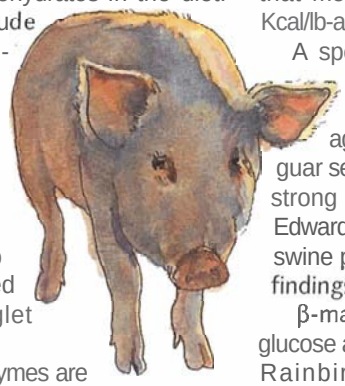
NSP enzymes in corn-soy based swine diets

by Mark Jackson, PhD

Non-starch polysaccharides (NSPs) are not readily digested by swine and have antinutritional properties that depress animal performance. Examining different wheat samples in 1999, Cadogan and colleagues observed that feed intake varied inversely to the amount of non-starch carbohydrates in the diet. NSPs of particular concern include beta-glucans (β-glucans), pentosans, arabinogalactans, galactomannans, xylans and pectins.



Two commercially available NSP enzymes that are extensively used are xylanase and β-glucanase in wheat and barley based diets. These enzymes have been shown to stimulate feed intake or reduce feed intake variation, especially in piglet diets.

The modes of action of NSP enzymes are likely a reduced water holding capacity and subsequently gut fill and an increased digestibility of cell wall fractions. In contrast to poultry, NSPs in pig diets do not lead to an appreciable increase in gut viscosity, as the digesta in swine is less dilute than that of chickens.

Soybean meal has high levels of NSPs. As a result, the pigs can metabolize only about 68% of the energy from soybean meal. One NSP in soybean meal—beta-mannan (β-mannan)—has been shown to reduce swine performance by interfering with insulin secretion and glucose absorption.

Despite this finding, enzyme use in corn-soybean meal based diets for swine in the USA is limited. Several recent studies demonstrate that an enzyme to counteract these effects—beta-mannanase (β-mannanase)—has positive effects on poultry and swine performance. An experiment with weanling pigs shows that β-mannanase has a similar effect as increasing the energy level of a corn-soybean meal based diet by 100 Kcal/kg.

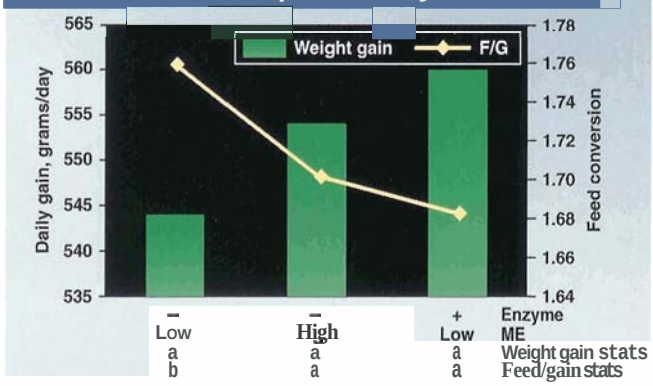
NSPs in soybean meal

Leguminous seeds have high concentrations of hemicelluloses, which are NSPs. Chesson indicated in a 1987 trial that soybean meal can contain up to 22.7% NSPs on a dry matter basis. These NSPs inhibit energy use from the soybean meal. The gross energy of soybean meal is approximately 2,130 kilocalories per pound (Kcal/lb), but the 1998 National Research Council for swine indicates that metabolizable energy content is only about 1,442 Kcal/lb-a 68% utilization rate.

A specific NSP in soybean meal, galactomannan (P-mannan) is composed of delta-mannose (D-mannose) units in a chain attached by β-1,4 linkages. Research with galactomannan derived from guar seed—which is high in galactomannan—has shown strong negative effects in monogastric animals. In 1988 Edwards and colleagues showed large reductions in the swine performance. Other research has confirmed these findings.

β-mannan also interferes with insulin secretion and glucose absorption. In a 1984 experiment with guar gum, Rainbird and associates observed a reduction in

Pmannanase compared to soybean oil.



