Avoiding Drug Carryover During Feed Processing and Delivery

Department of Grain Science and Industry

Drug carryover is a form of feed contamination that may result when the substance in question has been transferred (carried) from an acceptable location or feed to an unacceptable location or feed. Carryover of an animal drug can occur during feed processing, handling, or delivery.

The Food and Drug Administration's (FDA) Good Manufacturing Practices (GMPs) provide guidance for medicated feed manufacturers to ensure their products meet the identity, strength, and quality standards that they should with respect to their drug content. These regulations stipulate adequate procedures be established and followed for all equipment used in the production and distribution of medicated feeds to avoid unsafe contamination of medicated and nonmedicated feeds.

Carryover of a Category II drug (one which requires a withdrawal period) into a finishing ration may result in a tissue-residue problem in meat animals. Producers experiencing this problem in their market animals may incur significant financial loss. Carryover of either a Category I drug (one which does not require a withdrawal time) or a Category II drug into a batch of feed intended for an off-label species may create serious problems. For example, carryover of monensin from cattle feed to horse feed may kill the horse.

The intent of this bulletin is to provide feed manufacturers, whether a commercial mill operator or an on-farm feed manufacturer, information that will help them avoid drug carryover. This information should help feed processors improve their product quality, reduce the likelihood of feed contamination, and help ensure safe meat, milk, and eggs destined for human consumption.

Risk Assessment

Meat, milk, and egg producers have many options for obtaining a complete feed ration, as depicted in Figure 1. It is the responsibility of the feed processor (whether commercial or on-farm) to ensure that the correct amount of the desired drug is properly incorporated and that no cross-contamination of an unwanted/unspecified drug is present in that feed. Whether the manufacturing system is simple or complex, it is possible to avoid drug carryover by following the GMPs.

The type of drug (Category I or II), number of species, and feed delivery system determine the degree of risk associated with drug carryover. Feed processors who manufacture products for one species and use only Category I drugs experience the least amount of risk associated with cross-contamination and tissue residue. Since there is no withdrawal time associated with this product, it may be used until the time of slaughter.

The individual who uses a Category II drug can avoid carryover and tissue residue problems by using separate delivery systems for these feeds and by sequencing, flushing, and cleaning feed processing equipment. Mills that produce feed for multiple species experience an increased risk of cross-contamination by medicated articles (either Category I or II) than mills manufacturing products for one species. When changing feed rations from one species to the next the risk of cross-contamination is minimized through sequencing, flushing, and equipment clean-out of feed processing and delivery equipment.

