2002 Annual Report

Swine Section

Dickinson Research Extension Center
1089 State Avenue
Dickinson, ND 58601

Effects of Fibrozyme and Phytase Enzymes on Growing-Finishing Pig Performance in Field Pea-Canola Meal Supplemented Diets

Interim Progress Report

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Abstract

Supplemental phytase improves phosphorus availability and subsequent digestibility. Research with ruminants direct-fed protected fibrolytic enzymes has shown improved organic matter digestibility, growth performance in steers and milk production in dairy cattle. Field peas and canola meal have been proven to be complementing sources of protein and energy. The purpose of this study was to determine the potential for improved pig performance resulting from fibrozyme activity when fed with and without phytase enzyme in field pea-canola meal supplemented corn-based growing-finishing diets. Allzyme phytase and fibrozyme were furnished by Alltech Biotechnology, Inc. Ninety (PIC - C22 x 356) barrows and gilts were assigned to dietary treatments: 1) Corn-SBM control, 2) Corn-Pea-Canola meal, 3) Corn-Pea-Canola Meal + fibrozyme, 4) Corn-Pea-Canola Meal + phytase, 5) Corn-Pea-Canola Meal + phytase + fibrozyme. The corn-SBM control diet was pelleted and all other diets were prepared in meal form. Compared to diets prepared in meal form, pigs receiving the pelleted corn-SBM control diet consumed less feed (P= .0001), grew at the fastest rate (P=.001), were more efficient (P= .001), and had heavier hot carcass weight (P=.0001) . Diets with enzymes were formulated to contain 500 U/kg of phytase and 4000 IU/kg of fibrozyme. Correspondingly, in the presence of phytase, dietary available phosphorus requirement was reduced 0.1%. Growth performance and carcass characteristics among pigs receiving the corn-pea-canola control diet and the same diet with added phytase were similar. Feed intake for pigs receiving Allzyme Phytase was greater and feed consumption per pound of gain was greater. Growth performance and

carcass characteristics among pigs receiving Fibrozyme was similar to control pigs for most criteria measured. Feed efficiency (P=.042) and hot carcass weight (P=.045) were improved in the presence of Fibrozyme. When two enzymes were fed together there was a trend toward improved ADG, feed efficiency (P=.042), and hot carcass weight (P=.045). Partial economic analysis for returns over feed and feeder pig costs resulted in comparable returns from the pelleted external control and the test diet containing both enzymes. These data suggest that fibrozyme+phytase enzyme addition can reduce supplemental phosphorus requirement, improve performance efficiency and hot carcass hot weight, and may contribute to increased enterprise returns when added to corn-based pea/canola meal growing-finishing diets.

Objectives

- Evaluate the biological benefit with respect to growth responses and carcass characteristics following xylanase/cellulase and phytase enzyme treatments in field pea/canola meal supplemented corn-based growing-finishing pig diets.

- Based on the results of objective one, establish ingredient price sensitivity modulation and economic implications for using phytase and Fibrozyme enzyme preparations.

Introduction and Purpose

Field pea and canola production in ND have increased significantly becoming important rotation crops with respect to disease, soil fertility, and income diversity. Nutritionally, peas are an excellent replacement for soybean meal in barley-based growing-finishing diets provided synthetic amino acids, especially methionine, are added to the diet (Landblom and Poland, 1997). For the pig, peas are a good source of energy and lysine (Harrold, et al., 1999), show moderate phosphorus availability but are severely deficient in methionine. Conversely, canola meal, a co-product of the canola oil industry, is a more fibrous feedstuff containing 9.6% less energy than field peas and 13-19% less energy than soybean meal but has relatively high levels of available sulfur containing amino acids (methionine and cystine). Canola meal contains one of the highest total phosphorus levels (1.01%) among feedstuffs fed to swine. However, the majority of this phosphorus is present as phytic acid and is unavailable for intestinal absorption.

