

SLOVAK ENVIRONMENT AGENCY

is implementing an activity



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CONTAMINATED SITES
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INTERNATIONAL CONFERENCE

CONTAMINATED SITES 2018

BANSKÁ BYSTRICA, SLOVAK REPUBLIC, 8 – 10 OCTOBER 2018

*The activity has been implemented within the framework of national project
Information and providing advice on improving the quality of environment in Slovakia.
The project is cofinanced by Cohesion Fund of the EU under Operational programme Quality of Environment.*

An original approach in green chemistry : from assisted-phytoremediation of contaminated soil to upcycling of plant biomass for biosourced catalyst production

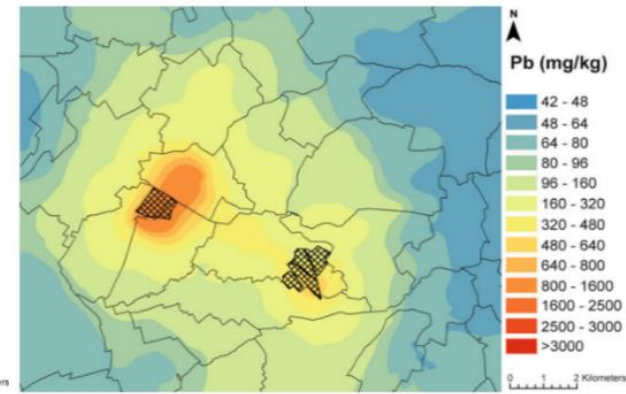
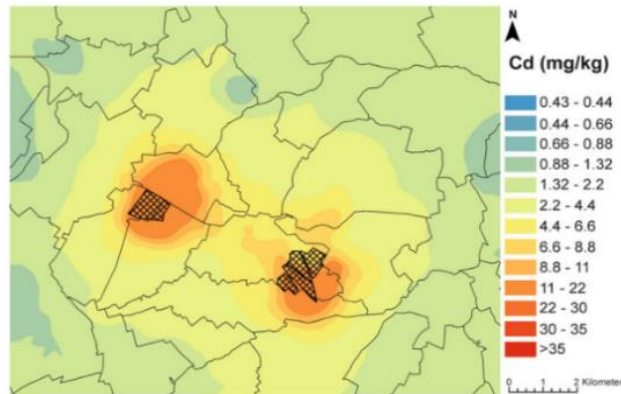
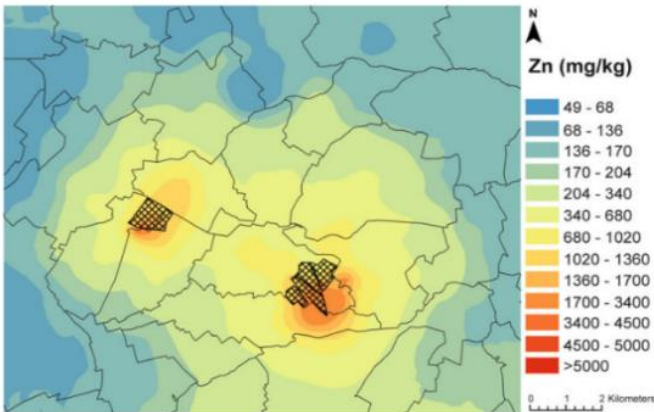
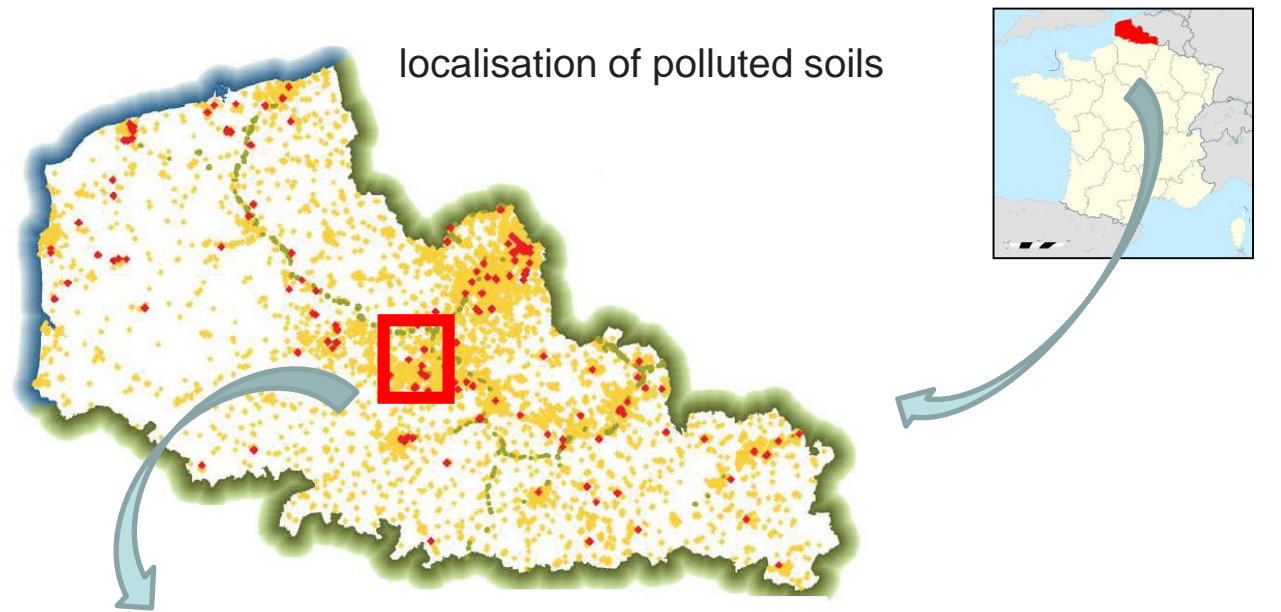
HECHELSKI Marie, LOUVEL Brice, DUFRENOY
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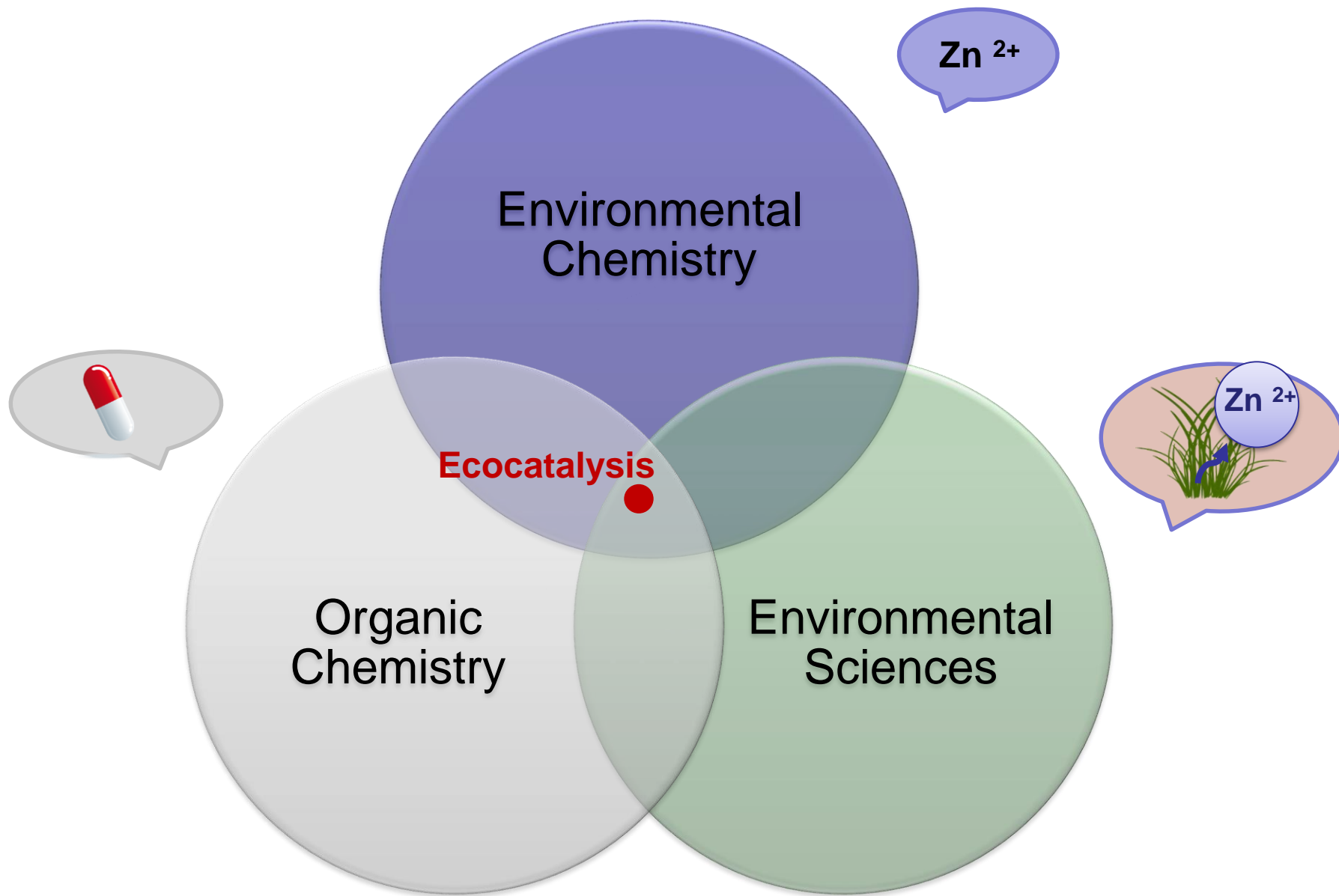
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CONTEXT



Adapted from Pelfrène *et al.*, 2015

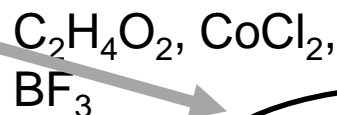
AN INTERDISCIPLINARY APPROACH...



