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Growing Green: Transforming Waste Biomass into Sustainable Horticultural Media

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PUMASKA Project

Co-funded by
the European Union

Scope of Biostimulants application in peatless growing media

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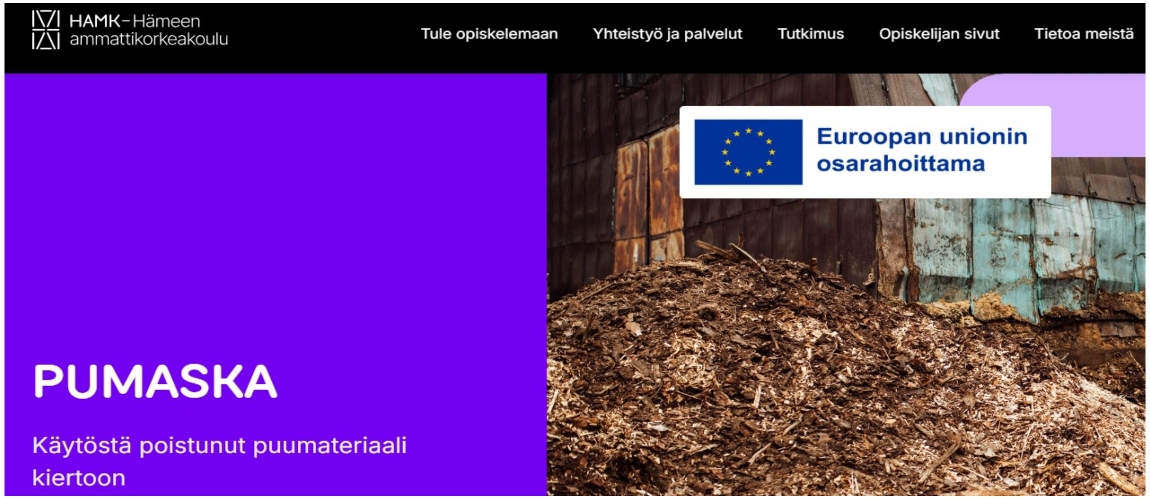
PUMASKA project goals



Screenshot of the project page from the website: hamk.fi

- ✓ The project aims to develop processes to treat waste wood to make safe growing media, soil improvers, and other value-added products.
- ✓ It assesses environmental impacts, including emissions and carbon footprint, to promote sustainable wood recycling.
- ✓ Innovative ways to recycle discarded wood, extending its life-cycle and advancing its reuse.

This project is hosted by Häme University of Applied Sciences, Aalto University, and University of Eastern Finland. Co funded by European Union

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Why treat waste wood?

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Waste wood from construction or demolition often contains impurities such as paint residues, adhesives, preservatives, nails, or other contaminants. These substances can negatively affect plant growth, soil health, or microbial activity when the wood is used as a growing medium. Therefore, treating the waste wood—for example, by composting, grinding, washing, or heat treatment is essential to make it safe and suitable for horticultural use.

In experiments, we compare treated waste wood with commercial wood fiber to understand how well it performs as a growing medium. Commercial wood fiber is processed and manufactured under controlled conditions, ensuring consistent quality, structure, and safety for plants.

By treating waste wood and comparing it with commercial products, we can assess whether recycled wood is a viable, sustainable alternative helping to promote circular economy practices and reduce reliance on virgin materials.

