



**CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY**

Name(s) Trevor B. Frisbee	Project Number 34262
Project Title Can Sodium Bicarbonate Fix Viscous Cystic Fibrosis Mucus?	
Abstract Objectives/Goals The objective is to determine if sodium bicarbonate (NaHCO ₃) will decrease the viscosity of cystic fibrosis (CF) mucus. Methods/Materials To model the high viscosity of CF mucus, sterile vaginal cow mucus was used in the experiments due to its similar properties to CF mucus. A capillary viscometer combined with a manometer was built. A sample of 5 mL of raw mucus was tested with the viscometer to establish a baseline flow rate at a pressure of 20 cm H ₂ O. Five test sets were established by mixing different volumes of 8.4% NaHCO ₃ with the 5 mL of raw mucus. The selected volumes of 8.4% NaHCO ₃ were 0.125, 0.25, 0.5, and 1.0 mL. The flow rate for each mixture of mucus and NaHCO ₃ was measured at pressures of 5, 8, 11, 14, 17, and 20 cm H ₂ O. 5 mL of mucus or mixtures were used for all flow times. To determine if sodium (Na) or bicarbonate (HCO ₃ ⁻) is responsible for changing the viscosity of mucus, the tests were repeated with 8.4% NaCl. Results The flow time of mucus decreased with increased concentrations of NaHCO ₃ . The flow time for 5 mL raw mucus at 20 cm H ₂ O was 271 seconds, while adding 0.125 mL 8.4% NaHCO ₃ decreased the flow time to 64 seconds. Some of the decrease in flow time was due simply to dilution of the mucus. Further tests showed that bicarbonate influenced the viscosity reduction more than sodium or dilution. Comparing the flow times at 20 cm H ₂ O for the mucus mixtures of 0.5 mL of 8.4% NaHCO ₃ to 0.5 mL of 8.4% NaCl showed a flow time of 29 seconds for the NaHCO ₃ mixture, and 71 seconds for the NaCl mixture. Conclusions/Discussion The results of the experiments show NaHCO ₃ decreases the viscosity of cow mucus, and possibly of CF mucus. Further results show that bicarbonate has more effect on mucus viscosity than sodium or simple dilution. CF is a life threatening genetic disease. The viscous mucus in the CF lung prevents the cilia from clearing the mucus, causing lung infections, leading to early lung failure. Decreasing the viscosity of CF lung mucus could help cilia to work correctly, resulting in better mucus clearance and fewer infections. Further research should be done to test the effectiveness of NaHCO ₃ on CF mucus, with the possibility of treating CF mucus in the lungs with nebulized NaHCO ₃ inhalation.	
Summary Statement The objective is to determine if sodium bicarbonate (NaHCO ₃) will decrease the viscosity of cystic fibrosis (CF) mucus.	
Help Received Dr. Paul Quinton of UCSD helped with technical details over video chat. My father taught me how to use power tools and Excel.	