

Table 2. Economic assumptions

Price		
Piglets	**Price**	**Correction**
7 kg piglets	DKK 219 per head	+ DKK 11.17/kg (7-9 kg)
		+ DKK 7.85/kg (9-12 kg)
30 kg piglets	DKK 372 per head	+ DKK 6.14/kg (12-25 kg)
		+ DKK 6.01/kg (25-30 kg)
		+ DKK 6.00/kg (30-40 kg)
Finished pig		
Incl. bonus payment	DKK 10.98/kg	Pig price DKK 10.39/kg -DKK 0.30/kg deduction at slaughter +DKK 0.89/kg bonus payment
Feed 5-year pricing (1 September 2011 to 1 September 2016):		
Weaning feed (7-10 kg):		DKK 3.46/FU pig
Piglet feed (10-30 kg):		DKK 2.09/FU pig
Finisher feed:		DKK 1.76/FU pig

Table 3. Value of daily gain

Average for 7 kg pigs	Average for 30 kg pigs	Value of daily gain, DKK/kg daily gain
7.08625	32.7348	6.56744

Statistics

The trial hypothesis assumed that the feed in group 2 (OVN concept) would improve the production value (PV) by minimum 3% compared to the feed in group 1 (control group).

Dimensioning

The production value was analysed as the primary parameter for the entire piglet period. The trial was designed to test a difference in PV of (3%) DKK 0.0434 per pig per day.

A paired comparison was carried out, i.e. $\alpha = 0.05$. Assuming a standard deviation in the production value of DKK 0.12 per pig per day, 96 replicates were required to achieve 80% statistical power. The dimensioning was based on 1 September 2011 - 1 September 2016 pricing.

Statistical models

The variables “Feed intake”, FUgp per day”, “Feed conversion”, ”FUgp per daily gain”, ”Daily gain” and ”Production value per pig per day” were analysed for three periods (7-9 kg, 9-30 kg and 7-30 kg). The variables “Entry weight”, “Intermediate weight”, “Exit weight” were analysed for the entire period.

The above variables were analysed using proc mixed in SAS as a “block” trial with “Group” as a systematic effect and ”Batch” as a random effect (block effect) to correct any effects of time, season and housing in the estimates for ”Group”. All analyses were corrected for 7 kg start weight (albeit not for the variable “Entry Weight”).

The variables “Dead”, “Dead and culled” and “Percentage pens flock treated for diarrhoea” were subject to logistical regression using proc glimmix in SAS. The “Group” factor was included as a systematic effect and “Batch” as a random effect. Correction was made for 7 kg start weight.

The variable “Single animal treatment for diarrhoea” was subject to logistical regression using proc glimmix in SAS for the periods before and after intermediate weighing. The factor “Group” was included as a systematic effect and “Batch” as a random effect. In the model, it was included if pigs had received flock treatment on pen level as well as a correction for piglet start weight at 7 kg.

Results and discussion

Analyses of feed carried out by DSM

The analysed content of several relevant vitamins in the four diets can be seen in table 4, which also shows the declared content based on the calculations for feed optimisation. Overall, the content of the analysed vitamins is in line with the declared levels.

Table 4. Content of vitamins in the four diets. Analyses carried out by DSM.

Group	1 Control		2 OVN concept	
Number of analyses	12		12	
Weaning feed	Declared	Analysed	Declared	Analysed
Vitamin A, IE/kg	6,255	7,341	15,000	14,817
Vitamin E (Alpha-tocopherol), mg/kg	150	174	150	167
Vitamin D3, IE/kg	750	1,097	-	-
Hy*D(25(OH)D3), mcg/kg	-	-	50	33
Vitamin B12, mg/kg	0.03	-*	0.06	-*
Biotin, mg/kg	0.3	-*	0.5	-*
Number of analyses	20		16	
Piglet feed	Declared	Analysed	Declared	Analysed
Vitamin A, IE/kg	6,255	7,379	15,000	16,213
Vitamin E (Alpha-tocopherol), mg/kg	150	181	150	182
Vitamin D3, IE/kg	750	1,267	-	-
Hy*D(25(OH) D3), mcg/kg	-	-	50	44
Vitamin B12, mg/kg	0.03	-*	0.06	*
Biotin, mg/kg	0.3	-*	0.5	-*

* : Analyses not carried out for this vitamin

Production results

Piglet productivity was generally at a high level in this trial with a daily gain of over 500 g per day and a feed conversion of around 1.59 FUgp/kg daily gain in the period 7-30 kg. The productivity figures and the production value are shown in table 5. P-values with different superscripts denote the dimension of the statistical significance. The production value is indexed in the bottom row of the table. The production value was calculated using the same feed price in the two groups. Consequently, the production value does not include the additional costs for the higher vitamin content in group 2.

