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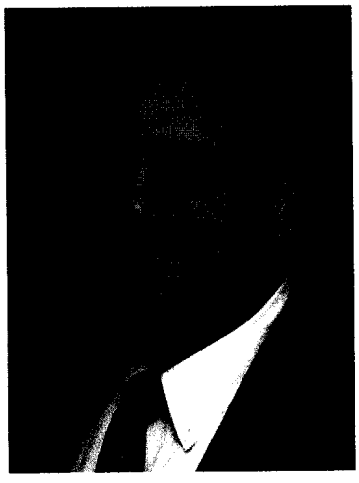
HRI Update

Keratin biodegradable plastics



by MARC TEFFEAU

'USDA-ARS has invented a process to convert the feather keratin into tough, lightweight polymers or plastics that can be extruded or molded just like any other plastic product.'

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The increased interest in sustainability concepts in the green industry has resulted in the introduction of various "sustainable" products into the plant-production chain. In the past 18 months or so, we have seen a collection of "biodegradable" containers being brought to the marketplace — made from straw; rice hulls; corn derivatives, such as PLA (polylactic acid or polylactide); cow manure; and other organic-based plant materials. Dr. Michael Evans of the University of Arkansas, Fayetteville, presented a very informative program at July's OFA Short Course in Columbus, OH, on assessing the biodegradable containers for greenhouse and landscape performance. This research was conducted cooperatively by Dr. Evans, Dr. Jeff Kuehny from Louisiana State University, Baton Rouge, and Matthew Taylor from Longwood Gardens, Kennett Square, PA. Their ongoing research on the current biodegradable pots on the market evaluated the physical properties of various types of biodegradable containers as compared to traditional plastic containers.

The big picture. There are a number of elements driving the move to biodegradable containers in the nursery and greenhouse industry. There is increased consumer demand for "green products" from our industry, not just the plants themselves. The need to reduce, reuse and recycle is also becoming more important. The recent increases in petroleum prices forced the industry to look for other feedstocks for fuels, chemicals and plastics. And, lest we get lulled into a false sense of security, the long-term forecast is for petroleum to be expensive.

In addition, large amounts of organic waste products are generated each year by agricultural product processing. This agricultural waste stream is potential nonpetroleum feedstock for fuels, chemicals and plastics. The Horticultural Research Institute (HRI), the research and development corporation of the American Nursery & Landscape Association, with its Cooperative Research and Development Agreement (CRADA) with the USDA-Agricultural Research Service (ARS), has focused on development of biodegradable plastics from an agricultural waste product that is a protein, specifically keratin — aka chicken feathers.

USDA-ARS estimates that there are more than 5 billion pounds (dry weight: 2.5 billion pounds) of feather waste generated by the US poultry industry each year. Currently, the waste is converted into an animal feed called feather meal. Excess feather waste not converted to feather meal is sanitized by autoclaving and landfilled at an enormous cost to the poultry industry. Outside of the US, concern over mad cow disease and avian flu means only landfilling is allowed. The recent appearance of mad cow disease and avian flu in the US could eventually make this domestic policy, as well. The landfill required to bury all of the feathers each year, if feather meal was not an option, would cover 984 acres of land at a depth of 50 feet.

Feathers are entirely composed of the structural protein keratin. Keratin persists in hair and feathers (features that protect the animal), hooves (a feature that bears the animal's load) and horns (a feature that both protects and supports the ani-

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mal) because it is tough, strong and lightweight. In 1998, USDA-ARS scientists were granted a patent for a process that efficiently cleans and sanitizes feather waste and separates it into useable fiber and quill fractions. In addition, USDA-ARS has invented a process to convert the feather keratin into tough, lightweight polymers or plastics that can be extruded or molded just like any other plastic product.

From feathers to functions. The objective of the HRI/USDA-ARS CRADA is to develop uses of the feather keratin fiber and quill in value-added products for the horticulture industry. These commercial products for the nursery, landscape and floriculture industries include biodegradable pots, plastics, trays, greenhouse films, turf mesh netting and related products. Products made from feather keratin would be sustainable and environmentally friendly because they are not derived from petroleum, and they are biodegradable through natural environmental processes. The initial research focus is to develop biodegradable plastic resins for injection molding of nursery containers. To expand the scope of the research, HRI has added another CRADA to the research effort that will focus on the use of plant-based proteins and other plant agricultural waste products that may be included in the resin formulations.

This joint research effort is being conducted by Dr. Masud S. Huda, HRI research associate, and Dr. Walter F. Schmidt, ARS research scientist at the USDA-ARS Environmental Quality Laboratory at Beltsville Agricultural Research Center in Beltsville, MD. Accomplishments to date include the filing of a joint provisional patent (USDA-ARS/HRI) application in October 2008. The project has successfully extruded and pelletized 11 keratin formulations and successfully produced injection-molded, prototype nursery pots from various resin formulations. As these formulations are developed, all the background technical polymer science work is being completed to add the needed technical and performance details to the patent application. Five test runs of resin formulations have been completed with cooperating pot manufacturers. To establish the biodegradability characteristics of the resin formulation, composting/biodegradable research trials to meet ASTM 6400 Standards for biodegradable plastics were also initiated at Beltsville.

The business of research. Because this is not only a research and development project on the part of HRI but also a business venture, HRI has signed mutual nondisclosure and materials transfer agreements with four pot manufacturers, one turf equipment producer and a plastics resin formulator. HRI has established the legal corporate format to license formulations and retained Finnegan, Henderson, Farabow, Garrett & Dunner LLP, Washington, DC, as legal counsel to support patent and intellectual property rights discussions. A business plan has been developed and continues to be refined to guide the research, and HRI retained the services of the retired president of DuPont Plastics, Wilmington, DE, as business consultant to assist in that process.

HRI has to look at the complete supply chain to bring a biodegradable product to market, so we have established a relationship with a Baltimore-based plastics resin compounder/formulator and collaborated on related projects with a Maryland company and a poultry processor in Delaware to build a pilot-test plant to process feathers with proprietary technology.

Just as there are many steps in bringing a plastic water bottle to market, the development of a biodegradable plastic pot is as involved. The challenge in working with keratin, as compared to working with a known feedstock like PET (polyethylene terephthalate) or HDPE (high-density polyethylene) petroleum resin material, is that many of the production parameters will have to be determined.

With continued industry financial support, we can bring alternative biodegradable plastic materials to the nursery and floriculture marketplace to help support the movement of the green industry to sustainability — while still remaining profitable.