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Byproducts, Damaged Feeds and Nontraditional Feed Sources for Swine

John C. Rea, Ronald O. Bates and Trygve L. Veum
Department of Animal Sciences

In Missouri, corn and soybean oil meal are the principal feed ingredients used in formulating swine rations. Rations using corn and soybean meal remain the standard to which other ingredients are compared.

Considerable use is made of other ingredients, however, depending on cost.

Milo and wheat have been substituted for corn, primarily for energy. Tankage, meat and bone meal and fish meal have been used in place of soybean meal for protein.

Occasionally, producers have an opportunity to use nontypical sources of feedstuffs as a substitute for the standards. These sources become more attractive when costs of traditional sources are considerably higher than normal.

Energy and protein

Most substitute feeds for swine are evaluated on the basis of their protein and energy. Some feeds have additional value from their mineral and vitamin content. However, these nutrients can be added economically from other sources. Therefore, this discussion will deal with protein and energy.

Energy nutrients are primarily carbohydrates and fats, although some protein may be used for energy. Energy is the most costly item in swine production. It is necessary for all body action, including breathing, moving muscles and keeping the body warm. Excess energy is stored as body fat. Both carbohydrates and fat are energy nutrients, but fat is a more concentrated source of energy, containing about 2-1/4 times as much energy as carbohydrates. Feeds high in fat have a much higher energy value than low-fat feeds.

Energy values are usually expressed as ME (metabolizable energy) or DE (digestible energy). Carbohydrates are separated into nitrogen-free extract (NFE) or crude fiber. The NFE portion includes the more soluble carbohydrates — sugar, starch and some hemicellulose. They are all very digestible. Crude fiber contains cellulose, lignin and other complex carbohydrates, all of which are highly indigestible for pigs. The type of carbohydrate in a feed source determines its value as a source of energy for the pig. Cereal grains containing 60 to 70 percent NFE are the usual standard and are low in crude fiber.

Digestible energy is defined as the dietary gross energy intake minus energy excreted in the feces. Metabolizable energy is gross energy minus both fecal and urinary energy. Gases of fermentation (primarily methane) are quite small in pigs compared to ruminants and are usually ignored in calculating apparent metabolizable energy values for pigs. The metabolizable energy content of ingredients used in swine rations generally compromises 90 to 97 percent of digestible energy.

Protein is an important part of the feed for swine. Definitive requirements have been determined

experimentally for total protein and the individual amino acids that make up protein. The term "protein quality" refers to the makeup of the amino acids. Quality protein has a favorable balance of amino acids in its makeup. A common practice is to refer to percent protein in swine rations, but without some information on the balance of amino acids in the protein, the data is insufficient for formulating superior rations.

The following sources may be available as substitutes for energy and protein. Compare them with corn and soybean meal. Use the best information available and consider how you plan to use them. Remember the limitations given, then figure the cost. Most of these ingredients provide energy and protein but are usually used to provide just one.

Substitutions for energy

High-moisture corn
On an equivalent moisture basis, many trials in the Midwest have shown that performance of pigs fed high-moisture corn rations is similar to performance of those fed regular corn rations. To obtain the same energy, pigs must eat more of the high-moisture ration; young pigs may lack the capacity to eat enough of this type ration. Make decisions based on harvesting advantages rather than improvement in pig performance.

Molds and bridging occasionally cause problems in feeding complete rations using high-moisture corn. Some trials indicate that pigs fed high-moisture corn free-choice with a protein supplement tend to overeat on the corn, resulting in a lower-than-normal total protein level.

Corn silage
Corn silage is too low in energy and too high in fiber to be satisfactory for growing and finishing hogs. It can substitute in sow rations for energy if you provide protein supplements. Self-fed sows eat from 10 to 14 pounds of corn silage daily.

Moldy or damaged grain
You can feed livestock moldy or damaged grain that is not acceptable for human food. Evaluate these feeds on a case-by-case basis, following some general guidelines:

- Loss of nutrients may occur, but this is not usually the major problem. Normally, the grain will have enough value to be considered a substitute for regular corn.
- Refusal to eat damaged grain is common.
- Fusarium molds and aflatoxin can be toxic to hogs, resulting in reduced performance, reproductive failure and, occasionally, death.

