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Combining alginate beads with methylene to create a biosensor to assess the quality of milk

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Introduction:

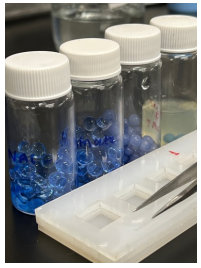
Methylene Blue Reduction Test: Simple test used to measure the quality of raw and pasteurized milk. Methylene blue is a widely-available dye that can be metabolized by bacteria in the presence of oxygen. When this happens, the dye turns transparent. The bacteria present in milk ferments lactose to form lactic acid which consumes oxygen in the process, causing the discoloration of the dye. Thus, the greater amount of bacteria present, the quicker the decolorization process.

Alginate: A natural polymer found in brown seaweed. It is widely used due to its low toxicity, biodegradability, low costs, and being readily available.

Goal: To incorporate methylene blue in alginate beads, so they become sensitive to the presence of bacteria. The hypothesis is that this test will be more sensitive than the traditional one, enabling a quicker and more efficient way of testing milk quality.

Materials:

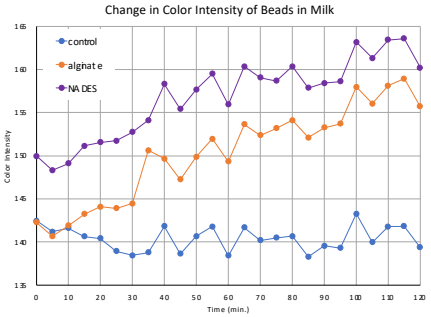
- 2% alginate solution (sodium alginate)
- 0.1 M calcium chloride
- Alginate & glycerol NADES
- 2% reduced fat milk (supernatant)
- Methylene blue solution (0.5 - 2.5%)
- Camera: iPhone 13, Manual Camera App
- ImageJ software
- UV lamp

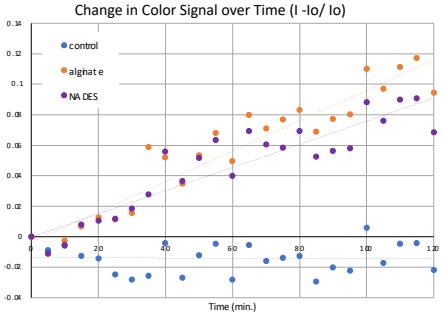


Results:

Part 1: Alginate vs NADES

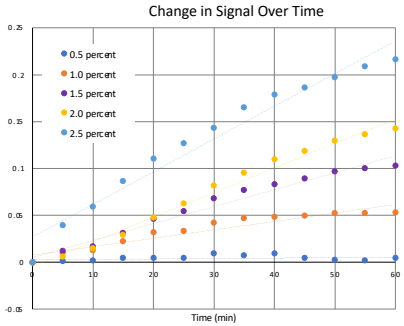
3 conditions: control (alginate), Alginate beads in milk, Alginate-NADES in milk

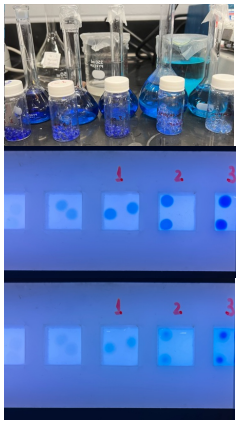




Part 2: Applications

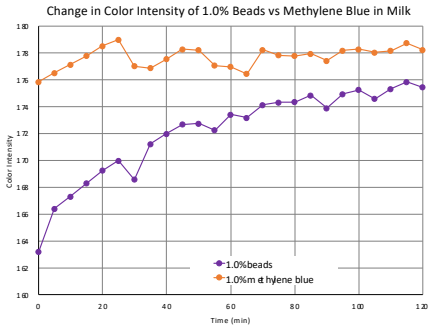
Different concentration of methylene blue

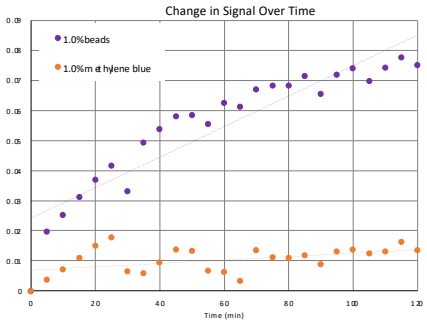




Part 3: Comparison

1.0% Beads vs methylene blue in milk





Conclusions:

In the first experiments, we focused on the efficiency of alginate beads vs NADES beads and concluded that they produced similar results. Due to their easier preparation, we decided to focus on the plain alginate beads and their possible applications. We compared beads with different concentrations of methylene blue and observed that higher concentrations displayed a more pronounced change in color. Finally, we did a comparison of the beads vs the methylene blue in solution and found that the beads indeed showed a greater change when exposed to spoiled milk. Based on our current results, we concluded that using the alginate beads is indeed a more efficient way of conducting the methylene blue reduction test.

Future Research:

Throughout our experiments, we faced a major issue on trying improve the retention of the dye within the beads. Further research can be conducted on determining ways to balance the ionic strength and reduce osmotic effect, as a way of retaining the dye within the beads. More experiments can be made during preparation process of the bead and observing how it influences the reaction process.

Acknowledgments:

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