Skjoldborg test station

TestGris***

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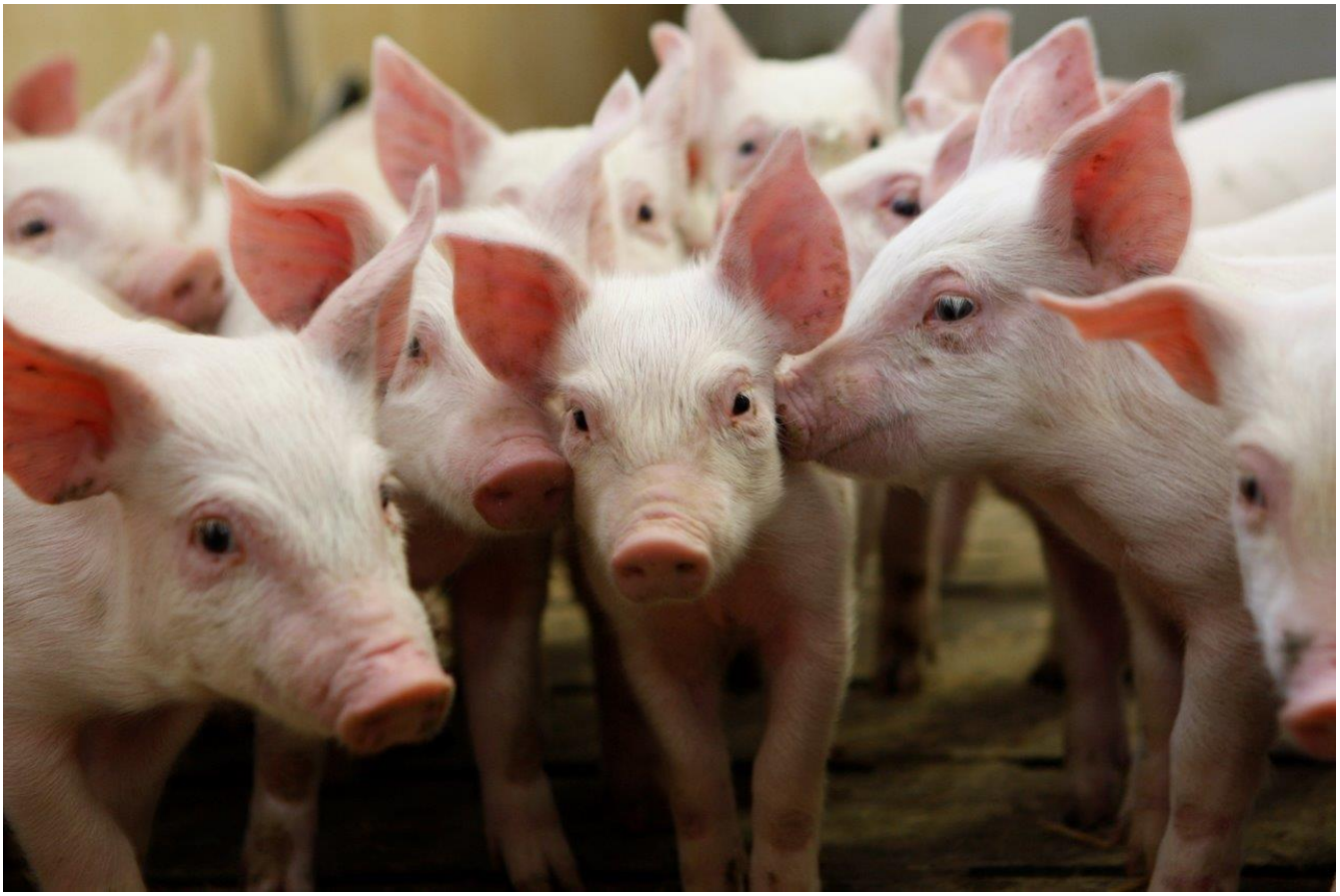

Performance effects of AX3Digest® in comparison to fish based diets for nursery pigs

Test conducted on request from TripleA

June, 2018

Sammendrag
Denne test havde til formål at undersøge effekten af at erstatte protein fra en kombination af fiskemel og soja-proteinkoncentrat med AX3Digest® på produktionsresultaterne efter fravænning. Produktionsresultaterne blev målt som daglig tilvækst (ADG), foderoptagelse (FI) og foderudnyttelse (FU).

