The effects of adding Turbozyme 160 to starter diets for pigs.

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Abstract.
Two experiments were conducted in order to investigate the role of Turbozyme 160 in starter diets for piglets. In exp. 1, 150 pigs were weaned at 21 days of age and assigned randomly to one of five treatment groups. Pigs in group 1 were fed a high density starter diet and served as the control group. From the control diet, 4 additional diets were created by adding 0.05%, 0.1%, 0.15%, and 0.2 % of Turbozyme 160, respectively. These diets were fed to pigs on experimental groups 2, 3, 4, and 5, respectively. Daily growth rate, daily feed intake and feed utilization was calculated over a three week experimental period. Significant improvements in growth rates during the first two weeks of the experimental period were obtained by pigs receiving 0.1%, 0.15%, or 0.2% Turbozyme 160 in the diet compared to pigs who did not receive the enzyme product. At the end of the experiment, only the differences in growth observed in pigs receiving 0.1% or 0.2% Turbozyme 160 were significantly different when compared to the negative control diet. It was concluded from this experiment that Turbozyme 160 is efficient in improving pig performance during the post-weaning period if added to the diets at levels at or above 0.1%. The addition of 0.1% of the product seemed to be equally efficacious to higher inclusion levels. In exp. 2, 120 newly weaned pigs of approximately 21 days of age were used in a 2 x 2 factorial design, in order to investigate the effect of adding 0.1% Turbozyme 160 to starter diets in a traditional complex-diet feeding program and in a less expensive and simpler feeding program over a 35 day experimental period. In contrast to experiment 1, no improvement in pig performance was observed on the addition of Turbozyme 160 to the complex diets in this experiment. However, a significant increase in growth rate was experienced when pigs fed the simpler diets received supplemental Turbozyme 160. Furthermore, pigs fed the simpler diets supplemented with Turbozyme 160 grew at a rate not significantly different from pigs fed the complex and more expensive diets. The result of this experiment support the hypothesis that feeding programs for weanling pigs can be based on less expensive feed ingredients if Turbozyme 160 is added to the diets.

Background

The early-weaned pig often experiences a post-weaning growth depression caused by the change from sow milk to complex, but less digestible diets based on carbohydrate and plant protein. This is explained by decreased villus height and increased crypt depth in the small intestine due to a cell-mediated immune response caused by feeding vegetable proteins (Li et al., 1990). In addition, environmental as well as social changes occur at

weaning, making this one of the most stressful periods in the pig's life (Brumm, 1989). In many circumstances the pig's natural enzyme levels are too low or the requisite enzymes are missing. This is especially true in the newly weaned pig, where the lag of digestive enzymes is well established (Chapple et al., 1989). Hence, it is imperative that starter diets be designed to match the digestive capabilities of the young pig and to reduce unneeded strain on the immune system (Goodband et al., 1991). Therefore, feedstuffs with a high digestibility are usually used in starter diets in consideration of the pig's limited enzyme production at this stage. However, such diets are usually relative expensive.

Exogenous enzymes have the potential of increasing digestibility of feedstuffs by degrading carbohydrates such as raffinose-oligosacharides and NSP-polysacharides, which are poorly degraded by the pig's enzymes (Knudsen, 1993). By doing so, otherwise indigestible carbohydrates becomes available for absorption in the small intestine, and, in addition, fats and amino acids may be released from a polysacharide matrix and hence, available for absorption as well. If this hypothesis is valid, it would be anticipated that feedstuffs that are less digestible - and less expensive - than traditional starter feed ingredients could be used in starter diets if appropriate exogenous enzymes are added to the diet. By this, the total feed costs during the starter period might be reduced.

Previous research has demonstrated that the inclusion of an exogenous enzyme mix in starter diets under certain conditions can improve digestibility and growth performance (Rotter, 1990). However, results obtained so far have been variable and inconsistent (Easter et al., 1993). Maxwell et al.(1994) examined the commercial enzyme product Turbozyme 160 (JEFO, Canada), and a consistent positive response in average daily pig growth rate and efficiency of feed utilization was obtained when fed to pigs during the post-weaning period. In these studies, Turbozyme 160 was included at a level of 0.2% in the diets, however, is was not investigated whether a similar response could be obtained at lower inclusion levels of Turbozyme 160.

Objectives.