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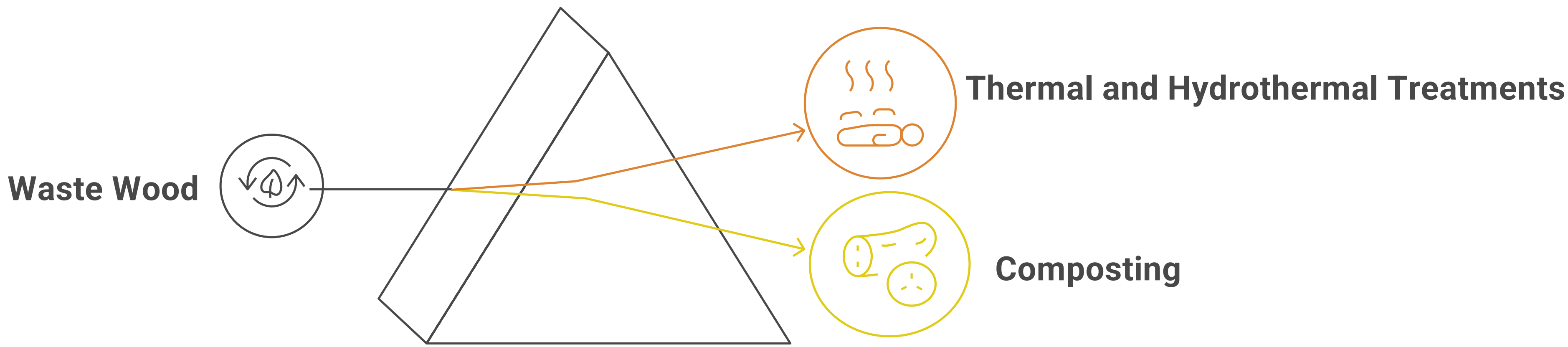
Waste Wood Treatment Approaches



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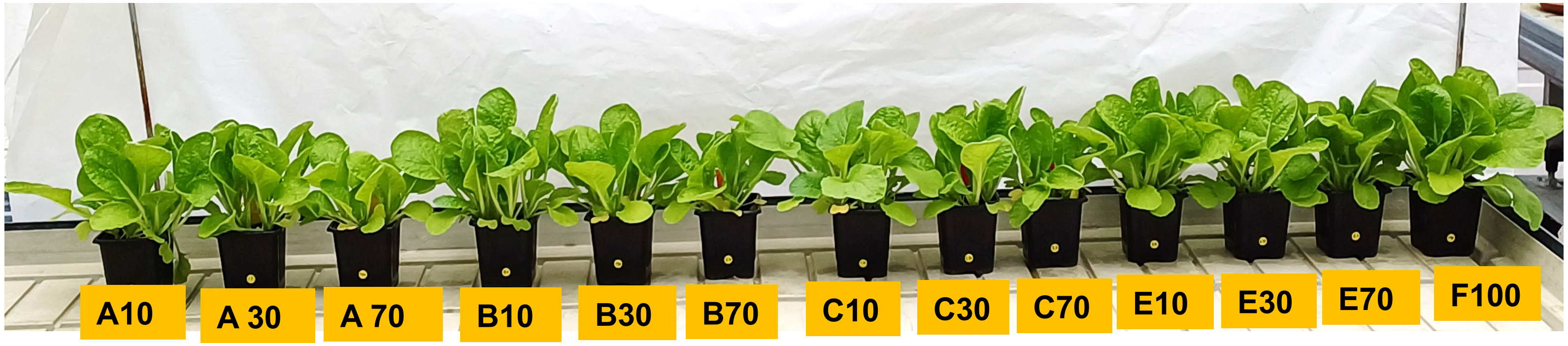
Greenhouse trial for studying plant response in Chinese cabbage (*Brassica rapa L. subsp. pekinensis* 'Preduro' F1) to waste wood fibre given different treatments



Commercial Horticultural Peat + Wood Fibre

100% Commercial Horticultural Peat

Waste Wood treatments

- Untreated Ground Waste Wood
- Heat-treated Ground Waste Wood
- Steam-Treated Ground Waste Wood

→ Wood fibre was mixed with Peat in ratio- 10:90, 30:70 and 70:30 v/v → Planting Chinese Cabbage → 40 Days Growth

