ALCOHOL- AND WATER-EXTRACTED SOY PROTEIN CONCENTRATES FOR EARLY-WEANED PIGS

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Summary

A total of 72 weanling pigs (average initial wt of 7 lb and 10 d of age) was used in a 38-d growth assay to determine the nutritional value of alcohol- and water-extracted soy protein concentrates. Pigs were sorted by sex, weight, and ancestry and assigned to 12 pens with six pigs/pen. The soy preparations were fed in a nursery regimen with Phase I (d 0 to 10), Phase II (d 10 to 24), and Phase III (d 24 to 38) diets. Pigs and feeders were weighed at initiation and conclusion of each phase, with fecal samples collected on d 38 for determination of DM and N digestibilities. Pigs fed the alcohol-extracted soy protein concentrate had greater average daily gain (ADG) in all phases, with similar increases in average daily feed intake (ADFI) compared to pigs fed water-extracted soy protein concentrate. However, feed/gain (F/G) was similar throughout the experiment for pigs fed the soy protein treatments. The diets with water-extracted soy protein concentrate had greater digestibility of dry matter (DM) than the diets with the alcohol-extracted product, but N digestibility was similar for both treatments. Although water is an inexpensive solvent compared to alcohol, pigs fed the alcohol-extracted soy protein concentrate had improved growth performance compared to those fed the water-extracted product.

(Key Words: Alcohol Extraction, Water Extraction, Soy Protein Concentrate, Nursery Pigs.)

Introduction

Recent trends for weaning pigs at very young ages (i.e., 14 d or less) has increased the need for highly palatable and digestible diets. For early weaning to be economically viable, the very young pig must adapt to solid feed as soon as possible postweaning. Once these pigs do begin to eat, feed intake is low, so that maximum digestibility is of paramount importance to meet tissue needs for nutrients. Generally, diets for early weaning have a high proportion of animal protein sources such as dried milk and blood products. These protein sources successfully promote growth in this critical phase; however, they are expensive and carry risks of contamination with pathogens not typically found in plant protein sources.

To decrease diet costs, vegetable proteins are preferred protein sources. Soybean meal, although an extremely economical plant protein source, contains antinutritional factors that reduce its value for young pigs. Further refined soy products, such as soy protein isolates and alcohol-extracted soy protein concentrates, are lower in antinutritional factors, but the added processing also increases their cost.

The purpose of the experiment reported herein was to determine if a low-cost water-extracted soy protein concentrate could be used to replace alcohol-extracted soy protein concentrate in diets for early-weaned pigs without reducing growth performance or nutrient digestibility.

Procedures

Seventy-two weanling pigs (7 lb average body wt and 10 d of age) were sorted by weight, sex, and ancestry and allotted to 12 pens, with six pigs per pen and six pens per treatment. Treatments were 1) alcohol-extracted soy protein concentrate and 2) water-extracted soy protein concentrate. The alcohol-extracted concentrate was made by extraction of defatted soy flakes with hot aqueous alcohol. The extraction process concentrates the protein fraction by removal of soluble carbohydrates and is thought to denature biologically active soy proteins (i.e., trypsin inhibitors, glycinin, and β-conglycinin). The water-extracted concentrate was made from whole soybeans that were roasted, cracked, and extracted with water. The initial roasting was used to inactivate the biologically active proteins and reduce protein solubility before extraction with water. The water removes soluble carbohydrates but also may remove some water-soluble proteins. The pigs were housed in an environmentally controlled nursery room with wire mesh flooring and had ad libitum access to feed and water. The diets were fed in pelleted form, with 3/32" pellets in Phase I and 5/32" pellets in Phases II and III. Pigs and feeders were weighed at initiation of the experiment and at the end of Phases I, II, and III (i.e., d 10, 24, and 38, respectively). Fecal samples were collected from four pigs per pen on d 38; dried; and analyzed for concentrations of Cr, DM, and N. Thus, response criteria were ADG, ADFI, F/G, and digestibilities of DM and N.