It was the objectives of the present studies to investigate the possible growth promoting effect of Turbozyme 160 in starter diets for pigs, and to determine the optimum inclusion rate of the enzyme mixture. In addition, it was also the objective to investigate the interaction between Turbozyme 160 addition and types of diets.

Materials and methods.

Animals and housing. In both experiments, pigs arising from the mating of Camborough 15 Females to PIC Line 326 boars were weaned at 21(±2) days of age, and assigned to their respective treatment groups. Allocations to treatments were made from outcome groups formed by priority of : 1) genetic background, 2) sex, and 3) weight. There were five pigs per pen, and each pen was considered the experimental unit.

Pigs were housed in the nursery building at the Swine Research Center, University of Illinois. These facilities are similar to a typical commercial production unit. The pens have expanded metal wire floors and solid side walls. Urine as well as feces fall through the floor openings into an underfloor collection pit. Each pen is 1.22 by 1.22 m in dimension providing each pig 0.3 sq.m. Pigs were given ad libitum access to feed from a five space standard nursery feeder. Water was provided ad lib. from a biting nipple suspended on the

pen sidewall. The nursery is heated by a natural gas combustion unit and ventilated with sidewall extraction fans.

Experimental designs. In exp.1, four different inclusion levels of Turbozyme 160 were evaluated during a three week post-weaning test period against a control diet. Thus, in total there were five treatment groups arranged in the design shown in table 1.

Table 1. Experimental design, exp.1.

Group #	1	2	3	4	5
Turbozyme 160, %	0	0.05	0.1	0.15	0.20

In exp. 2, the effect of adding Turbozyme 160 to starter diets for pigs was tested in either a complex, highly-digestible feeding sequence of diets or in a simpler and less-digestible feeding program fed to pigs for five weeks post weaning. Turbozyme 160 was added to both of the two programs at a level of 0.1%. The four treatment groups were arranged in the design shown in table 2.

Table 2. Experimental design, exp.2.

Group #	1	2	3	4
Feeding Program	Complex	Complex	Simple	Simple
Turbozyme 160	-	+	-	+

Diets. In exp. 1, pigs were fed the same diet during the entire 21 day experimental period. This diet was a commercial type starter diet containing corn, soybean meal, milk products and spray dried porcine plasma (SDPP). The diet was formulated to contain 3.3 Mcal ME per kg and 1.4 % total lysine.

In exp. 2, pigs were fed a phase 1 diet during the initial two weeks post weaning, and a phase 2 diet during the remaining three weeks of the experimental period. In total, therefore, eight different diets were used. The phase 1 diets were formulated to contain 3.4 Mcal ME per kg and 1.4 % lysine. The phase 2 diets contained 3.38 Mcal and 1.1 % lysine. In the complex phase 1 diets, 15 % rolled oats and 7.5% spray-dried porcine plasma (SDPP) was included, whereas no rolled oats and only 4 % SDPP was included in the simple phase 1 diets. Similarly, in the complex phase 2 diets, 2.5 % blood meal and 5% fish meal was included, whereas neither blood meal nor fish meal were included in the simple phase 2 diets.

In both experiments, all indispensable amino acids were added at an ideal ratio relative to lysine (Baker and Chung, 1992). Other nutrients were added at the levels recommended by NRC (NRC, 1988). Copper Sulfate (0.05 %) and ASP 250 (0.2 %) were added as growth promoters in all diets. Following mixing, all diets were pelleted through a 3 mm die, and pigs were allowed ad libitum intake of their diet.

Data collection and statistical analysis. Pigs were weighed individually one and two weeks post weaning as well as at the end of the experiment. The amount of fresh feed given to each pen was recorded daily, and the consumption per pen was calculated by weighing the

feed in the feeders, when the pigs were weighed. There was no mortality during the experimental period on either experiment.

After termination of the experiment, the weight gain and feed intake data were summarized and feed efficiency for treatment groups was calculated. The treatment effects on the response variables were analyzed by "Repeated Measure Analysis" under GLM procedure of SAS statistical package (SAS,1987).

Results.

The results from the two experiments are given in table 3 and 4, respectively.

