Waterlogging Tolerant Mechanisms of *Streptomyces thermocarboxydus* S3 for Growth Promotion of Kale (*Brassica oleracea* var. *acephala*)

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Abstract

Kale is a highly nutritious leafy vegetable that thrives in cold climate, making it well-suited for cultivation in Northern Thailand. However, the Northern currently faces rainstorms and flash floods, which cause significant damage to kale production. Actinobacteria are Gram-positive bacteria capable of surviving under stress and promote plant growth under inappropriate conditions. This research investigated waterlogging tolerance mechanisms of *Streptomyces thermocarboxydus* S3 and its potential to enhance kale growth under waterlogging conditions. Experimental data showed the reduction of H_2O_2 accumulation through the production of catalase (CAT), and the accumulation of total soluble sugars and proline. Antioxidant activity was also detected using DPPH and ABTS assays. Whole genome analysis using the RAST server of this actinobacteria revealed genes related to osmotic and oxidative stress. *In planta* experiment, the study was divided into 4 treatments: (1) kale grown in normal soil, (2) kale grown in waterlogging soil, (3) kale inoculated with *S. thermocarboxydus* S3 spore suspension ($1x10^9$ spores/mL) in normal soil, and (4) kale inoculated with *S. thermocarboxydus* S3 spore suspension ($1x10^9$ spores/mL) in waterlogging soil. Kale was cultivated for 45 days followed by 10 days of waterlogging period. Inoculation with *S. thermocarboxydus* S3 effectively promoted kale growth under both normal and waterlogging conditions, as reflected by increases in biomass, leaf number, and total chlorophyll content, as well as increased accumulation of total soluble sugars and proline.

Objectives

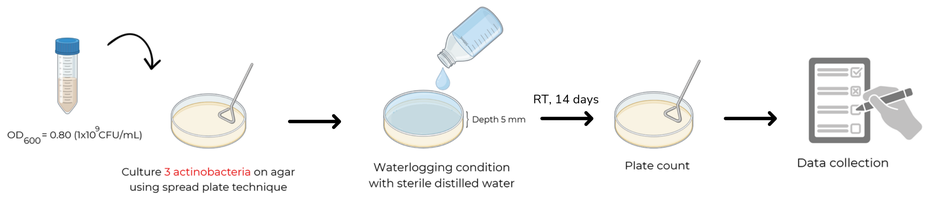
- To investigate mechanisms of waterlogging tolerance in *Streptomyces thermocarboxydus* S3
- To study growth promotion of kale under waterlogging conditions using *Streptomyces thermocarboxydus* S3

Methodology

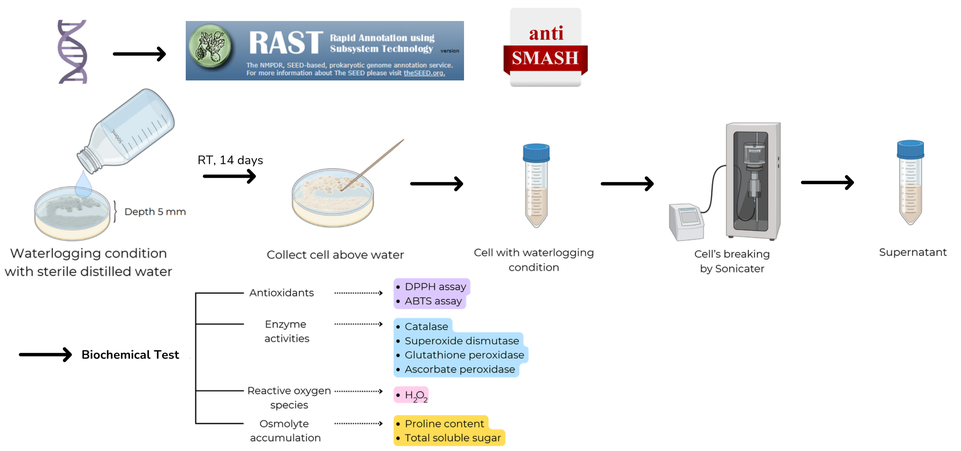
Actinobacteria used in experiment

Streptomyces thermocarboxydus S3
Micromonospora chalcea CMU 66-1
Micrococcus yunnanesis ORF 15-23

