Genetic modification may help tobacco find new life as health savior and biofuels source

Since scientists first began to understand the health risks of smoking several decades ago, tobacco has not been viewed in a positive light. However, that's on the cusp of changing. Innovative researchers are now genetically modifying tobacco plants for several innovative projects, from biofuels to medicine, that could revolutionize the notorious reputation of the plant.

Scientists have been experimenting with GM tobacco recently and have discovered its potential as an alternative for biofuels. Using GM tobacco as a source for biofuels could help jumpstart the biofuels industry and help it take off. While biofuels have numerous environmental benefits, their widespread use has been inhibited by a lack of economic incentive. Currently, biofuels come primarily from crops such as corn and soybeans, which are not very efficient as fuel sources and might actually contribute to global warming.

In fact, there has been some controversy in recent years over whether biofuels are an economic bleed. Critics claim that the industry has been artificially propped up by government subsidies based on outdated ideas of what is sustainable. Most of America's corn subsidies go into making biofuels, which has kept the controversy boiling, given the lack of progress made on the promise of their efficiencies and the waste that has occurred.

These critics argue that given the costs and unintended consequences, biofuels are not a viable alternative to oil-based fuels. But those who believe in the promise of biofuels maintain that scientists may soon find more efficient crops to use that will balance out the benefits of using them. GM tobacco, which could produce at least twice as much biodiesel as a hectare of soybeans, could prove to be the crop that turns the perception of biofuels around and helps lift the industry.

Researchers at the Public University of Navarre in Spain have demonstrated that specific tobacco proteins, known as thioredoxins, can be tweaked and turned into viable biotechnological tools. Led by doctoral candidate Ruth Sanz-Barrio, the team was able to increase the amount of starch produced in tobacco leaves by 700% and fermentable sugars by 500%, two of the key ingredients in crops used for biofuels.

"We believe that these genetically modified plants could be a good alternative to food crops for producing biofuels, and could provide an outlet for the tobacco-producing areas in our country that see their future in jeopardy owing to the discontinuing of European grants for this crop," Sanz-Barrio said.

The benefits of GM tobacco may not be limited to biofuels, however. In recent years, scientists have also been able to use a modified tobacco virus to deliver delicate gene therapies into the heart of diseased cells. This type of gene therapy could potentially treat most cancers, viruses and genetic disorders.

Much of the pioneering research in this area traces to the work of University of Maryland bioengineering professor William Bentley, who led the study of a modified tobacco virus, known as the "tobacco mosaic

virus," as a delivery mechanism for vaccines. The virus disrupts the function of the tobacco plant it grows in but is not harmful to humans. The hollow virus can be filled with "small interfering RNA" molecules and then used to treat patients, which a *Wired* article suggests is one of the most significant developments in medicine since the discovery of vaccines.

By utilizing the unique structure of genetically modified tobacco plants, scientists might also be able to fight deadly cancers and genetic disorders, which are very difficult to treat with traditional methods. Additionally, GM tobacco might allow researchers to study a number of rare diseases that often go overlooked by big pharmaceutical companies.

"The speed with which you develop siRNA drugs is truly amazing," Oxford University geneticist Dr. Stephen Hyde has said. "In the past, a traditional small molecule drug might take several years of intensive research effort by a large team of scientists to develop. Today, with siRNA technology, it is possible for a single researcher to develop a drug candidate in a few weeks."

Scientists are also looking to GM tobacco as a revolutionary way of delivering vaccinations to the masses in a medical crisis. Canadian biopharmaceutical company Medicago, which has its American headquarters in the heart of North Carolina's once-thriving tobacco industry, is developing highly effective and competitive vaccines based on proprietary manufacturing technologies and Virus-Like Particles (VLPs).

VLPs, while similar to actual viruses, are non-infectious due to the fact that they do not contain any viral genetic material. Because of this, wrote David Worthington on the SmartPlanet blog, they are a safer alternative for the development of vaccines. VLPs could yield stronger and longer-lasting protection against influenza than traditional vaccines. Medicago is currently one of only two companies to have run clinical trials on VLP flu vaccines.

Medicago's transient expression system for developing VLP vaccines speeds up the process of producing large-scale vaccines, which would allow vaccination of the population before the first wave of a pandemic, and supply large volumes of vaccine antigens to the world market. Unlike manufacturing methods that produce traditional egg-based vaccines, Medicago's method only requires the genetic sequence of the viral strain, dramatically limiting potential delays.

Just last year, the biopharmaceutical company was able to produce 10 million doses of a H1N1 VLP influenza vaccine candidate in one month, a process known as a "rapid fire test." This success was enough to entice Japan-based Mitsubishi Tanabe Pharma to acquire the company earlier this year.

Scientists have also used a similar process to create a new treatment for rabies, which has long been a painful and lengthy disease to combat. They were able to produce an antibody in GM tobacco plants that proved effective in neutralizing the rabies virus. The antibody works by preventing the rabies virus from attaching to the nerve ending around the wound and therefore, prevent the rabies virus from traveling to the brain.

Similar research is being done to explore GM tobacco's potential for treating the HIV virus. Scientists

believe they might be able to utilize the specific proteins grown in GM tobacco as antibodies to fight some of the effects of the virus. Unlike current treatments for HIV, using GM tobacco could be done cheaply and on a large scale, which would allow poorer citizens in developing countries to access treatment for the disease.

While GM tobacco was initially used as an inexpensive alternative to other test plants, it has been shown to have remarkable capabilities in helping to treat a wide variety of diseases and disorders. If this research momentum continues, innovative scientists may be able to rewrite the legacy of this much maligned plant.

Additional Resources:

- "Could tobacco be used to produce biofuels?" Salon
- "Fighting HIV in developing countries – with tobacco," The Guardian
- "Genetically Engineered Tobacco Plant Cleans Up Environmental Toxin," Science Daily