Skjoldborg test station

TestGris***

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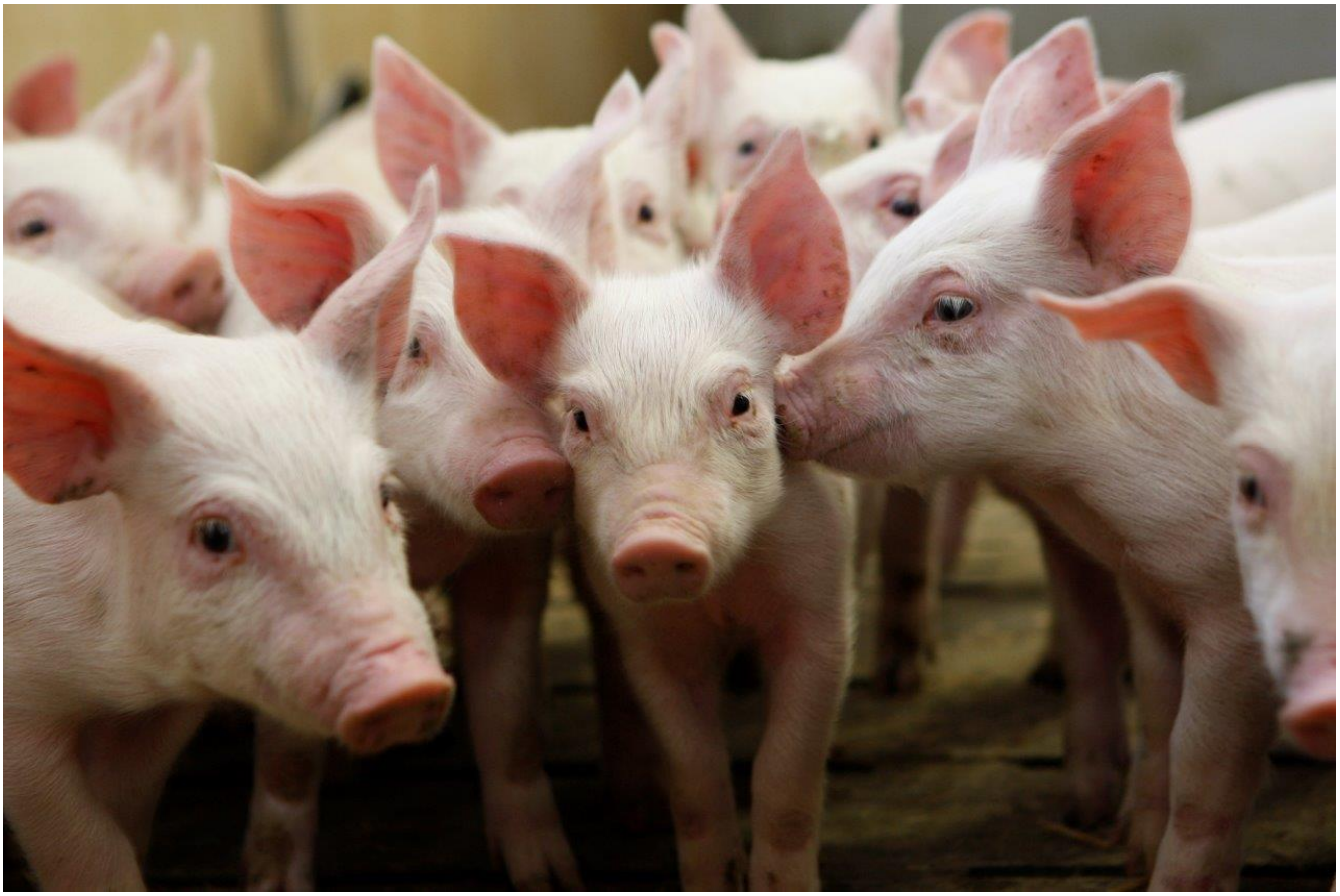

The effect of BalanGut® LS P on post weaning performance

Test conducted on request from BASF

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Summary

This study aimed to test the effect of BalanGut® LS P inclusion in weaning diets on pig performance for the first 6 weeks after weaning (approx. 6-30 kg live weight), under practical Danish pig production conditions.