1. Screening for waterlogging tolerant in 3 actinobacteria

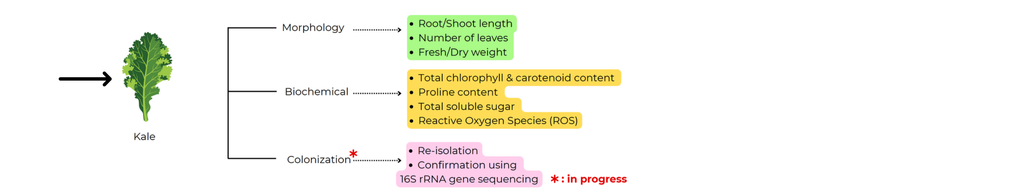


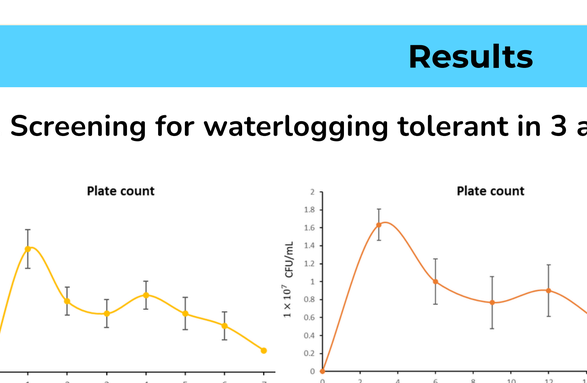
2. Waterlogging tolerance mechanisms in *S. thermocarboxydus* S3



3. Growth promotion of kale using *S. thermocarboxydus* S3 under waterlogging conditions

4 treatments (n=10) : T1: No waterlogging, - *S. thermocarboxydus* S3
T2: No waterlogging, + S. thermocarboxydus S3 ($1x10^9$ spores/mL)
T3: Waterlogging, - S. thermocarboxydus S3
T4: Waterlogging, + *S. thermocarboxydus* S3 ($1x10^9$ spores/mL)





Results

1. Screening for waterlogging tolerant in 3 actinobacteria

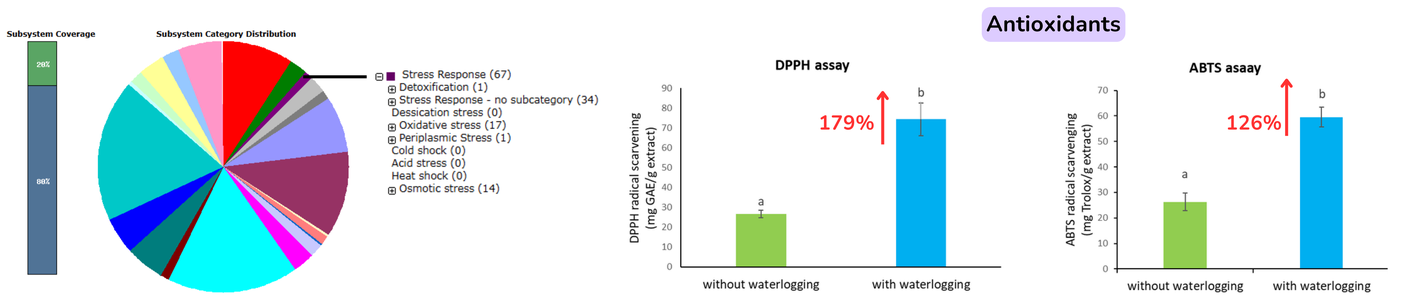
Micrococcus yunnanesis ORF 15-23 *Micromonospora chalcea* CMU 66-1 *Streptomyces thermocarboxydus* S3

