Management to Prevent Drug Residue Problems in Pork: Pork Industry Handbook
Michigan State University Extension Service
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pork industry handbook

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Management to Prevent Drug Residue Problems in Pork

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Antibiotics and other feed additives are widely used in the swine industry for growth promotion and for the reduction of mortality and morbidity in pigs. Certain feed additives require a withdrawal period prior to slaughter in order to insure that residues do not occur in the carcass. The additives that require withdrawal and their withdrawal times are given in Table 1.

The feed additives causing the greatest residue problem in recent years have been the sulfonamides (or sulfa drugs). The sulfonamides are commonly used in combination with certain antibiotics in pig feeds. The feed additive combinations that include sulfa are Aureo SP-250 and Chlorachel-250 (chlortetracycline, penicillin and sulfamethazine), Tylan-Sulfa (tylosin and sulfamethazine) and CSP-250 (chlortetracycline, penicillin and sulfathiazole). The approved level of sulfamethazine and sulfathiazole is 100 grams per ton. In addition, the sulfas are sometimes used as water medications for controlling pneumonia, scours and other bacterial infections.

Sulfa drugs are primarily used with young pigs during the early growth stages. Nearly all starter feeds and approximately 75% of grower feeds are medicated. Approximately 60% of these medicated feeds contain sulfa. One reason for the popularity of the sulfa-antibiotic combinations is that they are very effective growth promoters, as shown in Table 2.

A summary of 378 experiments involving over 10,000 pigs indicates that pigs fed sulfa-antibiotic combinations from 19 to 57 lb gained 21.7% faster and required 8.2% less feed per pound of gain than control pigs that received no antibiotics. For 10 other antibiotics, the average improvements in daily gain and feed efficiency were less, 13.7% and 6.5%, respectively.

Similar trends were found in a summary of 280 experiments involving slightly heavier pigs, fed from 37 to 109 lb. The sulfa-containing feed additives also have been shown to be effective in maintaining performance in herds having chronic or acute respiratory infections such as Bordetella atrophic rhinitis.

The regulatory tolerance level for sulfa in pork tissue (liver, kidney or muscle) is 0.1 ppm, as established by the Food and Drug Administration. Regulations require that sulfamethazine be withdrawn from the feed for 15 days and sulfathiazole for 7 days in order to insure that tissues do not exceed the tolerance level for sulfa.

During the early 1970s, a national monitoring program was initiated by the USDA. By the mid-1970s, it was discovered that about 15% of hog carcasses were in violation because of sulfa residues. In almost all cases, sulfamethazine was the sulfonamide found in the tissues. A major effort was initiated in 1977 by the USDA, the Federal Extension Service and the National Pork Producers Council to solve this problem by means of research and educational programs. Although the problem has not been completely solved, the industry has been successful in getting the violation rate down to below 5% (Table 3).

Causes of Sulfa Residues

What is the reason for the high incidence of sulfa residues, and why has it been so difficult to eliminate the problem? Initially, producers were blamed for not complying with the withdrawal period. However, it was later realized that many violations were from farms where producers were following proper withdrawal times. In some cases, violations were even being reported on farms in which pigs were not known to have had access to any sulfa medication.

Finally, results of research conducted at Iowa, Illinois and Kentucky shed new light on the problem. It was found that very small amounts of sulfamethazine in the feed would cause a residue problem in the tissue. An early study at Kentucky indicated that as little as 1 gram of sulfamethazine per ton of feed would cause a high incidence of residues in the liver. Table 4 illustrates data from a later

study in which 2 grams of sulfamethazine per ton of feed was found to cause a violative residue in liver tissue. A higher level of sulfamethazine (8 grams per ton) was required before a violative level of sulfa occurred in the muscle.

Sulfathiazole is excreted more rapidly than sulfamethazine and, therefore, is less likely to cause residue problems. Table 4 shows that feed can be contaminated with up to 16 grams of sulfathiazole per ton before a residue occurs.

It is now clear that a major cause of the high incidence of sulfa residues observed in the mid-1970s was due to the unintentional cross-mixing of clean feed with sulfa-containing feed. Drug carry-over can occur in commercial feed mills or on the farm. It can also result from the inadvertent purchase of sulfa-containing premixes and supplements. As little as 40 lb. of a sulfamethazine-medicated feed (containing 100 g/ton), if unintentionally mixed into a ton of "clean" feed, will result in a feed containing 2 grams of sulfamethazine per ton—a contamination level that is liable to leave a residue of sulfa in edible tissue.