A B C E

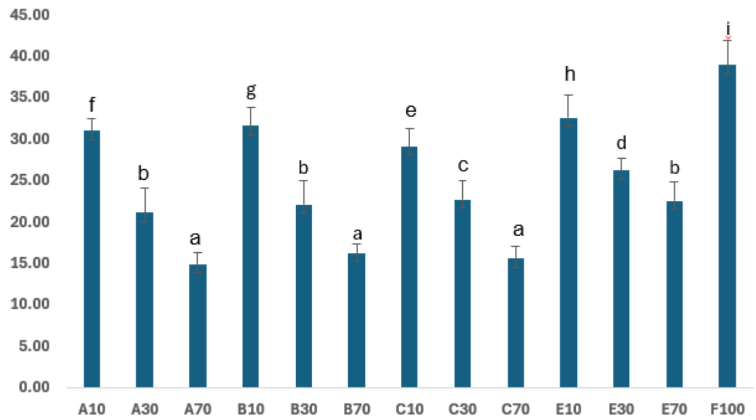
Treatment Details

A- Untreated ground waste wood
B- Heat-treated ground waste wood
C- Steam-treated ground waste wood
E- Commercial horticultural peat + commercial Wood fibre (Control)
F-100 percent Commercial horticultural peat (Positive control)

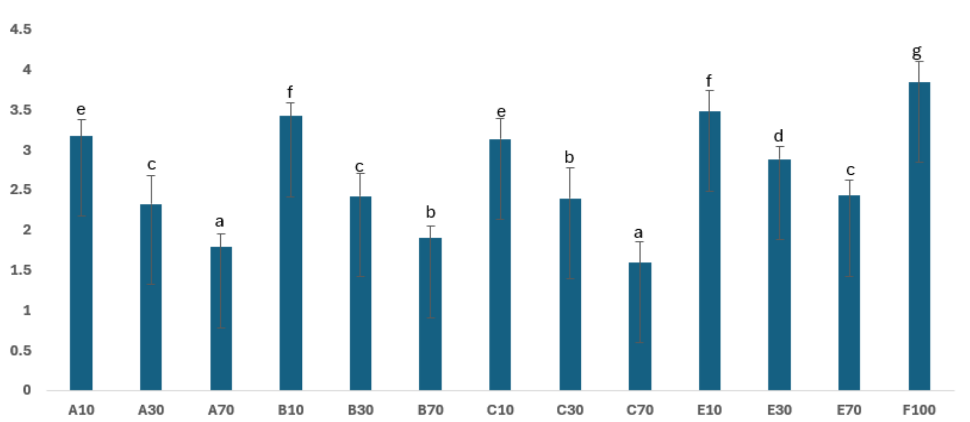
Parameters recorded:
% germination of seeds, no. of plants, shoot fresh weight, shoot dry weight, chlorophyll content in leaves, physico-chemical properties of growing media before and after the experiment.

Results

- % germination of seeds was found 100% in A10,C10 and C70, in all other cases it was found to be more than 90%
- No. of plants before harvest was found to be close to 100% in all cases.
- SFW in peat was higher among all, lower concentration of treated waste wood shows better results, B10 being highest in SFW.
- SDW was highest in peat, B10, A10 and C10 among all cases.



SFW (g)



SDW(g)

Shoot fresh weight (SFW) and Shoot Dry Weight (g) (SDW) of Chinese Cabbage plants were recorded at harvest. (bars with different letters indicate statistical difference)

Preliminary greenhouse pot trial for studying plant response in Chinese cabbage (*Brassica rapa L. subsp. pekinensis* 'Preduro' F1) **to sawdust (SD) treated at lab scale using different treatments and waste wood (WW) material treated with hot water extraction method**

