EXTENSION

# Feed Additives for Beef Cattle Production

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## Introduction

Feed additives are added to beef cattle diets in small amounts with expected benefits based on biological impacts (such as improved performance, health or efficiency) not related to direct supply of nutrients. These compounds may or may not qualify as drugs to be regulated by the United States Food and Drug Administration (FDA). There are various classes of feed additives. Medicated feed additives include antibiotics, antimicrobials, anti-coccidials, antiparasitics, sulfonamidics, hormones, anti-bloat compounds and beta-agonists. Nonmedicated feed additives include probiotics, prebiotics, enzymes, phytogenics, enzymes and many other compounds. Feed additives can be useful tools to address key consumer issues such as reducing antibiotic use or greenhouse gas emissions, improving product safety and increasing animal health and efficiency.

Specific drug levels for use are not provided in this publication. Label and dose information for each of the drugs and additives described are available depending on the type of product from prescribing veterinarians, company websites, specific company representatives or by searching the FDA online listing of approved animal drugs (https://animaldrugsatfda.fda.gov/adafda/views/#/blueBirdLabels).

**Figure 1.** Finishing cattle at the Willard Sparks Beef Research Center.

## Classes of Feed Additives

### Antibiotics

Many of these compounds, used to kill or reduce bacterial growth, are important for human medicine and veterinary medicine, including livestock production. In order to reduce the development of antibiotic resistance in both human and veterinary medicine and improve antibiotic stewardship, the Federal Drug Administration now requires the use of a Veterinary Feed Directive (**VFD**) order to acquire and use certain medically important antibiotics for animal feed use. Common beef cattle feed grade antimicrobials requiring a VFD are shown in Table 1.

### Veterinary Feed Directive

A VFD order is a written statement from a licensed veterinarian that authorizes a client to use a feed additive that requires a VFD. This allows a client to obtain and use a VFD drug in or on animal feed according to FDA approved label directions. This rule became effective on January 1, 2017 and covers the use of any 'medically important" antibiotic or antimicrobial agent. The use of these compounds must be authorized by a licensed veterinarian and used in compliance with these regulations. Use for growth promotion and feed efficiency is no longer covered by these approved labels. There is no legal extra-label usage for medicated feed additives.

The compounds in Table 1 are all considered to be antibiotics that are medically important for humans. The approach is to manage antibiotic use to decrease the development of antibiotic resistant bacteria. Notice there is no approved use for these compounds to be fed for the reduction of pinkeye or foot rot.

| **Table 1.** Common medically important feed grade antibiotics requiring a VFD | | | |
|---|---|---|---|
| Drug Name | Drug Trade Names | Classification | Approved Uses |
| Chlortetracycline (CTC) | Aureomycin, Chloratet, Pennchlor, ChlorMaz | Antibiotic | • Treatment and control of bacterial pneumonia caused by *Pasteurella* spp.<br>• Treatment of bacterial enteritis<br>• Control of active anaplasmosis<br>• Reduction of the incidence of liver abscesses |
| Oxytetracycline | Terramycin, Pennox, | Antibiotic | |
| CTC + Sulfamethazine | Aureo S 700, Aureomix S, Pennchlor S | Antibiotic + Sulfonamidic | Maintenance of weight gains in the presence of respiratory disease |
| Neomycin + Oxytetracycline | Neo-Terramycin, Neo-Oxy | Antibiotic | Treatment of diarrhea, pneumonia, and shipping fever in cattle |
| Tylosin | Tylan, Tylosin, Tylovet | Antibiotic | Reduction of liver abscesses associated with *Fusobacterium necrophorum* and *Arcanobacterium pyogenes* |
| Virginiamycin | Virginiamycin, V-Max | Antibiotic | Reduction in incidence of liver abscesses in cattle fed in confinement for slaughter |
| Tilmicosin | Pulmotil, Tilmovet | Antibiotic | For control of bovine respiratory disease associated with *Mannheimia haemolytica, Pasturella multocida* and *Histophlus somni* ***where active BRD has been diagnosed in at least 10% of the group.*** |

In order to use these VFD drugs a producer must have a valid Veterinary Client Patient Relationship (**VCPR**) with a licensed veterinarian. The minimum federal regulations defining a VCPR are 1) A veterinarian has assumed the responsibility for making medical judgments regarding the health of (an) animal(s) and the need for medical treatment and the client (the owner of the animal or animals or other caretaker) has agreed to follow the instructions of the veterinarian; 2) There is sufficient knowledge of the animal(s) by the veterinarian to initiate at least a general or preliminary diagnosis of the medical condition of the animal(s); and 3) The practicing veterinarian is readily available for follow-up in case of adverse reactions or failure of the regimen of therapy. Such a relationship can exist only when the veterinarian has recently seen and is personally acquainted with the keeping and care of the animal(s) by virtue of examination of the animal(s), and/or by medically appropriate and timely visits to the premises where the animal(s) are kept. Additionally, case and treatment records must be maintained for 2-years by the veterinarian and the producer.

