



CALIFORNIA SCIENCE & ENGINEERING FAIR 2018 PROJECT SUMMARY

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| Name(s) Braedyn D. Hutchison | Project Number 38772 |
| Project Title The "Sweetest" Rocket Candy: Evaluating Sucrose, Glucose, and Fructose as Fuels for Sugar-Based Solid Rocket Motors | |
| Abstract Objectives/Goals Determine which sugar among Sucrose, Glucose, and Fructose makes the best choice of sugar fuel for sugar-based solid propellant motors. Gain experience with materials, equipment, methods, and safety precautions necessary for continuing research with higher-energy composite and electric solid propellants that are relevant for modern launch, orbital, and space operations. Methods/Materials Solid propellant motors were prepared using a Potassium Nitrate (KNO ₃) oxidizer with Sucrose (C ₁₂ H ₂₂ O ₁₁), Glucose (C ₆ H ₁₂ O ₆), and Fructose (C ₆ H ₁₂ O ₆) sugar fuels. Observations regarding ease of preparation were recorded. A reusable test motor harness and test firing safety cage were constructed of durable materials to ensure safe and consistent test conditions. Thrust measurement equipment was constructed using a strain-gauge-based single-point load cell, a voltage-regulated instrumentation amplifier circuit, an analog-to-digital data acquisition device, and a laptop computer. High-sample-rate thrust data were recorded during test firings of motors prepared with each sugar fuel. Data were analyzed in terms of performance metrics and statistical significance/validity. Results Qualitative observations regarding ease of solid propellant motor preparation as the average ordinal ranking among six factors were: Sucrose = 1.67, Fructose = 2.00, and Glucose = 2.33. Quantitative measurements (and ordinal ranking) of the average specific impulse produced by solid propellant motors were: Sucrose = 129.41s (1), Glucose = 126.17s (2), and Fructose = 124.20s (3). Total scores (qualitative average rank + quantitative rank) were: Sucrose = 2.67, Glucose = 4.33, and Fructose = 5.00. Conclusions/Discussion The experimental results of this project provide a clear answer to the research question: Among Sucrose, Glucose, and Fructose, Sucrose (score = 2.67) makes the best choice of sugar fuel for sugar-based solid propellant motors; Glucose (score = 4.33) makes the second best choice of sugar fuel; and Fructose (score = 5.00) makes the third best choice of sugar fuel. These results help inform the amateur rocketry community regarding the preparation and use of sugar-based solid propellant motors for small-scale rocketry. Further, knowledge and experience gained via this project enable continuing research into preparation and use of composite and electric solid propellants which are extremely relevant in current rocketry operations. | |
| Summary Statement This project determined which of Sucrose, Glucose, and Fructose makes the best choice of sugar fuel for sugar-based solid rocket motors when evaluated in terms of both quantitative thrust performance and qualitative ease of preparation. | |
| Help Received Adult supervision and assistance by Tre Hutchison for procedures involving potential safety concerns, including: operating power tools on exceptionally durable materials, transferring molten propellants to molds, and designing safety equipment. | |