



Heat Tolerant Mechanisms and Growth-Promoting Potential of *Streptomyces thermocarboxydus* isolate S3

for Kale (*Brassica oleracea* var. *sabellica*) Cultivation

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Abstract

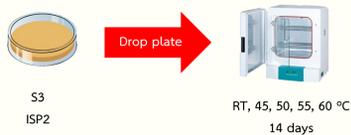
Streptomyces thermocarboxydus is a thermotolerant actinomycete with plant growth-promoting potential. This study investigates the heat tolerance mechanisms of *S. thermocarboxydus* isolate S3 and its ability to enhance the growth of kale (*Brassica oleracea* var. *sabellica*) under high-temperature conditions. *S. thermocarboxydus* isolate S3 can grow at a maximum temperature of 45°C and promote kale growth under heat stress. Kale seedlings treated with S3 spore suspension exhibited significantly higher growth parameters than the control group ($P < 0.05$) in terms of height (20.3±1.2 cm), root length (23.6±2.2 cm), and fresh weight (4.01±0.4 g). *S. thermocarboxydus* isolate S3 reduced the accumulation of H₂O₂ in kale under heat stress. Furthermore, whole-genome analysis identified genes associated with heat tolerance and plant growth promotion.

Introduction

Extreme heat stress poses a significant challenge to crop production, affecting plant growth and yield. *Streptomyces thermocarboxydus* isolate S3, a heat-tolerant plant growth-promoting bacterium, has shown potential in enhancing stress resilience and improving kale cultivation. This study explores the heat tolerance mechanisms of *S. thermocarboxydus* isolate S3 and its role in promoting plant growth under high-temperature conditions, offering a sustainable approach to improving crop productivity in changing climates.

Methodology

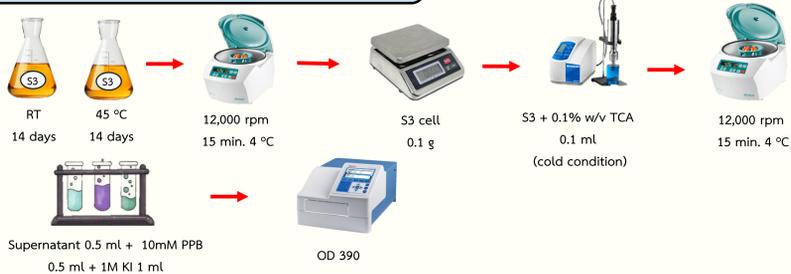
Part 1 : Heat tolerance assay of *S. thermocarboxydus* isolate S3



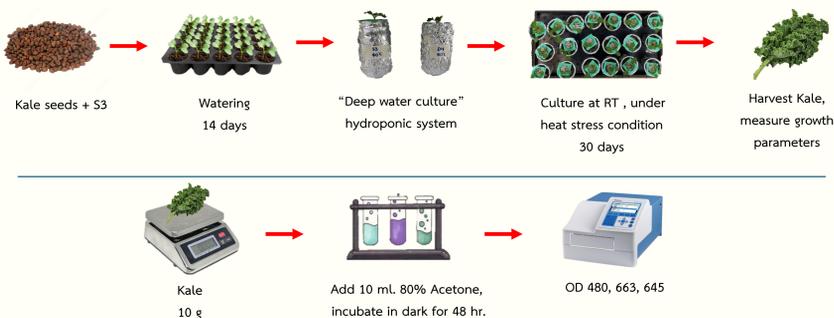
Part 4 : Whole genome analysis using RAST annotation server



Part 2 : Production of plant growth promoting substances *in vitro*



Part 3 : Potential of *S. thermocarboxydus* isolate S3 to promote growth of kale under heat stress



References

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Lasudee K, Tokuyama S, Lumyong S and Pathom-aree, W. 2018. Actinobacteria associated with arbuscular mycorrhizal *Funneliformis mosseae* spores, taxonomic characterization and their beneficial traits to plants: evidence obtained from mung bean (*Vigna radiata*) and Thai jasmine rice (*Oryza sativa*). *Frontier in Microbiology* 9:1247. doi: 10.3389/fmicb.2018.0124

