

NIXT

Investigating the viability of fungi for explosive decontamination and environmental clean-up

BECOME **GREATER**
TODAY **THAN** YOU WERE YESTERDAY!

#MyNWU | #GreaterThan

Pentolite properties

- Pentolite is a mixture of TNT and PETN
 - 50/50 of 2,4,6-trinitrotoluene & pentaerythritol tetranitrate.
 - Used as boosters in blasting operations.
- Highly nitrated compounds
- Low solubility.
 - TNT: 100 – 130 mg/L aq.
 - PETN: 1 - 2 mg/L aq.



Problem with Pentolite

- Chemically stable – difficult to decontaminate.
- Environmental leaching and entrapment.
- TNT is poisonous, mutagenic and carcinogenic
- TNT degrade into various toxic compounds.
- PETN very insoluble = persistent.



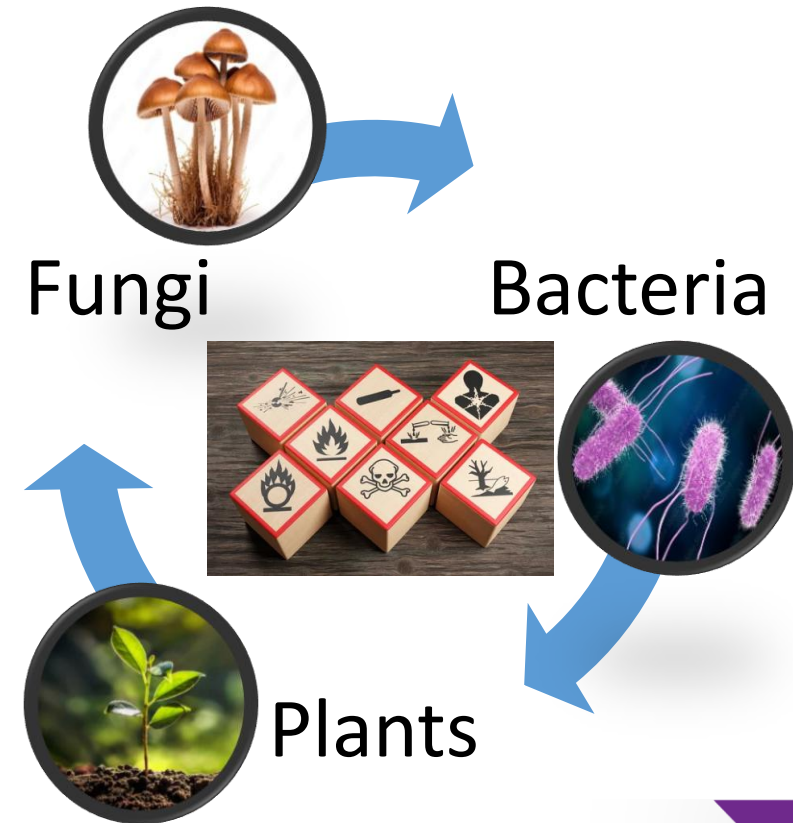
Conventional decontamination

- In situ or ex-situ?
- Thermal
 - Incineration
 - Burn in situ
- Chemical
 - Alkaline / acidic decomposition
 - Oxidizing reagents
 - Leaching & adsorbtion
- Storing & Containment
 - Ponds / slime dams / landfills



Bioremediation

- Use living organisms to remove pollutants
 - Plants, fungi, bacteria
- Biological process
 - Natural or adaptive
 - Enzyme based
- Pollutants are
 - Adsorbed & sequestered
 - Degraded
 - Mineralized



