BioComplete™ Compost

Lecture 2 – What Defines BioComplete™ Compost

Thermal Composting Regulations

Current compost regulations focus maintaining high temperatures for a long enough time to kill the pathogens.

Temperatures above 131 F for 10 – 15 days, during which time, the pile must be turned 5 times.

Is this adequate to make good compost?

Landfills and Waste Reduction

As landfills filled up, organic material was diverted from the landfill to be reduced in volume so the landfill wouldn't fill up so fast.

Landfill operators learned they could sell their reduced waste if they labeled it "compost".

No effort was made to maintain aerobic conditions or beneficial organisms.

Anaerobic Waste Reduction

Waste reduction does not recognize that anaerobic conditions are dangerous.

Organic matter will shrink in volume even under anaerobic conditions, but terrible problems are also a consequence.

1. Stink or GHG are caused by anaerobic organisms producing ammonia, hydrogen sulfide, putrid organic acids (low pH as a consequence), terpenes, phenols, etc

GHG Released by Microbes Using Organic Matter In Different Conditions

Type of Organism	Percent CO_2 Released	Other GHG Released
Aerobic Bacteria	80%	None
Beneficial Fungi	20%	None
Anaerobic Bacteria	50%	N_2O, NH_3, H_2S, CH_4

Anaerobic Waste Reduction

2. <u>Alcohol Fires</u> occur as the result of rapid growth of microbes.

Rapid growth causes rapid temperature increase, as well as using up oxygen.

Anaerobic microbes produce a variety of alcohols which spontaneously combust when the temperature reaches 180 F or higher.

Anaerobic Waste Reduction

3. Disease-causing organisms out-compete beneficial aerobic microorganisms in anaerobic conditions because the enzymes of anaerobic organisms function better in anaerobic conditions (<6 PPM O_2).

Aerobic organism go dormant, or die.

4. Toxic compounds, such as extremely low pH organic acids are produced dropping pH in the pile to very low, and highly toxic, levels.

Reduced Waste Is Not Compost

But, by selling anaerobic reduced wastes as "compost", the reputation of compost began to be destroyed.

A host of scientific papers were published claiming "compost" kills plants. But the scientists doing this research used anaerobic reduced waste, not compost.

Can compost regain a good reputation?

Aerobic Composting

1. **Aerobic decomposition requires ALL the indigenous microbial functional groups.**
2. **These organisms build the structure which maintain aerobic conditions.**
3. **Nutrient cycling is maintained if both predators and prey are active.**
4. **Competition, consumption, and inhibition on the smallest scale selects against diseases, pests and weeds.**

The Chemical World Ignores This

- **There are other ways to deal with diseases, pests, parasites, and weed seeds.**

- **Composting isn’t just about killing.**

- **Composting uses competition and consumption as well as inhibition.**

Factors that Define Quality

Active beneficial organisms maintain the conditions, the habitat, to support the beneficial food web:

1. **Aerobic = well structured aggregates**

2. **Adequate moisture (50%)**
   – evaporation occurs where?

Factors that Define Quality

Biology determines Chemistry:

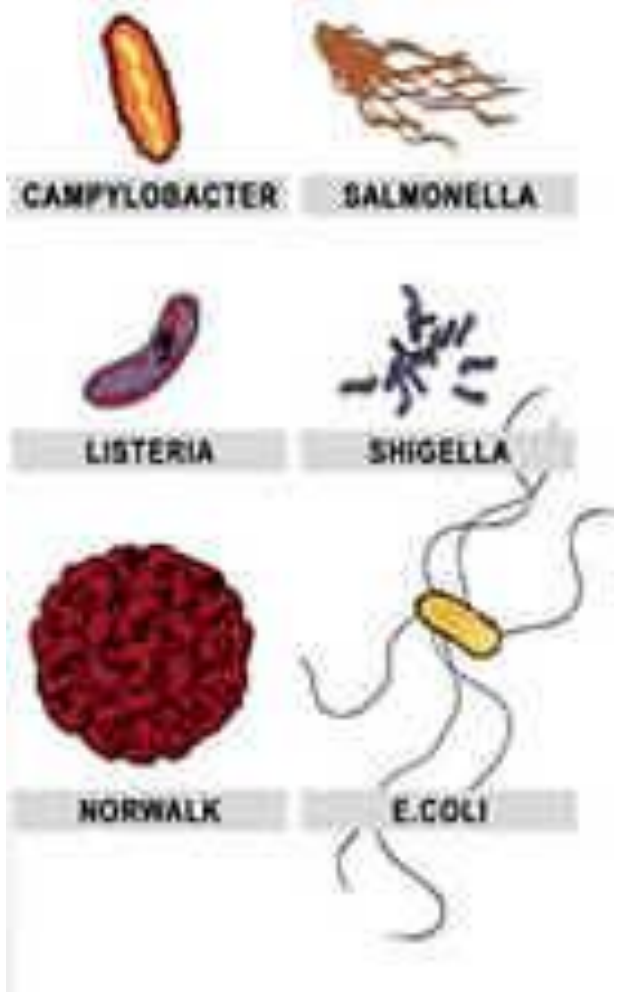
1. **The activity of the organisms in the food web determine what the chemistry is and will be**

2. **The starting organic materials used**

Factors that Define Quality

Growth of aerobic microbes cause increases in temperature if the rate of reproduction is fast enough.

