

Tobacco Tech

Looking to the Future of Tobacco, Issue 3, July 2000

Molecular Farming Using “Tobacco Gum”

Using biotechnology, tobacco can be engineered as a “plant factory” to produce a variety of new materials including pharmaceuticals, vaccines and industrial enzymes. Several companies are already utilizing this technology and moving tobacco “molecular farming” (or “pharming”) toward commercial-scale production.

There are several different molecular farming systems under development. Some focus on corn, soybeans, or alfalfa as their “plant factories” of choice, with each system having its own advantages. Tobacco produces a large amount of green leaf material per acre and is easy to scale-up resulting in abundant production of product. It is also easily engineered to produce new products, making it particularly productive for molecular farming applications.

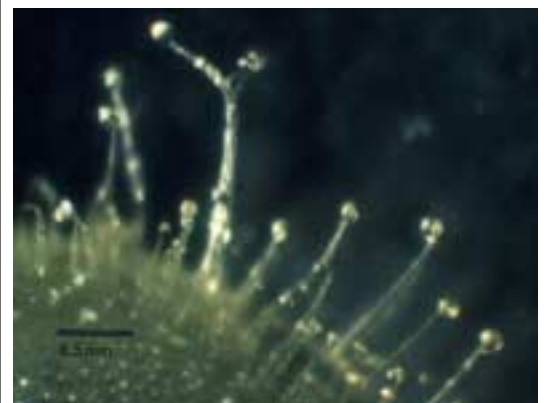
Unlike traditional tobacco production, molecular farming involves grinding up green tobacco plants which have been engineered to produce a high-value product and then extracting that product from the liquid material. Profit levels are largely determined by the amount of the product produced in the leaves and the cost of purification. Processing and purification for molecular farming systems may be very expensive, but through the collaborative research efforts of THRI and the Agronomy Department at the University of Kentucky, there may soon be a new, potentially cheaper, production method that uses tobacco as a “plant factory.”

Everyone who has worked in a field of tobacco is familiar with “tobacco gum.” It is almost impossible to walk through a tobacco patch and not get this sticky

material on your skin and clothes. Most types of tobacco secrete sticky compounds that are deposited on the outer leaf surface, compounds that are thought to be the plant’s first line of defense against insects and disease. Some tobacco varieties can produce as much as 16% of the leaf dry weight as “gum”. Controlling the output of this sticky material could provide a new production method for biochemicals in tobacco.

Dr. George Wagner and Dr. Susheng Gan at the University of Kentucky have recently isolated a genetic “promoter” which represents an important first step in this direction. This new technology will facilitate efforts to control the types of compounds that are secreted by tobacco leaf hairs or trichome glands (shown below).

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The magnified picture above shows tobacco leaf hairs or trichome glands. Some tobacco varieties are capable of producing up to 16% of the leaf dry weight as secreted material, making tobacco gum a potential high capacity factory for biochemicals.

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Tobacco Gum

Production of biochemicals in tobacco gum offers several advantages over other molecular farming systems. By targeting the production of new materials to the gum, the desired product is secreted outside the plant onto the leaf surface. Because some target compounds may be toxic to the plant this should provide a way to produce some compounds whose production was not possible using prior technology, increasing the number of potential materials that might be produced using genetically engineered tobacco. Purification should also be much easier and cheaper with commercial products produced in the tobacco gum and recovered by simply washing the plant with an appropriate solvent. In addition, a second, different product could be produced inside the tobacco leaves making this a dual production system and greatly enhancing the profit potential.

While most molecular farming strategies involve inserting genes into the plant to produce an entirely new product, there is another unique potential application of this “tobacco gum” system. Instead of producing a totally new product in the “tobacco factory,” it may be possible to modify the sticky compounds in tobacco gum

to make them intrinsically more useful.

There are certain Caribbean, reef-dwelling soft corals that produce compounds that are chemically similar to those that are abundant in tobacco gum. These endangered corals (shown below and on the front page) are currently being harvested from coastal reefs to extract anti-inflammatory drugs and for use in the cosmetics industry. It may be possible to use genetic material from these corals to engineer tobacco to produce these drugs. The next step in this project is to isolate specific genes from the coral and transfer them to the very sticky tobacco varieties to determine if these drugs might be produced in tobacco gum. If successful, this would create a new crop opportunity for Kentucky tobacco farmers and have substantial environmental benefits.

In addition to using this technology as a high-level production system for biochemicals, there is considerable potential for using the “tobacco gum” technology to express new genes in tobacco plants to improve insect and disease resistance (e.g. to engineer resistance to blue mold). These improvements are also being pursued.



The “tobacco gum” in these magnified tobacco leaf hairs has been stained purple to show how the gum is produced in the trichome glands and then moves outside and down the leaf hairs onto the leaf surface.

Endangered marine corals are being harvested from coastal reefs to extract anti-inflammatory drugs and for use in cosmetics. It may be possible to alter “tobacco gum” to produce these highly valuable materials.

Ag. Biotech Update

Recent surveys indicate that genetically engineered crops are gaining broad acceptance worldwide; the adoption rate has been the highest ever for any new agricultural technology. The USDA crop acreage survey of U.S. producers indicates that in 2000, biotech crops account for 25% of corn acreage, 54% of soybean acreage, and 61% of cotton acreage, with both soybeans and cotton increased from 1999. Worldwide biotech crop acreage jumped 44% between 1998 and 1999 to 100 million acres (Survey by International Service for Acquisition of Agri-biotech Applications).

The rapid adoption of any new technology will inevitably result in a heightened public interest and demand for information. The University of Kentucky is developing an educational program to assist the dissemination of science-based information concerning ag. biotechnology. This program, called **BREI** (*Biotechnology Research Education Initiative*) consists of a multi-disciplinary team of research, extension, and teaching professionals from the College of Agriculture. BREI will provide internet-based educational materials, extension publications, and presentations to assist educators and the general public. THRI is pleased to participate in BREI by providing information in the field of plant / tobacco molecular farming.

TOBACCO TECH is an occasional series published by THRI to inform growers and others about exciting new possibilities for tobacco. Topics will provide information on our cutting-edge biotechnology research program and our efforts to stimulate new crop opportunities for Kentucky tobacco farmers.