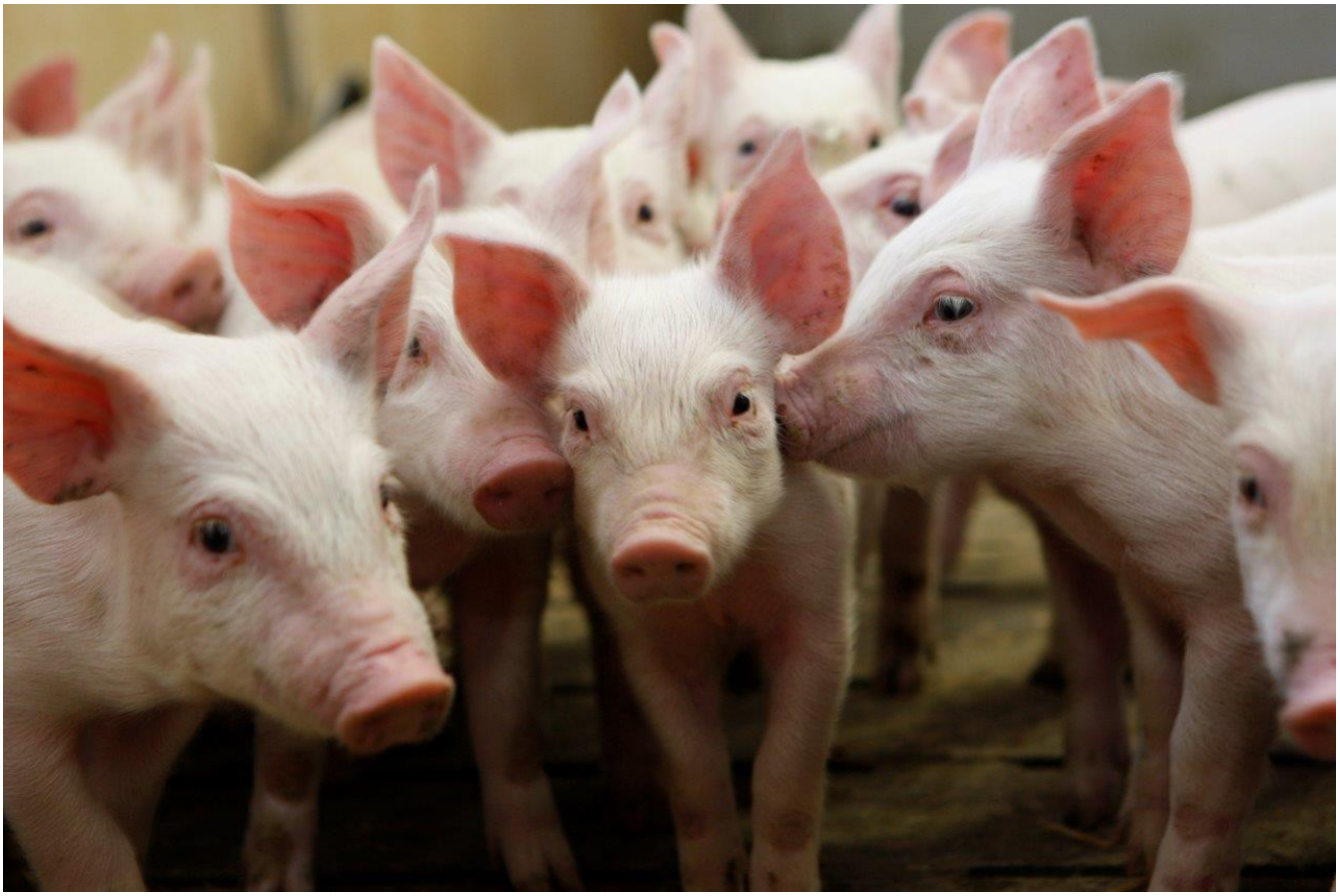
Skjoldborg test station

TestGris***

SvineRådgivningen

Birk Centerpark 24, 7400 Herning
www.svineraadgivningen.dk
CVR: 25399781



Performance effects of four weaning diets in nursery pigs (IV)

Test conducted on request from Hamlet Protein
Authors: Dorthe Carlson and Niels Ove Nielsen

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Content

Summary

This test aimed to test the effect of 4 different diets (HP1, HP2, HP3 and HP4) fed the first 4 weeks after weaning on piglet performance. The piglets were followed until 6 weeks after weaning. Only one diet (HP1) contained therapeutic levels of veterinary ZnO in phase A. Apart from ZnO the main differences between the diets were the type and level of soy protein concentrate.