Combining peas and canola meal in diets to be fed to swine represents a complementary nutrient relationship since peas offset a portion of the digestible energy and phosphorus deficiencies of canola meal, and canola meal balances the sulfur-containing amino acid deficiency of peas. The depressed net energy value of canola meal, compared to other protein sources, limits the level of meal that can be incorporated into pig diets, especially diets for pigs weighing less than 63.5 kg. Recent research with protected enzymes in ruminants may have application in the diets of monogastric animals such as the pig, and, when combined with phytase enzymes, may further enhance energy, protein, and phosphorus availability reducing manure nutrient levels (primarily N and P)and improve the subsequent environmental impact of manure application to soils.

Recent advances facilitated by molecular biology have resulted in bacterial and fungal enzymes resistant to gastrointestinal degradation. This enzyme resistance to hydrolysis allows direct-fed enzymes to enhance the digestion process. In addition to proteases, lipases, and phytases, many enzymes available today are carbohydrate component specific. Specific target substrates for non-ruminants include the largely indigestible non-starch polysaccharides (NSP) (e.g., cellulose, hemicellulose, and lignin). Since monogastric animals lack the necessary digestive enzymes to reduce NSP, the addition of exogenous enzymes capable of resisting normal digestive processes have the potential to enhance energy availability.

The concept of using enzyme products as animal feed additives has attracted considerable interest within the feed industry as a means for improving animal performance, lowering supplemental nutrient requirements, and lowering potential for soil overloading from manure.

Enzyme preparations with xylanase and cellulase activity that degrade cell walls are capable of hydrolyzing fiber components in the large intestine. Recent research with ruminants given direct-fed preparations of fibrolytic enzymes have demonstrated improved volatile fatty acid (VFA) production resulting in increased digestion, growth performance and milk production (Beauchemin et al., 1995; Feng et al., 1996; Lewis et al., 1996; Howes et al., 1998). This fibrolytic enzyme action associated with improved rumen fiber degradation resulting in better DM intake and growth performance in cattle may be beneficially used to improve fiber digestibility of canola meal and subsequently improved energy extraction in growing-finishing swine diets. Increased volatile fatty acid (VFA) production in ruminant animal diets is promising, however, the current literature is limited with respect to the effects of fibrolytic enzyme preparations on the release of simple sugars or VFA production in swine. It is suggested that a direct-fed enzyme preparation containing xylanase and cellulase (Fibrozyme) activity in swine diets formulated with canola meal may result in the release of simple sugars for absorption, anaerobic fermentation of the fibrous components of canola meal, or both.

A large body of data evaluating the use of phytase enzymes indicates that improved bioavailability of phosphorus, calcium, zinc, protein/amino acids and energy may be expected when adequate amounts of phytase are fed (Kornegay and Qian, 1996; Yi et al., 1996; Kornegay et al., 1998). A survey of phosphorus bioavailability for a number of feedstuffs commonly fed to swine reveals that 60-80% of the phosphorus present is bound as phytic acid (phytate) and is unavailable for intestinal absorption. Grains, seeds and oil seed co-products (such as canola meal and soybean meal) contain varying amounts of phytic acid which has a high potential to form metal-ion chelates in the digestive tract. Calcium, zinc, copper, cobalt, manganese, iron and magnesium cations, at neutral pH, complex with phytic acid to form insoluble salts that are largely unavailable for intestinal absorption. Phytic acid can also reduce protein digestion and absorption through phytate-protein/amino acid or phytate-mineral-protein/amino acid complexes and can interfere with intestinal pepsin and trypsin enzyme activity. Dietary addition of microbial phytase, therefore, not only lowers the requirement for supplemental phosphorus, but to also enhance the availability of calcium, zinc, amino acids, and carbohydrates for intestinal digestion and subsequent absorption.

The purpose of this project is to quantify the potential for enhanced nutrient retention (energy, nitrogen, phosphorous, and calcium) resulting from protected xylanase/cellulase (Fibrozyme) enzyme activity when fed with and without phytase enzyme in canola meal/field pea supplemented corn-based diets fed to growing-finishing pigs. And, using replicated growing-finishing trials, evaluate growth response, carcass characteristics, and ingredient price sensitivity following enzyme treatment.