The two test diets were compared with a positive and negative control diet and the 4 diets were designated “NOC”, “POC”, “LBG” and “HBG”. The four diets were as follows:

NOC (“Negative Control”): A typically Danish weaner diet used as standard on the test farm (zinc at requirement level)

POC (“Positive Control”): The same diet as NCO but supplemented with 2500 ppm Zn from ZnO for the first 14 days after weaning.

LBG: The NCO diet supplemented with 0.75 kg BalanGut® LS P per ton feed throughout the 6-week test period (phase A, B and C)

HBG: The NCO diet supplemented with 3.0 kg of BalanGut® LS P in phase A (week 1-2) and phase B (week 3-4) and 1.5 kg of BalanGut® LS P in phase C (week 5-6), respectively.

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.

From the results of the trial the following is concluded:

- As expected, high levels of Zn from ZnO improved performance in terms of improved ADG and FI for the first 2 weeks after weaning. In spite that no significant differences were observed between the POC and NEC group in phase B and phase C, the POC group was still superior to the NEC group in terms of ADG and FCR when looking at data from the total 6-week period.

- The BalanGut® inclusion (high or low level) did not affect ADG or FI compared with the negative control diet in any of the feeding phases or in the total 6-week test period.

- For the total 6-week test period the FCR in the HBG and LBG group was in between the NEC and POC group, which indicate a positive effect of BalanGut® LS P on FCR.

- The dietary treatments did not seem to have great impact on the health parameters recorded in this trial. However, there seemed to be a small effect of the high dose of BalanGut® on faeces score (more dry faeces).

Introduction

This study was conducted on request from BASF in the period March 22 (2021) to June 22 (2021) at Skjoldborg test station.

The study aimed to test the effect of BalanGut® LS P inclusion in weaning diets on pig performance for the first 6 weeks after weaning (approx. 6-30 kg live weight), under practical Danish pig production conditions.

The two test diets were compared with a positive and negative control diet and the 4 diets were designated “NOC”, “POC”, “LBG” and “HBG”.

NOC (“Negative Control”): A typically Danish weaner diet used as standard on the test farm (zinc at requirement level)

POC (“Positive Control”): The same diet as NCO but supplemented with 2500 ppm Zn from ZnO for the first 14 days after weaning.

LBG: The NCO diet supplemented with 0.75 kg BalanGut® LS P per ton feed throughout the 6-week test period (phase A, B and C)

HBG: The NCO diet supplemented with 3.0 kg of BalanGut® LS P in phase A (week 1-2) and phase B (week 3-4) and 1.5 kg of BalanGut® LS P in phase C (week 5-6), respectively.

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.

In addition, information regarding the number of piglets taken out of test due to disease and death was collected. Furthermore, faecal score was evaluated during the first two weeks after weaning.

Materials and methods

Animals and housing conditions

The test station is a conventional (Health status: Blue Spf + myc + AP6 +AP12+Vac.) integrated production herd, which runs weekly operation in the sow unit.

The test included a total of 4206 Danbred crossbred (Landrace/Yorkshire x Duroc) female and castrated male piglets with approximately the same number of both genders. All pigs were vaccinated against PCV2 and Mycoplasma before weaning. The piglets were 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. The exact number of each gender in each pen was not recorded. Thus, two pens around 2 feeders constitute one observation (photo of pen design in Appendix A). Around 33 piglets were inserted in every pen after weaning. The pens measured 2.4 x 4.3 m and were 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 7.8 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, 6.4, 6.4 and 6.4 kg for diet HBG, LBG, NEK and POK, 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.

Diets

The diets fed in test were formulated by TestPig. Diets were optimized to provide nutrients according to the Danish feeding standards for piglets in the weight intervals of 6-9 kg (phase A), 9-15 kg (phase B) and 15-30 kg (phase C). The composition of the diets is given in Appendix B and the composition of the testmixes used in the diets is shown in Appendix C. Diets were produced on farm under the supervision of TestPig.

All the diets were fed as meal feeds *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.

