Considerations for Protein Alternatives in Swine

Feeding pigs a balanced ration can be a challenge. Not only is feed expensive, but as monogastric animals, a pig’s growth and well-being is readily influenced by the nutrient composition of its diet.

Two commonly used feed ingredients in swine diets are corn and soybean meal (extruded). Corn contributes energy to the diet to support growth, maintenance, and fat deposits in the finishing phase while the soybean meal contributes protein for building tissue, predominantly muscle. In times of elevated soybean prices, you may want to consider replacing soybean meal with alternative protein sources to lessen the cost of the daily ration.

Soybean meal is a commonly used protein source in pig diets because the amino acid content in soybean meal complements the amino acid profile in corn, which is one reason why this combination is one of the most common in the United States. A variety of protein sources can be used in pig diets and are commonly utilized in nutritionist formulated complete diets. However, when you mix your own feed, finding a replacement for soybean meal can be a bit trickier. Producers who mix their own feed need to be aware that, when replacing soybean meal, finding the right balance of amino acids in the diet is critical, otherwise you may need to accept a loss in animal performance.

When selecting a protein source, consider the cost, shipping, and practicality in the current operation. Luckily, there are a variety of protein sources suitable for pigs due to their omnivorous capacity. Protein sources can be broken into two categories, plant-based protein sources, and animal-derived protein sources. In this article, you will find some information on protein sources that can be used in pig feed. You might notice that each are compared to soybean meal. As stated above, soybean meal has the superior amino acid profile that complements corn, making soybean meal the 'gold standard' in corn-based pig diets. Everything else is an 'alternative' to soy protein.

Plant-based protein sources

Soybean meal (extruded)

The most common plant-based protein in swine diets is soybean meal. Soybean meal contributes a balanced and digestible amino acid profile, making it the 'go-to' protein source for maximizing growth in swine. The most common form of soybean meal used in pig diets comes from soybeans that have had the fat (oil) removed. This is referred to as 'extruded' soybean meal.

The nutritional profile of soybean meal will change based on if the soybeans are hulled or dehulled. Soybean meal from dehulled soybeans will have less fiber and more protein content. Dehulled soybeans will range between 45 to 48% crude protein (CP) and 2.8 to 3.0% lysine. Hulled soybeans will be approximately 44% CP and 2.8% lysine.

Some variation in CP, lysine, and energy comes from how oil is extracted from whole soybeans. Two processing methods for extracting oil from soybeans are expelling and solvent extraction. Soybeans that go through the expelling method are mechanically extruded to extract the soybean oil. The resulting by-product is soybean meal, which has inactivated trypsin inhibitors. Alternatively, in the solvent extraction process, oil is removed from soybeans using a solvent. This process more efficiently removes oil, leaving the soybean meal with less oil and less fat content or energy. The soybean meal by-product must be toasted to inactive trypsin inhibitors left behind after
the solvent extracting process. In dehulled soybeans, expelled soybeans contain approximately 6.6% fat; whereas solvent extracted soybeans contain 1.5% fat.

Another attractive aspect of soybean meal is its low fiber content. Dehulled soybean meal will retain approximately 8 to 9% neutral detergent fiber (NDF) or minimally digestible fiber. Hull soybean meal will contain 10 to 14% NDF. For the least amount of fiber inclusion and highest protein and lysine content, dehulled soybean meal is the best option for growing pig diets.

Roasted Soybeans, ground

One of the alternatives for soybean meal is ground roasted soybeans. Home grown soybeans can be used at the cost to produce the soybeans, which can lower the cost of the diet. If using whole soybeans, also known as full fat soybeans, make sure that the soybeans are roasted and ground. Soybeans have anti-nutritional factors, such as trypsin inhibitors that decrease growth potential. When soybeans are heated or roasted, the anti-nutritional factors are denatured, which removes the inhibition on growth. Grinding of roasted soybeans makes the protein source more digestible; thus, pigs grow more efficiently with finely ground roasted soybeans than whole soybeans. When soybean pricing is high, the opportunity cost of selling soybeans can still be more attractive than using them in a swine diet. Alternative protein sources will need to be acquired.

