Canola-based Epoxy Resins for Bio-based Plastic Composites
North Central Region Canola Research

Principal Investigator: Dennis P. Wiesenborn, Professor
Department of Agricultural and Biosystems Engineering
North Dakota State University, Dept. 7620
Fargo, ND 58108-6050
Ph. 701.231.7277, d.wiesenborn@ndsu.edu

COOPERATING INVESTIGATORS:
Chad Ulven, Co-PI, Mechanical Engineering,
Zhigang Chen, Co-PI, Center for Nanoscale Science and Engineering,
Judith Espinoza-Perez, Postdoctoral Researcher. Agricultural & Biosystems Engineering
Darrin Haagenson, Research Specialist, Agricultural & Biosystems Engineering
Undergraduate students: Katherine McKinnon, Autumn McDougall, Harjot Sidhu, Brent Nerenz

OVERVIEW AND PROJECT IMPACT:
The development of canola oil-based resins for commercial application to composite materials is the long-term objective of this project. Epoxies are already a well-established type of resin used in composites, and thus the current focus is on blends of canola oil-based epoxy and synthetic epoxy resins. The supporting objectives are stated below. By achieving these objectives, we are demonstrating that canola oil-based resins are suitable for high-value applications, thereby helping to create a new market for canola, fostering new business opportunities in the North Central U.S., and lessening our nation's dependence on imported petroleum.

OBJECTIVES:
1. Compare the effect of different curing agents on the mechanical properties of composites containing canola oil-based resin.
2. Compare the effect of different chemical treatments on the fiber-matrix adhesion of composites containing canola oil-based resin.

SUMMARY:
Our previous work showed that resin blends containing up to 30% canola oil-based epoxy resins produced composites with acceptable mechanical properties. The curing of those resins requires addition of a chemical hardener, and alternative hardeners might yield improved performance. Therefore, a major focus during this reporting period was the evaluation of different hardeners to maximize mechanical and thermal performance. Of the six hardeners evaluated, one hardener stood out as having superior thermal performance: PACM. Glass transition temperature (T_g) is an excellent measure of thermal performance, and PACM-hardened resins exhibited a high T_g of 100°C. The higher the T_g, the more resistant is the material to high temperatures. PACM was subsequently used to harden composite samples containing 30% canola-based epoxy. The mechanical and thermal characterization of those samples showed that the PACM-canola composite is suitable for applications where temperature is a critical factor. The next step of this research is to use the defined conditions included in this report to improve the fiber-resin/hardener adhesion of the composites.

PUBLICATIONS:

- Espinoza-Pérez, J. D, C.A. Ulven and D.P. Wiesenborn. 2010. Epoxidized high-oleic vegetable oils applied to composites. *Transactions of the ASABE*, 53(4): 1167-1174.

- Espinoza-Pérez, J.D. 2010. Production, characterization, and raw material cost analysis of a canola oil-epoxy resin applied to composites. Ph. diss. Fargo, N.D.: North Dakota State University, Agricultural and Biosystems Engineering Department.

PRESENTATIONS:

- Espinoza-Pérez, J. D., C.A. Ulven, C. Gustafson and D.P. Wiesenborn. Canola-based epoxy resins for bio-based plastic composites. Symposium--Canola End Uses – Biofuels/Bio-Based Products Canola Research Conference Agenda / Nov 2-3, 2010. Long Beach California ASA-CSSA-SSSA Annual Meetings / Oct 31-Nov 4, 2010

- McKinnon, K., J. D. Espinoza-Pérez, D. Haagenson, C.A. Ulven, B. Nerenz and D.P. Wiesenborn. Improved curing of bio-based resin applied to composites. CSBE/ASABE North Central Inter-sectional Conference, October 7-9, 2010. University of Saskatchewan, Saskatoon, SK.