VIDENCENTER FOR SVINEPRODUKTION

FINE GRINDING AND BS3 XYLANASE IMPROVE PRODUCTIVITY

TRIAL REPORT NO. 952

Daily gain and FCR improved when weaners were fed a finely ground diet compared with a coarsely ground diet. The addition of BS3 Xylanase also improved gain and FCR.

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Abstract

This trial demonstrated that finely ground feed improves weaner productivity. Two different products containing carbohydrate-splitting enzymes (xylanase) were also investigated, and results demonstrated that each product affected weaner productivity differently.

Weaners are unable to digest coarsely ground meal feed as well as finely ground meal feed, and their growth rate slows. Results revealed that grinding affected FCR and daily gain by approx. 3% (0.05 FUgp/kg gain and 18 g daily gain). The effect of adding xylanase was the same irrespective of grinding. The addition of BS3 Xylanase improved weaner productivity by 2-3% (÷ 0.03 FUgp/kg gain and + 16 g daily gain), whereas the addition of Porzyme 9302 had no significant effect. The costs related to BS3 Xylanase were fully covered by the improved productivity.

Weaners fed coarsely ground meal feed had significantly fewer treatments for diarrhoea (1.35 treatment days per pig) compared with weaners fed finely ground meal feed (1.82 treatment days per pig). However, more weaners died and more were moved to hospital pens in the group fed coarsely ground feed. This was not investigated further.

The trial comprised weaners in the growth period 8 - 30 kg. The trial set-up comprised six groups all fed not-heat-treated meal feed:

Group	1	2	3	4	5	6
Grinding	Fine	Coarse	Fine	Coarse	Fine	Coarse
Sieve profile in grain, % under:above 1 mm	65:35	40:60	65:35	40:60	65:35	40:60
Xylanase	None	None	875 units/kg BS3 Xylanase	875 units/kg BS3 Xylanase	4,000 units/kg Porzyme 9302	4,000 units/kg Porzyme 9302

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Background

In the Danish pig production industry, carbohydrate-splitting enzymes, primarily xylanase, are often added to pig feed to improve gain and feed conversion ratio (FCR). Several trial activities have investigated various enzyme products for pigs – nationally as well as internationally - all with highly varying outcome [1]. Danish trials with finishers revealed effects on FCR ranging from 0 to 3% when xylanase is added to the feed [2], [3], [4], [5], [6]. Lately, most trial activities have focused on the effect of xylanase on finisher production, whereas in Denmark in recent years no investigations have focused on the effect of xylanase on weaners.

Enzymes are proteins found in plant and animal tissue where they form part of the structure and decomposition of chemical compounds. They act as catalysts accelerating processes that would otherwise not occur or would occur very slowly. Enzymes are specific, ie. they can only break down certain types of bindings. Xylanase splits coherent xylose units in large complex molecules such as arabinoxylans. Arabinoxylans constitute a significant part of the fibre fraction in grain and by-products of grain with the highest concentration found in wheat.

There is an on-going development of new xylanases that may have a significantly greater potential than the xylanases currently available. BS3 Xylanase from DuPont Nutrition Bioscience ApS (previously Danisco) is one such product. BS3 Xylanase has not previously been tested on pigs in Denmark or in other countries.

Finisher trials have demonstrated a poorer FCR when pigs are fed coarsely ground meal feed compared with finely ground meal feed [7], [8], [9]. The outcome of a small-scale trial with different grinding of feed for weaners indicated that coarse grinding reduces the digestibility of feed [10].

A finisher trial comparing finely ground, pelleted feed with coarsely ground meal feed [3] revealed that the effect xylanase was not affected by grinding, ie. the effect of adding xylanase was identical for the two types of feed. Despite a negative effect on feed conversion, coarse grinding is an interesting option as it improves gastric health and the gastrointestinal tract [7], [11]. In terms of health, it is therefore be relevant to clarify whether the addition of xylanase may neutralize a drop in FCR.