Piglet performance was measured as average daily gain (ADG), feed intake (FI) and feed conversion ratio (FCR; kg feed per kg gain) under practical pig production conditions. In addition, a faecal score was given for each pen during the first 2 weeks after weaning.

When piglets showed signs of diarrhoea or were unthriving they were removed to a disease pen (where necessary medical treatment was given). No medical treatments were provided in the water or feed.

This trial confirmed the well-known positive effects of high levels of ZnO on weight gain, feed intake, faeces score, diarrhea etc. for the first 2 weeks after weaning. However, in this test there were no long-lasting effect of using high levels of ZnO, as the performance did not differ between the positive and negative control group over the whole 6-week test period.

For the whole 6-week test period the HP3 diet resulted in performance similar to the positive and negative control diets, whereas the HP2 diet resulted in lower performance both in respect of ADG and FI.

Introduction

This study was conducted on request from Hamlet Protein in the period November 04 (2019) to February 04 (2020) at Skjoldborg test station.

The test aimed to test the effect of 4 different diets fed the first 4 weeks after weaning on performance during the first 6 weeks after weaning.

The 4 diets were designated “HP1”, “HP2”, “HP3” and “HP4”.

The test was designed to test the effect of the diets on average daily gain (ADG), feed intake (FI) and feed conversion ratio (FCR; kg feed per kg gain) in weaned piglets under practical pig production conditions.

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.

The test included a total of 4578 Danbred crossbred (Landrace/Yorkshire x Duroc) female and castrated male piglets with approximately the same number of both genders. The piglets where weaned at 25 ± 3 days of age.

Housing conditions for piglets complied fully with EU and Danish legislation. Eight 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 8 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 35 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 pens according to size (small, small/medium, large/medium and Large). The average body weight of piglets in the pens was in the range of 5.1 to 8.1 kg. The double-pens were allocated to one of four diets i.e. two dry feed dispensers for each diet per room. The average initial body weight of the piglets was 6.5, 6.5, 6.5 and 6.6 kg for diet HP1, HP2, HP3 and HP4, respectively

The test period was initiated at the day of weaning and was divided into three phases (Phase A, B and C). Phase A was from day 0 to day 14 (15 days), phase B was from day 14 to day 28 (14 days) and phase C was from day 28 to 42 (14 days), 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 pre-starter diet containing corn, wheat, oat, milk powder, soy protein concentrate, plasma and potato protein.

The test diets fed in phase A and phase B were formulated and produced by Hamlet Protein. The composition of the test diets was unknown for the personnel at the test station and only limited information was available for the personnel at TestPig***. The diets fed phase C were formulated by TestPig*** and optimized to provide nutrients according to the Danish feeding standards for piglets in the weight intervals of 15-30 kg, respectively. The phase C diet was produced on farm under the supervision of TestGris***. The composition of the diets is given in Appendix B. None of the diets contained antibiotics. Only one diet (HP1) contained therapeutic levels of veterinary ZnO in phase A.

Diet HP1 and HP4 were very similar in composition except for the high inclusion of ZnO in HP1 in phase A. In this report these two diets will be referred to as the positive- and negative control diets, respectively. All 4 diets contained the Soy Protein Concentrate (SPC) HP300, however in diet HP2 some of the SPC was exchanged with a product named “HP Test” and in diet HP3 some of the SPC was replaced with HP FiberStart.

The diets fed in phase A and phase B were pelleted and crumbled and the diet in phase C were fed as meal feed. All diets were fed *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.

If pigs showed signs of diarrhoea, they were moved to a disease pen (taken out of test) where medical treatment was given.

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.

Before change to the next feeding phase any feed residues in the feed dispenser was weighed and subtracted from the amount supplied in the previous phase

The amount of feed produced per feed dispenser per day was recorded by the feeding computer.

