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Making Blue in the Dark

Can *Galdieria sulphuraria* convert kiwifruit waste into phycocyanin?

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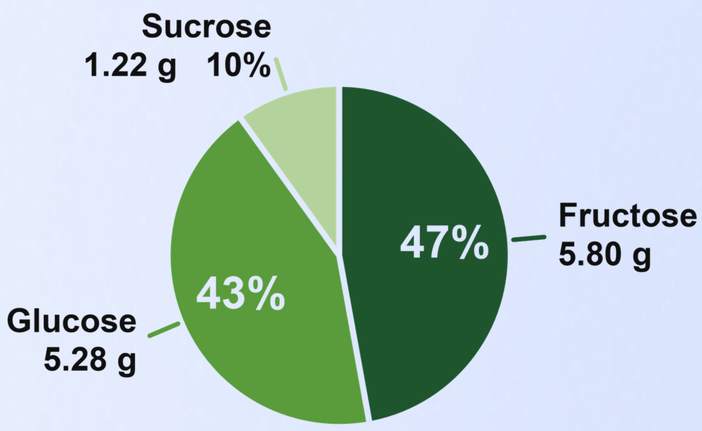
Background

Blue is among the rarest naturally occurring food colours and historically the most difficult to source naturally (Eriksen, 2008).

Phycocyanin (C-PC) could be the answer. It is also a bioactive antioxidant and a fluorescent pigment for bioimaging (Ferraro et al., 2020; Chhirang et al., 2024). Currently, almost all C-PC comes from *Spirulina*.

The opportunity in kiwifruit waste

In New Zealand, 50,000 tonnes of kiwifruit are discarded annually to landfill or stockfeed (Scion, 2025). Its glucose, fructose and sucrose are directly accessible without thermo-acid pretreatment (Portillo et al., 2022). This presents an opportunity to turn a waste product into a high value export.

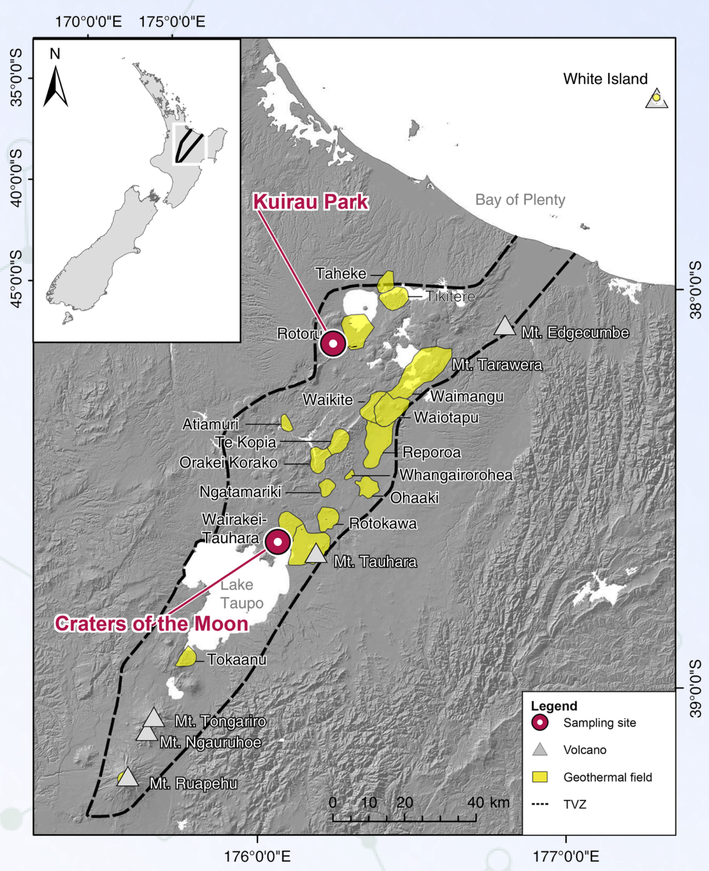


Sugar composition of Zespri SunGold kiwifruit flesh (Sivakumaran et al., 2018).

Galdieria sulphuraria is the solution

Galdieria sulphuraria, a thermoacidophilic red alga from the Taupō Volcanic Zone, grows heterotrophically at pH 2.5 and 45 °C. Growing in the dark decouples productivity from light and area; growing at pH 2.5 excludes most contaminants and relaxes the sterility that drives cost in conventional fermentation.

Galdieria-derived C-PC is more thermally and acid stable than *Spirulina*-derived C-PC, remaining stable to 55-60 °C and surviving pasteurisation that denatures *Spirulina* C-PC (Abiusi., 2022; Pleissner., 2025; Wan et al., 2021).



Geothermal fields of the Taupō Volcanic Zone. Sample sites where *Galdieria* was found. Adapted from Power et al. (2018).

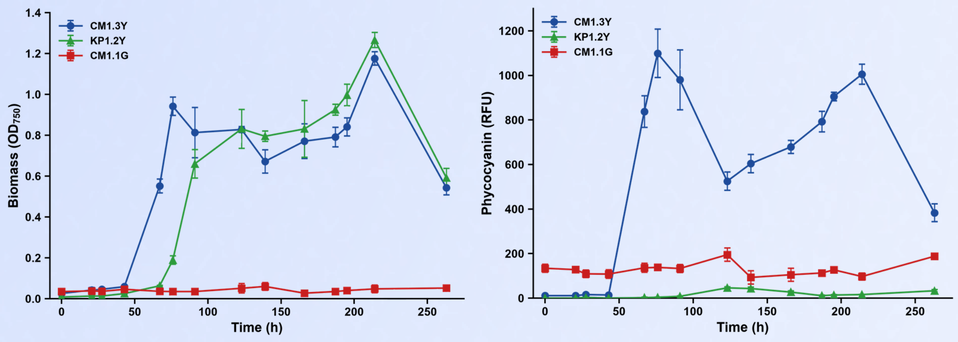
Phylogeny of TVZ *Galdieria* isolates

Cladogram from Bayesian analysis of five concatenated genes (psaA, psbA, rbcL, 18S and 16S rRNA). Redrawn from Colsell (2020).

Which isolate?

Galdieria isolates from the TVZ differ in their capacity for dark heterotrophic growth (Colsell, 2020).

To identify a single champion, I screened three isolates in the dark on a waste-mimetic mixed-sugar medium.



Results

So far, I have demonstrated that a *Galdieria sulphuraria* isolate from New Zealand can produce phycocyanin whilst growing heterotrophically on a multi-sugar feedstock, mimicking real kiwifruit juice composition.

Next steps:

Does oxygen impact production?

C-PC biosynthesis requires oxygen (Brzezowski et al., 2015). I will investigate whether oxygen limits pigment synthesis directly or only through its effect on biomass.

Acknowledgements

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Hi, I'm Hamish

References and Contact info

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