The seriousness of the moldy grain problem depends partially on the kind of mold involved and how much is present, as well as the sex and age of animals being fed. Many producers feed a lot of moldy corn each year with little problem. Consider these factors in trying to salvage such grain:

- The moldier the corn, the greater the chance for problems with animals eating it.
- Younger animals are more susceptible to mold toxicants than older animals.
- Pregnant females are more susceptible than open females and males.

Try trial feeding moldy corn with a few animals. Dilute moldy grain with regular corn.

Sprouted milo
Milo that contains sprouted kernels is usually heavily docked at grain elevators, which often means you can use it as an inexpensive livestock feed. Chemical analysis of sprouted milo samples, which contain 20 to 30 percent damaged kernels, show little difference in crude protein, amino acids, calcium and phosphorus when compared to milo samples that did not contain sprouted kernels. Fiber content of sprouted samples was higher

(0.15 to 0.61 percent) than non-sprouted milo samples.

In feeding trials in Texas and Missouri, nursery pigs (15 to 17 pounds) fed sprouted milo tended to consume 7 to 8 percent less feed and grow 6 to 12 percent slower up to about 30 pounds. Feed efficiency (pounds of feed per unit gain) was not affected. Performance improved from 30 to 50 pounds. Pigs that were started at 50 pounds on rations that contained 20 to 30 percent damaged kernels consumed less feed (decrease of 8 percent) and grew 4 percent slower from 50 to 120 pounds. Feed efficiency was not affected. Feed intake, average daily gain and feed efficiency were not significantly affected from 120 to 220 pounds. Thus, pigs fed rations containing sprouted milo with 20 to 30 percent damaged kernels eat less and grow slower for the first two to four weeks before their performance improves to levels near that expected of pigs consuming milo with no damaged kernels.

Researchers from Kansas studied milo that contained about 40 percent damaged kernels. Growing pigs had similar average daily gain when compared to pigs fed milo that was not sprouted. Feed efficiency, however, was increased by 12 percent when pigs consumed the ration containing sprouted milo as the grain source. In all experiments that reported rations in which the grain source was one-half sprouted milo, no difference in feed consumption, growth rate or feed efficiency was reported. When using sprouted milo in growing pig diets, performance does not appear to be affected when it is mixed in equal amounts with unsprouted milo.

Before you use sprouted milo in rations, analyze samples for molds and mycotoxins. This is especially true if the sprouted milo is for the breeding herd.

Corn gluten feed
This feed can become very competitive in price as an energy and protein source for hogs. Energy, however, is limiting, like in oats. Protein is about 21 percent and lysine is 0.5 percent. Tryptophan availability is poor, probably about 0.05 percent. Up to 20 percent corn gluten feed may be used in growing and finishing rations if the ration is adequate in lysine, tryptophan and energy. Properly supplemented, corn gluten should work well for gestating sow rations. Compared with corn, amounts fed will probably need to be increased.

Rice bran
Swine producers in southern Missouri are using small amounts of rice bran in swine rations. Rice bran contains about 13 percent protein, 14 percent fat and 10 percent fiber. It has about 80 percent of the metabolizable energy of corn. When price is favorable, you can use it to replace up to 25 percent of corn in rations for sows and finishing pigs. Do not feed rice bran to young pigs.

Bread and bakery waste
Stale bread and bakery crumbs are high carbohydrate products and high-energy feeds. Nutritionally they compare with corn, with the protein content averaging about 10 percent. Fat content may vary depending on any additions made. Data on amino acid content and protein quality are insufficient. Some research indicates a value for these products from 75 to 100 percent of corn, depending on the fat and water content. Other research indicates the wastes could be substituted for corn at 100 percent, but most recommendations limit substitutions to 50 percent of the grain in the ration. It's a good idea to supplement the ration with proteins, minerals and vitamins as you normally would.

must be cooked for best results. Average analysis on cooked potatoes shows a value of 22 percent dry matter, 2.2 percent protein, 1 percent fiber and a low energy content.

Sweet potatoes
As with regular potatoes, sweet potatoes are a fair source of carbohydrates, but they contain little protein. Some research suggests that for best results, sweet potatoes should replace no more than half of the grain in a ration. The ration should also be properly supplemented with protein, minerals and vitamins. Because of the higher moisture content in sweet potatoes and potatoes, these feeds probably work best with hogs that weigh

more than 100 pounds.

