Pathogens in Manure

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Many potential pathogens for livestock as well as humans can be found in manure of both livestock and poultry. These pathogens include bacteria, protozoan and viruses (Table 1). The focus of this paper will be on those pathogens commonly found in bovine manure with the greatest risk of infection for humans. When these potential pathogens move through the slaughterhouse on livestock or poultry, they may cause disease in humans.

E coli O157

Cattle are thought to be the primary reservoir of E coli O157. Poultry and birds are not felt to be important sources or reservoirs of human infections. In dairy cattle, while in most herds a fecal shedder can be found by diligent search and repeated cultures, the prevalence of fecal shedders is usually less than 1% of the herd.. The greatest prevalence is usually found in heifers and calves under 24 months of age. Calves that have been recently weaned off milk appear to have the highest prevalence. The prevalence in milk fed calves is very low. While fecal shedding is sporadic, it does seem to occur at the same time in clusters of animals. Feed deprivation may cause animals to increase their shedding. The amount of E coli O157 shed in the manure is estimated to be between 3 – 50,000 cfu/gram of feces. Note that the E coli O157 infective dose for humans is about 10 cfu – the lowest of the common human food-borne pathogens.

Fortunately, E coli O157 does not persist for long periods in the dairy environment. This may reflect pressures from the environment itself or it may reflect the shedding patterns of animals – sporadic and short term. Fecal shedding in cattle has not been found to reflect grazing on forages that have been fertilized with cattle manure. This may be another indication that E coli O157 does not survive for long periods after being spread on fields.

As illustrated by some of the foods that have been contaminated by E coli O157, it can grow under conditions normally considered adverse for bacteria. Outbreaks have occurred from contaminated apple cider that was kept refrigerated and has a low pH. Other times it has been found in contaminated hard salami with high nitrates, nitrites and salt content. It actually survives better in colder temperatures: - 5 C, 70 days; 22 C, 56 days; and 37 C, 49 days.

Listeria

This bacterium is found naturally living in plants and soil as well as poorly fermented silage (high pH). Cattle seem to shed more Listeria in their feces during the colder winter

months. Many humans and livestock, especially sheep, are carriers. Shedding is induced by stress such as birthing or prolonged transportation. Fresh vegetables fertilized with animal manure are thought to be important sources of contamination for humans.

Listeria grows well at a wide range of temperatures, wide pH range (5-9), and in high salt concentrations.

Salmonella

Many types of salmonella are known to exist (2000+ species). Fortunately, only a few consistently cause disease in cattle or humans. Up to 75% of dairies are positive on fecal culture for salmonella. Over 50% of the cattle have been found to be shedding on some dairies. A small percentage of cattle are colonized carriers that continually shed salmonella in their feces. Most shedding cattle have between 20 – 50,000 cfu of salmonella per gram manure. There are many other sources of salmonella on dairies such as contaminated feeds, rodents, wild animals and birds.

Salmonella has been reported to survive in detectable quantities (small quantities at the limits of detection by culture) for 286 days in slurry or lagoons. However, there is a 90% reduction in slurry in just 30 days. Salmonella survival in manure is highly dependent on temperature and ammonia concentration.

Mycobacterium paratuberculosis

M. paratuberculosis is the causative organism for Johne's Disease in cattle. Infected cows may shed the pathogen in her feces for months to years before she develops clinical signs. At the peak of shedding, an infected cow may shed a million bacteria/gram of manure. Cows with clinical signs of diarrhea and weight loss tend to shed more bacteria in their feces than non-clinically infected cows. Two thimbles full of manure from an infected cow is enough to infect a calf. Consider forage crops that had fresh manure applied as fertilizer as a feed risk to young stock. The bacteria can live in the environment for up to one year.

Cryptosporidia and Giardia

These protozoan are shed by wildlife, livestock and humans. The primary concern is water contamination from livestock manure. Dairy calves between 7 – 21 days old are the main shedders for Crypto on dairies. Beef calves are also the main concern for beef cattle, however, they shed at a slightly old age than dairy calves, 2 – 4 months old. Both of these organisms survive for a long time in manure. Lagoons are usually not contaminated with Cryptosporidia unless flushing systems are used to remove the manure from beneath pens of young dairy calves.

Survival of Pathogens

Survival of potentially pathogenic organisms in manure depends on many factors (Table 2). Keep in mind that manure is also made up of various elements including feces, urine, bedding materials, flush water, placenta, abortus, dead wildlife and animal secretions (nasal, blood, reproductive, mammary). There are many different organisms within what we commonly term "manure" and each of these has a preference for location. In general terms, the limiting factors are exposure to sunlight, extreme temperatures and exposure to oxygen and ammonia (Table 3).