...TOWARD THE SYNTHESIS OF AN ANTI-INFLAMMATORY AGENT

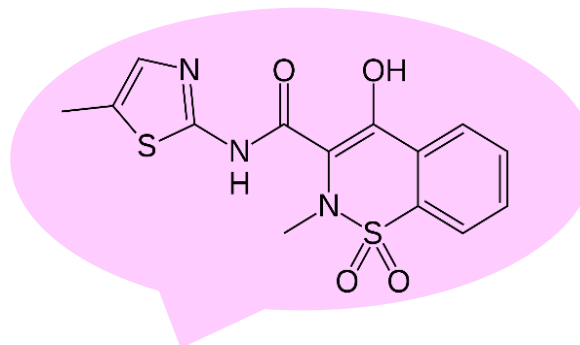
Classical synthesis

(Zia-ur-rheman *et al.*, 2005
Cunling *et al.*, 2010
Sultana *et al.*, 2011)

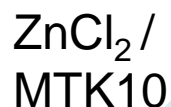


Meloxicam

Anti-inflammatory drug



Amynolysis reactions



Original environmental friendly synthesis

(Dufrenoy *et al.*, 2017)

Ecocatalyst
(EcoZn)



Manufacturing of
ecocatalyst

Green Chemistry



Aided phytostabilisation

OBJECTIVES

To elaborate a new recovery method of contaminated plant biomass using non-hyperaccumulating plants



1

Transfert of Zn and immobilisation of carcinogenic metal with inorganic amendments



Plant biomass

2

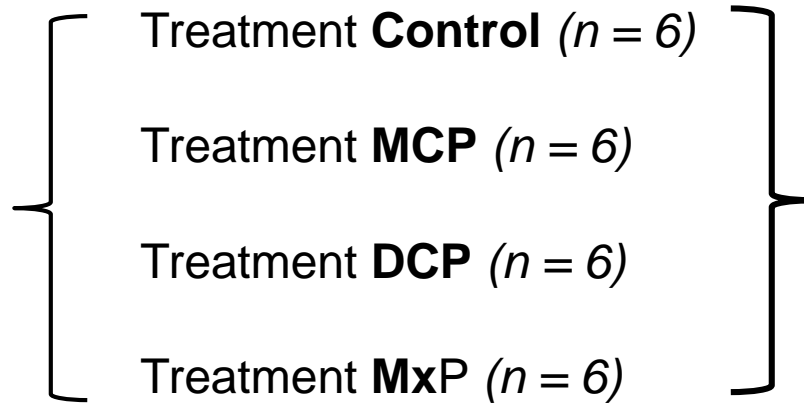
Ecocatalysts

MATERIAL AND METHODS

Ryegrass: growth period $t = 8$ weeks



Contaminated
kitchen garden
soil
(2 kg/pot)



Heavy metal
concentrations



① ➤ Soils + plants

② ➤ Plant ashes



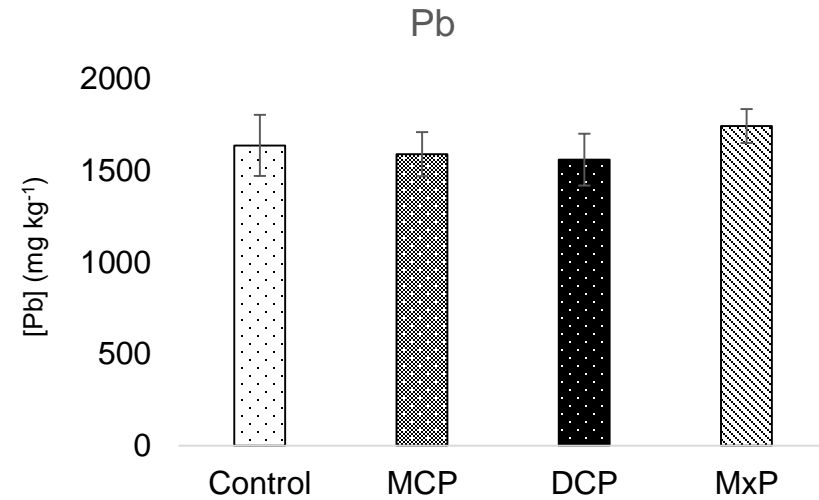
Ecocatalyst

Without amendment (**Control**)
Calcium monophosphate (**MCP**)
Calcium biphosphate (**DCP**)
Mixture of phosphates (**MxP**)

