SL-239

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E. coli and *Salmonella* on animal farms: sources, survival and management[1]

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Introduction

Despite impressive gains in modern biology and medicine, diseases are not disappearing. On the contrary, humans and farm animals are constantly exposed to new pathogens and antibiotic-resistant strains of 'old bugs'. In the last two decades, *Salmonella* strain DT104 that is resistant to multiple antibiotics, and highly virulent *E. coli* strain O157:H7 were identified. While the majority of *E.coli* strains are non-pathogenic and normally reside in healthy human intestine, strain O157:H7 is estimated to cost the U.S. economy millions of dollars each year (ERS/USDA 2001a). Similarly, *Salmonella* is estimated to infect over 1.4 million Americans, and to cost the U.S. economy ~ $3 billion annually (ERS/USDA 2001b). Fairly or not, farming operations are often blamed for these disease outbreaks, as they have been associated with meat, poultry, produce and farm waste runoff. Significant effort has been made by universities and research agencies to help eliminate *Salmonella* and pathogenic *E. coli* from animal and dairy farms. This article highlights findings from these recent studies.

Most *Salmonella* and pathogenic *E. coli* can infect humans, domestic animals, and many wild animals. Flies caught around farms often carry *Salmonella*, and shed up to ten million bacteria per dropping (enough to cause disease in a healthy adult male). On average, ten percent of pets, feral animals, and rodents carry *Salmonella*. Random samples from farms indicated that a similar percentage of farm animals may be infected. Infected animals (including horses, cattle and poultry) are not always visibly sick. However these 'asymptomatic' carrier animals shed billions of virulent organisms in each ounce of their feces. Virulent *E. coli* strains can survive for a few months in animal waste, and *Salmonella* can persist in untreated farm waste for up to two years (Winfield and Groisman 2003). Proper utilization and composting of animal wastes are important steps for reducing *Salmonella* and *E. coli* contamination, and breaking the cycle of reinfection.

Waste Composting

Contaminated animal and human wastes are important reservoirs of these pathogens. Farm run-off, contaminated with the *E.coli* O157:H7 strain along with other bacteria, was blamed for the

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deadliest waterborne outbreak in North America (Holme 2003). Therefore, it is crucial to develop strategies for reducing or eliminating pathogens in farm wastes. Maintaining the temperature of composting animal waste at 160-170°F for 2-3 weeks seems to effectively kill these pathogens. Forced aeration or manual turning of compost and the associated increased alkaline reaction also seem to reduce the *Salmonella* and *E. coli* bacteria numbers. Research also suggested that vermicomposting (composting using earthworms) eliminates *Salmonella* and *E. coli* from wastes (Kumar and Sukaran 2005), although the mechanism of this selective elimination is unknown. Kumar and Sukaran (2005) indicated that these pathogens were not detectable after passage through the guts of earthworms. Regardless of the composting method, during the first 2-5 weeks of composting, wastes and liquid runoff should be contained to prevent seepage of bacteria into ground water, where *Salmonella* can survive for months.

The role of different bedding materials in survival of *Salmonella* and *E. coli* is unclear. On-farm studies at the Ohio State University indicated that there were fewer *E. coli* bacteria in cattle raised on sand bedding compared to those raised on wood shavings, while a German study reported that there was no difference in the number of *Salmonella* isolated from broilers raised on wood shaving bedding or on plastic “trampoline” floors. Other factors, like moisture content of different bedding materials, their temperature, processing, aeration, etc., may make interpretation of these results difficult.

Feed and Drinking Water Safety

Salmonella and *E.coli* can contaminate healthy herds by several routes: 1) introduction of infected animals (pathogens then spread rapidly by mutual grooming or through infected water and feed); 2) contaminated drinking water; 3) flies and other insects; and 4) feeding improperly composted poultry litter.