Causes for Carryover

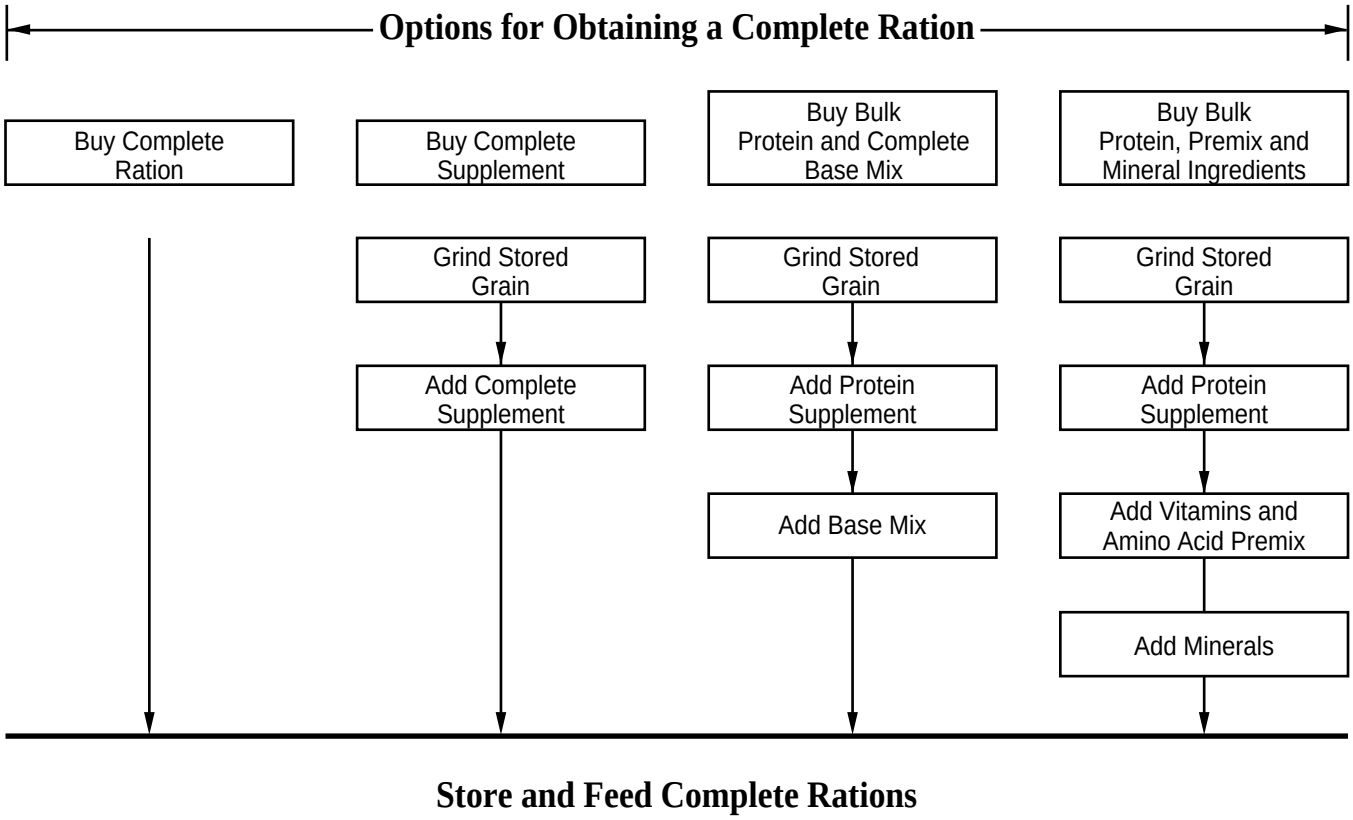
Drug carryover may occur for many reasons as outlined in Table 1. Significant amounts of the drugs or medicated feed may remain in the production system and contaminate the following batches of feed. It may occur in one piece of equipment, or it may result from a combination of residues throughout the entire system.

Once the source of carryover is known, corrective action can be taken. Often, adjustment of equipment will markedly relieve the problem. Repairs, remodeling, or replacement of worn components may be necessary. A few of the more common corrective measures are listed in Table 2.

Table 1. *Sources of Carryover*

Equipment	Mode Of Carryover
Dust system	-delayed return of dust to production line -excessive pickup of drug and carrier -hang-up (electrostatic or moisture)
Mixer	-residual feed remaining in mixer -buildup of material on ribbons and walls -electrostatic hang-up on walls and top -leaking mixer gate (not fully closed)
Surge bin	-incomplete clean-out -electrostatic or moisture hang-up
Conveyors	-same as surge bin
Elevators	-residual feed remaining in buckets and boot -electrostatic or moisture hang-up
Bins	-bridging -residual feed from incomplete cleanout
Bulk truck	-error in bin chart records -incomplete clean-out -bridging and hang-up

Figure 1. *Different Methods Producers can use to Prepare Swine Rations*



Sequencing, Flushing and Equipment Clean-out

When working with a drug that requires a withdrawal time before the meat animal goes to market or when manufacturing and delivering feed for several animal species, one must be careful to follow the label and use GMPs to avoid drug cross-contamination. The GMPs state that adequate procedures shall be established and used for all equipment used in the production and distribution of medicated feeds to avoid unsafe contamination of medicated and nonmedicated feed. Three techniques to avoid cross-contamination include sequencing, flushing, and equipment clean-out.

The ordering **sequence** in which feed rations are processed and delivered determines the likelihood of drug carryover and tissue residue. It is an excellent practice to schedule the production of all medicated feeds having the same drug(s) in sequence with the higher levels first and ending with a low level. This sequence should be followed by a nonmedicated feed for the same animal.

Individuals manufacturing feed for a single species such as swine, in which a withdrawal drug is fed to young animals, should generally mix feed in the following order: nursery ration containing the withdrawal drug, sow feed, grower, and finishing ration. Place cull sows in the finishing pen prior to sending them to market if this sequence is followed. When using a sequencing pattern to avoid cross-contamination, it is imperative that feed production records are kept and are detailed enough to denote the last batch/ration. Otherwise, the sequencing pattern could be violated by the next individual preparing feed.

