Effect of metal speciation on the functional and morphological responses of soil fungi: case of Cu and Zn in Trametes versicolor

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The present study aims at establishing the influence of metal speciation on both specificity and sensitivity of fungal responses to essential metals. For that purpose, Trametes versicolor was cultured in liquid media exhibiting different levels of metal concentration. Three functional and two physiological traits were compared for their pertinence as metal exposure biomarkers.

METAL SPECIATION

Cu
Zn
organic and inorganic ligands
metal speciation
METAL EXPOSURE
FUNGAL RESPONSES

At morphological level
- Growth (dry biomass)
- Morphology of mycelium

At functional level
- Extracellular oxidase activity: peroxidases

I. CULTURE MEDIA and METAL SPECIATION

Fig. 1: Metal speciation in liquid media: Cu (abscissa) vs Zn (ordinate). (A) Organic-complexed, (B) inorganic-complexed and (C) free forms.

- Metals are mainly complexed by organic ligands in Lesa (>80%)
- The presence of free metal species are favored in Aba5 and Aba2.5 (until 13% for Cu2+ and 74% for Zn2+, in red Fig. 1)

Free forms of metals: Lesa < Aba5 < Aba2.5

a. Oxidase responses to essential metals (1 mM)

Fig. 2: Oxidase activity in liquid media: Lesa, Aba5 and Aba2.5. (A) Lignin peroxidase, (B) Mn-peroxidase and (C) Laccase.

- Zn has no effect on the oxidase activities, whatever the complexation level of the used medium
- Laccase and Mn-peroxidase activities are highly increased by Cu in low complexing media Aba5 and Aba2.5

The intensity of enzymatic responses is increased when free forms of Cu are favored; it is not the case for Zn

b. Dose-response curves to Cu in low complexing media

Fig. 3: Dose-response curves to Cu in low complexing media: Lesa, Aba5 and Aba2.5. (A) Lignin peroxidase, (B) Mn-peroxidase and (C) Laccase.

- The threshold appearance of oxidase stimulation is lowered in the media Aba5 and Aba2.5 (in Lesa, Fig. 3) to 1 mM (Fig. 4)
- Lignin peroxidase is specifically expressed in the presence of Cu only in these low complexing media

The sensitivity of enzymatic responses to Cu is increased when the metal is more bioavailable

5. CONCLUSION

The response of Trametes versicolor is specific to one essential metal and depends on metal speciation. We found that Zn leads to some morphological alterations at high concentration levels while Cu highly stimulates extracellular oxidase activities at environmental levels of metal contamination.

These enzymatic actors of soil functioning can be biomarkers of fungal exposure to Cu in soils. Furthermore, the specificity and sensitivity of fungal responses to metals confirm that fungal traits can be used as tools for metal ecotoxicity assessment.

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