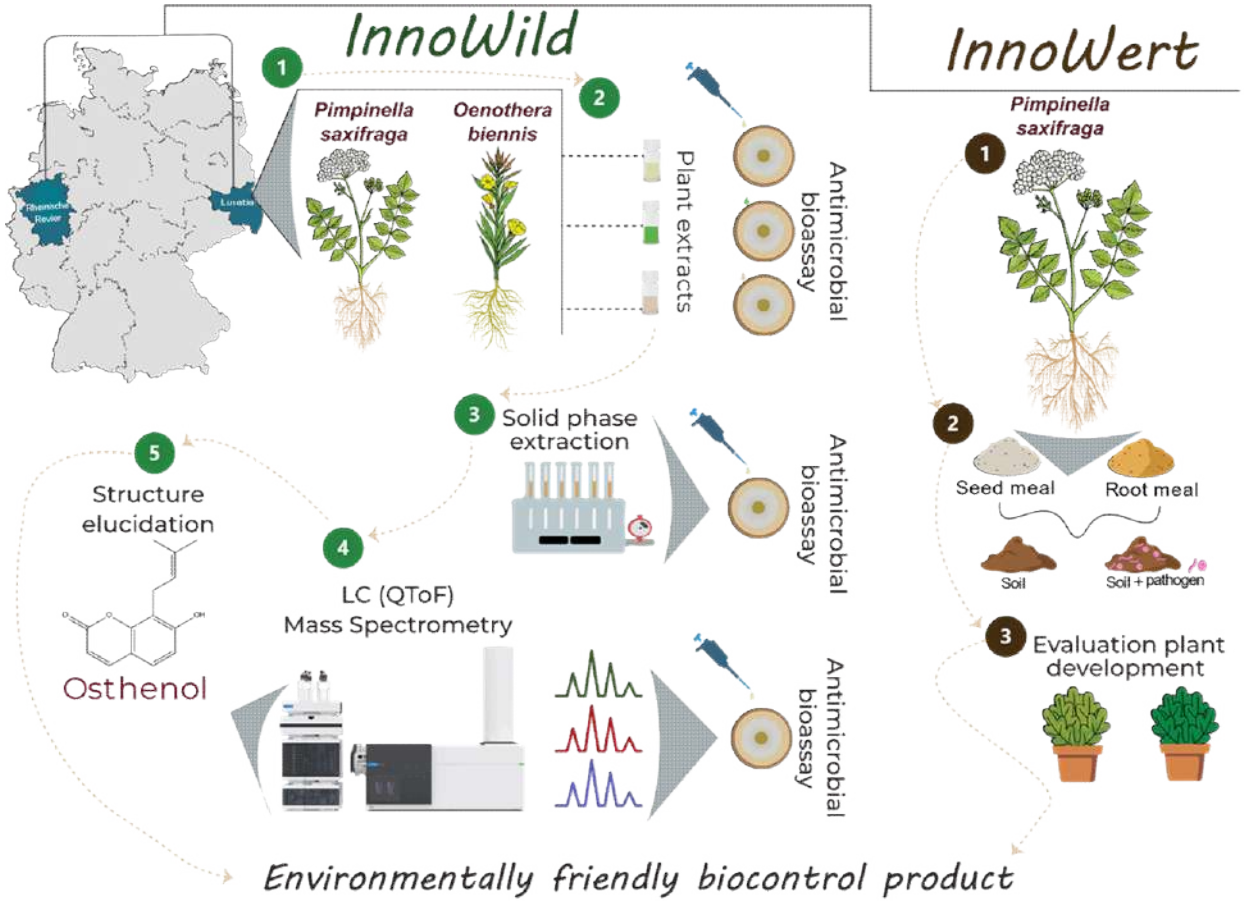
Utilization of plant-microbial interactions as contribution to sustainable cropping systems.

