Crops absorb livestock antibiotics, science shows

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For half a century, meat producers have fed antibiotics to farm animals to increase their growth and stave off infections. Now scientists have discovered that those drugs are sprouting up in unexpected places.

Vegetables such as corn, potatoes and lettuce absorb antibiotics when grown in soil fertilized with livestock manure, according to tests conducted at the University of Minnesota.

Today, close to 70 percent of the total antibiotics and related drugs produced in the United States are fed to cattle, pigs and poultry, according to the Union of Concerned Scientists. Although this practice sustains a growing demand for meat, it also generates public health fears associated with the expanding presence of antibiotics in the food chain.

People have long been exposed to antibiotics in meat and milk. Now, the new research shows that they also may be ingesting them from vegetables, perhaps even ones grown on organic farms.

The Minnesota researchers planted corn, green onion and cabbage in manure-treated soil in 2005 to evaluate the environmental impacts of feeding antibiotics to livestock. Six weeks later, the crops were analyzed and found to absorb chlortetracycline, a drug widely used to treat diseases in livestock. In another study in 2007, corn, lettuce and potato were planted in soil treated with liquid hog manure. They, too, accumulated concentrations of an antibiotic, named Sulfamethazine, also commonly used in livestock.

As the amount of antibiotics in the soil increased, so too did the levels taken up by the corn, potatoes and other plants.

“Around 90 percent of these drugs that are administered to animals end up being excreted either as urine or manure,” said Holly Dolliver, a member of the Minnesota research team and now a professor of crop and soil sciences at the University of Wisconsin-River Falls. “A vast majority of that manure is then used as an important input for 9.2 million hectares

of (U.S.) agricultural land."

Manure, widely used as a substitute for chemical fertilizer, adds nutrients that help plants grow. It is often used in organic farming.

The scientists found that although their crops were only propagated in greenhouses for six weeks--far less than a normal growing season--antibiotics were absorbed readily into their leaves. If grown for a full season, drugs most likely would find their way into parts of plants that humans eat, said Dolliver.

Less than 0.1 percent of antibiotics applied to soil were absorbed into the corn, lettuce and other plants. Though a tiny amount, health implications for people consuming such small, cumulative doses are largely unknown.

"The antibiotic accumulation in plants is just another negative consequence of our animal agriculture industry and not surprising given the quantity fed to livestock," said Steve Roach, public health program director for the non-profit Food Animal Concerns Trust.

For highly processed plants such as corn, the drugs would most likely be removed, added Dolliver. But many food crops such as spinach and lettuce are not processed, only washed, allowing antibiotics to remain.

"Nobody particularly eats corn or soybean directly," said Satish Gupta, a University of Minnesota professor of soil science and study leader. "But there are crops I am much more worried about, like cabbage and lettuce, because these are leaves we eat directly and consume raw."

One finding that particularly worries food scientists is the accumulation of antibiotics within potato tubers. Tubers are an enlarged, underground stem that uptake and store nutrients from the soil. In crops like potatoes, carrots and radishes, it is the part humans eat.

"Since these tubers and root crops are in direct contact with the soil they may show a greater propensity for (antibiotic) uptake," said Gupta.

Health officials fear that eating vegetables and meat laced with drugs meant to treat infections can promote resistant strains of bacteria in food and the environment.

Roach said "the clearest public health implication" from treating livestock with antibiotics is the development of resistant bacteria that reduces the effectiveness of human medicine. Past studies have shown overuse of antibiotics reduces their ability to cure infections. Over time, certain antibiotics are rendered ineffective.

Scientists believe antibiotics also may have contributed to the explosive rise in asthma and allergies in children over the last 20 years. Researchers at Henry Ford Hospital in Detroit, following 448 children from birth for seven years, reported that children who received antibiotics within their first six months had a higher risk of developing allergies and asthma.