Enzyme treatment contains 100 MU/ton β-mannanase (Hemicell®).
21-day, phase 3 post *weaning*.
Source: Petty et al, 2002.

β-mannanase and pig performance.

	Control	Enzyme	Std. Error	P-Value
Gain (g/day)	606	660	21	0.09
Feed intake (g/day)	836	868	22	0.31
Feed/gain	1.379	1.316	0.02	0.03

Enzyme treatment contains 100 MU/ton β-mannanase (Hemicell® from ChemGen Corp.).
Source: Van Heugten (2000).

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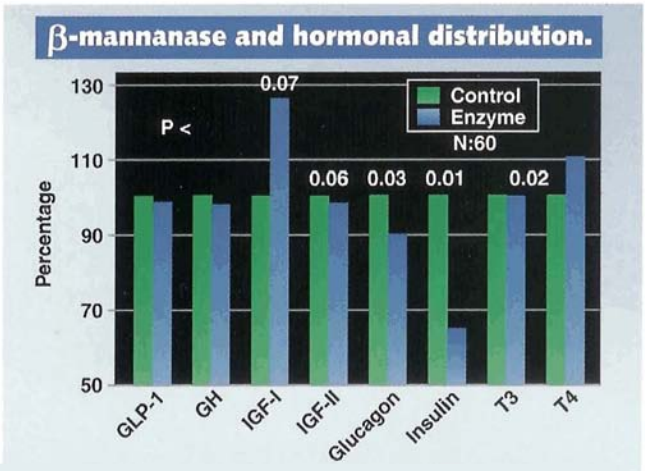
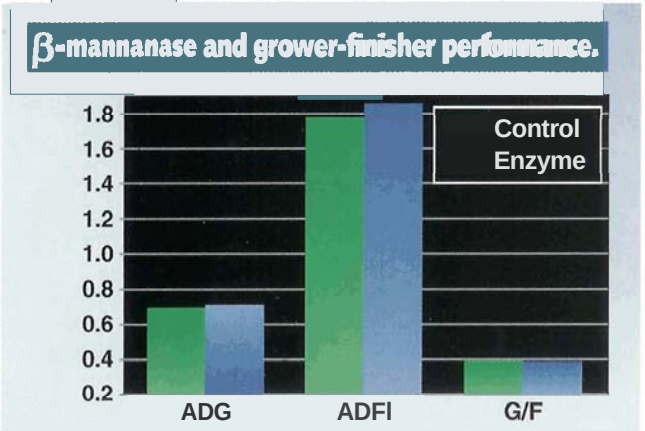
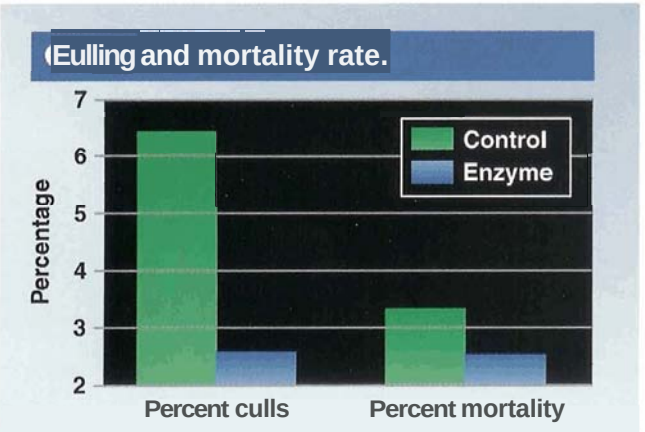


Blood analyses conducted by J. P. McMurlry, USDA, Beltsville,MD 20705.
60-day old pigs following a 2-hour feed withdrawal.
Enzyme treatment contains 100 MU/ton β-mannanase (Hemicell®).
Source: Van Haugten *(2000).*



40-250 lbs.
Enzyme treatment contains 100 MU/ton β-mannanase (Hemicell®).
Source: O'Quinn et al, 2002.



