All-Soy-One-Component Bioplastics for Food Packaging

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Objectives of the research

The primary objective of this work is to determine the feasibility of covalent grafting (attachment) of polymeric fragments from high oleic soybean monomer (HOSBM) onto soy protein isolate (SPI). Furthermore, it is the aim of this work to utilize this grafted copolymers ("one component" system) for making and modification of soy protein-based bioplastic films. Based on previously obtained experimental results, a limiting factor to using HOSBM-based latex polymers for modification of soy protein films is the compatibility between the latex and the protein. Previous work clearly identifies the benefits of HOSBM-based latex as a bioplastic film modifier, however, only a restricted amount of this latex can be incorporated, thus limiting the extent of modification. By covalent grafting of HOSBM fragments (chains) to SPI (**Figure 1**) it is possible to better compatibilize the two materials and achieve greater synergy in mechanical and barrier properties with the resulted one-component systems.

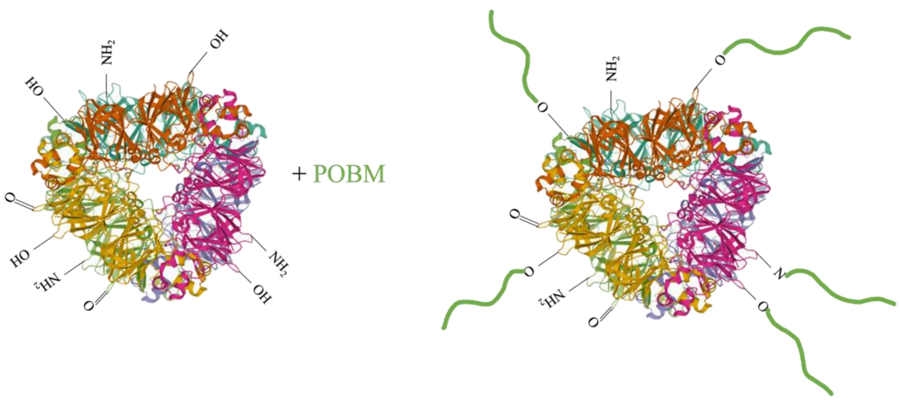

Figure 1. Proposed method of grating HOSBM-based polymer chains onto SPI.

Completed work

At the time of the mid-year report, miniemulsion polymerization has been identified as an effective method to covalently graft the HOSBM polymer chains onto soy protein isolate. The surfactant type and concentration is adjusted in order to yield a stable emulsion which demonstrates significant grafted content.

HOSBM has been prepared as described in *U.S. Patent, 10,315,95, June,11th 2019.* This plant oil-based monomer is then grafted onto soy protein isolate via miniemulsion polymerization

(**Figure 2**) where the soy protein dispersion is considered as the aqueous phase, and HOSBM in the oleo phase added dropwise.

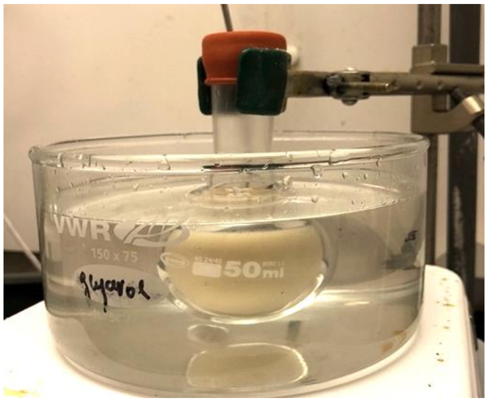

Figure 2. Miniemulsion set up to synthesize poly(HOSBM)-*graft*-SPI.

Preliminary results

Preliminary results show successful attachment (grafting) of the HOSBM polymer fragments onto SPI. **Table 1** highlights the synthetic results of conversion, solids, and grafted content for a poly(HOSBM)-*grafted*-SPI latex. By incorporating plant oil-based surfactant (also synthesized in our lab using HOSBM as starting material) at low concentration, a stable emulsion is formed. (**Figure 3**).

Material	% Solids	% Conversion	% Grafted Content	% Coagulum
HOSBM-grafted- SPI	17	70	75	0

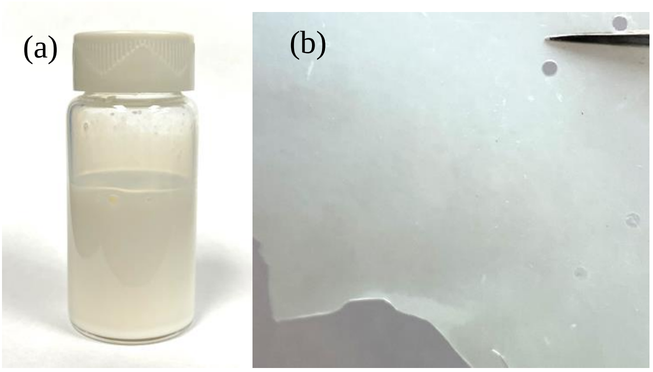

Figure 3. a) poly(HOSBM)-*graft*-SPI stable emulsion b) homogenous film formed from resulted poly(HOSBM)-*graft*-SPI material.

Work to be completed

Moving forward, the effect of the new grafted copolymers on soy protein bioplastic films formation and properties needs to be tested. By using this new material for film formation, we can test the effect of grafting on water contact angle, tensile strength, and water vapor permeability. Furthermore, it will be of interest to graft alternative POBMs onto soy protein isolate, such as soybean oil monomer (SBM) which has higher degree of unsaturation in comparison to HOSBM and will provide greater opportunity for crosslinking of the material which may impact all-soy based films properties and performance.