Results and Discussion

Pigs fed the alcohol-extracted soy protein concentrate had greater ADG in Phases I, II, and III and overall ($P < .06$) compared to pigs fed the water-extracted soy protein concentrate. Similar responses were noted for ADFI, with greater consumption of feed for pigs fed the alcohol-extracted product. No significant differences ($P > .6$) occurred in F/G among pigs fed the two treatments during any phase of the experiment. Digestibility of DM was greater for the diet with water-extracted soy protein concentrate than for the diet with the alcohol-extracted product ($P < .001$), but digestibility of N was similar for the two treatments.

In conclusion, water is an inexpensive, nontoxic, and environmentally friendly solvent compared to alcohol. However, the alcohol-extracted soy protein concentrate was a superior protein source for nursery pigs. This was the first evaluation of the water-extracted product, and further research is needed to develop a water-extracted soy protein concentrate equal in nutritional value to the alcohol-extracted product.

Table 1. Diet Composition (Phases I, II, and III)[a]

Ingredient, %	Phase I (d 0 to 10)		Phase II (d 10 to 24)		Phase III (d 24 to 38)	
	Alcohol-extracted	Water-extracted	Alcohol-extracted	Water-extracted	Alcohol-extracted	Water-extracted
Corn	33.76	31.77	49.11	46.42	62.07	59.22
Dried whey	20.00	20.00	20.00	20.00	10.00	10.00
Soy product	11.72	17.18	15.84	23.23	16.44	24.11
Spray-dried plasma protein	10.00	10.00	2.00	2.00	---	---
Lactose	10.00	10.00	---	---	---	---
Fish meal	5.00	5.00	2.00	2.00	---	---
Blood meal	2.00	2.00	2.00	2.00	1.50	1.50
Soybean oil	3.90	.39	4.79	.06	5.15	.24
Monocalcium phosphate	1.86	1.89	2.12	2.15	2.12	2.16
Limestone	.16	.14	.42	.40	.64	.62
Vitamins & minerals[b]	.40	.40	.40	.40	.40	.40
Lysine HCl	---	---	.15	.15	.15	.15
DL-methionine	.13	.15	.09	.11	.05	.08
Antibiotic[c]	1.00	1.00	1.00	1.00	1.00	1.00
Chromic oxide	---	---	---	---	.25	.25
Copper sulfate	.08	.08	.08	.08	.08	.08
Salt	---	---	---	---	.20	.20
Total	100.00	100.00	100.00	100.00	100.00	100.00

[a]The diets were formulated to 1.8% lysine, .9% Ca, and .8% P for Phase I, 1.5% lysine, .9% Ca, and .8% P for Phase II, and 1.2% lysine, .8% Ca, and .7% P for Phase III.
[b]KSU vitamin and mineral premixes.
[c]Supplied 150 g/ton apramycin in Phases I and II and 50 g/ton carbadox in Phase III.

Table 2. Alcohol- and Water-Extracted Soy Protein Concentrates for Early-Weaned Pigs (Phases I, II, and III)[a]

Item	Alcohol-extracted	Water-extracted	CV
d 0 to 10			
ADG, lb[b]	.51	.43	10.4
ADFI, lb[c]	.54	.47	8.3
F/G	1.06	1.09	6.4
d 10 to 24			
ADG, lb[d]	.82	.70	6.2
ADFI, lb	1.19	1.02	21.4
F/G	1.45	1.46	15.9
d 24 to 38			
ADG, lb[e]	1.04	.88	11.9
ADFI, lb	1.61	1.42	12.1
F/G	1.55	1.61	11.6
d 0 to 38			
ADG, lb[f]	.82	.70	4.9
ADFI, lb	1.18	1.02	13.3
F/G	1.44	1.46	12.5
Digestibilities (d 38), %			
DM[g]	87.7	89.7	.6
N	88.2	87.8	.6

[a]A total of 72 pigs (six pigs per pen and six pens per treatment) with an average initial body wt of 7 lb.

[bcdefg]Water-extracted vs alcohol-extracted ($P < .04$, .02, .007, .06, .002, and .001, respectively).