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# **Bioremediation for waste treatment**

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# Bioremediation

is the process that uses **living organisms** to

- degrade hazardous organic contaminants or
- reduce inorganic contaminants to environmentally safe levels in  
soils, subsurface materials, water, sludges and waste.

Waste treatment is a complex problem due to

- the great quantity
- the possible presence of toxic compounds and pathogens.

Any biotechnological approach able to reduce them is suitable for application especially if it is also economical.

Bioremediation is recognised as an inexpensive, effective and environmentally safe technology

Bioremediation technology exploits various naturally occurring mitigation processes.

Among them

- **biostimulation**, which utilizes indigenous microbial populations and
- **bioaugmentation**, which involves introduction of exogenous microorganisms

- Microbes utilize chemical contaminants in the mixture as an energy source
- through oxidation-reduction reactions they metabolize the target contaminant
- By-products (metabolites) released back into the environment are typically in a less toxic form than the parent contaminants.

## Composting

biostimulation of indigenous microorganisms in biopiles that are kept aerated by pumping air through an injection system or by mechanical mixing.



Several waste materials can be suitable for composting:

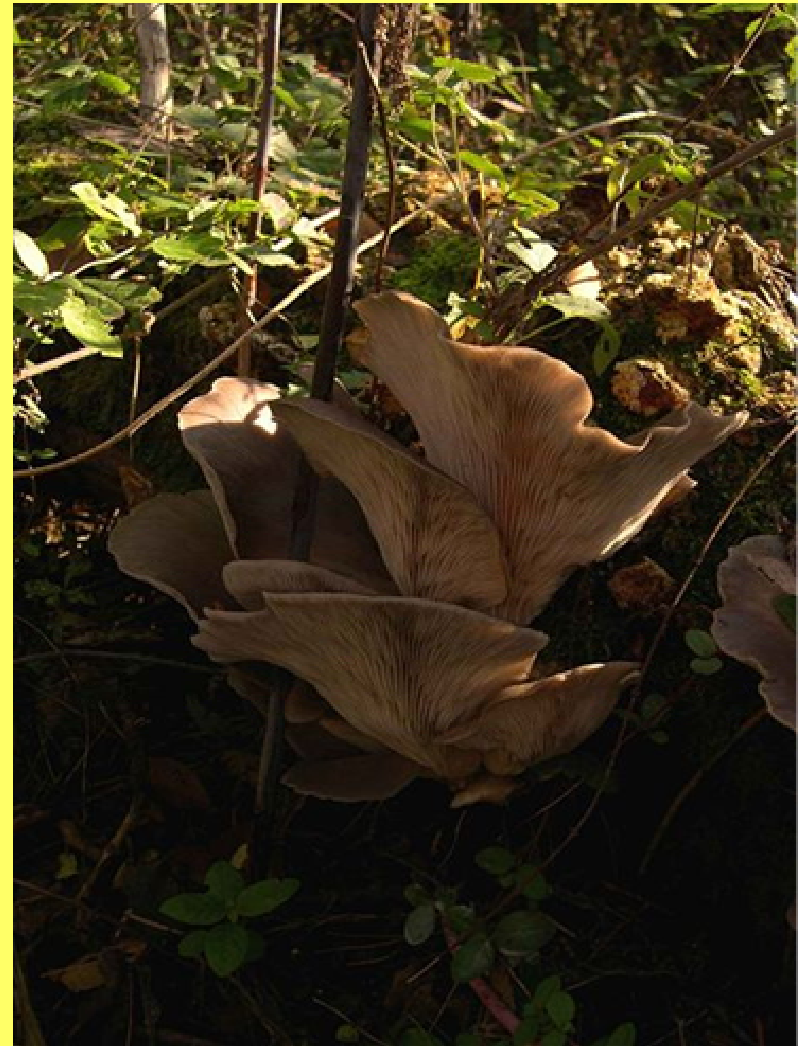
- green waste from gardens,
- organic waste from selected areas like fruit and vegetable markets, fish markets, restaurants, houses, refectories and canteens,
- organic waste from food or paper industries,
- urban sludges (no heavy metals),
- industrial sludges from agro-food, paper and wood industries,
- zootechnical sludge, slaughtering waste, animal bedding.

An appropriate starting mixture is necessary, with a C/N ratio in the range 20-40 and a right density, essential for aerobic process and gaseous exchanges.