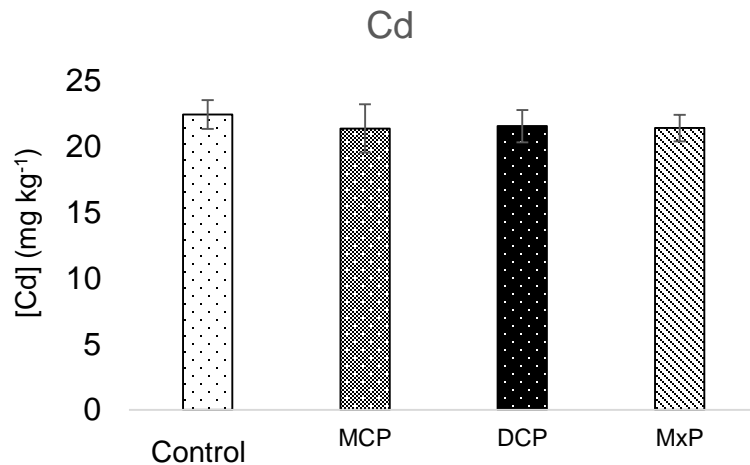
RESULTS

Heavy metal concentrations in soil at t = 0

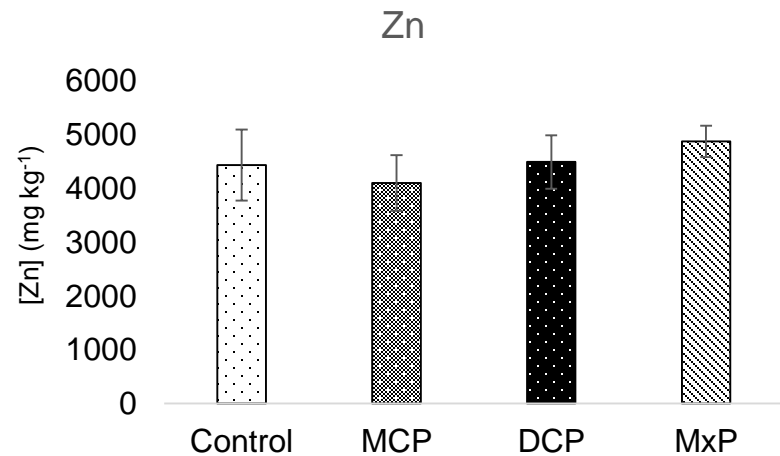
- Without amendment (**Control**)
- Calcium monophosphate (**MCP**)
- Calcium biphosphate (**DCP**)
- Mixture of phosphates (**MxP**)



[Pb]: 1 625 mg kg⁻¹



[Cd]: 21 mg kg⁻¹

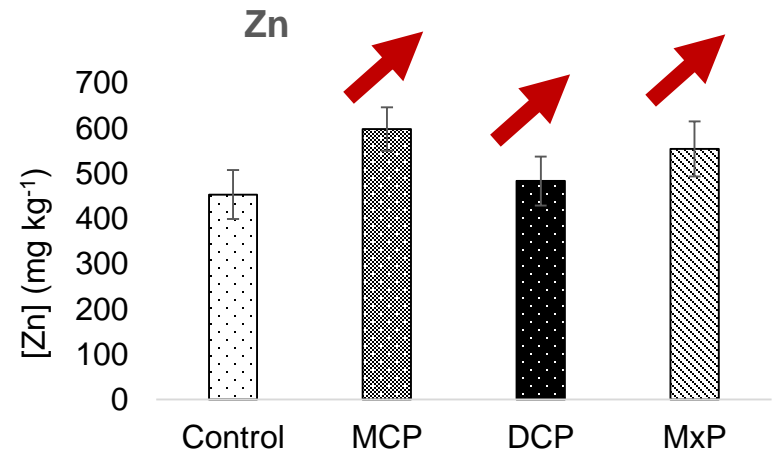
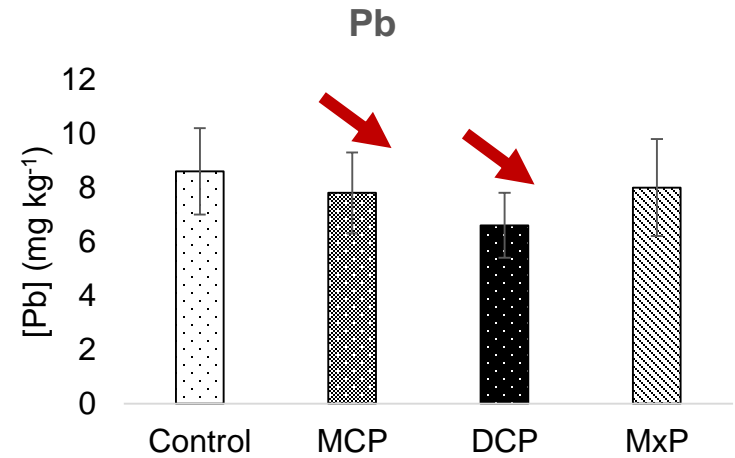
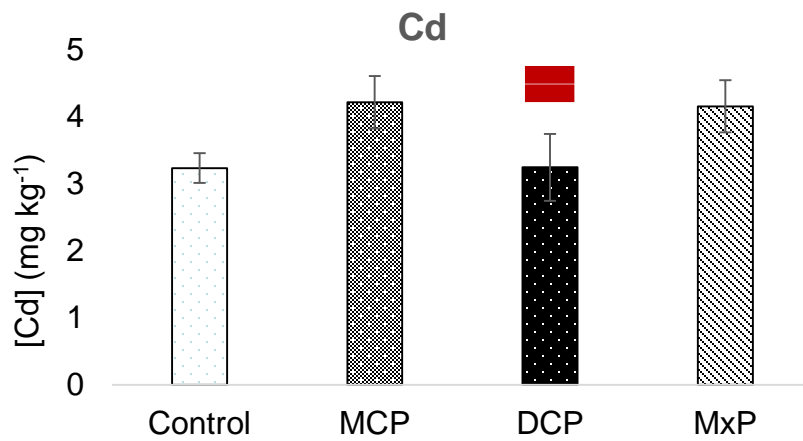