Feed analyses

Once every week during the whole test period subsamples representing each diet were taken from individual feed dispensers. Each of the subsamples were weighed and the weight of the sample was deducted from the total amount of diet consumed by pigs in that double pen. All subsamples were stored in a cool (<20 ºC) and dry place. When a feeding phase was finalised all the subsamples were pooled into one sample per treatment in each feeding phase ending up with four samples from phase A, three samples from phase B and three samples from phase C. The samples were sent to BASF for analysis.

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 were 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.

A standard procedure was followed in respect of registration of any medical treatment (including treatment days) against diarrhoea and infections.

Faeces score

During the first 2 weeks fecal score was observed and registered once every day. The registration sheet is presented in Appendix D. 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.

Calculations and statistics

Average daily gain (ADG) per piglet was calculated as the difference in weight of piglets at insertion in the pen and total piglet weight at exit of each feeding phase (A, B and C) divided by the number

of pigs in each pen and the number of days in each phase. The ADG in the overall test period from weaning to end of trial was likewise calculated as the difference in weight at insertion and at exit of the trial divided by the number of pigs and days in test:

$$ADG\ (\frac{g}{d}) = \frac{\text{Pen weight at exit (g)} - \text{Pen weight at insertion (g)}}{\text{number of pigs per pen } * \text{ days in each phase (d)}}$$

When a pig was taken out of the trial due to disease or death, the number of pigs and days in each phase was adjusted (only the number of days that the piglets were in test was used). The weight of piglets taken out of test was included in the pen weight at exit.

Feed intake (FI) was calculated as the amount of feed provided per feed dispenser in each phase (or the total test period) minus the remaining feed residues and feed taken out for chemical analyses in each of the feeding phases. When a pig was taken out of the trial the days in each phase was adjusted (only the number of days that the piglets were in test was used).

$$FI\ (\frac{g}{d}) = \frac{\text{Feed provided in each phase (g)} - \text{Feed residues at phase shift (g)} - \text{Feed sample (g)}}{\text{number og pigs per pen} * \text{ days in each phase (d)}}$$

Feed Conversion Ratio (FCR) was calculated as FI (g/day) divided by ADG (g/day).

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

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, 2018). 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”, “weekly batch number” and “diet” (HBG. LBH, NCO, PCO). “Weekly batch number” was included in the model as a random parameter and “diet” was included in the model as a fixed parameter.

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 FI in 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 this variable.

Statistical significance was accepted at $P< 0.05$.

This test was mainly designed to analyse performance data and hence health data in terms of PTO and medical treatments are only reported in a descriptive way (no statistical analyses were performed on these data).

Results and comments

The results from the analyses of the feed samples representing each diet from each feeding phase were not ready when writing this report and hence are not presented.

The pig performance results are presented in Table 1. It shows, as expected, a significantly ($P<0.001$) higher ADG for the first 2 weeks after weaning in the POC group compared with the NEC group (212 vs 160 g/day). In the same period, the ADG in the HBG and LBG group was 169

and 167 g/day, respectively, which according to the pairwise comparisons did not differ significantly from the NEC group.

In phase B, the differences in ADG between diets were not statistically significant (P=0.12) with values of 497, 483, 482 and 505 g/day for HBG, LBG, NEC and POC, respectively. Also in phase C, there was no significant effect (P=0.10) of diet on ADG which was 777, 786, 760 and 706 g/d in the HBG, LBG, NEC and POC group, respectively.

For the total 6-week test period there was a significant (P<0.001) effect of diet on ADG. The overall weight gain in the positive control group was significantly higher than in the other three groups, with LS-means values of 473, 474, 468 and 503 g/d in the HBG, LBG, NEC and POC group, respectively. The final body weight (means) of the piglets at day 43 was 26.8, 26.7, 26.3 and 28.0 kg for the HBG, LBG, NEC and POC group, respectively.

The daily FI followed the same pattern as ADG. In phase A, the FI was significantly (P<0.001) higher in the POC group compared with the NEC, HBG and LBG group (272 vs 219, 230 and 228 g/day, respectively). In phase B and phase C, the differences were not significant (P=0.28 and P=0.34, respectively). However, for the total 6-week test period there was a significant effect (P=0.03) of diet on FI with the lowest and very similar FI in the NEC (707 g/day), HBG (708 g/d) and LBG (705 g/day) group and a higher FI in the POC (734 g/day), respectively.