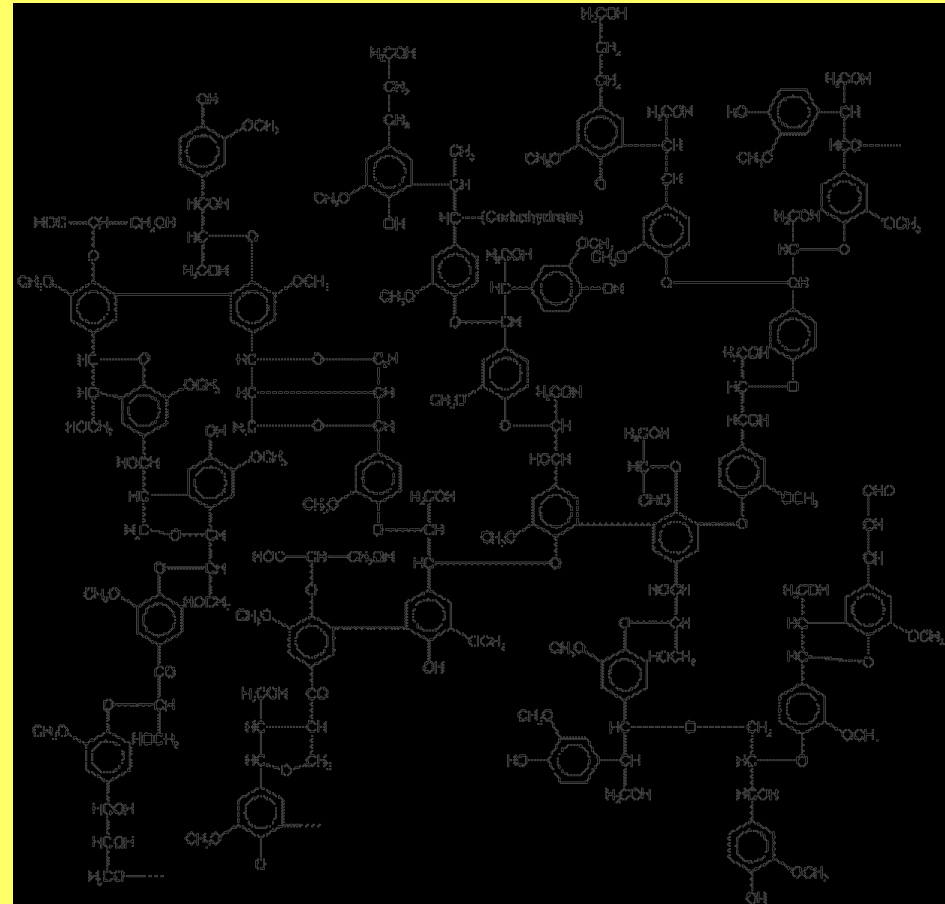
**When composting is applied to contaminated waste or compost is used for *in situ* bioremediation of contaminated soil, many recalcitrant molecules are destroyed.**

# bioaugmentation

- The addition of selected microorganisms for the treatment of waste permits to accelerate the process of degradation of toxic substances.
- Mycoremediation is a form of bioremediation that uses fungal mycelia