The aim of this trial was to establish the effect on weaner productivity of adding one of two different xylanase products to coarse or fine meal feed, respectively. The effect was recorded on daily gain and FCR analysed jointly in a production value.

The trial is part of a co-operation between DuPont Nutrition Bioscience ApS, Aarhus University, Dept. of Animal Science, and Pig Research Centre. The overall purpose of the project is to establish the potential for improving FCR, reducing feed costs and minimising the environmental impact of using xylanases.

Material and method

The trial was conducted at Pig Research Centre's experimental station Grønhøj with weaners purchased at weaning. Two different housing units were used for the trial: one with 12 pens/section each holding 16 pigs, and the other had 18 pens/sections each holding 11 pigs.

The effect of feeding the pigs either a fine or coarse wheat-based diet combined with the addition of xylanase was investigated from approx. 8 kg (approx. 1 week after transfer to the weaner section) until approx. 30 kg. The trial design is shown in Table 1.

Table 1. Trial design (approx. 8-30 kg). All diets were not-heat treated dry feed (meal).

Group	1	2	3	4	5	6
Grinding	Fine	Coarse	Fine	Coarse	Fine	Coarse
Xylanase	None	None	BS3 Xylanase	BS3 Xylanase	Porzyme 9302	Porzyme 9302

See Appendix 1 for more information on BS3 Xylanase and Porzyme 9302.

The trial comprised 61 replicates per group corresponding to 781 pigs/group and a total of 4,686 pigs.

Fine grinding was defined as approx. 65% particles below 1 mm and 35% above 1 mm, while coarse grinding was defined as approx. 40% particles below 1 mm and 60% above 1 mm. Fine grinding was obtained with a 2.5 mm sieve vs 5.5 mm for coarse grinding.

Table 2 shows the expected activity of the two xylanases.

Table 2. Declared enzyme activity of xylanases. Inclusion rates correspond to the maximum approved inclusion.

Xylanase	Enzyme activity (U/kg)
BS3 Xylanase	875 TXU (Total Xylanase Units)
Porzyme 9302	4000 DXU (DAN Xylanase Units)

Feed and feeding

Feed was produced at Danish Agro in Sjølund over a total of nine production rounds. The diets complied with the Danish nutrient standards for weaners in the weight interval 9-30 kg [12], and phytase was added to the diets (100% inclusion). All diets included a safety margin on the calculated amino acid content of 5% above the current standard and of 10% for phosphorus and calcium. A safety margin is included to neutralize any effect of nutrient deficiencies per feed units as the addition of xylanase increases the energy content of a diet. The addition of xylanase increases the energy level of a diet by approx. 1 feed unit per 100 kg feed, and the formulation of the diets in this trial did not take this into consideration [13], [14]. Thereby, the outcome of the trial will be the pigs' biological response to xylanase without having included the effect in the energy value of the grain.

Microgrits (coloured particles) were added to the diets to be able to confirm that the correct diet was fed to the right pens. One diet (for group 5) did not contain microgrits, which was thereby the characteristic of that diet. All six diets had the same ingredient profile. However, as the feed for group 5 did not contain microgrits and as the feed for groups 1 and 2 did not contain xylanase, profiles differed marginally (see Appendix 2). To ensure optimum conditions for xylanase, the feed consisted

of 67% wheat, which contains large quantities of arabinoxylan, which is the carbohydrate most often split by these xylanases.

At trial start, the pigs were fed a meal-based starter diet. For the first 14 days post-weaning, the pigs in all groups were given 2,500 zinc (prescribed by the herd vet) mixed manually into the feed regardless of whether the pigs were fed starter diet or weaner diet. The pigs switched from starter feed to trial feed (weaner feed) 1-2 weeks post-weaning. All pigs switched diets at an average weight of 8 kg (trial start). The pigs were fed not-heat-treated meal feed ad lib from dry feeders. Feeding was managed by a computerised dry feeding system.