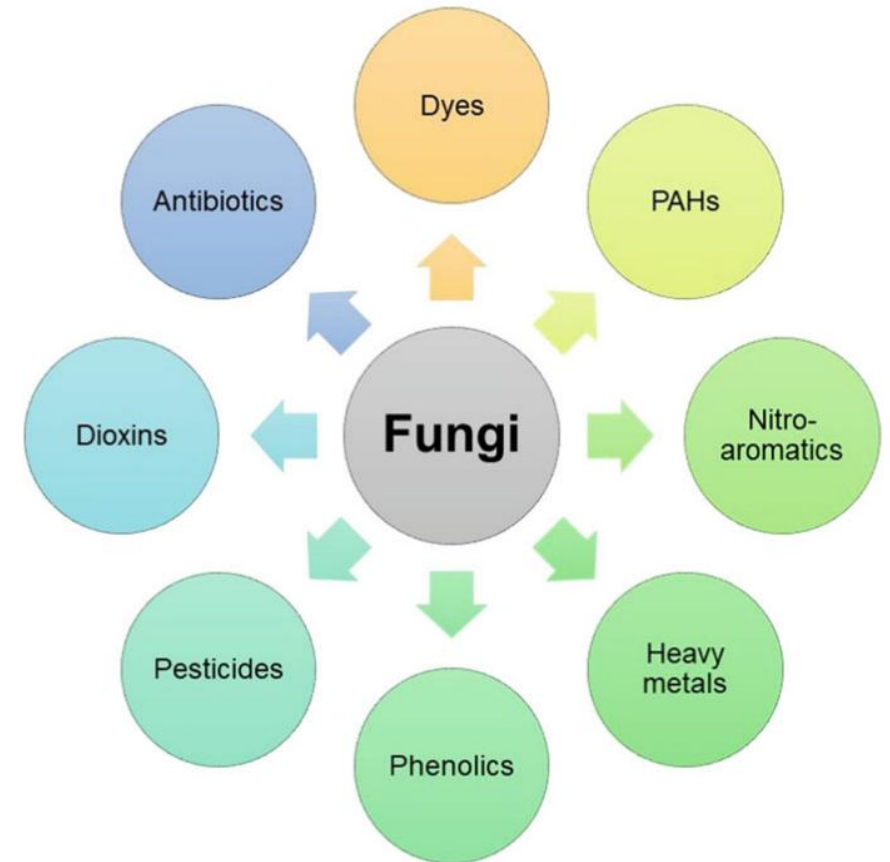
Fungal mycelium



- Find nutrient rich environment
- Secretes enzymes to digest substrate
- Absorb & distribute nutrients
- Create fruiting bodies for reproduction

Why fungi?

- Abundant.
- Saprophytic = natural decomposers.
- Degrade a wide range of compounds.
 - Wood to petroleum, plastics, pesticides and explosives
- Produce non-specific extracellular enzymes.
 - Co-metabolism transform other compounds
- Resilient and easy to grow.