Table 1. Average daily gain (ADG), feed intake (FI) and feed converstion 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	**HBG**	**LBG**	**NEC**	**POC**	**P-value**	**LSD**
ADG, g/d	A	169[b]	167[b]	160[b]	212[a]	<0.001	14
	B	497	483	482	505	0.12	24
	C	777	786	760	806	0.10	37
	A-C	473[b]	474[b]	468[b]	503[a]	<0.001	17
FI, g/d	A	230[b]	228[b]	219[b]	272[a]	<0.001	17
	B	708	704	691	720	0.28	30
	C	1205	1214	1231	1275	0.34	40
	A-C	708	705	707	734	0.03	22
FCR,	A	1.37[ab]	1.39[b]	1.39[b]	1.30[a]	0.005	0.06
kg	B	1.45[b]	1.45[b]	1.42[ab]	1.41[a]	0.01	0.03
feed/kg	C	1.55	1.55	1.61	1.54	0.07	0.06
gain	A-C	1.50[ab]	1.49[ab]	1.52[b]	1.46[a]	0.002	0.03

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

The FCR in phase A was significantly influenced by diet (P=0.005) and not surprisingly it was the POC group that utilised the feed most efficient (1.30 kg feed/kg gain) compared with 1.39 and 1.38 kg feed/kg gain in the NEC and LBG group, respectively. In the HBG group the FCR was 1.37 kg feed/kg gain, which according to the pairwise comparisons did not differ significantly from the other 3 groups.

In phase B, FCR was also significantly influenced by the diets (P=0.01) and the feed was most efficiently utilised in the POC group (1.41 kg feed/kg gain) and less efficiently utilised in the HBG and

LBG groups (1.45 kg feed/kg gain for both diets). With 1.42 kg feed/kg gain the NEC group was in between.

In phase C diets did not significantly (P=0.07) influence FCR. However, there was a tendency that the NEC group utilised the feed less efficient (1.61 kg feed/kg gain) compared with the other 3 groups (1.55, 1,55 and 1.54 kg feed/kg gain for the HBG, LBG and POC group, respectively).

For the total 6-week test period there was a significant (P=0.002) effect of diet on FCR with the most efficient FCR in the POC group (1.46 kg/kg) and a less efficient FCR in the NEC group (1.52 kg/kg). The HBG and LBG group (1.50 and 1.49 kg feed/kg gain, respectively) did not differ significantly from either the NEC or POC group.

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 data in table 3 to 5 indicates that the reasons for taking pigs out differed randomly between phases and treatment groups.

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	HBG	LBG	NEC	POC
PTO:				
Disease pen	3	12	4	8
Dead	3	1	7	1
Reason:				
Diarrhoea	0	0	1	0
Arthritis	2	9	4	5
Cerebrospinal Meningitis	0	0	1	1
Blood ear	0	1	1	1
Hernia	1	1	2	0
Un-thriving	2	2	1	1
Tail biting	0	0	0	0
Other	1	0	1	1
PTO (% of total):				
Disease pen (%)	0.3	1.1	0.4	0.8
Dead (%)	0.3	0.1	0.7	0.1

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	HBG	LBG	NEC	POC
PTO:				
Disease pen	12	18	15	7
Dead	3	1	8	6
Reason:				
Diarrhoea	0	0	0	0
Arthritis	3	3	3	2
Cerebrospinal Meningitis	0	0	0	1
Blood ear	1	4	0	1
Hernia	1	1	5	3
Un-thriving	9	11	11	3
Tail biting	0	0	0	0
Other	1	0	2	1
PTO (% of total):				
Disease pen (%)	1.2	1.7	1.4	0.7
Dead (%)	0.3	0.1	0.8	0.6

Table 5. Pigs taken out of study (PTO, number of pigs) in phase C (day 29-42) divided on the experimental diets and the reason for taking it out and PTO in % of total number of experimental pigs.

