

Title: Manure Composting as a Pathogen Reduction Strategy

Division: Agriculture and Rural

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Why is Reducing Pathogens Important?

Manure and improperly composted manure can be a source of pathogen contamination on crop products intended for human consumption. Pathogens have the potential to cause human illness when consumers are exposed to them.

Good agricultural practices frequently suggest that uncomposted manure should only be applied when the interval between application and harvest is greater than four months.

Composting of manure kills most pathogens and greatly reduces the risk of pathogen contamination.

What Pathogens?

Livestock and poultry manures naturally contain a wide range of bacteria, viruses and protozoa. Some of these are known for their adverse effects on people. Bacteria known to be human pathogens include certain strains of *E. coli*, including 0157:H7, *Salmonella* spp., *Listeria*, *Streptococcus* spp., *Campylobacter*, *Clostridium* spp. Protozoa include *Giardia* and *Cryptosporidium*. Most viruses found in animal manure do not infect humans.

The levels of these pathogens in manure can vary and depend partially on the livestock species. Generic *E. coli* can be found in the manure from all species. *E. coli* 0157:H7 is most common in cattle manure but has also been found in the manure of other mammals. *Salmonella* is most commonly found in poultry manure.

Campylobacter is common in poultry manure but can be found in all species. *Listeria* is common in cattle and sheep manure but may be found in all species. *Cryptosporidium* are common in cattle manure

(particularly young animals) but may also be found in manure from pigs and sheep.

Occasionally food products are found to be contaminated with one or more of these organisms. There are many sources of contamination beyond improperly composted manure such as poor water quality, transmission from improperly sanitized equipment and people handling produce during processing (improper hand washing procedures) have been found to be sources in some cases.

In addition to livestock sources of pathogens, there have been studies to indicate that green yard wastes can be contaminated, primarily due to pet droppings. These materials should be composted and used with care in the planting of food crops.

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How Long Do Pathogens Survive?

The survival of these pathogens in manure will largely depend on the temperature and moisture content of the materials. Other factors are oxygen level, pH, ammonium content, microbial competition, etc. In general, the higher the temperature and the longer the storage or treatment time of the manure, the less likely pathogens will survive. Most pathogens have short survival times when under very dry conditions.

The following table shows some reported survival times based on materials temperatures or moistures as indicated.

Table 1. Potential Survival of Fecal Pathogens in the Environment

Material	Temp.	Duration of Survival			
		Cryptosporidium	Salmonella	Campylobacter	E. coli 0157:H7
Water	Frozen	>1 year	>6 months	2–8 weeks	>300 days
	Cold (5°C)	>1 year	>6 months	12 days	>300 days
	Warm (30°C)	10 weeks	>6 months	4 days	84 days
Soil	Frozen	>1 year	>12 weeks	2–8 weeks	>300 days
	Cold (5°C)	8 weeks	12-28 wks	2 weeks	100 days
	Warm (30°C)	4 weeks	4 wks	1 week	2 days
Cattle manure	Frozen	> 1 year	>6 months	2–8 weeks	>100 days
	Cold (5°C)	8 weeks	12–28 weeks	1–3 weeks	>100 days
	Warm (30°C)	4 weeks	4 weeks	1 week	10 days
Liquid manure		>1 year	13–75 days	>112 days	10-100 days
Composted manure		4 weeks	7–14 days	7 days	7 days
Dry surfaces		1 day	1–7 days	1 day	1 day

Source: *Human and Animal Pathogens in Manure*, Olsen, M. E.

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Does Composting Help?

Using proper composting procedures can drastically reduce the number of pathogens in manure. One of the parameters identified in many composting procedures is to maintain temperature above 55°C for at least 3 days when using aerated or in-vessel systems. In windrow systems, the core of the windrow may reach these temperatures, but surface zones and near the base of the windrow will have lower temperatures. Turning or mixing the windrow will introduce oxygen to the windrow and quickly increase temperatures in the earlier stages of composting. Turning with equipment that moves material from the surface to the core of the windrow will expose more materials to higher temperatures. Repeated turnings are necessary to ensure all materials are exposed to at least 3 consecutive days of high temperature.

It is generally recommended that windrows maintain a core temperature of 55°C for 15 days with at least

5 turnings. Due to the need for proper mixing and consistent high temperatures, pathogen reduction in windrow composting has sometimes been found to be less consistent than when using well-managed, aerated static pile or in-vessel systems.

Some organisms are more difficult to kill than others and temperatures must be regularly monitored to ensure that appropriate temperatures are maintained. Proper moisture levels (50%-60%), optimum C:N ratios (25:1-30:1) and appropriate aeration or turnings are all factors to ensuring the conditions are optimum to reach and maintain the necessary temperatures. Records should be kept for temperatures, compost conditions, C:N ratio, moisture, and the date/time of turnings.

Clean the compost turning equipment between uses to avoid re-establishing the pathogens in the compost. Equipment should not go from a new compost pile to an established windrow without being cleaned as it may carry pathogen contaminants from one pile to another. Loaders used to handle fresh manure should be cleaned before handling compost. Windrows should be turned with equipment that is capable of turning the surface material into the middle of the windrow.

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Compost Teas

Compost teas are made by putting a small quantity of mature compost (in a perforated bag) into water and allowing it to steep (also known as brewing). This creates a compost tea solution that can be applied to the crop as a foliar source of nutrients. Some research has also found suppression of certain plant diseases when applied to crop foliage. Compost teas should only be made with fully mature compost to reduce pathogens. Adding sugar or molasses materials during the steeping process has been reported to increase the incidence of pathogens in the compost tea. Compost tea must be aerated during the "steeping" process and used immediately after steeping to reduce the risk of pathogen contamination. Do not apply compost teas to edible parts of the crop or apply near harvest time.

Manure tea is made using non-composted or improperly composted manure and may contain high levels of pathogens. Do not apply manure tea directly to crops. After field application, observe the appropriate waiting periods before harvest of food crops (example: 4 months).

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Summary

Composting is a useful strategy to reduce pathogens in manure but care must be taken to correctly manage the composting process.

For More Information On Composting

- **Ontario Ministry of Agriculture and Food Factsheets**
 - Agricultural Composting Basics, Order No. 05-023
 - Temporary Field Storage of Solid Manure or Prescribed Materials, Order No. 05-009
 - On-Farm Composting of Livestock and Poultry Mortalities, Order No. 03-083
- **Art and Science of Composting**
14 pages of basic composting information by Leslie Cooperbrand, Univ. of Wisconsin, 2002, www.cias.wisc.edu/pdf/artofcompost.pdf
- **CORNELL Composting Homepage**
Web site maintained by the Cornell Waste Management Institute and provides access to a variety of composting educational materials and programs developed at Cornell University, compost.css.cornell.edu/Composting_homepage.html
- **On-Farm Composting Handbook (NRAES-54)** - definitive guide on Composting edited by R. Rynk, 1992
compost.css.cornell.edu/OnFarmHandbook/coverpg.html
- **On-Farm Composting** - A review of the scientific literature maintained on the Alberta Agriculture, Food and Rural Development website (over 500 references) [www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/sag2150](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/sag2150)
- **ManureNet** - a database of manure management technologies

Related Links

- [Temporary Field Storage of Solid Manure or Prescribed Materials](#), OMAF Factsheet
- [On-Farm Composting of Livestock and Poultry Mortalities](#), OMAF Factsheet
- [Art and Science of Composting](#)
- [CORNELL Composting Homepage](#)
- [On-Farm Composting Handbook](#)
- [On-Farm Composting](#)
- [ManureNet](#)

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