In the first period, 7-9 kg, the piglets in group 2 had a significantly higher feed intake and daily gain compared to the pigs in group 1. There were no differences in production value and feed conversion.

In the second period, 9-30 kg, the piglets in group 2 achieved a significantly better feed conversion, daily gain and production value, which leads to a significant difference in all four production parameters.

For the entire 7-30 kg period, a significantly higher productivity was also observed among the pigs in group 2 for all four parameters; feed intake, feed conversion, daily gain and production value. For the three latter parameters, the statistical significance was at a 0.1 percentage level, while for feed intake

it was at a 5 percentage level. The results of this trial thus reveal an unusually strong statistical significance.

Table 5. Production results

Group	1 Control	2 OVN concept	P-value
Number of pens (replicates)	101	102	
Number of pigs at trial start	1,247	1,259	
Number of pigs on exit	1,203	1,231	
Entry weight, kg	7.08	7.08	
Weight at intermediate weighing, kg	9.05	9.15	0.019
Exit weight, kg	32.59	32.82	0.101
Mortality, %	0.6	0.0	-
Dead and culled, %	3.3	2.1	0.056
Period 1 (7-9 kg) Weaning feed - corrected for 7 kg start weight			
Feed intake, FUgp/pig/day	0.29	0.30	0.008[b]
Daily gain, g	184	194	0.009[b]
Feed conversion, FUgp/kg daily gain	1.57	1.56	0.514
PV, 7-9 kg	0.22	0.25	0.08
Period 2 (9-30 kg) Piglet feed - corrected for 7 kg start weight			
Feed intake, FUgp/pig/day	1.08	1.09	0.020[c]
Daily gain, g	670	687	<0.0001[a]
Feed conversion, FUgp/kg daily gain	1.61	1.59	0.0008[a]
PV, 9-30 kg	2.13	2.20	<0.0001[a]
Entire period (7-30 kg) - corrected for 7 kg start weight			
Feed intake, FUgp/pig/day	0.88	0.89	0.016[c]
Daily gain, g	551	566	<0.0001[a]
Feed conversion, FUgp/kg daily gain	1.60	1.58	0.0003[a]
PV 7-30 kg	1.67	1.72	<0.0001[a]
PV 7-30 kg, index[1)]	100	103.5	<0.0001[a]

[1)] The least statistically significant difference was estimated to be 2.1 index points

[a] = Significant difference of 0.1 percentage level

[b] = Significant difference of 1 percentage level

[c] = Significant difference of 5 percentage level

The health status in this trial was very high in both groups and higher than normally at the trial station (see table 6). Mortality and the number of pigs that were culled from the trial due to disease were thus very low. There was no difference between the two groups in terms of mortality nor in the occurrence of disease measured as “Dead and culled” and ”Single animal treatment for diarrhoea”.

Table 6. Single animal treatment for diarrhoea

Group		1 Control	2 OVN concept	P-value
Period 1 (7-9 kg)	Percentage days of single animal treatment out of feeding days	0.7	0.8	0.873
Period 2 (9-30 kg)	Percentage days of single animal treatment out of feeding days	2.3	2.6	0.342

Analyses of feed carried out by SEGES Danish Pig Research Centre/Eurofins Steins Laboratory A/S

The analysed content of several essential nutrients in the four diets is shown in tables 7 and 8.

Analyses revealed a lower content of lysine, methionine, threonine, tryptophan and valine in the weaning feed in group 1 compared to the weaning feed in group 2 (table 7). This is probably linked to a higher crude protein content in the weaning feed for the pigs in group 2. The content of threonine was 8.5% lower in group 1 compared to group 2. The tryptophan content was 9.8% lower in group 1 compared to group 2.