Recordings

All recordings were made at pen level.

Weight and number of pigs were recorded upon transfer to the weaner section and at departure from the weaner unit at approx. 30 kg. The trial period began when the pigs switched from the starter diet to the weaner diet. Date, weight and cause were recorded for all pigs that were moved to a hospital pen, died and were destroyed. Number of pigs and date of treatment were recorded for all disease treatments. Sick/weak pigs were moved to a hospital pen and treatment procedures followed the regular routines of the farm. Feed consumption was calculated from trial start to departure from the weaner unit.

Forty-six pigs (23 pigs fed finely ground feed and 23 pigs fed coarsely ground feed) were destroyed immediately when the trial ended at approx. 30 kg in order to examine their stomachs. The white part of the stomach was evaluated at the Laboratory for Pig Diseases in Kjellerup according to the scale normally used for scoring stomachs.

Table 3. Scale for scoring of gastric ulcers/lesions.

Score	Evaluation
0	Normal stomach without changes
1-3	Keratinisation
4-5	Erosion
6-8	Ulcers or scars from ulcers
9-10	Contracted oesophagus

Analyses of feed

Samples from the diets in each group were collected at each feed production and split according to the TOS principles (Theory of Sampling) [15].

The diets were analysed for energy content (Enzyme Digestible Organic Matter at ileum = EDOMi) and for lysine methionine, cystine, threonine, calcium, phosphorus and phytase at Eurofins Steins Laboratorium A/S. Enzyme activity was analysed by DuPont Nutrition Bioscience ApS.

In nine samples of ground wheat (one from each production round), particle distribution was analysed using the Retsch sieve.

Production value and statistics

The production value was obtained by using the following variables:

- Value of gain calculated on the basis of the pigs' gain in kg × value of 1 kg gain
- Feed costs calculated as (end weight ÷start weight) × FUgp per kg gain × DKK per FUgp.
- Productive days, which is the number of days the average pig was in the trial.

Based on prices of the last 5 years (September 1, 2006 – September 1, 2011), the following values were also used for calculating the production value:

- Average price of a 7 kg pig: DKK 913 per pig, ± DKK 9.47 per kg
- Average price of a 30 kg pig: DKK 331 per pig, ÷ DKK 5.72 per kg (25-30) / DKK + 5.41 per kg (30-40)
- Weaner feed: DKK 1.77 per FUgp – identical feed prices in all groups.

One kg gain was valued at DKK 5.97, which was the value of the average gain in the entire period.

Production value (PV) per place unit/day was calculated as follows:
PV per place unit/day: (value of gain÷feed costs) / productive days.

An average price of pigs and feed based on 5 weeks (weeks 23-27, both weeks included) and the price of the product as stated by the producer (see Appendix 1) were used for calculation of the **actual PV**. This did not include identical feed prices in the six groups.

- Price of 7 kg pigs: DKK 236, ± DKK 11.64 per kg
- Price of 30 kg pigs: DKK 397, ÷ DKK 6.39 per kg (25-30) / + DKK 6.55 per kg (30-35 kg)
- Weaner feed:
    a) Groups 1-2: DKK 216 per 100 FUgp
    b) Groups 3-6: DKK 216.46 per 100 FUgp

Data was subject to analysis in the MIXED procedure in SAS as a factor trial with the two factors grinding (to levels: fine vs coarse) and xylanase (three levels: none/product 1/product 2). Production results, daily gain and FCR was summed up in a production value (PV) that was subject to statistical analysis as primary parameter with weight at transfer as co-variable. If significant differences in PV

were observed, each individual production parameter was subject to analysis in the same model as PV. The model for calculation of PV included the variables housing unit, batch (replicate) and group. Production value was calculated using identical feed prices and with the average number of analysed feed units for the two groups without xylanase (112.7 FUgp per 100 kg) as the analysed energy content in the groups with xylanase was approx. 1 FUgp per 100 kg higher than in the feed without xylanase. This procedure was employed to ensure that the pigs' biological response to xylanase inclusion was obtained. Disease and mortality rates were recorded as secondary parameters, and the trial was not designed to detect any differences in these two parameters. Disease recordings and mortality rates were subject to analysis in the same model as PV.