I testen indgik 3 diæter TA0, TA50 og TA100 tildelt i fase A og B:

TA0: Kontrol blanding med fiskemel (FMDK) og sojaproteinkoncentrat (SPCDK) af dansk oprindelse, som primære proteinkilder
TA50: 50 % af protein fra fiskemel og SPC i kontrolblandingen (TA0) erstattet med AX3Digest®
TA100: 100 % af protein fra fiskemel og SPC i kontrolblandingen (TA0) erstattet med AX3Digest®

Testen viste, at grisene i fase A havde signifikant højere tilvækst, når de blev tildelt TA50 i forhold til TA100 og TA0 gruppen lå midt imellem (246, 260 og 234 g/dag i hhv. TA0, TA50 og TA100 gruppen). I fase B, voksede grisene i TA100 gruppen signifikant mere end grisene i TA0 gruppen, TA50 gruppen lå midt i mellem (554, 569 og 587 g/dag i hhv. TA0, TA50 og TA100 gruppen). I fase C, hvor alle 3 grupper fik den samme foderblanding var der ingen forskelle på tilvæksten (P=0,94). Som resultat af forskellene i tilvækst i fase A og B opnåede grisene i TA50 gruppen 1,1 kg højere afgangsvægt (dag 43) og grisene i TA100 gruppen opnåede 0,8 kg højere afgangsvægt sammenlignet med grisene i TA0 gruppen.

I fase A var der en tendens til, at foderoptagelse i TA50-gruppen var forøget i forhold til de to andre grupper, men for hele testperioden var der ingen forskel (P=0,62).

I fase A var foderudnyttelsen signifikant bedre i TA50- i forhold til TA100 gruppen (1,31, 1,30 og 1,38 kg foder/kg tilvækst i hhv. TA0, TA50 og TA100 gruppen). I fase B, udnyttede grisene i TA100 gruppen foderet signifikant bedre end grisene i TA0- og TA50 gruppen (1,43, 1,42 og 1,38 kg foder/kg tilvækst i hhv. TA0, TA50 og TA100 gruppen). For perioden som helhed opnåede grupperne TA50 og TA100 signifikant bedre foderudnyttelse end gruppe TA0 (1,48, 1,44 og 1,44 kg foder/kg tilvækst i hhv. TA0, TA50 og TA100 gruppen).

Summary
This trial aimed to investigate the effect of replacing the protein from a combination of fishmeal (FM_{DK}) and soy protein concentrate ($SPC56_{DK}$) with AX3Digest® on performance after weaning. The performance parameters measured were Average Daily Gain (ADG), Feed Intake (FI) and Feed Utilization (FU).

The test involved 3 diets which were designated TA0, TA50 and TA100:

TA0: A control diet with FM_{DK} and $SPC56_{DK}$ (2:1) as the main protein source
TA50: 50% of the protein from the FM_{DK} and $SPC56_{DK}$ combination in the control diet was replaced with AX3Digest®
TA100: 100% of the protein from the FM_{DK} and $SPC56_{DK}$ combination in the control diet was replaced with AX3Digest®

The test showed that in phase A the TA50 diet resulted in a higher ADG ($P<0.001$) compared to the TA100 diet while the TA0 diet caused intermediate ADG (246, 260 and 234 g/d in the TA0, TA50 and TA100 group, respectively). In phase B, ADG differed with the highest ADG in the TA100 diet compared to the TA0 diet, while the TA50 showed intermediate ADG (554, 569 and 587 g/d in the TA0, TA50 and TA100 group, respectively). In phase C, where all pigs received the same standard diet there was no difference between groups in ADG ($P=0.94$). As a result of the differences in growth in phase A and B, the pigs in the TA50 group achieved 1.1 kg higher final weight (day 43) and the pigs in the TA100 group achieved 0.8 kg higher final weight compared to the pigs in the TA0 group.

In phase A, FI in group TA50 tended to increase compared with the other two groups, but for the entire 43-day test period there was no difference ($P=0.62$).

