Good compost and ensuring the quality of compost

Julie Schou Christiansen, HortiAdvice

We will look in to:

- Compost is no just compost – compost can be many different products …
- Quality of the compost is also a result of the composting process, therefore we must also know something about the composting process
- Analyses of compost og quality parameter
- Compost properties
- Carbon storage
- Legislation main topics and differences between countries
- Use in field and pot

Compost can be used to different purposes – to achieve different things.

Definition of compost and composting: a process with oxygen presence.
Composting in pile

Compost are made of residual materials.
At first the thought is to recycle nutrients, but compost can have many other effects on soil og plants.

The purpose for composting:

- Sanitation (weeds/pathogens)
- High quality soil improver
- Recycling of nutrients

So how do we ensure this?

Compost

Compost is not just compost

- What material is used
- The mixing
- The composting process
- The maturation
- Time of year

All thinks fundamental for the degradation and the finished compost in the end.

Waste management ≠ Quality compost

“Ret tiddig omhu” (danish)

Materials for composting

What material is used for composting:

- Waste from garden and park
- Waste from kitchen
- Manure
- Residual from vegetable, fruit production

Composition of materials to get the right C/N ratio for composting. C/N: 25-30/1.

(Wheat straw 80/1. Mature alfalfa hay 25/1. Young alfalfa hay 13/1. Sawdust 500/1)

The idea of compost as fertiliser -> lower C/N ratio.
High N fx manure composting -> risk of ammonia emission -> loss

Temperature

Temperature important factor for hygiene of compost – elimination of human and plant pathogens, harmful nematodes, weed seeds

Our composting recommendation:

55 °C minimum 2 weeks
or
65 °C minimum 1 week

Cover of pile can

- Reduce evaporation
- Less colling (easier to keep the temperature)
- Less absorption of water (rain)

-> better possibility of control

-> mere uniform distribution of heat in the pile

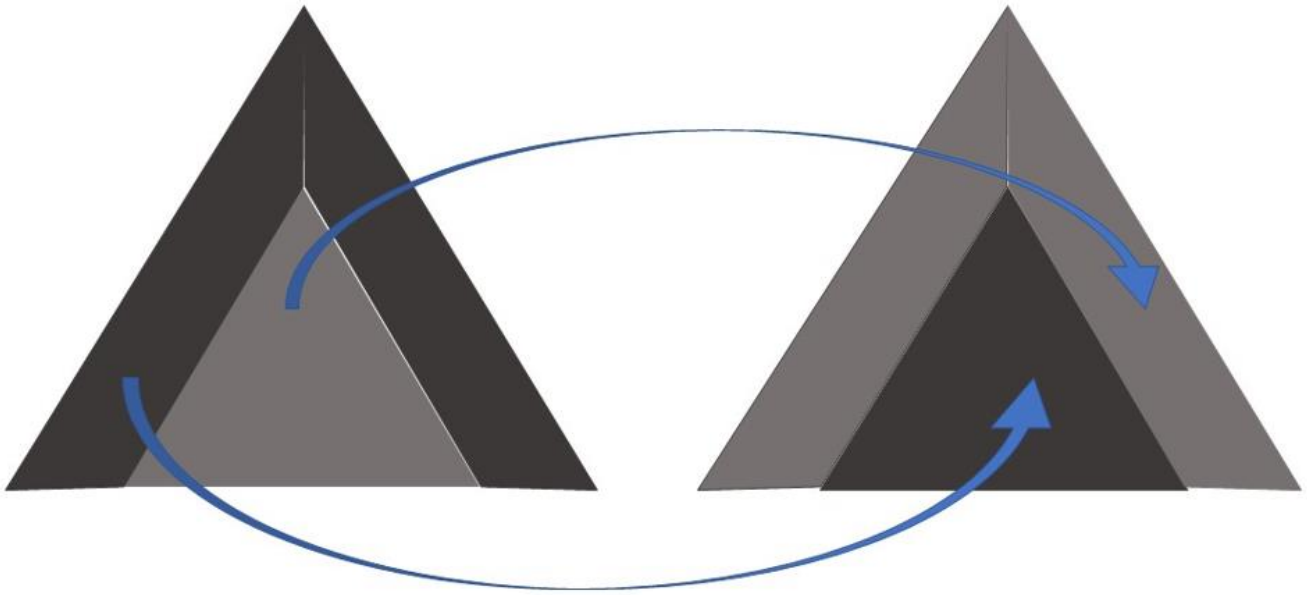
Turning

Important, all material get the heating. Therefore turning.