In most feed mills, sequencing feed will reduce carryover enough to eliminate the potential for tissue residue. However, sequencing may not reduce carryover to a sufficiently low level if maintenance or design problems exist in the mill as described in Table 2.

***Table 2**. Some Common Corrective Actions for Carryover*

Mode of Carryover	Corrective Actions
1. Electrostatic hang-up	-ground wire to affected equipment -purchase nonelectrostatic form of premix -use liquid ingredient to control dust -vibrators to shake hang-up loose
2. Delayed or extended dust return	-adjust air velocity at collection points -allow more time for dust to clear system -use liquid ingredient to reduce dustiness -collect and discard dust following production of medicated feeds (or retain for next run of like medicated feed) -remodel dust system
3. Mixer residues	-adjust ribbons or paddles -install plastic “wipers” on ribbons -install air sweep jets for cleaning -remodel discharge for more complete cleanout -add drug when mixer is 1/2 to 3/4 full (may affect mixing time required for good mix)
4. Surge bin, conveyor residues	-adjust for more complete cleanout -remodel bin or discharge
5. Elevator residues	-adjust bucket clearance in boot (if possible) -install air sweep jets -remodel boot for more complete cleanout
6. Bin residues	-manual inspection and cleaning when changing kind of feed stored -install vibrator or air sweep jets
7. Pellet mill and dryer residues	-flush blender and dies -adjust dryer for more complete cleanout
8. Entire system	-use production scheduling -allow time between kinds of feed for manual cleaning of system -use “flush” material—about 5% of mixer capacity, but not less than 200 lbs. (should be established by actual tests)
9. Bulk truck	-establish cleanout procedure for truck -require a sample from the first product discharged at point of delivery -analyze delivery samples randomly and let driver know that samples are being analyzed

Flushing involves taking a known ingredient, usually ground grain, and moving a quantity through the system to “flush” out any medicated feed that remains. The amount of flush material depends on the system (about 5-10 percent of mixer capacity) but should not be less than 200 pounds of ground grain. Once the material has passed through the feed processing/conveying system, it must be stored in a separate bin for use in an identical medicated ration.

Flushing a portable grinder-mixer poses several difficulties, since it would either require transporting several hundred pounds of ground grain (in sacks) to the bulk feeder or storing ground grain in a covered container near the bulk feeder. Flushing procedures for this system include the following:

- add 300 pounds (or 5 percent of mixer capacity) of ground grain to the mixer through the charging chute (note: to compensate for the addition of 300 pounds of grain used to flush the mixer, deduct that amount from the feed ration),
- run the mixer for 30 to 60 seconds before discharge,
- discharge the flush material into the bulk feeder containing the feed most recently mixed.

A simpler option may involve cleaning the mixer by discharging carryover feed out the bottom port in the vertical mixer. Some portable systems do not contain clean out ports; in this instance flushing may be essential.

Equipment clean-out is often the least used, but potentially most effective, method of avoiding drug carryover during feed processing and delivery. Cleaning the mixer, conveying system, pellet cooler, and sack-off bin or delivery truck between runs to remove residual feed is recommended under high risk situations. These may include the following: working with a high potency form of a drug (making premixes); sequencing cannot be incorporated into the production schedule; feed processing systems have large carryovers between batches (e.g. portable grinder-mixers); or when physical properties of drugs are such that sequencing and flushing is not sufficient to prevent carryover.

The GMPs stipulate that all equipment shall be designed, constructed, installed, and maintained so as to facilitate inspection and use of clean-out procedures. Scheduled cleaning of mixers is required where liquid ingredients (molasses or fat) are added to the feed ration in the mixer.

Segregation During Handling and Delivery

Segregation can occur in ingredients and mixed feeds. A number of sites in the processing, handling, and transit of feed and feed components can produce conditions favorable to the segregation process (Table 3). Segregation of the drug from the medicated feed may lead to carryover and nonuniform concentration of the medication. Both situations may result in violative tissue residue in the market animal.

