Development of a Biological Carbon Capture System in *Escherichia coli*

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Background

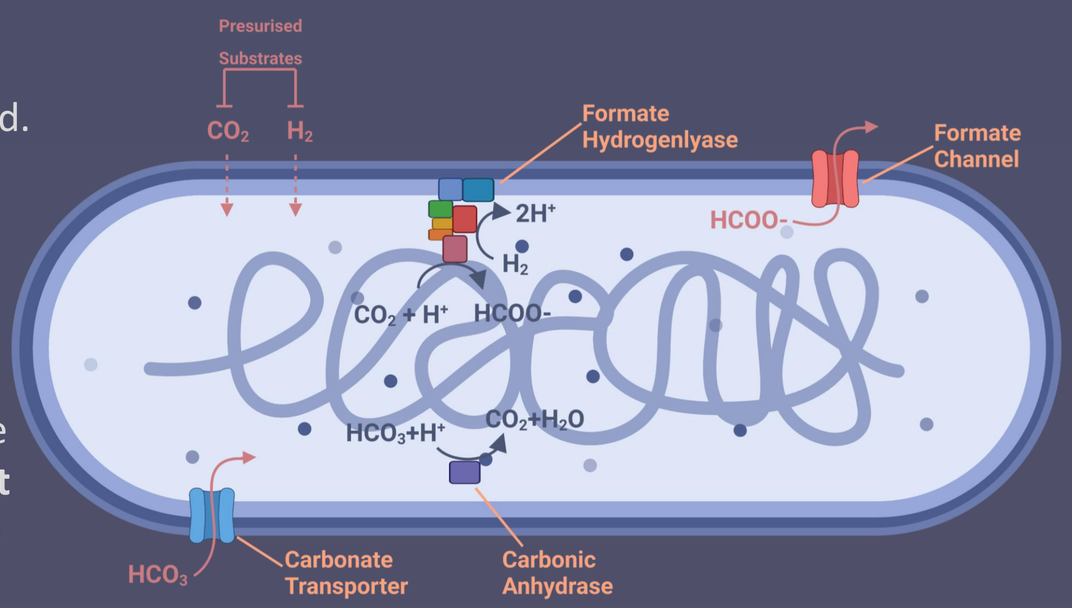
The Problem

Global climate change is having unprecedented effects around the world.

The UK alone Contributes over **400 million tonnes** of greenhouse gas emissions annually, with over ¾ being Carbon Dioxide (CO_2) [1].

Global efforts are being made to reduce carbon emissions through **carbon credit systems** and **carbon capture**, utilisation and storage technologies.

One Method of capturing carbon is to chemically convert CO_2 into carbonate.



Our Solution

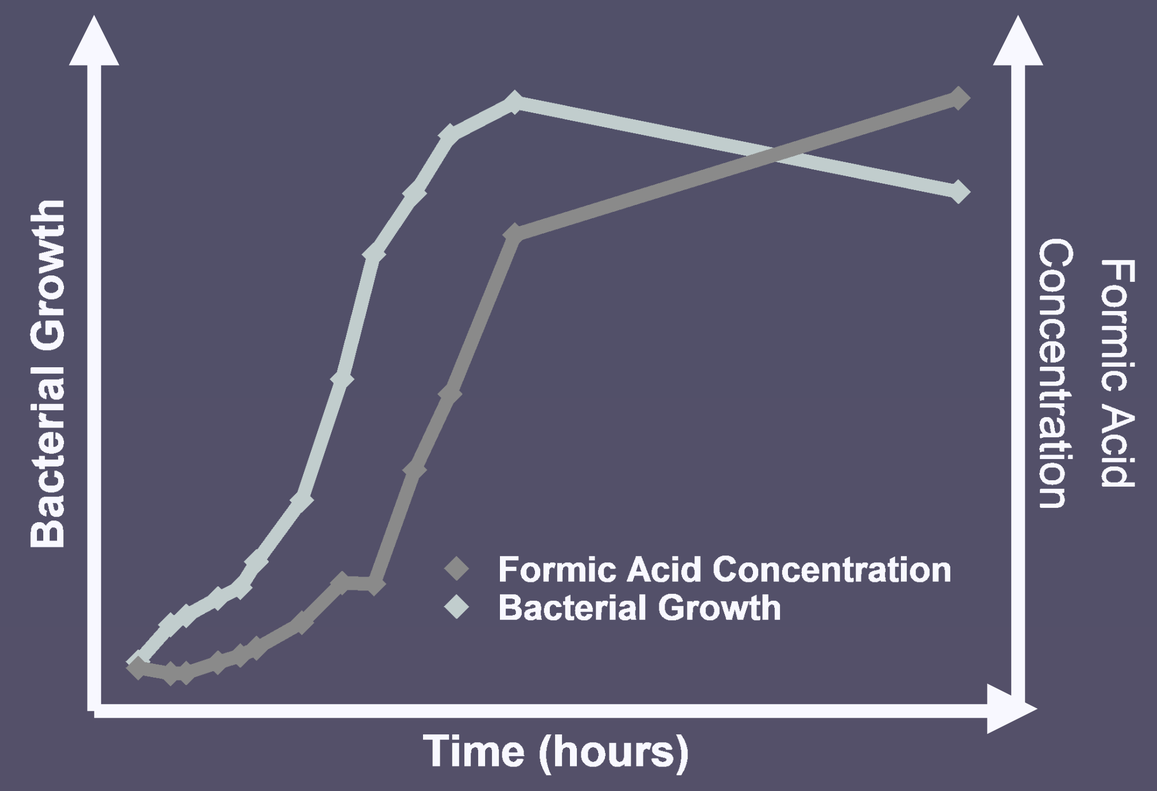
Escherichia coli (E. coli) is often considered the workhorse microbe for biotechnology.