Composting is an aerobic process, need of oxygen

Turning and avoid unmixed spaces

Turning inside out and outside in…



Moisture

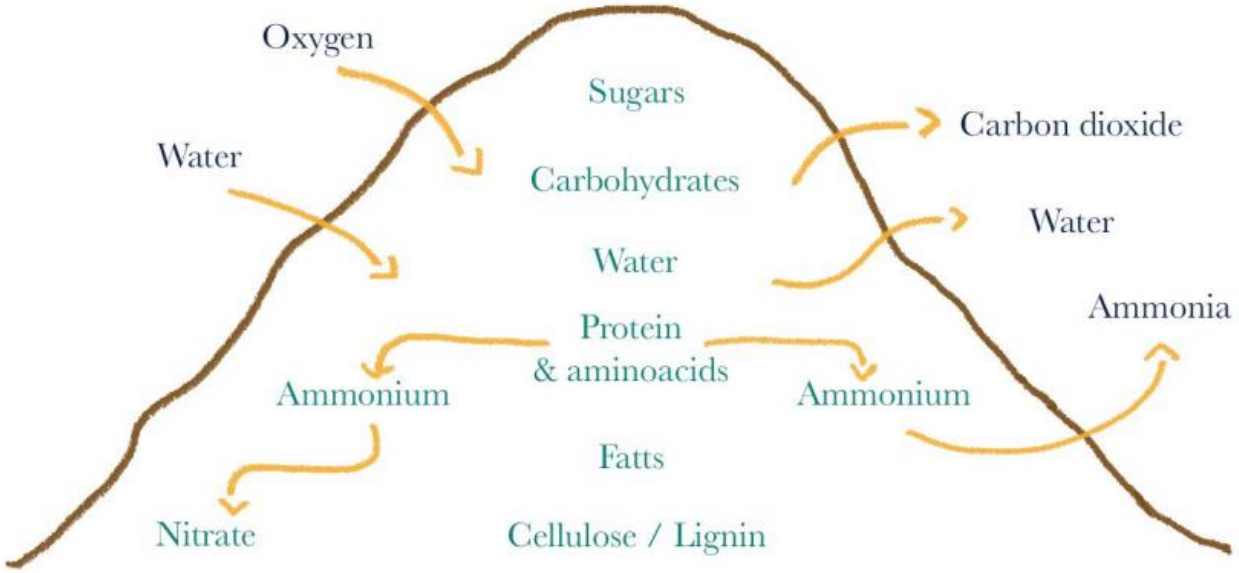
Moisture
Effect of temperature and moisture - together

Microbes function. Optimum moisture content 40-70%

Lower -> minimal biological activity
Higher -> low oxygen availability -> anaerobic degradation -> gases

Watering feedstock
- and then composting

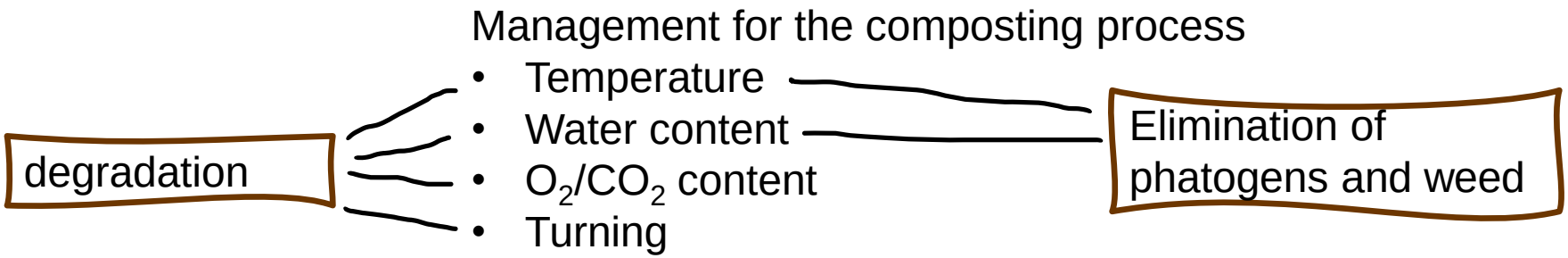
Our composting recommendation:
- Minimum 40%
- In the starting phase higher: 45-55%



(Schuchardt, 2005)

Substrates and products in the composting process.

Management, documentation



Management for the composting process

- Temperature
- Water content
- O_2/CO_2 content
- Turning

Measurements – log book !!

Composting process and pathogens

- Total death of 2 strains of E. Coli was achieved at 60°C in compost with 40% water after 16,3 and 28,8 minutes respectively in the laboratory.

- The water content of the compost had a great impact on mortality. Where low water content reduces mortality.

- Clubroot (kålbrok), Fusarium oxysporum can withstand long-term high temperatures.

Therefore ensure the composting process!!

