COLLEGE OF ENGINEERING

Chemical, Biological & Environmental Engineering

PRODUCTION OF OXALIC ACID FROM DAIRY WASTES

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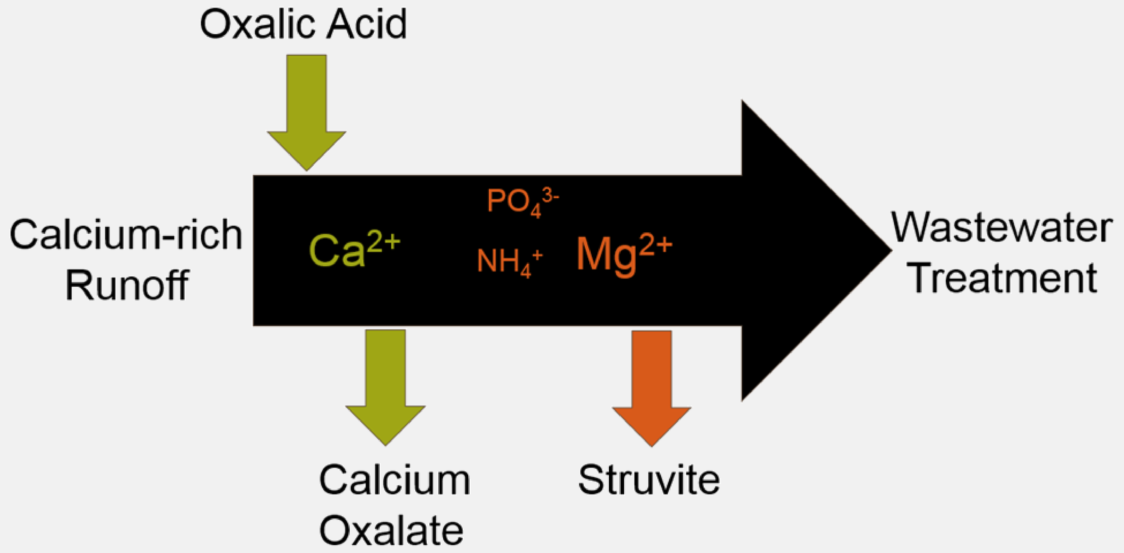
Opportunity

Oxalic acid is naturally synthesized by living organisms and has many known applications, one of which is calcium removal from agricultural runoff. Calcium inhibits the removal of other harmful ions such as phosphorous and magnesium. Once calcium is removed wastewater treatment facilities can remove these ions through precipitation of struvite.



Aspergillus Niger is a fungus which can ferment lactose and produce oxalic acid. Lactose rich whey is currently a waste product of the dairy industry. Our objective is to produce low cost oxalic acid at 3 wt% from *A. Niger* grown in whey.

