Fermentation Processes Using Biomass Materials

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The USDA-ARS is developing processes for conversion of alfalfa fiber to ethanol for use as a liquid fuel, using anaerobic bacteria that convert cellulose and hemicelluloses to soluble sugars, and that ferment these sugars directly to ethanol. For these processes to be commercially viable, it is necessary to find uses for the fermentation co-products.

While investigating alfalfa fermentation to make ethanol fuel, Paul Weimer of the USDA-ARS Dairy Forage Research Center in Madison and his colleagues have discovered a natural adhesive that could be used in wood products, such as plywood and particleboard. They looked at two species of bacteria: *Ruminococcus albus* which lives in the rumen of cows, and *Clostridium thermocellum* which is widespread in the environment. The bacteria cling to the alfalfa's cellulose fibers and release enzymes that degrade them. A slimy, sugar-based secretion from the microbes' cell walls keeps the bacteria stuck to the fibers.

Alfalfa is the starting fiber material that is wet-fractionationed to yield a juice fraction (high in protein and various nutriceuticals) and a solid residue (alfalfa fiber). The dried alfalfa fiber is fermented and the bacteria produce a sticky material (called a glycocalyx) allowing them to attach to the alfalfa fibers and enhance the breakdown process.

Work is being done with researchers at the USDA Forest Products Laboratory to explore the use of the microbial products as a biologically based adhesive for production of plywood paneling. They have been able to substitute 30% or more of the phenol-formaldehyde (PF) resin currently used in forming plywood panels with an equal weight residue fermentation product by these bacteria. The resulting plywood has wood-failure and moisture resistance characteristics almost equal to that of PF-formed panels, and has the additional benefit of a very light-colored glue-line that is in demand for interior applications such as furniture manufacturing.