Composting Organisms

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Composting of organic wastes

…I have always looked upon decay as being just as wonderful and rich an expression of life as growth.

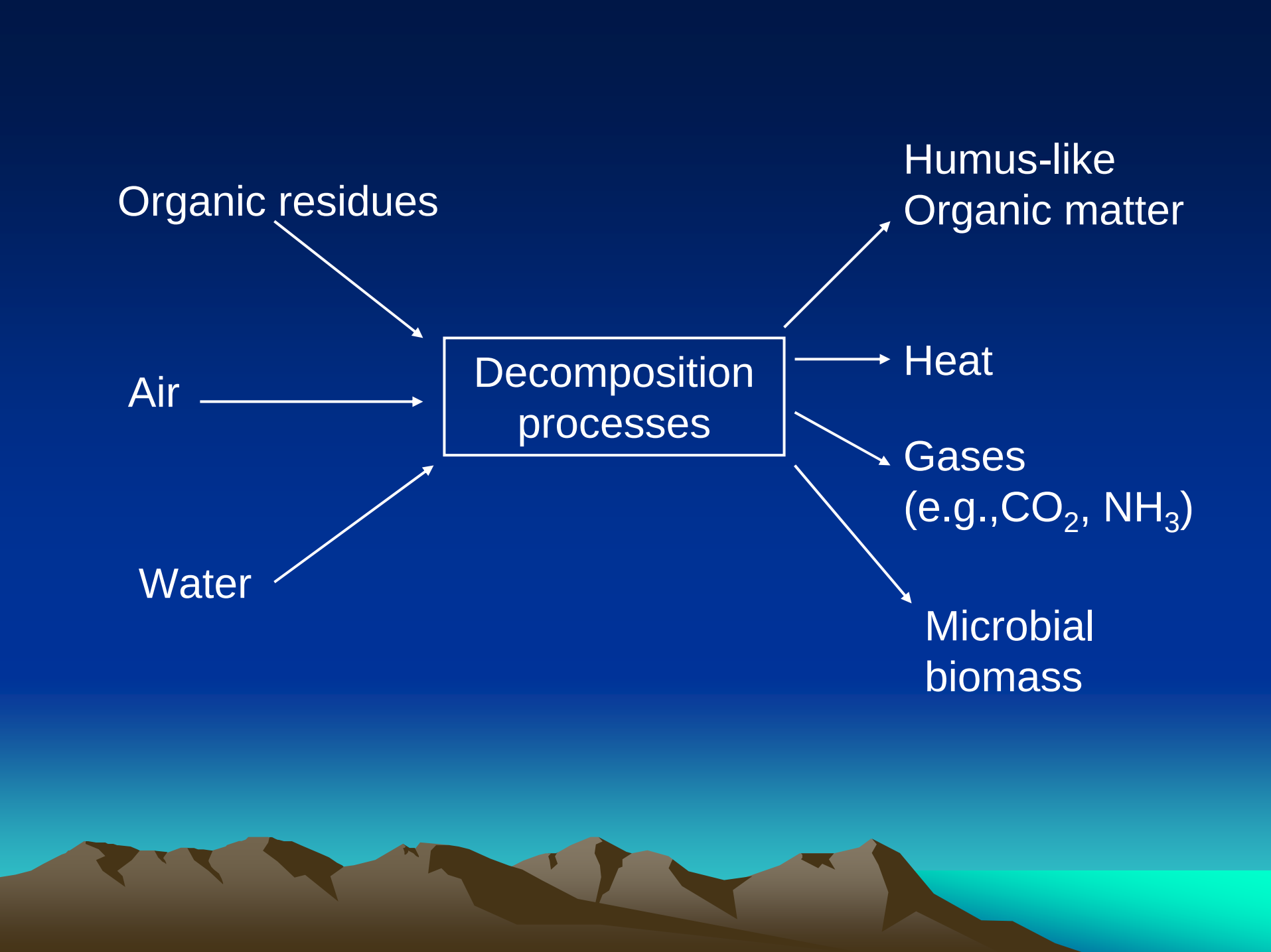
-- Henry Miller, The Wisdom of the Heart

- The what and why of composting
- Compost biota and their activities
- Vermicomposting

