ID-66
# RESIDUE AVOIDANCE PROGRAM - FEED ADDITIVES AND RESIDUE PREVENTION IN SWINE

ISSUED: 2-85
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The goal of any pork producer is to make a profit on the product. Feed additives play a direct role in achieving, or failing to achieve, this goal. When properly used, they can result in increased profit. Conversely, feed additives used haphazardly or indiscriminately can cut into profits.
The level of a feed additive for growth promotion and improvement of feed efficiency is lower than the level used for the control or treatment of disease. Producers should consult with a veterinarian or nutritionist before developing a drug or feed additive program for the swine herd.

## Types of feed additives

Feed additives are compounds added to premixes, supplements, and complete feeds. The major feed additives used in swine feeds are drugs [antibiotics, chemotherapeutics, and anthelmintics]. Other types of feed-additive compounds [probiotics, enzymes, etc.] are less commonly used. Following is a brief description of the various types of feed additives for swine.

## Antibiotics

Antibiotics are produced by bacteria or mold that kill or inhibit the growth of other microorganisms. Antibiotics are used in the feed to stimulate growth rate, improve the efficiency of feed utilization, and reduce mortality and morbidity in pigs.

## Chemotherapeutics

Chemotherapeutics are chemically synthesized compounds which inhibit the growth of certain microorganisms. Chemotherapeutics are used alone or in combination with certain antibiotics for the purpose of enhancing growth and feed efficiency and for disease control and treatment.

## Anthelmintics

Anthelmintics are deworming compounds which are used to control the accumulation of internal parasites in swine. The parasites that are of economic importance include large roundworms [ascarids], nodular worms, whipworms, lungworms, kidney worms, stomach worms, and intestinal threadworms.

## Probiotics

Probiotics include yeasts, lactobacilli and similar compounds. The intent of these compounds is to shift the bacterial population in the tract to a "more desirable" type. Probiotics have been shown in certain instances to improve performance in stressed pigs under field conditions, but their efficacy in improving performance in controlled experiments is less consistent than is the case for antibiotics.

## Enzymes

Enzymes improve digestion of protein, carbohydrates, and fat. They are more likely to be beneficial in the early-weaned pigs than in older animals.

Flavors

Flavors sometimes are included in feeds to create a pleasant odor or taste, or to mask an undesirable odor or taste in low-quality feedstuffs. They are more commonly used in starter feeds than in other swine feeds.

Antioxidants

Antioxidants are added to prevent the development of rancidity in feeds. They are often used when feeds contain added fat.

Mold inhibitors

Mold inhibitors are certain organic acids [i.e. propionic acid] commonly used as a preservative in high-moisture grain to prevent mold growth.

Pellet binders

Pellet binders are added to feeds prior to pelleting in order to produce a hard, cohesive pellet.

Growth-promoting feed additive drugs

Antibiotics and chemotherapeutics are the feed additives that have been most widely used in the swine industry for the past three decades The use of antibiotics, in conjunction with good management, has been one of the reasons that swine producers have been successful in raising healthy 'pigs in the highly intensive confinement systems that are commonly found in the swine industry today.

It is estimated that about 85 to 95 percent of all starter feeds, 75 to 80 percent of all grower feeds, and 60 percent of finisher feeds contain feed additive drugs. The antibacterials most commonly used in starter and grower feeds are chlortetracycline [Aureomycin], oxytetracycline [Terramycin], tylosin [Tylan], carbadox [Mecadox], lincomycin [Lincomix], and combinations of certain antibacterials, which include chlortetracycline-penicillin-sulfamethazine [aureo-SP-250, chlorachel-250], chlortetracycline-penicillin-sulfathiazole [CSP-250], tylosin-sulfamethazine [Tylan-Sulfa) and neomycin-oxytetracycline [Neo-Terramycin]. The sulfa-containing combinations are very popular and account for approximately 50 percent of the total usage during the starter-grower phase. The sulfa drugs are particularly useful for maintaining performance in herds with atrophic rhinitis and other respiratory problems. For finishing hogs, tylosin, oxytetracycline, chlortetracycline, penicillin-streptomycin [Pro-Strep], virginiamycin [Stafac], bambermycins [Flavomycin], lincomycin and bacitracin are the most commonly used feed additives. Tylosin and the tetracyclines account for about 55 percent of the usage during the finishing stage.

The efficacy of antibiotics in improving the rate and efficiency of growth in pigs is well documented in many research studies. Table 1 summarizes data from over 900 experiments conducted in the United States between 1950 and 1975, involving more than 20,000 pigs. Note the growth rate and feed efficiency improvements for various weights of pigs.