Experimental Set-up

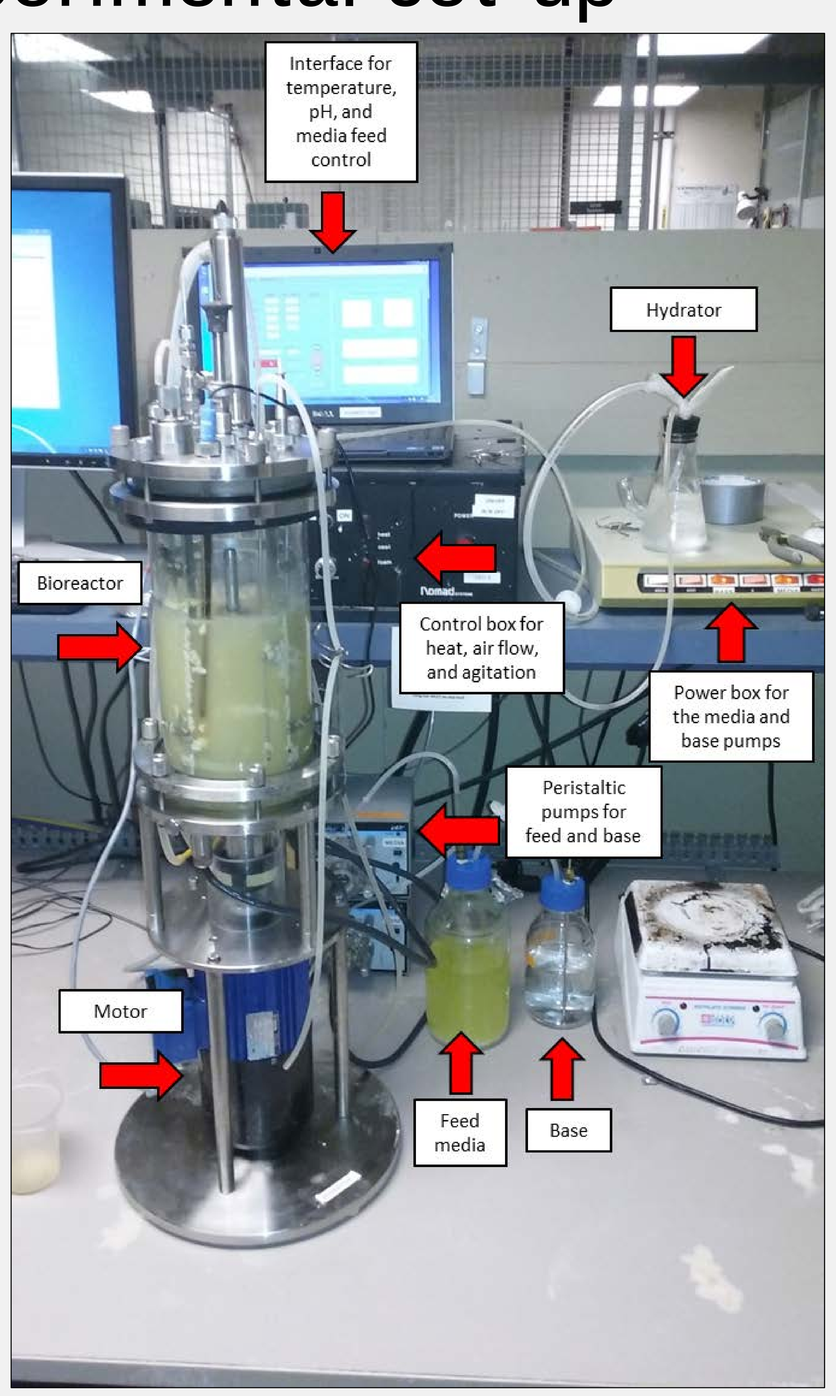
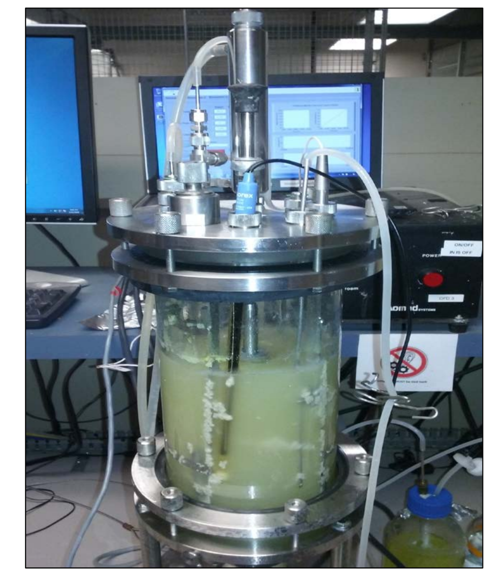


