NMSU industrial engineering seeks to expand wood-plastic composites - with chile plant

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Delia Valles-Rosales, an associate professor of industrial engineering at New Mexico State University, shows samples of wood-plastic composites developed by her research team, using plastic molds developed by industrial and mechanical engineering students, as well as students from NMSU's Manufacturing, Technology and Engineering Center. Valles-Rosales' research team is studying the

possibility of using chile plants as a wood substitute in WPCs. (NMSU photo by Harrison Brooks)

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It is common knowledge that New Mexico State University's Chile Pepper Institute has worked for years in crossbreeding and combining chile varieties to provide for delectable culinary experiences. Now the university's Department of Industrial Engineering is getting in on the act - but researchers there are looking at ways to combine the chile plant itself with plastic. Not a tasty venture, to be sure, but if successful, it could be a significant income generator for New Mexicans.

Wood-plastic composites (WPCs) - also known as natural fiber plastic composites or natural fiber reinforced plastics - are composite materials comprised mainly of a mixture of wood fibers and plastics, as well as small amounts of additives to enhance the compatibility and mechanical properties of the composite material. The wood particles act as reinforcement fibers while the plastic serves as a matrix to hold the fibers. The material originally was developed in the 1960s, and improved applications coupled with increased market demand have allowed the industry to grow rapidly over the last two decades.

Anatole A. Klyosov reported in his book "Wood-plastics composites," from 2007, that "...by 2011, the market for composite decking is expected to surpass $2 billion, or a third of the overall decking market according to estimates from the Freedonia Group." Revenues could top $5 billion by 2013, as the composite material grows in popularity, particularly in decking and railing products. The product is environmentally friendly, resistant to decay and insects, and weathers better than wood, rarely splintering, cracking or warping.

Companies use both recycled and virgin plastic to combine with wood products like pallets, furniture waste, recycled oak wood flour, oak and pine from millwork and reclaimed cedar wood chips, among other sources. Over time, researchers have investigated high levels of wood and plastic combinations with functional additives, such as coupling agents, UV stabilizers, antimicrobials and antioxidants.

Delia Valles-Rosales, associate professor in NMSU's Department of Industrial Engineering, believes manufacturers in New Mexico could cash in on this growth by using chile plants for the composite material. For the last 18 months, she has directed research on the viability of such a combination with a team of IE graduate students comprised of Haytham Alodan, Steven Hespeler, Ivan Rodriguez, Alejandro Alvarado, John Giusto and Kazunari Maeda. The group is collaborating with Stephanie Walker from the Extension Plant Science Department; Paul Bosland in the Department of Plant and Environmental Sciences in the College of Agriculture, Consumer and Environmental Sciences; Kenny Stevens in the Department of Engineering Technology; Juan Noveron at the University of Texas at El Paso's Department of Chemistry; and Biad Chili Ltd. Co. of Mesilla Park.

"We went to Biad and talked to Mr. Don Valles and Mr. Vince Hernandez about the possibility of using chile plants," Valles-Rosales said. "Biad gets chile from more than 100 farms around the state and eastern Arizona and West Texas. Farmers bring the whole plant and the chiles are dried and separated in the facility, so we can share the plant waste with the farmers who pick some of it up for feed. Our job is to analyze how we're going to collect these plants and how much it's going to cost. This could lead to economic development for New Mexico, with mass production of wood-plastic products."

About 60 percent of a mature chile plant's weight resides in its stems, leaves and roots - which typically are discarded or used as cattle feed post-harvest. If that material could be utilized for WPCs, local manufacturing facilities could be built to produce the product - since New Mexico is the nation's

leader in chile production, the industry would be a natural fit.

The research team is exploring a wide range of composite ratios - how much wood versus how much plastic, and also varying grain sizes - 120, 150 and 600 microns, which basically ranges from product that resembles sawdust all the way down to a floury, sandy type of grain. The plastics used in the process also are comprised of recycled material.

"We got about 84 samples, about five for each combination, then we conducted the tests," Halodan said. "We got promising results. Some results exceeded the minimal industry requirements even without any additives added. If we add the coupling agent it's going to increase quality and durability about 30 to 40 percent, so we're going to get a good result. The objective is reducing the cost of WPCs while increasing the mechanical physical properties."

The research is far-reaching. In order to test the various WPC ratios and grain combinations, the team must create product models that measure up to standards set forth by ASTM International, a globally recognized leader in the development and delivery of international voluntary consensus standards (specifically ASTM D638-9 - Standard practice for tests to evaluate the tension test of plastics and plastics composites). To meet these standards, very particular, exact models of each WPC combination had to be manufactured. Students from mechanical and industrial engineering, and M-TEC (Manufacturing, Technology and Engineering Center) designed plastic molds to create the models, and also were involved in using injection-molding machinery to actually fill the molds with the WPC sample.

Degradation testing is another part of the research and development process. The team will subject the samples to UV light testing and as many other weather and environmental conditions as possible in a very intense fashion, to replicate years of wear in a matter of months. It is crucial to measure and record how well the samples created at NMSU with the chile plant holds up in comparison to other WPC products, as well as regular plastic and wood products of similar type.

Part of the research Valles-Rosales and her team are doing includes examining the costs of collecting the chile plants, included logistics and transportation analysis and a feasibility analysis on the ability to temporarily store the plant waste. Also, since red chile is seasonal, the team is investigating other potential local resources for use in WPCs, such as byproducts from cotton plants, branches from pecan trees and even the pecan shells themselves.