Materials and Methods

Ninety (PIC C-22 X 256) barrows and gilts were assigned to an external control group and four experimental dietary treatments in a complete randomized design to evaluate enzyme effects on growth and carcass characteristics when fed in low-input outdoor housing system.

Treatments:

1. Corn/soy external control (Pelleted)

2. Corn/Pea/Canola Meal (Meal)

3. Corn/Pea/Canola Meal + Fibrozyme®

4. Corn/Pea/Canola Meal + Allzyme Phytase®

5. Corn/Pea/Canola Meal + Fibrozyme® + Allzyme Phytase®

It was assumed phytase would increase phosphorus content 0.1%, therefore, dietary requirements for available phosphorus were reduced 0.1%. Calcium:phosphorus ratios of approximately 1.1:1.0 were specified for diets that did not contain phytase. When phytase was present in the experimental formulations, absolute levels of calcium were maintained relative to other diets formulated for that growth phase.

Enzyme Inclusion: Phytase - 500 U/kg; Fibrozyme - 4000 U/kg

Three phase diets evaluated were formulated to meet or exceed NRC (1998) recommendations (Table 1).

Measurements:

- Growth - gain, feed intake, feed efficiency
- Carcass - hot carcass wt., fat depth, loin depth, percent yield, percent lean, fat-free lean index
- Pigs slaughtered at John Morrell & Co., Sioux Falls, SD (Fat-O-Meter measurements)

- Economic - feed cost/pound of gain, lean premium, carcass value, treatment return over feed and feeder pig ($45.00)

- Data analyzed as a completely randomized design (SAS, 1996).

Results

1. No interactions were measured.

2. Compared to meal diets, pigs receiving a pelleted external control consumed less feed (P=.0001), grew at the fastest rate (P=.001), were more efficient (P=.001), and had heavier hot carcass weight (P=.001). (Tables 2 & 3)

3. Growth performance and carcass characteristics among pigs receiving a reduced phosphorus diet plus Allzyme Phytase® performed similarly to control pigs. Feed intake was greater for pigs receiving Allzyme Phytase® and feed consumed/kg of gain was greater. (Tables 2 & 3)

4. Growth performance and carcass characteristics among pigs receiving Fibrozyme® were similar to control pigs for most criteria measured. Feed efficiency (P=.042) and hot carcass weight (P=.045) improved in the presence of Fibrozyme. (Tables 2 & 3)

5. When the two enzymes Allzyme Phytase® and Fibrozyme® were fed together, there was a trend toward improved ADG, feed efficiency(P=.042), and hot carcass weight (P=.045). (Tables 2 & 3)

6. Partial economic analysis for return over dietary cost and feeder pig resulted in comparable returns from the pelleted external control and the treatment in which Allzyme phytase® and Fibrozyme® were fed together. (Table 4)

Conclusion

These data suggest that dietary enzymatic enhancement with the enzymes Fibrozyme and Allzyme Phytase can reduce supplemental phosphorus requirement, improve performance efficiency and may contribute to increased enterprise returns when added to corn-based pea/canola meal growing-finishing pig diets.

Acknowledgment

This material is based upon work supported by the Cooperative State Research, Education and Extension service, U.S. department of Agrivculture, under Agreement No. 00-34216-8980. Enzymes were provided by Alltech Biotechnology, Inc., Nicholasville, KY.

Table 1. Feeding phase diet specifications.

Phase	ME/kg	C. Prot.	Lysine	Sulfur AA	Threo.	Trypto.	Calcium	Total Phos.	Avail. Phos.
Grow 1	3150	18.4	1.1	0.66	0.72	0.23	0.67	0.62	0.30
Grow 2	3150	15.7	0.9	0.54	0.59	0.20	0.58	0.53	0.25
Finish 1	3150	14.3	0.8	0.48	0.52	0.18	0.57	0.52	0.25

Table 2. Effect of enzyme on growth and feed efficiency.