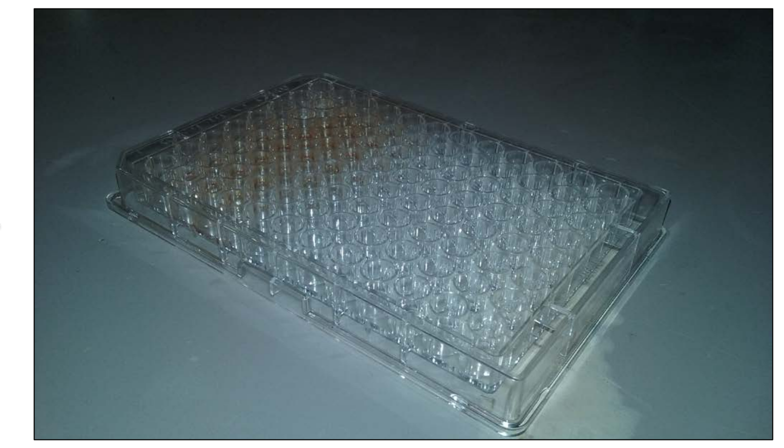
Figure 1: A labelled diagram showing bioreactor with all of it's supporting equipment. The media shown is whey permeate obtained from Darigold and the base shown is 4 M NaOH. The hydrator was used to saturate the air before blowing it into the bioreactor to prevent evaporation.

Methods

A. Niger obtained from USDA is cultured in shaking flasks and synthetic media for at least 7 days at 30°C

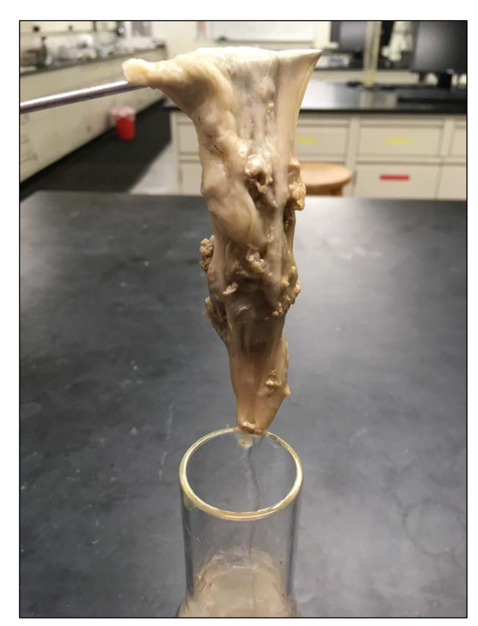


Cells are transferred to bioreactors for 8 days with various temperature, pH, air and media flow settings. Samples are taken every 24 hrs.



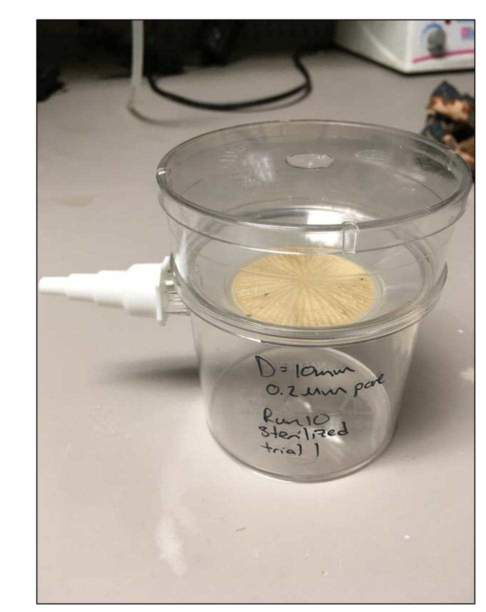
Cells are measured by dry weight. Lactose is measured by blood glucose monitor. Oxalic acid is measured by colorimetry

Scale-up Parameters



Cells form large aggregates which can clog drainage pipes and accumulate on sensors. A settling tank should be used to decrease filtration time and energy requirements.

The terminal velocity was estimated to design a settling tank in the full scale process. Two 45 mL samples with 7.7 g/L cell density were used. The terminal velocity was 45 µm/s.