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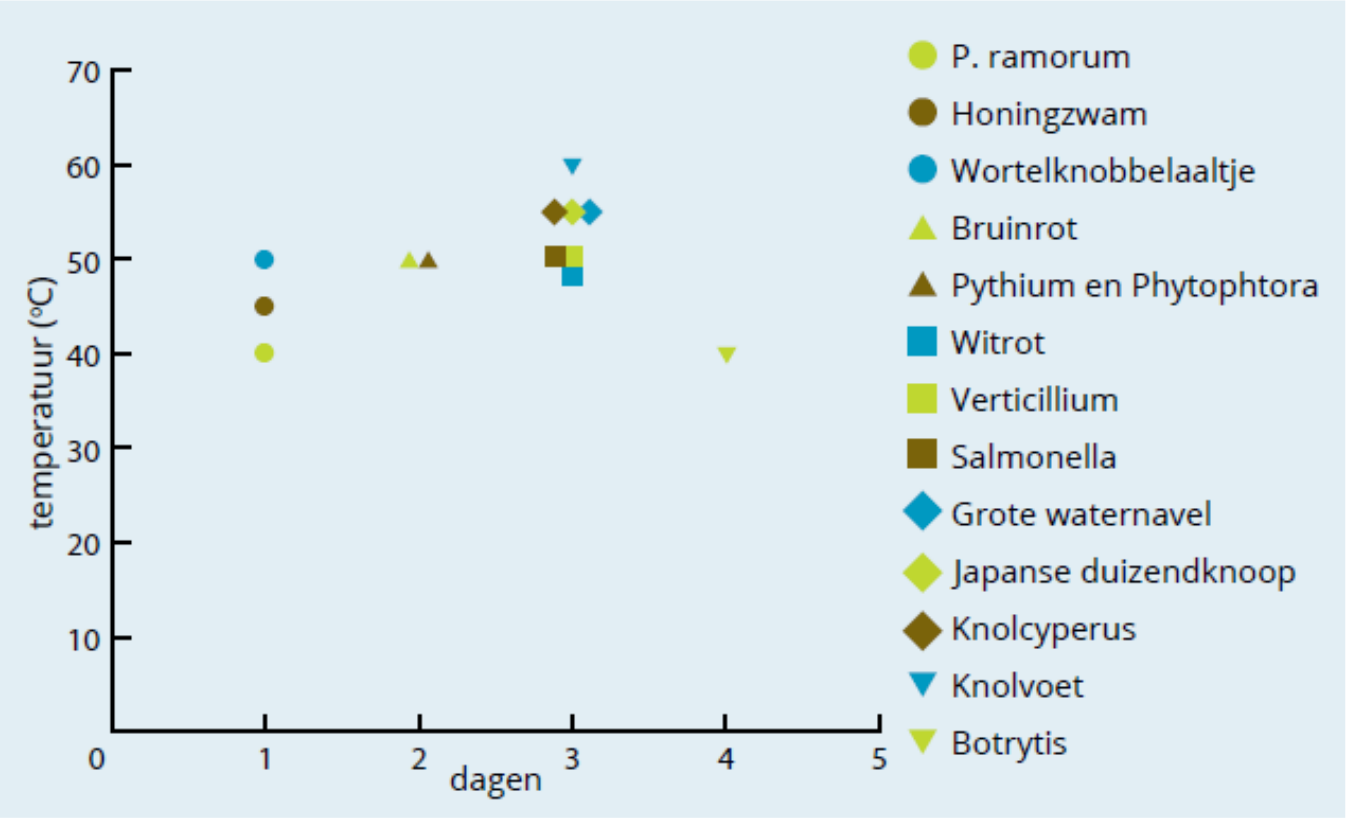
Effekt. Temperature and duration



The figure showes time – temperatur profil the weed seeds and plante pathogenes are killed.

Komposteringsproces skal eliminerer eventuelle ukrudt

	Temperatur (C)	60	50	46	42
		Antal timer til 90% frødødelighed			
Sonchus oleraceus	Alm.svinemælk	<1	2,1	13,3	46,5
Echinochloa	Hanespore	<1	5,4	12,6	Upåvirket
Sisymbrium irio	Glat vejsennep	<1	4,0	21,4	83,1
Protulaca	Portulak	1,3	18,8	Upåvirket	Upåvirket
Solanum nigrum	Sort natskygge	2,9	62,0	196,6	340,6
Amaranthus albus	Hvid amarant	1,1	107,0	268,5	Upåvirket

. 2007)

Composting: temperature, time, turning, moisture - an example

Composting of residual material from flower bulbs
1. from infected hyacinth bulbs
2. from plant material and tubers of Zantedeschia

After composting -> no pathogens in the material.

The compost used for new production of hyacinth and tulip.

Hyacinth: no effect on the yield.

Tulip: Strong Gold, with compost significantly lower % fusarium infected.

Tulip: Parade, not significant effect og compost on fusarium.

(Malou, okt 2021)

Temperature

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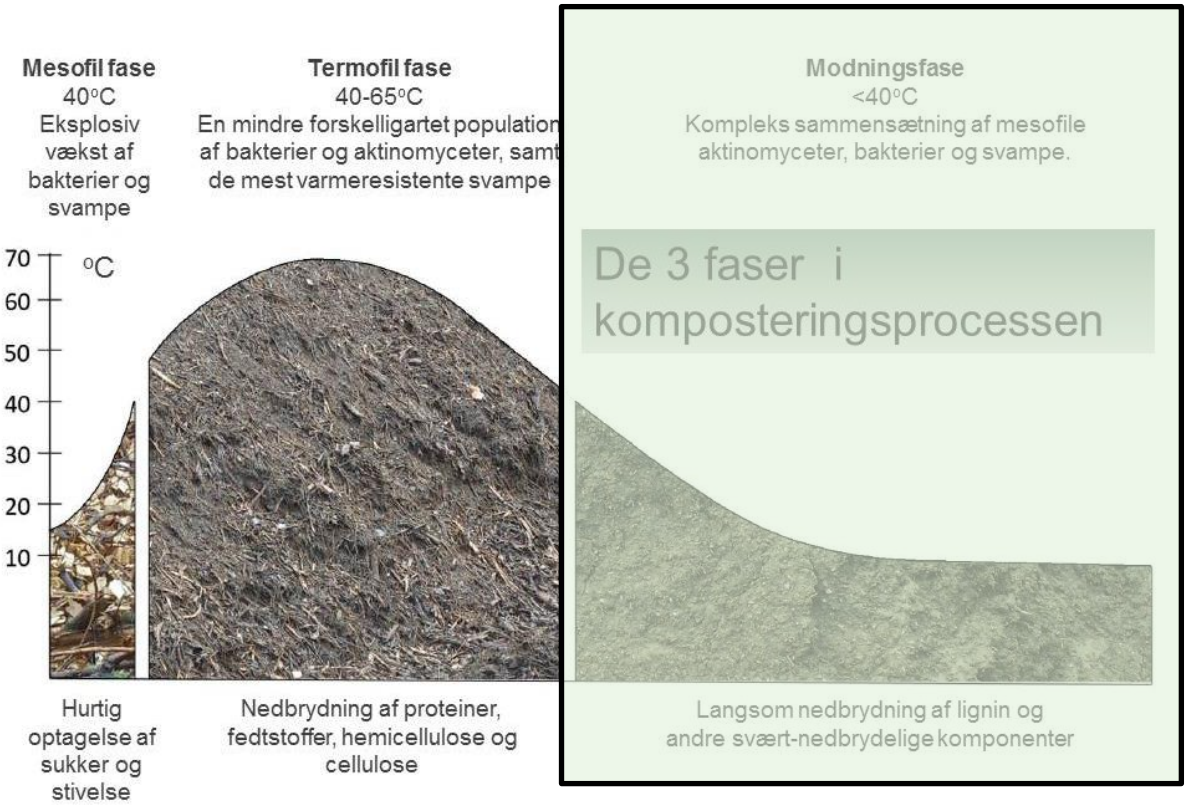