Mixed feeds are subject to segregation due to differences in particle size, shape, and density. For example, feed ingredients can be evenly dispersed following the mixing process, become slightly segregated as they drop into the surge bin, experience some remixing during transport from the surge bin auger to the elevator leg, become segregated as feed is discharged from the leg and undergoes a free-air fall into the holding bin over the pellet mill, and be partially remixed as material is transferred into the conditioning chamber above the pellet mill. When pellets are formed, the segregation process ceases. The preparation of a meal feed ration may experience segregation and partial remixing throughout the entire handling process until the feed is consumed.

Figure 2. *Segregation - Rough Roads*

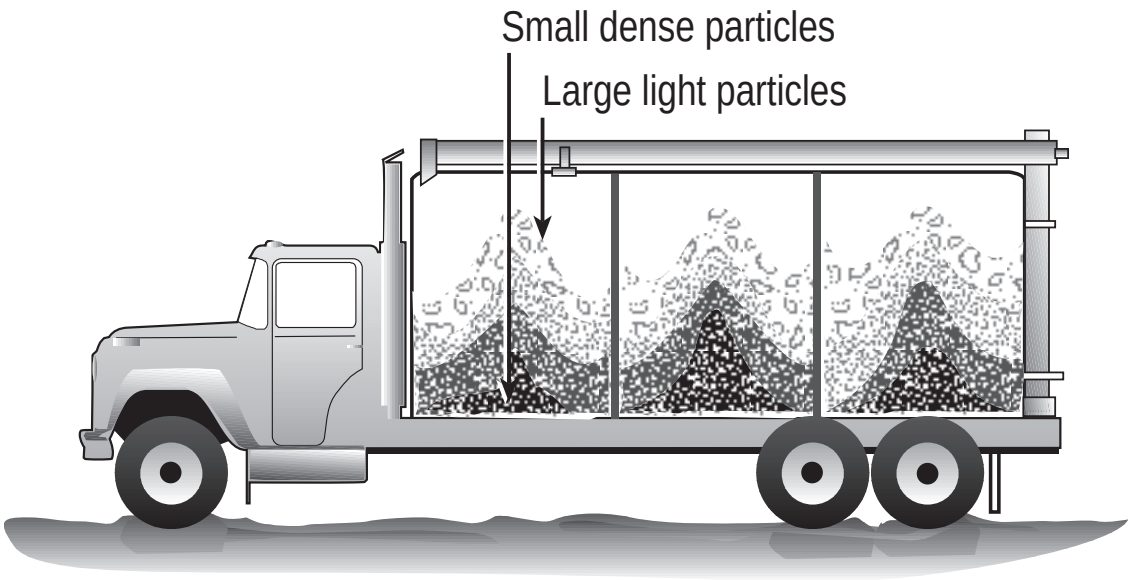


Table 3. *Sources of Segregation Problems*

Sources	Possible Segregation Problems
Mixer surge bin	-Free-fall from mixer -Air pressure relief -Mill or equipment vibration -Electrostatic hang-up
Bucket elevator	-Free-fall at elevator discharge
Pneumatic conveying	-Segregation at cyclone collector -Free-fall from collector to bin -Feed angle of repose segregates particles by size
Holding bin, Bagging bin, Bulk bin, Bulk truck, Customer bin	-Free fall through air -Funneling during discharge accentuates segregation -Vibration of mill or equipment -Electrostatic hang-up
Dust collecting system	-Very fine particles tend to aspirate off -Residue dust is not thoroughly mixed back into feed