A 50 mL sample of broth from Run 10 was filtered to estimate filtration time in the full scale process. A Nalgene filter unit with 50 mm diameter and 0.2 µm pore size was used. The filtration time was 1 hour.

Results

Run	Investigative Purpose
1	Replicate work of Vickery et al (2015)
2	Effects of a shorter batch phase
3	Extended batch phase
4	Alternating batch/fed-batch phases
5	New Strain
6	Increased dissolved oxygen content
7	Using a sparger for better mass transfer
8	Saturating influent air with water
9	Anaerobic fed-batch phase
10	Eight days of batch

Table 1: *A list of completed runs and their respective purposes. Runs with an asterisk have not been started yet. The parameters for runs 10 and 11 will be decided after run 9*

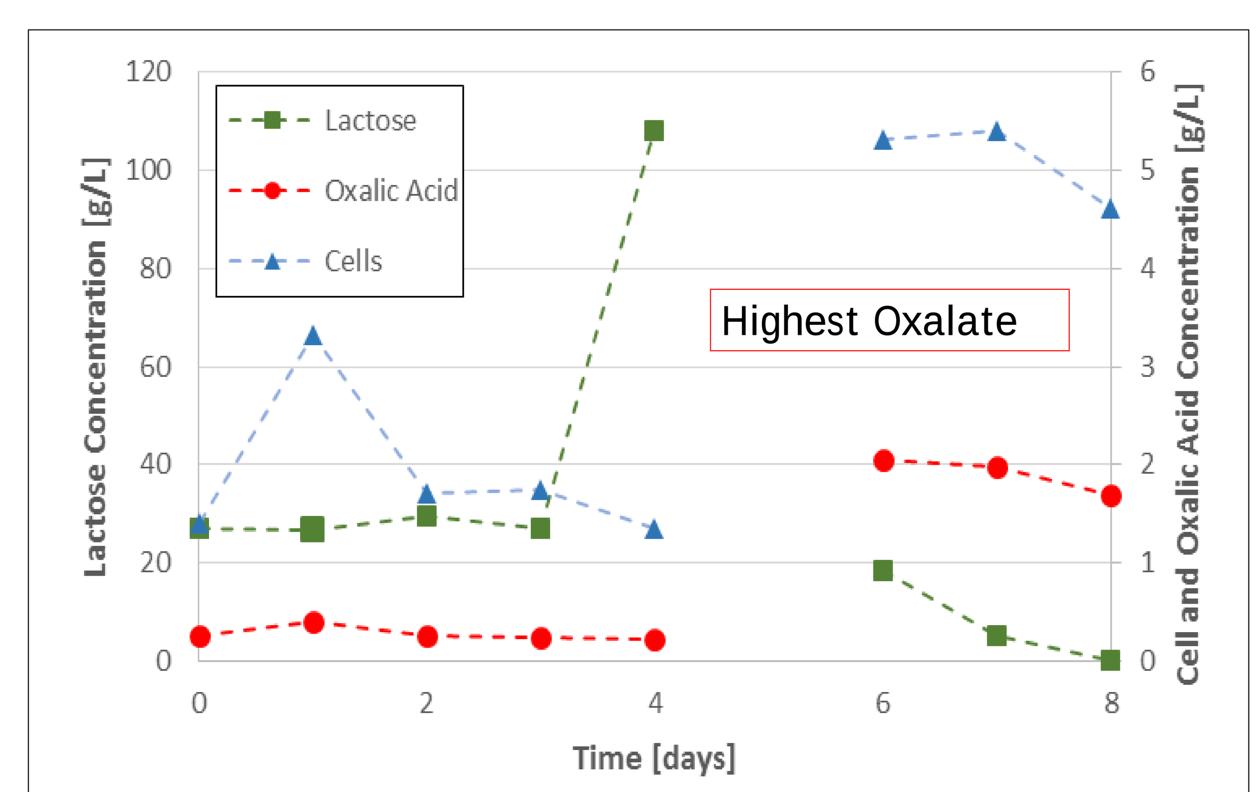