Ten pens were excluded from data processing either due to the fact that the pen in question was a significant outlier or due to inadequate data quality. The affected groups are shown in Appendix 5.

Results and discussion

Nutrient content

Appendix 3 shows the declared and analysed nutrient content of the six diets. For most nutrients, the declared and analysed contents corresponded in all six diets. The analysed content of calcium and phosphorus was lower than declared, but due to the safety margin and since this deficiency was identical in all groups, it did not affect the outcome of the trial. The analysed phytase content was approx. 3 times higher than declared, which is attributed to the fact that the analysis method detects the added as well as the natural content of phytase in the feed.

Porzyme 9302 increased the EDOMi value by approx. 1 percentage point as seen in other trials [13], [14]. BS3 Xylanase did not have the same impact in EDOMi (0-0.45 percentage points).

Particle distribution and enzyme activity

Fine grinding was intended to be 35% above and 65% below 1 mm, while coarse grinding was intended to be 60% above and 40% below 1 mm. The average particle distribution found with a Retsch sieve in ground wheat is shown in Table 4. Coarse as well as the fine grinding was slightly finer than intended, but the difference between the two was as planned.

Table 4. Average particle distribution in ground wheat (Retsch sieve).

Grinding	Fine (2.5 mm sieve)	Coarse (5.5 mm sieve)
Above 2 mm, %	0.3	13.5
1-2 mm, %	27.1	37.4
Below 1 mm, %	72.6	49.1

Average of 9 samples of each type of grinding.

The Bygholm sieve was also used at the first 1-2 rounds of production. At fine grinding, particle distribution averaged 68% below 1 mm and 32% between 1-2 mm, while at coarse grinding particle distribution averaged 51% below 1 mm; 41% between 1 and 2; and 8% above 2 mm. There was no significant difference between the Retsch sieve and the Bygholm sieve in particle distribution when assessed on the basis of such few repetitions of each sieving.

Table 5 shows the average of nine enzyme activities for each of the four groups in which xylanase was added to the feed.

Table 5. Average analysed enzyme activity for BS3 Xylanase and Porzyme 9302, ± standard variation of enzyme activities.

Group	3	4	5	6
Xylanase	BS3 Xylanase (TXU)		Porzyme 9302 (DXU)	
Declared enzyme activity, U/kg	875 TXU/kg		4,000 DXU/kg	
Analysed enzyme activity, U/kg	1,053 ±246	935 ±324	4,151 ±965	3,176 ±625

Average of 9 samples per group.

For both xylanases, enzyme activities varied over the course of the trial in all four diets (Appendix 4). Variations in enzyme activity were also observed when Bergazym P was studied in feed mixed on-farm [4] and when Porzyme 9302 was investigated in ready-mixed feed [6].

The average enzyme activities found during analyses corresponded fairly well with the declared value except for group 6 where activity where found to be lower than declared (Table 5). Previous trials with finishers also found lower activities than declared [2], [3], [6].

Production results

Table 6 shows the production value in relation to grinding and inclusion of xylanase, respectively, along with a comparison of the two or three levels for each factor. Production value was significantly lower ($p<0.0001$) for pigs fed coarsely ground feed compared with pigs fed finely ground feed. This is attributed to a significantly lower gain ($p<0.0001$) and a poorer FCR ($p<0.0001$) as shown in Table 7. Grinding thereby affects FCR in weaners in the same way as in finishers. Production results for each of the six groups are shown in Appendix 5.

No interaction was observed between the factors, which means that the effect of adding xylanase was identical regardless of grinding. Consequently, the effect of adding xylanase was not greater in coarsely ground feed than in finely ground feed, and this corresponds with findings in another finisher trial [3].