Table 4. *Overcoming Segregation Tendencies of Mixed Feed*

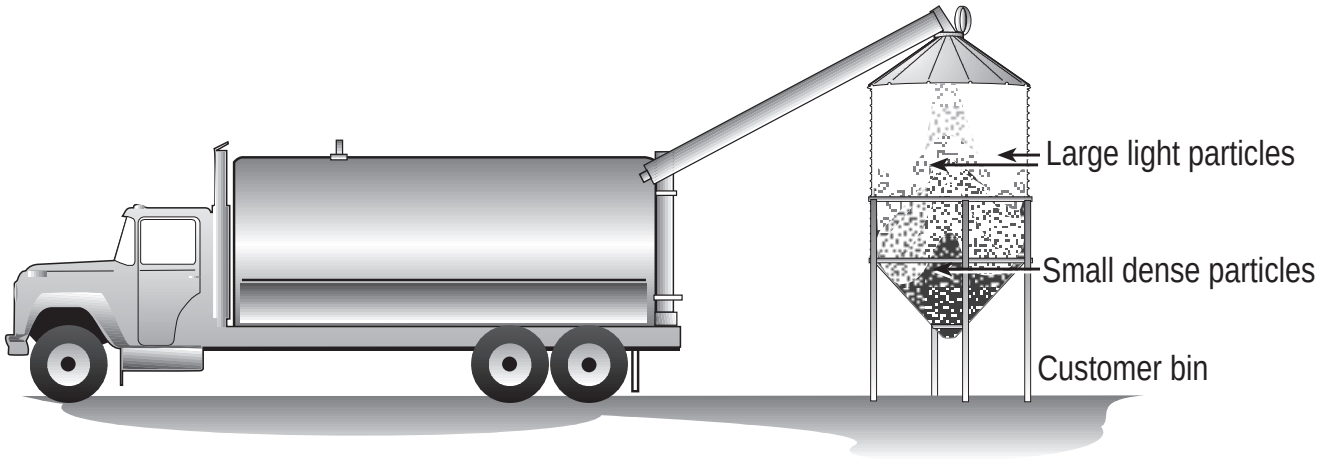
Property	Remedy
Particle size	-Grind ingredients to a uniform particle size range - Use liquids to agglomerate
Particle shape	-Process to more uniform particle shape range -If shape is a desired characteristic, use fat or molasses to agglomerate
Particle density	-Agglomeration is the most common way to overcome density differences -Finer particle size reduces tendencies to segregate because of density differences

Particles tend to segregate when combined in a complete feed and there is a large size difference between ingredients (Figure 2). Particle shape affects the movement of a material through the air in a free-fall situation. Flat particles will tend to fall slower and remain where they fall, whereas particles that are round or cuboidal will fall faster and tend to roll toward the storage wall (Figure 3).

Particles with high density will be less affected by free-fall air resistance than those of low density. The less dense particles will tend to be carried toward storage walls by the air currents created in the bin.

Management opportunities exist to reduce the amount of segregation that may occur in feed and feed ingredients (Table 4). Most feed rations contain between 60 and 70 percent ground grain; consequently, the particle size reduction process is critical. Routinely monitoring the grain after grinding will

Figure 3. *Segregation - Free-Air Fall*



ensure that the desired particle size and uniformity is achieved. Many of the other feed ingredients are delivered in granular form. Purchasing specifications should be placed on particle size for potential problem ingredients, such as limestone, dicalcium-phosphate, salt, etc. The procedure for evaluating particle size is described in the Kansas State University Extension bulletin MF-2051, *Evaluating Particle Size.*

Another processing method that will reduce ingredient segregation involves the production of feed pellets. Although a pellet mill is less common for on-farm feed processors due to the capital and operating costs, individuals purchasing complete feed (or processing over 20,000 tons of feed annually) may consider this option.

Another commonly used technique to reduce segregation is to add a liquid, usually molasses, fat, or water, to the feed formula. These liquids act to unite small and large particles into agglomerates, which maintain their homogeneity through the subsequent processing and handling. However, liquid addition may create as many problems as it solves. Feed may adhere to equipment and bins creating cleanout and possible feed cross-contamination problems. Proper application, equipment, and location of the spray bar on the nozzle can help avoid these problems.

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Summary

Medicated feeds are important to animal health and growth promotion. Avoiding drug carryover during feed processing and delivery is essential when using medicated articles/feeds. Following the FDA's Good Manufacturing Practices will assist feed processors avoid cross-contamination and help ensure the production of safe meat, milk, and eggs destined for human consumption.

Procedures to avoid cross-contamination between feed batches include assessing the risk and potential causes for drug carryover, preventative maintenance of feed processing equipment, and correct use of sequencing, flushing, and equipment clean-out procedures. Ingredients can segregate during feed handling and delivery. The causes and methods for avoiding these problems are discussed in this bulletin.

Adapted from bulletins entitled:

Feed Manufacturing Problems, Incomplete Mixing and Segregation. C-555. Cooperative Extension Service, Kansas State University, Manhattan.

Feed Manufacturing Problems, Drug Carryover and Control and Prevention. C-548. Cooperative Extension Service, Kansas State University, Manhattan.

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MF-2055 March 1996