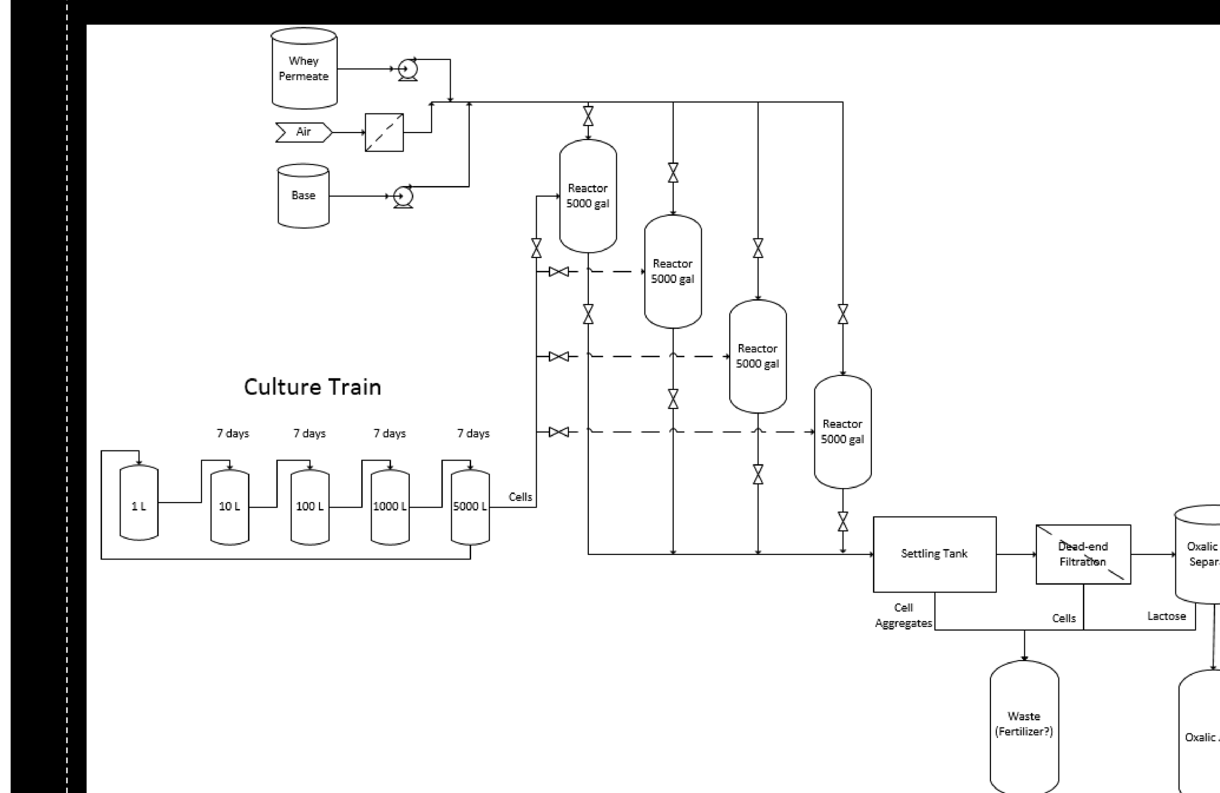
Figure 2: *Run #3 with an extended batch phase of 4 days and a fed-batch phase of 4 days yielded our highest final oxalic acid concentration of 2 g/L.*

MULTIFORM HARVEST

Dairy Applications

- 100,000 gal of runoff per day containing 300 ppm Ca^{2+}
- Must produce 80 m^3 of 3 wt% oxalic acid solution per 8 day run
- Agitation dimensions are important
- Oxalic acid may be hard to purify

Scale-up Design



The scale up design uses four 5000 gal reactors in parallel. Each reactor should be run in batch mode for eight days. The end date for each run should be two days apart. The settling tank and filtration process should have a 5000 gal capacity.

Acknowledgments

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