In phase A, fecal score was observed and registered once every day (Monday to Friday). The registration sheet is presented in Appendix C. The registrations were performed by the same person every day and when this person was absent the registrations were not done this day. The fecal score involved four levels: 1: firm and shaped, 2: Soft and shaped, 3: Loose and 4: Watery. The observer observed the total amount of manure on the slatted part of the floor in each pen and roughly estimated and registered the proportion (%) of each of the four scores out of the total amount of manure (100 %) on the floor.

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

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.

In all calculations, data were adjusted for number and weight of piglets taken out of trial.

As a supplement to the calculation of total feed intake in each phase, the amount of feed supplied per feed dispenser on each individual day was used to calculate the accumulated feed intake, per pig per treatment, on each day for the first 15 days after weaning.

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 FCR in phase A, phase B, phase C and the total test period were analysed in a Gaussian mixed effect model including “initial body weight at day 0”, “room number” and “diet” (HP1, HP2, HP3 and HP4). “Room number” was included in the model as a random parameter and “diet” was included in the model as a fixed parameter. Statistical significance was accepted at $P<0.05$.

Standard model control for all outcome variables were performed to assure that the normality assumptions for the models were met. This was not true for FCR in phase A and Phase C and therefore the test statistics were not accurate. To obtain a more accurate test of treatment effect, bootstrapping was applied to the analysis of FCR.

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

Results and comments

In general, piglets maintained good health during the experiment. Based on veterinary diagnosis (lung disease), 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.

The results clearly confirm the positive effect of medical ZnO (2500 ppm Zn) for the first two weeks after weaning. Pigs that received this treatment (HP1) showed a significantly higher ($P<0.001$) growth rate (214 g/day) compared to the other 3 diets in phase A. The ADG in the HP2, HP3 and HP4 dietary group did not differ significantly in phase A (153, 165 and 167 g/day, respectively).

The feed intake in phase A was also significantly affected by the dietary treatments ($P<0.001$). The highest feed intake was observed in the positive control (HP1) group (266 g/d) and the lowest FI was observed in the HP2 group (216 g/d). The FI in the HP3 group, was similar to the negative

control (HP4) (237 and 242 g/d, respectively). In Figure 2, (Appendix E), it is illustrated how the accumulated FI in the HP1 group is slightly lower or equal to the other dietary groups until day 9 after weaning. Hereafter, it starts to deviate in terms of higher feed intake in the HP1 group compared to the other three dietary groups. In contrast, figure 2 may indicate that the accumulated FI is slightly higher in the HP2 dietary group for the first 4 days after weaning, however, from day 8 and onwards the FI in the HP2 group is lower than for the other dietary treatments.

In phase A, the FCR was significantly better (P<0.001) in the positive control group (HP1) group (1.23 kg/kg) compared to the other three groups. The FCR was 1.43, 1.43 and 1.44 kg/kg in the HP2, HP3 and HP4 group, respectively. The pairwise comparisons showed that the FCR of these three groups was similar.

In phase B, the dietary treatments did not affect ADG significantly (P=0.10). However, numerically the ADG was highest in the HP3 group and lowest in the HP1 group. There was a significant effect of diet (P<0.001) on FI in phase B. Pigs fed the HP4 diet consumed the highest amount of feed (676 g/d) and pigs fed the HP2 diet consumed the lowest amount of feed (620 g/d) in phase B. As a consequence, the FCR was reduced in the HP4 group (1.40 kg/kg) compared with the other dietary groups (1.34, 1.32 and 1.35 kg/kg in the HP1, HP2 and HP3 dietary groups, respectively).

In phase C, all pigs in test received the same standard diet, consequently the significant effect of diet on ADG, FI and FCR (P<0.001, P=0.009 and P=0.015, respectively) must be ascribed to the differences in diets fed in phase A and/or phase B. The HP3 and HP4 diets resulted in higher ADG (696 and 687 g/d, respectively) and higher FI (1119 and 1126 g/d, respectively), compared with the HP2 diet (ADG=611 g/d and FI=1075 g/d). The HP1 group showed intermediate ADG (659 g/d) and FI (1110 g/d). FCR was significantly improved in the HP3 group (1.61 kg/kg) compared with the HP2 group (1.76 kg/kg). The FCR in the positive and negative control group (HP1 and HP4) was in between with values of 1.69 and 1.65 kg/kg, respectively.