Maturation phase is an imported part of the composting.

- Change in composition of microorganism in the compost
- Non-composted / young compost / poorly composted may contain phytotoxic substances

The compost can be checked by germination test

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Different methods measuring microorganisms:

- PLFA (phosphilipid fatty acid analysis)

- Measuring activity (eg. respiration)

- DNA and RNA

- Microscopic

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Method - one way of analyse for microorganisms.

Good compost well-matured can result in a microbial active compost.

Immediately after finished composting

ANALYSRESULTAT	Uppmätt nivå	Önskad nivå
BAKTERIER		
Totalt antal /g	886 666 667	
µg bakterier/g	1 773	>4000
Diversitet	God/Good	Mycket god
AKTINOBAKTERIER		
µg aktinobakterier/g	0	<10
cm aktinobakterier /g	0	
GODA SVAMPAR		
µg god svamp /g	35	>300
Genomsnitt hyfdiameter µm	3,7	> 2,5
Diversitet	Acceptabel/Acceptable	Mycket god
SKADLIGA SVAMPAR		
µg skadlig svamp /g	0	<5
SVAMP:BAKTERIE KVOT (BIOMASSA)		
Uppnådd nivå	0,02	Varierar med växtslag
PROTOZOER		
Flagellater totalt antal/g	0	
Amöbor totalt antal/g	0	>50 000
Ciliater totalt antal/g	0	<40 000
Vorticella totalt antal/g	0	0
Rotifer totalt antal/g	0	0
Diversitet	Dålig/Bad	Mycket god
NEMATODER		
Bakterieätare, totalt antal/g	0	
Svampätare, totalt antal/g	0	
Predatorer, totalt antal/g	0	
Rotätande, totalt antal/g	0	0
Totalt antal nematoder/g	0	Totalt >100
Diversitet	Dålig/Bad	God

Matured for 1 month

ANALYSRESULTAT	Uppmätt nivå	Önskad nivå
BAKTERIER		
Totalt antal /g	713 333 333	
µg bakterier/g	1 427	>4000
Diversitet	Mycket god/Very good	Mycket god
AKTINOBAKTERIER		
µg aktinobakterier/g	0	<10
cm aktinobakterier /g	0	
GODA SVAMPAR		
µg god svamp /g	6	>300
Genomsnitt hyfdiameter µm	1,5	> 2,5
Diversitet	Acceptabel/Acceptable	Mycket god
SKADLIGA SVAMPAR		
µg skadlig svamp /g	0	<5
SVAMP:BAKTERIE KVOT (BIOMASSA)		
Uppnådd nivå	0,00	Varierar med växtslag
PROTOZOER		
Flagellater totalt antal/g	20 382	
Amöbor totalt antal/g	30 573	>50 000
Ciliater totalt antal/g	0	<40 000
Vorticella totalt antal/g	0	0
Rotifer totalt antal/g	0	0
Diversitet	Acceptabel/Acceptable	Mycket god
NEMATODER		
Bakterieätare, totalt antal/g	0	
Svampätare, totalt antal/g	0	
Predatorer, totalt antal/g	0	
Rotätande, totalt antal/g	0	0
Totalt antal nematoder/g	0	Totalt >100
Diversitet	Dålig/Bad	God

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Germination test. What happens here?

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What can go wrong…..

- C/N-forhold >>30 of materials when starting the composting -> slow turnover, low temperature, large carbon loss
- C/N-forhold <<30 of materials when starting the composting -> rapid turnover large loss of NH_3 og N_2O by emission
- Too much water result in too little oxygen -> anaerobic decomposition
- Too little water -> too little microbiological activity -> the process stops /standstill
- Sanitization can fail due to insufficient mixing (pockets)
- Too few turns -> anaerobic process
- To high EC (salt content)

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- **Analyses of compost og quality parameter**
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Parameters

- Visual screening
- Water density, bulk density
- Organic matter content (or organic C)
- Total macro elements (N, P, K, Ca, Mg)
- pH
- NO_3 and NH_4
- EC
- Cation exchange capacity (CEC)
- Compost maturity
- Physical impurities (plastic, metal, glass)
- Possible limit values (e.g. Cd, Pb)

Note the compostering input materials

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Mesofil fase
40°C
Eksplosiv vækst af bakterier og svampe

Termofil fase
40-65°C
En mindre forskelligartet population af bakterier og aktinomyceter, samt de mest varmeresistente svampe

Modningsfase
<40°C
Kompleks sammensætning af mesofile aktinomyceter, bakterier og svampe.

