Compost Feed Stock

How to calculate the proportions of raw materials for composting

A variety of organic byproducts or waste could be used for composting. An appropriate proportion of the organic materials known as feedstocks are blended to achieve the desired characteristics for hot composting. The feedstocks are divided in three categories: Amendments, which maintain moisture, texture, and carbon-to-nitrogen ratio; bulking agents to maintain structure and porosity for air movement; and carbon sources to raise the carbon-to-nitrogen ratio. Maintaining certain parameters of the compost pile is important for optimal microbial activity and desired outcomes.

Recommended Conditions for Hot Composting

Parameter	Reasonable range	Preferred range
Carbon-to-nitrogen (C:N) ratio	20:1 – 40:1	25:1 – 30:1
Moisture content	40%-65%	50%-55%
pH	5.5-9.0	6.5-8.5
Oxygen concentration	>5%	>5%
Particle size (diameter in inches)	0.2-1.0	0.2-0.5
Pile porosity	>40%	
Bulk density (lbs./ cu. Yd.)	800-1,200	<1100
Temperature	110-140	130-140

(Adapted from On-Farm Composting Handbook NRAES-54)

These recommendations are for rapid composting. Conditions outside these ranges may also yield successful results

Carbon-to-Nitrogen Ratio:

The proportion of carbon-to-nitrogen (C: N) ratio by weight is an important parameter for hot composting. A reasonable range of C:N is from 20:1 to 40:1. However, a range of around 30:1 would provide best the results. Carbonaceous (C) material in compost serves as a source of energy for microorganisms. Nitrogen (N) is important for microbial growth because it is an important component of protein and is required for bacterial cell growth. A high C:N ratio indicates inadequate nitrogen compounds in a compost mix, which could result in limited microbial growth and the slow decomposition of compost materials. A low C:N ratio indicates excessive nitrogen compounds, which result in losses of gaseous ammonia and leads to bad odor.

Moisture Content:

Moisture is an important component of hot composting. Too much moisture takes the pore space, which will restrict airflow inside the pile. This could lead to anaerobic degradation, which produces bad odor and prevents the pile from reaching the desired temperature. Too little moisture causes composting materials to dry out and stop the microbial activity. For best results, compost pile moisture should be maintained between 50%-55%.

pH

Different types of feedstocks may affect the pH of the compost pile. Fruit and vegetable byproducts would lower the pH (<5.0), while high pH may be found in feedstock from dairy operations, where lime is used as bedding. A higher pH value will increase the loss of nitrogen. The pH value of acidic compost will increase within a few days of hot composting.

Oxygen Concentration:

At or below 3% oxygen will facilitate anaerobic degradation and increase foul odors. Maintaining aerobic conditions and having an oxygen level greater than 5% is key to control odor problems.

Particle Size

Particle size is important because it would provide necessary air space inside the pile. As materials decompose during composting, they settle under their own weight and lose the porosity, which results in poor pile aeration. Too large particle sizes would be difficult to decompose.

Porosity

Porosity determines the effective air flow inside the pile. A poor porosity reduces air diffusion inside the pile, which leads to anaerobic conditions.

Bulk Density

High bulk density indicates materials are too wet and dense. This can cause issues with aeration and moisture control. The bulk density of the initial mix should not be higher than 1,000 pounds per cubic yard.

Temperature

The increase in temperature of the pile is the result of microbial activity inside the pile. This leads to a cooking effect and destroys seeds, weeds and bacterial pathogens. To meet the Environmental Protection Agency Process to Further Reduce of Pathogens (PFRP) requirement, an internal pile temperature of 131 degrees Fahrenheit is needed for at least three days for an aerated static pile or, for turned pile composting, after each turning for at least five turnings.

Formulas for Determining Composting Recipes by Weight

(Adapted from Field Guide to On-Farm Composting [NRAES-114])

Formulas for an individual ingredient

Moisture content = % moisture content ÷ 100

Weight of water = total weight x moisture content

Dry weight = total weight - weight of water

= total weight x (1 - moisture content)

Nitrogen content = dry weight x (% N ÷ 100)

% carbon = % N x C:N ratio

Carbon content = dry weight x (% C ÷ 100)

= N content x C:N ratio

General formulas for a mix of materials

$$\text{Moisture content} = \frac{\text{weight of water in ingredient a + water in b + water in C +...}}{\text{total weight of all ingredients}}$$

$$\text{Moisture content} = \frac{(a \times m_a) + (b \times m_b) + (c \times m_d) + \ldots}{a + b + c + \ldots}$$

C:N ratio=

$$\frac{\text{weight of C in ingredient a + weight of C in b + weight of C in c + ...}}{\text{weight of N in a + weight of N in b + weight of N in c + ...}}$$

C:N ratio=

$$\frac{[\%Ca \times a \times (1- m_a)] + [\%C_b \times b \times (1-m_b)] + [\%C_c \times c \times (1- m_c)] + \ldots}{[\%Na \times a \times (1-m_a)] + [\%N_b \times b \times (1- m_b)] + [\%N_c \times c \times (1- m_c)] + \ldots}$$

Symbols:

a = total weight of ingredient *a*

b = total weight of ingredient *b*

c = total weight of ingredient *c*

m_a, m_b, m_c, ... = moisture content of ingredients a, b, c, ...

% N_a, N_b, N_c, ... = % nitrogen of ingredients *a, b, c,* ... (% of dry weight)

% C_a, C_b, C_c, ... = % carbon of ingredients a, b, c, ... % of dry weight)

Shortcut formulas for only two ingredients

(For example, manure plus straw)

1. Required amount of ingredient a per pound of b based on the desired moisture content:

$$a= \frac{mb-M}{M-ma}$$

Then check the C:N ratio using the general formula.

2. Required amount of ingredient a per pound of b based on the desired C:N ratio:

$$a= \frac{\%Nb}{\%Na} \times \frac{(R- Rb)}{(Ra- R)} \times \frac{(1- mb)}{(1- ma)}$$

Then check the moisture content using the general formula.

a = pounds of ingredient a per pound of ingredient b

M = desired mix moisture content

m_a = moisture content of ingredient a

m_b = moisture content of ingredient b

R = desired C:N ratio (by weight) of the mix

R_a = C:N ratio (by weight) of ingredient a

R_b = C:N ratio (by weight) of ingredient b

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