Table 1. Average daily gain (ADG), feed intake (FI) and feed convertion ratio (FCR) in phase A (6-9 kg) phase B (9-15 kg), phase C (15-30 Kg) and the whole test period (A-C) of pigs fed the four experimental diets.

		Diet					
	Phase	**HP1**	**HP2**	**HP3**	**HP4**	**P-value**	**LSD**
ADG, g/d	A	214^{a}	153^{b}	165^{b}	167^{b}	<0.001	14
	B	478	467	492	484	0.10	21
	C	659^{ab}	611^{b}	696^{a}	687^{a}	<0.001	45
	A-C	445^{a}	405^{b}	445^{a}	440^{a}	<0.001	20
FI, g/d	A	266^{a}	216^{c}	237^{b}	242^{b}	<0.001	12
	B	643^{bc}	620^{c}	668^{ab}	676^{a}	<0.001	24
	C	1110^{ab}	1075^{b}	1119^{a}	1126^{a}	0.009	32
	A-C	665^{a}	623^{b}	663^{a}	669^{a}	<0.001	19
FCR,	A	1.23^{a}	1.43^{b}	1.43^{b}	1.44^{b}	<0.001	0.05
kg	B	1.34^{a}	1.32^{a}	1.35^{a}	1.40^{b}	<0.001	0.03
feed/kg	C	1.69^{ab}	1.76^{b}	1.61^{a}	1.65^{ab}	0.015	0.09
gain	A-C	1.50^{ab}	1.55^{b}	1.49^{a}	1.52^{ab}	0.018	0.04

^{x} Values are LS-means (n=16).

^{ab} LS-Means within rows without a common superscript differ (P<0.05).

For the whole 6-week test period the performance in terms of ADG and FI was similar for the HP1 HP3 and HP4 group (ADG: 440-445 g/d and FI: 663-669 g/d), whereas the HP2 dietary group differed significantly (P<0.001) with an ADG of 405 g/d and a FI of 623 g/d. The FCR differed only significantly (P=0.018) between the HP2 and HP3 dietary group (1.55 and 1.49 kg/kg, respectively). The FCR in the positive and negative control group were in between (1.50 and 1.52 kg/kg, in the HP1 and HP4 group, respectively.)

The average piglet weight (± standard deviations) on day 43 was 25.8 (± 2.5), 24.0 (± 2.8), 25.7 (± 2.0) and 25.6 (± 2.8) kg for HP1, HP2, HP3 and HP4, respectively.

In Table 3, Table 4 and Table 5 the number of pigs taken out in percentage of the number of pigs inserted in each phase of the study is presented. The reason for taking the pigs out included different kinds of veterinary observations e.g. diarrhoea, hernia, arthritis etc. The health data were not statistical analysed. However, the data may indicate that in phase A the PTO is lower in the positive control group (HP1) compared to the other dietary groups. The difference seems mainly to be caused by a lower number of pigs taken out in the HP1 group due to diarrhoea and un-thriving in phase A.

In phase B (Table 4) the number of pigs taken out appears to be independent on the dietary treatments whereas in phase C (Table 5) there seems to be a higher number of pigs taken out in the HP2 dietary group due to unthriving (12 pigs) compared to the other three dietary groups (4-6 pigs).

Table 3. Pigs taken out of study (PTO, number of pigs) in phase A (day 0-14) divided on the experimental diets and the reason for taking it out and PTO in % of total number of experimental pigs.

Reason	HP1	HP2	HP3	HP4
PTO:				
Disease pen	7	18	17	13
Dead	0	1	0	1
Euthanized	0	1	3	0
Reason:				
Diarrhoea	0	5	2	2
Arthritis	0	0	3	2
Cerebrospinal Meningitis	0	0	0	0
Blood ear	1	1	0	2
Hernia	0	1	1	0
Un-thriving	6	11	13	6
Other	0	2	1	2
PTO (% of total):				
Disease pen (%)	0.61	1.58	1.48	1.13
Dead (%)	0.00	0.18	0.26	0.09

Table 4. Pigs taken out of study (PTO, number of pigs) in phase B (day 15-28) divided on the experimental diets and the reason for taking it out and PTO in % of total number of experimental pigs.

