FSMA Compliant On-Farm Thermophilic Composting: A Safe Way to Enrich the Soil

The Food Safety Modernization Act (FSMA), signed into law in 2011, is the most sweeping change to food safety in over 70 years. FSMA's focus is on preventing food borne illness and includes regulations for farms that grow fresh produce and for facilities that process food.

The majority of standards related to soil amendments can be found within Subpart F: Standards Directed to Biological Soil Amendments of Animal Origin and Human Waste (*§112.51-§112.60*). Composting is defined in *§112.3(c)* as "a process to produce stabilized compost in which organic material is decomposed by the actions of microorganisms under thermophilic conditions for a designated period (e.g., 3 days) at a designated temperature (e.g., 131˚F or 55˚C) followed a curing stage under cooler conditions". Curing is defined in *§112.3(c)* as "the final stage of composting, which is conducted after much of the readily metabolized biological material has been decomposed, at cooler temperatures than those in the thermophilic phase of composting, to further reduce pathogens, promote further decomposition of cellulose and lignin, and stabilize composition".

Key facts for thermophilic composting:

- Temperature is the primary method of pathogen reduction.
- Length of time depends on management parameters (aeration, turning, cover, moisture, type of manure).
- Only a composting process that has been scientifically validated ensures pathogen reduction. Scientifically valid composting methods per *§112.54(b):*
    a. Static composting that maintains aerobic (oxygen) conditions at a minimum of 131˚F (55˚C) for 3 consecutive days and is followed by adequate curing; and
    b. Turned composting that maintains aerobic conditions at a minimum of 131˚F (55˚C) for 15 days (can be non-consecutive), with a minimum of 5 turnings and followed by curing.
- Process monitoring and recordkeeping are required to ensure the compost is adequately treated as per *§112.60(b)(2).*

Parameter	Degree of food risk (Higher to lower)		
Soil Amendment	Raw Manure	Composted Manure	Chemicals
Crop	Fresh Produce	Agronomic crop	
Time of application	Near Harvest	Days to harvest	
Method of application	Surface applied	Injected and Incorporated (data unclear on risk level)	
Frequency	Excessive application	Adequate use	

Selection of Site

When selecting a composting site, growers must ensure the area and location is suitable for this activity and would not pose environmental and food safety risks.

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- Maintain separation distances and barriers (such as buffer zones) between areas where compost is produced and crop fields, water sources, water distribution systems, food contact areas [*§112.52(a)*] and nearby human housing.
- Manure and compost should not be stored in areas likely to experience runoff. Compost and manure must be stored separately [*§112.52(b)*].
- Foot and equipment traffic should be directed away from soil amendments of animal origin to reduce the risk of cross-contamination.

Factors affecting the composting process

The composting process should be viewed as a continuous process that transforms the readily available nutrient sources into mineralized, environmentally stable forms of nutrients. The following factors control the efficiency of the composting process:

Parameter	Effect
Oxygen	For aerobic composting and results in fast decomposition
Aeration	Helps to distribute heat, moisture, incorporate oxygen and distribute other gases trapped within the composting material
Nutrients (C:N ratio)	Microorganisms need both carbon and nitrogen for energy, protein synthesis and reproduction. An effective C:N ratio is critical at the beginning of the composting process to ensure that thermophilic, pathogen-reduction temperatures will be achieved. The rule-of-thumb is to incorporate feedstock into the compost pile that targets a 30:1 C:N ratio
Moisture	Supports the metabolic processes of the microbes. Water provides the medium for chemical reactions, transport nutrients, and allows the microorganisms to thrive
Porosity, Structure, Texture, and Particle Size	Affects aeration in the compost pile
pH	Aerobic microorganism grow well and most efficiently decompose organic matter around neutral pH of 7.0
Temperature	Temperatures at or above 131˚F are necessary to ensure that pathogen kill is being achieved
Homogenization/Turning	Encourages proper moisture content, aeration and exposure to thermophilic temperatures of every particle in the compost
Time	Measured from the start of the composting process. The monitoring (and record) of degree days above 131˚F is critical to maintaining compliance with FDA standards (*§112.54(b)*)

Choice of Raw Materials

The ingredients for composting could be a mixture of manure, bedded manure, non-fecal animal byproducts, peat moss, pre-consumer vegetative waste, sewage sludge biosolids, table waste, yard waste materials. It is rare for ingredients to have all of the characteristics required for efficient composting. Therefore, it is usually necessary to blend several materials in suitable proportions to achieve a mix of desirable characteristics.