There is a misconception that all feed-grade antimicrobials and feed additives require a VFD. Many compounds used in beef production do not fit the definition of “medically important” or antimicrobial. Common beef cattle feed additives and their uses that do NOT require a VFD are shown in Table 2.

| **Table 2.** Common beef cattle feed additives NOT requiring a VFD | | | |
|---|---|---|---|
| Drug Name | Drug Trade Names | Classification | Approved Use |
| Amprolium | Corid | Anti-coccidial | Prevention and treatment for intestinal coccidiosis |
| Bacitracin | Albac, BMD | Antibiotic | Reduction in liver abscesses |
| Bambermycin | Gainpro | Ionophore-like antibiotic | Increased growth and feed efficiency of growing and finishing cattle |
| Decoquinate | Deccox | Anti-coccidial | Prevention of coccidiosis |
| Diflubenzuron | JustiFly, ClariFly | Insect growth regulator | Horn Fly Control |
| Fenbendazole | Safe-Guard | dewormer | Internal parasite control |
| Laidlomycin | Cattlyst | Ionophore | Improved feed efficiency and weight gain of cattle being fed in confinement for slaughter |
| Lasalocid | Bovatec | Ionophore | • Improved feed efficiency for cattle fed in confinement for slaughter<br>• Improved weight gain for growing cattle on pasture<br>• Coccidiosis control |
| Lubabegron | Experior | Beta-agonist | Reduction of ammonia gas emissions per pound of live or carcass weight and improved feed efficiency during the last 14 to 91 days of feeding |
| Melengestrol acetate | MGA | Hormone | Estrus suppression |
| Monensin | Rumensin, | Ionophore | • Increase gains of grazing cattle<br>• Prevention and control of coccidiosis<br>• Improved feed efficiency of cattle in confinement |
| Morantel tartrate | Rumatel | Antiparasitic | Internal parasite control |
| Poloxalene | Bloat Guard | Anti-bloat | Prevention of legume and wheat pasture bloat |
| Ractopamine | Optaflexx, Actogain | Beta-agonist | Increased rate of weight gain, improved feed efficiency and increased carcass leanness during the last 28 to 42 days of feed |
| S-Methoprene | Altosid IGR | Insect growth regulator | Horn fly control |
| Tetraclorvinphos | Rabon | Antiparasitic | Control of horn flies, face flies, house flies, and stable flies |
| Zilpateral | Zilmax | Beta-agonist | Increased rate of weight gain, improved feed efficiency and increased carcass leanness during the last 20 to 40 days of feed |

**Ionophores**

Ionophores are one of the most commonly used classes of feed additives in beef production. Although these compounds are classified by FDA as antibiotics, they are not considered to medically important to humans and therefore do not require a VFD (Table 2). The mode of action of ionophores is to disrupt ion movement across cell membranes of affected bacterial species in the rumen. This shifts microbial populations toward bacteria that produce more propionic acid and away from bacteria that produce acetic acid. There are also indications that ionophores target bacterial species that produce methane, a waste product of ruminal fermentation which is considered to be a potent greenhouse gas. Although not considered an ionphore, bambermycin has a similar mode of action and similar effects on production.

It has been estimated that 90 to 97% (Samuelson et al., 2016) of feedlots use ionophores in finishing diets. An analysis of 64 experiments with the ionophore monensin found that feed efficiency is improved by 6.4% and average daily gain is improved by 2.5%. The increased feed efficiency is related to the increased gain and a 3% decrease in feed intake (Duffield et al., 2012). Other ionophores have also proven to be effective in promotion of gains and feed efficiency of finishing cattle. Cernicchiaro et al. (2016) found that average daily gains, average feed intake, and liver abscesses were greater for steers fed lailomycin propionate than monensin with no difference in feed efficiency.