Table 7. Declared and analysed content of relevant nutrients in the two weaning diets

Group	**1 Control**			**2 OVN concept**		
Weaning feed	Declared	Average of analysis	Standard deviation	Declared	Average of analysis	Standard deviation
FUgp per 100 kg	121	120.0	0.37	121	120.5	0.38
Phosphorus (P), g/kg	6.9	7.0	0.11	6.9	7.1	0.21
Phytase activity, FYT/kg	1,000	995	74	1.000	955	284
Copper, mg/kg	140	140	6.9	140	141	7.6
Zinc, mg/kg	2,518	2.513	26.3	2.518	2.773	12.5
Lysine, g/kg	14.9	14.6	0.19	14.9	14.8	0.43
Methionine, g/kg	4.7	4.3	0.11	4.7	4.5	0.13
Threonine, g/kg	9.4	8.9	0.19	9.4	9.6	0.26
Tryptophan, g/kg	3.4	2.8	0.08	3.4	3.1	0.05
Valine, g/kg	10.7	9.8	0.15	10.7	10.0	0.23
Water, %	10.0	10.7	0.07	10.0	10.7	0.09
EDOM* pig, %	91.5	92.0	0.27	91.5	92.3	0.4
EDOMi*, %	87.7	88.7	0.11	87.7	88.8	0.24
Ash, %	5.9	4.6	0.04	5.9	4.5	0.04
Fat, %	3.4	3.3	0.12	3.4	3.4	0.04
Crude protein, %	18.6	18.1	0.15	18.6	18.6	0.12

Number of analyses: Amino acids: 12 / Energy: 5 / Protein: 14 / Others: 3.

* EDOM: Enzyme Digestible Organic Matter. EDOMi: Enzyme Digestible Organic Matter at ileum.

In the piglet diets (table 8) a similar trend was observed: the content of almost all the above-mentioned amino acids was higher in the feed for group 2. Crude protein content was also higher in the piglet feed in group 2.

There was no significant difference between other nutrients that directly affect the piglet productivity.

Table 8. Declared and analysed content of relevant nutrients in the two piglet diets

Group	1 Control			2 OVN-concept		
Piglet feed	Declared	Average of analysis	Standard deviation	Declared	Average of analysis	Standard deviation
FUgp per 100 kg	113.0	113.2	1.39	113.0	113.2	0.94
Phosphorus (P), g/kg	5.8	6.3		5.8	6.3	
Phytase activity, FYT/kg	1.000	1.499	209.5	1.000	1.527	121.5
Copper, mg/kg	140	139	9.8	140	139	6.5
Zinc, mg/kg	100	180	2.4	100	154	1.9
Lysine, g/kg	13.3	13.7	0.36	13.3	14.2	0.36
Methionine g/kg	4.2	4.1	0.10	4.2	4.3	0.11
Threonine, g/kg	8.4	8.6	0.23	8.4	9.0	0.16
Tryptophan, g/kg	2.7	2.7	0.10	2.7	2.8	0.08
Valine, g/kg	9.2	9.0	0.19	9.2	9.4	0.05
Water, %	13.0	11.98	0.10	13.0	11.8	0.05
EDOM pig, %	90.6	90.2	0.36	90.6	90.0	0.22
EDOMi, %	83.9	83.7	1.28	83.9	73.7	0.71
Ash, %	6.0	5.2	0.04	6.0	5.3	0.06
Fat, %	4.3	4.5	0.13	4.3	4.6	0.07
Crude protein, %	18.9	19.5	0.20	18.9	20.0	0.32

Number of analyses: Amino acids: 12 / Energy: 5 / Protein and water: 14 / Others: 3

* EDOM: Enzyme Digestible Organic Matter. EDOMi: Enzyme Digestible Organic Matter at ileum

Calculations show that the difference in the amino acid content between the two groups leads to a change in production value of 1.9% [5]. This is based on the average effect on productivity achieved in all the amino acid trials, carried out by SEGES Danish Pig Research Centre, that form the basis for determining the official amino acid standards in Denmark.

On this basis it would be incorrect to change the productivity achieved in this trial (table 5) or the statistical calculations that form the basis of the p-values shown in table 5. Table 5 therefore shows the results achieved in this trial.