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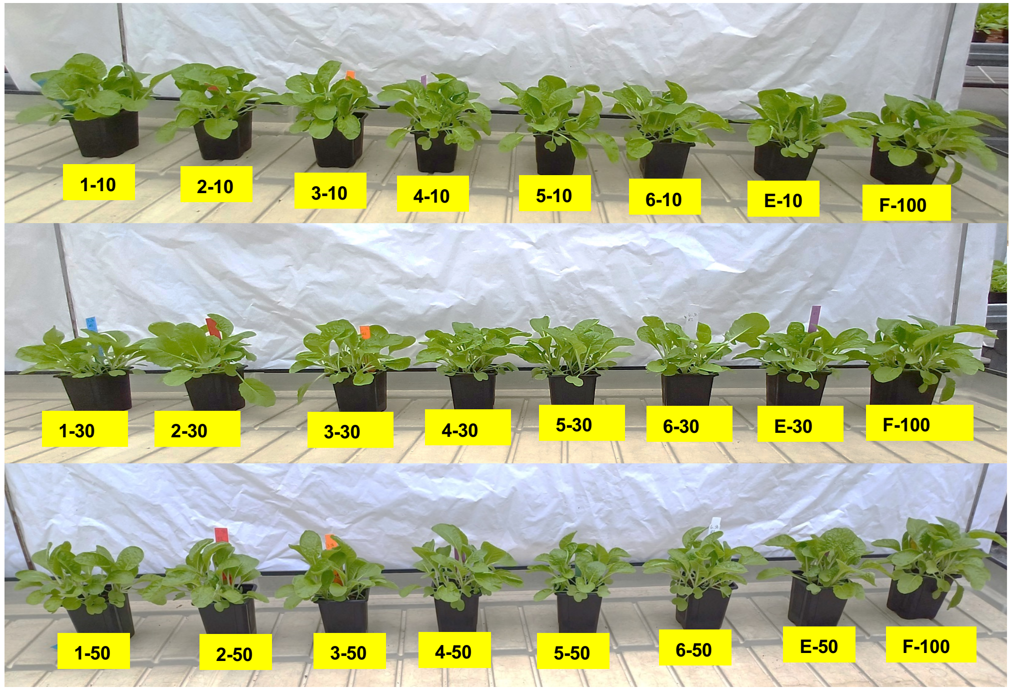
Treatment Details

1	Fresh sawdust
2	Heat treated sawdust
3	Ground fresh sawdust
4	Ground heat treated sawdust
5	Hot water extracted waste wood
6	Hot water extracted sawdust
E	commercial wood fiber
F	Peat

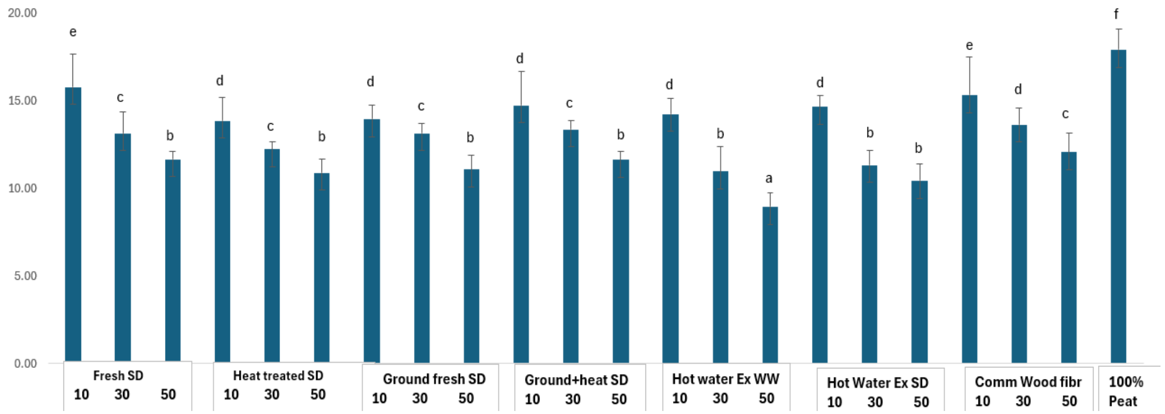


Results

Percent germination of seeds was found to be above 90% in all cases, 100% in Hot water extracted waste wood, and 100% in Peat

-Plant survival rate was found to be above 95% in most cases

-Shoot fresh weight SFW (g) values suggest that Fresh sawdust at 10% concentration performed better than the commercial wood fibre at 10% concentration.