Preventing Drug Carry-over in Feeds

Drug carry-over in feeds can occur in a number of ways. Feed manufacturing equipment such as mixers, pellet mills, augers, elevator legs, dust control devices and storage bins can harbor dust and residual feed, which can contaminate clean feed (Figures 1, 2, 3 and 4). A vertical screw mixer may contain 40 to 50 lb. of residual feed in the boot after the feed is discharged. Failure to remove this residual feed will cause the next batch to be contaminated. In some farm mixers (portable grinder-mixers), even more residual feed can remain, in some cases over 100 lb. per batch. Thorough cleanout of all mixing equipment, conveyors, augers, elevator legs, and similar equipment is imperative in order to reduce the chance of drug carry-over. Some producers use a second set of equipment for mixing sulfa feeds in order to solve the drug residue problem.

A proper feed mixing sequence will reduce the degree of drug carry-over. For example, a finishing feed should never immediately follow a sulfa-medicated feed. Instead, one should follow a sulfa-medicated feed with a feed that is less likely to cause residue problems, such as a gestation or lactation feed.

Table 1. Feed additives that require withdrawal and those requiring no withdrawal from swine feed.[1]

Additives requiring withdrawal	Withdrawal time
Growth promoters	
Carbadox	70 days
Neomycin	20 days
Sulfamethazine	15 days
Sulfathiazole	7 days
Lincomycin	6 days
Arsanilic acid, sodium arsanilate	5 days
Furazolidone	5 days
Nitrofurazone	5 days
Roxarsone (3-Nitro)	5 days
Dewormers	
Thiabendazole	30 days
Hygromycin B	15 days
Levamisole hydrochloride (Tramisol)	72 hours
Pyrantel tartrate (Banminth)	24 hours
Additives requiring no withdrawal	
Growth promoters	
Bacitracin, zinc or MD	
Bambermycin	
Chlortetracycline	
Erythromycin	
Oleandomycin	
Oxytetracycline	
Penicillin	
Streptomycin	
Tylosin	
Virginiamycin	
Dewormers	
Dichlorvos (Atgard)	
Phenothiazine	
Piperazine	

[1]Feed Additive Compendium, 1983

Table 2. Comparison of antibiotics as growth promoters for young pigs.

	Number of experiments	Percent improvement over control pigs: Avg. daily gain	Percent improvement over control pigs: Feed/gain
Starting pigs (19 to 57 lb)[1]			
Antibiotic-sulfa combinations[2]	104	21.7	8.2
Other antibiotics	274	13.7	6.5
Growing pigs (37 to 109 lb)[3]			
Antibiotic-sulfa combinations[2]	32	15.4	5.7
Other antibiotics	248	10.7	4.6

[1] Data from 378 experiments; 10,023 pigs.

[2] Aureo-SP-250, Chlorachel-250, Tylan-Sulfa and CSP-250.

[3] Data from 280 experiments; 5,783 pigs.

Table 3. Percent sulfa violations in liver tissues of pigs.[1]

Year	Period	Violations, %
1977	July-December	13.2
1978	January-June	9.3
1978	July-December	10.1
1979	January-June	7.5
1979	July-December	5.1
1980	January-June	4.1
1980	July-December	4.8
1981	January-June	7.0
1981	July-December	5.1
1982	January-June	4.8
1982	July-December	3.7

[1] Based on over 25,000 liver samples, USDA.

Table 4. Effects of form (sulfamethazine vs. sulfathiazole) and level of sulfa in finisher feed on sulfa residues in pork.[1]

Form and level of sulfa	Sulfa residue		Violations[2]	
	Liver	Muscle	Liver	Muscle
	ppm	ppm	%	%
Sulfamethazine[3] in feed, g/ton				
0	<.01	<.01	0	0
1	.04	.01	0	0
2	.09	.02	38	0
4	.20	.05	100	0
8	.43	.09	100	40
16	.88	.19	100	100
100	4.55	1.52	100	100
Sulfathiazole[4] in feed, g/ton				
0	.01	<.01	0	0
1	<.01	<.01	0	0
2	.01	<.01	0	0
4	<.01	<.01	0	0
8	.03	.01	0	0
16	.07	.02	20	0
100	.30	.05	78	6

[1] University of Kentucky and University of Nebraska, 1981, 16 pigs/treatment.

[2] Percent of samples having .1 ppm or more of sulfa, based on two assay methods: colorimetric (corrected for background) and GLC.

[3] Sixteen pigs per treatment were fed 100 grams of sulfamethazine per ton for 2 weeks, then these levels were fed for 15 days prior to slaughter.

[4] Sixteen pigs per treatment were fed 100 grams of sulfathiazole per ton for 2 weeks, then these levels were fed for 7 days prior to slaughter.