Manure Management Methods

Many different systems and combinations of systems for manure removal and handling can be found on California dairies. In California, most dairies use liquid wash or flush waters. Settling pond or basins are found on 39% of the dairies and about 14% use some type of mechanical solid separator. Only 4% use some form of composting of manure. Liquid manures are used for year-round irrigation (63%), spread as a slurry (10%), sold or transported off the dairy 12%) or seasonally irrigated (62%). Solid manure was spread on farm land (78%), used for bedding (27%), sold off the farm (58%), removed from the farm (7%) or composted (5%).

Influence of Storage Methods

The method of manure storage will also impact the pathogen content of the manure. There are three common methods for handling manure – lagoon storage (slurry), deep stacking and composting. Each method may result in a decrease in the number of pathogen from the initial amount found in the manure. The rate of destruction and site of destruction may vary between methods of storage.

Stacked Manure

Manure that is placed in large piles after removal from livestock housing areas is referred to as stacked manure. It is usually not turned. Heating does occur in the stack, however, it is non-homogeneous therefore it is possible for pathogens to survive in unheated areas. Pathogens that do survive, survive near the outer crust of the stack. It has been reported that salmonella can survive for up to 200 days in stacked manure. Stacked manure is usually spread on pasture between crops.

Composting

During composting, stacked manure is turned periodically to insure that all areas of the pile reach at least 55 – 65 C (131-149 F) for 3 days or more. Periodic turning of the pile eliminates areas within the pile and near the crust that might escape the heating process. Most composting guides suggest that the pile should be turn when the temperature exceeds 145 F. If the piles do not heat, they can be turned to induce heating. Often the

piles need added materials if the pile dry matter is too low. Usually water is added to begin the heating process after more materials are added. After several turnings, the pile should be left undisturbed for at least a month.

Lagoon or slurry

The liquid and its contained dry matter substances taken from lagoons is slurry. The slurry is usually stored for variable time periods in the lagoon before application to pastures or field crops. During the storage time, most pathogens decline in numbers from the initial loading amounts. Storage for at least one month prior to spreading on land significantly reduces the level of salmonellas contained in slurry. Colder slurry temperatures favor longer survival of salmonella. Dry matter content and pH are other important factors. The effects of temperature, dry matter content and pH may not act directly on the salmonella. Their effect may be to favor the growth of other organisms found in the slurry that in turn affect the growth or survival of salmonella (competitive exclusion?). Often there is a 90% reduction in the number of salmonella in the lagoon during the first two weeks.

Use of Fly Ash in Manure

The use of 25% fly ash (pH about 13) with 75% dried manure and almond hulls reduced bacterial growth for 4-5 days compared to dried manure and hulls alone on a dairy that used excellent bedding maintenance (daily leveling and remove of pats, weekly replacement of bedding, high stall usage reflecting proper stall comfort and design). Clinical cases of mastitis were not monitored during this trial. See “Studies on the Potential Use of Fly Ash in Bedding on Dairies” for more details on the use of fly ash..

Processed Poultry Waste

Processed poultry waste is often fed to growing heifer replacement and dry cows as a so-called hay supplement. The processed poultry waste has been processed (heated) according to proprietary methods to destroy the primary pathogens that might be present. However, the processed waste is not sterile. In a study done in California, no E coli or Salmonella was detected upon arrival at the dairies or during the next 4 weeks while it was stacked on the dairy waiting to be fed. During the time the processed poultry litter was held in stacks on the dairies, it heated to greater than 140 F in a fashion similar to composting.

Summary

Several potential pathogens can be found in manure. Most of these pathogens transfer by fecal contamination of feed or animals followed by ingestion. The numbers of pathogens is usually reduced by most storage methods used on dairies.

Table 1. Some potential pathogens for livestock and humans found in bovine manure.

Bacteria
- Listeria monocytogenes
- E coli O157
- Salmonella spp.
- Mycobacterium paratuberculosis

Protozoans
- Cryptosporidia parvum
- Giardia spp.

Viruses
- Bovine Virus Diarrhea Virus
- Coronavirus
- Foot and Mouth Disease Virus

Table 2. Important survival factors for potential pathogens in manure.

Type of slurry or manure
pH
Dry Matter content
Temperature
Numbers and type of pathogen present
Presence of competing organisms

Table 3. Limiting factors for survival of pathogens in the environment.

Sunlight
Drying
Freezing and thawing cycles
High temperature
High or low pH
Exposure to oxygen
Ammonia concentration

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