The What and Why of Composting

- Composting = biological decomposition and stabilization of organic substrates
  - Under biologically-produced thermophilic temperatures
  - Produces a final product that is stable, free of pathogens and plant seeds and can be beneficially applied to land

- Reduce waste volume
- Promote plant productivity and soil quality
- Eliminate pathogens, deleterious organisms, and weed seeds
- Sanitize organic wastes


Organic residues
Air
Water
Decomposition processes
Humus-like Organic matter
Heat
Gases (e.g.,CO_2, NH_3)
Microbial biomass

Compost Biota

- Fauna
- Protozoa
- Decomposer microorganisms
  - Bacteria
  - Actinomycetes
  - Fungi

Fauna

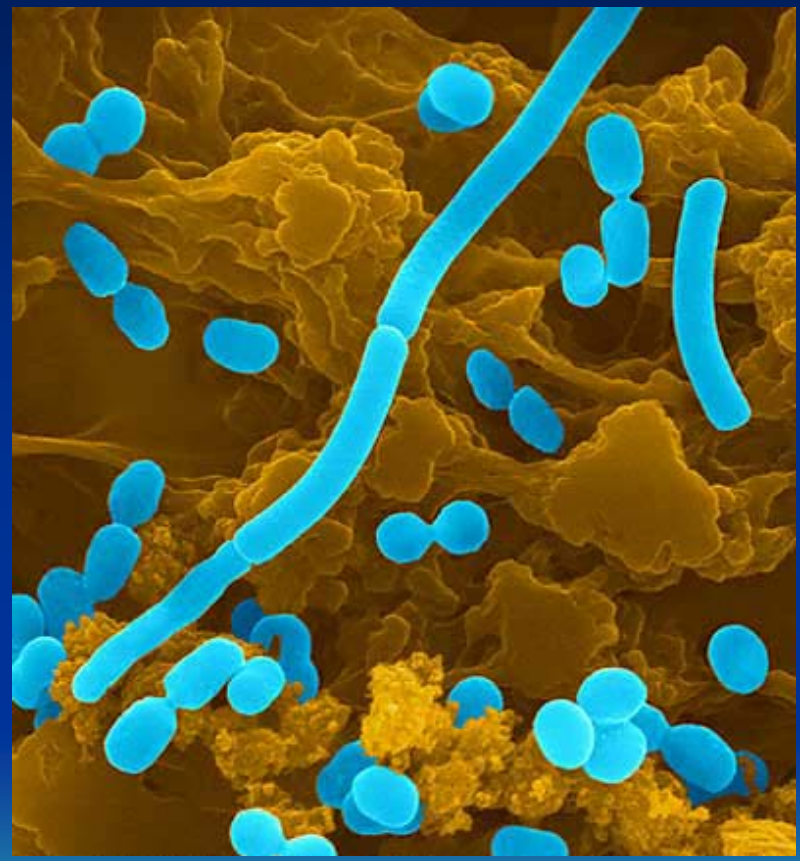
- Important in the beginning of compost process
- Grind coarse materials into smaller bits (communition)
- Increases surface area:volume ratio
- Improves access of microbes to organic substrates

Protozoa

- Active in the early phases of composting
- Process smaller bits of organic matter
- Prey upon microbial populations
  - Regulates numbers
  - Recycles nutrients