The sulfonamides tend to be electrostatic and will cling to metal surfaces. Grounding of equipment will reduce this but will not completely eliminate it. Fortunately, the new granulated sulfa premixes recently introduced should help to eliminate this problem. In a recent study at Kentucky, the sulfa level in feed dust taken from the inside surface of a mixer was 276 ppm when powdered sulfamethazine was used, but it was only 59 ppm when granulated sulfamethazine was used.

Excessive dust and waste feed should never be allowed to accumulate around feed mixing equipment, as it can be a source of drug carry-over. Accumulated dust should be removed at regular intervals.

Bulk delivery trucks also can be responsible for drug carry-over in feeds if medicated and nonmedicated feeds are hauled at the same time or if the conveying system on these trucks is not cleaned out well between batches (Figure 5). Bulk storage bins on the farm should never be used for both sulfa-medicated feed and nonmedicated feed unless they are thoroughly cleaned out between batches. Feed tends to cling to the sides and corners of the bins (Figures 6 and 7) and in the discharge auger. Cross-contamination can occur in these structures if they are not completely emptied and properly cleaned between batches of feed. Hog feeders need to be emptied after sulfa-medicated feeds are used, if the same feeders will be used to finish out hogs. Medicated feed can build up in certain parts of feeders (Figure 8) and can contaminate several batches of nonmedicated feed if feeders are not cleaned out completely. If thorough cleanout and flushing of the feed delivery system in a building is not possible, then separate delivery systems are recommended for sulfa-medicated and nonmedicated feeds. Another alternative is to completely avoid the use of any sulfa-medicated feed in a building that houses finishing pigs.

The same principles hold for water medicators. Care should be taken to prevent contamination of clean water with sulfa-medicated water. Also, one should not medicate the feed and the water at the same time.

Proper Mixing of Feeds

Producers who mix their own feed on the farm must follow good feed mixing practices to insure uniform dispersal of drugs and other microingredients in feed. Accurate scales must be used. Volumetric mills must be calibrated often to insure proper mixing of ingredients. Producers must be certain that only approved levels of drugs and approved combinations of drugs are used in feeds. Levels and combinations of drugs are regulated by the FDA and are published in the Feed Additive Compendium (Miller Publishing Co., Minneapolis, MN).

Producers should use a recording system so that they can keep track of their medicated feeds. An example of one is shown in Figure 9. A good record system also will help to avoid mixing errors.

Preventing Access to Sulfa-containing Manure

A study at Illinois indicates that sulfa residues can be caused by pigs having access to sulfa-containing manure. Swine housed on solid floors that allow accumulation of urine are more likely to experience recycling of sulfa than swine housed on slotted floors.

Following sulfa withdrawal, pigs should be moved to a clean pen or the pen should be thoroughly cleaned at the time of withdrawal. These pens need to be cleaned daily for

Figure 1. This type of grinder-mixer is commonly used on hog farms. Mixers can harbor excessive residual feed and dust, and must be cleaned after mixing sulfa-medicated feed.

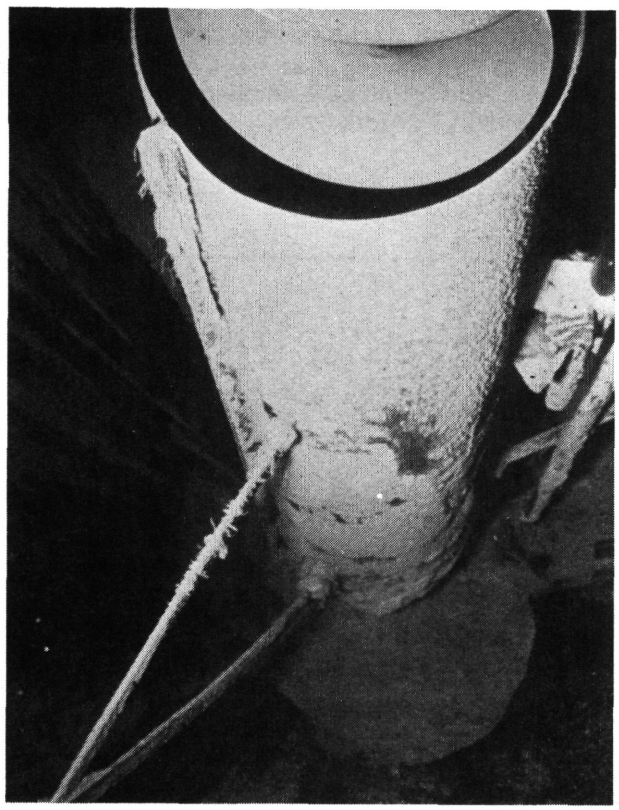

Figure 2. Vertical screw mixers are commonly found in small feed mills and in some feed mixing centers on hog farms. Because the discharge opening is above the lower end of the mixing auger, considerable amounts of feed can remain after feed no longer comes out of the discharge opening. This type of mixer also can harbor sulfa-laden dust.