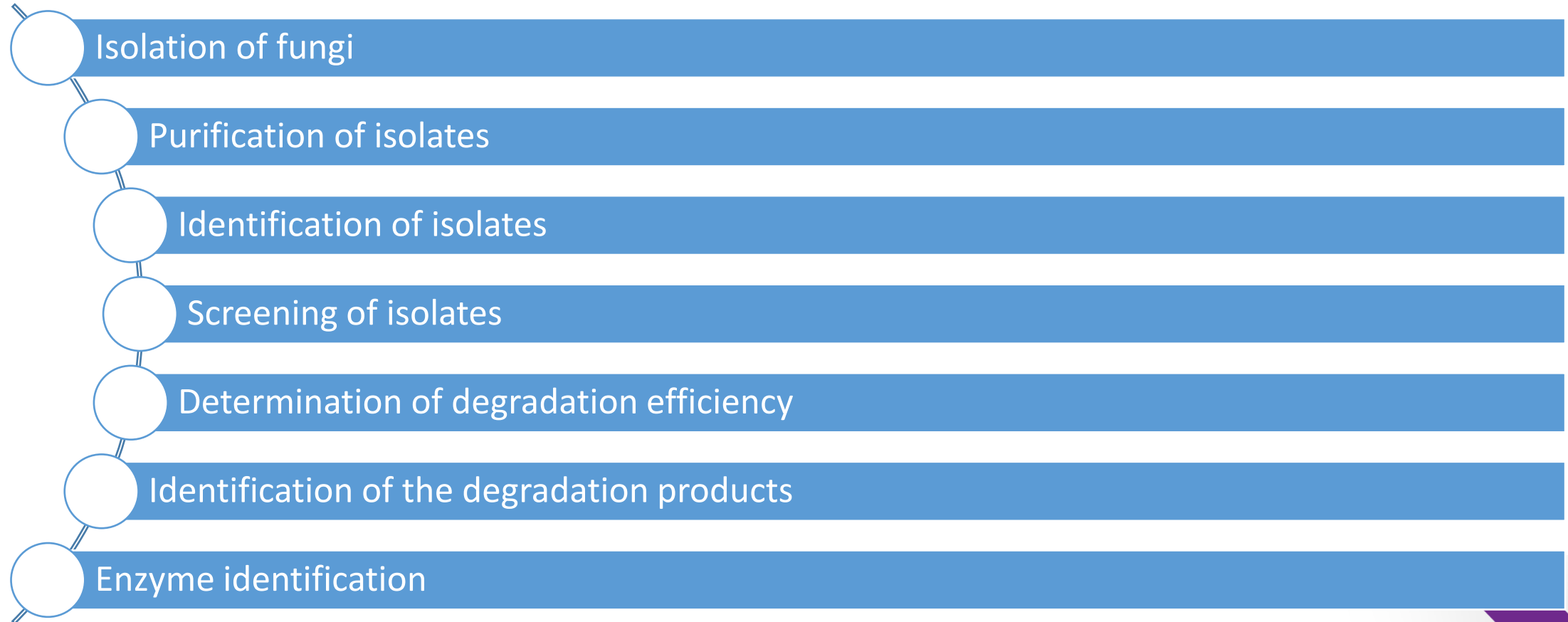


Bioremediation strategies with fungi

Bioremediation strategies	1. Biomineralization – Compound transforms into solid form
	2. Biosorption – Metal and/or chemical absorbs/adsorbs
	3. Biodegradation – Compound breaks into simpler molecules
	4. Biotransformation – Compound transforms into other chemical compound
	5. Bioconversion – Economical biochemical process to produce chemical compound
	6. Bioaugmentation – Compound remediates/removes by inserting microorganism
	7. Biostimulation – Compound remediate/removes by nutrient/electron acceptors
	8. Biodeterioration – Compound becomes less active than actual form
	9. Bioleaching – Extraction of certain metals using biological process
	10. Biovolatilization – Compound converts into volatile compound using biological process
	11. Biomagnification – Concentration of compound increases in organisms
	12. Bioaccumulation – Entry of metals/contaminants via active transport

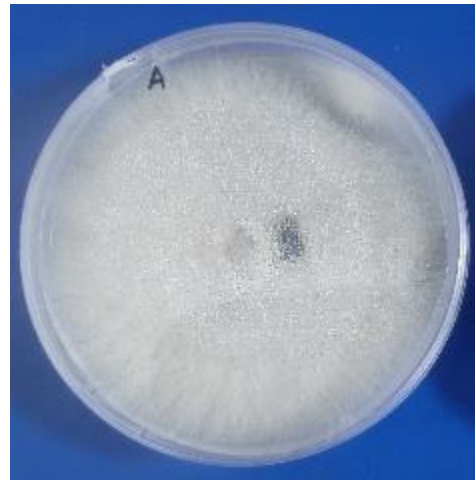
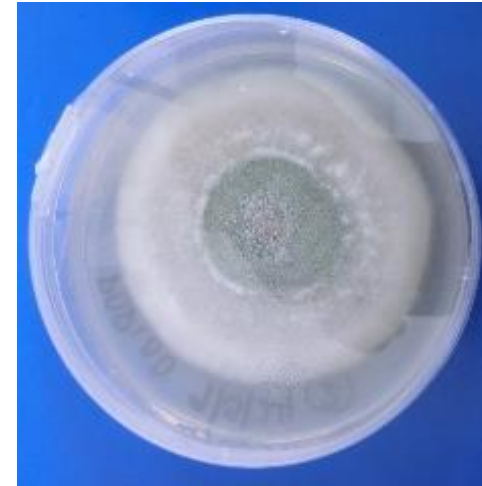
Rudakiya et al, 2021