Table 3. Performance of pigs in experiment 1.*

Group	1	2	3	4	5	
Enzyme,%	0	0.05	0.1	0.15	0.20	
Week #1.						s.e.
ADG, g[1]	259^{ab}	241^{a}	294^{b}	282^{ab}	260^{ab}	21
ADFI, g[2]	251^{ab}	217^{a}	276^{b}	261^{b}	244^{ab}	17
GF, g/kg[3]	1021^{a}	1118^{a}	1062^{a}	1080^{a}	1082^{a}	42
Week #2.						
ADG, g.	304^{a}	328^{ab}	397^{c}	390^{bc}	421^{c}	28
ADFI, g	419^{ab}	406^{a}	475^{b}	482^{b}	483^{b}	27
GF, g/kg	721^{a}	803^{ab}	840^{b}	809^{ab}	880^{b}	42
Week #3.						
ADG, g.	368^{a}	437^{ab}	442^{ab}	377^{a}	478^{b}	40
ADFI, g	455^{a}	487^{ab}	558^{bc}	475^{a}	604^{c}	33
GF, g/kg	800^{a}	894^{a}	792^{a}	755^{a}	789^{a}	57
Week #1+2.						
ADG, g.	281^{a}	284^{a}	346^{b}	337^{b}	341^{b}	22
ADFI, g	335^{ab}	311^{a}	376^{b}	372^{b}	363^{b}	21
GF, g/kg	835^{a}	913^{b}	921^{b}	905^{b}	945^{b}	28
Week # 1-3.						
ADG, g.	311^{a}	336^{ab}	378^{b}	350^{ab}	386^{b}	23
ADFI, g	375^{a}	370^{a}	437^{bc}	403^{abc}	444^{bc}	23
GF, g/kg	821^{a}	907^{b}	865^{ab}	844^{ab}	875^{ab}	30

* Values with different superscripts are significantly different ($p<0.1$).

1. ADG = Average daily gain.
2. ADFI = Average daily feed intake.
3. GF = Gain : feed.

Table 4. Performance of pigs in exp. 2.*

Treatment #	1	2	3	4	
Turbozyme	-	+	-	+	
Week #1.					s.e.
ADG, g.[1]	212^{a}	195^{a}	145^{b}	186^{a}	15
ADFI, g[2]	219^{a}	207^{a}	148^{b}	190^{b}	14
GF, kg/kg[3]	0.971	0.947	0.954	0.982	0.061
Week #2.					
ADG, g.	277^{ab}	257^{bc}	217^{c}	248^{bc}	17
ADFI, g	389^{a}	370^{ab}	304^{c}	342^{bc}	19
GF, kg/kg	0.710	0.692	0.722	0.729	0.039
Week 1+2					
ADG, g	244^{a}	226^{a}	181^{b}	217^{a}	14
ADFI, g	304^{a}	288^{ab}	226^{c}	266^{b}	15
GF, g/kg	0.801	0.782	0.801	0.817	0.032
Week 3 to 5.					
ADG, g.	466	448	448	479	23
ADFI, g	690	698	669	675	33
GF, g/kg	0.676^{ab}	0.642^{a}	0.673^{ab}	0.713^{b}	0.024
Week 1 to 5.					
ADG, g.	378	359	341	374	17
ADFI, g	536	534	491	511	24
GF, g/kg	0.705^{ab}	0.673^{a}	0.697^{ab}	0.734^{b}	0.023

* Values with different superscripts are significantly different ($P<0.1$).

1. ADG = Average daily gain.
2. ADFI = Average daily feed intake.[1]3. GF = Gain : feed.

In exp. 1, only treatment group 3, significantly improved growth rate during the first week post weaning (Table 3). However, a significant improvement in growth rate ($P<0.05$) during the second week was obtained by treatment groups three, four, and five. Treatment groups three and five showed an improved ($P<0.05$) gain:feed ratio during the second week post weaning compared to group one, and all the Turbozyme-supplemented groups showed an increase ($P<0.1$) in the gain:feed ratio over the combined week one and week two post-weaning period. During the whole experimental period (week 1-3 post-weaning), all the Turbozyme 160 supplemented groups showed a numerical increase in growth rate compared to the non supplemented group. However, only the growth rates obtained for group 3 and 5 were significantly higher than that obtained on the negative control group ($P<0.05$). Also, the feed intake for group three and five was higher compared to the negative control group ($P<0.1$), whereas no differences in gain:feed ratios were obtained for the entire experimental period ($P>0.1$).