De 3 faser i komposteringsprocessen

Hurtig optagelse af sukker og stivelse

Nedbrydning af proteiner, fedtstoffer, hemicellulose og cellulose

Langsom nedbrydning af lignin og andre svært-nedbrydelige komponenter

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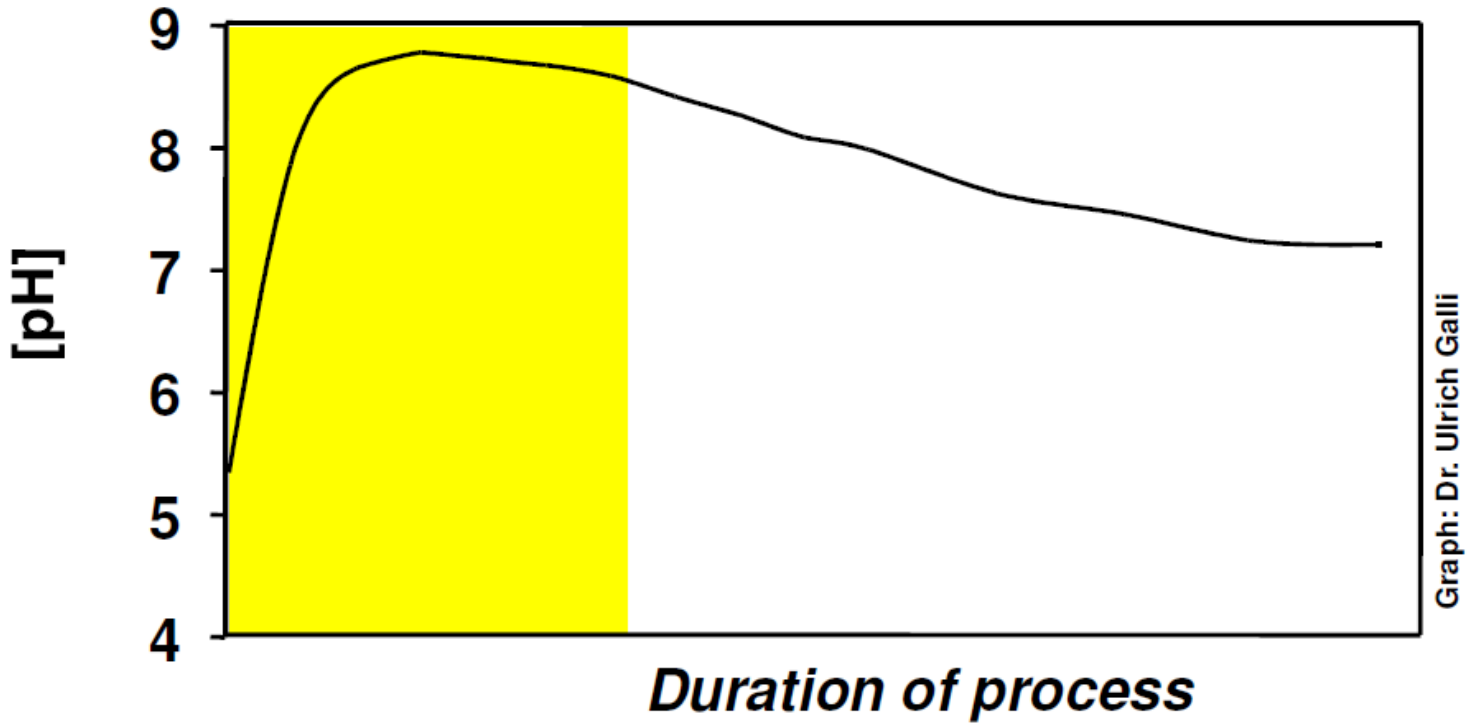

