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# Basic Concepts for Composting Poultry Mortalities [1]

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The purpose of this fact sheet is to briefly describe the concepts associated with composting poultry mortalities. Composting is an aerobic (oxygen present), biological process by which organic materials, including poultry carcasses, are reduced to soil-like materials. Anaerobic (without oxygen) reduction can be defined simply as putrification. Each process involves different species of microorganisms and each process produces different intermediate products.

Microbial activity requires several conditions for efficient and rapid composting. These include:

- oxygen and aeration
- nutrients
- moisture
- porosity
- structure
- texture
- surface area
- pH
- temperature

## Oxygen and Aeration

Aerobic reduction of poultry tissues consumes large amounts of oxygen especially during the early stages (first 7 days). The minimum amount of oxygen required as a percent of air is 5 percent. Air is 20.8 percent oxygen at sea level.

Several methods are available to move air into the composting mixture to promote aerobic reduction. These include physical turning of the materials in drums or in static piles, passive aeration using perforated plastic pipes, and static aeration. In static aerated piles, air is actively pumped into the pile from beneath with a blower or pulled down through the pile using a vacuum.

## Nutrients

Like other organisms, including both plants and animals, microorganisms utilize a wide variety of nutrients. Those of most concern in composting are carbon (C), nitrogen (N), phosphorus and potassium. Organic materials such as poultry manures and poultry carcasses contain ample amounts of all these necessary nutrients except carbon. In these materials,

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the ratio of carbon to nitrogen (C:N) is generally considered to be about 6 to 1.

Microorganisms use carbon for both energy and growth while nitrogen is necessary for protein synthesis and reproduction. Biological organisms need about 25 times more carbon than nitrogen to maintain a balanced diet. When the C:N ratio of the compost pile is less than 15:1, nitrogen (in the form of ammonia and nitrous oxide) is lost. When C:N ratios are greater than 50:1, excess carbon is lost as carbon dioxide. Excess carbon can cause problems such as "nitrogen robbing of the soil" after the product has been land applied. Maximum efficiency is obtained when the carbon source is in direct contact with the nitrogen rich carcass tissue.

Several sources of carbon can be used in composting depending upon cost, availability and how the carbon rich materials are to be used. Quite often two types of carbon material are provided. One type of material is used to promote structure such as wood chips and yard waste. These materials can be screened off and reused after the composting is finished. This reduces the C:N ratio in the final product. Other forms of carbon rich material are used as elemental carbon by the microorganisms. These carbon materials include straw, peanut hulls, wood shavings, sawdust and many others. Old poultry feed is especially good for this purpose.

## Moisture

Water is necessary to support the metabolic processes of the microbes. Water provides the medium for chemical reactions, transports nutrients and allows for mobility of the microorganisms. Biological activity is greatest when the composting materials are saturated with water. This activity ceases when moisture levels are below 15 percent. Generally, moisture levels should be kept between 40-65 percent for the most efficient rate of reduction. When the composting activity is greatest and temperatures in the core of the composting pile are very high, water must be added at regular intervals to support maximum activity.

## Porosity

Porosity is a measure of air space within the composting materials which determines the resistance to air flow. Size gradation of poultry tissues and other materials, continuity of the air spaces and moisture level determine the porosity of the compost pile. Porosity can be negatively affected by the application of water.

## Structure

Structure is affected by the rigidity of the materials that make up the compost pile and their ability to resist compaction. Good structure reduces the loss of porosity in a moist environment.

Various types of materials are added to the compost pile to promote structure. These materials can include yard waste or shredded wood. When the poultry carcasses have been chopped, feather shafts also provide structure in the early stages of composting.

## Texture

Texture is the characteristic that describes the available surface area for aerobic microbial activity. Most aerobic reduction occurs on the surface of tissues. Oxygen moves readily as a gas through pore spaces but much slower through the liquid and solid portions of the tissues. A population of aerobic microorganisms builds up in the liquid layer surrounding the surface of tissues. The microorganisms use the available carbon at the tissue surface, leaving the interior essentially unchanged in an anaerobic state. The tissue is reduced in size as the composting microorganisms work their way toward the center of the poultry tissues.

## Surface Area

Surface area of tissues increases with decreasing tissue size. This increases the rate of microbial action on carcass tissues as long as reduced tissue size does not negatively affect other characteristics such as porosity and texture. Chopping poultry mortality and reducing tissue size can greatly increase the tissue surface area.

## pH

The composting process for poultry mortality is normally not sensitive to pH due to the large numbers, diversity of microorganisms and organic materials found in composting poultry tissues. The acceptable range is between pH 5.5-pH 9. The preferred range is between pH 6.5-pH 8.

## Temperature

Temperature is generally considered an indicator of microbial activity. Microorganisms that prefer temperatures between 50-105°F are known as *mesophilic* , and those microorganisms that prefer temperatures above 105°F are referred to as *thermophilic* .

Temperatures above 130°F are preferred because of the destruction of pathogens, fly larvae, and other insects. Compost piles containing daily mortality (either whole or chopped carcass) can generate temperatures of 170-173°F for the first 2 weeks if the following conditions are met. Highly available carbon must be in close contact with the tissues. The oxygen level in the core must be from 14-17 percent and the moisture level between 50-60 percent.

## Problems with Flies and Other Insects

Flies can be a problem when composting poultry carcasses. This is especially true in Florida where flies are active almost all year.

Blow flies (Family *Calliphoridae* ) are the flies of primary concern. Blow flies deposit thousands of eggs in and on chickens just before or soon after death. Fly larvae begin leaving the compost pile when temperatures approach 115°F. Temperatures above 120°F are lethal to these insects. Normally, adult blow flies lose interest after the temperatures in the compost pile begin to rise.

A fly that shows interest in the compost pile as it begins to cool is the soldier fly, *Hermetia illucens* (Family *Stratiomyidae* ). Another insect that can cause trouble if the carcasses are not handled correctly is the beetle, especially the hide beetle ( *Dermestes maculatus* ) and the larder beetle ( *Dermestes lardarius* ). Adults of both species feed on the carcass tissues, and their larvae cause damage by burrowing into and weakening wood structures in an attempt to pupate.

## Obtaining Additional Information

These are some of the concepts that are important when considering composting daily mortalities. A more detailed description of these subjects can be found in the publication, "On-Farm Composting Handbook." NRAES-54. Northeast Regional Agricultural Engineering Service. Ithaca, NY.

For information on construction of composters for poultry mortality, refer to Fact Sheet AE-243, "Structure for Composting Broiler Mortality."