Plastic Films from Soybean Derivatives for Food Packaging

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Objectives of the research

The primary goal of this work is to demonstrate feasibility of incorporating soy derivatives, specifically soy protein and soybean oil-based vinyl monomer (SBM, developed at NDSU, *U.S. Patent, 10,315,95, June,11th 2019*), in the formation of (bio)plastic films targeted toward food packaging applications. In an effort to reduce brittleness of unmodified soy protein films, SBM-based latexes will be incorporated into the films in a one-step method. This addition will work to improve surface hydrophobicity and mechanical properties of the protein based (bio)plastics.

Completed work

At the time of the mid-year report, high oleic soybean monomer (HOSBM) has been prepared as described in *U.S. Patent, 10,315,95, June,11th 2019.* Synthesis of the HOSBM-based latexes has likewise been achieved (**Table 1**) and particle size was successfully manipulated.

Table 1. HOSBM-Based Latex Characterization

Latex Type	Solids %	Conversion %	Particle Size (nm)	Molecular Weight (g/mol)
Poly(HOSBM)	20	65	100	~20,000
Poly(HOSBM)	20	62	40	

Latexes of differing particle sizes were prepared and the feasibility of incorporating the latexes into soy protein films tested (Figure 1). The mechanical properties and surface hydrophobicity was then analyzed (Table 2).

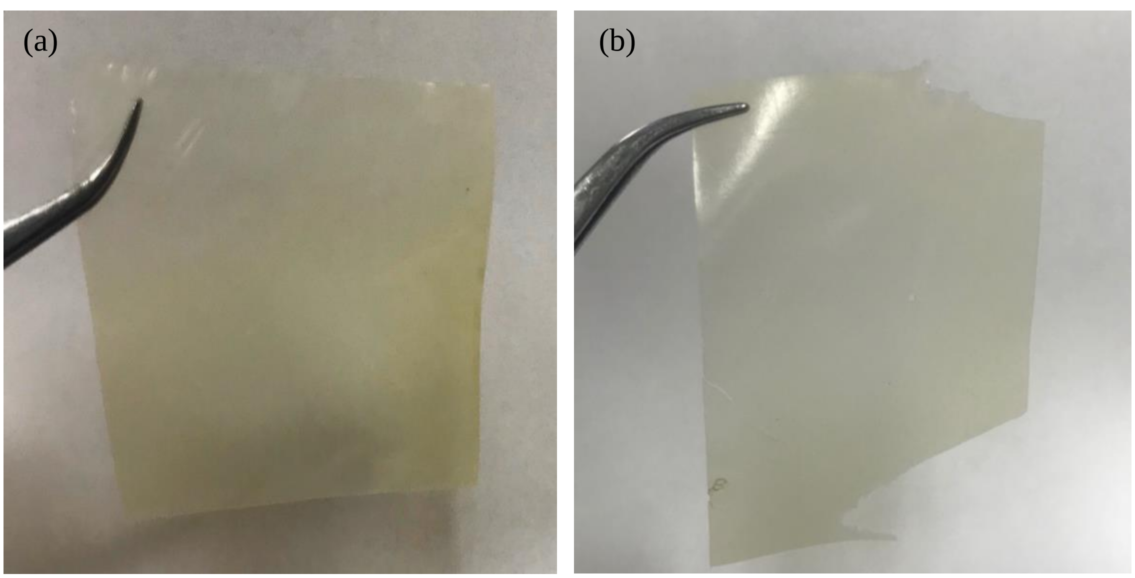

Figure 1 – Soy protein films with HOSBM-based latex incorporated (a) poly(HOSBM) 100nm (b) poly(HOSBM) 40nm

Table 2. Soy-based bioplastic film characterizations

Film Composition	Contact Angle (º)	Tensile Stress (MPa)	Elongation %	Toughness (MPa)	Moisture Content %
Soy protein + poly(HOSBM) (100nm)	89 ± 5	0.86 ± 0.03	38 ± 6	29.7 ± 1.8	
Soy Protein + poly(HOSBM) (40nm)	124 ± 7	0.85 ± 0.04	60 ± 6	49.6 ± 4.2	10.32

Additionally, surface morphology was observed via scanning electron microscopy (SEM, **Figure 2**) and a preliminary study of water vapor permeability performed via computational methods (**Figure 3**).