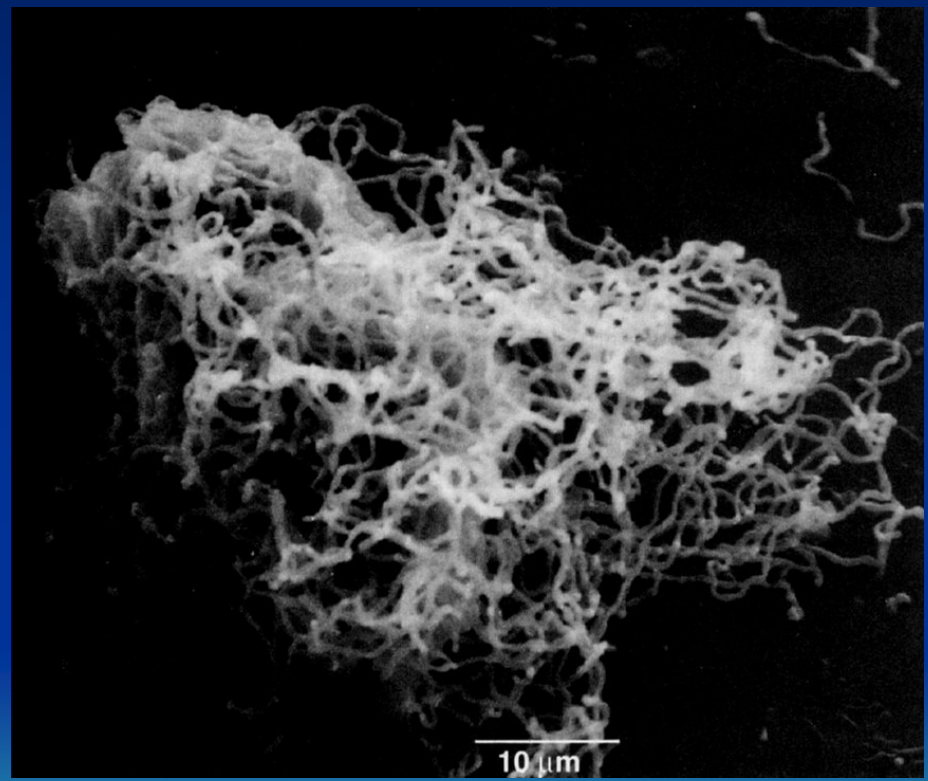
Bacteria

- Single-celled prokaryotes
- Smallest living organisms
- Most numerous group in compost
- Responsible for most of the decay and heat generation in compost
- Nutritionally diverse



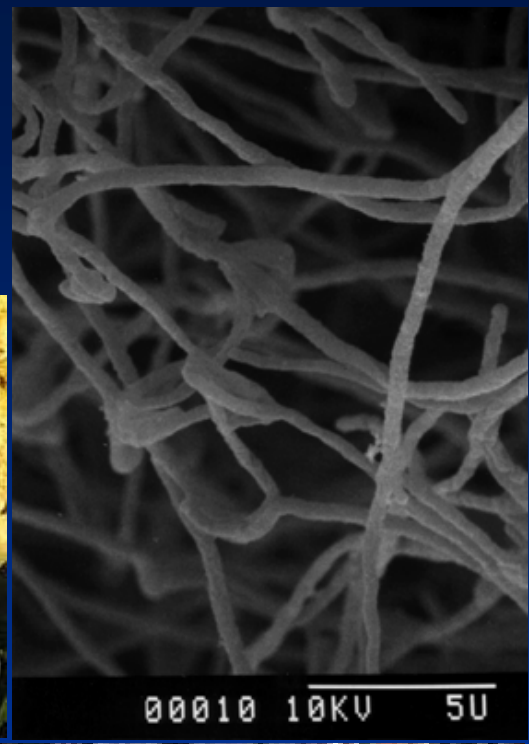
Actinomycetes

- Filamentous bacteria
- Produce geosmin
- Degraders of cellulose, hemicellulose and lignin
- Important during the thermophilic and cooling stages