High temperatures kill human pathogens, plant pathogens, root-feeding nematodes, pests, parasites, and seeds.

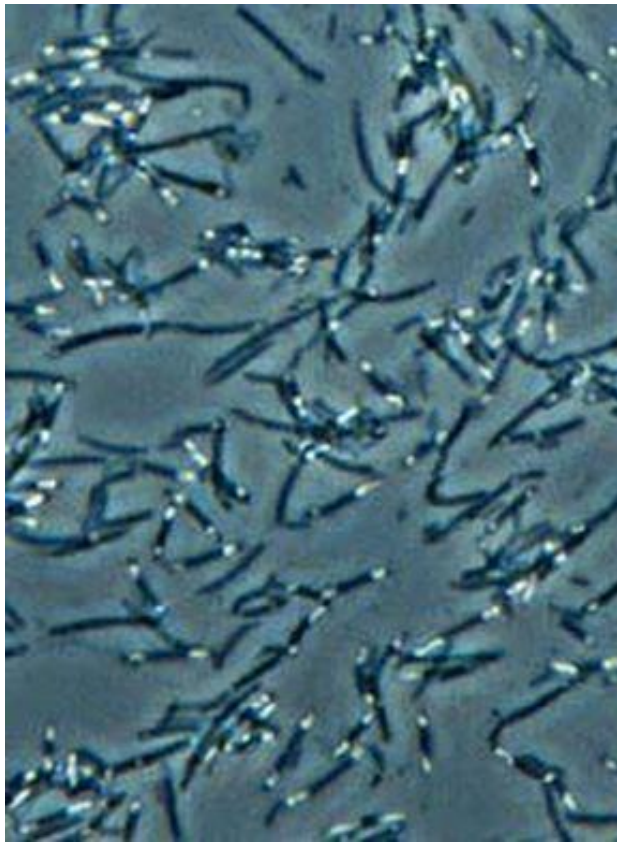


Temperature in Compost Piles

Approximately 10^{-6} of a degree of heat is released by one bacterium reproducing.

Not enough to make much difference in the temperature of any amount of compost.

But what if you have 1 million bacteria reproducing all at the same time?



Temperature in Compost Piles

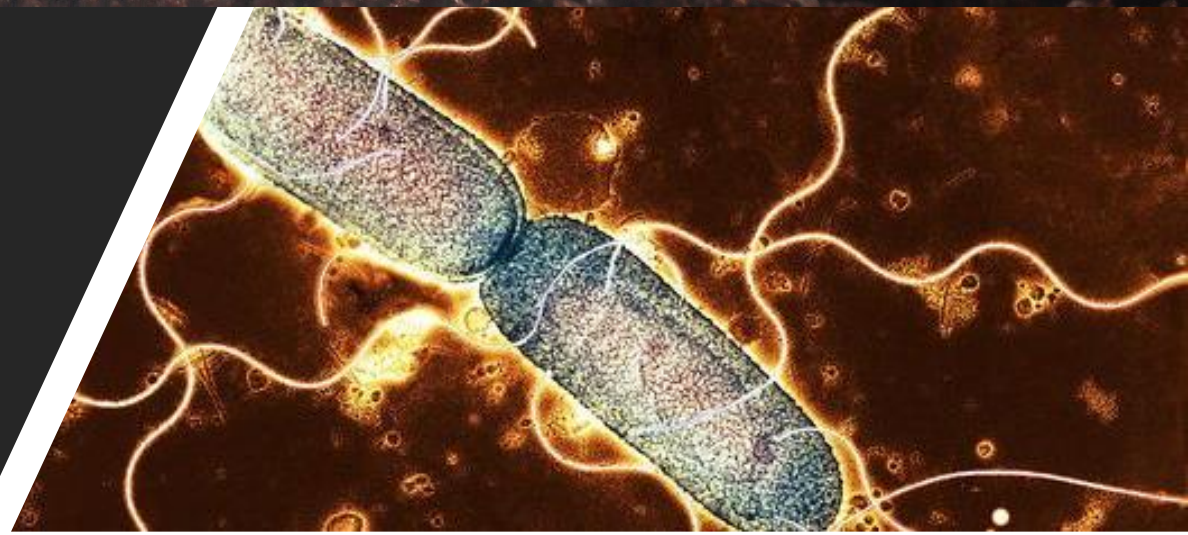
Then temperature will increase by 1 degree.

What happens when each quarter teaspoon or gram of compost containing 10 million bacteria reproduce every 20 minutes?

Each gram will experience a temperature increase of 10 degrees each 20 minutes.

Temperature in Compost Piles

Fungi produce a new leading tip cell every 3 hours, when food is adequate. The same calculations for temperature can be applied to fungi as bacteria.



