Desert Shrub
May Help Preserve Wood

Chemist Francis Nakayama removes a sample of wood impregnated with guayule resin from a pressure treatment chamber.

EDWARD MCCAIN (K9852-1)

Termites and wood-rot microbes that make a meal of wooden beams, walls, and floors may soon be outwitted by ARS scientists and their USDA Forest Service and university colleagues. The researchers have determined that combining components of the guayule *(why-YOU-lee)* plant, a desert shrub, with plastic from recycled soft drink or milk containers yields a composite material that repels these tiny attackers.

The plastic acts as a binder in this durable and versatile composite, says Francis S. Nakayama, a research chemist with ARS' U.S. Water Conservation Laboratory in Phoenix, Arizona.

"The guayule composite can replace many kinds of wood that are exposed to—and susceptible to—costly insect and microbial damage," Nakayama notes. "These include wood for floor, wall, and roof construction in homes and commercial buildings."

Why Guayule?

Guayule is a hardy, drought-resistant native of the southwestern United States and northern Mexico. Known to scientists as *Parthenium argentatum*, the plant's silvery, grayish-green leaves and yellow flowers make it resemble the more familiar sagebrush.

Scientists and growers alike are interested in making guayule a profitable crop. That's because it yields high-quality latex, ideal for making medical and personal products such as surgical gloves, catheters, and condoms.

Studies led by plant physiologist Katrina Cornish at ARS' Western Regional Research

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Nakayama displays board samples exposed to termites in the laboratory. The control sample of untreated pinewood (left) is badly damaged, but the block made from guayule and recycled plastic milk containers is intact.

Center in Albany, California, have shown that guayule latex is hypoallergenic. In contrast, latex from the tropical rubber tree *Hevea brasiliensis* can cause allergic reactions ranging from discomforting rashes to life-threatening shock. *Hevea* is the world's predominant natural latex source, but it contains more than five dozen allergy-causing proteins. Hypoallergenic guayule latex should soon provide an excellent alternative for the estimated 20 million Americans allergic to *Hevea* latex.

But production of hypoallergenic guayule latex will yield huge amounts of leftover plant material. For every acre of guayule processed for latex, 20,000 to 50,000 problematic pounds of leftovers, called bagasse, are produced. Bagasse is the brownish-white slurry that remains after guayule stems and leaves are ground up and their latex removed. "Bonding the bagasse with recycled plastic to make a guayule composite would be an ideal use of the leftovers," Nakayama says.

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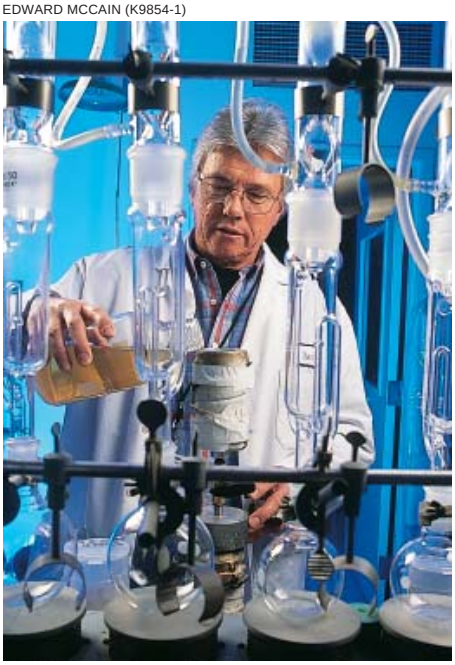

Technician Steve Vinyard pours guayule resin into a pressure treatment chamber that impregnates wood with the termite-repelling liquid.

Guayule Boards Formed

For experiments to make and test guayule-composite particleboard, Nakayama sent air-dried guayule bagasse to colleague John A. Youngquist at Madison, Wisconsin. Youngquist, now retired, was a chemical engineer with the Forest Service's Forest Products Laboratory there.

From the dried guayule bagasse, Youngquist produced three prototype particleboards. One was formed from dried bagasse alone. A second was made of dried bagasse mixed with phenol formaldehyde, or PF, a binder or adhesive compound for making conventional particleboard. The third test particleboard was made from dried bagasse plus recycled high-density polyethylene, or HDPE, from melted-down milk containers. All these prototypes were shaped into panels of various commercial thicknesses with a steam-heated platen press. Using the same press, the boards were next exposed to 730 pounds per square inch of pressure at 350˚F.

Guayule Boards vs. Termites and Rot

Colleague Poo Chow, professor of wood science with the University of Illinois, Urbana, tested the guayule prototypes for resistance to attack by hungry termites and destructive wood-rot microbes. In the United States alone, termites and wood rot cause an estimated $7 billion worth of damage every year.

Chow used the methods and standards set for testing conventional wood products. To evaluate termite resistance, Chow and co-researchers placed small sections of each board in jars containing 400 Eastern subterranean termites, *Reticulitermes flavipes.* This species is one of the most damaging termites in the United States. After a week, the scientists counted the number of surviving termites.

In the decay-resistance experiments, the researchers exposed pieces of the guayule boards to two common brown rot fungi, *Gloeophyllum trabeum* and *Poria placenta*. After 65 to 80 days, scientists looked for two signs of microbial damage: a decrease in weight and an increase of thickness of the guayule boards.

In both types of tests, the HDPE board outperformed the PF board as well as the board made without plastics, according to Chow. "These results," says Nakayama, "suggest that the HDPE board is a promising substitute for conventional particleboard."

Guayule Resins Protect Wood

The scientists also scrutinized a second type of product from guayule bagasse, a mixture known as resin. Their studies are an outgrowth of discoveries made in the 1990s by John D. Bultman of the U.S. Naval Research Laboratory in Washington, DC. Bultman's analysis of dozens of compounds for protecting wooden piers revealed that wood treated with guayule resin is resistant to attacks by several types of termites and marine borers.

Nakayama used acetone, a solvent, to extract the resin from guayule bagasse. He applied various amounts of resin to small blocks of Southern yellow pine that he had placed in a pressurized chamber. This wood is normally vulnerable to both termites and wood rot. The amount of resin in the wood blocks ranged from 0 to 97 percent.

Next, Chow put the blocks through the same termite and wood-rot resistance tests as the guayule particleboards. He found that the wood had to contain at least 50 percent resin in order to resist termite and wood-rot attack. Says Nakayama, "The guayule resin, when properly incorporated into wood, may be an effective natural preservative for wooden buildings, boats, decks, and outdoor furniture."—By **Marcia Wood,** ARS.

This research is part of Quality and Utilization of Agricultural Products (#306) and Plant, Microbial, and Insect Genetics Resources, Genomics, and Genetic Improvement (#301), two ARS National Programs described on the World Wide Web at http://www.nps.ars.usda.gov.

For information about U.S. Patent Application Serial No. 09/828,634, "Composites Comprising Plant Material from Parthenium *spp. and Plastics," contact Francis S. Nakayama, USDA-ARS Environmental and Plant Dynamics Research Unit, U.S. Water Conservation Laboratory, 4331 E. Broadway Rd., Phoenix, AZ 85040; phone (602) 437-1702, ext. 255, fax (602) 437-5291, e-mail fnakayama@uswcl.ars.ag.gov.* ◆