

Effect of Protein Source (Casein vs. Soy) on Growth in Antigen Exposed Pigs

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Summary and Implications

Thirty sets of four littermate pigs were reared via a segregated early weaning (SEW) scheme, individually penned, and allowed to consume one of four diets ad libitum from body weights of 6 to 25 kg. The dietary protein sources (29% total diet) consisted of casein-starch (Cas) and isolated soy (Soy) that provided, respectively, 100/0, 66/33, 33/66, and 0/100% of the digestible lysine in the supplemental protein mix in the four diets. The Cas and Soy contained 0 and 604 ppm of isoflavones, an inhibitor of cytokine synthesis and immune cell reactivity. Eight days post-allotment, pigs in one-half of the litters were exposed to an antigen, 1ml of 10^9 attenuated porcine reproductive and respiratory syndrome (PRRS) virus cells administered intramuscularly.

Exposure to the nonreplicating, attenuated virus resulted in elevated serum acute phase protein (AGP) concentrations (581 vs. 668 $\mu\text{g}/\text{mL}$) pooled across time. The magnitude of the response was greater in the initial 12 days of the study. Antigen exposure (AE) also resulted in lower daily gains (665 vs. 644 g) and gain:feed ratios (.719 vs. .713) over the duration of the study. As dietary Soy content increased, serum concentrations of the AGP in the AE pigs were decreased (669, 722, 637, 626 $\mu\text{g}/\text{ml}$). Similarly, greater Soy inclusion depressed gain:feed ratios in the AE pigs (.730, .731, .699, .693), but not in the non-AE pigs (.708, .728, .723, .716), resulting in a protein source by AE interaction. Greater Soy inclusion did not alter daily gains in either AE group. Based on these data, the response of pigs to dietary protein source (Cas vs. Soy) is dependent on the pig's level of antigen exposure.

Introduction

During an antigen exposure, the pigs immune system becomes activated. One of the initial immune responses that occurs is the release of cytokines. These cytokines stimulate the proliferation of immune cells and production of antibodies, as well as the production of fever. The chronic release of proinflammatory cytokines also results in the reduction of body growth and efficiency of feed utilization.

Currently, protein sources that contain compounds that modify the immune system are being evaluated to help reduce the negative effects resulting from antigen exposure.

A compound of interest is genistein, which is an isoflavone found in soybeans. Genistein has been noted to reduce the production of cytokines in vitro through the inhibition of tyrosine kinase activity (1). This reduction of cytokines could reduce the release of proinflammatory cytokines, which in turn may improve efficiency of feed utilization in animals experiencing minimal antigen exposure.

The reduction in cytokine release, however, also may be associated with the lower production of lymphocytes and antibodies. This potentially could increase the pigs' susceptibility to secondary antigens, which would result in a more prolonged stimulation of the immune system and loss of pig productivity.

Therefore, the objective of this study was to determine the effect of dietary protein source (Casein vs. Soy) on the rate and efficiency of growth in pigs experiencing a minimal or moderate antigen exposure.

Materials and Methods

Experimental treatments consisted of two levels of (AE) and four dietary protein sources. All pigs were reared via a SEW scheme to minimize the animals exposure to antigens. The minimal and moderate level of AE was created by administering pigs either 0 or 1 ml of 10^9 nonreplicating attenuated PRRS virus. Pigs were self-fed a basal mix (71% of the diet) that consisted of corn and soy protein concentrate. The basal mix was supplemented with one of four dietary protein sources (29% of diet, Table 1). The protein sources (Table 2) consisted of four combinations of casein-starch and isolated soy protein, which provided, respectively, 0/100, 33/66, 66/33, and 0/100 of the digestible lysine in the supplemental protein mix. The diets were analyzed for amino acid and isoflavone (genistein) concentration. The four diets contained the same concentration of digestible lysine (1.27 to 1.35%) and provided amounts of other amino acids relative to lysine that met or exceeded the ratios in an "ideal protein" for pigs. The analyzed concentration of dietary genistein increased from 0 to 118 ppm as the proportion of Soy in the protein source increased (Table 2).

Thirty sets of four littermate pigs from a high-lean

Table 1. Supplemental protein source treatments.

IsoSoy %	Casein: IsoSoy	Genistein mg/kg diet
0	0:100	0
33	33:66	39
66	66:33	79
100	100:0	118

genetic strain were weaned at 11±3 days of age, penned individually, and allowed to consume feed and water ad libitum.

At 8 days post-weaning, pigs in each litter were randomly allotted to one of the four dietary protein sources. At 16 days post-weaning, pigs in 15 of the 30 litters were administered the attenuated PRRS virus.

