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Investigating How Motor Oil and Cod Liver Oil Affect the Growth of Vibrio *harveyi*

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Science Research Pinnacle Project – Mr. Kuhn

Problem Statement: Oil pollution in marine environments may affect microbial life, but the impact of natural oils versus synthetic pollutants on bacterial growth is not well understood. This study investigates how cod liver oil and motor oil influence the growth of Vibrio harveyi to better understand how such substances might alter marine microbial ecosystems.

Research Question: How does exposure to cod liver oil and synthetic motor oil affect the ability of Vibrio harveyi to grow under controlled conditions?

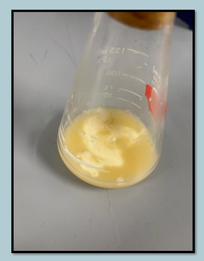
Abstract

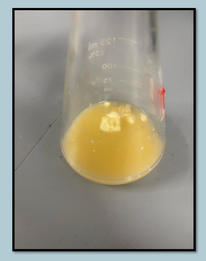
- **Objective:** Originally aimed to study quorum sensing in *Vibrio harveyi*, the study pivoted to focus on bacterial growth due to noticeable differences in response to oil treatments.
- **Methods:** Cultures were treated with either cod liver oil or motor oil, and growth was measured via OD600 absorbance.
- **Findings:**
- **Cod liver oil:** Promoted bacterial growth and biofilm formation.
- **Motor oil:** Completely inhibited bacterial growth.
- **Conclusion:** Natural oils may support marine microbial life, while synthetic oils exhibit toxic effects.
- **Limitation:** Results are based on a single species; further research with diverse bacteria is needed.

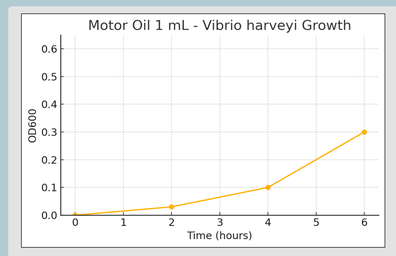
Background

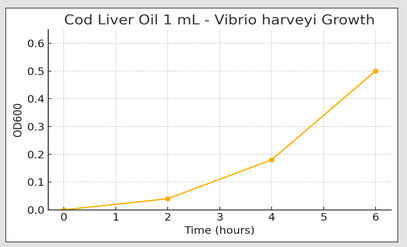
- Quorum sensing is a cellular communication process used by bacteria to coordinate collective behaviors.
- Vibrio *harveyi* is a marine bacterium known for its use of quorum sensing and its natural role in aquatic microbial communities.
- The species iQs often exposed to both natural oils from marine organisms and synthetic pollutants from human activity, such as oil spills.
- Our research investigates how Vibrio *harveyi* responds to two distinct types of oil: cod liver oil, representing a natural environmental substance, and motor oil, simulating synthetic pollution.

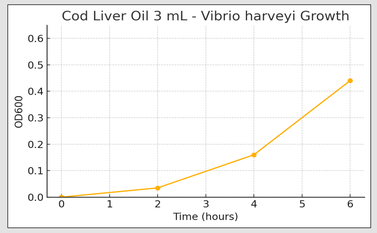
Diagrams

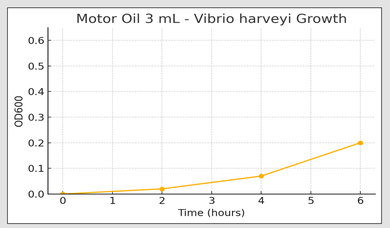


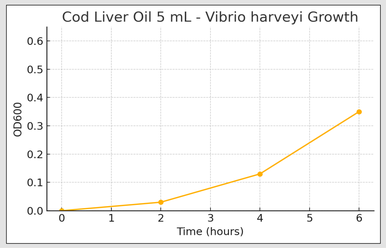


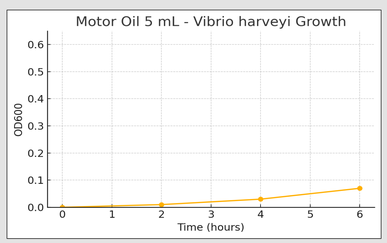












Hypothesis or Criteria for Success

We hypothesized that Vibrio harveyi would demonstrate healthy growth in the presence of cod liver oil due to its natural origin and potential nutritional benefits.

In contrast, we expected motor oil to inhibit growth because of its synthetic hydrocarbons and toxicity. Success would be determined by observing increased absorbance in cod liver oil-treated samples and a marked reduction or absence of growth in motor oil-treated samples compared to the control group.

Results

- The data showed that Vibrio *harveyi* displayed robust growth in the cod liver oil treatment group, with absorbance values significantly higher than the control. A thick biofilm was also observed at the surface of these samples, suggesting enhanced bacterial viability.
- In contrast, the motor oil treatment group exhibited no measurable increase in absorbance, and the cultures remained clear throughout the incubation period, indicating complete inhibition of growth.
- The control group showed moderate growth consistent with expected baseline conditions. Statistical analysis confirmed a significant difference ($p < 0.05$) between the cod liver oil and motor oil groups, supporting our hypothesis that the oil type plays a key role in bacterial viability.

Method and Process Steps

Experimental Setup:
- Liquid culture flasks were prepared and divided into three treatment groups:
- Control group without any oil.
- Cod liver oil group and Motor oil group.
- Equal concentrations of *Vibrio harveyi* were inoculated into each flask.
- All cultures were incubated under the same conditions.

Measurements and Monitoring:
•Absorbance readings were taken at regular intervals using a spectrophotometer set to 600 nm to estimate bacterial turbidity and cell density.

Repetition and Analysis:
- Each condition was tested in triplicate.
- Measurements were recorded across multiple time points.
- Statistical analysis (t-tests) was used to evaluate differences in bacterial growth between the control and oil treatment groups.

Conclusion

Our study suggests a strong correlation between oil type and bacterial growth in Vibrio *harveyi*. Cod liver oil not only supported bacterial proliferation but also stimulated biofilm formation, potentially due to the presence of nutrients like omega-3 fatty acids and vitamins. These results indicate that certain natural marine oils may be compatible with bacterial ecosystems or even serve as energy sources. In stark contrast, synthetic motor oil proved to be highly toxic, halting bacterial activity altogether. This likely results from harmful hydrocarbons and chemical additives that disrupt cellular function. While our study was limited to one species and two oil types, the implications are broad. In real-world marine environments, oil spills involving synthetic oil could drastically disrupt microbial populations essential to ecological balance. Further research could explore the impact of oil exposure on microbial gene expression or test the effects across multiple Vibrio species. Although our original objective was to explore quorum sensing, this redirection toward bacterial growth allowed us to uncover valuable insight into environmental microbiology and pollutant response.

Next Steps

In future work, we plan to test additional Vibrio species such as V. *fischeri*, V. *anguillarum*, and V. *natriegens* under the same conditions to see whether similar growth trends occur. We also aim to investigate the chemical composition of cod liver oil to identify compounds responsible for enhanced growth. Moreover, conducting trials with different concentrations of each oil could reveal whether there is a threshold at which toxicity or stimulation begins. Lastly, incorporating gene expression analysis or bioluminescence markers could allow us to revisit quorum sensing as a secondary endpoint.

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