2-3 days following withdrawal. Pigs also should not be allowed to have access to manure in trucks, holding pens, etc., where other hogs that may have had sulfa in their feed were kept. Holding pens that allow pooling of urine should be avoided.

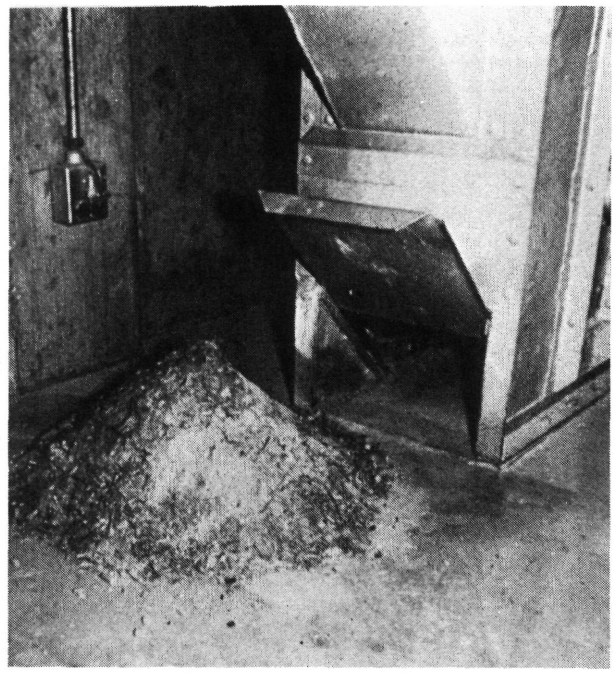

Figure 3. Elevator legs can hold sizable amounts of residual feeds or ingredients. Some of this material can be incorporated in the next batch of feed.

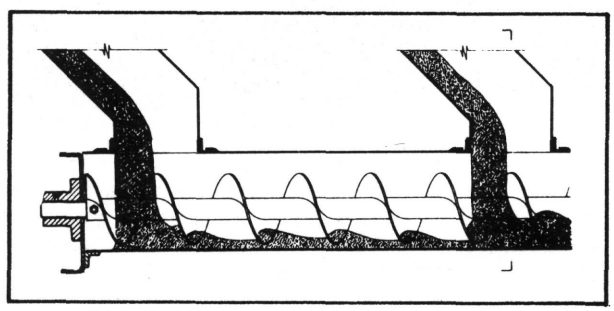

Figure 4. Augers often leave residual feed in the housing because the screws must have clearance. Drag-type conveyors are preferred where they can be used because they are self-cleaning.

Adherence to Withdrawal

Producers must be certain that they comply with the proper withdrawal periods, 15 days for sulfamethazine and 7 days for sulfathiazole. To be on the safe side, it is best to include sulfa only in the starter and grower feed (up to 125 lb.) and leave it completely out of the finisher feed. Some producers finish their hogs in a separate building and avoid the use of sulfa in the finishing building. This practice also solves the recycling problem via sulfa-contaminated manure.

Some have suggested that finishing hogs be fed only corn for several days prior to slaughter. While this practice might help insure that sulfa will not be present in the pre-slaughter feed, it may be a costly practice. Corn is extremely low in lysine and other amino acids, so growth rate and feed conversion will be markedly reduced by feeding shelled corn for any extended period of time, even to finishing hogs. However, this practice might be feasible as a last resort for producers having a serious residue problem.

In summary, the following practices will help to reduce drug residues in pork.

1. Use only approved levels and combinations of drugs.
2. Follow good feed mixing practices to insure that feed is mixed properly.
3. Maintain a record system to keep track of medicated feed.
4. Mix feed in proper sequence to reduce the chance of carry-over of drugs into finishing feed.
5. Clean feed mixing and conveying equipment to reduce cross-contamination of feeds.
6. Adhere to proper withdrawal periods.
7. Prevent recycling of drugs via manure.

Figure 5. A feed delivery truck can be a source of carry-over. Feed can remain in the lower horizontal conveyor and in the vertical conveyor. Although the amount of residual feed depends on the design of a particular system, residual feed can range up to 100 pounds.