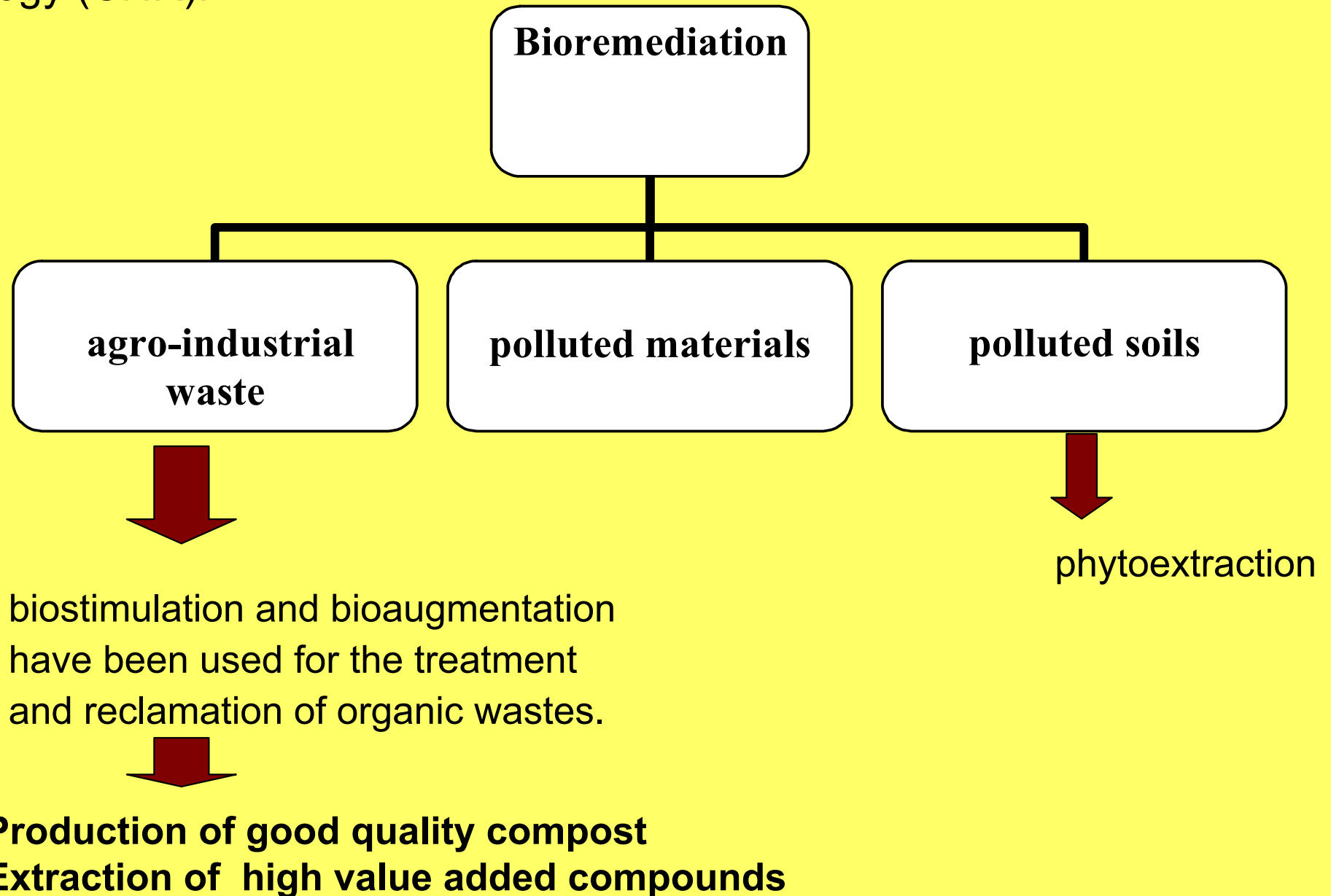
- One of the primary roles of fungi in the ecosystem is decomposition.
- The mycelium secretes extracellular enzymes and acids that breakdown lignin and cellulose



The key to mycoremediation is determining the right fungal species to target a specific pollutant.