Table 6. Production value (PV) and actual PV for weaners for grinding and inclusion of xylanase.

Factor	Grinding		Xylanase			Effect of grinding	Effect of BS3 Xylanase	Effect of Porzyme 9302
Level	Fine	Coarse	None	BS3 Xylanase	Porzyme 9302			
PV per place unit/day, DKK[1)]	1.59	1.50	1.52	1.58	1.55	*** [3)]	* [4)]	NS[5)]
PV index[1)]	100	94	100	104	102			
Actual PV per place unit/day, DKK[2)]	1.78	1.67	1.69	1.76	1.72	No statistical calculations of actual PV		
Actual PV index[2)]	100	94	100	104	102			

1) 5-year prices (September 2006 – September 2011). When comparing production value, there must be a minimum difference for grinding of 2 index points and minimum 3 index points for xylanase for a difference to be significant ($p<0.05$).

2) 5-week prices (wks 23-27, 2012) and price of xylanase as informed by the producers (see Appendix 1).

3) Significant ($p<0.0001$).

4) Significant ($p<0.05$).

5) Not significant.

The addition of BS3 Xylanase resulted in a significantly higher production value ($p<0.05$) compared with feed without xylanase. This difference was caused by a positive impact on gain ($p<0.01$) and on FCR ($p<0.05$) among the pigs given BS3 Xylanase. Despite a numerically higher gain and a better FCR, Porzyme 9302 did not significantly affect the production value.

Table 7. Production results for the entire trial period for grinding and inclusion of xylanase.

Factor	Grinding		Xylanase			Effect of grinding	Effect af BS3 Xylanase	Effect of Porzyme 9302
Level	Fine	Coarse	None	BS3 Xylanase	Porzyme 9302			
Daily gain, g/day	561	543	544	560	553	* 1)	* 1)	NS2)
FCR, FUgp/day	0.99	0.98	0.97	0.99	0.98	NS2)	NS2)	NS2)
FCR, FUgp/kg gain	1.76	1.81	1.80	1.77	1.78	* 1)	* 1)	NS2)

1) Significant ($p<0.05$).

2) Not significant.

The vale 'actual PV per place unit/day' shows the production economy in feeding weaners meal feed with xylanase with today's prices. The additional cost (DKK 5.2 per tonne finished feed) of adding BS3 Xylanase was fully covered by the improvement in gain and FCR, which is illustrated with an index above 100.

Health

Table 8 shows health conditions of the pigs in the trial in relation to the two factors (grinding and xylanase).

Table 8. Health in relation to grinding and inclusion of xylanase.

Factor	Grinding		Xylanase			Effect of grinding	Effect of BS3 Xylanase	Effect of Porzyme 9302
Level	Fine	Coarse	None	BS3 Xylanase	Porzyme 9302			
Treatment for diarrhoea, days per pig	1.82	1.35	1.63	1.52	1.60	* 1)	NS2)	NS2)
Mortality	0.7	1.0	1.2	0.8	0.6	NS2)	NS2)	NS2)
Dead and moved to hosp.pen, %	3.9	6.0	5.4	4.6	4.7	* 1)	NS2)	NS2)

1) Significant ($p<0.05$)

2) Not significant.

Treatments for diarrhoea averaged 1.6 days per pig. Pigs fed finely ground meal feed had significantly more treatment days for diarrhoea than pigs fed coarsely ground feed. The outcome of a weaner trial comparing meal with pelleted feed also revealed fewer treatments among pigs fed meal feed with a coarser particle distribution than pelleted feed [16]. In another trial, the impact of feed on the gastrointestinal tract was analysed by comparing coarsely ground meal feed with finely ground pelleted feed for weaners. Results revealed that coarsely ground meal feed makes it more difficult for pathogen bacteria to pass the stomach and colonize in other parts of the intestinal tract [17].

