Kansas Agricultural Experiment Station Research Reports

Volume 0
Issue 10 *Swine Day (1968-2014)*

Article 478

1991

# Comparison of conventional and low-inhibitor soybeans with different heat treatments and lysine concentrations in diets for finishing pigs

M A. Giesemann

B J. Healy

A J. Lewis

*See next page for additional authors*

# COMPARISON OF CONVENTIONAL AND LOW-INHIBITOR SOYBEANS WITH DIFFERENT HEAT TREATMENTS AND LYSINE CONCENTRATIONS IN DIETS FOR FINISHING PIGS

*J. D. Hancock, M. A. Giesemann[1], B. J. Healy, and A. J. Lewis[1]*

## Summary

Two experiments were conducted to determine the effects of gene expression for the Kunitz trypsin inhibitor, heat treatment, and concentration of lysine in the diet on nutritional value of soybeans for finishing pigs. In Experiment 1, 108 pigs (113 lb avg initial wt) were fed diets with two soybean cultivars (Williams 82 and Amsoy 71), with (+K) and without (-K) gene expression for the Kunitz trypsin inhibitor, subjected to three heat treatments (1/2-, 3/4-, and full-roasting). Nutritional value of the Williams 82 and Amsoy 71 cultivars was not different, but -K soybeans were superior to +K soybeans at all levels of heat treatment. Results indicated that full-roasted -K soybeans were of the greatest nutritional value, and 3/4-roasted -K soybeans were of equal nutritional value to full-roasted +K soybeans. In Experiment 2, Amsoy 71 soybeans (+K and -K) were fed raw and extruded, at 80 and 110% of the lysine concentration recommended by the NRC. Growth performance was improved by feeding the -K vs +K, extruded vs raw, and 110 vs 80% treatments. Additionally, the -K soybeans supported greater performance than +K soybeans, even when both were fully processed and fed in diets above the lysine requirement for finishing pigs.

(Key Words: GF, Process, Soybeans, Trypsin Inhibitors, Lysine.)

## Introduction

In the 1989 KSU Swine Day Report (page 65), we reported that heat treatment of Williams 82 soybeans with (+K) and without (-K) the Kunitz trypsin inhibitor gave improvements in growth performance of finishing pigs. These improvements in growth performance seemed to plateau between 1/2- and full-roasting time, but with treatments of none, 1/2-, and full-roasting, it was not possible to determine if less than full-roasting (e.g., 3/4-roasting) might be sufficient to optimize nutritional value of the +K and(or) -K soybeans. A second observation was that -K soybeans were of greater nutritional value than +K soybeans at all levels of heat treatment, even with full-roasting. Those differences were observed in diets that were formulated to be deficient in lysine (i.e., 80% of NRC) to accentuate differences in protein quality.

With those observations in mind, two experiments were conducted to determine if reduced roasting time of -K soybeans would yield a soybean product of equal or greater nutritional value than fully processed, conventional soybeans and to determine if -K soybeans were of greater nutritional value than +K soybean in diets that were adequate as well as deficient in lysine concentration.

## Procedures

Experiment 1 was conducted at the University of Nebraska to determine the effects of roasting +K and -K soybeans on growth per-

[1]University of Nebraska, Department of Animal Science.

formance of finishing pigs. Two soybean cultivars (Williams 82 and Amsoy 71), each with +K and -K isolines, were heat processed for 1/2-, 3/4- and full-roasting times in a Roast-A-Tron® roaster (i.e., a 2×2×3 factorial arrangement of treatments). Full-roasting was a throughput of approximately 1000 lb/h and an exit temperature of 245°F. Three-fourths- and 1/2-roasting treatments were accomplished by increasing throughput to 1,500 lb/h and 2,000 lb/h, respectively. The soybeans were ground through a hammermill, and added to 12 corn-soybean-based diets (Table 1). The diets were formulated to supply .48% lysine (i.e., 80% of the NRC requirement) to ensure that differences in protein quality would be detected. One hundred eight finishing pigs (nine pigs/treatment) were individually penned and fed from 113 to 219 lb. Response criteria included ADG, ADFI, F/G, and last rib fat depth.