In phase A, FU was significantly better in the TA50 group compared with the TA100 group (1.31, 1.30 and 1,38 kg/kg in the TA0, TA50 and TA100 group, respectively). In phase B, the pigs in the TA100 group utilized the feed significantly better than pigs in the TA50 and TA0 group (1.43, 1.42 and 1.38 kg/kg in the TA0, TA50 and TA100 group, respectively). For the total 43-day test period, group TA50 and TA100 utilized the feed significantly better than group TA0 (1.48, 1.44 and 1.44 kg/kg in the TA0, TA50 and TA100 group, respectively).

Introduction

This study was conducted on request from TripleA in the period August 28 (2017) to December 05 (2017) at Skjoldborg test station.

The test aimed to test the effect of replacing protein from a combination of Fish Meal of Danish origin (FM_{DK}) and Soy Protein Concentrate of Danish Origin (56% protein, $SPC56_{DK}$) partly (50%) or fully (100 %) with protein from AX3Digest® in post weaning diets.

The test involved 3 diets which were designated TA0, TA50 and TA100:

TA0: A control diet with FM_{DK} and $SPC56_{DK}$ (2:1) as the main protein source
TA50: 50% of the protein from the FM_{DK} and $SPC56_{DK}$ combination in the control diet was replaced with AX3Digest®
TA100: 100% of the protein from the FM_{DK} and $SPC56_{DK}$ combination in the control diet was replaced with AX3Digest®

The test was designed to test the effect of the diets on average daily gain (ADG), feed intake (FI) and feed utilisation (FU; kg feed per kg gain) in weaned piglets under practical pig production conditions. The test period lasted from weaning at approximately day 25 until conclusion of the nursery period at day 68, i.e. 43 feeding days from approximately 6 kg BW at weaning to 30 kg at exit of nursery.

Pigs taken out of study because of illnesses or death, and diarrhoea related treatments were also registered in the three periods.

Materials and methods

Animals, diets and protocol

The test station is a conventional (Health status: Blue Spf + myc + AP6 +AP12+Vac.) integrated production, which runs weekly operation in the sow unit. This means, that every week, the sows are farrowing and piglets are weaned.

The test included a total of 3163 Danbred crossbred (Landrace/Yorkshire x Duroc) female and castrated male piglets with approximately the same number of both gender. The piglets where weaned at 25 ± 3 days of age.

Housing conditions for piglets complied fully with EU and Danish legislation. Six similar rooms of 12 double-pens where used. Rooms were cleaned and disinfected before insertion of piglets. The double-pens were traditionally structured sharing two dry feed dispensers integrated in the mid-pen wall partitioning the double-pen in two pens. Of the 12 double-pens per room only 9 were used for this trial. The piglets were group housed in pens and allocated randomly; females and castrated males mixed on both sides of the feed dispensers. Thus, two pens around 2 feeders constitute one observation (photo of pen design in Appendix A). Around 29 piglets were inserted in every pen after weaning. Pens are designed as 2-climate pens with an insulated piglet nest and a slatted activity area.

At the day of weaning, all piglets were distributed in the pens according to size (small, medium and Large). The average body weight of piglets in the pens was in the range of 4.8 to 7.8 kg. The double-pens were allocated to one of three diets; TA0, TA50 and TA100, i.e. six dry feed dispensers

for each diet per room. The average initial body weight of the piglets were 6.2, 6.3 and 6.3 kg for the TA0, TA50 and TA100 diet, respectively

The test period was initiated at day of weaning and was divided into three phases. Phase A was from weaning until an average weight of 10.4 kg (16-18 days), the following phase B was from 10.4 kg to 18.4 kg on average (13-15 days) and the final phase C lasted 12 days (average weight 28.7 kg) resulting in a total test period of 43 days.
The test diets were fed in Phase A and Phase B whereas in phase C all piglets were fed the same diet.

Prior to weaning piglets received a prestarter diet containing similar raw materials as the control diet while they were not receiving AX3Digest®.
In the nursery, test diets were formulated by TestGris***. The diets were optimized to provide nutrients according to the Danish feeding standards for piglets in the weight intervals of 6-10, 10-16 kg and 16-30 kg, respectively. The composition of the diets is given in Appendix B. Diets were produced on farm under the supervision of TestGris***. None of the diets contained antibiotics or therapeutic levels of veterinary ZnO.

