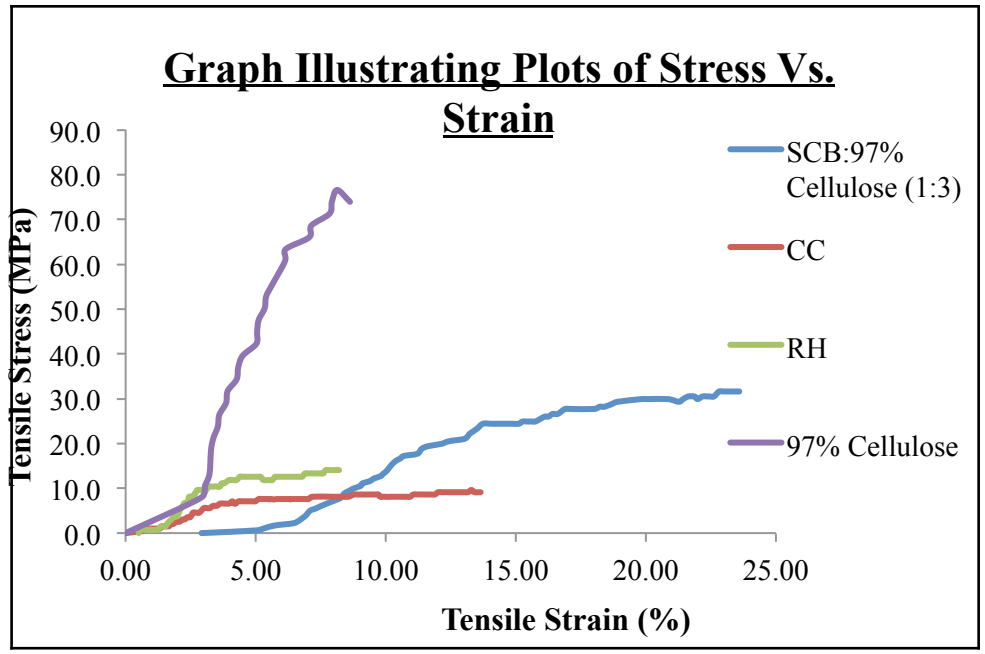
The Forum for Global Challenges 2022
Investigation of the Mechanical Properties of Tuneable Cellulose Based Plastic From Sugarcane Bagasse

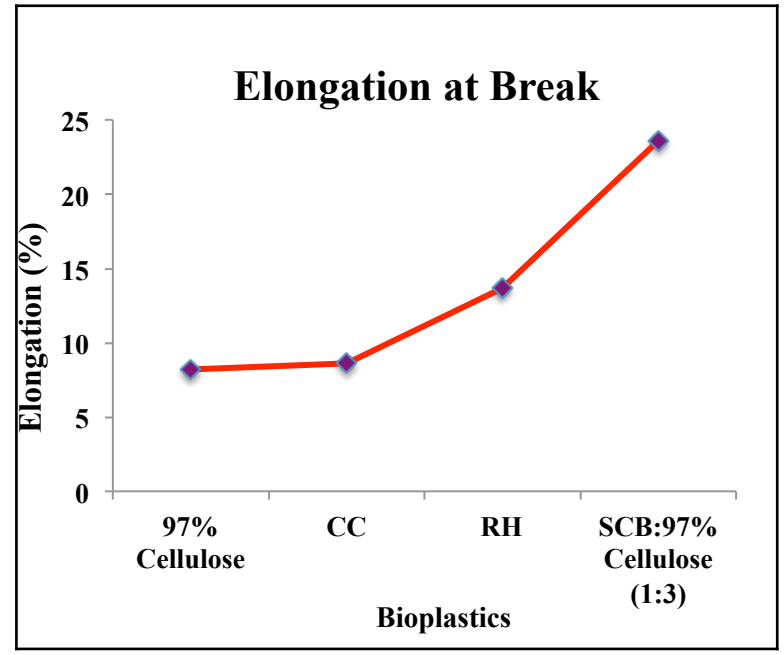
Vishal Mahabir* [1] , Patrick Ketwaru[2] , Randy Sanichar[3]

Problem: Engineered petroleum based plastics persist in the environment for thousands of years after they are disposed. Production of these non renewable plastics consumes chemicals and energy that contribute negatively to our planet's balance.