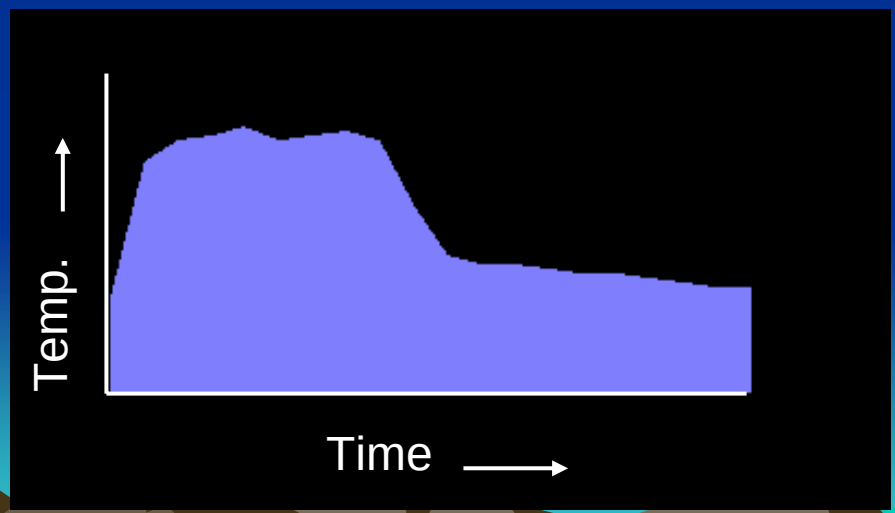
Fungi

- Multicellular eukaryotes
- Include mushrooms, molds and yeasts
- Usually filamentous
- Decomposers of complex plant polymers
  - cellulose, hemicellulose and lignin



Overview of the compost process

Mesophilic Phase	Thermophilic Phase	Curing Phase
20 - 40°C A few days	40 - 65°C, as high as 80°C A few days to several months	Cooling and maturation Several months



Stage 1: Mesophilic Stage

- Bacteria and Fungi are key players
  - Fauna and protozoa also important
- Decomposition of readily available substrates
  - Sugars, proteins and starch
- Excess energy is released as heat, causing pile temperature to increase

Stage 2: Thermophilic Stage

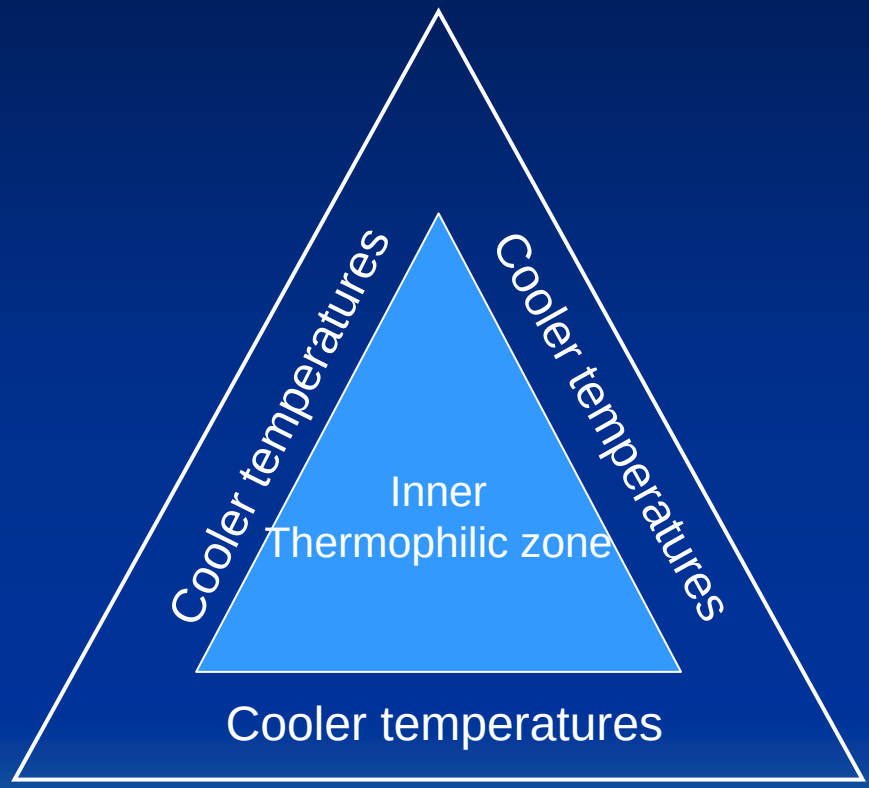
- Heat-loving bacteria, actinomycetes and fungi are key players
- Heat intolerant organisms go dormant or are destroyed
  - Human and plant pathogens
- High temperatures accelerate breakdown of proteins, fats, and complex polymers