Silke Ruppel, Katja Witzel

UnderPlaNet Workshop Ecuador 18.-22.11.2024

Novel antimicrobial compounds from endogenous wild plant secies

Activity-driven identification of novel compounds:



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Tested plant species

Meadow clary (*Salvia pratensis*)

Burnet-saxifrage (*Pimpinella saxifraga*)

Breckland thyme (*Thymus serpyllum*)

Hare's-foot clover (*Trifolium arvense*)

Evening primrose (*Oenothera biennis*)

Wild carrot (*Daucus carota*)

Tested plant species: most promising results

Meadow clary
(*Salvia pratensis*)

Burnet-saxifrage (*Pimpinella saxifraga*)

Breckland thyme (*Thymus serpyllum*)

Hare's-foot clover
(*Trifolium arvense*)

Evening primrose
(*Oenothera biennis*)

Wild carrot
(*Daucus carota*)

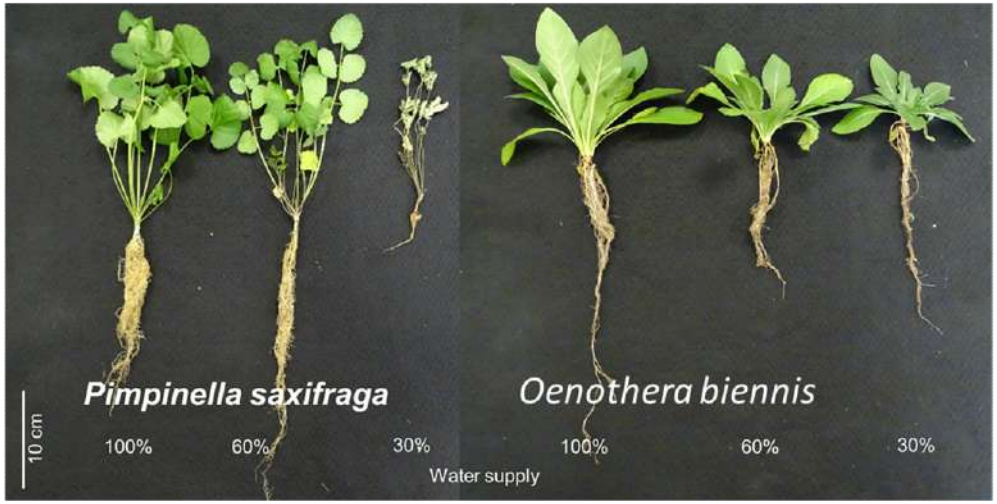
Our favourites:

- High antimicrobial activity in seeds and roots
- Culinary herb
- Fleshy root formation to loosen compact soils

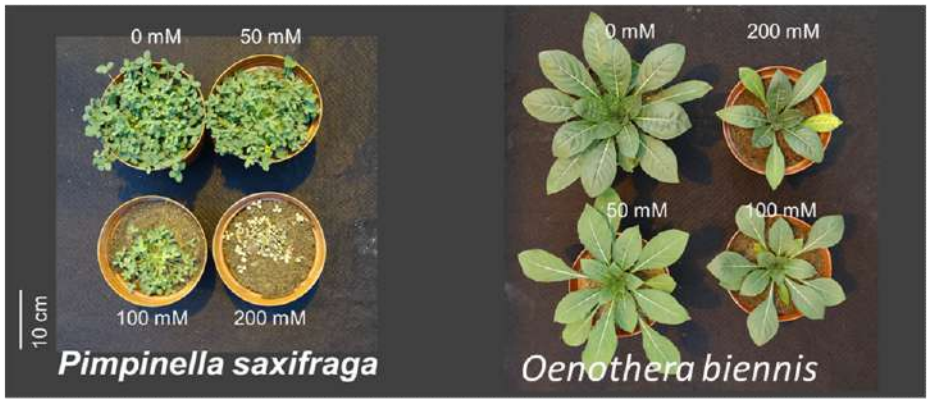
- high content of polyunsaturated omega-6 fatty acids: production of cosmetics, treatment of skin diseases
- Fleshy root formation to loosen compact soils

How resilient are wild plant species towards abiotic stress?