Fats, oils and tallow
These products are available and useful as a source of high energy, particularly in rations containing low-energy byproduct feed ingredients. Amounts in swine rations commonly range from 2.5 to 5 percent. In addition to increasing energy, they decrease dustiness and increase binding qualities in pelleted feeds. Feed efficiency is improved when fat is added. Fats contain no protein or minerals, so you must add supplements for them.

Garbage and processing plant offal
Garbage feeding is regulated in Missouri, and you should carefully follow the regulations. Disease is a risk when the materials are improperly cooked. Researchers have studied the composition and digestibility of garbage, and they found considerable variation in digestibility, depending on the source. Data from New Jersey give the following average percentages for municipal garbage: moisture, 83.4; protein, 2.9; fat, 3.6; fiber, 1.4; and nitrogen-free extract, 7.3. In southern Missouri, some material from poultry processing plants is used in swine rations. Producers need to analyze these materials and take note of excess levels of salt when formulating acceptable rations.

Substitutions for protein

Cooked whole soybeans
Research at Missouri and other Midwest experiment stations shows that producers can use properly cooked whole soybeans as a source of protein and energy for hogs. When rations using whole beans were formulated on an equal protein basis, performance was equal to corn/soybean meal rations. In one trial, a 10 percent improvement over corn/soybean meal rations occurred. For most comparisons, equal protein amounts or 5 percent improvement is reasonable. Consider the economics before substituting whole beans for soybean meal. Consider the market value of whole beans and the processing, storage and labor costs associated with cooking the beans.

Raw soybeans
Uncooked whole soybeans are unsatisfactory in rations for growing swine. They have poor nutritive value because of a trypsin inhibitor that interferes with maximum amino acid use. Additionally, a toxic prohibitor, soyin, diminishes feed intake. Recent research from Midwest experimental stations shows producers can substitute raw soybeans satisfactorily in gestating sow rations. You need a slightly larger amount of whole beans because they contain less protein than soybean meal.

Sunflower seeds
You can use sunflower seeds in swine rations. A level of 10 to 20 percent sunflower seeds is acceptable in growing and finishing rations. Formulate diets on a lysine basis. You can also use sunflower seeds as a fat source in sow diets. Limit use to 25 percent of total sow rations.

Meat meal and tankage
Meat meal (50 percent protein) and tankage (60 percent protein) have long been used as sources of protein in swine rations. They provide a good source of lysine, calcium, phosphorus and certain B vitamins. They usually vary more in quality than does soybean meal, and pigs do not like them as well. Generally, you should limit these products in the ration because of their high calcium level and poor palatability. If you can get them at a price that is competitive with soybean meal, limit their use to a maximum of 50 percent of the supplemental protein. They work well when the protein supplement is self-fed, such as when "hogging down corn," because they help limit intake compared to soybean meal, which hogs tend to overeat.

Blood meal

Blood meal is a byproduct of the packing industry. It is high in protein (about 80 percent), but is generally considered less digestible and poorer in quality than the protein of meat meal. Its greatest value occurs when it is only part of the supplement and in the rations of heavier hogs.

Flash-dried blood meals are higher in quality than conventional air-dried meals. They improve nitrogen retention over soybean meal when added at 3 to 6 percent in starter diets.

Fish meal
It is unlikely that fish meal will ever compete effectively in price with soybean meal, but it is an excellent source of protein. Crude protein varies from 60 to 70 percent, and the quality is superior although less uniform than that of soybean meal. It is particularly high in two essential amino acids, lysine and methionine. Producers often use it in creep rations to raise the level of these two amino acids.

Skim milk and buttermilk
Dried skim milk is a good source of protein and energy. It contains about 33 percent protein, is of excellent quality and may be used in creep rations. It is higher in energy than either corn or soybean meal. Fluid skim milk contains only about 9.5 percent dry matter and is worth about 1/10 as much as dry milk on a pound-for-pound basis. Buttermilk has about the same chemical composition and feeding value as skim milk, except it has a higher fat content.

Whey — liquid or dry
Some research indicates the feeding value for whey is about half that of skim milk or buttermilk. The protein in liquid whey is very low (about 1 percent), but the quality of the protein is excellent. Nutrient intake is limited by the high water content. Pigs probably will consume a gallon or less a day. You can feed hogs weighing more than 100 pounds all the whey they will drink if you supply additional nutrients. This reduces the amount of protein supplement needed in the ration by 35 percent. Dried whey varies from 13 to 14 percent protein and is lower in energy than dry skim milk or buttermilk.