	Corn/ Soy Ctrl	Pea/C. Meal Ctrl	Pea/C. Meal + Fibro-zyme	Pea/ C. Meal + Phytase	Pea/C. Meal + Fibrozyme + Phytase	Pellet vs Meal Diets	Pellet vs Pea/C. Meal Ctrl.	Effect of Phytase	Effect of Fibro-zyme	Inter-action
Physical Form	**Pel**	**Meal**	**Meal**	**Meal**	**Meal**					
Growth Summary:										
No.	18	18	18	18	18					
Days Fed	88	88	88	88	88					
Initial Wt, lb	67.2	66.3	67.3	67.3	67.8					
Final Wt. lb	292.5^{c}	260.2^{b}	268.4^{ab}	268.6^{ab}	274.2^{a}	.0075	.0034	.128	.240	.607
Gain, lb	225.3^{c}	193.9^{b}	201.1^{ab}	201.3^{ab}	206.4^{a}	.0006	.0006	.19	.21	.82
ADG, lb	2.56^{c}	2.20^{b}	2.29^{ab}	2.29^{ab}	2.35^{a}	.0006	.0006	.19	.21	.82
Feed Summary:										
Fd/Hd, lb	490.8	557.5	550.6	577.4	560.8					
ADFI, lb	5.58^{c}	6.34^{ab}	6.26^{b}	6.56^{a}	6.37^{ab}	.0001	.0002	.088	.172	.561
F:G, lb	2.18^{c}	2.88^{a}	2.74^{ab}	2.88^{a}	2.72^{b}	.0001	.0001	.878	.042	.859

Fd Cst/Hd, $	34.32	32.74	34.03	34.76	34.78					
Fd:Ga Cost, $	.1523	.1688	.1691	.1727	.1685					

Table 3. Effect of enzyme on carcass characteristics.

	Corn/ Soy Ctrl	Pea/C. Meal Ctrl	Pea/C. Meal + Fibro-zyme	Pea/ C. Meal + Phytase	Pea/C. Meal + Fibrozyme + Phytase	Pellet vs Meal Diets	Pellet vs Pea/C. Meal Ctrl.	Effect of Phytase	Effect of Fibro-zyme	Inter-action
Physical Form	**Pel**	**Meal**	**Meal**	**Meal**	**Meal**					
Carcass Summary:										
H. Carc. Wt. lb	206.8[c]	183.1[b]	189.4[a]	187.9[a]	192.2[a]	.0001	.0001	.13	.045	.69
% Yield	73.3	72.8	72.7	71.7	72.3	.512	.772	.453	.782	.727
% Lean	49.9	52.7	52.6	51.8	52.8	.156	.199	.819	.754	.671
Fat Depth, in	.86	.76	.78	.82	.77	.379	.356	.727	.848	.623
Loin Depth, in	2.08	2.01	1.97	2.06	2.01	.190	.273	.236	.181	.870
Fat Free Lean Index	48.2	48.6	48.6	48.4	48.8	.713	.751	.993	.811	.785
Lean Prem., $	1.61	3.98	3.68	2.41	3.98					

Table 4. Partial economic analysis following enzyme addition.

	Corn/Soy Ctrl	Pea/Canola Meal Ctrl	Pea/Canola Meal + Fibrozyme	Pea/Canola Meal + Phytase	Pea/Canola Meal + Fibrozyme + Phytase
Physical Form	**Pel**	**Meal**	**Meal**	**Meal**	**Meal**
Partial Econ. Summary					
Fd Cost/Hd, $	34.32	32.74	34.03	34.76	34.78
Feeder Pig/Hd., $	45.00	45.00	45.00	45.00	45.00

Total Carc. Value, $	123.08	117.23	119.76	117.13	122.98
Return Over Feed and Pig,$	43.76	39.49	40.73	37.37	43.20

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