[Zn]: 4 477 mg kg⁻¹

RESULTS

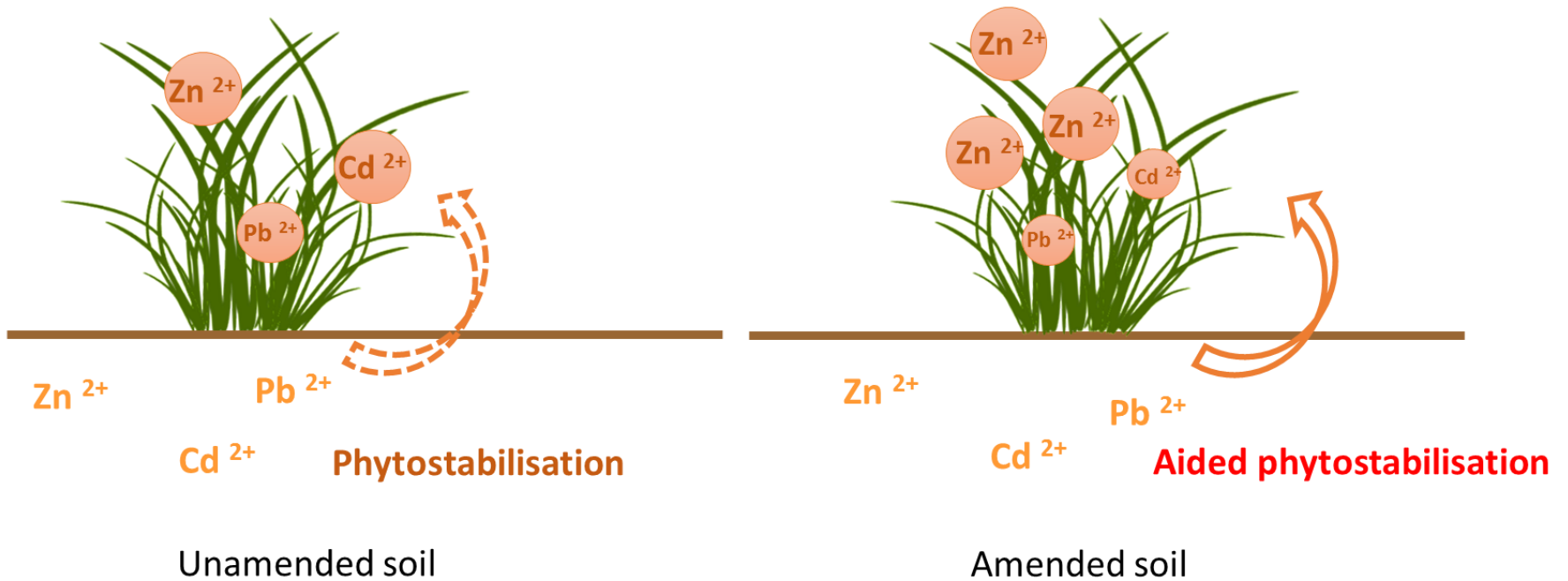
Heavy metal concentrations in plants at t = 8 weeks

Without amendment (**Control**)
Calcium monophosphate (**MCP**)
Calcium biphosphate (**DCP**)
Mixture of phosphates (**MxP**)