Investigation process



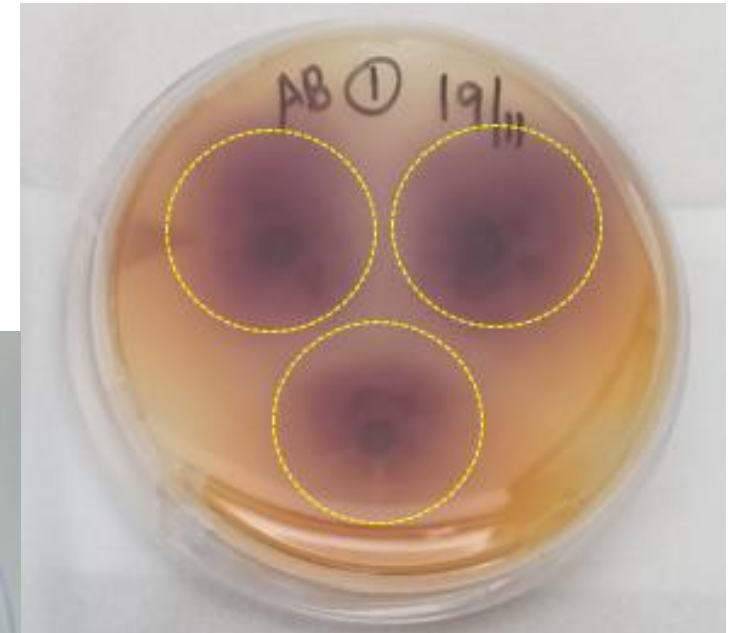
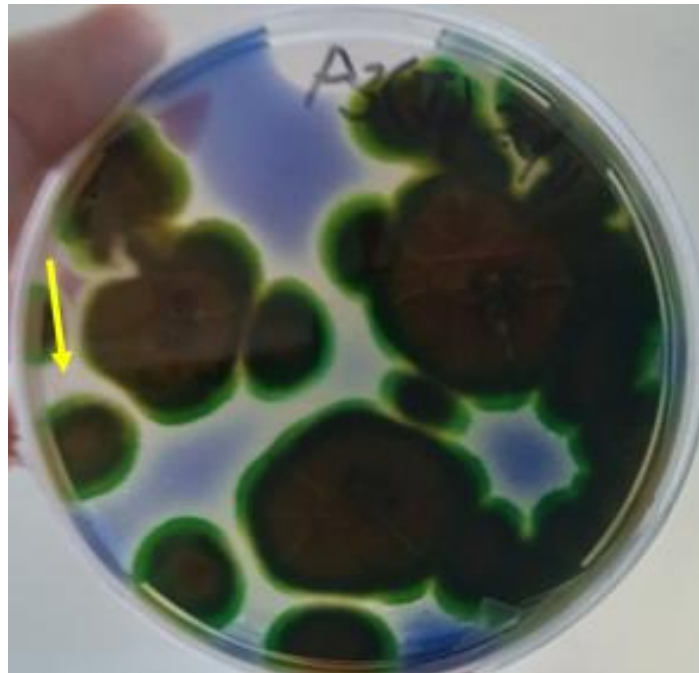
Fungal isolation and identification

- In soil / organic layer.
 - *Trichoderma*
 - *Fusarium*
 - *Bjerkandera*
 - *Neocosmospora*
 - *Purpureocillium*
- Pentolite tolerant
- Adapted to site conditions