E. coli possesses a special enzyme, the formate hydrogenlyase complex (FHL-1), which we use to convert CO_2 into formic acid (a type of vinegar) under our experimental conditions[2].

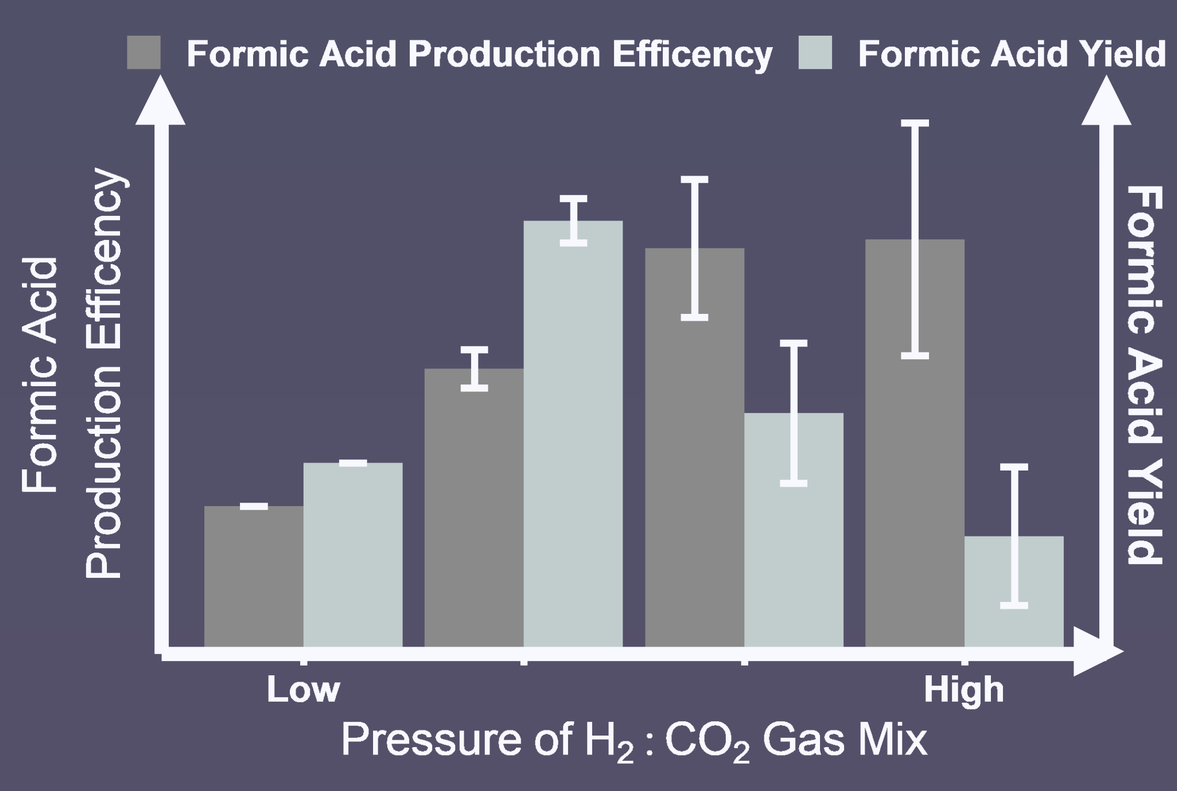
We have genetically optimised a strain of *E. coli* (MR60) for formic acid production from gaseous CO_2 and hydrogen (H_2) [3].