Drought tolerance



Salt stress tolerance



Soil compactness tolerance

The selected wild plant species are suitable to replace glycophytic crops to some extent.
Because they require considerably less fertilizer than conventional crops and are resilient to salt, drought and soil compactness, those plant species could be an alternative to cultivated crops on poor or salinized soils.

How resilient are wild plant species towards biotic stress?

Application of a consortium of phytopathogenic fungi:

- *Fusarium subglutinans*
- *F. culmorum*
- *F. equiseti*
- *F. verticillioides*
- *F. proliferatum*
- *F. graminearum*
- *Rhizocotonia solani*

Plant dry matter data show drought stress decreases the pathogenic pressure, probably due to suboptimal microbial conditions. Plant species show high resistance towards the applied consortium.

+ Pathogen

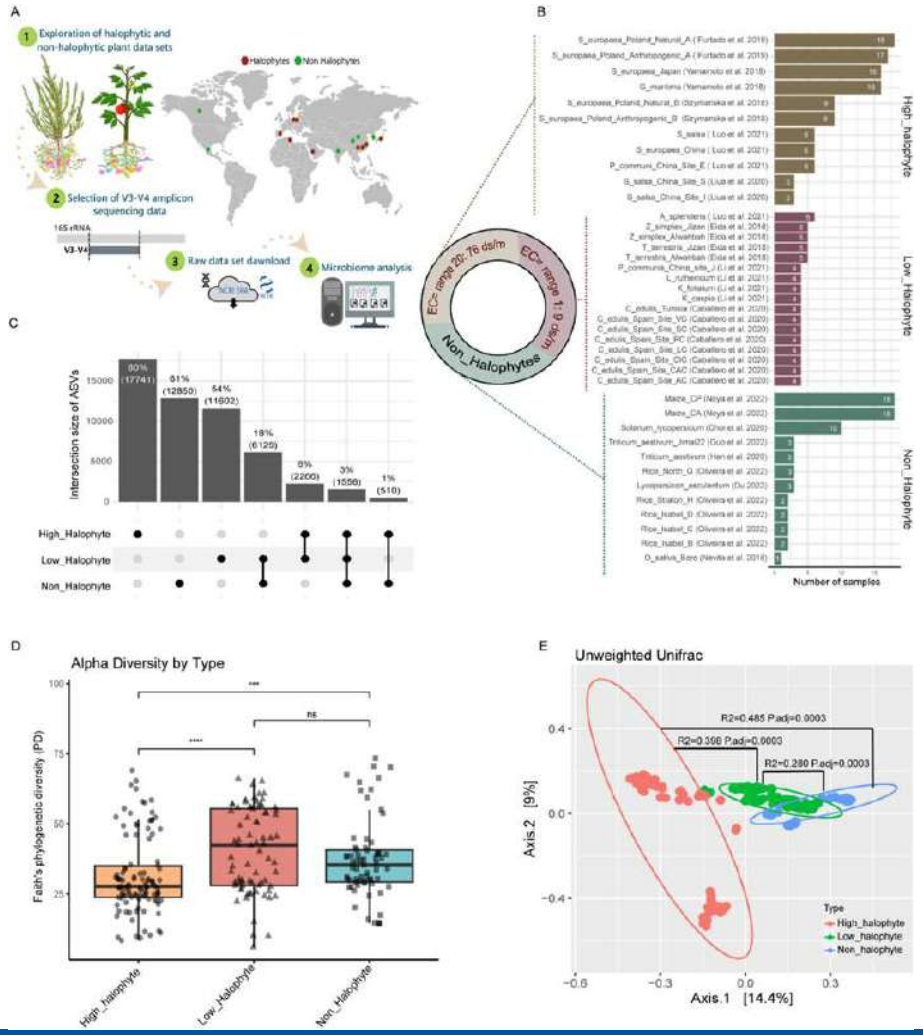
- Pathogen

Water supply 30% 60% 100%

+ Pathogen

- Pathogen

Plant microbiome specification of halophytes compared to crop plants



(A) Schematic overview of an experimental analysis workflow.