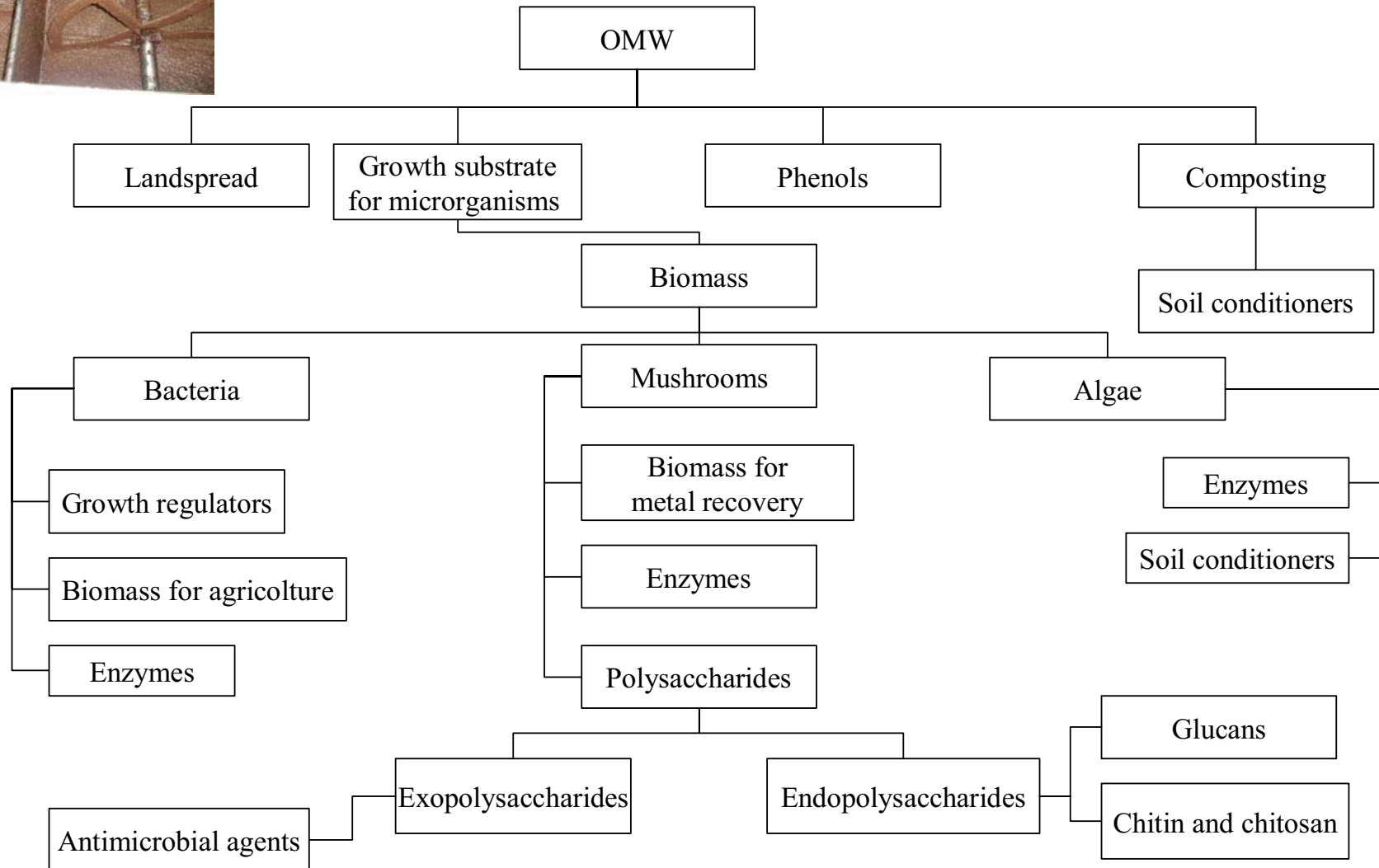
Wood-degrading fungi are particularly effective in breaking down aromatic pollutants (toxic components of [petroleum](#)), as well as chlorinated compounds (certain persistent [pesticides](#)).

Activities performed in the Institute of Agro-Environmental & Forest Biology (CNR):





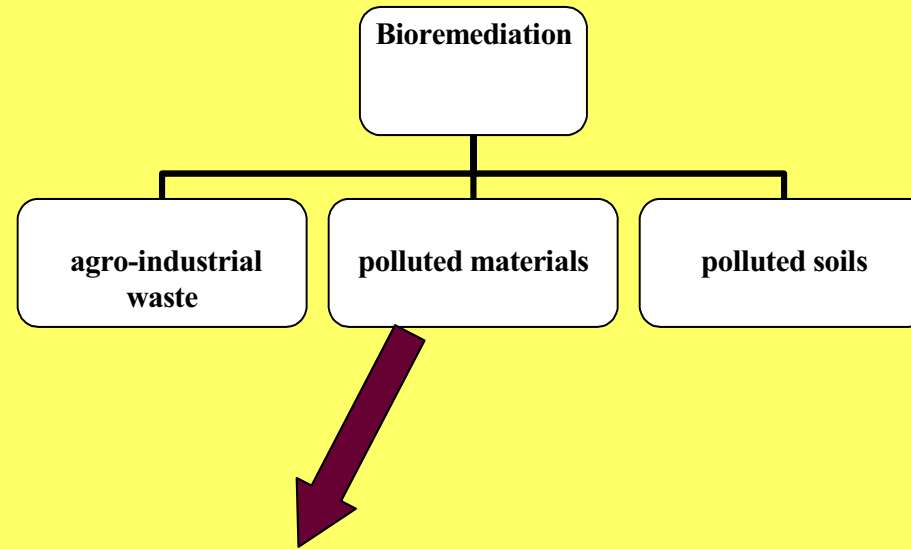
## OLIVE MILL WASTES (OMW) AS A RESOURCE