All diets were fed as meal feeds and *ad libitum*. The diets were supplied when requested by a sensor in one of the 2 feed dispensers up to several times per day. When delivered to the individual feed dispensers, the amount of diet dropped into the feeders was registered by weight. The pigs had permanent access to fresh water from 2 types of nipple drinkers; one separate and one that was built into the feed dispensers.

The composition of the test diets was unknown for the personnel at the test station.

Registrations
The piglets were weighed when allocated to the pens at the day of insertion. Subsequently, they were weighed when changing to phase B and phase C diets and at the end of test. All pigs in one pen were weighed as a unit. Whenever a pig was taken out of the study due to death or disease the weight was recorded.

The amount of feed used per feed dispenser was recorded, before changing to the next diet. The feed residue in the feed dispenser was removed, weighed and subtracted from the amount supplied before a new diet was fed.

In addition the normal procedure was followed in respect of registration of any medical treatment (including treatment days) against diarrhoea and infections.

Analysis
All the test diets were analysed for the content of dry matter, crude protein, fat, feed units (FEsv) calcium, phosphorus, copper, zinc, lysine, methionine, cysteine+cysteine and threonine. The chemical analyses were performed by Eurofins, see Appendix C.

Calculations and statistics
Average daily gain per piglet was calculated as the difference in weight at insertion and exit of each feeding phase (A, B and C) as well as the overall period from weaning to end of trial at day 43. The body weight used was an average of the piglets in the double pen sharing the two dry feed dispensers.

Feed intake (FI) was calculated as the amount of feed provided per feed dispenser minus the remaining feed residues and feed taken out for chemical analyses in the feeding periods (phase A, Phase B and phase C).

In all calculations, number and weight of piglets out of trial were subtracted.

Pigs taken out of study (PTO) were calculated as percentage of the initial number of piglets in each phase (A, B and C) as well as the total period (A-C).

All statistical analyses were done in cooperation with the Danish Technological Institute, Department of field trials, technology and analysis, Aarhus, Denmark. Animal performance data were statistically analysed by the GLMM procedure of R (R Core Team, 2014). ADG, FI and FU in phase A, phase B, phase C and the total test period were analysed in a Gaussion mixed effect model including initial body weight at day 0, diet (TA0, TA50, TA100) room number and side of the room. Statistical significance was accepted at $P<0.05$.

The number of observations did not allow for statistical analysis of PTO.

Results and comments

The feed analyses (Appendix C) show that the diets contained the expected concentrations of the analysed nutrients which demonstrate the accuracy of the feeding system. An exception is the analysed level of Ca which exceeds the expected dietary content with 25-45%. This may in part have neutralized the beneficial effect of the low pH = 4 from AX3Digest.

In phase A the TA50 diet resulted in a higher ADG ($P<0.001$) compared to the TA100 diet while the TA0 diet showed intermediate ADG (Table 3). Partly, this might be explained by the large change in diet from the fish meal based pre-starter with 0% AX3Digest® to the weaner diet TA100 containing >16% AX3Digest®. In phase B, ADG differed ($P=0.008$) with the highest ADG in the TA100 diet compared to the TA0 diet, which may indicate that the piglets in the TA100 group were compensating for their lower growth in phase A.
In phase C, where all pigs received the same diet there was no difference between groups in ADG ($P=0.94$).
When looking at the total test period from 6-30 kg BW ADG was similar for TA100 and TA50 diets, however the TA50 diets resulted in significantly better ADG compared to the TA0 diets ($P=0.048$).

The average weight of piglets at the start of the test and at the end of each phase is presented in figure 1 (Appendix D). It shows that the average initial body weight of the piglets was 6.27 kg for the TA0, TA50 and TA100 diet, respectively. The higher daily weight gain in the TA50 group resulted in 0.3 kg extra live weight at the end of phase A. At the end of phase B (31 feeding days) the TA50 piglets weighed 0.5 kg more than the TA0 group and the TA100 group weighed on average 0.3 kg more than the TA0 group.