(B) The distribution number of sample sizes included in the meta-analysis grouped by plant species and salt concentrations in the rhizosphere from 15 diverse studies, encompassing High-halophyte, Low-halophyte, and Non-halophyte plants.

(C) UpSet plot showing the number of ASVs that are unique and shared between the High_halophyte, Low-halophyte, and Non-halophyte plants

(D) Alpha diversity using the Faith's PD index between High_halophyte, Low-halophyte, and Non-halophyte plants

(E) Principal coordinate analysis (PCoA) based on unweighted UniFrac revealed clustering between High_halophyte, Low-halophyte, and Non-halophyte plants.

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https://doi.org/10.1186/s40793-024-00592-3

Identification of marker taxa within the group of halophytic plants

Core taxa	Key Hub taxa	Most important taxa
Thalassospira	***Thalassospira***	***Thalassospira***
Erythrobacter	***Erythrobacter***	***Erythrobacter***
Marinobacter	***Marinobacter***	***Marinobacter***
Marivirga	*Gracilimonas*	*Marivirga*
Devosia	*Planomicrobium*	*Devosia*
Lewinella	*Psychroflexus*	*Lewinella*
Marinoscillum	*Martelella*	*Marinoscillum*
Fulvivirga	*Fulvivirga*	*Hoeflea*
Ilumatobacter	*Tangfeifania*	*Marinomonas*
Maritalea		
Muricauda		
Roseovarius		
Altererythrobacter		
Pelagibius		
Halomonas		
Loktanella		
Roseivivax		

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Are wild plant species compatible with growth-promoting bacteria?

Application of the growth-promoting *Kosakonia radicincitans* confers growth in some of the selected wild plant species

+ *Kosakonia* - *Kosakonia*

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+ *Kosakonia* - *Kosakonia*

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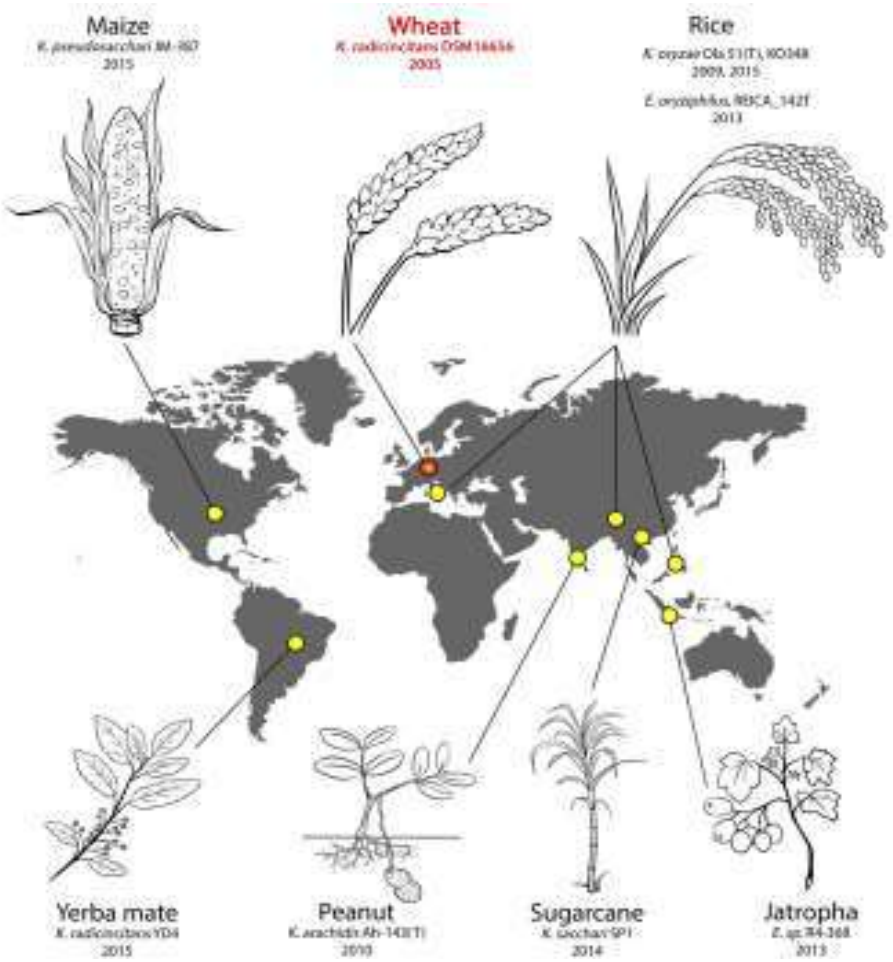
Kosakonia radicincitans isolated and yield improvement worldwide