Reason	HP1	HP2	HP3	HP4
PTO:				
Disease pen	14	12	13	14
Dead	3	0	1	1
Euthanized	1	2	4	1
Reason:				
Diarrhoea	1	0	0	0
Arthiritis	4	1	4	4
Cerebrospinal Meningitis	0	0	0	1
Blood ear	2	2	2	2
Hernia	1	0	1	0
Un-thriving	5	9	10	8
Other	5	2	1	1
PTO (% of total):				
Disease pen (%)	1.24	1.07	1.15	1.23
Dead (%)	0.35	0.18	0.44	0.18

Table 5. Pigs taken out of study (PTO, number of pigs) in phase C (day 19-42) divided on the experimental diets and the reason for taking it out and PTO in % of total number of experimental pigs.

Reason	HP1	HP2	HP3	HP4
PTO:				
Disease pen	16	18	9	11
Dead	0	0	1	0
Euthanized	3	2	3	2
Reason:				
Diarrhoea	0	1	0	0
Arthiritis	5	2	1	5
Cerebrospinal Meningitis	1	1	1	0
Blood ear	4	0	1	3
Hernia	3	2	2	0
Un-thriving	4	12	6	5
Other	2	2	2	0
PTO (% of total):				
Disease pen (%)	1.71	1.81	1.17	1.16
Dead (%)	0.27	0.18	0.36	0.18

To sum up the data in table 3 to 5 the percentage of pigs moved to a disease pen and the percentage of pigs that died during the 6-week test period is presented in Table 1.

Table 6. Pigs taken out of study (PTO, %) in the total test period (day 0-42)

Reason	HP1	HP2	HP3	HP4
Disease pen (%)	3.51	4.38	3.75	3.48
Dead (%)	0.61	0.53	1.05	0.44

In table 7 (Appendix F) the number of pigs taken out of test due to “diarrhoea and not thriving” on the different days after weaning is presented.

The development of feces texture, during the first 2 weeks after weaning, is presented in Figure 1 (Appendix D). During the first 4 days there were no visible differences between the dietary groups However, from day 5 and onwards the “Score 1” share was increasing distinctly in the HP1 group while the “Score 4” share was declining to 0% in the HP1 dietary group.

Conclusion

This trial confirmed the well-known positive effects of high levels of ZnO on weight gain, feed intake, faeces score, diarrhea etc. for the first 2 weeks after weaning. However, in this test there were no long-lasting effect of using high levels of ZnO, as the performance did not differ between the positive and negative control group over the whole 6-week test period.

For the whole 6-week test period the HP3 diet resulted in performance similar to the positive and negative control diets, whereas the HP2 diet resulted in lower performance both in respect of ADG and FI.

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 (6-9 kg).

	HP1	HP2	HP3	HP4
Wheat	49,0	46.7	45.1	49.7
Barley	15.0	15.0	15.0	15.0
HP Test[1]	-	10.3	-	-
SPC	12.1[2]	5.4[2]	5.2[1]	11.9[2]
HP FiberStart	-	-	10	-
Milk powder	13.8	13.8	13.8	13.8
Potato protein	2.0	2.0	2.0	2.0
Palm oil	1.5	1.0	0.3	-
Leci E	1.3	1.8	3.7	2.7
Vet ZnO	0.3	-	-	-
Premix[3]	5.0	4.0	4.9	4.9

[1]Unknown to TestPig [2]Soy Protein Concentrate (HP300),
[3]Containing vitamins, minerals, amino acids, phytase, Ronozyme and benzoic acid

Table 2. Feed ingredients (%) in the test diet used in phase B (9-15 kg).

