

# Water movement can supply motive force for chain entanglement between pectin chains and films

## Background

- Cost-effective generation of biofuels from plant biomass is enhanced by generation of value-added products from non-cellulosic biomass glycans such as pectins – galacturonic acid-containing glycans that are most abundant in non-grass feedstock. Pectins have many functional groups involved in entanglement. The bioadhesivity of pectin is important for production of commercial gels, coatings and thickeners using pectin. For interpenetration of pectin with natural (e.g. cell walls) or synthetic matrices, a wetting phase followed by an entanglement phase at the polymer:matrix interface is required to enable polymer entanglement and subsequent chemical interactions.

## Approach

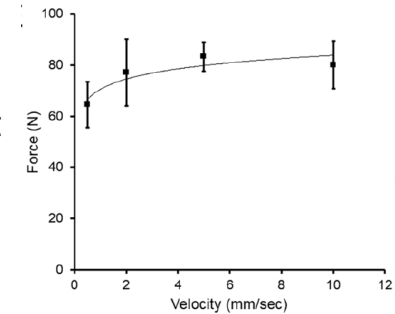
- Physical conditions that influence pectin polymer-polymer entanglement including potential roles of water movement were investigated.
- Water droplets were placed between two pectin gel phase films with equivalent water content and films were compressed at variable glass probe velocities.

## Outcome

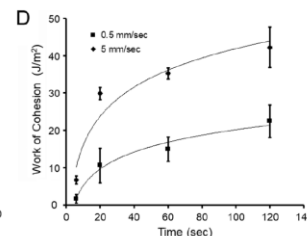
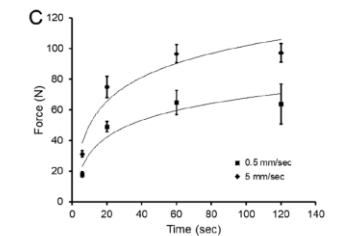
- Slow probe velocity (0.5 mm/sec) demonstrated no significant debonding of pectin polymers.
  - Corresponding videomicroscopy demonstrated an occasional water bridge, but no evidence of stranding or polymer entanglement.
- Fast probe velocity (5 mm/sec) resulted in increased peak adhesion strength, a progressive debonding curve, and increased work of cohesion.
  - Corresponding videomicroscopy demonstrated pectin stranding and delamination between pectin films.
- Scanning electron microscopy during pectin debonding revealed both stranding and delamination.

## Significance

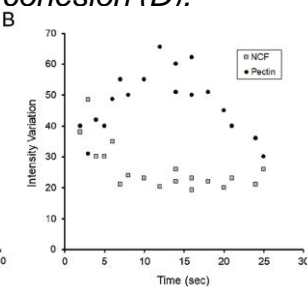
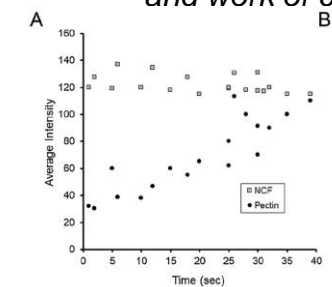
- The results show that water movement can supply the motive force for rapid chain entanglement between pectin films. In contrast to conventional polymer melts, pectin entanglement was observed between glass phase films at room temperature, implying suitability for biocompatible applications.



*Increasing compression velocities resulted in increased pectin peak adhesions strength.*



*Fast probe velocity correlated with greater pectin adhesion strength (C) and work of cohesion (D).*



*Morphometry of entangled polymers from average optical intensity between two polymers during probe withdrawal. Pectin (circles) and nanocellulose fibers (boxes).*