We have also engineered a strain of *E. coli* that contains a carbonic anhydrase, to utilise bicarbonate in place of CO_2[3].

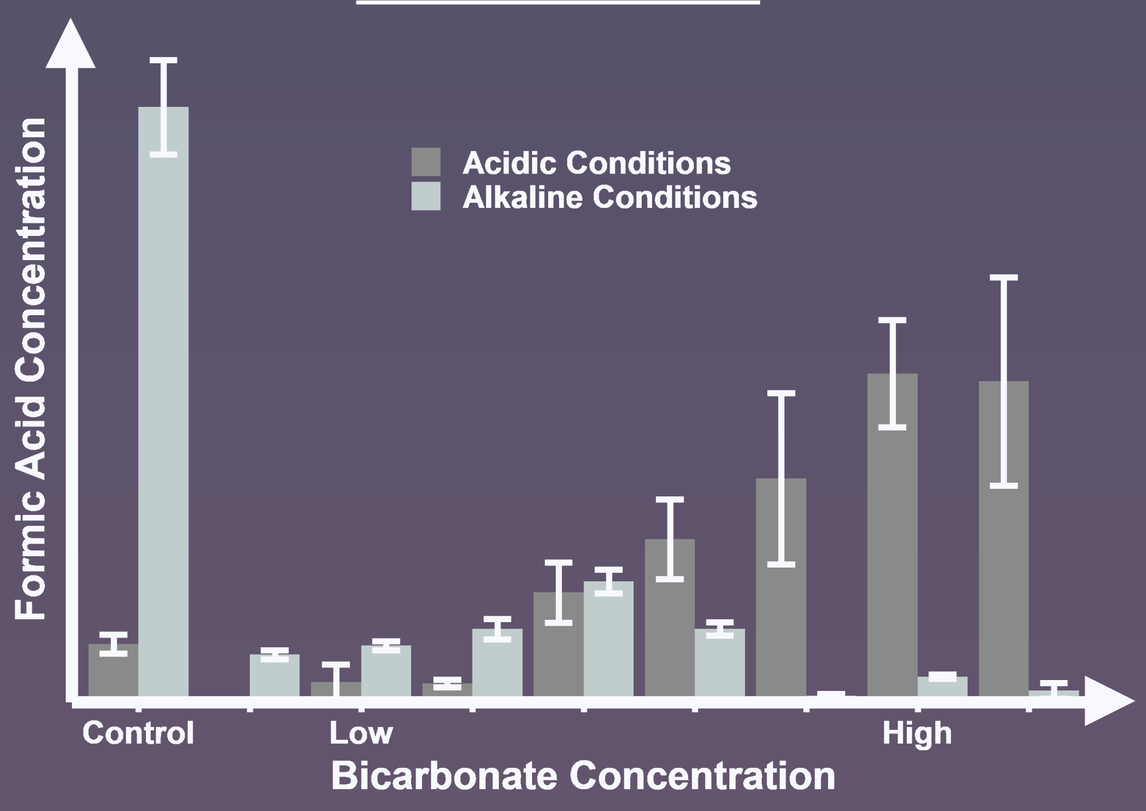
E. coli Can Produce Formate During Growth



Increasing Gas Pressure Affects Formate Yield



Bicarbonate Can Also Be Used For Formic Acid Production



Conclusions

Our *E. coli* MR60 strain is capable of producing formic acid from gaseous CO_2:H_2 during fermentative growth.

Production is comparable to that of micro-organisms that naturally produce formic acid[4].

Increasing gas pressure of CO_2:H_2 increases the production efficiency of formic acid (amount produced per cell) but decreases the total yield.

Bicarbonate can be used instead of CO_2 in formic acid production.

Increasing bicarbonate concentration increases formic acid production under acidic conditions.

Formic acid production from bicarbonate is lower under alkaline conditions.

Bio-engineering of *E. coli* offers a new bioprocess for carbon capture

References

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3. Roger M, Reed TCP, Sargent F. Harnessing Escherichia coli for Bio-Based Production of Formate under Pressurized H 2 and CO 2 Gases. Appl Environ Microbiol. 2021 Oct 14;87(21):e0029921.
4. Mourato C, Martins M, da Silva SM, Pereira IAC. A continuous system for biocatalytic hydrogenation of CO2 to formate. Bioresour Technol. 2017 Jul 1;235:149–56.

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