	HP1	HP2	HP3	HP4
Wheat	61.2	59.2	58.1	61.2
Barley	10.0	10.0	10.0	10.0
Soybean meal	10.0	10.0	10.0	10.0
HP300	9.6	5.2	4.9	9.6
HP FiberStart	-	-	7.0	-
HP Test[1]	-	7.0	-	-
Potato protein	1.8	1.8	1.8	1.8
Palm oil	1.2	1.3	1.5	1.2
Leci E	1.5	1.5	2.0	1.5
Premix[2]	4.7	4.0	4.7	4.7

[1]Unknown to TestPig
[2]Containing vitamins, minerals, amino acids, phytase, Ronozyme and benzoic acid

Table 3. Feed ingredients (%) in the diet used in phase C (15-30 kg).

	Content (%)
Wheat	47.9
Barley	20.0
Soybean meal	26.0
Soy oil	1.2
Premix containing vitamins, minerals, amino acids and enzymes	4.9

Appendix C. Registration sheet for faecal score

Date: _____ Initials:_____Section:_____

Score 1-4:

1. Firm and shaped	2. Soft and shaped	3. Loose	4. Watery
			

Pen no.	% with score 1	% with score 2	% with score 3	% with score 4
_02H				
_02V				
_03H				
_03V				
_04H				
_04V				
_05H				
_05V				
_06H				
_06V				
_07H				
_07V				
_08H				
_08V				
_09H				
_09V				
_10H				
_10V				

Appendix D. Fecal score in phase A

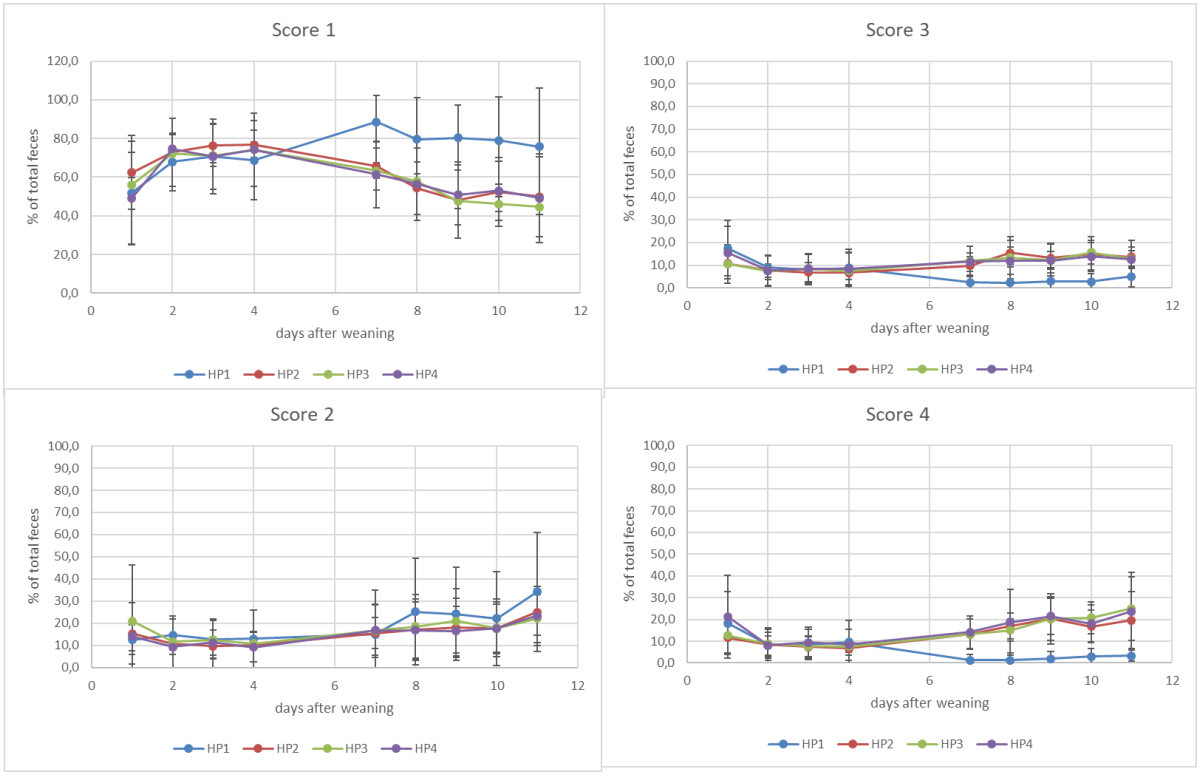

Figure 1. The percentage of total feces with score 1, score 2, score 3 and score 4, respectively, in phase A. Values are means ± standard deviations (error bars)