Desired Characteristics of raw material mixes

Characteristic	Reasonable Range	Preferred Range
Carbon to Nitrogen Ratio (C:N) ratio	20:1 – 40:1	25:1 – 30:1
Moisture Content	40 - 65%	50 – 60%
pH	5.5 – 9	6.5 – 8.5

Microbial Standards for Composting [§112.55(b)]

The FSMA Produce Safety Rule sets standards for the thermophilic composting process. The composting processes allowed by the Rule and described in *§112.54(b)(1)* and *§112.54(b)(2)*, have already been scientifically validated to meet the relevant microbial standards listed below:

Microorganism	Microbial Standard
Salmonella species	Not detected using a method that can detect three most probable numbers (MPN) per 4 gram (or milliliter, if the liquid is being sampled) of total solids
Fecal coliforms	Less than 1,000 MPN per gram of total solids (dry weight basis) or milliliter if the liquid is being sampled

Animal manure is a well-known potential source of pathogenic microorganisms that can cause disease in humans, directly or indirectly, through consumption of contaminated water or food. The possible contamination sources of concern include wildlife and domestic animals, runoff from pasture and pasture grazing, contaminated surface water, and manure-based soil amendments. The most commonly used animal manures come from cattle, swine, sheep, poultry, goat, and horses. The characteristics of the different types of manure and the natural presence of certain human pathogens and their virulence are all critical factors in evaluating microbial risks.

Bacteria	Disease/Illness	Potential Animal Manure Source
Campylobacter coli and *C. jejuni*	Campylobacteriosis (diarrhea)	Cattle, Sheep, Swine, Poultry, Goat, Wildlife
Bacillus anthracis	Anthrax (cold, fever)	Cattle, Sheep, Swine, Wildlife
Brucella abortus	Brucellosis (fever)	Cattle, Sheep, Swine, Wildlife
Escherichia coli (pathogenic)	Diarrhea	Cattle, Sheep, Swine, Wildlife
Listeria monocytogenes	Listeriosis (miscarriage in pregnant women)	Cattle
Salmonella spp.	Salmonellosis (diarrhea, fever)	Cattle, Sheep, Swine, Poultry, Goat
Yersinia influenza	Yersiniosis	Swine
Viruses		
Avian – Swine influenza	Fever, cold, sore throat, diarrhea	Poultry, Swine
Hepatitis E	Infects Liver (weight loss, nausea)	Swine
Parasites		
Cryptosporidium parvum	Cryptosporidiosis (diarrhea)	Cattle, Sheep, Swine
Giardia spp.	Giardiasis (diarrhea)	Cattle, Sheep, Swine
Toxoplasma spp.	Toxoplasmosis (swollen lymph nodes)	Warm Bloodied Animals

Best Practices to Consider

Composting is a beneficial approach to convert organic waste into a valuable soil amendment. This factsheet discussed the validated biological decomposition process that is laid out in the FSMA Produce Safety Rule under section *§112.55(b)*.

To reduce the risk of contaminating fresh produce:

- Untreated compost must be applied in a manner that minimizes the potential for contact with covered produce during and after application *§112.56(1)(ii)*.
- Direct contact of compost with the harvestable portion of the crop must be avoided *§112.56(2)*. For example, broadcasting compost in an established field of leafy greens would be in direct contact with the crop. However, side dressing would be a suitable application method (minimized contact).
- For root crops, compost that meets the codified treatment process of *§112.54(b)* is unacceptable as it would result in direct contact with the edible portion of the crop [*§112.56(a)(2)*]. Only compost that meets the treatment process criterion of *§112.54(a)* is acceptable for amending soils intended to grow root crops.
- You must ensure that the composted materials do not become a source of contamination for covered produce, food contact surfaces, areas used for the covered activity, water sources and water distribution systems *§112.52(a)*.

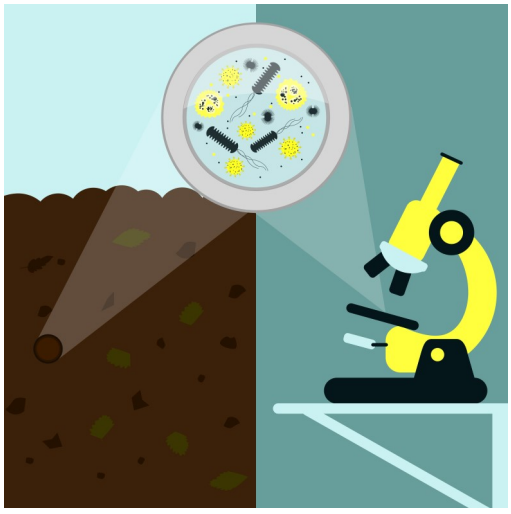
Following these best practices will reduce your food safety risk when utilizing compost.

Prepared by:

Manreet Bhullar, MS and Smaranda Andrews, PhD

Reviewed by: Angela Shaw, PhD

This material was developed by the North Central Regional Center under a grant from the Food and Drug Administration. FDA has provided technical assistance in developing this material; however, this information has not been formally approved by FDA. It does not represent any agency determination or policy.



Funding provided through the Department of Health and Human Services Food and Drug Administration (Grant Number 1R01FD005685-01) titled "Strategies for Successful Implementation of FSMA (Food Safety Modernization Act) in the North Central Region through Adoption of a Systems Approach and Stakeholder Engagement Framework."