Canola meal

Canola is a variety of rapeseed originating in Canada that was designed for its oil profile. Canola meal is a by-product from expelling or solvent extracting oil from canola seed. In expelled canola meal, CP will be 35%, lysine will be 2.0%, and fat content will be 10%. Canola meal that has been solvent extracted will be 38% CP, 1.5% lysine, and 3 to 4% fat. Fiber content is around 23 to 24% NDF, which is approximately 3 times higher than dehulled soybean meal. If cost and nutritional profile are appropriate, canola meal can fully replace soybean meal in a growing pig diet.

Cottonseed meal

Another seed used for oil extraction is cottonseed. Once oil is removed, the leftover by-product is known as cottonseed meal. Cottonseed meal is known to have approximately 39% crude protein, 1.5% lysine, 6% fat, and 25% NDF. Similar to canola meal, cottonseed meal has approximately 3 times higher fiber content than soybean meal. Unheated cottonseed meal will have free gossypol, which can be toxic if the diet is not balanced correctly. Heating cottonseed meal is required to cause free gossypol to bind with lysine thus making the product less toxic to swine. Heat treating of the cottonseed meal decreases the lysine digestibility when compared to all other oilseed meals. Cottonseed meal is not a commonly used feed source for pigs but might be desirable as a feed ingredient for diversified farms already using cottonseed meal for cattle rations.

Corn gluten meal

As the name indicates, corn gluten meal is a by-product from corn that is used in the wet industry. Corn-based diets using a corn-based protein source will be deficient in lysine and tryptophan, critically important amino acids for muscle growth and health. Rations utilizing corn-based proteins will need synthetic amino acids to balance amino acid ratios. Amino acids can have an antagonistic effect with each other if not in the correct ratio, so consult a nutritionist when rebalancing amino acid concentrations in a diet with synthetic amino acids. Corn gluten meal contains approximately 58% CP, 0.9% lysine, 5% fat, and 2% NDF. Compared to soybean meal, corn gluten feed has less fiber than soybean meal.

Corn gluten feed

Another by-product from the wet milling industry is corn gluten feed. Similar deficiencies in lysine and tryptophan will be noticed, so synthetic amino acid fortification will be needed. Corn gluten feed contains approximately 17% CP, 0.6% lysine, 4% fat, and 28% NDF. Due to the significantly higher levels of fiber in corn gluten feed compared to soybean meal, corn gluten feed is not as commonly fed to swine.

Sunflower meal

Sunflower meal is a by-product from extracting oil from sunflower seeds. Sunflower oil can be extracted through expelling or solvent extraction. Sunflower meal contains approximately 31 to 40% CP, 1.1 to 1.5% lysine, 3% fat, and 30 to 37% NDF. Since fiber is approximately 4 times the amount as soybean meal, sunflower meal is included at low concentration in the diet. The unsaturated fatty acid profile can also cause soft bellies in pork, so avoid feeding at least in the last month before slaughter.

Field peas

Field peas are an excellent alternative source of protein for swine compared to soybean meal. Field peas are a great source of lysine and have a relatively high concentration of starch available to swine. Although field peas have small amounts of trypsin and chymotrypsin inhibitors, those can be inactivated by heating. Field peas contain 22% CP, 1.6% lysine, 1% fat, and 13% NDF. Available starch levels are approximately 43%, which provides additional energy to the diet. When corn and soybeans are high in price, field peas are one of the most attractive alternative protein sources.
Animal-derived protein sources

Blood meal

Blood meal is obtained from slaughter facilities, where the product is collected, chilled, and heated to eliminate any potential pathogen contamination. Blood meal contains up to 90% CP and 8.6% lysine. If blood meal is excessively heated, then lysine availability can be reduced. Variability in amino acid profile can make this product difficult to use without consulting a nutritionist to rebalance the amino acid profile with synthetic amino acids. Many animal-derived protein sources are used in nursery piglets, because of the high concentration of highly digestible protein.