From start to end of the trial piglets fed the TA50 gained 1.1 kg extra weight (significant higher ADG) and piglets fed TA100 gained about 0.8 kg extra weight compared to the TA0 diet.

There was a tendency to increased FI in the TA50 group in phase A, however the difference was not statistical significant ($P=0.07$). In the remaining test period the feed intake was not affected by diet.

In phase A, the FU in the TA50 and the TA100 diets did not differ significantly from the TA0 diet. However, when comparing the TA50 and TA100 diet the TA50 diet resulted in the most efficient FU ($P=0.02$). Also in phase B the dietary treatments significantly ($P<0.001$) affected the FU where the TA100 group significantly outperformed both the TA0 and TA50 groups. For the total test period

both the TA50 and TA100 diet resulted in a significant better FU compared to the TA0 control diet (P=0.007).

Table 3 Average daily gain (ADG, g), feed intake (FI) and feed utilisation (FU) in phase A (6-10 kg) phase B (10-18 kg), phase C (18-29 Kg) and the whole test period (A-C) of pigs fed the three experimental diets.[x]

	Phase	**TA0**	**TA50**	**TA100**	**P-value**
ADG, g/d	A	246[ab]	260[a]	234[b]	<0.001
	B	554[b]	569[ab]	587[a]	0.008
	C	862	866	869	0.94
	A-C	525[b]	550[a]	541[ab]	0.048
FI, g/d	A	316	331	314	0.07
	B	786	801	807	0.38
	C	1331	1332	1345	0.89
	A-C	774	790	782	0.62
FU,	A	1.31[ab]	1.30[a]	1.38[b]	0.02
kg feed/kg gain	B	1.43[b]	1.42[b]	1.38[a]	<0.001
	C	1.58	1.52	1.54	0.23
	A-C	1.48[b]	1.44[a]	1.44[a]	0.007

[x] Values are LS-means (n=18).
[ab] LS-means within rows without a common superscript differ (P<0.05).

The values of least significant difference (LSD) indicated that the test was scaled to identify differences in ADG of 14 to 38 g/day and differences in FU of 0.03 to 0.08 kg feed/kg gain.

In general, piglets maintained good health during the experiment. Based on veterinary diagnosis, all pigs in test received treatment with Doxycyclin (Doxx-Sol®) in the drinking water for the first 5 days after weaning. There were no other treatment days against any specific diseases for pigs that stayed in test.

Table 4. Pigs taken out of study (PTO, %).

	Phase	**TA0**	**TA50**	**TA100**
PTO	A	1.0	0.8	1.4
	B	2.3	0.5	2.0
	C	0.6	1.5	1.0
	A-C	3.8	2.7	4.3

In table 4, the number of pigs taken out in percentage of the number of pigs inserted in each phase of the study and the total 6 week test period is presented. The reason for taking the pigs out included different kind of veterinary observations e.g. hernia, arthirits etc. The trial was not designed to analyse health data. The data indicates that the PTO are random and not related to the dietary treatments.

Conclusion

It is concluded that AX3Digest can substitute a FM_{DK} – $SPC56_{DK}$ combination in nursery diets.

If 50% of the FM_{DK} – $SPC56_{DK}$ combination was replaced with AX3Digest (TA50) in phase A the ADG was better than if 100 % of the FM_{DK} – $SPC56_{DK}$ combination was replaced with AX3Digest (TA100). In phase B the ADG was superior for the 100% AX3Digest (TA100) fed piglets compared to piglets fed the 100% FM_{DK} – $SPC56_{DK}$ combination (TA0).

At day 43 the increased ADG in both the TA50 and TA100 group resulted in 1.1 kg and 0.8 kg extra live weight (LW), respectively, compared to the TA0 group based on the FM_{DK}-$SPC56_{DK}$ combination.

In the total test period of 43 days FU was improved significantly in both the TA50 and TA100 group compared to the TA0 control group only containing the FM_{DK} – $SPC56_{DK}$ combination.

Implications

From the data obtained in this test it is clear that a FM_{DK} – $SPC56_{DK}$ combination in a weaning diet can be partly or fully substituted with AX3Digest resulting in similar or even better performance after weaning.