Adoption of ionophore use is much lower in stocker and cow-calf production than in feedlots. Bretschneider et al. (2008) found that ionophores increased average daily gain of growing cattle on forage based diets by 0.16 to 0.22 pounds per day. Gadberry et al. (2022) found that monensin fed to beef cows increased milk yield and decreased forage intake, showing that it provides potential benefits to cow-calf production systems as well.

**Direct Fed Microbials and Probiotics**

Probiotics are live cultures of microorganisms fed in diets to alter the microbial balance in the GI tract of the host. These cultures can be bacteria species (*Lactobacillus acidophilus, Enterococci faecium, Bacillus* species *Bifidobacterium bifidum*) or yeast species (*Saccharomyces cerevisiae*) and are used to improve the balance of bacteria species in the GI tract. To be an effective probiotic, the culture must have stability in feed processing process, have the ability to replicate after passage through the abomasum and have the ability to reduce impacts of undesirable microorganisms. The impacts probiotics have on undesirable microorganism populations can be by competitive exclusion of unwanted populations or by excretion of metabolites that can inhibit growth of unwanted microbe populations (Collins and Gibson, 1999). Other activities of probiotics can also include toxin and pathogen binding or support of desirable endogenous microbial species. Probiotics have been shown to change ruminal fermentation end products to reduce subacute ruminal acidosis or methane production

**Prebiotics**

Prebiotics are nondigestible food substances primarily in the form of oligosaccharides that can selectively stimulate the growth of favorable bacterial species in the gut to the benefit of the host animal. They provide readily available substances for normal bacteria to grow. Prebiotics can balance the populations and activities of microbes in the GI tract and show promising benefits to the host. Benefits have been minimal in generally health calves, but under stress conditions, they have shown benefits in reduction of scours. Prebiotics have also shown increased gain and feed efficiency of dairy calves during the post-weaning growing period (Hansunuma et al., 2011).

**Yeast Cultures and Fermentation Products**

Some yeast products have been reclassified as post-biotics, a relatively new term within ruminant nutrition. Many of these products have been on the market for quite some time, but have been classified as prebiotics. These are microbial metabolites delivered with inactivated cell or cell fragments of the microbes or yeast that produced them. Commercial products are often called cultures or extracts or described by their source (such as hydrolyzed yeast or yeast cell wall). One way to differentiate between pre- and post- is by saying “prebiotics” act on native microbial populations and “postbiotics” act on the host animal.

Post-biotics are often attributed with the ability to confer health-related benefits. Research with specific products has shown desirable impacts on immunity, modulation of inflammation, and toxin or pathogen binding capabilities. However, because they are not registered and regulated as drugs, companies must be very cautious about publicly making what could be considered a “health claim.”

**Enzymes**

There are now enzymes on the market that are supplements to native enzymes that can increase fiber, starch or protein digestion in the animal. These often encourage fermentation of fiber in the lower gastro-intestinal tract or break down physical barriers to nutrient digestion.

**Essential Oils**

Essential oils are secondary plant metabolites that are responsible for the odor of plants and spices, have important ecological functions as chemical messengers between plants and their environment, and exhibit antimicrobial activity against a wide range of bacteria, yeasts and molds. Essential oils are often fed in blends in livestock diets and because these compounds have diverse composition, nature and activity, the results of their use can be variable. Essential oils can have positive effects on cardiovascular disease and inflammatory processes. Essential oils with antimicrobial activity are sourced from many plants including: garlic, dill, paprika, cinnamon, juniper, oregano, anise, rosemary, clove, thyme and ginger. Essential oils appear to have activities that make them natural alternatives to growth promoting antimicrobials and ionophores with multiple experiments showing they have similar effects on ruminal acetate, propionate and other volatile fatty acid production in the rumen as monensin. There has not been conclusive evidence that growth performance and feed efficiency are improved by feeding essential oils. There are mixed results with some research showing no improvement in performance on pasture (Beck et al., 2017) or during finishing (Wilson et al., 2020); but Torres et al. (2021) showed in an analysis of multiple research trials where finishing cattle fed essential oils had similar performance and feed efficiency to cattle fed monensin. Torres et al. (2021) analysis also indicated that cattle fed high concentrate diets with essential oils replacing monensin had greater liver abscesses possibly due to changes in feed consumption patterns commonly observed with monensin.