Acknowledgements

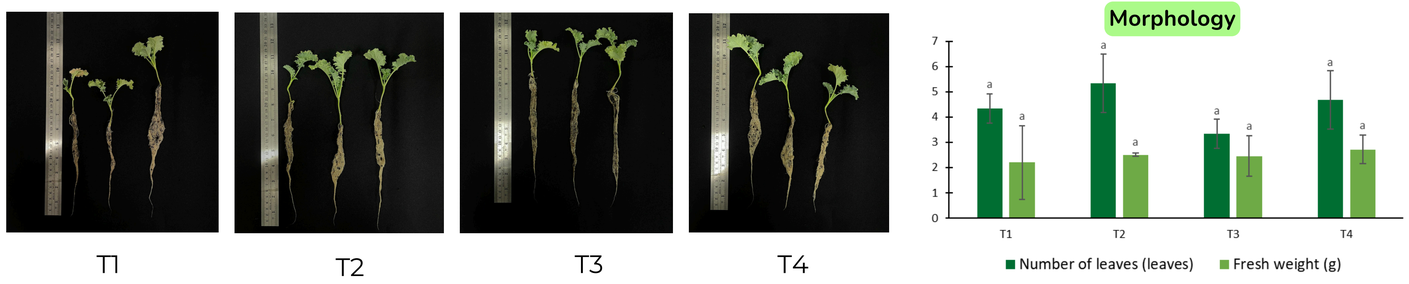
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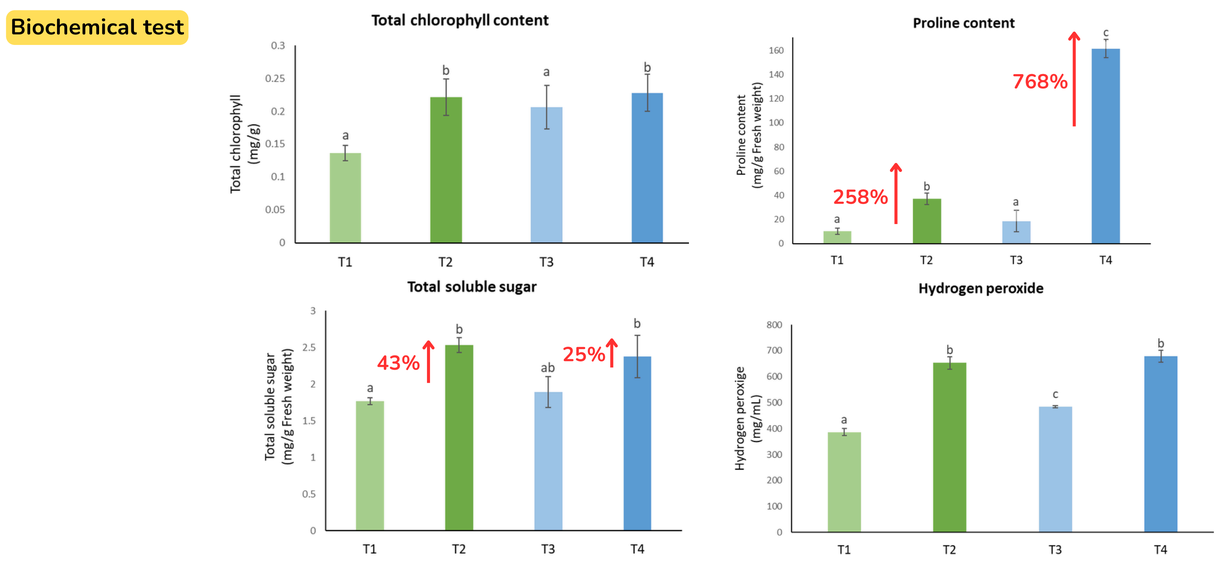
Results

2. Waterlogging tolerance mechanisms in *S. thermocarboxydus* S3



3. Growth promotion of kale using *S. thermocarboxydus* S3 under waterlogging conditions





Conclusions

Streptomyces thermocarboxydus S3 is a waterlogging tolerant strain possibly by the accumulation of compatible solutes (proline and total soluble sugars) and induction of antioxidant defense mechanisms (catalase, ABTS, DPPH). This strain promotes kale growth under waterlogging condition in terms of number of leaves, fresh weight and total chlorophyll content through proline and total soluble sugars accumulation

References

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