

# Soybean Meal - The "Gold Standard"

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Soybean meal has long been considered the best source of supplemental protein in diets for swine. In fact, it is often referred to as the "gold standard" in that all other protein sources are generally compared to soybean meal. However, in spite of its many virtues, soybean meal is not perfect; it has some shortcomings. A considerable amount of new research is being directed toward solving some of the problems associated with the undesirable factors in soybean meal, and these will be discussed in this paper. The swine nutrition group at the University of Kentucky has participated in some of this research.

But first, let's look at soybeans and soybean meal from a broad perspective. Soybean meal is by far the most widely used protein source in the USA and throughout the world. Soybean acreage accounts for about 26% of the crop land in the USA, similar to that devoted to corn (29%) and wheat (26%) production and considerably greater than the crop land devoted to cotton (5%), sunflower (1%), and other oilseed crops.

On a global basis, soybean meal accounts for approximately 63% of all protein sources used in animal feeds followed by rapeseed (canola) meal (12%), cottonseed meal (8%), sunflower meal (6%), fish meal (4%), and peanut meal (4%). However, in the USA, soybean meal accounts for approximately 92% of the total oilseed meals fed to livestock and poultry. Approximately 53% of this soybean meal is used in poultry feeds followed by 27% in swine feeds, 14% in cattle feeds, and 6% in pet foods, fish feeds, and miscellaneous feeds.

The popularity of soybean meal in swine and poultry feeds is largely due to its high concentration of protein (44 to 48%) and its excellent profile of highly digestible amino acids. Although not a perfect blend of amino acids (it tends to be low in methionine), soybean meal is a rich source of lysine, tryptophan, threonine, isoleucine, and valine -- the amino acids that are seriously deficient in corn, grain sorghum, and other cereal grains that are commonly fed to pigs and poultry.

The exceptional quality of soy protein is evidenced by its high content of lysine, the first limiting amino acid for pigs. There is approximately 6.5% lysine in the protein of soybeans and soybean meal. Actually, the concentration of lysine in soy protein is not greatly different from that of pork muscle protein, which ranges from 6.5 to 7.0% lysine. Other oilseed meals have considerably less lysine in their protein. For example, the lysine percentage in canola meal protein is 5.8%, in cottonseed meal, 4.2%, in peanut meal, 3.4%, and in sunflower meal, 2.8%. Some of the protein sources of animal origin have higher concentrations of lysine in their protein (dried blood plasma, 8.8%; dried milk powder, 8.3%; dried blood meal, 8.4%; fish meal, 7.6%; dried whey, 7.4%), while others do not (meat meal, 5.7%; meat and bone meal, 4.9%; feather meal, 2.5%).

The two major kinds of soybean meal available for use in the swine industry are regular, 44% protein soybean meal and dehulled soybean meal (47-48% protein). Both types are "solvent-extracted" which means that solvents are used to extract the oil from the soybeans. The oil-extracted residue is then heated to drive off the solvent and the meal is carefully toasted to destroy the inhibitors (discussed later). Soybean hulls are either blended back with the meal to standardize the protein to 44%, or they are not added (resulting in dehulled soybean meal).

Either type of soybean meal can be used in swine diets. Besides being higher in amino acids, dehulled soybean meal is also slightly lower in fiber and higher in energy. But it is also priced higher than regular 44% protein meal. Because the amino acids in both types of meal are in direct proportion to the crude protein content, one can compare the cost per unit of protein in the two types of meals and select the one that is the best buy.

### **Anti-Nutritional Factors in Soybeans and Soybean Meal**

Most all of the oilseeds possess a certain amount of anti-nutritional factors, and soybeans are no exception. Several of these factors are known to cause depressed growth performance in swine. Some of these factors can be reduced or eliminated by various processing methods. Also some have been reduced or eliminated by breeding programs.

*Trypsin Inhibitors.* Soybeans contain several factors that inhibit the activity of trypsin, one of the major protein-digesting enzymes in the intestinal tract of pigs. Fortunately, these inhibitors are destroyed by moist heat, so they are routinely destroyed during the normal processing steps in preparing soybean meal. If unprocessed, whole soybeans are fed directly to young pigs, growth is severely depressed due to the trypsin inhibitors. That is why full-fat soybeans must first be roasted or heated in some way to destroy these inhibitors.

Plant breeders have successfully produced soybeans with reduced amounts of trypsin inhibitors. We conducted some research with low trypsin inhibitor soybeans several years ago and found that they were significantly better than normal soybeans when fed as whole unprocessed beans to growing pigs. We also found that they still required heat processing to maximize their nutritional value. In our studies, about half as much heat was required with low-trypsin inhibitor beans as with normal beans.

*Phytic Acid.* Most of the phosphorus in soybeans is in an indigestible form called phytic acid or phytate. Pigs do not have the digestive enzymes to degrade this phytate into a form of phosphorus that can be utilized by pigs. To overcome this problem, we simply have to add additional inorganic phosphorus (in the form of dicalcium phosphate) to the diet. The end result of the poor phosphorus utilization and the high amount of inorganic phosphorus that must be added to the diet is that excessive phosphorus is excreted in the manure -- and this contributes to environmental pollution.

Genetically enhanced soybeans with low phytate content have been developed and tests are in progress at the University of Kentucky to evaluate low phytate soybeans for pigs. We have found that the bioavailability of phosphorus in low phytate soybean meal is considerably higher than in normal soybean meal. We have also tested genetically enhanced, low phytate corn and found that its phosphorus is three to four times as bioavailable to pigs as the phosphorus in normal corn. We are finding that when pigs are fed a combination of low phytate soybean meal and low phytate corn, the excretion of phosphorus in their manure is substantially reduced.

*Oligosaccharides.* Raffinose and stachyose are two types of short-chained carbohydrates that make up about 5-7% of the soybean. These oligosaccharides are not digested and they cause digestive disturbances and depressed growth in early-weaned pigs. The oligosaccharides can be removed by special processing, resulting in a product called soy protein concentrate.

Mutant genes have now been identified that eliminate or greatly reduce the oligosaccharides in soybeans. Incorporation of these genes into commercial soybean varieties should have a positive impact on the nutritional value of soybean meal, especially for early-weaned pigs.

*Antigenic Factors.* Certain specific types of protein in soybeans have been shown to cause an inflammatory response in the intestine when exceptionally high levels of soybean meal are included in diets for early-weaned pigs. This allergic response seems to be greater if pigs are exposed to soybean meal (for example, in the sow's feed) before they are weaned. The processing that soybeans undergo in the production of soy protein concentrate seems to reduce the amount of these antigenic proteins.

*Other Factors.* Soybeans contain compounds called lectins that bind with intestinal cells and interfere with absorption of nutrients. Fortunately, the lectins are destroyed with proper heat treatment. Other compounds such as saponins, lipoxidase, phytoestrogens, and goitrogens also exist in soybeans, but whether or not they have anti-nutritional effects in pigs is not well understood.

### **Pro-Nutritional Factors in Soybeans and Soybean Meal**

There are some factors in soybeans that may have benefits. Dr. Tim Stahly at Iowa State University (formerly a swine nutritionist at UK) has found that certain compounds called isoflavones in soybeans improve growth and stimulate lean tissue synthesis in young pigs. His group has also found that certain isoflavones seem to benefit pigs challenged with the PRRS virus. While this research is still in its infancy, the results certainly look promising. Several of the isoflavones have been claimed to have health benefits in humans in that they are thought to have anti-cancer properties.

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