**Beta-agonists**

Beta-adrenergic agonists are non-hormonal compounds that bind to fat and muscle cell receptors in the animal's body. When they bind to these cells they redirect nutrients away from fat metabolism while increasing the size of muscle fibers increasing the leanness of carcasses. These compounds significantly increase carcass gain and feed efficiency during the end of the finishing period. Ractopamine (Optaflexx or Actogain) is the only beta-agonist currently being used in the U. S. beef production system and is labeled for feeding during the last 28 to 42 days before slaughter. Ractopamine has been shown to increase average daily gain in this period by 15 to 25% with no increase in feed intake. Zilpateral is still labeled for use by the FDA but has been withdrawn from the market by the manufacturer due to animal welfare concerns by beef packers. A new compound called lubabegron (trade name Experior) is classified as a beta-adrenergic receptor agonist/antagonist and has been approved by the FDA for use in beef steers and heifers fed in confinement for slaughter during the last 14 to 91 days on feed to reduce ammonia gas emissions per pound of live weight and hot carcass weight.

**Antiparasitics**

There are a variety of compounds available for inclusion in beef cattle feeds with efficacy against internal and external parasites. Modes of action differ for compounds with similar target organisms. For example, tetraclorvinphos (Rabon) is a larvicide and Diflubenzuron is an insect growth regulator, but both target horn, face, house, and stable flies. S-Methoprene is an insect growth regulator that only targets horn flies.

Decoquinate and amprolium are anti-coccidial compounds used for the prevention and treatment of intestinal coccidiosis, while the ionophores lasalocid (Bovatec) and monensin (Rumensin and Monovet) also have efficacy for prevention and control of coccidiosis.

Other compounds such as fenbendazole and morotel can be included in feeds to treat cattle for internal parasites. These compounds have been shown to be highly effective in treating internal parasite infections.

**Others**

Melengestrol acetate (MGA) is a hormonal feed additive that suppresses estrus activity which is used to improve feed efficiency and gain in finishing cattle and in heifer estrus synchronization.

Poloxalene (Bloat Guard) is a surfactant approved for use in prevention of pasture bloat commonly occurring in cattle grazing legume or small grain pastures.

## On-Farm Mixing

When considering the use of a medicated feed additive the decision must be made whether mixing of the final feed will occur at a commercial mill and purchased retail or made on the farm. Most cow-calf, stocker and small backgrounding operations do not have the feed mixing facilities or adequately trained personnel to utilize concentrated forms of these medicated feed additives.

Feed additives come in 3 Types (A, B, or C). Type A feed is the most highly concentrated form and some are restricted to only licensed feed mills. Type A feeds are used to manufacture other Type A, B or C feeds. Type B feeds are premixes consisting of nutritional supplements along with the feed additives. Type C feeds are complete feeds that can be fed alone, top dressed onto whole rations or possibly offered free-choice. Most operations will need a premix (Type B) or complete feed (Type C).

## BQA Guidelines

The Beef Quality Assurance Manual outlines best management practices for feed additive and medications (https://www.bqa.org/Media/BQA/Docs/nationalmanual.pdf). These include:

1. Only FDA-approved medicated feed additives can be used in rations.

2. Feed only at recommended rates. Exercise caution when calculating rates for medicated feeds.

3. All medicated feed additives must be used in accordance with the FDA approved label. Extra-label use of feed additives is strictly prohibited by federal law. No one has the authority to adjust the dose as labeled, including veterinarians. All directions for the use of a medicated feed additive will be on the label attached to the bag or will be supplied with a bulk order. Water medications are not considered feed medications; therefore, they can be used under the extra-label drug use guidelines provided by the FDA Center for Veterinary Medicine.

4. Ensure that all additives are withdrawn at the proper time to avoid a violative residue.

5. For operations formulating and mixing rations on site, such as stocker operators, medicated feed additives must be used in accordance with the FDA current Good Manufacturing Practices. These include a formula record of all medicated feed rations produced and production records of all batches of feed produced that contain medicated feed additives. Production records must include additive used, date run, ration name or number, the name of the person adding the additive or responsible for mixing the feed and amount produced. Use separate mixers for mixing medicated feeds and nonmedicated feeds, or clean mixers between batches of each.

6. Pre-mixed or formulated supplements typically used by many smaller beef operations and most cow calf operations do not require FDA registration of any type. Larger beef operations that use certain highly concentrated medications may be required to register with the FDA via a FD-1900 permit.

7. Identify treated individuals or groups.

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