Rhizobacterial isolates from the metal hyperaccumulator *Noccaea caerulescens* growing in a Ni enriched soil

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Introduction

Ultramafic (serpentine) outcrops occupy about 1% of the planet and are constituted by igneous or metamorphic rocks with low content in silicon (< 45 % SiO2) more than 70 % of ferromagnesium minerals and usually with high contents of several toxic trace elements (TEs) (Brooks, 1987). The soils developed over these rocks are characterized by deficiency in organic matter and essential nutrients, unfavourable Ca/Mg ratio, high concentrations of potentially phytotoxic trace metals such as Ni, Co and Cr, etc. which make them a harsh environment for the plant growth (serpentine syndrome). The organisms inhabiting these environments developed numerous adaptation mechanisms, as a result, they host a highly valuable biodiversity. The ultramafic flora includes a particular group of plants called hyperaccumulators, which are able to accumulate in their aboveground tissues extremely high concentrations of Ni. The ultramafic outcrops in the NW of Spain host two endemic TE hyperaccumulators: *Noccaea caerulescens* (J.Presl & C.Presl) and *Odontarrhena serpyllifolia* (Desf.) Jord. & Fourr.

The project Phy2SUDOE (SOE4/P5/E1021), funded by Interreg SUDOE, works on the establishment and maintenance of phytomanagement options, as well as, on the conservation and valorisation of endemic plant and microbial biodiversity in several degraded areas, among them a serpentine quarry in Bandeira (NW Spain). In the frame of this project, this study presents data relative to the hyperaccumulating characteristics of the population of *N. caerulescens* growing in the Bandeira quarry, as well as, the first results on the diversity of isolates cultivated from the rhizosphere of individuals of this species.

Material and Methods

- ✓ An ultramafic area in Bandeira (42º 45´N; 8º 17´W, NW of Spain) was selected for the study (Fig.1).
- ✓ Several individuals of *Noccaea caerulescens* were collected in the surroundings of a serpentine quarry (Fig. 2).
- ✓ The rhizosphere soil tightly attached to the roots was carefully separated and extracted with 1% sodium hexametaphosphate solution.
- ✓ Dilutions of the soil extract were cultivated in mineral medium amended with 3 mM Ni and with glucose fructose, gluconate, lactate and pyruvate as C sources.
- ✓ 48 bacterial strains were isolated after repeated subculturing.
- ✓ Partial sequencing of the gene 16S rRNA was used for the identification of isolates.
- ✓ Properties related to plant growth promotion (PGP) and mobilization of TE of the rhizobacterial isolates are being studied (e.g. P solubilization, production of organic acids, siderophores and indoleacetic acid (IAA))

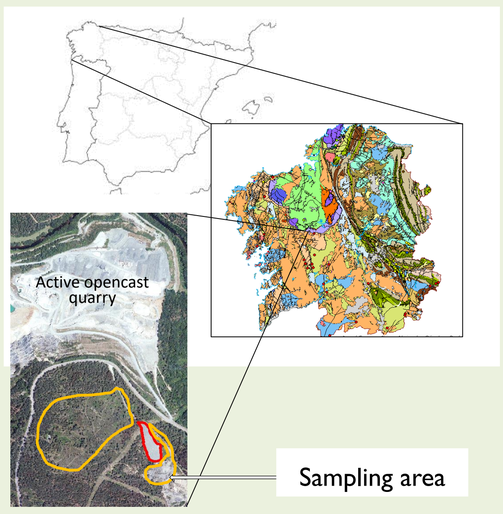


Fig.1 Localisation of the sampling area

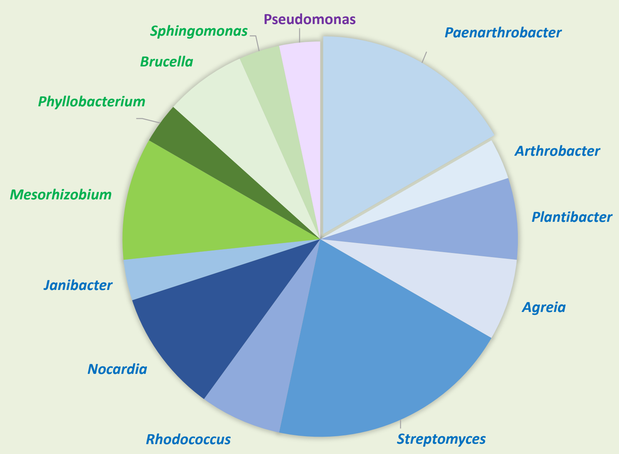
Results and discussion

Table 1. Ni content in the biomass of *N. caerulescens* individuals and in the soil of the root ball of collected plants.

	Ni in plant biomass (mg kg^{-1}DW)		Pseudototal Ni in soil	Available Ni in soil
	leaves	roots	mg Ni Kg^{-1}soil	mg DTPA Ni Kg^{-1}soil
Noccaea Indiv 1	6633	964	505	23.4
Noccaea Indiv 2	5871	1962	812	60.1
Noccaea Indiv 3	5620	1514	1721	
Noccaea Indiv 4	5786	1499	2560	122.6
Average	**5977±450**	**1485±408**	**1400±930**	**69±5**

The population of Noccaea caerulescens studied absorbed, translocated and hyperaccumulated Ni in the shoots. The average Ni content in leaves reached 0.6% (w/w) despite the low Ni availability in the substrate.

N. caerulescens in the quarry also showed capacity for absorption and translocation of Co and Zn.
The concentration of Co in leaves was on average 2.6 fold higher than in roots. The average ratio in the case of Zn was 1.7.
The hyperaccumulation capacity of these TEs has to be evaluated in substrates enriched in these elements.



About 25% of the isolates were classified as *Pseudomonadota*. The most represented family of this phylum was *Phyllobacteriaceae* of the *Alphaproteobacteria* class.

Fig. 2. Individuals of *Noccaea caerulescens* growing in the surroundings of the Bandeira quarry

The collection of bacterial isolates obtained from the rhizosphere of *N. caerulescens* was dominated by *Actinomycetota* (more than 70 % of the strains), mainly of the families *Micrococcaceae, Microbacteriaceae, Streptomycetaceae* and *Nocardiaceae*.

10% of the rhizobacterial isolates are able to solubilise inorganic P and 13% produce organic acids. The analysis of these and other PGP properties in the collection of strains continues, to identify candidates with potential use for improving phytotechnologies such as phytomining.

Conclusions

- ✓ The *N. caerulescens* growing in the serpentine quarry hyperaccumulates Ni and shows capacity of uptake and translocation of Co and Zn.
- ✓ The *N. caerulescens* studied seems unsuitable as monocrop in phytomining because of its reduced biomass; however, it is interesting to explore its usefulness in intercropping with other hyperaccumulators.
- ✓ Most of the rhizobacterial isolated obtained from *N. caerulescens* where classified as *Pseudarthrobacter, Streptomyces* or *Mesorhizobium,* genera which include known PGP strains.
- ✓ The identified isolates with PGP and TE mobilization capacities may have potential application in phytomining or in other biotechnologies aiming at the mobilization of valuables elements from soils and other TE enriched substrates.

References: Brooks RR (1987) Serpentine and its vegetation: a multidisciplinary approach. Croom Helm, Dioscorides Press

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