The difference in the amino acid content can explain around half of the difference in the production value shown in table 5, whereas the other half is likely attributed to the difference in vitamin content as these are the only differences between the feed in the two groups.

Analyses of blood samples, DSM

The vitamin levels in plasma are shown in appendix 3.

In general, the vitamin content in plasma increased over time in both groups. For some vitamins, the content changed over time. For most vitamins, there was no clear numerical difference between the two groups. For vitamin 25-hydroxyvitamin-D3, analyses showed a numerically higher level in plasma from pigs in group 2 at the end of the trial whereas there was no difference at the start.

Analyses of liver samples, DSM

The vitamin levels in liver samples are shown in appendix 4.

For some vitamins, analyses demonstrate an increase in the content over time, and for others, the content is unchanged or decreasing over time. For most of the vitamins, there was no clear numerical difference between groups. For vitamin-A 13z-retinol and vitamin-A all-E-retinol, there was a numerically higher content in the liver from pigs in group 2 at the end of the piglet period whereas there is no difference between groups at the start of the trial.

Conclusion

Overall, the vitamin content in the four diets included in this trial were at the desired level. Consequently, this trial demonstrates whether a difference can be found in productivity between pigs that were given vitamins according to the Danish standard versus the OVN concept which is DSM's recommendation for vitamin allocation.

Results show a significant difference in how the vitamin levels in plasma developed over time from vitamin to vitamin. There was also a significant difference in how the content of vitamins in the liver tissue developed over time from vitamin to vitamin.

For the first period (weaning feed, 7-9 kg), results reveal a significant difference between the two groups in feed intake and daily gain (with a significantly higher feed intake and daily gain among the pigs in group 2), but there is no significant difference between the groups in terms of feed conversion and production value in this period.

For the second period (piglet feed, 9-30 kg) there is a significant difference between the two groups in all four parameters (production value, daily gain, feed intake and feed conversion). The pigs in group 2 have a significantly higher feed intake, daily gain and production value and a significantly lower feed conversion compared with the pigs in group 1.

For the entire period (7-30 kg), the conclusion is the same as for period 2: results demonstrate significant differences between the two groups in all four parameters (production value, daily gain, feed intake and feed conversion). The pigs in group 2 have a significantly higher feed intake, daily gain and production value and a significantly lower feed conversion compared to group 1. The pigs in

group 2 had a higher production value in the entire period of 3% compared to the pigs in group 1 corresponding to a difference of 0.05% per pig per day.

The highest amino acid content and the highest crude protein content were found in the feed for group 2. Around half of the recorded difference in productivity can be ascribed to the unintentional difference in amino acid content. There was no difference in the content of other nutrients between the two groups.

The production value was calculated with the same feed price for both groups, ie. the additional costs for the increased vitamin level in the feed for group 2 were not included.

As there were too few observations of dead pigs, the mortality model did not converge. Results show no significant differences between the two groups in the parameters “Dead and culled” and ”Single animal treatment for diarrhoea”.

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Appendix 1: Group 1, 7-9 kg

Declared and calculated content of ingredients as well as selected nutrients (excluding vitamins) in weaning feed.