Body weight and feed intake was measured every 4 days to determine daily gain and daily feed intake. Blood was collected for determination of alpha-1-acid glycoprotein (AGP) levels. Pigs were removed from test when they reached a body weight of 25±2 kg (34±8 days on test).

Data was analyzed as a split-plot design by using the general linear model procedure of SAS. Pig weight on the day of the attenuated PRRS administration was used as a covariate in the analysis. Growth response over time was analyzed as a repeated measure. The pig was considered the experimental unit.

Results and Discussion

Antigen exposure effect. Over the duration of the study, exposure to the attenuated virus resulted in a lower utilization of feed and daily gain (Table 2), but did not alter daily feed intake. The AGP values also were higher in the moderate AE group, which indicates that the attenuated virus stimulated an immune response, because AGP is produced by the liver in response to cytokine production. These data indicate that the antigen chosen for this experiment was effective in creating two different types of immune statuses.

Antigen exposure by dietary protein source effect.

There were no differences in daily gain among the four dietary protein sources (Table 3) in either AE group. There was also no difference in gain:feed ratios in the minimal AE group among the four diets. There was, however, a reduction in utilization of feed in the moderate AE group as dietary Soy increased (Table 3). Serum AGP concentrations also were lowered in the moderate AE group as dietary Soy increased. The similarity of gain and gain:feed ratios among dietary protein sources in the minimal AE group indicates that the presence of a less “ideal” amino pattern and

Table 2. Main effects of antigen exposure (AE).

Criteria	AE	
	Minimal	Moderate
Growth and feed utilization, g		
Daily feed	928	908
Daily gain ^a	665	644
Gain:feed ^a	.719	.713
Serum acute phase protein, µg/mL		
AGP ^a	581	688

^a AE effect, P<.01.

Table 3. Effects of dietary protein source in pigs exposed to a minimal or moderate level of antigen exposure (AE).

Criteria	AE	IsoSoy %			
		0	33	66	100
Daily gain, g ^a	Min	676	670	665	648
	Mod	627	655	648	647
Gain:feed ^b	Min	.708	.728	.723	.716
	Mod	.730	.731	.699	.693

^a AE effect, P<.01.

^b AE X protein source effect, P<.12.

antigenic proteins in the Soy protein source per se did not elicit a significant biological response. In contrast, the reduction in serum AGP and gain:feed ratios in the moderate AE groups as dietary Soy increased indicates that components in the Soy may have suppressed the immune system resulting in a less effective removal of the antigen and a subsequent reduction in the efficiency of feed utilization.

These data show that the biological value of Cas versus isolated Soy as a dietary protein source is similar for pigs experiencing minimal antigen exposure, but not in those experiencing a moderate level of antigen exposure.

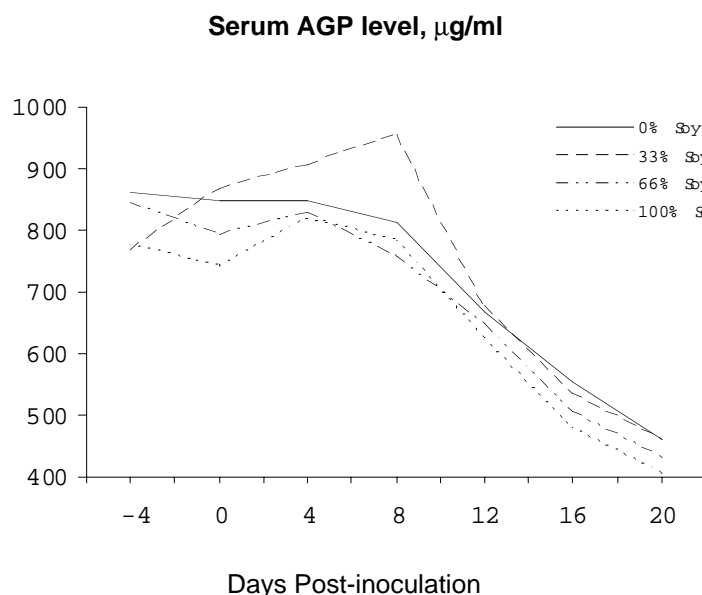


Figure 1. Effect of dietary protein source on serum AGP concentrations in the moderate AE group.

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References

1. Akiyama, T, J. Ishida, S. Nakagawa, H. Ogawara, S. Wantanabe, N. Itoh, M. Shibuya, and Y. Fukami, 1987. Genistein, a specific inhibitor of tyrosine-specific protein kinases. *J. Biol. Chem.* 262: 5592-5595.