RESULTS

1 First conclusion



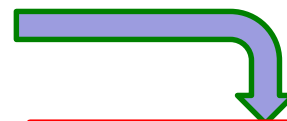
RESULTS

From ryegrass to ecocatalyst



Non-hyper accumulating plants

Thermal treatment

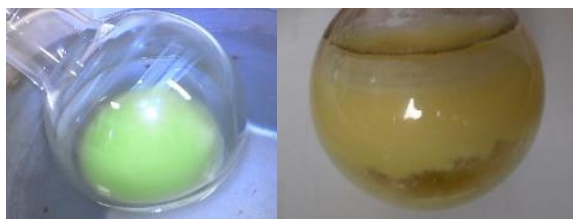


Ashes



Ecocatalyst

Acid treatment
+ purification



Purified Lewis acids solution

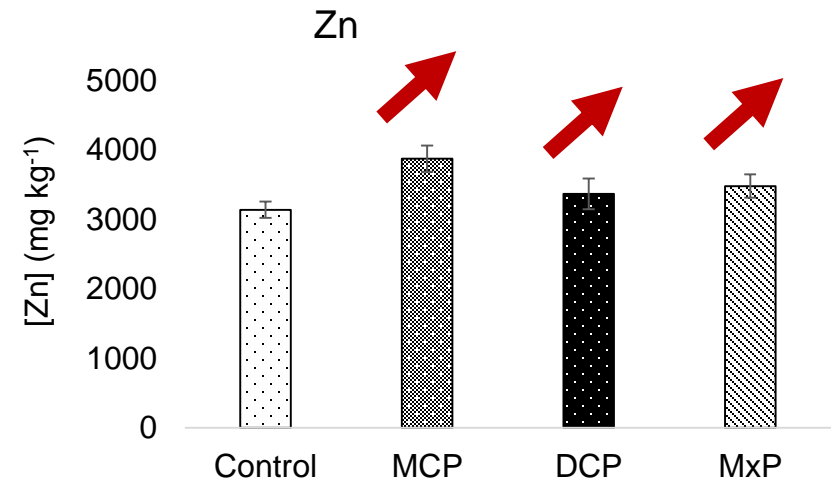
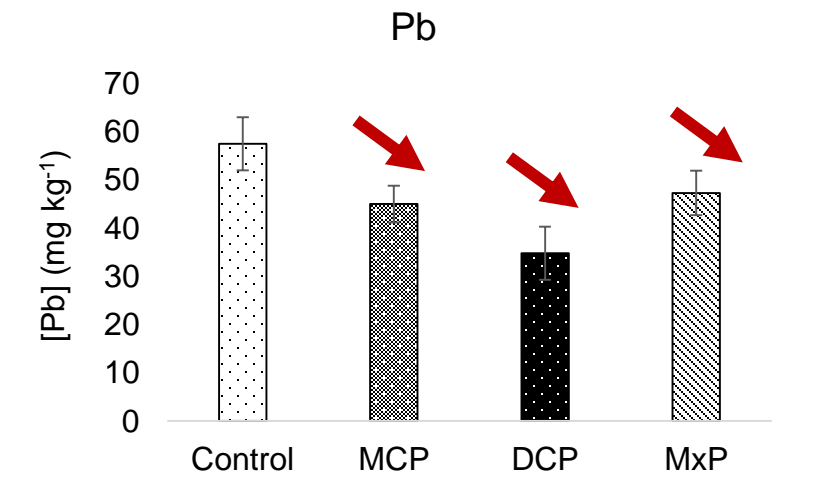
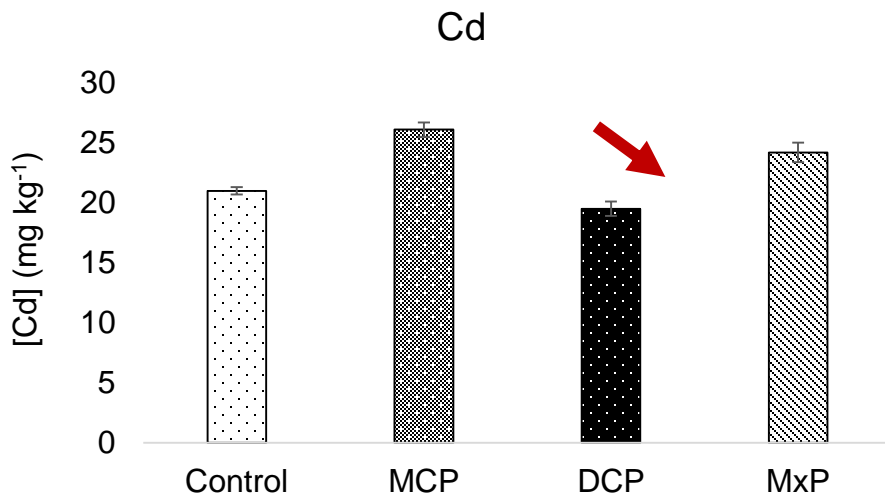
Evaporation and
heating