The results indicates that it is optimal to substitute 50% of a FM_{DK} – $SPC56_{DK}$ combination with AX3Digest in the first period after weaning (phase A) whereas from 10 kg live weight (phase B) 100% of the FM_{DK} – $SPC56_{DK}$ combination can be substituted resulting in superior weight gain.

In the test period the price of fish meal was 1.28 EUR (9.50 DKK) per kg. With this price on fish meal the three diets were price neutral if AX3Digest were priced to 1.26 EUR (9.35 DKK) per kg.

With an extra 0.80 EUR (5.96 DKK) per kg live weight (German marked price) the extra 0.8 and 1.1 kg piglet obtained in the TA100 and TA50 group resulted in 0.64 and 0.88 EUR extra gross margin per piglet sold.

14-06-2018

Dorthe Carlson

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Project Leader

Appendix A. Photo of the pens used for test

Appendix B. Feed ingredients in test diets

Table 1. Feed ingredients (%) in the test diets used in phase A (6-10 kg).

	TA0	TA50	TA100
AX3Digest	0	8.1	16.2
Fish $Meal_{DK}$	10	5.0	0
$SPC56_{DK}$	6.5	3.2	0
Soy bean meal	0	0	0
Wheat	65.0	64.7	65.2
Barley	0	0	0
Concentrate containing milk and whey powder, oil, oat flakes, potato protein, vitamins, minerals, amino acids, organic acids and enzymes	18.5	19.0	18.6

Table 2. Feed ingredient (%) in the test diets used in phase B (10-18 kg).

	TA0	TA50	TA100
AX3Digest	0	4.4	9.0
Fish $Meal_{DK}$	5.0	2.5	0
$SPC56_{DK}$	4.0	2.0	0
Soy bean meal	9.5	9.5	9.5
Wheat	58.7	58.6	58.4
Barley	15.0	15.0	15.0
Premix containing oil, potato protein, vitamins, minerals, amino acids, organic acids and enzymes	7.8	8.0	8.1

Table 3. Feed ingredients (%) in the diet used in phase C (18-29 kg).

	Content (%)
Wheat	39
Barley	30
Soy bean meal	24
Soy oil	2.4
Premix containing vitamins, minerals, amino acids and enzymes	4.6

Appendix C. Chemical composition of feed (E=expected and A=analysed)

Expected (E) and analysed (A) chemical composition of the phase A diets[a]

	TA0		TA50		TA100	
	E	A	E	A	E	A
Dry matter, %	88.0	89.0	88.0	89.0	88.0	89.4
Crude protein (N*6.25), %	20.7	20.4	20.6	20.8	20.7	20.4
Total fat, %	6.3	6.4	6.2	6.2	6.3	6.4
Total Ash, %	4.9	5.4	4.7	4.9	4.6	5.1
FEsv, per 100 kg	124	125	124	126	124	125
Ca, g/kg	7.7	11.0	7.7	9.6	7.7	10.0
P, g/kg	6.7	7.3	6.7	7.5	6.7	8.0
Cu, mg/kg[b]	150	209	150	210	150	190
Zn, mg/kg[b]	124	269	124	210	124	200
Lys, g/kg[c]	14.9 (13.6)	15.7	14.5 (13.6)	15.3	14.2 (13.6)	15.5
Met, g/kg[c]	4.6 (4.3)	5.1	4,6 (4.3)	4.7	4.6 (4.3)	4.8
Cys, g/kg[c]	3.1 (2.6)	3.0	3.3 (2.8)	3.1	3.4 (2.9)	3.3
Thr, g/kg[c]	9.2 (8.3)	9.8	9.0 (8.3)	9.3	8.9 (8.3)	8.7

[a] The chemical analyses (A) were performed by Eurofins. All parameters are on an “as is” basis. n=1.
[b] The expected concentration of Cu and Zn is the amount added to the feed
[c] The values in bracket are the expected concentrations of “ileal digestible amino acids”.