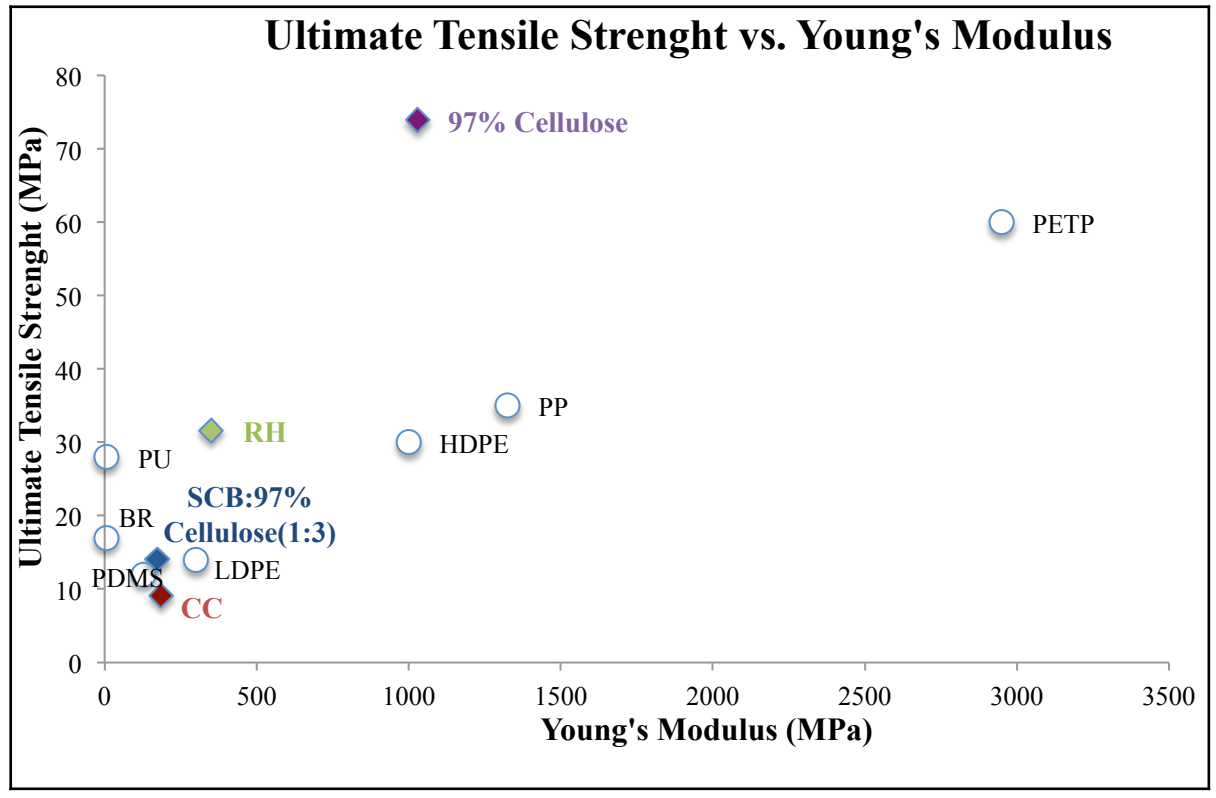
Evidence: According to the 2014/2015 plastics report published by Plastics Europe, roughly one third of the bio-plastics produced worldwide are limited to Latin and South America. In 2013, the world plastic production peaked at 299 Mtonne, a 3.9 % increase from 2012. This demand for plastics has continued to grow by around 2-5 % per year.

Solution/Results: Sugarcane bagasse was pre-treated to remove the hemicellulosic and lignin fractions before cellulosic acidic digestion using trifluoroacetic acid (TFA). A 16% NaOH treatment followed by 8% $NaClO_2$ bleaching was the most effective and confirmed by IR. A yield of about 41% was obtained after pre-treatment. As a result, plastic films were produced with similar mechanical properties to established engineered polymers like LDPE, PU, and rubber products. In addition, It was discovered that bioplastic films can be tuned to produced materials with desired tensile strength properties as evident with SCB:97% cellulose combination in a ratio of 1:3. Therefore, SCB has the ability to produce plastic films with a range of mechanical properties and has the potential to replace the existing engineered polymers.





It was observed that SCB tuned/reinforced with cellulose in a 1:3 ratio resulted in a material that can withstand a higher amount of stress and % strain before breaking as compared to films from rice husk and coconut coir. In addition, the SCB:97% cellulose film is able to stretch or elongate more before breaking compared to the others. Thermal properties via TGA showed that the films can also accommodate heat similar to the mentioned engineered, starch based polymers and elastomers.



The 3rd figure on the left intends to show the similar relationship between some of the more popularly known engineered polymers and those from this study. It can be seen that films produced have ultimate tensile strengths which are comparable with elastomers like polyurethane (PU) and rubbers (BR), silicone materials (PDMS), and low density polyethylene(LDPE)