Experiment 2 was conducted at Kansas State University, to determine the effects on finishing pigs of feeding raw and heat processed +K and -K soybeans at 80 and 110% of the NRC requirement for lysine, with a 2×2×2 factorial arrangement of treatments. The +K and -K soybeans were the Amsoy 71 cultivar, and heat processing was extrusion in a Wenger extruder with a barrel temperature of 300°F. The raw soybeans were ground through a hammermill before being added to the experimental diets, but the extruded soybeans required no further processing before use. The treatments were fed to 80 finishing pigs (two pigs/pen and five pens/treatment), with an avg initial wt of 124 lb and an avg final wt of 219 lb. Response criteria were ADG, ADFI, F/G, last rib fat depth, and digestibilities of DM and N.

## Results and Discussion

No differences were observed for pigs fed the two soybean cultivars in Experiment 1 (Table 2). Furthermore, there were no interactions between soybean cultivar and gene expression for the Kunitz trypsin inhibitor (+K and -K) or duration of heat treatment (1/2-, 3/4-, and full-roast). Thus, differences between +K and -K isolines and 1/2-, 3/4-, and full-roasting treatments were consistent for both soybean cultivars.

Pigs fed -K soybeans had 5% greater ADG (1.93 vs 1.84 lb) and a 3% improvement in F/G (3.38 vs 3.49) compared to pigs fed the +K soybeans. Increasing time of heating from 1/2- to full-roasting improved ADG by 8%, F/G by 7%, and last rib fat depth by 8%. Of particular interest was that -K soybeans were of greater nutritional value than +K soybeans at all heat treatments. This was a surprise, because with full-roasting, trypsin inhibitor activities for +K and -K soybeans would be sufficiently low to give similar growth performance. However, these results are in agreement with the data we reported in the KSU 1989 Swine Report (page 65). Thus, less processing time (i.e., 3/4-roasting) can be used with -K soybeans to give performance equal to that obtained with fully processed +K soybeans, or full-processing of -K soybeans can be used to yield a soybean product of greater nutritional value than fully processed +K soybeans.

For Experiment 2, pigs fed -K soybeans had improved ADG and F/G and greater digestibilities of DM and N than pigs fed +K soybeans (Table 3). One objective of this experiment was to determine if improved nutritional value of -K soybeans would be observed with a different form of heat processing, i.e., extrusion rather than roasting. Extrusion processing improved the nutritional value of both soybean isolines, but -K soybeans were still of greater nutritional value than +K soybeans even with adequate heat treatment.

Increasing lysine concentration of the diets from 80 to 110% of NRC improved growth performance of pigs fed +K or -K soybeans, raw or extruded. With digestibility of raw -K soybeans being only slightly lower than that of fully roasted +K soybeans in previous

experiments, it seemed possible that feeding an excess of lysine in diets with raw -K soybeans might meet the pig's needs for amino acids, even with slightly reduced nutrient digestibilities. This was not the case in the current experiment, with growth performance of pigs fed extruded +K soybeans being greater than that of pigs fed raw -K soybeans. Factor(s) other than decreased nutrient digestibility must have limited growth of pigs fed the raw soybeans. Alternatively, extruded -K soybeans were of greater nutritional value than extruded +K soybeans at 80 and 110% of NRC for lysine. This response was particularly surprising, because differences in protein sources are typically not observed when diets are formulated such that amino acids are in excess of their requirements. A similar response in nursery pigs fed extruded -K soybeans in protein-adequate diets is reported elsewhere in this publication (Hancock et al.).

In conclusion, -K soybeans required 25% less heat treatment to support growth performance equal to fully processed +K soybeans. Full-processing (roasting or extruding) of -K soybeans resulted in greater growth performance than full-processing of +K soybeans. This response was observed not only in the protein-deficient diet formulations (Experiment 1) used to measure quality of these protein sources, but also in diets above the current NRC recommendation for lysine (Experiment 2).

**Table 1. Composition of Diets, %**

| | Experiment 1 | | | | Experiment 2 | | | |
|---|---|---|---|---|---|---|---|---|
| | Williams 82 | | Amsoy 71 | | +K | | -K | |
| Ingredient | +K | -K | +K | -K | 80% | 110% | 80% | 110% |
| Corn | 84.65 | 84.65 | 84.65 | 84.65 | 84.72 | 74.62 | 84.72 | 74.62 |
| Soybeans[a] | 10.95 | 11.55 | 11.65 | 11.00 | 11.44 | 20.56 | 10.47 | 19.26 |
| Cornstarch | 1.15 | .55 | .45 | 1.10 | .84 | 1.82 | 1.81 | 3.12 |
| Vitamins and minerals | 3.25 | 3.25 | 3.25 | 3.25 | 3.00 | 3.00 | 3.00 | 3.00 |

[a]The raw soybeans were analyzed for lysine concentration, and diets were formulated to .48% lysine in Experiment 1 and .48% (80% of NRC) and .66% (110% of NRC) lysine in Experiment 2. One-half, 3/4-, and full-roasted soybeans were substituted (protein basis) for the raw soybeans in Experiment 1. Extruded soybeans were substituted (protein basis) for the raw soybeans in Experiment 2.