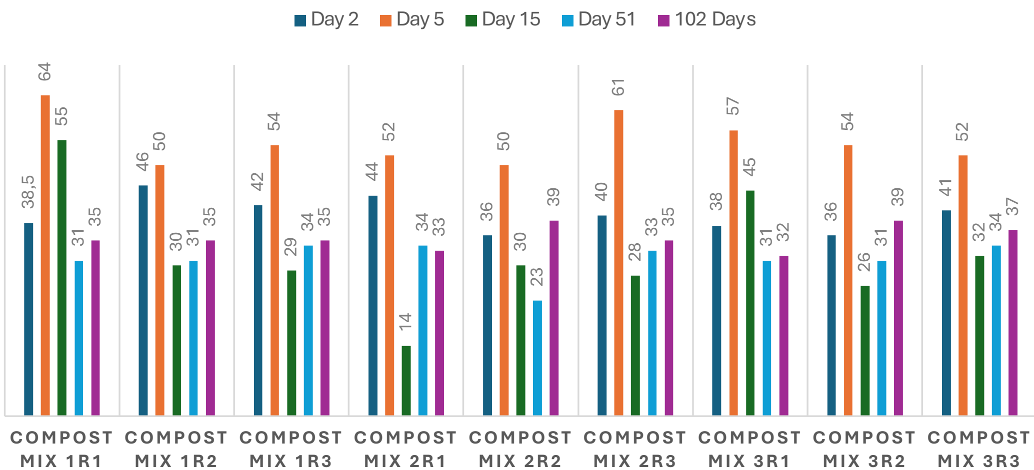


Shoot fresh weight (g) (SFW) of Chinese Cabbage plants was recorded at harvest.*(bars with different letters indicate statistical difference)*

Composting of waste wood

Components	Mixture 1 (*n=3*)	Mixture 2(*n=3*)	Mixture 3(*n=3*)
wood chips	15	15	22
Chicken manure	8	0	10
Blood Powder	0	1.6	0
komposti Herate	1	1	2
Cow manure	10	17	0
Total weight in (Kg)	34	34	34
Carbon/Nitrogen	**27**	**27**	**27**
Moisture	**65-70%**	**65-70%**	**65-70%**
pH	**8.4**	**8.4**	**8.1**
EC (electrical conductivity µS/cm)	**1218**	**1041**	**1261**

- Composting mixtures were prepared after analysing the input material's Carbon and Nitrogen ratio
- The compost has completed 125 days and is being monitored for temperature
- After the maturation, this compost will be tested as a component of growing media for plant growth response



Composting Process

- Composting is a natural process where organic materials like manure, food scraps, green waste, and crop residues break down into stable, humus-like substances. During this process, nutrients are recycled, and energy is released. It takes place in the presence of oxygen and partly under high-temperature (thermophilic) conditions
- Composting process eliminates phytotoxicity, eradicates pathogens and weed seeds and stabilizes the material
- Composting results in an easily handled material that can be used as soil improver and as a component of growing media
- The complete process can take between 10 weeks and 10 months depending on the input material, the composting system and the intensity of process management.

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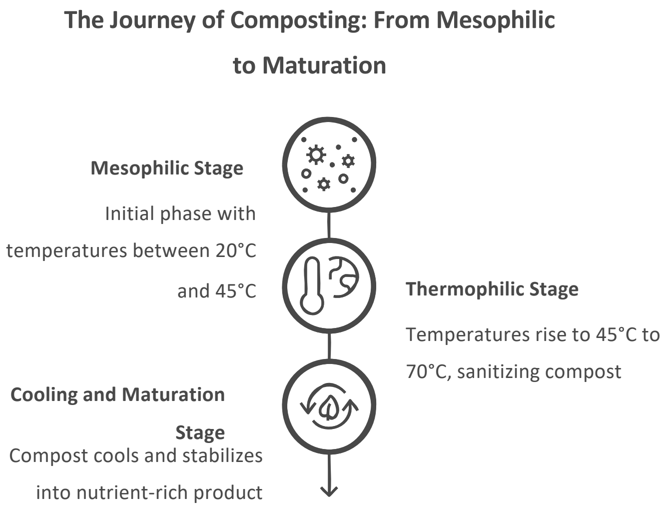
Stages of Composting