Compost piles have more than adequate foods for bacteria, as well as complex foods for fungi to grow. That pile is going to get quite hot, quite fast.

Temperature in Compost Piles

Thus, compost piles containing millions of bacteria reproducing every 20 minutes, and miles of fungal hyphae reproducing at an exponential rate, could generate enough heat to increase the temperature by 30 degrees each hour, or reach 180 F in less than 4 hours.

Worm compost can also experience massive increases in temperature, if the worms don’t keep up their job of eating bacteria and fungi.

Temperature in Compost Piles

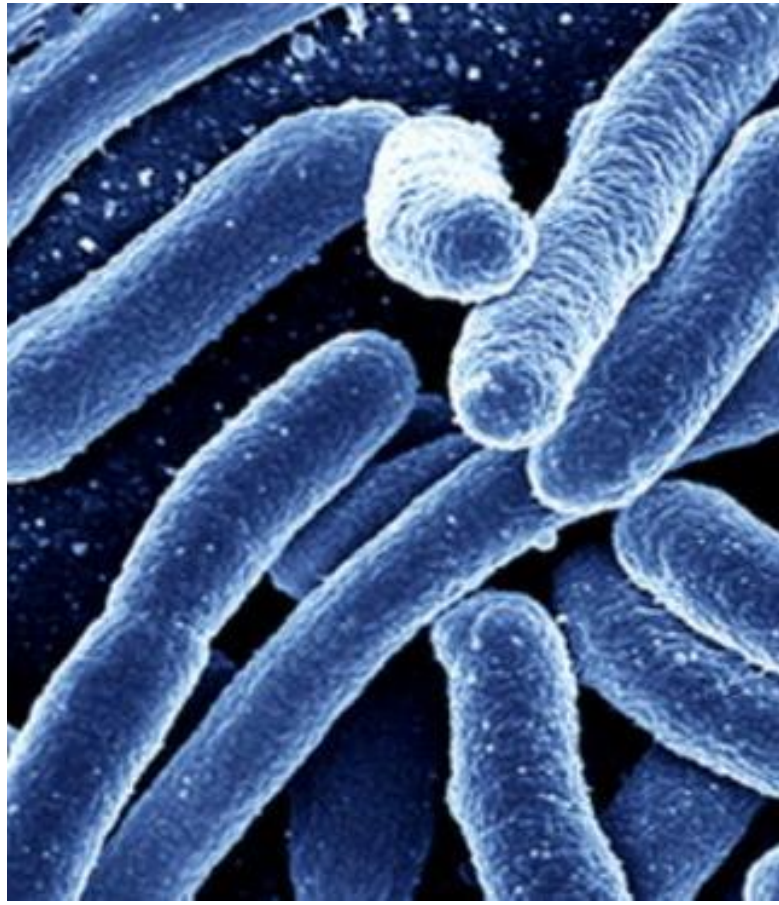
We know why anaerobic piles of organic matter burst into flame.

But why don't piles of aerobic organic matter burst into flames?

Because PREDATORS eat bacteria and fungi and air outside the pile cools the top, sides and bottom of the pile.

Composting Concentrates Nutrients: Bacteria

- **Bacteria make enzymes that are best at rapidly decomposing structurally simple organic compounds**
- **Simple Sugars do not contain nitrogen. Plant tissue generally has a C:N of 30:1**
- **Bacterial C:N is around 5:1. Thus bacteria must exit C from their bodies in order to concentrate N to maintain their narrow nutrient concentrations**
- **Bacteria release CO_2 in aerobic conditions in order to concentrate nutrients in their bodies**



Composting Concentrates Nutrients: Fungi

- **Fungi make enzymes that decompose structurally complex organic compounds with C:N above 60:1**
- **Fungal C:N varies from 10:1 in the tip (cytoplasm 5:1), to 150:1 – 300:1 in the older empty hyphae**
- **Fungi lay down massive amounts of C in their older hyphae. As a result, fungi release much less CO_2 as compared to bacteria**
- **This lower level of CO_2 release means that fungi don't get credit when measurements of respiration (CO_2 release) is used to assess activity**

Given All This…
How Should Compost Be Defined?

All the important factors in making good compost need to be included:

- Organisms – Full Food Web
- Aerobic conditions (more “chimneys”, fewer turns, so structure is built by organisms)
- Moisture maintained
- Temperature hot enough, long enough in all parts of the OM; or adequate worms per top 6 inches

Real Compost Defined

- **Aerobic decomposition of**
- **A mix of highly diverse organic materials**
- **On which resides a high diversity of indigenous organisms performing all food web functions needed for the desired plant(s):**
  - Nutrient cycling
  - Structure building; hold and detoxify water
  - Maintaining beneficial organism habitat

How Do We Repair the Reputation of Compost?

Teach people about the real definition of “compost”:

- Fully aerobic
- Full food web
- Biologically diverse

Introducing a new term: BioComplete™ Compost

And with time, implement the stricter regulations focused on life, not death.