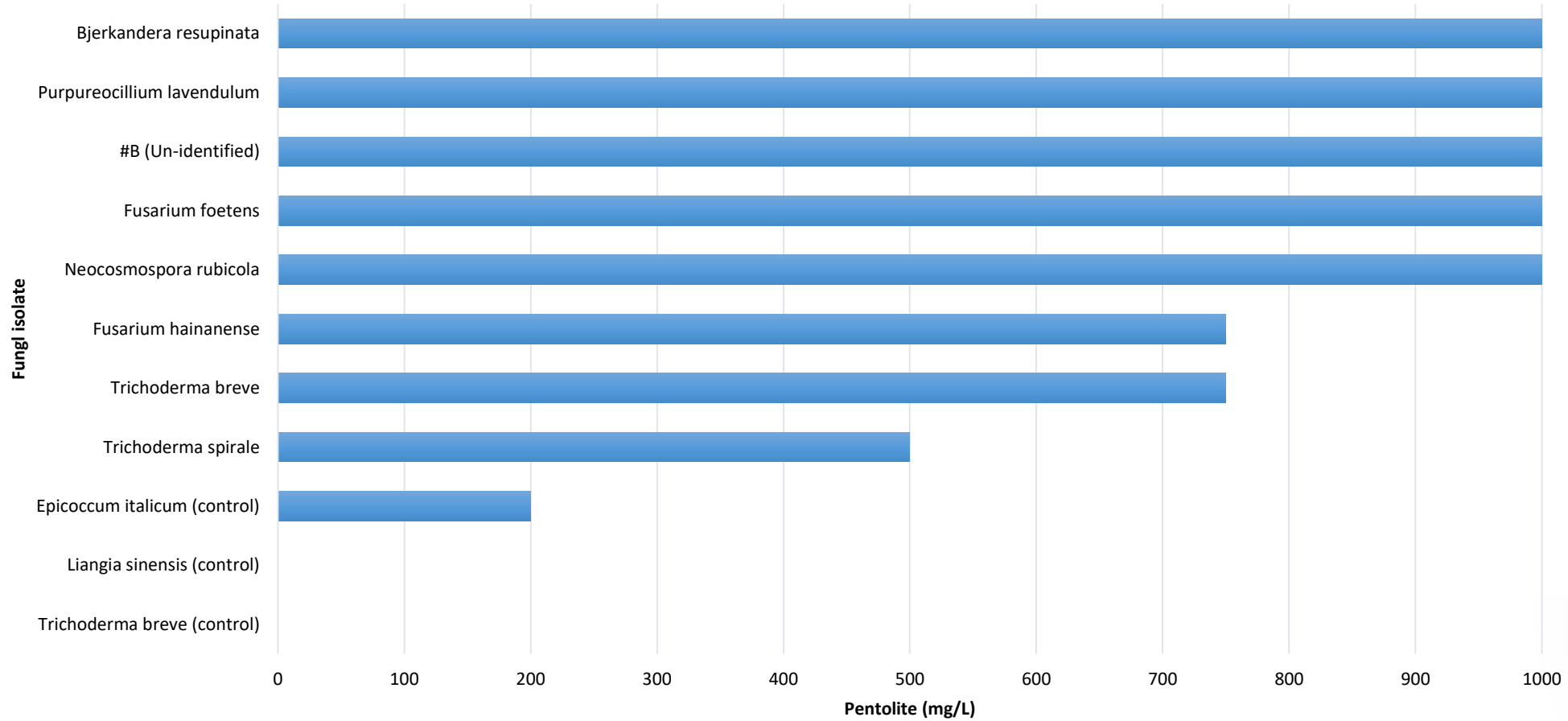
Extracellular enzyme screening

- Colour reaction of organic complexes.
- Enzyme activity within 1-5 days.
- Specific enzymes expressed
 - Manganese peroxidase (MnP) & laccase (Lac).