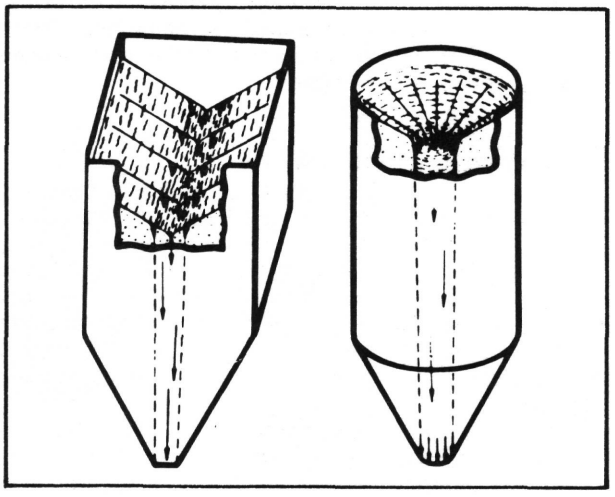

Figure 6. Movement of feed out of a bin occurs directly above the discharge opening. The remaining material then cascades down the slope of the crater that is subsequently formed. Failure to completely empty bins before refilling will result in residual feed being left in the bin.

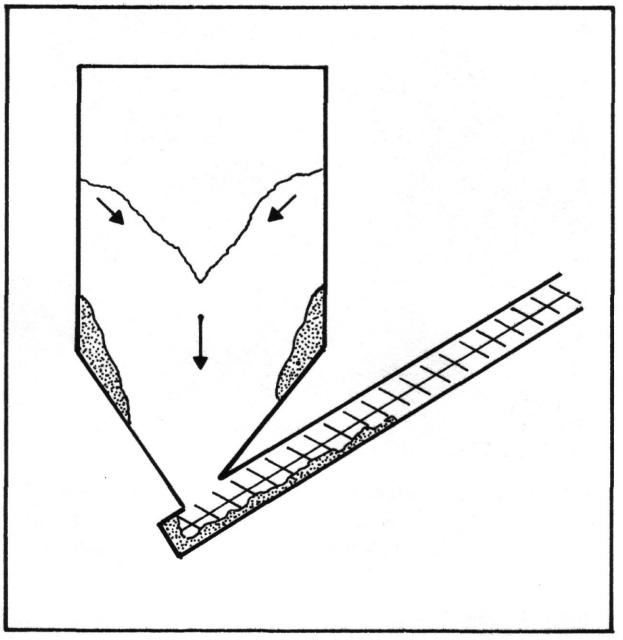

Figure 7. This drawing illustrates feed flow in a typical bin with the dark areas illustrating where the feed is most likely to be carried over.

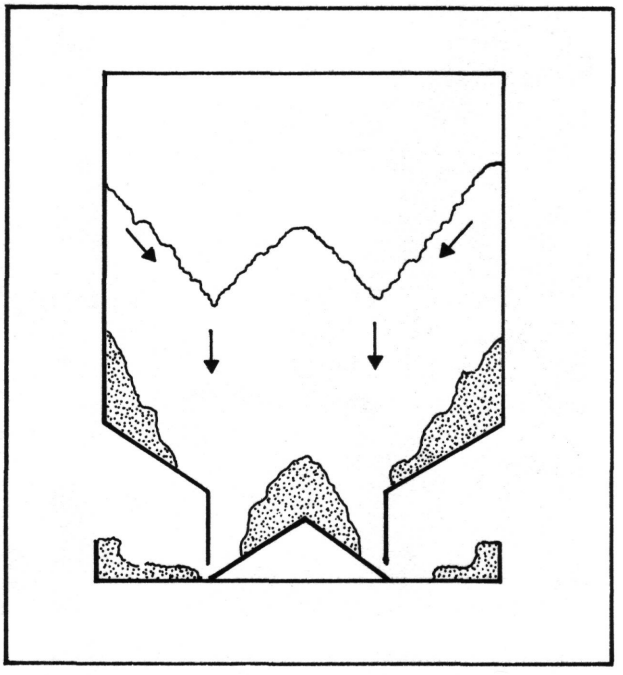

Figure 8. This diagram illustrates feed flow in a hog feeder. Residual feed areas are indicated by dark areas. Failure to completely empty the feeder before refilling will result in residual feed being left in the feeder.

Date mixed	Tank number	Description of feed	Tons	Medication	g/ton
10-14-82	2	Gestation, 14%	3	—	—
10-16-82	1	Starter, 18%	1	Tylan-Sulfa	100-100
10-16-82	3	Lactation, 14%	3	Neo-terramycin	50-50
10-21-82	4	Finisher, 13%	5	Aureomycin	50

Figure 9. A feed mixing record sheet will help to eliminate mixing errors and help producers keep track of medicated feeds.

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