## **Production of good quality compost**

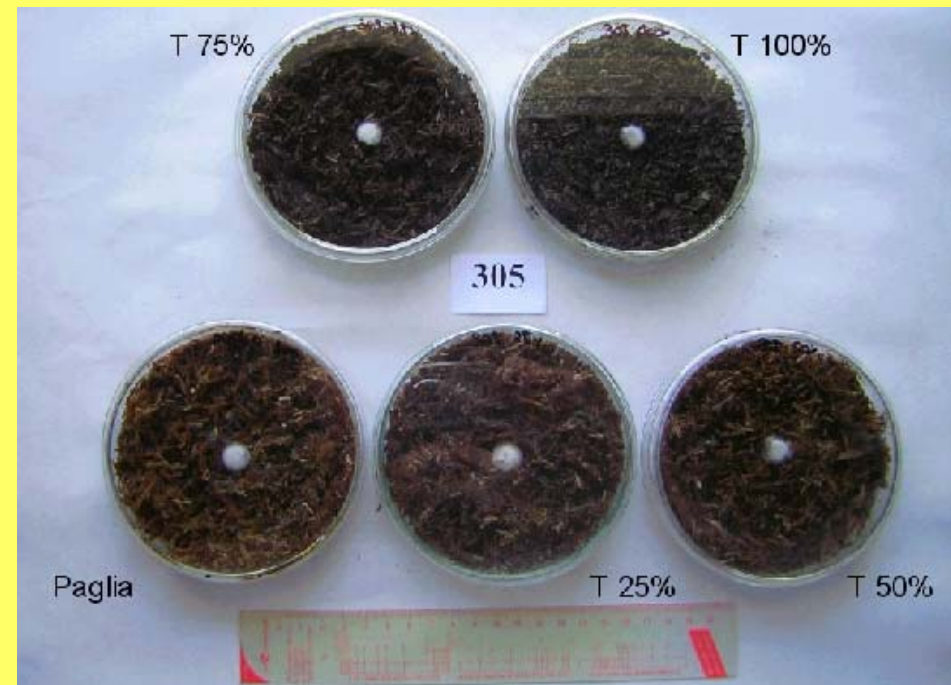
### **Composting as a treatment for olive mill wastes and solid cake residues**

- Addition of several bulking agents such as grape stalk , poplar sawdust, bark chips, cotton gin waste and wheat straw.
- Studies on humic acid formation during the process
- A new index for the evaluation of compost maturity
- End-products with a high content of organic matter and significant amounts of plant nutrients were obtained.
- Agronomic experiments showed positive effects on soil characteristics and on plant growth and yield.



Reclamation of wood treated with creosote, a mixture of phenols, polycyclic aromatic hydrocarbons (PAH) and heterocyclic compounds.