In exp. 2, no significant differences ($P>0.1$) in growth rate, feed intake, or gain:feed ratio were obtained between the two groups on the complex starter diets (group 1 and 2) during any of the experimental periods. Pigs on the simple starter diets grew significantly ($P<0.1$) faster during the first week and during the first two weeks combined, if

Turbozyme 160 was added to the diet (Group 4 vs. group 3). Also during week 3 to 5, pigs receiving Turbozyme 160 in the simple diets grew faster than pigs receiving unsupplemented diets, although this difference was not significant ($P=0.19$). Pigs on treatment four also had larger feed intake during the first to weeks of the experiment ($P<0.1$) than had pigs on treatment three, whereas no differences in the gain:feed ratio were detected between the two groups. Pigs receiving unsupplemented diets grew significantly faster ($P<0.05$) during week one and week two if they were fed the high density diet (group 1 vs. group 3). During week 3-5 the difference was not significant ($P>0.1$). Similarly, pigs fed diet 1 had a higher daily feed consumption than had pigs fed diet 3, although the difference was only significant during week one and week two ($P< 0.05$). Due to the increase in growth rate observed on pigs fed the Turbozyme 160 supplemented low density diet (group 4), these pigs grew at the same rate as did pigs fed the complex diets, and there were no differences in feed intake or gain:feed ratio between group four and the two groups on the complex diets ($P>0.1$).

Discussion and conclusions.

The potential of exogenous enzymes to improve pig performance is based on the hypothesis that nutrient digestibility can be improved by enzyme addition (Chesson, 1987; Li et al.,1994). Maxwell et al (1994) reported increases in daily gain (7.7%, 6.2%, and 23.3%) and in the gain:feed ratio (7.2%, 7.1%, and 11.9%) on the supplementation of starter diets with 0.2% Turbozyme 160 during the first two weeks post-weaning in three different experiments, indicating that digestibilities of the diets were indeed improved. In the present investigations, daily gain was improved by 8%, 21.5%, 12.5%, and 24.1%, respectively, by the addition of Turbozyme 160 at 0.05%, 0.1%, 0.15%, and 0.2% of the diets during the 3 week post-weaning period (exp.1). Likewise, gain:feed was improved by 10.9%, 6.1%, 2.4% and 7.3% respectively. These results agrees with those obtained by Maxwell (1994). However, the improvement in gain:feed was not significant, and this improvement can not entirely explain the magnitude of the increase in growth rate. No significant differences between pigs receiving 0.1%, 0.15% or 0.2% Turbozyme in the diets were observed in exp. 1.

In exp. 2, no increase in performance was obtained when Turbozyme 160 was added to the complex diet. The reason for this might be that higher density diets were used in this experiment compared to exp. 1. The value of feeding complex, high density diets compared to low-density diets during the post weaning period was confirmed in this study. This finding is in agreement with previous reports showing that 7.5% SDPP and rolled oats in the phase 1 diet improves pig performance compared to diets with a lower inclusion level of these two ingredients. (Gatnau et al. 1991, Gatnau et al., 1993). However, the study also revealed that relatively simple starter diets can be improved when supplemented by Turbozyme 160. The addition of Turbozyme 160 to the simple diet sequence elicited a 19.9 % increase in growth rate during the first two weeks of the experiment, and a 9.7 % increase during the entire experimental period. These values are close to those reported by Maxwell et al. (1994), and also agrees with those obtained by Hansen (1991). The increases in growth rates can be explained by increases in feed intake of 17.7 % during the first two weeks of the study and 4.1 % during the entire study.

If the effect of adding enzymes to diets should be entirely explained by an increased digestibility of the diets, an increased feed utilization - and consequently an increase in the gain:feed ratio - would be expected. In both experiments, the gain:feed ratios were improved numerically by the addition of Turbozyme 160 to the diets, but these differences were not significant ($P>0.1$). Thus, the main reason for the improvement in growth rates was the increase in feed intake. The reason for this may have been due to changes in digesta viscosity in the GI-tract. Such a response has been reported by Graham et al. (1994), and Graham et al. (1986).

In conclusion, the two experiments have shown that Turbozyme 160 has the potential of improving performance of pigs if added to the post weaning diets. The response seems to be elevated in pigs fed relatively simple diets, thus, the costs of starter diets may be reduced without reducing pig performance, if Turbozyme 160 is added to the diets. The addition of 0.1 % Turbozyme was shown to be equally efficient to higher inclusion rates.

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