Mode of action of antibiotics

The mechanism by which antibiotics improve growth rate and feed efficiency is not well understood, but generally is attributed to [1] a metabolic effect, [2] a nutritional effect, and/or [3] a disease-control effect.

The metabolic effect implies that antibiotics directly affect the rate or pattern of the metabolic processes

in the animal, such as influencing metabolic rate, nitrogen or water excretion, rate of nutrient oxidation, etc. However, a metabolic effect certainly is not a reasonable explanation for those antibiotics that are not absorbed from the intestinal tract.

The nutrient-sparing effect has a considerable amount of research support. Certain microbes that inhabit the intestinal tract produce vitamins and amino acids which are essential to animals, while other microbes compete with the host animal for essential nutrients. Shifts in bacterial populations associated with the feeding of antibiotics could account for a greater availability of nutrients for the host animal. Antibiotic feeding also has been shown to reduce the thickness of the gut wall, resulting in a potential for greater absorption of nutrients. The gut wall thickening is thought to be caused by bacteria that damage or produce toxins that, in turn, damage intestinal tissue. The increased ammonia production that occurs in the gut when nonantibiotic diets are fed is thought to be a major contributing factor to the increased gut wall thickness.

The disease-control effect is the most widely accepted explanation for the growth response to antibiotics. This mechanism implies that antibiotics suppress those organisms in the intestinal tract that are responsible for subclinical or nonspecific disease, thereby allowing pigs to perform up to their maximum genetic potential.

The growth response to antibiotics is influenced by several factors: the stage of growth of the pig, the cleanliness of the environment, the disease level in the herd, and the level and type of antibiotic. Young pigs have lower levels of immunity and are more susceptible to disease-causing organisms in their environment; therefore, they respond to antibiotics more than do older pigs [table 1]. Responses to antibiotics tend to be greater under conditions of poor sanitation, poor management, and high disease level. Again, this can be explained by the greater growth depression from subclinical disease in the poorer environment, which is partially alleviated by the feeding of antibiotics.

**Table 1. Effects of age and weight of pigs on response to antibiotic feeding[1].**

| | **Control** | **Antibiotic** | **Improvement, %** |
|---|---|---|---|
| Starter phase (15-57 lb) | | | |
| Daily gain, lb | .86 | 1.01 | 16 |
| Feed/gain | 2.32 | 2.16 | 7 |
| Grower phase (37-108 lb) | | | |
| Daily gain, lb | 1.30 | 1.45 | 11 |
| Feed/gain | 2.91 | 2.78 | 5 |
| Grower-finisher phase (44-189 lb) | | | |
| Daily gain, lb | 1.50 | 1.56 | 4 |
| Feed/gai7n | 3.37 | 3.30 | 2 |

[1]Data from 378, 280, and 279 experiments, involving 10,023, 5,782, and 5,666 pigs for the three phases, respectively. Source: Hays, 1977.

Estimates of the benefits of antibiotics from controlled experiments, such as reported in table 1, are probably less than what would be expected at the farm level. In experiment station tests, the environment generally is cleaner, pigs are penned in small groups, and the smaller, less thrifty pigs are not used. Table 2 illustrates that responses to antibiotics are about twice as great under field conditions as at experiment stations.

**Table 2. Comparisons of experiment stations tests and field tests[1].**

| Location | No. trials | Improvement from antibiotics, %[2] | |
|---|---|---|---|
| | (daily gain) | (feed/gain) | |
| Experiment Stations | 128 | 26.9 | 7.0 |
| Field Tests | 32 | 28.4 | 14.5 |

[1]Data on 12,000 pigs from 15 to 57 lb.
[2]Chlortetracycline-penicillin-sulfamethazine, tylosin-sulfamethazine, tetracyclines, and carbadox.
Source: Hays, 1977.

What is a residue?
A residue is a substance, or its metabolite, that remains in any body tissue after absorption. The original substance may have been a feed or water additive, an injectable or topical treatment, or an accidental contaminant. Some substances may be cleared from body tissues a few hours after absorption, others several months, and some may never entirely clear.

Why the concern?
Meat that contains an unsafe or violative residue is perceived as a public health concern for several reasons:
1.It is a violation of federal law to adulterate foodstuff. A violative residue is considered an adulteration. For some drugs an established tolerance level has been set by the FDA. The Food Safety and Inspection Service [FSIS] randomly samples animals at slaughter plants for residues using the Swab Test, which can be performed in 24 hours. If a suspect animal is slaughtered, the carcass will be retained until the test results are obtained.
2.Persons who are very sensitive to certain drugs may develop a severe allergic reaction if traces of drugs are in the meat.
3.The food supply is assumed to be wholesome. Therefore it is essential that animal products be acceptable to the consumer and free of residues.