Dead and removed pigs averaged 4.9% for all six groups. Mortality averaged 0.9% with no differences between the groups. However, the number of dead pigs and pigs moved to hospital pens differed significantly ($p<0.01$) between the group with coarsely ground feed and finely ground feed. The majority of those moved were pigs fed coarsely ground feed. This does not correspond with the fact that this was also the group with the fewest treatments for diarrhoea. This may, however, be explained by the fact that pigs moved were small wherefore the herd manager decided to move them to a hospital pen.

Gastric changes

Examinations generally revealed very few changes in the white part of the stomach among the examined pigs. Forty of 46 stomachs were scored index 0, which equals a normal stomach with no changes. Six were scored between index 1 and 6. An index below 6 is not considered to be of significant importance to the pig as research has demonstrated that daily gain is not affected until the index reaches 6 or more [8], [18]. It is known from finisher trials that meal feed protects against gastric changes, and this is probably the reason why very few changes were found in this trial. Results did not indicate any significant differences in gastric health regardless of whether pigs were fed finely ground or coarsely ground meal feed. However, 46 stomachs are not enough to make any conclusions on small differences in gastric health.

Conclusion

The effect of adding xylanase to pig feed did not vary regardless of whether the feed was finely ground or coarsely ground. This trial did thereby not confirm the hypothesis that the addition of xylanase may affect the reduced FCR seen when feeding coarsely ground meal feed.

Production value was significantly higher among weaners fed finely ground feed compared with coarsely ground feed, which is attributed to a higher daily gain (approx. 3%) and a better FCR. BS3 Xylanase also positively affected the pigs' daily gain and FCR by 2-3% compared with the pigs fed feed without xylanase, which was reflected in a significantly higher production value for the pigs fed BS3 Xylanase. The additional cost of adding BS3 Xylanase to pig feed was fully covered by the improved gain and FCR. Results revealed no significant effect of adding Porzyme 9302.

The fewest treatments for diarrhoea were seen in the group fed coarsely ground feed. Results revealed very few changes in the white part of the stomach in all examined pigs regardless of feed.

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Participants

Technical support: Per Mark Hagelskjær, Pig Research Centre

Statistical support: Jens Vinther, Pig Research Centre

Trial no.: 1129

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Appendix 1

Xylanases - product information provided by the producers.

Product	BS3 Xylanase
Producer	DuPont Nutrition Bioscience ApS Edwin Rahrs Vej 38 8220 Brabrand
Content	Endo-1,4-beta-xylanase (IUB No. 3.2.1.8). BS3 Xylanase has a pH optimum at 6.0.
Guiding price	DKK 26 per kg (end June, 2012). In this trial, 200 g enzyme product was added per tonne feed to obtain the planned activity of 875 TXU/kg feed, corresponding to 100% of maximum inclusion. The feed consequently increased by DKK 5.2 per tonne finished feed.

Product	Porzyme 9302
Producer	DuPont Nutrition Bioscience ApS Edwin Rahrs Vej 38 8220 Brabrand
Content	Endo-1,4-beta-xylanase (IUB No. 3.2.1.8). Porzyme 9302 has a pH optimum at 4.5-5.0.
Guiding price	DKK 26 per kg (end June, 2012). In this trial, 200 g enzyme product was added per tonne feed to obtain the planned activity of 4,000 DXU/kg feed, corresponding to 100% of maximum inclusion. The feed consequently increased by DKK 5.2 per tonne finished feed.