Objective

- To study heat tolerant ability of *Streptomyces thermocarboxydus* isolate S3
- To study heat tolerance related mechanisms by whole genome analysis
- To study ability of *Streptomyces thermocarboxydus* isolate S3 to reduce heat-induced stress in kale

Results

Part 1 : Heat tolerance assay of *S. thermocarboxydus* isolate S3

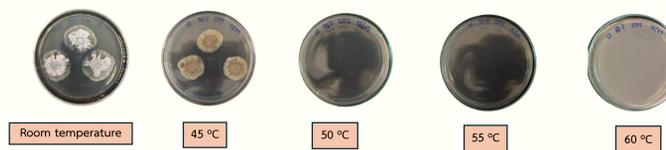


Fig. 1 Range of temperature that *S. thermocarboxydus* isolate S3 can grow

Part 2 : Production of plant growth promoting substances *in vitro*

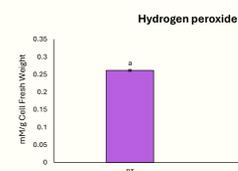


Fig. 2 Hydrogen peroxide production of *S. thermocarboxydus* isolate S3

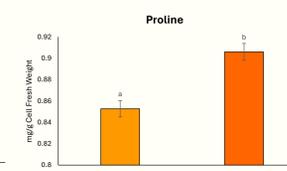


Fig. 4 Proline production of *S. thermocarboxydus* isolate S3

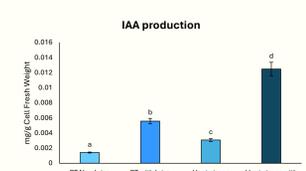


Fig. 3 IAA production of *S. thermocarboxydus* isolate S3

Part 3 : Potential of *S. thermocarboxydus* isolate S3 to promote growth of kale under heat stress

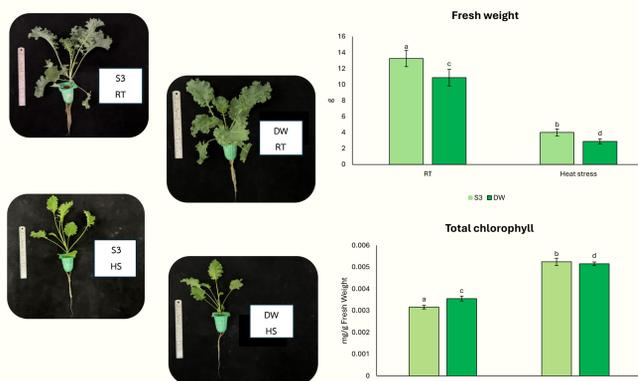


Fig. 5 Kale's growth in room temperature and under heat stress

Part 4 : Whole genome analysis using RAST annotation server

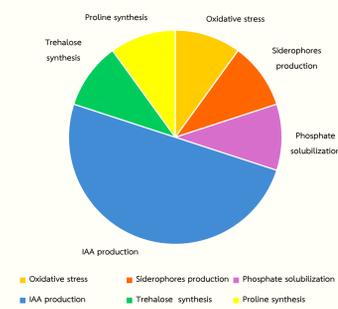


Fig. 6 Genomic insight into heat tolerance and plant growth promoting of *S. thermocarboxydus* isolate S3 by using RAST

Conclusion

Streptomyces thermocarboxydus isolate S3 revealed that this strain can withstand high temperatures while still promoting plant growth under heat stress conditions. S3 was found to produce various growth-promoting substances, such as IAA, siderophores, and phosphate-solubilizing compounds, even under high-temperature stress. Additionally, it can produce stress-protective compounds like hydrogen peroxide, proline, and sugars, which help safeguard cells from heat-induced damage. Experimental results in plants grown under high-temperature conditions showed that the use of S3 significantly enhanced growth compared to the non-inoculated group, leading to increased plant weight, length, chlorophyll, and carotenoid content. These findings suggest that *Streptomyces thermocarboxydus* isolate S3 has great potential in enhancing plant heat tolerance

Acknowledgements

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