Ingredient	Content, %	Nutrient	Content
Wheat	53.503	FUgp	121 per 100 kg
Barley	10.478	Crude protein	18.6%
Vilosoy, Soy protein	5.000	Lysine	14.9 g/kg
Potato protein	3.000	Methionine	4.7 g/kg
Potato protein Protastar	8.918	Threonine	9.4 g/kg
Grape sugar Dextrose	3.277	Tryptophan	3.4 g/kg
Whey powder Lactose 98 %	7.143	Valine	10.7 g/kg
Flaxseed oil	0.500	Phosphorus	6.9 g/kg
Palm oil	1.000	Calcium	8.1 g/kg
Beet molasses	1.000	Sodium	1.8 g/kg
Chalk	0.017	Potassium	6.3 g/kg
Monocalcium phosphate	1.855	Ronozyme P (3.1.3.26)	1,000 FYT/kg
Salt	0.336	Digestible phosphorus, 200 % Phytase	3.6 per FUgp
Sodium bicarbonate	0.088	Standardised (St.) digestibility crude protein	133.00 per FUgp
Lysine sulphate 70 %	0.735	St. digestibility lysine	11.00 per FUgp
DL-Methionine 98 %	0.114	St. digestibility methionine	3.52 per FUgp
Threonine 98 %	0.096	St. digestibility threonine	6.71 per FUgp
Tryptophan 99 %	0.087	St. digestibility tryptophan	2.31 per FUgp
L-Valine 96.5 %	0.035	St. digestibility valine	7.59 per FUgp
DA Premix Trial 1448 - 411007	1.500	Fe, added	200 mg/kg
Ronozyme HiPhos GT 4000	0.025	Cu, added	140 mg/kg
Lucta Aroma	0.010	Mn, added	55.5 mg/kg
Benzoic acid	0.500	Zn, added	2518 mg/kg
Formic Acid – Calcium formate	0.250	Se, added	0.4 mg/kg
Luctarom Advanced	0.133		
Zinc oxide Premix preparation	0.300		
Gærplus	0.050		
Microgrits Grøn	0.050		

Appendix 1 (cont.): Group 2, 7-9 kg

Declared and calculated content of ingredients as well as selected nutrients (excluding vitamins) in weaning feed.

Ingredient	Content, %	Nutrient	Content
Wheat	52.995	FUgp	121 per 100 kg
Barley	11.033	Crude protein	18.6%
Vilosoy, Soy protein	5.000	Lysine	14.9 g/kg
Potato protein	3.000	Methionine	4.7 g/kg
Potato protein Protastar	8.922	Threonine	9.4 g/kg
Grape sugar Dextrose	3.277	Tryptophan	3.4 g/kg
Whey powder Lactose 98%	7.143	Valine	10.7 g/kg
Flaxseed oil	0.500	Phosphorus	6.9 g/kg
Palm oil	1.000	Calcium	8.1 g/kg
Beet molasses	1.000	Sodium	1.8 g/kg
Chalk	0.017	Potassium	6.3 g/kg
Monocalcium phosphate	1.855	Ronozyme P (3.1.3.26)	1,000 FYT/kg
Salt	0.335	Digestible phosphorus, 200% phytase	3.6 per FUgp
Sodium bicarbonate	0.089	Standardised (St.) digestibility crude protein	133.00 per FUgp
Lysine sulphate 70 %	0.734	St. digestibility lysine	11.00 per FUgp
DL Methionine 98 %	0.114	St. digestibility methionine	3.52 per FUgp
Threonine 98%	0.096	St. digestibility threonine	6.71 per FUgp
Tryptophan 99%	0.087	St. digestibility tryptophan	2.31 per FUgp
L Valine 96,5 %	0.035	St. digestibility valine	7.59 per FUgp
OVN Premix Trial 1448 DSM	1.500	Fe, added	200 mg/kg
Ronozyme HiPhos GT 4000	0.025	Cu, added	140 mg/kg
Lucta Aroma	0.010	Mn, added	55.5 mg/kg
Benzoic acid	0.500	Zn, added	2518 mg/kg
Formic Acid – Calcium formate	0.250	Se, added	0.4 mg/kg
Luctarom Advanced	0.133		
Zinc oxide Premix preparation	0.300		
Gærplus	0.050		

Appendix 1 (cont.): Group 1, 9-30 kg

Declared and calculated content of ingredients as well as selected nutrients (excluding vitamins) in piglet feed.