Reason	HBG	LBG	NEC	POC
PTO:				
Disease pen	6	11	10	7
Dead	5	5	4	3
Reason:				
Diarrhoea	0	0	0	0
Arthritis	1	4	2	0
Cerebrospinal Meningitis	0	1	1	1
Blood ear	0	2	1	0
Hernia	4	4	2	2
Un-thriving	2	2	2	2
Tail biting	0	0	0	0
Other	1	0	1	0
PTO (% of total):				
Disease pen (%)	0.6	1.1	1.0	0.7
Dead (%)	0.5	0.5	0.4	0.3

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 6. The total mortality for the 6-weeks test period was relatively low (0.7 to 1.8%).

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

Reason	HBG	LBG	NEC	POC
Disease pen (%)	2.0	3.9	2.8	2.1
Dead (%)	1.1	0.7	1.8	1.0

When signs of diarrhoea were observed in a pen potato starch was spread on the floor in all pens in the room. This procedure was sufficient to avoid severe diarrhoea to develop in all pens and hence no antibiotic treatments were used in this trial. The piglets requiring medicine for other diseases (such as arthritis etc) were not treated before they were taken out of the study and placed in the disease pen.

The development of faeces texture, during the first 2 weeks after weaning, is presented in Figure 1 (Appendix E). The figure show that during the first 3-4 days the proportion of faeces with score 1 is generally decreasing and the proportion with score 4 (diarrhoea) is generally increasing. After day 4 the amount of score 4 is generally reduced until day 7. The faecal score in the POC group differed, as expected, from the other groups with a higher amount of faeces with score 1 and a lower level of faeces with score 4. There is no clear effect of BalanGut® on the faeces score, however, the data may indicate that the HBG group was slightly lower in Score 4 and slightly higher in score 1 compared to the NEC and LBG group.

Conclusion

On the background of this trial the following is concluded:

- As expected, high levels of Zn from ZnO improved performance in terms of improved ADG and FI for the first 2 weeks after weaning. In spite that no significant differences were observed between the POC and NEC group in phase B and phase C, the POC group was still superior to the NEC group in terms of ADG and FCR when looking at data from the total 6-week period.

- The BalanGut® inclusion (high or low level) did not affect ADG or FI compared with the negative control diet in any of the feeding phases or in the total 6-week test period.

- For the total 6-week test period the FCR in the HBG and LBG group was in between the FCR for the NEC and POC group, which indicate a positive effect of BalanGut® LS P on FCR.

- The dietary treatments did not seem to have clear impact on the health parameters recorded in this trial. However, there seemed to be a small effect of the high dose of BalanGut® on faeces score (more dry faeces).

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).

	HBG	LBG	NEC	POC
Wheat	62.0	62.0	62.0	59.0
ZnO premix	-	-	-	3.0
TM1[1]	-	-	3.0	3.0
TM2	-	3.0	-	-
TM4	3.0			
Fish Meal	6.5	6.5	6.5	6.5
Soy oil	2.4	2.4	2.4	2.4
Premix[2]	26.1	26.1	26.1	26.1

[1]Composition of TM1,TM2 and TM4 are presented in Appendix C.
[2]Containing soy protein concentrate, potato and milk proteins, vitamins, minerals, amino acids, phytase, antioxidants, xylanase and organic acids

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

	HBG	LBG	NEC	POC
Wheat	58.1	58.1	58.1	58.1
Barley	10.0	10.0	10.0	10.0
TM1[1]	-	-	3.0	3.0
TM2	-	3.0	-	-
TM4	3.0			
Soybean meal	10.0	10.0	10.0	10.0
Soy oil	1.5	1.5	1.5	1.4
Alpha Soy	10.1	10.1	10.1	10.1
Premix[2]	7.3	7.3	7.3	7.3

[1]Composition of TM1, TM2 and TM4 are presented in Appendix C.
[2]Containing vitamins, minerals, amino acids, phytase, antioxidants and organic acids

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

	HBG	LBG	NEC	POC
Wheat	38.3	38.3	38.3	38.3
Barley	25.0	25.0	25.0	25.0
TM1[1]	-	-	3.0	3.0
TM2	-	3.0	-	-
TM3	3.0	-	-	-
Soybean meal	26.9	26.9	26.9	26.9
Soy oil	1.7	1.7	1.7	1.7
Premix[2]	5.1	5.1	5.1	5.1

[1]Composition of TM1, TM2 and TM3 are presented in Appendix C.
[2]Containing vitamins, minerals, amino acids, phytase, antioxidants and organic acids

Appendix C. Composition of Test Mixes

Table 1. Composition of Test mixes (TM) used in the trial.