How to prevent a residue problem
Not all drugs have the potential for causing a violative residue problem. Those that may cause a residue have a "withdrawal time" on the label. The withdrawal time varies from a day to several months depending on the drug involved (table 3). Most drugs and their metabolites are excreted from the body by way of the urine and feces. Proper management of feed additives and feed mixing and handling systems to prevent accidental contamination of feedstuff is essential. Carry-over of drugs in feeders, bulk bins, auger systems, feed mixers, and manure are possible causes of residue problems.

**Table 3. Approved levels and withdrawal periods for feed additives used in swine feeds for improved growth rate and feed efficiency.**

| Feed additive | Growth promotion level (grams/ton) | Withdrawal period |
|---|---|---|
| **Antibiotics** | | |
| Bacitracin, M.D. | 10-30 | none |
| Bacitracin, Zinc | 20-40 | none |
| Bambermycins | 2-4 | none |
| Chlortetracycline | 10-50 | none |
| Erythromycin | 9.25-64.75 | none |
| Oleandomycin | 5-11.25 | none |
| Oxytetracycline | 7.5-50 | none |
| Penicillin | 10-50 | none |
| Tylosin | 10-100 | none |
| Virginiamycin | 5-10 | none |
| **Chemotherapeutics** | | |
| Arsanilic Acid | 45-90 | 5 days |
| Sodium Arsanilate | 45-90 | 5 days |
| Carbadox | 10-25 | 10 weeks [75 lb) |
| Furazolidone | 100-200 | 5 days |
| Roxarsone | 22.7-34 | 5 days |
| **Combinations** | | |
| Arsanilic Acid or Sodium Arsanilate | 45-90 | 5 days |
| + Streptomycin | 7.5-15 | |
| + Penicillin | 1.5-3 | |
| Arsanilic Acid or Sodium Arsanilate | 45-90 | 5 days |
| + Penicillin | 50 | |
| or Streptomycin | | |
| or Chlortetracycline | | |

| | | |
|---|---|---|
| or Bacitracin | | |
| or Oxytetracycline | 7.5-50 | |
| or Furazolidone | 100-200 | |
| or Oxytetracycline | 50-100 | |
| + Furazolidone | 100-200 | |
| Arsanilic Acid or Sodium Arsanilate | 45-90 | 15 days |
| + Hygromycin B | 12 | |
| or Oxytetracycline | 50 | |
| + Hygromycin B | 12 | |
| Chlortetracycline | 10-50 | 5 days |
| + Roxarsone | 22.7-34 | |
| Chlortetracycline | 100 | 15 days |
| + Sulfamethazine | 100 | |
| + Penicillin | 50 | |
| Chlortetracycline | 100 | 7 days |
| + Sulfathiazole | 100 | |
| + Penicillin | 50 | |
| Furazolidone | 100-200 | 5 days |
| + Oxytetracycline | 50-150 | |
| Penicillin | 1.5-8.5 | none |
| + Streptomycin | 7.5-41.5 | |
| Tylosin | 100 | 15 days |
| + Sulfamethazine | 100 | |
| Tylosin | 10-100 | 15 days |
| + Hygromycin B | 12 | |

*the source of the above information was the 1983 Feed Additive Compendium published by the Millet Publishing Company, Minneapolis, Minnesota.

If there is doubt about a residue problem, the producer or veterinarian can perform a Live Animal Swab Test [LAST] on several animals about to be sent to slaughter. This test uses the urine, which is placed on a culture plate to detect any bacteria-inhibiting substances. It is inexpensive, fast, and

dependable.

What If you are cited for a violative residue?
You will receive a letter from the regional FSIS office, telling you what residue was found. The animals involved will be "tanked" and you will receive no payment for them. Basically, five animals will need to be tested [kidney and livers] before any animals can be sold. These tests can be conducted at the slaughter plant, using the LAST, or may be sent to a private laboratory at the owner's expense. lf any of these five animals shows a violative residue, five more animals will need to be tested until no residue is detected. This can be a long and expensive time period.

Points to remember
1.Feed additive drugs, when properly used, are an effective means of improving growth rate, feed efficiency, and survival in pigs.
2.Producers should know what feed additives they are using and why they are using them. Feed additives must be used only at approved levels and in approved combinations.
3.Read the label and observe all feeding directions and cautions.
4.Management is critical in preventing a residue problem.
5.Disregarding regulations and withdrawal time is not only expensive but may cause loss of a drug from the market.
6.Producing a wholesome, safe product free of violative residues for the consumer can mean more profit for the producer.