AGRICULTURAL RESEARCH FOUNDATION
INTERIM REPORT
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TITLE: Value-added utilization of fruit pomace fiber for creating molded pulp package

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EXECUTIVE SUMMARY: Apple pomace (AP) presents abundantly and contains high insoluble lignocellulosic compounds, which can partially replace recycle newspapers (NP) to create molded pulp package. First of all, it was found that the prepared slurry (3%) of individual NP or AP was not precipitated, but after mixing them at the ratio of 1:1, the precipitation was clearly observed. AP was pretreated by chemical or physical treatment for having the similar quality to NP and/or producing the homogenous mixed slurry of NP and AP without the precipitation. Adding 0.5% or 1% polysaccharides helped AP slurry disperse well in the aqueous system. Alkali, acid, or bleaching pretreatments were unsuccessful for liberating fibers or removing pectin. Wet milling could liberate fibers of AP to form homogenous/smaller particle size of fibers with great amount of surface charges for better suspension. Hence, it was found that AP should be properly pretreated for producing the homogenous fiber slurry with NP and the wet milling could be potentially applied for treating AP.

OBJECTIVES:

- To evaluate the influence of polysaccharides on the stability and suspension of mixed slurry of AP and NP in the aqueous system
- To investigate the effect of chemical or physical treatment on water retention value (WRV) and/or liberating fibers of AP

PROCEDURES:

Part I: Chitosan with the positive charges in the acidic solution and carboxymethyl cellulose (CMC) with the negative charges at the series of concentration (0.1, 0.5, and 1%) were added to mixed slurry (3%) of AP and NP at the ratio of 1:1, respectively. After sitting them for 10 min, pictures were taken and observed whether there was any separation or precipitation in the suspension.

Part II: Alkali and acid treatments were conducted using NaOH and HCl (1%), respectively, to modify AP. Alkali was used to remove hemicellulose and lignin, while acid was used to hydrolyze pectin. Temperature was also used to accelerate the chemical reactions (60 °C) and the time for chemical treatments was 2 h. The bleaching using 2.8% hydrogen peroxide at 80 °C for 1 h was also conducted to remove non-cellulosic compounds. Obtained samples were measured for the particle size, surface charges, or WRV. The particle size and surface charge (zeta-potential) were determined by the Zeta potential analyzer (NanoBrook ZetaPALS,

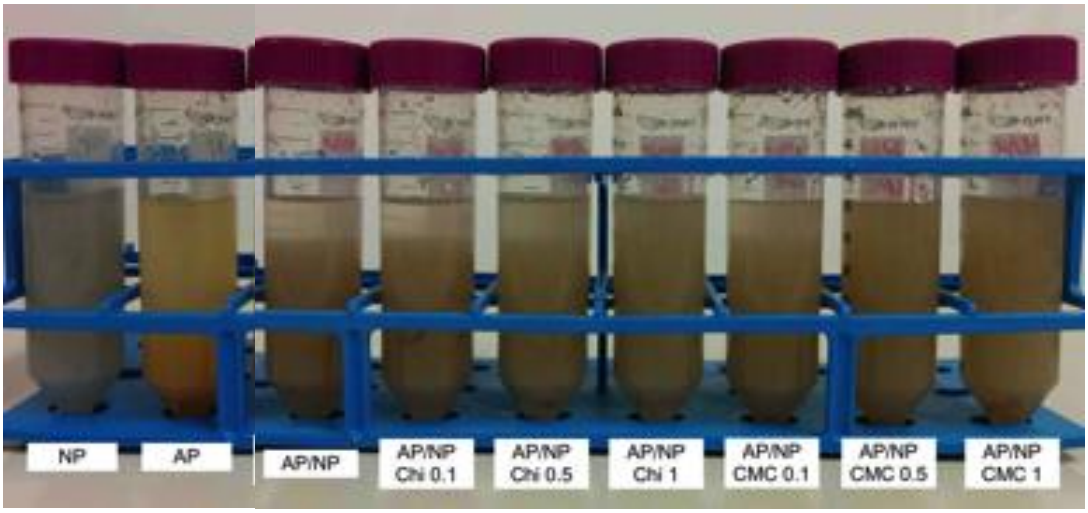
Brookhaven Instrument Corporation, Holtsville, NY). WRV was measured as follows: 100 g of 0.3% pulp suspension was filtered through Whatman GF/A filter paper under vacuum. The test-pad was removed, placed in a falcon tube, and centrifuged at 4,600 rpm and 2 °C for 30 min. The test-pad was weighed, dried in the oven at 105 °C for 24 h, and WRV was determined gravimetrically.

SIGNIFICANT ACCOMPLISHMENTS TO DATE:

Effect of polysaccharides on the stability of mixed slurry with AP and NP in aqueous system

Zeta potential of AP and NP was -2.95 mV and +1.55 mV, respectively. After adding 0.1% of chitosan or CMC to 3% AP slurry, the particle size and zeta potential of AP-chitosan and AP-CMC was 2.7 µm and 1.49 mV and 1.2 µm and -0.78 mV, respectively. Adding chitosan increased the size of particles and also induced the precipitation due to electrostatic interaction between oppositely charged AP and chitosan.

Slurry (3%) of individual NP or AP was not precipitated. However, after mixing them, the precipitation was clearly observed. The dispersion of mixed slurry was visibly observed after adding the series of concentration of chitosan and CMC. As shown below, mixed slurry with 0.1% polysaccharides had the precipitation, whereas adding 1% chitosan and 0.5% and 1% CMC helped the slurry disperse well in the aqueous system. However, it was also concerned that the dispersion was retained due to the viscosity of suspensions obtained from polysaccharide solutions. More fundamental studies in terms of interactions between NP and AP fibers should be conducted by using the scanning electron microscopy, Fourier-transform infrared spectroscopy (FTIR), or X-ray diffraction (XRD).



Chemical treatments on reducing WRV of AP

WRV is important parameter for evaluating the water drain ability of fibers after molding is performed. WRV of NP and AP itself was determined as 340% and 880%, which showed much higher value in AP in comparison with NP. Chemical treatments were performed to remove

hemicellulose and pectin and liberate fibers. The WRV of washed, NaOH treated, and HCl treated AP were 982, 1499, and 1227%, respectively. All treatments provided higher WRV of AP than non-treated AP. Hence, alkali and acid treatments were not effective to reduce the WRV. Washing treatment for removing pectin was also not effective to reduce WRV.

AP was also bleached for mainly retaining cellulose in the sample. However, bleached AP showed higher WRV ranging 1660 and 2385%. Likewise, bleaching treatment was not effective to reduce WRV.

Physical treatments on liberating fibers and reducing the particle size of AP

AP was milled by using wet miller with the nano-beads as shown in picture below.

Milling was conducted about 4 hours. The quality of AP slurry was as follows:

- Particle size: 500 – 900 nm
- Polydispersity: 0.2 – 0.3 (homogeneous)
- Zeta potential: -19 – -25 mV (negative surface charges)

Milling could produce homogenous and smaller particle size of fibers with the great amount of surface charges for better dispersion in the aqueous system. For the future study, milled AP will be combined with NP and investigated its stability and dispersion in the aqueous system.

ADDITIONAL FUNDING RECEIVED DURING PROJECT TERM: N/A

FUTURE FUNDING POSSIBILITIES: Work with an apple pomace producer and pulped contain manufacturer for funding to continue the studies and plan to apply state or federal grants to support the research.