

Antibiotics Residues in Dairy Manure

Part 5: What is known about antibiotic residues in dairy manure?

Introduction

Antibiotics are chemicals that kill or impede bacterial cell growth. They are important medicines used by dairy farms to treat bovine bacterial infections, prevent infections, and to a declining degree to promote growth/milk production. When antibiotics are administered to dairy cattle, milk and meat withholding times are strictly followed to prevent antibiotic residues from entering the food system. Highly successful adherence to, and enforcement of, these regulations has resulted in only 0.01% of milk loads and 0.02% of dairy cattle slaughtered for beef testing positive for residues^[1] with protocols at processing plants preventing these products from entering the food chain.

Antibiotic excretion rates & general properties in manure

During the withhold period, antibiotics and their breakdown products (metabolites) are excreted in manure. Antibiotics are effective at extremely low levels, but large dosages are prescribed to optimize drug delivery. As a result and due to the relative inertness of antibiotics, a large portion of a properly administered dose can be excreted. Manure excretion rates are dependent on the antibiotic, the age and condition of the animal and, the days since treatment (**Figure 1**).

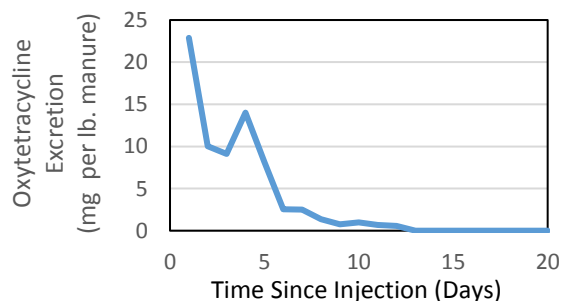


Figure 1. Excretion of oxytetracycline in feces of a 3.5 yr old, 970 lb Holstein cow following the intramuscular administration of 8,800 mg of oxytetracycline^[2].

Though studies in dairy cattle are limited, literature reviews suggest 40-90% of the administered dosages of tetracyclines and sulfonamides can be excreted unchanged. Reviews also show that 50-90% of the administered dosages of penicillins are excreted unchanged, with 10-70% of the administered dose excreted as metabolites^[1]. While some metabolites have no antimicrobial activity, other metabolites have sustained or increased effectiveness as antibiotics. Some metabolites may also transform back to their parent compound after excretion, reverting from inactive to active antibiotics. Once in manure some antibiotics, like fluoroquinolones and sulfonamides, may adsorb tightly to the organic matter in manure which can limit their ability to act as an antibiotic. For other highly soluble antibiotics like tetracycline, adsorption is less common, and microbial activity is maintained. While less soluble antibiotics may be less mobile in the environment, their tight bonding to soils and organic matter can also reduce biodegradability and increase persistence^[3].

Generalized fate of antibiotics^[4]

β -lactams (penicillins and cephalosporins) are very soluble susceptible to degradation. Consequently, the antibiotics and their metabolites are not typically detected in environmental samples. **Sulfonamides** are more persistent, and their metabolites can undergo reverse transformation to re-form the original antibiotic and typically bind to organic compounds in the environment. **Macrolides** are quite resistant to breakdown and are typically excreted unchanged. This class of antibiotics is also persistent and adsorbs strongly to organic compounds in the environment. **Tetracyclines**, depending on their composition, can complex and bind to various matrices in the environment, or can be

highly soluble and mobile in the environment. Their composition can also change depending on environmental conditions with metabolites able to transform not just to their original form, but to other tetracyclines with various antibiotic properties. The fate of *Fluoroquinolones* and *Aminoglycosides* are less characterized, but these antibiotics are typically excreted unchanged, are recognized to adsorb strongly to solids, but can have high solubilities that increase their environmental mobility.

Levels of antibiotics in manure

Only in the last 10 years have researchers began carefully measuring antibiotic residues in manure with the body of knowledge still small, particularly for dairy manure. The range of antibiotic residue levels found in dairy manures is summarized in Table 1. At

this point, the significance or potential impact these residue levels might have on the proliferation of antibiotic resistance is not well understood. Nor is the effect of manure handling and treatment systems on antibiotics and antibiotic resistance, though research is active in this area and is being conducted by our team and collaborators with preliminary results anticipated in 2018.

Table 1. Part per billion concentrations of antibiotic residues in dairy manures. Data is based on a summary of the scientific literature with results organized by the country where the research was conducted. If data is not listed, it was not an antibiotic targeted for measurement by the research.

Class	USA	EU*	China	Japan
Tetracyclines	0 - 1,200	0 - 871,700	210 - 103,700	0 - 1.3
Beta-lactams	0 - 480			
Sulfonamides	0 - 430		0 - 1,020	0 - 37
Macrolides	0 - <1,000	100 - 115,500	220 - 280	
Quinolones			0 - 46,700	1.1 - 12

* Includes EU applicant country Turkey

FACT SHEET SERIES Antibiotic Residues in Dairy Manure

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AUTHORS

Jason P. Oliver, PhD
Curt Gooch, PE

jpo53@cornell.edu
cag26@cornell.edu

(607) 227-7943
(607) 225-2088

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