Composting typically occurs in three main stages, each characterized by distinct temperature profiles:

Mesophilic Stage

- This initial phase occurs at temperatures between 20°C and 45°C (68°F to 113°F).
- Mesophilic microorganisms, such as bacteria and fungi, thrive in this temperature range, breaking down easily degradable materials like sugars and proteins.

Thermophilic Stage

- As microbial activity increases, temperatures rise to between 45°C and 70°C (113°F to 158°F).
- Thermophilic microorganisms take over, further decomposing organic matter and effectively killing pathogens and weed seeds.
- This stage is crucial for sanitizing the compost.

Cooling and Maturation Stage

- After reaching peak temperatures, the compost begins to cool as the readily available nutrients are depleted.
- Mesophilic organisms return, and the compost matures, stabilizing into a nutrient-rich product.

Where do the microorganisms in the compost come from?

-Each compost feedstock (e.g., manure, wood chips, food waste) contains its own mix of bacteria and fungi. **The types and numbers of microorganisms** present vary depending on:

- The kind of organic material
- Moisture content
- Temperature

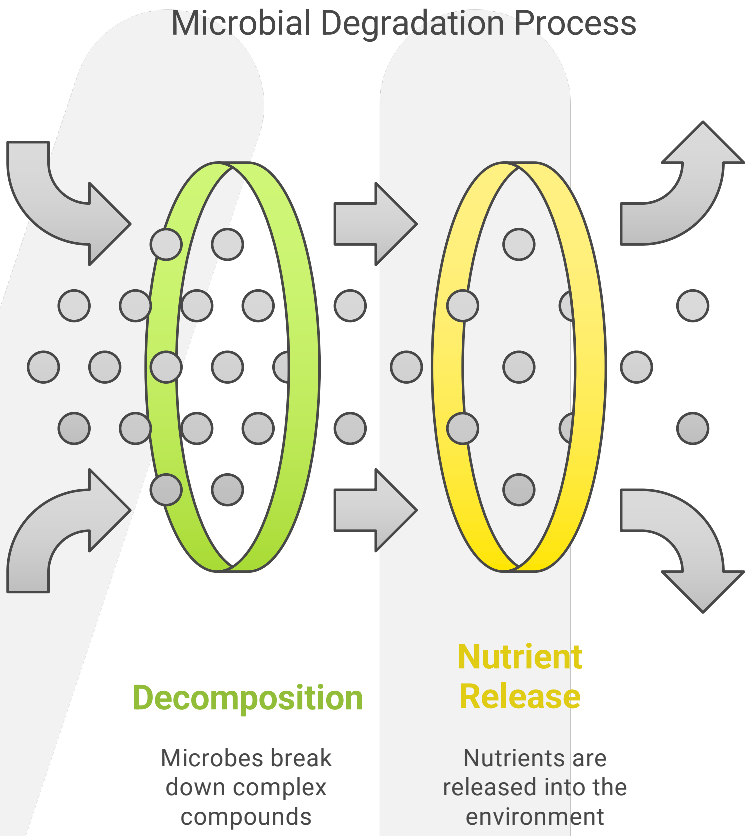
For example: Wood chips and cattle manure will have very different microbial communities.

Microbial diversity is beneficial because:

- Different microbes break down different types of organic compounds.
- This leads to a more complete and efficient composting process.

As composting progresses:

- Microorganisms begin to change the physical and chemical properties of the organic material.
- These changes, in turn, influence which microbial groups become more active or dominant at different stages.



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How do microorganisms do it?