**Table 2. Effect of Cultivar, Roasting Time, and Gene Expression for the Kunitz Trypsin Inhibitor on Nutritional Value of Soybeans for Finishing Pigs[a]**

| | Williams 82 | | | | | | Amsoy 71 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | +K | | | -K | | | +K | | | -K | | | |
| Item | 1/2 | 3/4 | Full | 1/2 | 3/4 | Full | 1/2 | 3/4 | Full | 1/2 | 3/4 | Full | CV |
| Growth performance | | | | | | | | | | | | | |
| ADG, lb[bc] | 1.79 | 1.87 | 1.92 | 1.92 | 1.92 | 1.98 | 1.74 | 1.76 | 1.98 | 1.83 | 1.98 | 1.96 | 11.1 |
| ADFI, lb[h] | 6.44 | 6.61 | 6.46 | 6.86 | 6.53 | 6.50 | 6.19 | 6.22 | 6.68 | 6.44 | 6.53 | 6.26 | 9.4 |
| F/G[cf] | 3.60 | 3.53 | 3.36 | 3.57 | 3.40 | 3.28 | 3.56 | 3.53 | 3.37 | 3.52 | 3.30 | 3.19 | 6.7 |
| Last rib fat | | | | | | | | | | | | | |
| depth, in[dg] | 1.18 | 1.14 | .98 | 1.18 | 1.02 | 1.06 | 1.10 | 1.10 | 1.14 | 1.14 | 1.10 | 1.06 | 14.9 |

[a]Values are means for five barrows and four gilts, fed individually, from 113 to 219 lb.
[bc]+K vs -K (P<.05, P<.01, respectively).
[def]Roasting time linear (P<.05, P<.01, P<.001, respectively).
[g]+K vs -K × roasting time linear (P<.10).
[h]No treatment effect (P>.10).

**Table 3. Growth Performance and Nutrient Digestibility in Finishing Pigs Fed Soybeans with (+K) and Without (-K) the Kunitz Trypsin Inhibitor, Raw and Extruded in Diets Formulated to Provide 80 and 110% of the Lysine Requirement[a]**

| | +K | | | | -K | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Raw | | Extruded | | Raw | | Extruded | | |
| Item | 80% | 110% | 80% | 110% | 80% | 110% | 80% | 110% | CV |
| Growth performance | | | | | | | | | |
| ADG, lb[bhi] | 1.44 | 1.57 | 1.62 | 1.77 | 1.48 | 1.64 | 1.83 | 1.95 | 10.4 |
| ADFI, lb[l] | 6.21 | 6.13 | 6.14 | 6.11 | 6.17 | 6.14 | 6.58 | 6.57 | 8.7 |
| F/G[chj] | 4.31 | 3.90 | 3.79 | 3.45 | 4.17 | 3.74 | 3.60 | 3.37 | 4.1 |
| Last rib fat | | | | | | | | | |
| depth, in[g] | .74 | .72 | .63 | .61 | .75 | .63 | .63 | .64 | 18.5 |
| Apparent digestibility, % | | | | | | | | | |
| DM[bc] | 80.7 | 81.0 | 81.5 | 83.5 | 84.4 | 82.1 | 85.7 | 85.6 | 4.0 |
| N[dfk] | 64.3 | 66.5 | 63.0 | 74.8 | 72.7 | 72.0 | 78.2 | 77.2 | 8.5 |

[a]Values are means for five pens/treatment and two pigs/pen, fed from 124 to 219 lb.
[bcd]+K vs -K (P<.05, P<.01, P<.001, respectively).
[efgh]Raw vs extruded (P<.10, P<.05, P<.01, P<.001, respectively).
[ij]Lysine concentration (P<.05, P<.001, respectively).
[k]+K vs -K × lysine concentration (P<.05).
[l]No treatment effect (P>.18).