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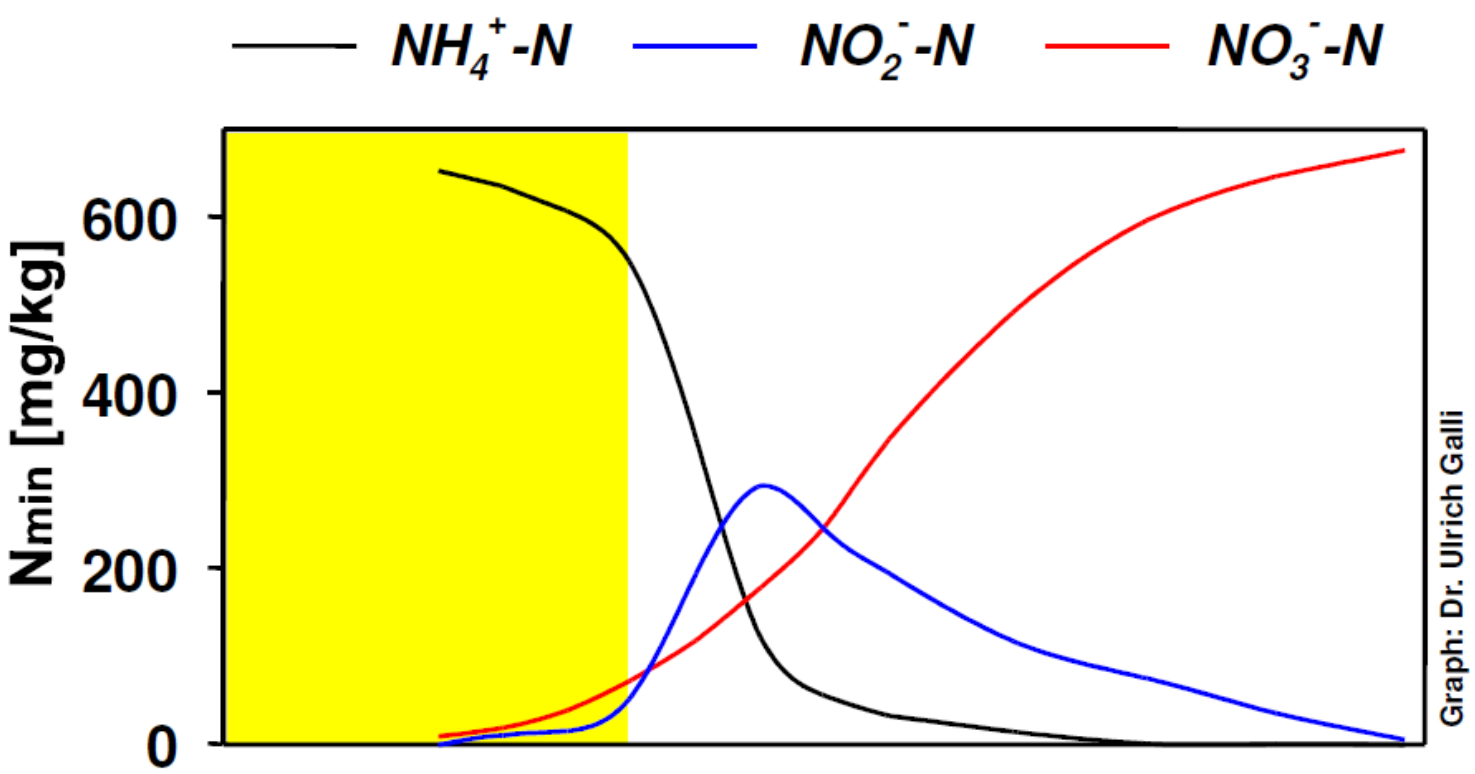
› Evolution of N_{min} during composting process



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Visual screening

	Good well done compost	**Bad or not finished compost**
Eyes	Uniform color. Color brown-black. The color may depend on what the compost is made of. The brown-black evidence of humus.	Material consists of a mosaic of different colors from the input materials. Gray color shows the compost has been relatively dry during composting
Nose	Well done compost must smell like forest jord og of nothing.	Ammonia smell indicates young compost. N rich material. H_2S smell indicates anaerob "composting"
Touch	Crumbling structure, Uniformity, although with some pieces of wood which break easily.	Wood grains, still hard and clearly visible

Typical value of macro elements (values only approximately!!)

Very much depending on what materials the compost is made of!!

- Total N 5 kg/t compost
- P 1 kg/t
- K 3-5 kg/t (is lost by long time storage)
- Ca 10 kg/t
- Mg 1-2 kg/t

Cation exchange capacity (CEC)

Comes from the residual materials composted!

Physical impurities (plastic, metal, glass)