RESULTS

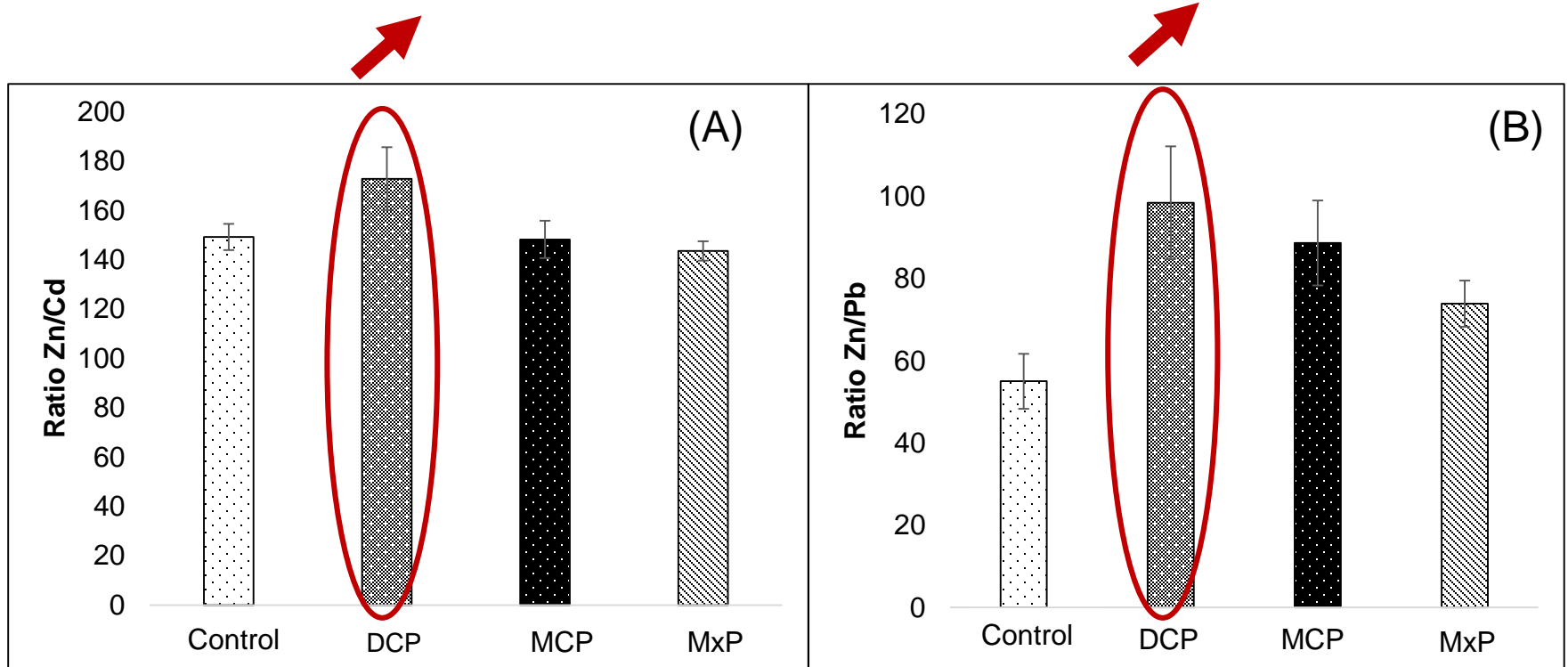
Heavy metal concentrations in calcined shoots of ryegrass

- Without amendment (**Control**)
- Calcium monophosphate (**MCP**)
- Calcium biphosphate (**DCP**)
- Mixture of phosphates (**MxP**)



RESULTS

Zn/Cd (A) and Zn/Pb (B) ratios in ashes



- A significant increase of the ratio Zn/metal for the **DCP** treatment

↪ Obtention of zinc rich-ashes

Without amendment (**Control**)
Calcium monophosphate (**MCP**)
Calcium biphosphate (**DCP**)
Mixture of phosphates (**MxP**)

RESULTS

From ryegrass to ecocatalyst



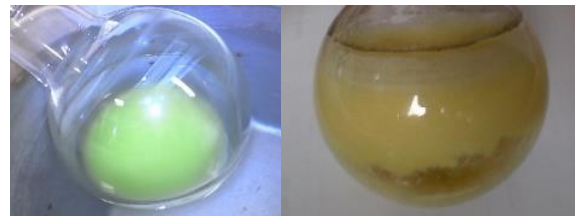
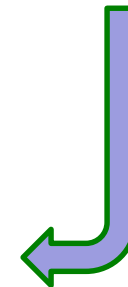
Hyper accumulating plants

