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ID-356

PUBLIC HEALTH

CAFOs and Public Health:
Pathogens and Manure

EXPERT REVIEWED

Paul Ebner
Animal Sciences
Purdue University

This publication is one title in the *Concentrated Animal Feeding Operations* series.

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Purdue Extension Knowledge to Go 1-888-EXT-INFO

Introduction

Concentrated animal feeding operations (CAFOs) can generate large quantities of manure, most of which is applied to fields as fertilizer. Plants are able to utilize many manure nutrients such as nitrogen and phosphorous; and in doing so, they limit the entry of these compounds into water resources where high concentrations can be harmful to both environmental and human health. Livestock manure can also contain disease causing microorganisms; and if manure is improperly stored or mishandled, these pathogens could pose a health hazard if they come in contact with water or raw foods. As such, there are concerns that the manure generated by CAFOs could result in infectious disease outbreaks in surrounding communities.

The aim of this fact sheet is to examine the fate of microbial pathogens in manure in an attempt to discern the actual health risks associated with the introduction of pathogens to the environment through livestock manure.

Manure and Microorganisms

Many of the organisms that cause infectious disease in humans, such as *Salmonella*, *E. coli,* and *Cryptosporidium* can be readily found in livestock manure. Often, these microorganisms are normal inhabitants of the intestinal tracts of animals and can replicate to high concentrations without doing any noticeable harm to the animal. In many cases, the organisms may be beneficial to the animal by aiding in the digestion

and absorption of nutrients similar to the non-harmful microbes found in the intestinal tracts of humans. These intestinal microorganisms become part of manure when they are shed or excreted in the feces along with undigested food.

How Could Contamination Occur?

In most modern livestock operations, manure is collected and stored for variable amounts of time before being applied to pasture or cropland. Producers use different types of manure collection and storage systems, including pits (located underneath the buildings that house the animals), separate outbuildings, and man-made lagoons, as well as others (see Reference

1 for more detailed information on modern manure management).

Indiana regulations do not allow any direct (point source) discharge of manure or contaminated water into the waters of the state from manure storage facilities. In the past, the transfer of manure or effluent through pipes to lagoons has resulted in a high number of spills. The majority of new CAFOs in Indiana, however, do not use lagoon systems. Therefore, if collection and storage facilities are properly designed and maintained, there should be minimal risk of manure spillage, seepage, or overflow during this stage.

After a period of storage, producers then apply manure in varying stages of decomposition to fields as fertilizer. At this stage, non-point source introduction of manure into water is possible if the manure is improperly applied (e.g., applied to sloped land, eroding or saturated soil, or at rates that would saturate, the soils, etc.). Therefore, because the manure is less contained at the stage of land application, there is probably a greater risk of contamination of water resources (see Reference 2 for more detailed information).

Case Studies

It is often very difficult to definitively determine the origin of a microorganism involved in an infectious disease outbreak. This can be especially true for outbreaks involving raw foods or water. As such, while there have been cases where the responsible microorganisms were conclusively shown to come from livestock manure, they are rare.

One such outbreak occurred in Walkerton, Ontario, when heavy rains washed manure into well water thereby causing high concentrations of *E. coli* and *Campylobacter* to enter public drinking water. Over 2000 people were affected by the outbreak which included seven fatalities[3]. A similar outbreak involving *E. coli* and *Campylobacter* occurred in Washington County, New York, where manure run-off washed into an untreated well that serviced the fairgrounds[4].

In the 1990s there were several outbreaks involving *E. coli* O157:H7 and apple cider. In most cases, it was believed that fallen apples were harvested from the ground of orchards that were either grazed by cows or were fertilized with cow manure. As a result, apple cider is now regularly pasteurized in the United States[5].

There are also cases where livestock waste was implicated but not clearly shown to be the cause of an outbreak. The *Cryptosporidium* outbreak of Milwaukee, Wisconsin, which affected an estimated 403,000 people[6,7], is probably the most famous. While this outbreak is often cited as a being caused by manure run-off from dairies, new evidence has shown that the origin of the causative agent is more uncertain[7]. Similarly, livestock waste was implicated in but not definitively shown to be responsible for a similar *Cryptosporidium* outbreak in Carrollton, Georgia, in 1989 affecting over 13,000 individuals[4].

It is important to note that in those outbreaks where livestock manure was clearly shown to be the cause of contamination, the involved farms would not be considered CAFOs. Therefore, the risks are not exclusive to larger, confined operations but apply to animal manure as a whole.

What Can Be Done to Minimize the Risk?

Most of the human pathogens found in manure have adapted to live in the intestine; thus, they do not tend to survive for extended periods in soil or even manure. Therefore, the most effective tool in eliminating pathogens from manure, from both practical and economic standpoints, is time. If manure is allowed to sit undisturbed in storage or in soil, the concentration of pathogens will decrease with time as they die out or are overgrown by native microbes.

In Indiana, CAFO operators are required to produce and adhere to a manure management plan. In basic terms, a manure management plan describes the actions to be taken by the operator to ensure that the storage of manure, and its land application to cropland or pasture, will not result in over-fertilization and contamination of waterways. CAFO operators must outline how manure is collected and stored, how both manure and soil are regularly tested, and how much manure will be applied to fields, all the while, taking into account topography of their land, soil types, drainage courses, and nearby streams, ditches, or lakes[8,9]. While not specifically designed for pathogen reduction, measures that guard against over-fertilization, i.e., application at agronomic rates, should decrease the risk of pathogens entering water supplies by allowing time for large percentages of the pathogens to die out.

The following are recommended "best management practices" that CAFO operators can employ to further decrease the risks of manure pathogens entering water or food supplies [2,10].

1. Do not apply manure to wet or saturated soils.
2. Inject liquid manure or incorporate (mechanically mix into soil) solid manure on the day it is applied.
3. Apply manure only to frozen land if approved by the manure management plan, and only to land not prone to flooding, i.e., land with less than a 2% slope or land with proper erosion control practices in place.
4. Incorporate liquid manure in karst areas (areas with a limestone landscape, which are characterized by caves, long cracks, and underground streams).
5. Incorporate manure on non-erosive soils unless erosion control practices are used.
6. Use cover crops and other erosion control practices with erosion-prone land.
7. Ensure that storage sites are impeccably maintained and managed.

Conclusions

Because it is difficult to pinpoint the exact source of contamination in infectious disease outbreaks involving raw foods or water, it is difficult to determine the level of risk posed by pathogens in livestock manure. It does deserve further study, however, as livestock manure has been implicated, albeit rarely, in outbreaks in the past.

In Indiana, CAFO operators are required to produce and adhere to a manure management plan. While not specifically designed to reduce the risk of pathogens entering water supplies, the regulations designed to minimize contamination of water resources with nutrients such as nitrogen and phosphorus should also reduce contamination of water resources by pathogens by allowing the time needed for the organisms to be destroyed naturally. Because the consequences of manure mismanagement can be severe and affect large groups of people, CAFO operators should adopt best management practices (BMPs) that further reduce risks such as immediately incorporating manure into the soil, adopting various soil conservation practices, and diligently managing and maintaining storage sites.

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