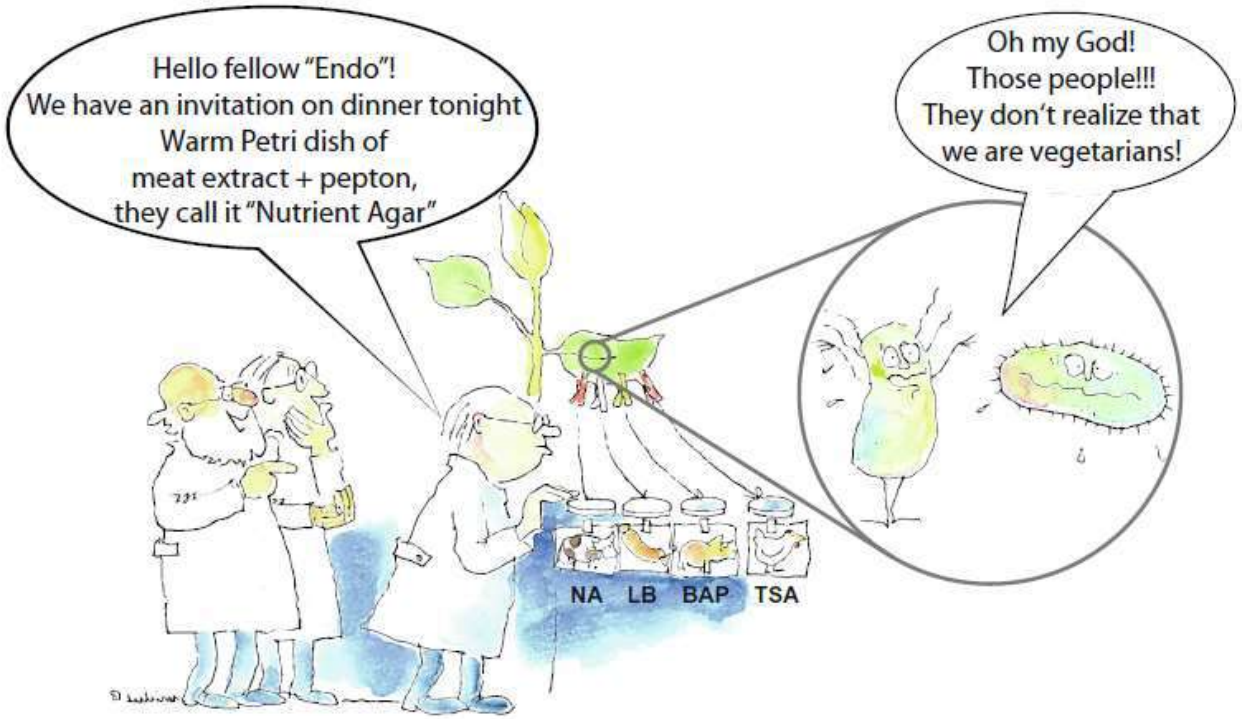
Becker et al. Frontiers in Microbiology 2018 | Volume 9 | Article 1997