Microorganisms Associated with Compost Piles

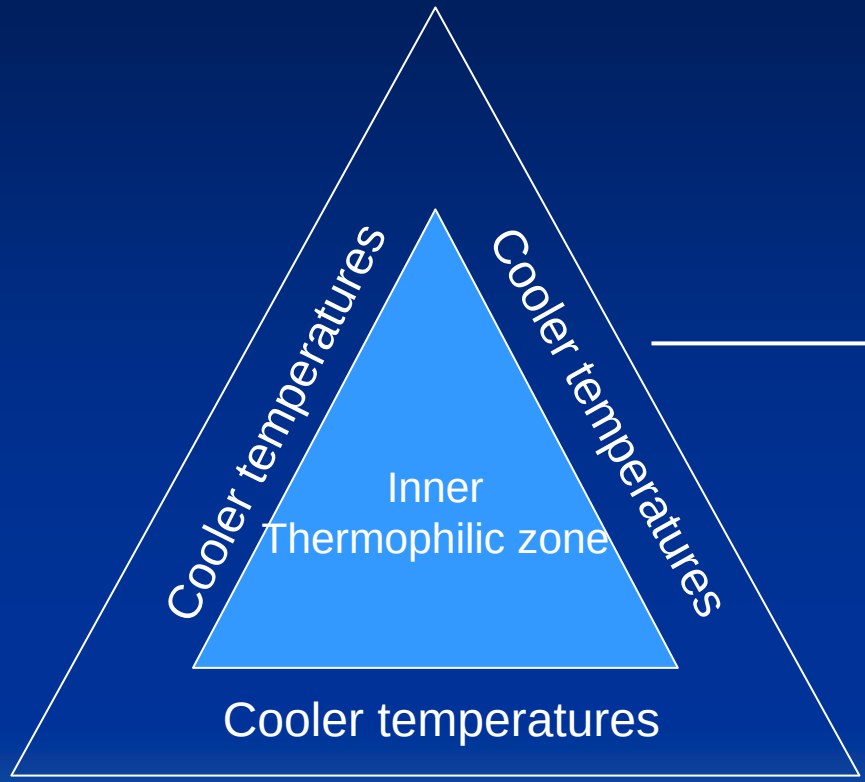
	Mesophilic Stage	Thermophilic Stage
Bacteria	10^8 cells g^{-1} *Pseudomonas, Bacillus, Flavobacterium, Clostridium*	10^9 cells g^{-1} *Bacillus, Thermus*
Actinomycetes	10^4 cells g^{-1} *Streptomyces*	10^8 cells g^{-1} *Streptomyces, Micropolyspora, Thermoactinomyces, Thermomonospora*
Fungi	10^6 fungi g^{-1} *Alternaria, Cladosporium, Aspergillus, Mucor, Humicola, Penicillium*	10^7 fungi g^{-1} *Aspergillus, Mucor, Chaetomium, Humicola, Absidia, Sporotrichum, Torula (yeast), Thermoascus*

Zonation of temperatures

- Internal temperatures can be as high as 70 or 80° C
- Center of pile is dominated by the most heat-tolerant bacteria (eg., *Bacillus*)
- Edges of pile support diverse populations of thermophilic bacteria, actinomycetes and fungi



Importance of turning the pile



-Redistributes microorganisms

-Cools the pile

-Aerates the pile

-Speeds up decomposition

-Allows microbial succession to reoccur

Stage 3: Curing/Cooling Stage

- Mesophilic bacteria, actinomycetes and fungi are key players
- Further chemical and physical changes in the compost
  - Decomposition of recalcitrant polymers by actinomycetes and fungi
  - Degradation of fermentation products, methane, and other noxious gases which accumulated earlier in anaerobic microsites
  - Reduction of odors and toxic intermediates

Vermicomposting

- Composting with worms and microorganisms
- *Eisenia foetida*
  - Aka redworms, red wriggler worms, tiger worms
  - Thrive on rotting vegetation, compost and manure

Physical effects on compost

Burrowing action of worms help

- aerate the compost
- mix substrates
- redistribute microorganisms

Composting time is faster!
Less need to turn the pile!

Biochemical effects on compost

- Communition of organic residues
  - Enhances microbial access to substrates
- Production of casts
  - Source of readily available sugars and proteins for microbes

Final Words

- Composting is a microbial process
- Its rate is controlled by factors which affect microbial activities
- Lack of suitable substrates, low moisture content, non-optimum temperatures, and poor oxygen diffusion are the most common rate-limiting factors in composting