Appendix 2

Ingredients, %

Group	1 + 2	3 + 4 + 6	5
Wheat	67.421	67.383	67.481
Soybean meal	22.544	22.557	22.523
Potato protein	2.657	2.653	2.662
Vegetable oil	2.749	2.758	2.734
Feed lime	1.534	1.534	1.534
Mono calcium phosphate	1.434	1.434	1.434
Salt	0.220	0.220	0.219
Lysine	0.430	0.429	0.430
Methionine	0.131	0.131	0.131
Threonine	0.102	0.102	0.102
Tryptophan	0.012	0.012	0.012
Valine	0.021	0.021	0.021
Vitamin/mineral mix	0.400	0.400	0.400
Vitamin E	0.012	0.012	0.012
Phyzyme XP 4000 TPT[1)]	0.013	0.013	0.013
Sodium acid carbonate	0.273	0.273	0.273
Xylanase	-	0.020	0.020
Microgrits (coloured particles)	0.05	0.05	-

1) Adds 500 FTU/kg feed.

Appendix 3

Declared and analysed nutrient content.

Group	1-6	1	2	3	4	5	6
	Calculated / declared	Analysed[1)]	Analysed[1)]	Analysed[1)]	Analysed[1)]	Analysed[1)]	Analysed[1)]
Crude protein, %	19.9	19.5	19.1	19.6	19.5	19.7	19.3
Fat, %	4.5	4.5	4.5	4.6	4.5	4.6	4.4
Ash, %	6.1	5.2	5.1	5.2	5.0	5.2	5.0
Water, %	13.1	11.6	11.7	11.7	11.9	11.7	12.0
EDOM	91.9	91.3	91.1	91.8	91.2	91.5	91.3
EDOMi	84.8	82.3	83.0	83.1	82.6	83.6	83.7
FUgp per 100 kg	113.0	112.4	113.1	113.4	112.6	114.0	113.8
Calcium, g/kg	9.95	8.7	8.5	8.6	8.5	8.8	8.0
Phosphorus, g/kg	6.60	6.4	6.3	6.4	6.3	6.4	6.1
Lysine, g/kg	13.60	13.8	13.3	13.7	13.4	13.7	13.5
Methionine, g/kg	4.22	4.1	4.0	4.2	4.1	4.2	4.1
Cystine, g/kg	3.35	3.4	3.3	3.3	3.3	3.3	3.3
Threonine, g/kg	8.32	8.3	8.0	8.3	8.3	8.4	8.2
Phytase, FTU/kg	500 [2)]	1,381	1,452	1,406	1,399	1,414	1,374

1) Crude protein, fat, ash, water, EDOM, EDOMi and FUgp: average of 9 analyses. Calcium and phosphorus: average of 8 analyses. Amino acids and phytase: average of 5 analyses.

2) Added inclusion rate.

Appendix 4

Enzyme activity recorded for each of the production rounds and average recorded enzyme activity.

Group	3	4	5	6
Xylanase	BS3 Xylanase activity, TXU/kg		Porzyme 9302 activity, DXU/kg	
Declared activity	875	875	4,000	4,000
1st round	723	796	2,872	4,017
2nd round	1,169	866	3,959	3,855
3rd round	962	729	5,331	3,424
4th round	1,179	1,048	3,847	3,101
5th round	883	949	4,286	2,680
6th round	1,137	621	5,956	3,187
7th round	765	668	4,214	2,059
8th round	1,508	1,697	3,321	2,691
9th round	1,153	1,039	3,577	3,573
Average enzyme activity ± standard variation	1,053 ±246	935 ±324	4,151 ±965	3,176 ±625

Appendix 5

Production results (rough average).

Group	1	2	3	4	5	6
Grinding	Fine	Coarse	Fine	Coarse	Fine	Coarse
Xylanase	None	None	BS3 Xylanase	BS3 Xylanase	Porzyme 9302	Porzyme 9302
Blocks	57	59	59	61	61	59
Pigs	716	749	759	781	781	754
Start weight, kg	8.2	8.3	8.2	8.2	8.3	8.2
End weight, kg	30.6	30.2	31.1	30.3	30.8	30.3
Daily gain, g/day	553	542	568	551	565	542
Feed intake, FUgp/day	0.98	0.98	0.99	0.99	0.99	0.98
FCR, FUgp/kg gain	1.78	1.81	1.75	1.80	1.75	1.81