Appendix E. Average accumulated feed intake

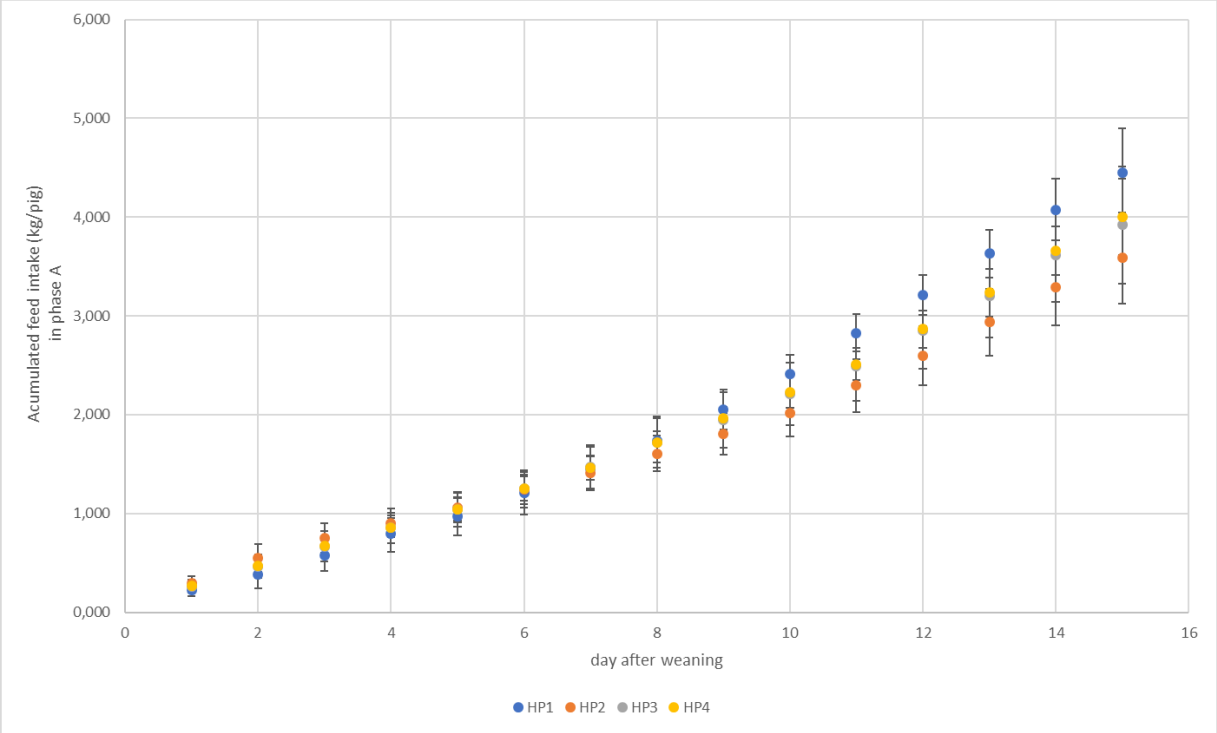

Figure 2. The average accumulated feed intake (kg/pig) during the first 15 days after weaning divided on the 4 dietary treatments (HP1, HP2, HP3 and HP4). Values are means ± standard deviations (error bars).

Appendix F. Number of pigs taken out of test due to “diarrhoea and not thriving”

Table 7. Number of pigs taken out of test due to “diarrhoea and not thriving” divided on days after weaning

Day	HP1	HP2	HP3	HP4
6			1	
7			1	
8	1	7	4	
9		3	4	2
10	3		1	2
11				2
12				1
13	1	5	1	1
14	1	1	3	
15	1	4	1	
16			2	
17	1	1	1	
20	1		3	1
21	2	2	1	1
22	1			2
24		1		2
27		1	2	1
28			1	
29		1		
30	1	3	2	
31	1	3	1	2
33				1
35		4	1	
37	2	2	1	2
Total	16	38	31	21