Such health concerns led the European Union in 2006 to ban antibiotic use as feed additives for promoting livestock growth. But in the United States, nearly 25 million pounds of antibiotics per year, up from 16 million in the mid 1980s, are given to healthy animals for agriculture purposes, according to a 2000 report by the Union of Concerned Scientists.

Livestock producers contend that the spread of resistant strains of bacteria stems from the overuse of all medicines to treat infectious diseases in both humans and animals. Removal of antibiotics, they say, would only lead to increased disease in animals and reduction in food safety.

Tainted manure can impact more than just the soil. Once applied to the land, antibiotics can infiltrate water supplies as it seeps through the soil into aquifers or spills into surface water due to runoff, explained Dolliver.

"The other thing to remember is that the field is not a sterile environment. Mice, rabbit and foxes traverse farmland while other animals graze, all with the potential to become vectors for the resistant bacteria organisms and spread it throughout different animal populations," said Pat Millner, a U.S. Department of Agriculture microbiologist based in Maryland.

The presence of antibiotics within the food chain is likely to increase as the U.S. Food and Drug Administration has permitted greater use of controversial drugs on farm animals. For example, this past October, the FDA dropped plans to halt use of cefquinome, a potent antibiotic, after it said in July it would push against its use in animals.

While there are restrictions on use of raw manure in U.S. organic farming because of concern over bacteria, no such rules are in place regarding antibiotics or hormones. Not all organic growers use manure with antibiotics, but many do, said Gupta. Even if a product has the USDA organic label, it still might harbor traces of antibiotics. ***[Correction 1/6/09: FDA was changed to USDA]***

High-temperature composting of manure, designed to kill pathogens, is required for crops certified under the USDA organic label. That could eliminate some antibiotics. But others are resistant, according to a study by Dolliver and Kupta published last year. Growers are not required to monitor crops for the drugs.

"Antibiotic uptake by plants may be of particular concern to organic crop producers....To our knowledge, there is no current plan or standardized methodology for monitoring antibiotics in animal manure, which is often obtained from nonorganic farms where antibiotics are commonly used," Dolliver said in the 2007 study.

Added Gupta, "We urgently need to find some way to put guidelines in place on organic food regarding these chemicals."

Gupta said all growers should be told that composting manure can help reduce antibiotics. Composting decays piles of food or manure as microbes decompose organic matter using oxygen to survive, grow and reproduce. Heating up the material creates conditions conducive for bacteria to break down antibiotics and pathogens.

A pilot study by USDA scientists in Maryland added straw to a beef cattle manure pile, heating up the dense material while allowing spaces for air to penetrate. The higher temperatures sped up the decaying process of harmful substances.

"The process happens very rapidly, in this study it took about 10 days," said Millner. "This is not too surprising since antibiotics are not a thermally stable chemical compound."

In another study, the same researchers who discovered the uptake of antibiotics by plants tested four of these drugs to determine how effective composting would be in reducing harmful chemicals in turkey manure. After 25 days using a combination of natural heat generated by microbial activity, three of the four antibiotics broke down under the high energy conditions created, said Dolliver.

Composting reduced concentrations of three antibiotics by 54 percent to 99 percent, although one drug, sulfamethazine, did not degrade at all, according to their study, published in May in the Journal of Environmental Quality.

"These findings suggest manure management can be an important strategy for reducing the overall impact for these compounds making their way into the environment," said Dolliver.

Many questions still remain. Currently, projects are underway to grow crops for a full season in antibiotic laced manure, to grow them in fields rather than greenhouses and to analyze the concentrations and locations of the antibiotics within the plants. Researchers also want to determine which antibiotics are more likely to be picked up, which plants are more prone to uptake, what composting methods are most effective in reducing

harmful material in manure and what antibiotics may be resistant to composting.

There are serious societal implications regarding the discoveries already made and the questions yet to be answered, Gupta concluded.

“We are a chemical society and humans are the main user of pharmaceutical products,” said Gupta. “We need a better understanding of what takes place when chemicals are applied to sources of food and must be more vigilant about regulating what we use to grow food and what we put in our bodies.”