Ingredient	Content, %	Nutrient	Content
Wheat	50.576	FUgp	113 per 100 kg
Barley	15.000	Crude protein	18.9%
Oats	1.617	Lysine	13.3 g/kg
Soybean meal, toasted, dehusked	15.750	Methionine	4.2 g/kg
Vilosoy, Soy protein	5.731	Threonine	8.4 g/kg
Potato protein	3.000	Tryptophan	2.7 g/kg
Beet molasses	1.000	Valine	9.2 g/kg
Palm oil	2.200	Phosphorus	5.8 g/kg
Chalk	0.704	Calcium	9.1 g/kg
Monocalcium phosphate	1.100	Sodium	1.7 g/kg
Salt	0.339	Potassium	7.8 g/kg
Sodium bicarbonate	0.052	Ronozyme P (3.1.3.26)	1,000 FYT/kg
Lysine sulphate 70 %	0.631	Digestible phosporus, 200% phytase	3.2 g/FUgp
DL Methionine 98 %	0.137	Standardised (St.) digestibility crude protein	144.0 per FUgp
Threonine 98%	0.133	St. digestibility Lysine	10.5 per FUgp
Tryptophan 99%	0.028	St. digestibility methionine	3.4 per FUgp
L-Valine 96.5 %	0.027	St. digestibility threonine	6.4 per FUgp
DA Premix Trial 1448 - 411007	1.500	St. digestibility tryptophan	2.1 per FUgp
Ronozyme HiPhos GT 4000	0.025	St. digestibility valine	7.0 per FUgp
Benzoic acid	0.40	Fe, added	200 mg/kg
Microgrits Grøn	0.05	Cu, added	140 mg/kg

Appendix 1 (cont.): Group 2, 9-30 kg

Declared and calculated content of ingredients as well as selected nutrients (excluding vitamins) in piglet feed.

Ingredient	Content, %	Nutrient	Content
Wheat	50.454	FUgp	113 per 100 kg
Barley	15.000	Crude protein	18.9%
Oats	1.719	Lysine	13.3 g/kg
Soybean meal, toasted, dehusked	15.750	Methionine	4.2 g/kg
Vilosoy, Soy protein	5.729	Threonine	8.4 g/kg
Potato protein	3.000	Tryptophan	2.7 g/kg
Beet molasses	1.000	Valine	9.2 g/kg
Palm oil	2.200	Phosphorus	5.8 g/kg
Chalk	0.704	Calcium	9.1 g/kg
Monocalcium phosphate	1.099	Sodium	1.7 g/kg
Salt	0.339	Potassium	7.8 g/kg
Sodium bicarbonate	0.053	Ronozyme P (3.1.3.26)	1,000 FYT/kg
Lysine sulphate 70 %	0.631	Digestible phosphorus, 200 % phytase	3.2 g/FUpig
DL Methionine 98 %	0.137	Standardised (St.) digestibility crude protein	144.0 per FUgp
Threonine 98 %	0.133	St. digestibility lysine	10.5 per FUgp
Tryptophan 99 %	0.028	St. digestibility methionine	3.4 per FUgp
L-Valine 96,5 %	0.027	St. digestibility threonine	6.4 per FUgp
OVN Premix Trial 1448 DSM	1.500	St. digestibility tryptophan	2.1 per FUgp
Ronozyme HiPhos GT 4000	0.025	St. digestibility valine	7.0 per FUgp
Benzoic acid	0.40	Fe, added	200 mg/kg
		Cu, added	140 mg/kg

Appendix 2a

Declared content of vitamins in the two groups, Danish standard and the OVN concept.

Applicable to both groups for the period 7-9 kg and 9-30 kg in this trial.

Vitamin	Control group (Danish Standard)	OVN concept
A, IU/kg feed	6,250	15,000
D3, IU/kg feed	750	0
Hy-D, µg/kg feed	0	50
C, mg/kg feed	0	150
E, mg/kg feed	150	150
B1, mg/kg feed	3	5
B2, mg/kg feed	6	15
B6, mg/kg feed	4.5	8
B12, mg/kg feed	0.03	0.06
K3, mg/kg feed	4.8	6
Niacin, B3, mg/kg feed	30	55
Folic Acid, B9, mg/kg feed	0	2.5
D-Pantothenic acid, B5, mg/kg feed	15	45
Biotin, mg/kg	0.3	0.5

Appendix 2b

Official Danish minimum standard at 1.13 FUgp/kg feed as the standard is expressed per energy unit. This official standard applies for the period between 9-30 kg.

Vitamin	Danish minimum standard
A, IE/kg feed	5650
D3, IE/kg feed	565
Hy-D, µg/kg feed	0
C, mg/kg feed	0
E, IE - as dl-alpha tocopherol mg/kg feed	158 147
B1, mg/kg feed	2.3
B2, mg/kg feed	4.5
B6, mg/kg feed	3.4
B12, mc/kg feed (mg/kg feed)	22.6 (0.02)
K3, mg/kg feed	2.3
Niacin, B3, mg/kg feed	22.6
Folic Acid, B9, mg/kg feed	0
D-Pantothenic acid, B5, mg/kg feed	11.3
Biotin, mg/ kg feed	0.2

Appendix 3

Analysed content in blood plasma of a number of vitamins included in the OVN concept. Blood samples were taken from the same pigs three times during the trial period (7-30 kg) to determine the development of the vitamin content in the blood plasma.