	BalanGut® LS P %	Wheat and Wheat middling %
TM1 - Control	0	100
TM2	2.5	97.5
TM3	5.0	95.0
TM4	10.0	90.0

Appendix D. 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 E. Development in Faecal Score the first 2 weeks after weaning

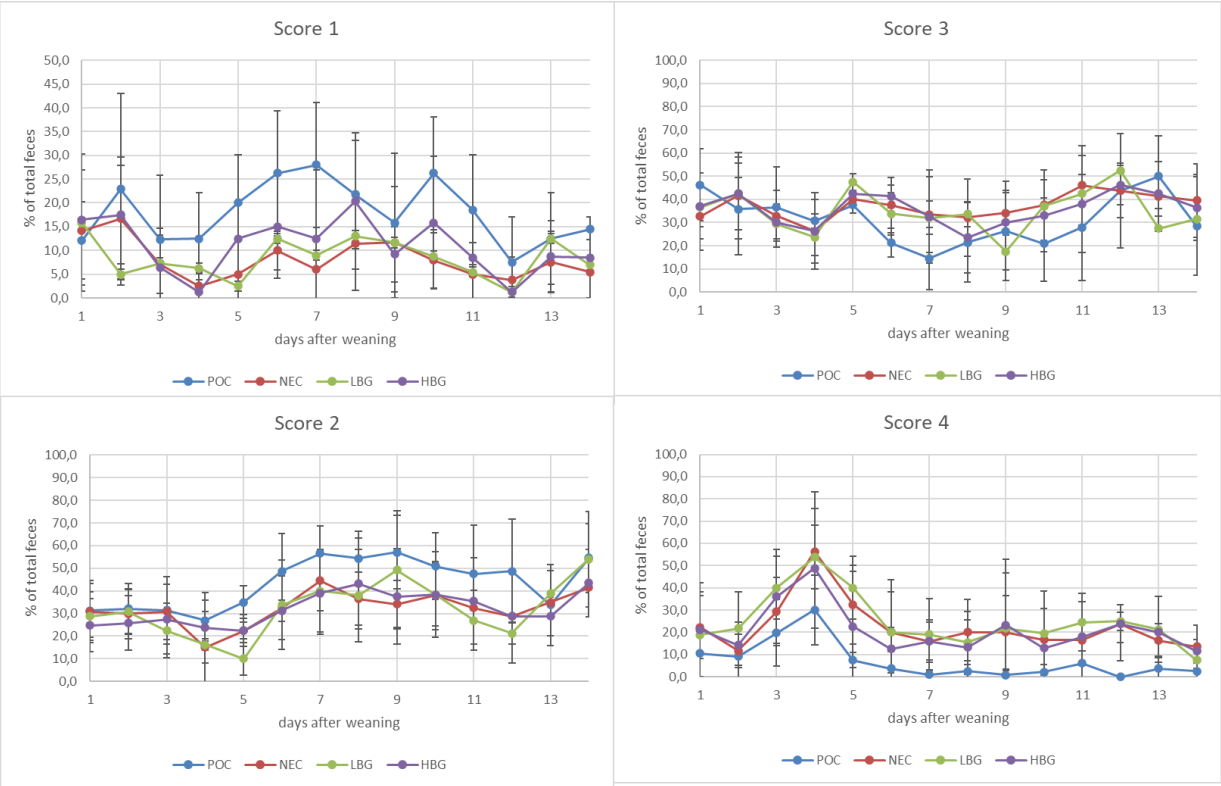

Figure 1. The percentage of total feces with score 1, score 2, score 3 and score 4, respectively. Values are means ± standard deviations (error bars). Number of observations per value (N) is between 2 and 14.