# Design and Commercialization of High Value Functional Products from Soybean Meal

Final Report (12/15/2023)
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## 1. Why the Research is Important to North Dakota Soybean Farmers

World's 85% of Soybean crop is processed into Soybean Meal (SM) and oil [1, 2]. The oil component is used for human consumption, bio-diesel component etc. Comparatively, SM component is predominantly used for animal feed. In 2020, US used 34 million metric tons and exported 11.88 million metric tons [3]. Currently, SB has a low valuation of 0.42 USD/Kg [4]. As a summary, the beneficial and synergistic usage of environmentally friendly SM for designing high performance functional materials with high profit margin is underutilized. Novel uses of SM will create new avenues for Soybean Farmers to sell their products.

## 2. Research Conducted: (brief description of materials and method)

During the research, we had focused on following objectives:

Objective 1: To create *novel pathways* of creating SM-based feedstock;

Objective 2: To create *transformative methods* for manufacturing novel sustainable composites by using SM;

Objective 3: To *understand* the properties of the composites by experimental studies.

Objective 4: To *formulate strategy for commercializing* the materials developed during work in phase-II.

## 3. Findings of the Research

### 3.1 Scaffold Samples

Figure 1 shows the compressive stress vs displacement plot of different SBM-PLA composites. The Ultimate Compressive Strength (UCS) refers to the maximum stress that each material can withstand under compression before failure. We have shown for the first time that it is possible to generate higher strength in Soybean Meal materials than different grades of concrete samples.

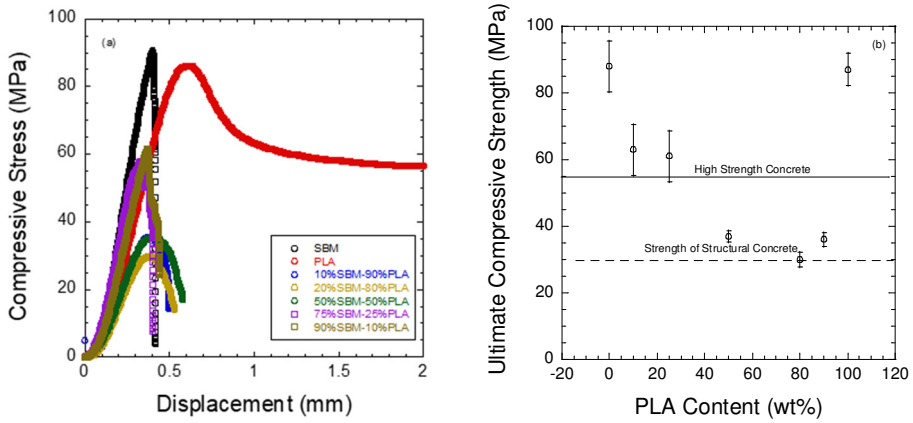


Figure 1: Plot of, (a) compressive stress vs displacement in SBM-PLA composites, and (b) the compressive stress vs displacement plot of PLA with varying compositions of SBM additive.

### 3.2 SBM-PLA Bioplastics Characterization by Solvent Casting

Figure 2 displays digital images of various solvent-cast samples. All the samples exhibit a uniform surface, indicating a well-dispersed arrangement of SBM fibers within the PLA polymer. These bioplastics can be used for packaging, structural and other applications due to their high mechanical strength (Fig. 3).

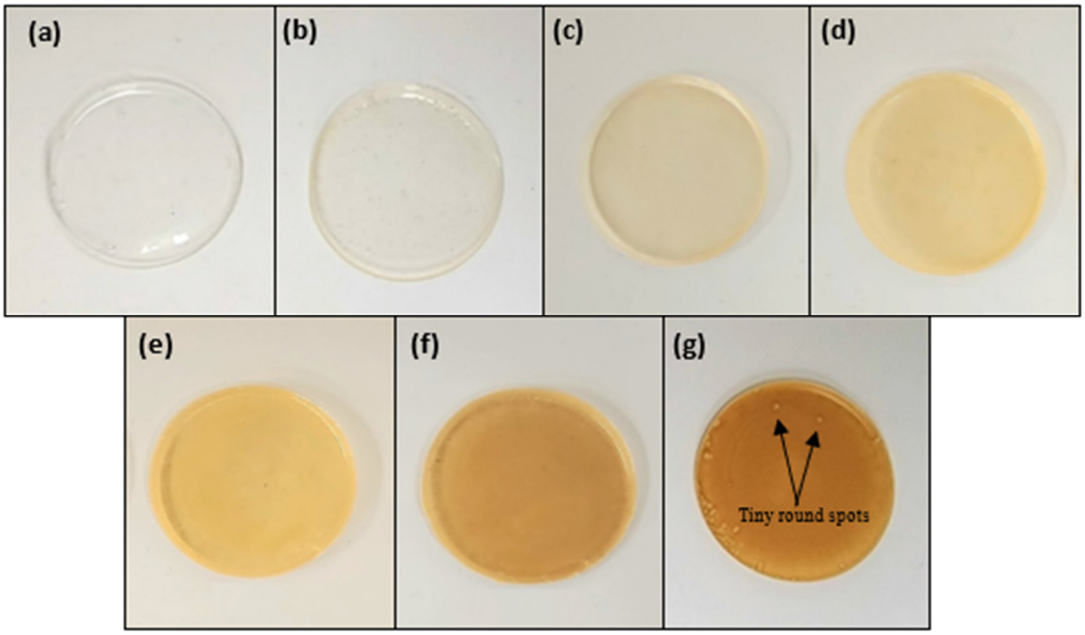


Figure 2: Digital pictures of solvent cast samples, (a) pure PLA (b) 2 % SBM – 98 % PLA, (c) 5 % SBM – 95 % PLA, (d) 10 % SBM – 90 % PLA, (e) 20 % SBM – 80% PLA, (f) 30 % SBM – 70 % PLA, and (g) 40 % SBM – 60 % PLA.

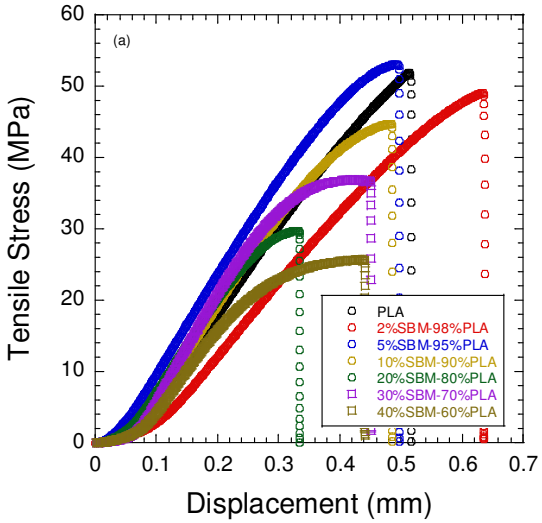


Figure 3: Plot of tensile stress vs displacement in solvent cast composites.

## 4. Conclusion/Benefits to the North Dakota Soybean Farmers and the Industry

Phase-I of this project is very successful. We have established that by using Soybean Meal, we can manufacture materials with high strength. These materials can be used in different high-performance applications. Based on the result presented, we think that the cementitious nature of composites is because of the protein-based nature of the Soybean Meal. We are planning to perform further research with Dr. Miranda's group to understand whether these properties can be further tailored by using crops with different concentrations of protein concentration. We are planning to submit a follow-up proposal. Based on these results, we can strongly conclude that

Soybean Meal is a effective source for making alternative materials. It will directly benefit the industry and Soybean farmers by finding alternative avenues for selling their product.

**References:**

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