Meat and bone meal

Similar to blood meal, meat and bone meal is obtained from various harvesting plants, where leftover animal tissues are collected to create meat and bone meal. Heating of meat and bone meal to eliminate pathogens is required to utilize this feed ingredient, however, this process can also denature the protein. Due to variation in the product, consulting a nutritionist to rebalance the amino acid profile with synthetic amino acids will be necessary. Meat and bone meal contains approximately 50% crude protein and 2.6% lysine. Also, meat and bone meal is an excellent source of calcium and phosphorus.

Fish meal

Whole fish or fish waste can be processed from fish processing plants to produce fish meal. Fish meal is a highly digestible source of protein and can increase intake for pigs consuming diets with fishmeal. Fish meal can vary in nutrient content and palatability depending on the type, species, and freshness of fish. Note that diets with high fish meal inclusion can cause a fishy flavor in pork when fed in the finishing stage. For this reason, fish meal is an excellent source of protein in starter diets. In general, fish meal contains high levels of lysine and methionine, calcium and phosphorus, and omega-3 fatty acids. Fish meal CP content is approximately 63%, and lysine content is 4.6%.

Poultry meal

Poultry meal is obtained from tissues during poultry harvesting. The amount of bone included in poultry meal can directly affect the digestibility of the by-product. The heating process to eliminate potential pathogens is required, but can further decrease digestibility of poultry meal. Poultry meal contains 65% CP and 4.0% lysine. Tryptophan can be a limiting amino acid in poultry meal, so consider adding synthetic amino acid fortification of the diet.

Milk, whole or skim (dried)

Milk provides a high-quality protein that is very palatable and digestible. Dried milk contains 37% CP and 2.4% lysine, making a very desirable product. Dried milk is very high in lactose (48%), so adjusting the energy inclusion in the diet is highly recommended. Note that these levels are on a 95% dry matter (DM) basis. If “slop-feeding” is an option, know that cow milk contains approximately 87% water, or 13% DM, so inclusion rates will need to be adjusted to account for gut fill with water. Also, the increased water consumption can cause pigs’ stool to become loose. When sourcing other species’ milk, know that protein, lactose, and water profiles will differ.

Dried whey concentrate and casein are alternative high-quality and highly digestible protein feeds. Casein contains 89% CP and 6.9% lysine, and whey concentrate contains 76% CP and 6.9% lysine. Both dried protein sources can be expensive to purchase due to competing with human markets for these proteins. Typically, whey concentrate and casein are used in young pig diets, because the protein profile matches the profile needed by a young growing pig.

Direct amino acid supplementation

When the ideal protein source is too expensive or difficult to find, swine nutritionists turn to supplementation through specific amino acids. Sometimes also referred to as crystalline amino acids (based on the chemical form of the compound), synthetic amino acids are created via bacterial fermentation and are isolated to contain a pure concentration of a specific amino acid. It is very common for commercially available complete pig rations to contain synthetic Lysine, as few protein sources contain enough available Lysine. If you are mixing your own rations at home, synthetic amino acids may help you boost the efficacy of your diet. Just be sure to consult a nutritionist before adding them to your ration, as adding too much can cause your pigs to go off feed.

Conclusion

When soybean prices are high, the cost of feeding pigs increases. Even if you produce your own soybeans, the opportunity cost to sell on-farm soybeans can be more attractive than feeding them through pigs. If this is the case, there are numerous alternative protein sources available to provide an excellent diet for swine. Be sure to consider the cost of the alternative source, and the ease of obtaining the source as a reliable ingredient in your feed. Finally, it is always recommended to consult with a nutritionist to ensure that the diet being fed provides the nutrients needed for optimum growth and to support pig health.

Additional resources on swine protein sources can be found through Extension partners:

KSU Protein Sources for Swine Diets fact sheet.pdf (k-state.edu)
AlternativeFeedIngredientsSwineDiets.pdf (illinois.edu)
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