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Enhancing metal uptake and nanoparticle deposition in plants to recover platinum group metals and gold

"The Network was instrumental in helping us communicate with new industrial companies, with nascent collaborations underway," University of York

PROJECT AIMS: The collaborators previously showed that the expression of synthetic peptides in Arabidopsis enhances the uptake of palladium and gold, and alters the deposition, size and catalytic properties of the resulting metal nanoparticles. Their current studies aim to increase the uptake of metal into plant tissues by modulating the expression of a plant transporter for palladium and gold, COPT2. In this project, they combined expression of synthetic peptides and the COPT2 transporter in Arabidopsis. The specific aims were to:

1. Establish whether plants expressing both peptide and COPT2 are more resistant to the effects of gold and palladium than plants expressing peptides or COPT2 alone.
2. Determine if gold uptake in plants expressing both peptide and COPT2 is increased.
3. Measure the size of gold nanoparticle profiles in tissue from plants expressing both peptide and COPT2.
4. Test plant biomass for catalytic activity.

OUTCOMES & NEXT STEPS:

- A PhD student is investigating *COPT2* expression levels in transgenic Arabidopsis; an undergraduate student is quantifying gold stress-induced ROS.
- Further funding from the E3B Network has been secured with the aim of translating the technology into a robust plant species suitable for use with mining waste.
- Funding applications have been submitted to the UKRI Developing Engineering Biology Breakthrough Ideas call and Horizon Europe.
- Two manuscripts are in preparation; '*Controlling* in planta *gold nanoparticle synthesis and size for catalysis*' and '*The plasma membrane located copper transporter, COPT2, is involved in Pd uptake in Arabidopsis*'.
- A recent outreach presentation was delivered to year 10 and 12 students at All Saints School, York.

RESULTS: Aim 1. There were no phenotypic differences in seedling weight or root length between plants expressing both peptide and COPT2 and plants expressing either protein alone. This result indicates that combined expression of peptides and COPT2 does not make seedlings more resistant to the effects of gold and palladium.

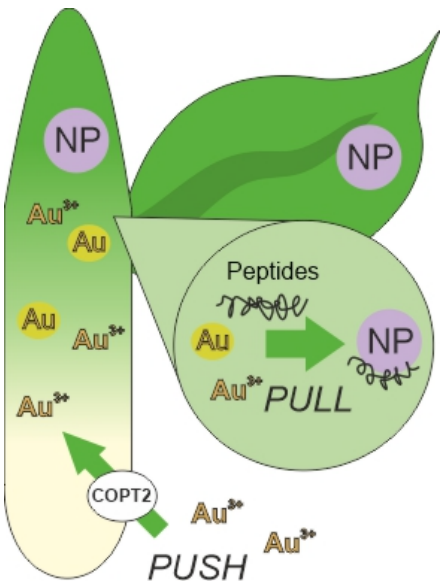
Aim 2. Gold uptake was not enhanced in plants expressing COPT2 or peptide and COPT2; however, expression of both *COPT2* and peptide-encoding genes needs to be confirmed.

Aim 3. The expression of four peptides (SEKLGASL, SEKLFFGASL, SEKLWWGASL and GASLWWSEKL) resulted in the accumulation of gold nanoparticles with mean diameters of 180nm, 80nm, 40nm and samples without visible particles, respectively.

Aim 4. Reducing nanoparticle diameter increased the catalytic activity of the subsequently pyrolysed plant biomass.

An additional experiment showed that palladium stress-induced expression of reactive oxygen species (ROS) was lower in the roots of COPT2-expressing plants than in wild-type plants; this result will be investigated further.

Change in technology readiness level: 2 to 3



A schematic of the overall idea of the project, which is based on manipulating expression of metal uptake transporters and peptides to promote metal uptake and nanoparticle (NP) formation.