- Plastics/glass/metal under 0,1% of dry matter

Heavy metal contents

- Limit values for Pb og Cd
- Or what ever is limit values

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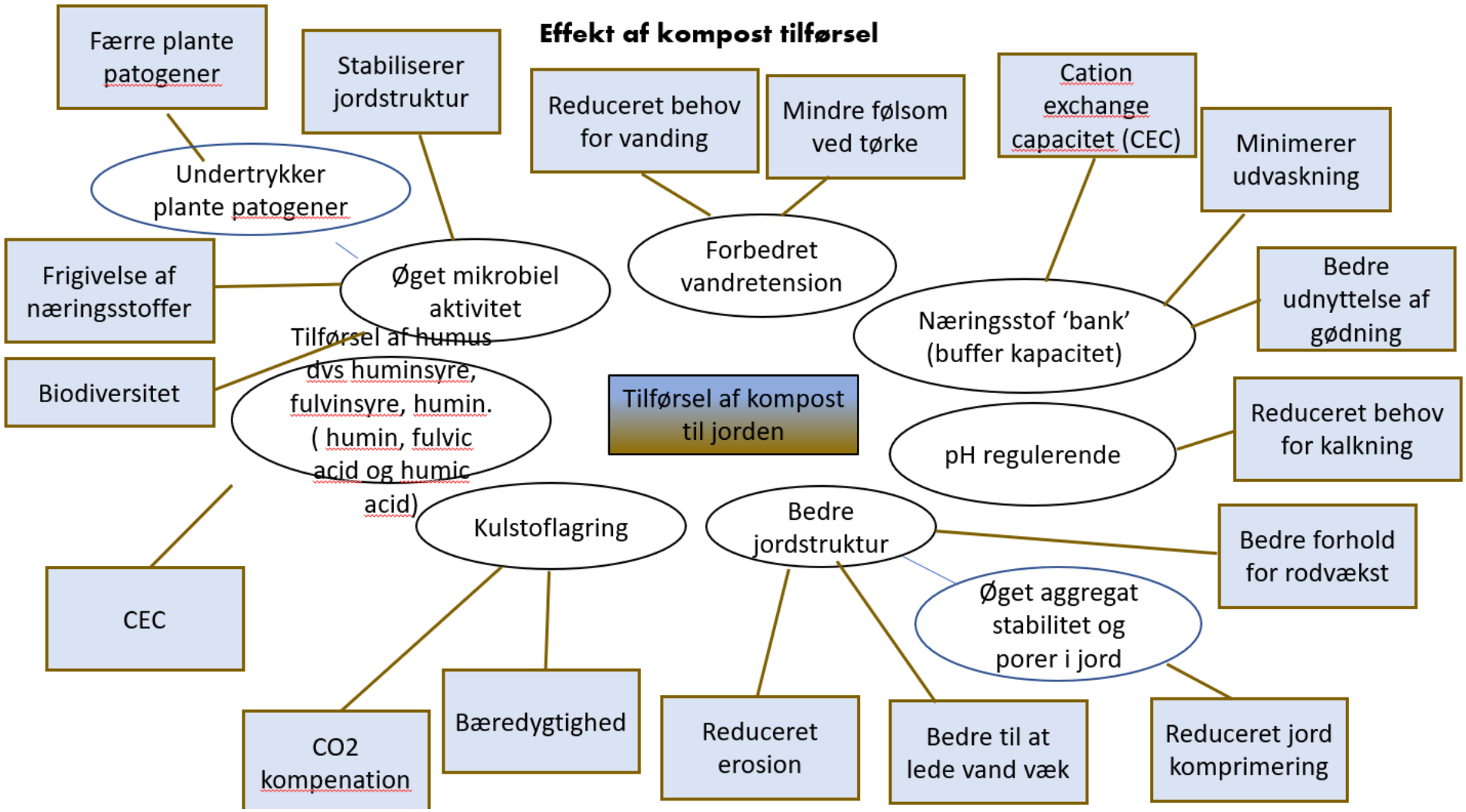
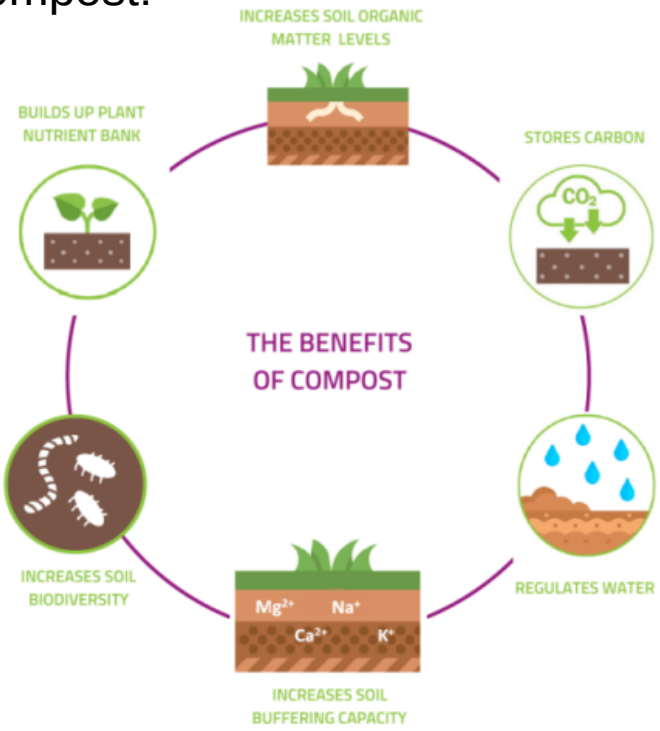


Properties and expected effect of good compost:

- ✓ Organisk materiale
  - ✓ buffer for næringsstoffer
  - ✓ øget CEC værdi
  - ✓ for mikroorganismer
- ✓ Organisk materiale
  - ✓ vandretention
  - ✓ porøsitet – vand
  - ✓ Luftskifte i jord
- ✓ pH virkning
- ✓ Liv i jord undertrykker plantepatogener
- ✓ Næringsstoffer
  - ✓ materiale nedbrydes over tid
  - ✓ tilførsel af P, K, Ca
- ✓ Kulstof lagring



Kilde: ECN

Depending on soil type and climate

Plant production – Soil fertility
Factors influencing

Soil fertility is the ability of the soil to function as growth media for plants including its ability to supply plant growth with the nutrients in the right quantities and qualities over time.

Factors that can be influenced:
pH
Water in adequate amounts
Soil structure
Plant nutrients
Microorganisms that support plant growth

The characteristics of compost

Organic matter content (or organic C)

Soil Organic Matter (SOM) play imported role e.g:

- Soil structure (effect air, temperature)
- Water retention capacity
- Buffer for nutrients
- Biological activity

