

## Information Sheet No. 5-7

### Composting Science for Industry

#### Carbon to nitrogen ratio (C:N) and other nutrients

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#### What is the carbon to nitrogen ratio?

Carbon (C) in organic matter is the energy source and the basic building block for microbial cells.

Nitrogen (N) is also very important and along with C, is the element most commonly limiting.

Microorganisms require about 25-30 parts of carbon by mass for each part of nitrogen used for the production of protein.

A carbon to nitrogen ratio of 30 parts carbon to 1 part nitrogen (by mass) is written as a ratio, 30:1. Therefore, a C:N ratio of 500:1 (e.g. sawdust) represents a high C:N ratio, and 5:1 (e.g. meat) represents a low C:N ratio.

Microorganisms also require adequate phosphorus, sulfur and micronutrients for growth and enzyme function, but their role in composting is less well known.

Preparing feedstock to an optimum C:N ratio results in the fastest rate of decomposition — assuming other factors are not limiting (e.g. oxygen,

‘A C:N ratio of between 20 and 40:1 is often suitable for composting depending on the make-up of the feedstock. As composting proceeds, the C:N ratio gradually decreases to between 10 and 20:1.’

moisture, nutrients etc.).

In general, a high C:N ratio slows the rate of decomposition so that the composting process takes longer.

#### How organic materials break down

Compost feedstock is a complex mix of organic materials ranging from simple sugars and starches to more complex and resistant molecules such as *cellulose* and *lignin*.

In general terms, composting microbes first consume compounds that are more 'susceptible' to degradation in preference to compounds that are more resistant (Table 1).

The breakdown of organic matter is

**Plate 1.** Examples of common feedstocks in compost recipes with different C:N ratios. Low C:N pre-consumer food organics (left) and high C:N wood chips (right). When these materials are blended approximately at a 1:1 ratio (w/w), a good composting mix with a C:N ratio of ~35:1 is achieved.



'Feedstocks of low C:N ratios (<15:1) may decompose rapidly, but odours can become a problem because of the complete and rapid usage of oxygen without replenishment. Anaerobic conditions that form result in the production of odourous sulfur compounds such as thiols.'

therefore a step-wise reduction of complex substances to simpler compounds.

During the intensive phase of composting, the more easily degradable compounds are broken down first (Table 1).

Feedstocks that contain a high proportion of compounds that are difficult to break down, such as lignin, require longer periods of composting — decomposition of lignin occurs more rapidly during the curing phase, at mesophilic temperatures.

However, the decomposition of organic matter is a dynamic process because different composting microorganisms have the capacity to utilise compounds of varying complexity and resistance to degradation.

For many organic materials, a period of *maturation* is also essential to eliminate compounds that are toxic to plant growth (*phytotoxic*).

### C:N ratios of common feedstock materials

The chemical and physical characteristics of various feedstock materials can be seen in Table 2.

**Table 1.** Susceptibility of organic compounds found in compost feedstock to decomposition.

Organic compound	Susceptibility
Sugars	Very susceptible
Starches, glycogen, pectin	
Fatty acids, lipids, phospholipids	
Amino acids	
Protein	Usually susceptible
Hemicellulose	
Cellulose	
Lignocellulose	Resistant
Lignin	

**Table 2.** Physical and chemical characteristics of various feedstocks.

Feedstock	Moisture	Structure	C:N	%N
<b>Garden organics</b>				
Mixed tree and shrub prunings	dry to moist	good	70-90	0.5-1
<i>Eucalyptus</i> bark	dry	good	250	0.2
<i>Eucalyptus</i> sawdust	dry	average	500	0.1
<i>Pinus radiata</i> bark	dry	good	500	0.1
<i>Pinus radiata</i> sawdust	dry	average	550	0.09
Grass clippings	moist to wet	poor	9-25	2-6
<b>Food organics</b>				
Mixed food organics	moist to wet	average	14-16	1.9-2.9
Vegetable produce	wet	poor	19	2.7
Fruit	wet	poor	20-49	0.9-2.6
Fish	moist to wet	poor	2.6-5	6.5-14.2
<b>Biosolids</b>				
Biosolids	moist to wet	poor	5-16	2-6.9
<b>Agricultural organics</b>				
Wool scour waste:				
(1) raw decanter sludge	moist	poor	13.8	0.81
(2) raw flocculated sludge	moist	poor	19	1.61
Tannery waste (hair)	dry to moist	average	3.1-4.3	11.7-14.8
Mixed abattoir wastes	moist to wet	poor	2-4	7-10
Chicken manure (layers)	dry to moist	poor	3-10	4-10
Chicken manure (broiler)	dry to moist	poor	12-15	1.6-3.9
Seaweed (kelp)	dry to moist	average	25	1.5
Sawdust	dry	poor	200-750	0.06-0.8
Wheaten straw	dry	good	100-150	0.3-0.5
<b>Paper products</b>				
Newsprint	dry	poor	398-852	0.06-0.14
Paper	dry	poor	127-178	0.2-0.25

Sources: Rynk *et al.*, (1992); Handreck and Black (1994); State Chemistry Laboratory unpublished data, Werribee, Victoria.



