Fabricio Medina-Bolivar, PhD

Harvesting a Healthy Future from Hairy Roots

Arkansas researcher harnesses medicinal power of plants & seeks partners to scale revolutionary technology

Dr. Fabricio Medina-Bolivar, a native of Lima, Peru, is studying ways to improve human health by increasing the amount of beneficial compounds produced in plants. Communities around the world have long relied on the medicinal power of plants. Dr. Medina-Bolivar's research is transformative because it allows the production of exponential quantities of these beneficial compounds by subjecting plants to specific stressors. Dr. Medina-Bolivar's patented technology specifically depends on the use of "immortalized" plant roots known as "hairy roots," a type of lab-grown plant tissue that has been modified to exhibit indefinite growth and proliferation. His technology has the potential to be applied to the pharmaceutical, nutraceutical, and cosmeceutical industries, and he's seeking partners to help take this technology to an industrial level.

The Challenge

Plants naturally produce compounds with antioxidant, anti-inflammatory, or anticancer properties. In normal conditions, they produce only what they need, which is a small or undetectable amount, so it's challenging to use their properties to create products for humans. Additionally, the process of finding plants in the field and making standardized extracts enriched in beneficial compounds is inefficient, requiring a lot of steps, time, and cost. It also has been difficult in the past to find these compounds - researchers often had to travel thousands of miles to collect thousands of plant samples from the field. Therefore, there is a need for a new, standardized approach that can scale production to meet demand from companies looking to use the medicinal power of plants to create products such as supplements, cosmetics, and pharmaceuticals.

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The Solution

Dr. Medina-Bolivar and his team are manipulating the plant system by subjecting the "hairy roots" of several plants such as peanut, mulberry, pigeon pea, and annatto, to stress, which forces them to produce more compounds that can be used to help humans. In nature, "stresses" such as changes in temperature, fungus, bacteria, or other factors make plants uncomfortable. The plants respond to stress by producing more chemicals that help them survive. In his lab, he mimics these stresses by applying chemical elicitors or inducers to the "hairy roots" to make them produce defense compounds - and these same chemicals happen to have the antioxidant, anti-inflammatory, and anticancer properties that can help prevent or treat diseases in humans. The chemicals are secreted by the "hairy roots" to produce an extract that's easy to use and control with a defined and reproducible chemical profile. The extracts are enriched in bioactive compounds - in some instances, the levels of these compounds can be increased more than 50,000 times normal levels.

Arkansas Research Alliance

Methods & Data

Dr. Medina-Bolivar's research group is using a few different techniques to study the “hairy roots” of different plants and the beneficial compounds they produce, including looking at the genes involved in making these compounds. They also are studying the effects of these compounds on different cancer cell culture models. For example, upon stress, peanut “hairy roots” secrete compounds known as prenylated stilbenoids.

These compounds are being studied as potential adjuvants, which are treatments used to enhance the effectiveness of therapy, in this case for triple-negative breast cancer (TNBC). TNBC is a particularly challenging type of breast cancer to treat, accounting for 10-15% of all breast cancers diagnosed annually in the US, with an estimated 42,000 cases per year. TNBC lacks the three receptors that are targeted by many standard breast cancer therapies, making it more aggressive and more likely to spread, leading to a poorer prognosis. The potential of prenylated stilbenoids from peanut "hairy roots" as adjuvants for TNBC is therefore an important area of investigation, with the potential to develop new treatments that could improve outcomes for patients with this difficult-to-treat cancer. Overall, Dr. Medina-Bolivar's team is working to understand how these plant roots make these helpful compounds, so they can find ways to produce more of them and potentially create new treatments for diseases.

Next Milestones

The novel and exponentially more efficient manufacturing process Dr. Medina-Bolivar developed has the potential to be applied to various industries, including discovering compounds for breast cancer prevention and treatment. This research aims to find ways to produce these beneficial compounds in larger quantities and use them in different ways, including medicine and nutrition. As long as plants react to stress, the technology can be adapted to produce biologically active compounds. To scale up the technology, Dr. Medina-Bolivar is seeking partnerships with industries and academia with expertise in bioprocessing engineering using plant-tissue bioreactors and large-scale purification strategies for small molecules. He is also seeking partners for in vivo studies to further advance the technology.

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