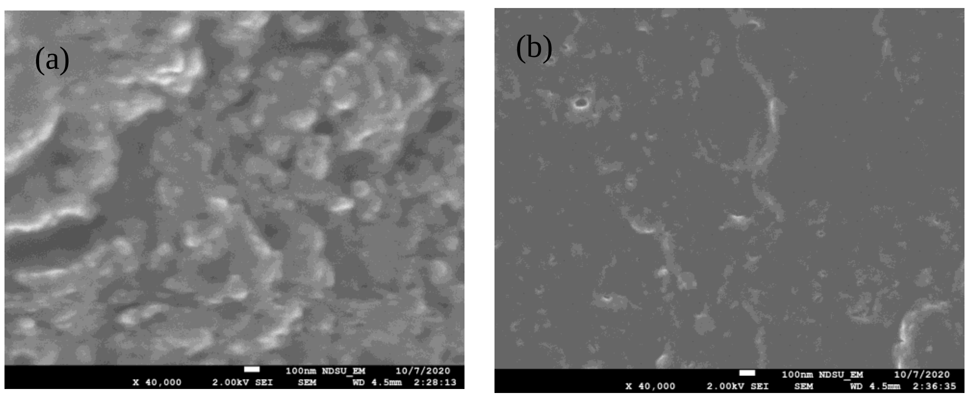

Figure 2. SEM images of soy-based bioplastic film surface upon latex incorporation of (a) poly(HOSBM) 100nm (b) poly(HOSBM) 40nm

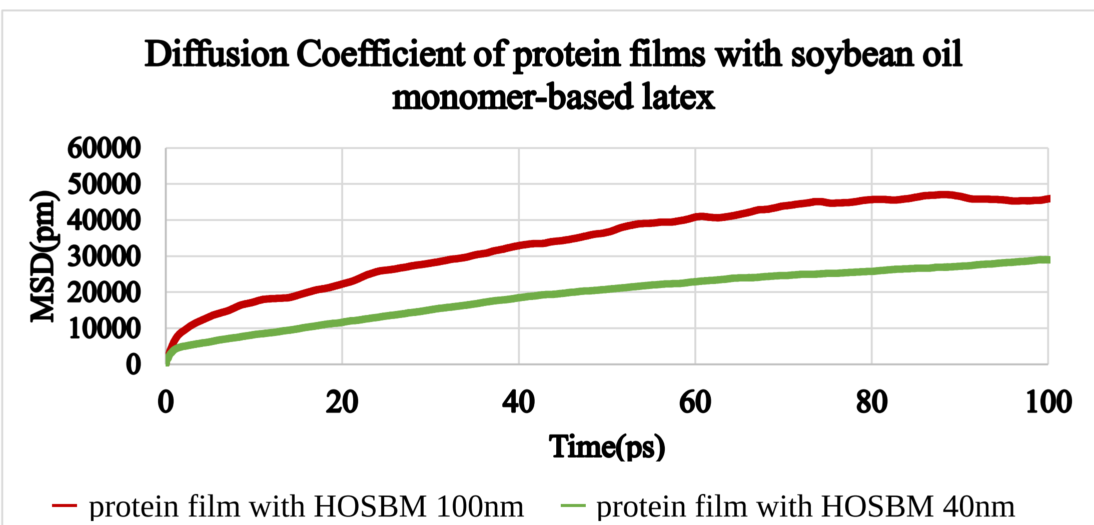

Figure 3. Computational diffusion coefficient for protein films with HOSBM-based latex

Preliminary results

Preliminary results demonstrate that incorporation of soybean oil based latexes into protein films is feasible. Additionally, by decreasing the particle size of the latex, the mechanical and theoretical water barrier properties of the bioplastics are greatly improved.

Work to be completed

Still to be completed are the experimental water vapor permeability tests via the modified cup method, and thermal analysis of the optimized films via dynamic mechanical analysis (DMA) and differential scanning calorimetry (DSC).