Thermal treatment



Ashes

Acid treatment
+ purification



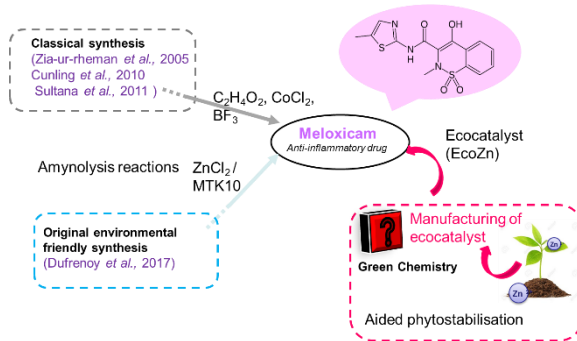
Purified Lewis acids solution

Evaporation and
heating



Ecocatalyst

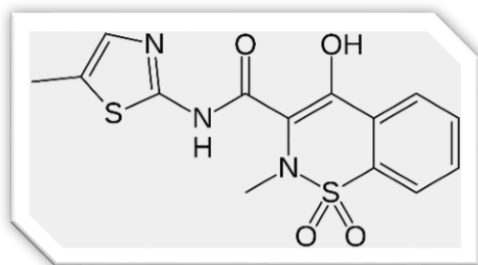
RESULTS



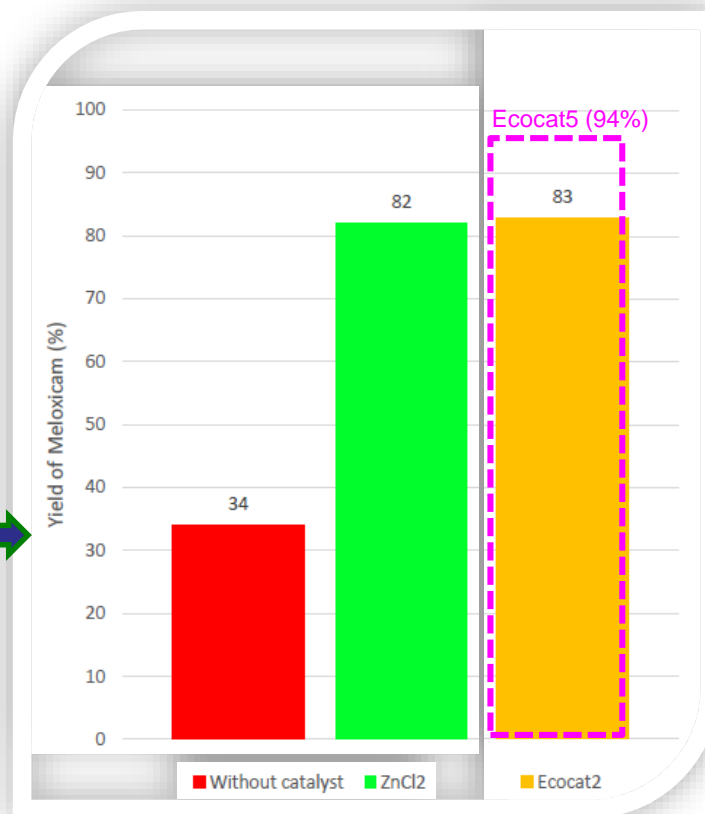
Ecocatalyst



Amynolysis reaction



Meloxicam

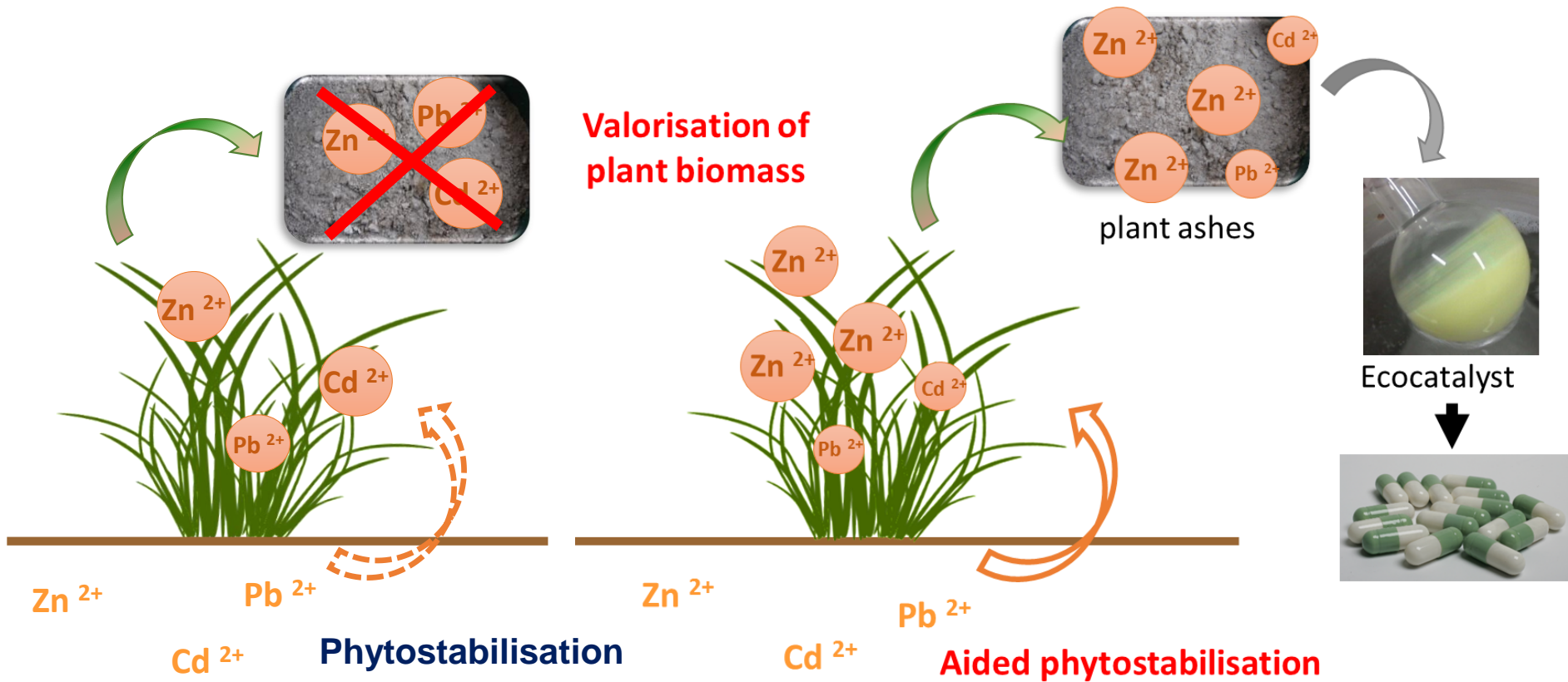


Adapted from Dufrenoy *et al.*, 2017

- **Best yields with ecocatalysts**
- **Post-reaction treatment is easier with Zn-ecocatalyst than ZnCl₂**
- **Note the recyclability of the Zn-ecocatalyst**

CONCLUSION

② Second conclusion



Thank you for your attention !

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HAUTS-DE-FRANCE



Fondation
de la Catho de Lille

Reconnue d'utilité publique



yncrea