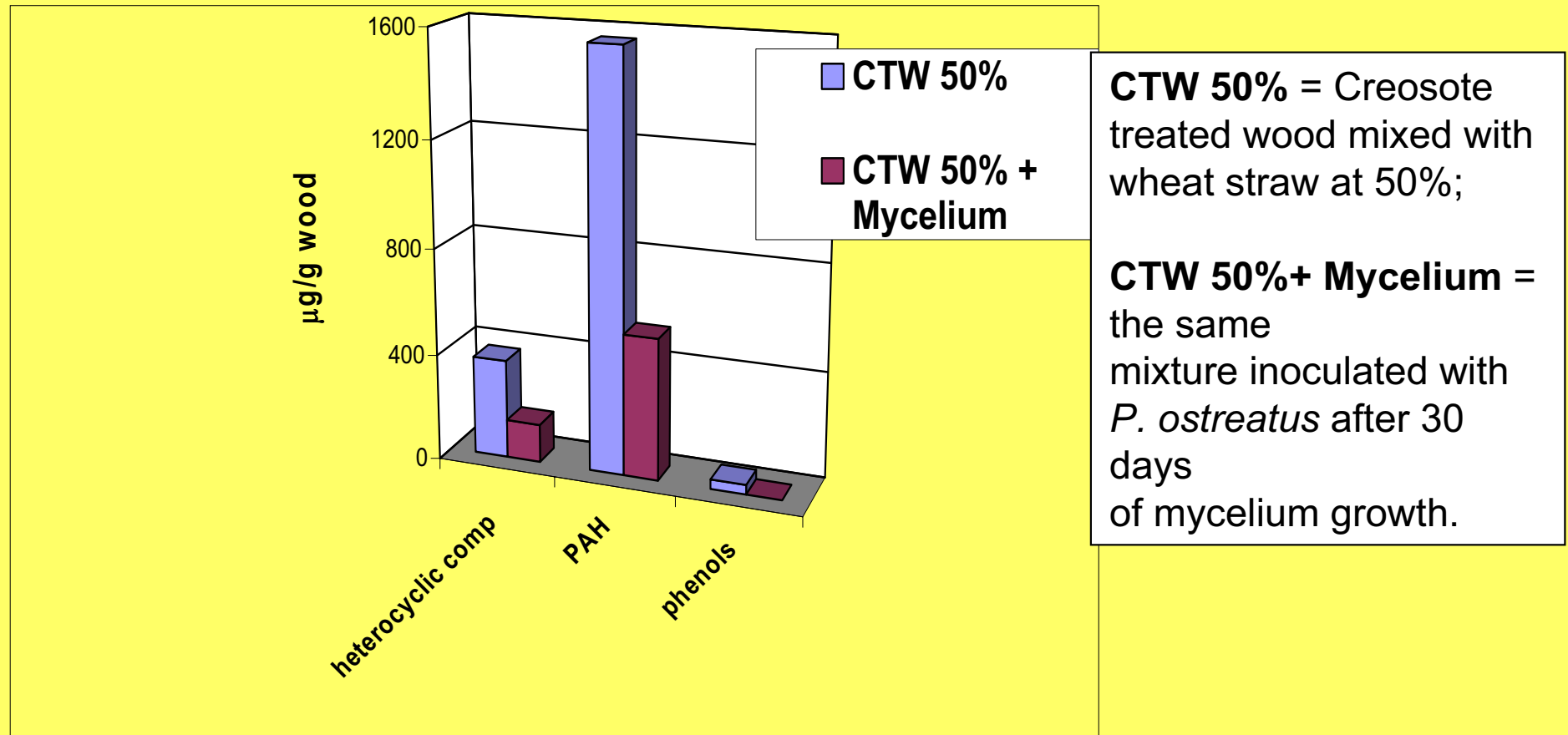
Tolerance of *Agrocybe*, *Armillaria*, *Auricularia*, *Daedalea*, *Pleurotus*, *Trametes* in creosote-treated wood (CTW) mixed with wheat straw



# Pleurotus ostreatus after 10 days of growth



After 30 days of treatment phenols completely disappeared, and a decrease of 65–70% in PAH and heterocyclic compounds was obtained.

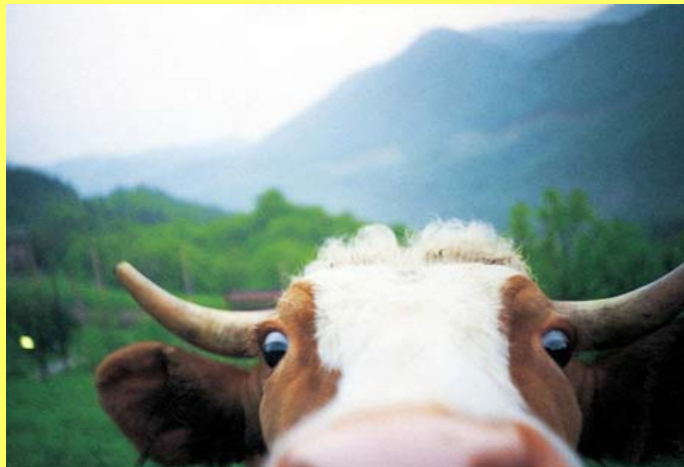
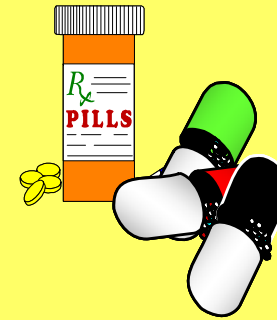


# Antimicrobial Oxytetracyclines

routinely used in  
intensive animal farming  
and aquaculture

## Problems:

- poor intestinal absorption;
- OTC concentration after 5 months: 820  $\mu\text{g}/\text{kg}$  of cattle manure.



**Ecological problems when  
manure is used for land  
fertilization**

# Mycoremediation experiments

Mycelium growth in presence of OTC (100  $\mu\text{g}/\text{ml}$ ) in batch

In a few days, *Pleurotus ostreatus* is able to

- absorb OTC and
- degrade it.

## **Conclusions**

Bioremediation has the potential to provide a low cost, non-intrusive, natural method to transform waste into a resource.

Most studies have been conducted under laboratory conditions and in pilot plants.

Some technologies have been already industrially developed.

The cooperation between research institutes and enterprises can be the key to a further development of practical technologies.

**Thank you for your attention!**