Warming-up Phase (25–40°C)

Organic matter contains many easily degradable compounds like sugars and proteins. Bacteria quickly outcompete fungi for these nutrients, making them dominant in the early stage of composting. This "warming-up" phase lasts only a few days, as intense microbial activity rapidly raises the temperature. Common bacteria at this stage include *Lactobacillus* and *Acetobacter*.

Thermophilic Phase (40–65°C)

During this phase, decomposition happens quickly and produces a lot of heat. The temperature inside the compost pile can rise to 65–70°C. At this stage, more complex materials like cellulose, lignin, and fats are broken down. The pH also increases because of ammonia released from protein breakdown. Heat-loving bacteria such as *Bacillus* and *Actinomycetes* become the main microbes. Fungi usually stop being active above 55°C, except for a few heat-tolerant species. However, if the compost contains a lot of cellulose and lignin, fungi may still play an important role throughout the process.

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Cooling Phase
(Second Mesophilic Phase)

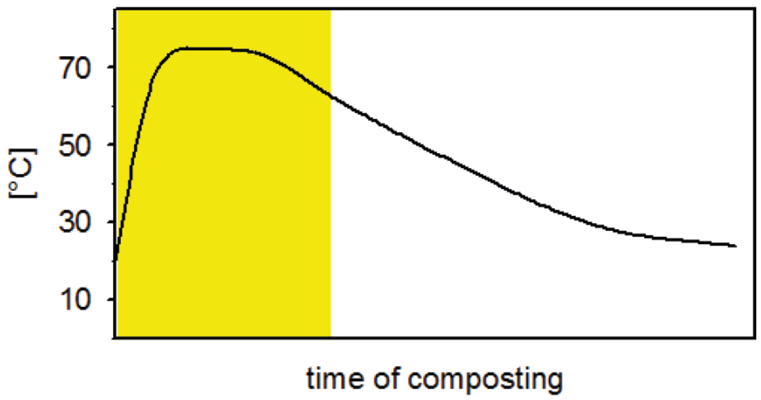

Figure 4.1 *Theoretical evolution of the temperature in the compost piles during the composting process (Graph: Ulrich Galli).*

- Microbial degradation slows down significantly, when the availability of almost all organic substrates becomes limited. Thus, less heat energy is produced and temperature of the compost pile declines.
- Compost is recolonized by bacteria which prefer temperatures around 25 – 40°C. During the warming-up phase, organisms that degraded sugars, oligosaccharides and proteins dominated the microbial community.
- In the cooling phase microorganisms with similar temperature tolerance, but with different metabolic activities dominate.

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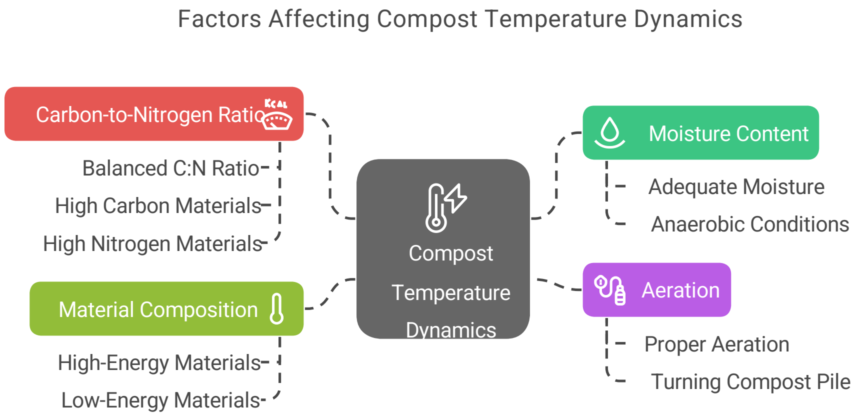
Factors Influencing Composting Process



Several factors affect the temperature dynamics of compost:

•**Moisture Content**: Adequate moisture is essential for microbial activity (60-70%). Too much water can lead to anaerobic conditions, while too little can slow down decomposition.

•**Aeration**: Proper aeration ensures oxygen availability for aerobic microorganisms. Turning the compost pile helps maintain airflow and regulate temperature.