Poultry litter is commonly used as a cattle feed supplement, although some consumers may find this practice unappetizing. Most researchers agree that proper ensiling of broiler or turkey litter eliminates *Salmonella* and *E. coli*, and may increase digestibility of the feed (Davis, et al. 2002; Hopkins and Poore 2001). The use of deeply ensiled broiler or poultry litter, therefore, can be both economical and safe (Bucklin, et al. 2004, Butcher and Miles 2003.).

On farms, harmful bacteria are often isolated from animal drinking water and water vessels. Once pathogens contaminate water vessels, they become established and form “biofilms” (bacterial communities encased in a protective slime layer). Frequent and thorough mechanical removal of microbial biofilms with brushes, hot water with soap, or diluted bleach solutions, is also effective in reducing the microbial loads in animal drinking water. To prevent survival of bacteria in drinking water, scientists suggest supplementation with sodium chlorate (Anderson, et al. 2000). Sodium chlorate targets a specific enzyme, respiratory nitrate reductase, found in *Salmonella, E. coli* and related bacteria. The reductase enzyme then processes sodium chlorate to the chlorite form, which is lethal to *Salmonella* and *E. coli*. Most representatives of normal microflora do not have the same enzyme, and therefore are insensitive to the chlorate treatment. This specificity is a major advantage of sodium chlorate over broad-spectrum non-selective antibiotics. Under laboratory conditions, sodium chlorate is effective at low concentrations (1.25 mM, which would correspond to a concentration of 0.13 g/L). Sodium chlorate has to be used and handled with caution, because it has known toxic effects at higher concentrations (1,200-1,700 mg/kg of body weight; EXTOXNET 1995).

Probiotics (Beneficial Bacteria)

Because antibiotic resistance arises in bacteria at an alarming rate, much research has focused on finding alternative treatments that do not involve the use of antibiotics. For example, the promotion of beneficial gut bacteria can increase resistance of animals to possible *Salmonella* infections. Sources of beneficial gut bacteria may vary. Free-range chicks usually acquire such bacteria normally. Feed of pen-raised chicks may be supplemented with various commercial probiotic formulations. Probiotic or “competitive exclusion” bacterial mixes in the form of spray for eggs were also shown to be moderately effective in inoculating hatchlings with beneficial gut organisms (Nisbet, et al. 1998; Nisbet 2002; Hume, et al. 1998). Alternatively, used poultry litter from healthy flocks could be used. Several studies demonstrated that raising newly hatched leghorn chicks on *Salmonella*-free littered bedding, or supplementation of their feed with litter, actually makes chicks more resistant to *Salmonella* infection. Supplementation of animal rations with corn or sorghum silage also increases animal resistance to infection, perhaps in part due to the beneficial lactic bacteria found in silage. This protective effect of beneficial bacteria in used litter and silage is probably similar to the commercial probiotics: beneficial bacteria colonizing animal guts outcompete and prevent *Salmonella* colonization and infection.

Summary

These methods may help control *Salmonella* and pathogenic *E. coli* on the farm. Proper hygiene, (Simonne, et al. 2005)quarantining of new animals and certified testing, however, remain the most important and least expensive means to prevent the spread of harmful bacteria. Education of the farm personnel on microbiological safety is also important. To help meet these education demands, the Soil and Water Science Department (UF/IFAS) has developed a short course on the Ecology of Bacterial Pathogens - Keeping *E. coli* and *Salmonella* out of Water Supplies, Recreation Areas, Pet Shops and Agricultural Produce. A course description is available online at: http://conference.ifas.ufl.edu/soils/pathogens.

Always wash your hands with very warm water and soap before and after tending to animals (be it pets, cattle, poultry, wildlife or their products). Wash and disinfect soiled clothes, tools and work surfaces with hot soapy water and freshly prepared solutions of bleach (prepared according to the manufacturers instructions). Wearing bioprotective plastic footwear over shoes usually functions to minimize or prevent transfer of pathogens onto or off the farm.

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