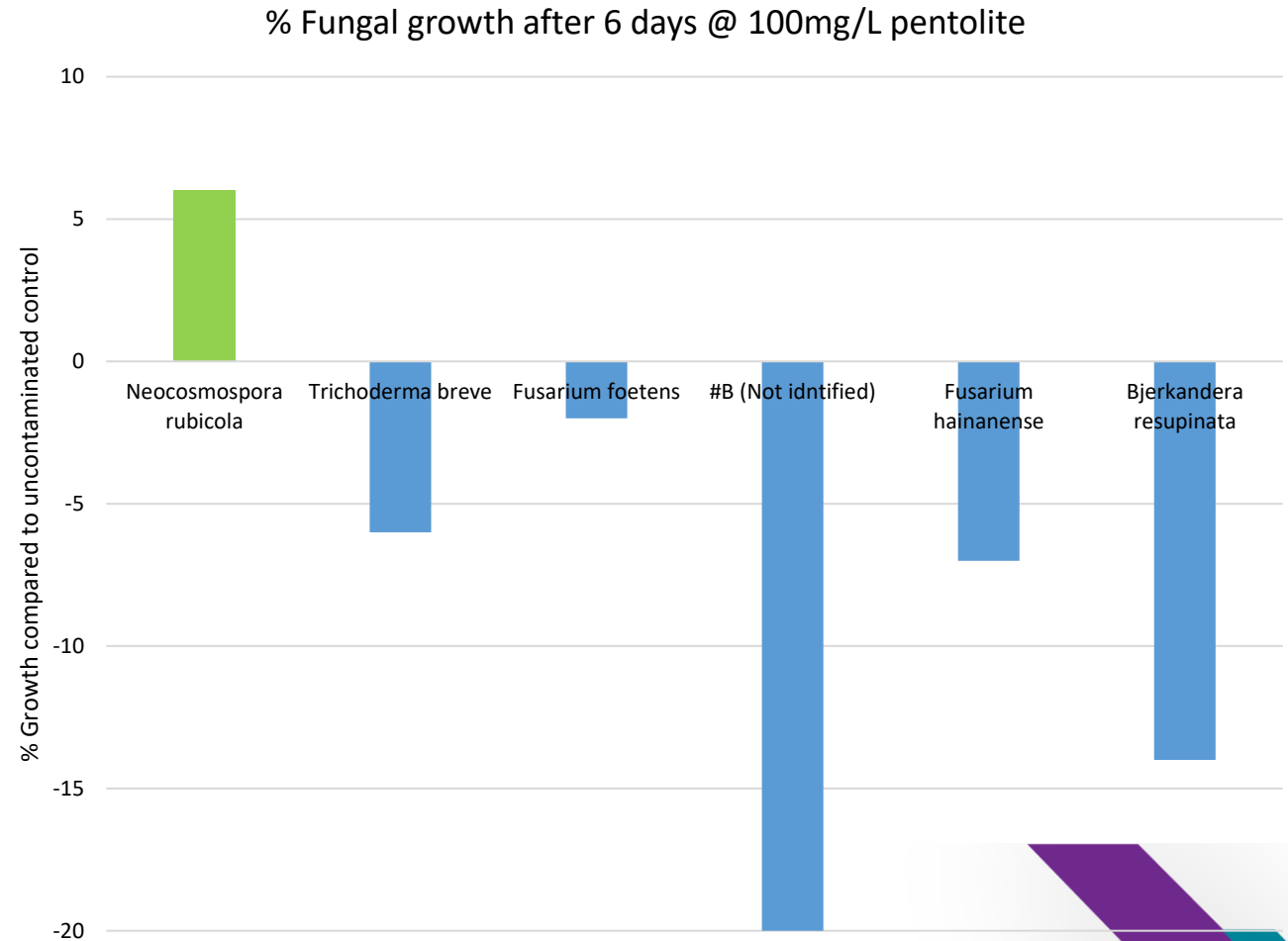
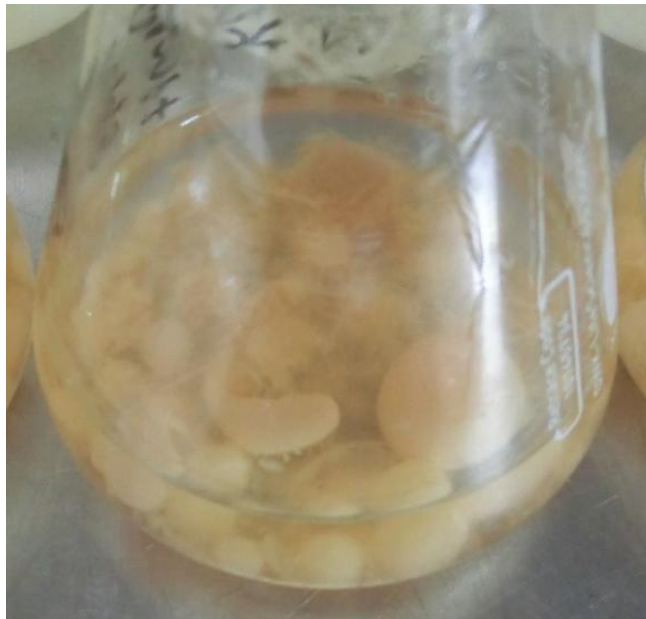
Pentolite tolerance