Kosakonia radicincitans properties

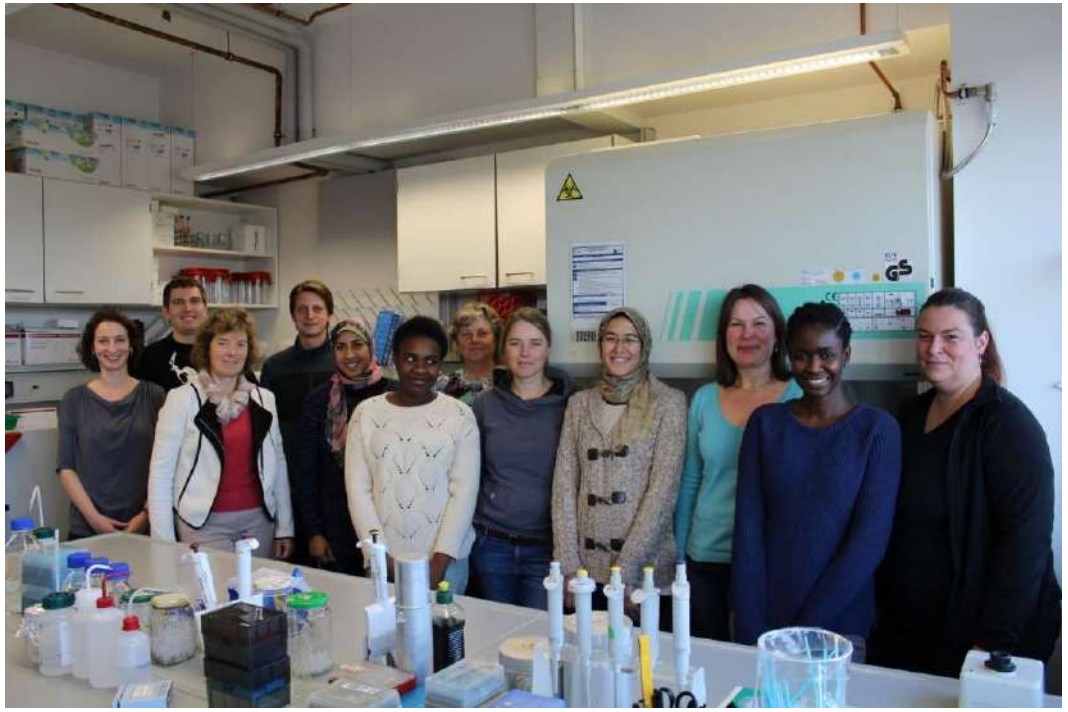
We know, that this colonization and competition behaviour of the plant growth-promoting bacterial strain
Kosakonia radicincitans DSM16656^{T} results in:

- Significant yield increases of several plant species (wheat, maize, rye, barley, tomato, pepper brassica rapa…and even wild plants)
- Improving plant health (Maize, Banana)
- Improving plant nutrition (N, P)
- Shaping glucosinolate profile (*Arabidopsis, Brassica oleracea*)
- Boosting plant immune responses
- Shaping native bacterial community

- Discovering which genetic profile contributes to these supportive properties is under progress in the ongoing work of Sascha Patz (*in silico* analysis plattform PLaBAse: A comprehensive web resource for analyzing the plant growth-promoting potential of plant-associated bacteria, https://doi.org/10.1101/2021.12.13.472471)