Group	Vitamin and unit	Sample date					
		29 April		24 May		15 June	
		Average value (31-35 ana.)	Standard deviation	Average value (31-35 ana.)	Standard deviation	Average value (31-35 ana.)	Standard deviation
Group 1	Vitamin B1, ng/ml	5.2	1.8	16.0	3.9	23.2	4.8
Group 2		4.6	1.2	29.3	5.5	25.1	4.5
Group 1	Vitamin B2, ng/ml	27.9	8.8	27.6	5.6	22.6	4.2
Group 2		25.8	7.5	43.5	11.9	28.5	6.0
Group 1	Vitamin B3, ng/ml	697.4	582.5	272.2	150.8	358.6	177.3
Group 2		599.5	483.1	411.7	269.7	525.0	215.5
Group 1	Vitamin B6, ng/ml	16.1	9.5	21.4	7.9	21.5	8.0
Group 2		17.1	7.7	26.1	5.9	27.6	6.5
Group 1	Total 25-Hydroxyvit-D3, ng/ml	3.2	1.2	18.6	3.2	36.3	4.9
Group 2		3.2	0.8	57.2	7.8	70.0	10.8
Group 1	Vitamin-D3, ng/ml	1.0	0.0	1.1	0.3	1.2	0.3
Group 2		1.0	0.0	1.1	0.2	1.0	0.0
Group 1	Vitamin A, ng/ml	230.5	44.3	337.0	74.9	388.6	55.1
Group 2		208.9	36.5	339.9	76.8	424.7	58.9
Group 1	Vitamin E, ng/ml	2,477.4	709.2	1,992.1	717.1	2,748.1	827.3
Group 2		2,846.3	980.6	2,133.5	637.0	2,786.45	652.9
Group 1	Vitamin B 12	Analyses not carried out for this vitamin					
Group 2							
Group 1	Biotin	Analyses not carried out for this vitamin					
Group 2							

Appendix 4

Analysed content in the liver tissue of a number of vitamins included in the OVN concept. The pigs were culled at two intervals during the trial period (7-30 kg) to determine the development of the vitamin content in the liver tissue

Group	Vitamin and unit	Sample date			
		13 May		8 June	
		Average value (30 ana.)	Standard deviation	Average value (30 ana.)	Standard deviation
Group 1	Vitamin B1, ng/g	714.7	293.6	2,408.9	530.1
Group 2		725.2	277.7	2,177.0	710.3
Group 1	Vitamin B2, ng/g	2,946.3	631.1	1,912.1	764.7
Group 2		2,707.6	710.3	1,506.1	486.8
Group 1	Vitamin B3, microg/g	189.5	17.3	172.4	12.3
Group 2		188.3	18.2	145.0	18.6
Group 1	Vitamin B6, ng/g	3,145.6	472.8	4,157.5	694.7
Group 2		3,109.0	600.0	5,021.2	525.1
Group 1	Total 25-Hydroxyvit-D3, ng/g	1.0	0.1	2.7	2.6
Group 2		4.3	2.7	8.2	2.0
Group 1	Vitamin D3, ng/g	1.0	0.0	1.4	0.6
Group 2		1.1	0.3	1.0	0.0
Group 1	Vitamin A 13z retinol, microg/g	1.1	1.1	0.9	0.3
Group 2		1.3	0.85	3.1	1.5
Group 1	Vitamin A all-E-retinol, microg/g	46.6	9.5	37.4	10.0
Group 2		59.4	10.3	96.3	18.6
Group 1	Vitamin E, microg/g	3.1	3.1	2.0	0.0
Group 2		3.6	3.6	2.0	0.0
Group 1	Vitamin B12	Analyses not carried out for this vitamin			
Group 2					
Group 1	Biotin	Analyses not carried out for this vitamin			
Group 2					

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