Maximum pentolite concentration tolerated per fungal isolate



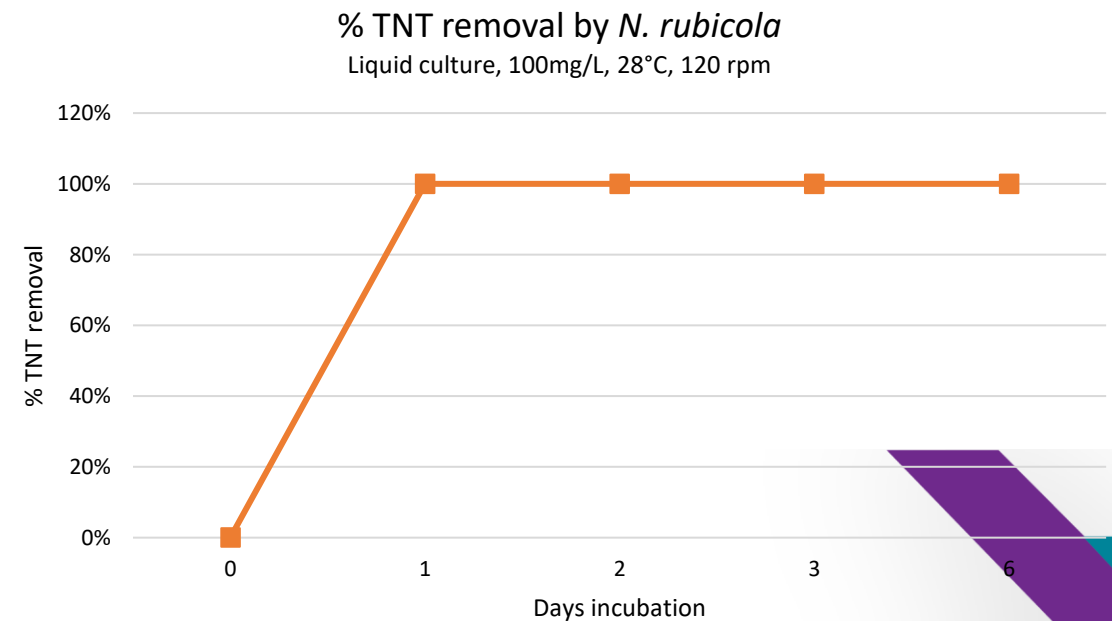
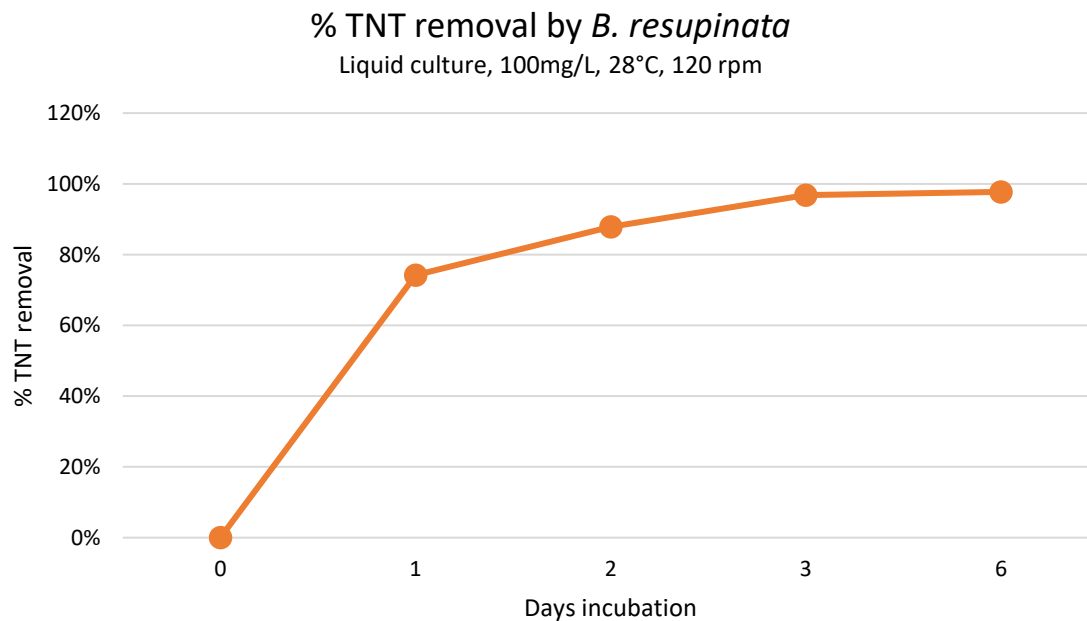
Fungal growth with pentolite

- *N. rubicola* with pentolite gain 6% additional mass.
- Inhibited growth of other isolates when exposed to pentolite.