•**Carbon-to-Nitrogen Ratio**: A balanced C:N ratio (ideally between 25:1 and 30:1) supports optimal microbial activity. High carbon materials (e.g., dry leaves, wood chips) and high nitrogen materials (e.g., kitchen scraps, manure) should be mixed appropriately.

•**Material Composition**: The type of organic materials used in composting can influence temperature. High-energy materials, such as grass clippings, can generate more heat than low-energy materials, like dry leaves.

Different Methods of Composting

Which composting method should be used?

Windrow Composting

Best for large-scale operations requiring space and machinery for turning.

Static Pile Composting

Suitable for medium to large operations with less labor or equipment.

In-vessel Composting

Ideal for urban settings and smaller spaces with odor control.

Vermicomposting

Perfect for small-scale/home composting with high-quality compost.

Trench or Pit Composting

Best for home gardens or farms with available land and no turning needed.

Bokashi Composting

Suitable for households, handling a wider range of waste with low odor.

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What are Biostimulants?

Biostimulants are defined as products that stimulate plant nutrition processes independently of their nutrient content, with the goal of improving at least one of the following features (EU VO2019_1009)

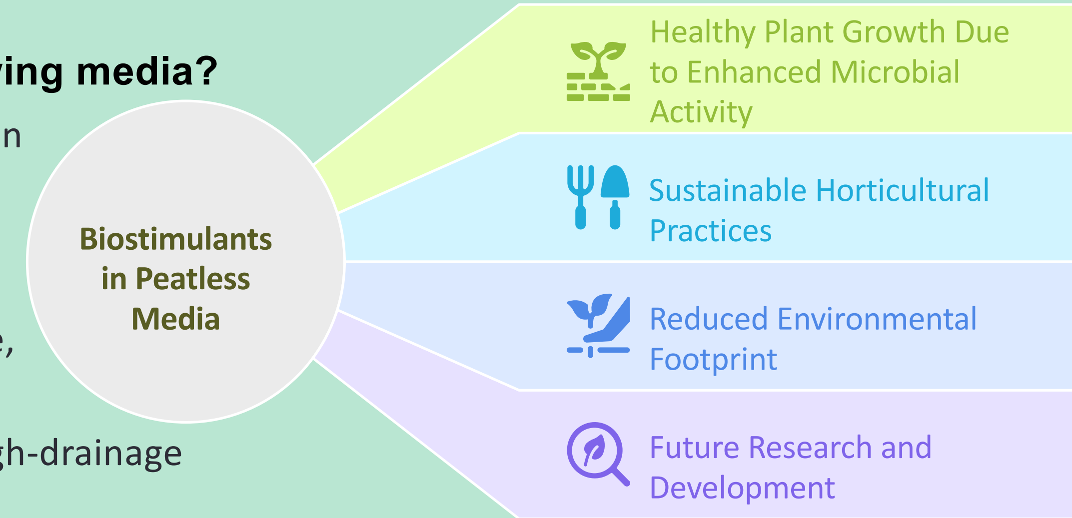
Nutrient use efficiency, Tolerance to abiotic stress, Crop quality traits, Nutrient availability in the rhizosphere

They can be microbial (e.g., inoculants) or non-microbial, such as humic acids, seaweed extracts, amino acids, and protein hydrolysates.

Why choose Biostimulants for the Peatless growing media?

-Biostimulants bridge nutrient, water, and microbial gaps in peatless media.
-Each peatless substrate presents unique biochemical and physical combination
-Targeted biostimulants support signaling, nutrient uptake, and stress resilience.

-Smart delivery enhances biostimulant performance in high-drainage substrates



Future studies with Biostimulant application in Peatless growing media will cover the following areas

- How microbial diversity differs among different new types of peat-free growing mediums and how it changes during cultivation as compared to commercial peat?
- Can the external (commercial) inoculation of microbe(s) improve substrate functionality?
- Can bio-stimulants enhance the activity of beneficial microbes / microbial growth in peatless growing media?

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