Sarhan et al Microbes Environ. Vol. 33, No. 3, 317-325, 2018



Herzlichen Dank

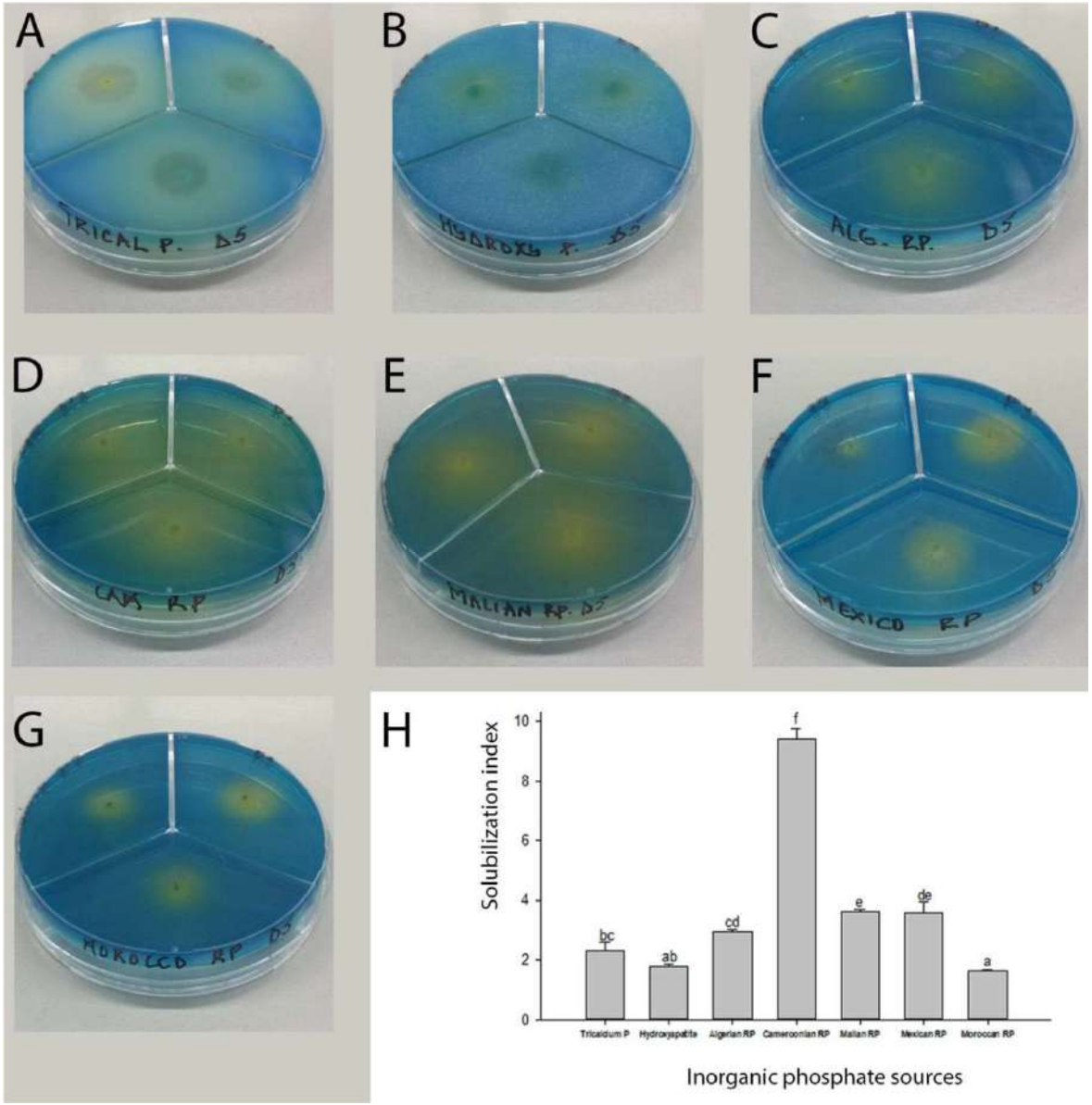


Fig. S9: Ability of *K. radicincitans* DSM 16656$_T$ to solubilize inorganic phosphate sources: **(A)** Tricalcium phosphate, **(B)** Hydroxyapatite, and **(C)-(G)** Rock phosphate (RP) from different origins: **(C)** Algerian RP, **(D)** Cameroonian RP, **(E)** Malian RP, **(F)** Mexican RP and **(G)** Moroccan RP on NBRIP agar plates. **(H)** Solubilizing index; order of phosphate sources corresponds to order of petri dishes shown in **(A)-(G)**; lower case letters above bars indicate significant differences in phosphate solubilization activity ($p < 0.05$) using Tukey test.