Brewers grains
Brewers dry grain contains about 26 percent protein, 6.2 percent fat and 15 percent fiber. It is a fairly low-energy feed, and high levels tend to depress intake and gains. It probably works best in the finishing stages of swine rations. It has provided from 25 to 50 percent of the supplemental protein in growing and finishing rations.

Linseed meal
Linseed meal is inferior to soybean meal; it has an approximate value of 85 percent that of soybean meal. It may have some laxative qualities, which may be a good addition to brood sow rations before and after farrowing. If the price is competitive, you should probably still limit its use to less than 25 percent of the total protein supplement in balancing a ration.

Cottonseed meal
Historically, producers have avoided including cottonseed meal in swine rations because it contains gossypol, which is toxic to hogs. Processing to reduce gossypol levels makes it possible to use cottonseed meal to some extent. Compared with soybean meal, cottonseed meal has a lower lysine content, is a lower-energy protein and is higher in fiber. It probably works best in the rations of heavier hogs rather than in starter rations. Arizona reports indicate that half cottonseed meal and half soybean meal supplements result in good performance. Adding one part of iron to each part of free gossypol seems to help block the effect of gossypol.

Feather meal
Some feed processors use feather meal. Hydrolyzed feather meal contains about 85 percent protein. It is, however, a poor quality protein and is deficient in methionine, lysine, tryptophan and histamine. Compared with soybean meal, it is low in energy and is generally regarded as a poor-quality feedstuff.

Alfalfa meal (dehydrated)
Dehydrated alfalfa meal contains about 17 percent protein. It is high in fiber (about 24 percent) and is relatively indigestible and unpalatable for young pigs. Low digestible energy is probably its first limiting factor. It contains vitamins (vitamin A in particular) and possibly some unidentified growth factors. Some experts recommend it for sow rations when used at a level of about 10 to 20 percent in the ration.

Field peas
Reports from Ontario indicate that cull-grade field peas containing 25 percent protein are an effective replacement for soybean meal.

Cull white beans
Cull white beans have about 23 percent protein and must be processed to destroy toxic factors. A heat process such as that used for raw soybeans is sufficient. Generally, 5 percent soybean meal or equivalent is recommended in a cull white bean ration.

High amino acid corn
You can use corn varieties containing higher-than-normal amino acid levels to lower protein requirements. First, obtain an analysis of actual lysine content.

Synthetic amino acids
Research indicates that you can successfully substitute synthetic amino acids for some natural protein. You can use synthetic amino acid sources, particularly lysine, to satisfactorily substitute for shortages of lysine in natural feeds. Synthetic amino acids also enable you to reduce total protein content of the diet up to 2 percent. This helps provide a better amino acid balance in practical diets because the levels of excessive amino acids are reduced. Tryptophan and threonine are also available commercially but are generally too expensive for practical rations. Be sure you make price determinations and choices based on actual lysine in plant sources compared to synthetic ones.

Commercial protein supplements
You should use commercial supplements primarily as a source of protein. Compare them to soybean meal in price on a cost-per-pound of protein basis. In calculating their value, determine the value of minerals, vitamins and antibiotics that may be included.

Using byproducts

When normal feedstuffs are expensive, hog producers become more interested in trying less expensive alternatives. There are some risks involved. You need better management skills and must put forth more effort if you are to successfully use substitutes. Consider these questions when thinking about new feed possibilities:

- Is the nutrient composition suited to swine feeding?
- What is the feeding value of the feedstuff?
- Are there any animal or human hazards associated with the byproduct?
- What added processing and other costs are associated with the product?
- Does the feed cost savings exceed other costs associated with the new feed?
- Is availability and consistency of product good enough to support long-time usage?

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Related MU Extension publications

- G2321, Vitamin Requirements of Swine
  http://extension.missouri.edu/publications/DisplayPub.aspx?P=G2321
- G2323, Feeding Organic and Inorganic Sources of Trace Minerals for Swine Production
  http://extension.missouri.edu/publications/DisplayPub.aspx?P=G2323
- G2324, Swine Diet Manipulation to Minimize Environmental Impacts
  http://extension.missouri.edu/publications/DisplayPub.aspx?P=G2324
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