- Reduction of soil erosion
- Soil moisture
- Humus
- Aggregate formation

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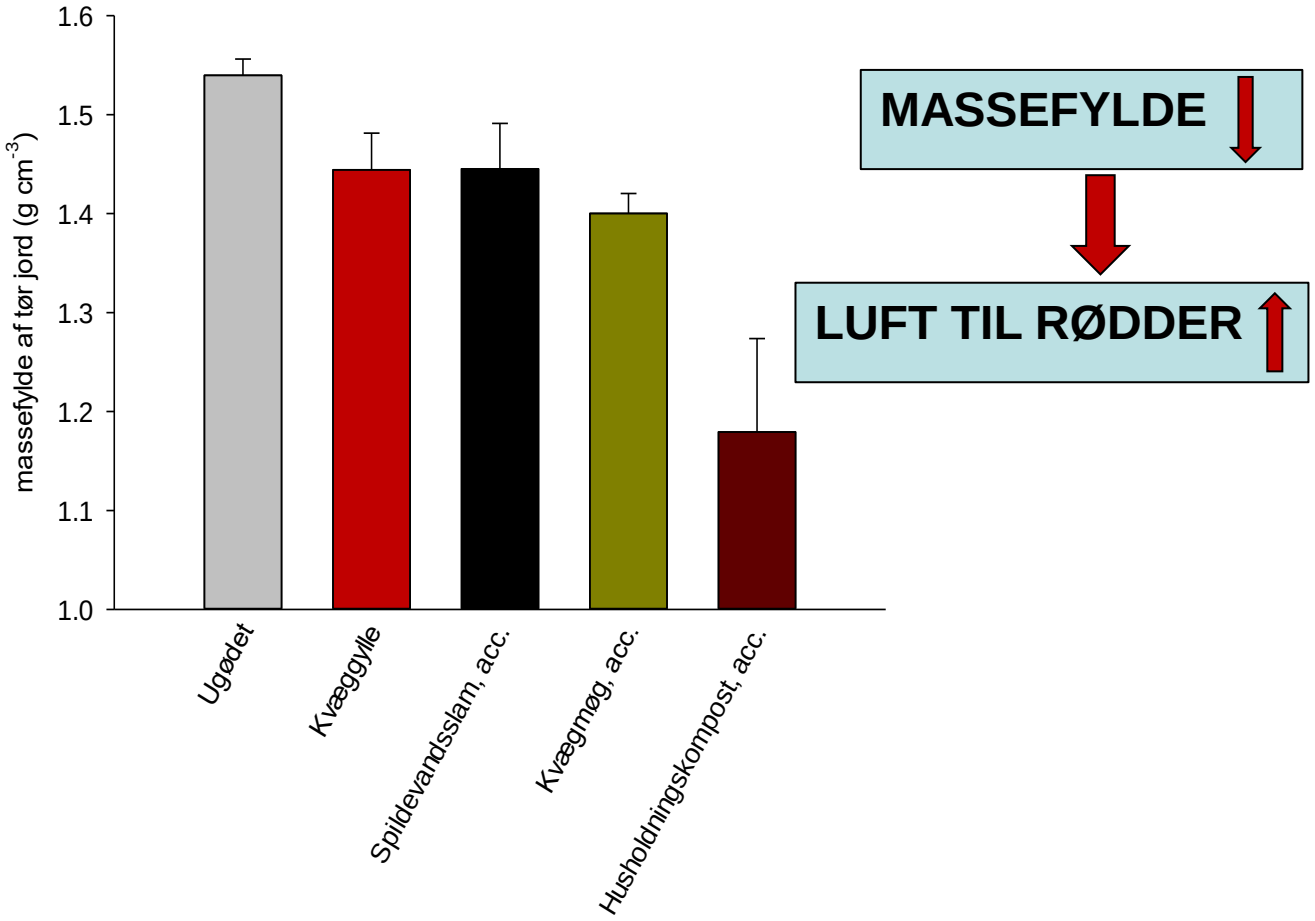
Spadestik, dry as no water for a longe time!

Top soil supplied NPK

Bottom supplied compost (lav mængde)


massefylde af tør jord (g cm-3)
1.6
1.5
1.4
1.3
1.2
1.1
1.0
Ugødet
Kvæggylle
Spildevandsslam, acc.
Kvægmøg, acc.
Husholdningskompost, acc.
MASSEFYLDE
LUFT TIL RØDDER

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Carbon storage

The maturation of compost makes more stabile carbon. The humus compounds
-> Carbon storage

Biochar

AU have collected Knowledge synthesis on biochar in Danish agroculture.

- Carbon storage
- But no other effect on soil og plant growth

The stories about effect of biochar is from bad soils.

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Legislation main topics

Difference between countries:

- Requirements for the composting process, for the sanitization
  - moisture content
- Temperature and duration

Be aware of legislation:

- Different materials for composting
- N and P efficiency %
- Storage and cover
- Documentation requirements
- Time of year for the use on field

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Use of compost

- Water retention -> for dry periods
- Better soil structure -> root growth, water drainage
- C-storage
- Buffer for nutrients (slow release)
- Compost stimulates soil biology in general leading to a good competitor for Pythium, Phytophtora og Fusarium

Adding 10-15 t/ha per year
- not just one year!

If not possible to add compost every year, larger quantity.

Soil type

pH effect, 15 t/ha upper soil layer 3 year in a row -> pH increased with 0,4. (NL)

Be sure of the quality!! (We have a checklist)

Soil improvement of spots in the field

K-resource

Compost in pot soil

Uniformity of the compost. Ensure uniformity of the plants

Culture differences (e.g. rose, campanula)

30% compost in a mix
Which soil mix partners

Future

Hope for further work with compost

- How to reduce emission
- Microbial in compost and soil
- Effect of long time use of compost

And much more

If a new project gets commitment.

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Kompost

Thanks for your interest in compost

Questions?

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