Expected (E) and analysed (A) chemical composition of the phase B diets[a]

	TA0		TA50		TA100	
	E	A	E	A	E	A
Dry matter, %	87.0	87.6	87.0	87.8	87.0	87.8
Crude protein (N*6.25), %	19.1	18.9	19.1	18.5	19.1	19.3
Total fat, %	4.7	4.8	4.8	4.9	4.8	4.7
Total Ash, %	5.5	5.5	5.5	5.4	5.5	5.4
FEsv, per 100 kg	114	117	114	116	114	116
Ca, g/kg	8.2	9.9	8.2	10.9	8.2	11.9
P, g/kg	5.9	6.2	6.0	6.4	6.0	6.6
Cu, mg/kg[b]	150	165	150	189	150	219
Zn, mg/kg[b]	114	199	114	219	114	209
Lys, g/kg[c]	13.2 (12.0)	12.0	13.0 (12.0)	12.7	12.8 (12.0)	12.7
Met, g/kg[c]	4.2 (3.9)	4.0	4,2 (3.9)	4.0	4.2 (3.9)	4.3
Cys, g/kg[c]	3.1 (2.6)	2.9	3.2 (2.7)	2.9	3.3 (2.7)	3.1
Thr, g/kg[c]	8.3 (7.3)	7.7	8.2 (7.3)	8.4	8.1 (7.3)	8.3

[a] The chemical analyses (A) were performed by Eurofins. All parameters are on an “as is” basis. n=1.
[b] The expected concentration of Cu and Zn is the amount added to the feed

[c] The values in bracket are the expected concentrations of “ileal digestible amino acids”.

Appendix D. Average weight of piglets at the start of test and the end of each phase

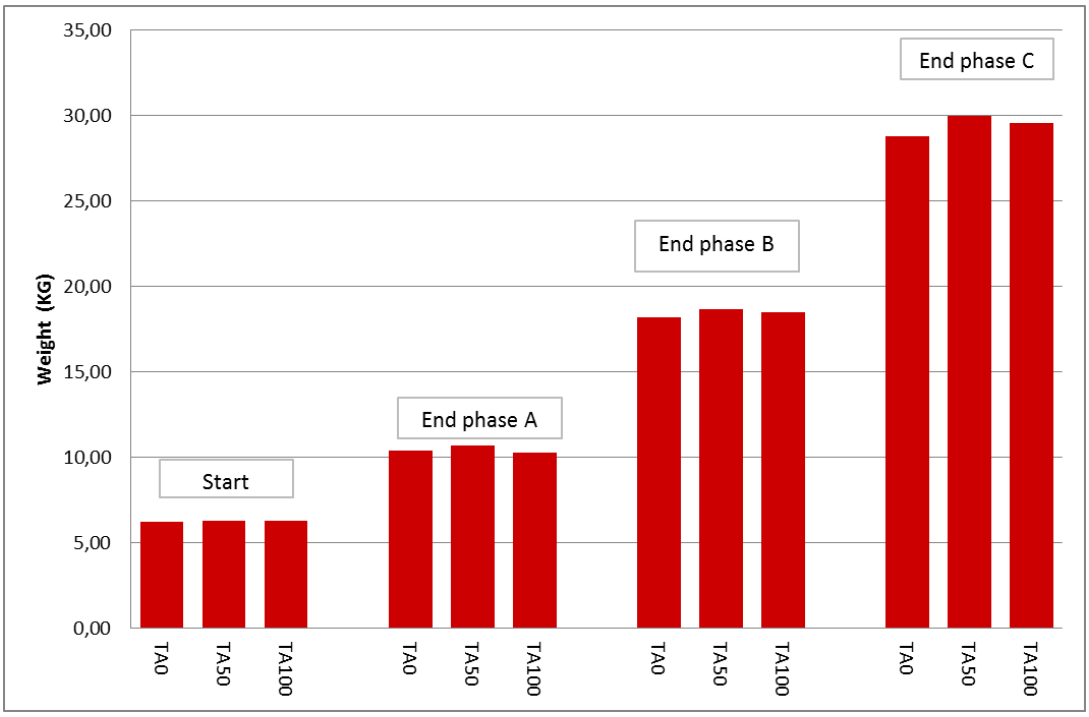

Figure 1. Average weight (kg) of piglets from the three dietary groups at start of test and at the end of each phase. The weights at the end of each phase are calculated from the LS-means for ADG in phase A, phase B and phase A-C (LS-means are presented in Table 3).