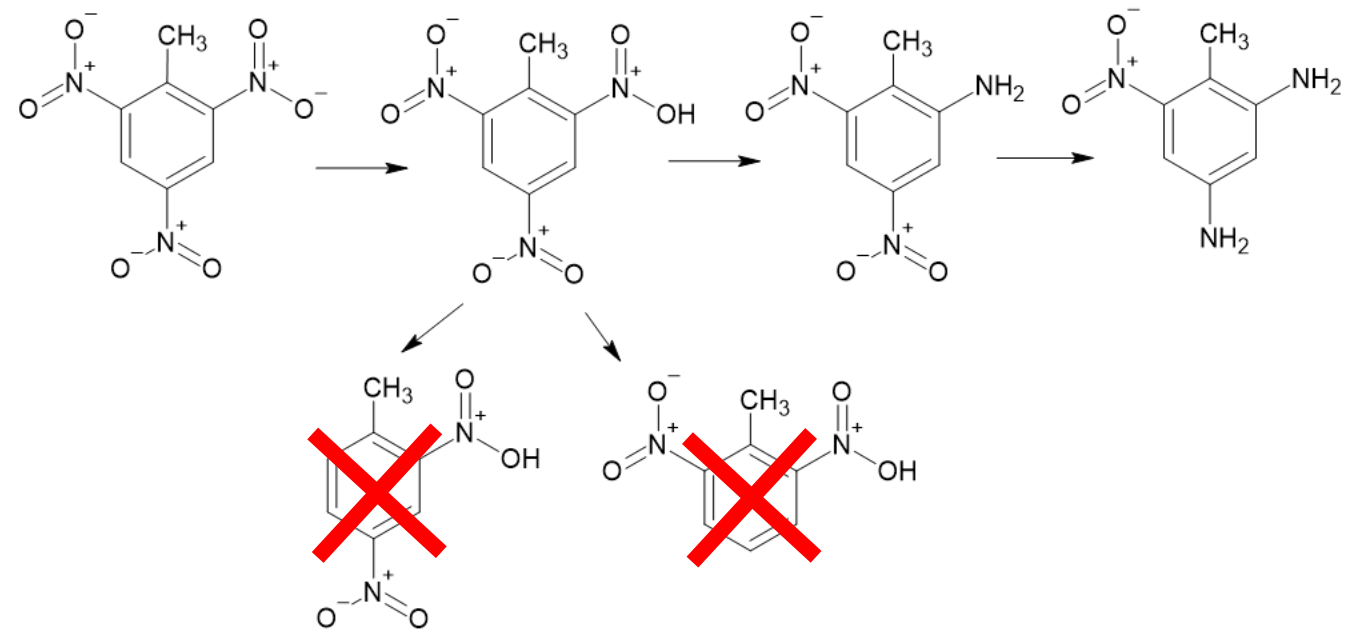
Fungal degradation of pentolite

- TNT degradation 98-100% in 1 – 6 days @ 100 mg/L
- PETN low solubility result in 6 – 27% degradation @ 100 mg/L



Pentolite degradation products

- *TNT degradation:*
 - No 2,4-dinitrotoluene or 2,6-dinitrotoluene detected
 - Further exploration of degradation needed
- *PETN degradation*
 - PETriN produced



Conclusion



Fungi from a pentolite contaminated site

- Tolerate up to 1000 mg/L pentolite.
- Degradation in 1 – 6 days depending on fungus.
- Degrade TNT quickly.
- Degrade PETN slowly.
- Express various extracellular enzymes.

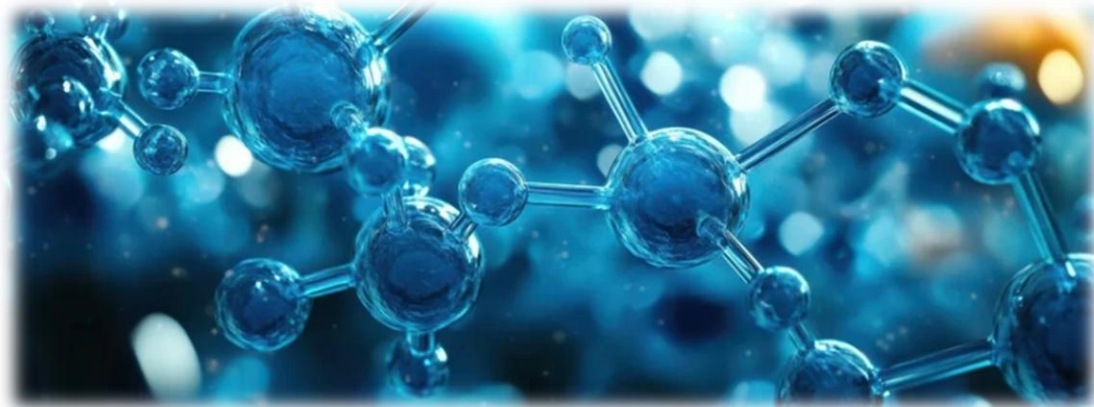
Way forward?

- Continue investigation on fungal abilities
 - Degradation rates & products
- Explore applications for soil and water
 - Bio-stimulation / Bio-augmentation
 - Bio-reactor
- Enzyme isolation
 - Decontamination solution applied in process.



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