40-250 lbs.
Enzyme treatment contains 100 MU/ton β-mannanase (Hemicell®).
Source: O'Quinn et al, 2002.

glucose absorption from 74.2 to 41.4 % with a P value less than 0.001. Nunes and Malmlof reported that β-mannan from guar gum in the diet reduced gastric emptying, insulin secretion and IGF-1 (insulin-like growth factor) secretion in swine in 1992.

Effect on animal performance

An enzyme that breaks down the β-mannan fraction of soybean meal—β-mannanase—has been shown to have positive effects on swine performance. Odetallah and colleagues showed that this enzyme can improve weight gain and feed efficiency in broilers and turkeys in research published in 2002. This enzyme can improve feed efficiency and lean gain in grow-finishing pigs. In a series of experiments conducted by Petty and colleagues in 2002, the group reported significant feed efficiency effects in pigs at various stages of development as well as improvements in lean gain in grow-finishing pigs.

One trial compared the effects of adding 2% soybean oil, increasing the metabolizable energy by 100 Kcal/kg to adding β-mannanase to a control corn-soybean meal diet in weanling pigs. Other essential nutrients were similar across diets with 1.2% total lysine in the diet. Both the increased energy and enzyme addition resulted in similar improvements in gain and feed conversion (see figure *β-mannanase compared to soybean oil).* This result suggests that the enzyme resulted in an energy improvement of approximately 100 Kcal/kg.

In a similar type experiment with weanling pigs in 2000, Van Heugten determined the effects of β-mannanase with complex, semi-complex and corn-soybean meal-based diets in three phases post weaning. In this experiment, the enzyme resulted in an 8.9% increase in weight gain and a 6.3 point feed conversion advantage from 47 to 60 days of age (see table *β-mannanase and pig performance).*

At the conclusion of the experiment following *2* hours of feed withdrawal, blood samples of 5 pigs per pen were taken for hormone analysis (see figure *β-mannanase and hormonal distribution).* IGF-1 levels were significantly higher and insulin levels were lower. This result was similar to work from 1992, in which Nunes and Malmlof reported that elevated levels of β-mannan in the diet decreased insulin and IGF-1 secretion rates. Since the blood samples were obtained following feed withdrawal, a lower insulin level may have been anticipated because insulin levels drop after feed withdrawal.

Commercial trial

O'Quinn and colleagues recently conducted a large commercial grow-finish swine trial to determine the effect of β-mannanase on general performance, carcass characteristics, and economics. The pigs were grown in the summer in North Carolina and were therefore subject to heat stress. A total of 5,350 Dekalb pigs were grown from approximately 40 to 250 lbs with commercial-type diets. Half the diets contained p-mannanase.

The enzyme resulted in a 3.2% increase in ADG (see figure *β-mannanase and grower-finisher performance).* More striking was the large effect on mortality and culling percentage (see figure *Culling and mortality rate).* Commercial processing data was obtained on a total of 3,975 pigs, and revealed an increased dressing percentage and an increased fat depth (see table *β-man-*

nanase and swine carcass characteristics). The researchers concluded that the enzyme may have increased the energy released from the diets. An economic analysis was conducted based on market prices of starter pigs, cull and market pigs, and feed costs. This analysis calculated the value of the enzyme at $14.43 per ton of complete feed.

Though enzyme use in corn-soybean meal based swine diets today is limited, the level of NSPs in soybean meal is high, resulting in energy use that is lower than necessaty. The trials cited in this article indicate that NSP enzymes can be one way to improve swine performance in pigs fed corn-soybean meal based diets. FM

β-mannanase and swine carcass characteristics.

	Control	Enzyme	P-Value
Number	1832	2143	
Carcassweight (Kg)	88.41	88.59	NS
Carcass yield (%)	76.66	77.11	0.06
Carcass fat (mm)	17.42	17.75	0.005
% Lean	55.25	55.02	0.002

47-60*day* pigs.
Enzyme treatment contains 100 MU/ton β-mannanase (Hemicell®).
Source: O'Quinn et al, 2002

References are available at

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