Plant-derived withaferin A is a potential anti-tumor agent

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Von Bieberstein measures the average leaf size and height of each plant weekly to collect data on growth. Credit: Michaela Brumbaugh

Philipp von Bieberstein's research focuses on the plant Withania somnifera, a member of the tomato family that contains a potential anti-tumor agent.

"It's going to change everything," says University of Arizona junior Philipp von Bieberstein.

He's talking about his independent study research comparing growth of a medicinal plant in hydroponic versus aeroponic systems in greenhouses at the University of Arizona's Natural Products Center, part of the College of Agriculture and Life Sciences' School of Natural Resources and the Environment.

Von Bieberstein's research focuses on the plant Withania somnifera, a member of the tomato family that contains a potential anti-tumor agent called withaferin A, which can be isolated through chemistry. The roots of the plant have been used medicinally for more than 3,000 years in India and adjoining countries. Historically, roots were used to treat cancer, stress and neurological disorders.

His work is taking place in greenhouses at the Natural Products Center, or NPC, which has a mission to discover and utilize arid land plants for natural products in both medicinal and agricultural applications.

Successful economies in arid lands, especially in the southwestern United States, depend upon developing new resources that require less water.

"For the survival of arid lands under these harsh ecological conditions, they have to produce natural products," says Leslie Gunatilaka, director of the NPC.

Gunatilaka's research group at the NPC focuses on utilizing the biologically active compounds in the aerial parts of the Withania somnifera plant to potentially treat cancer, stress and neurological disorders. The group anticipates the demand for the compound will be great in the future. As the patent holder for production of the withaferin

A compound by aeroponic cultivation, the group is investigating how to produce the compound more efficiently.

During the fall semester, von Bieberstein began working on an independent study regarding the effects of different growing conditions on the overall production of biomass in Withania somnifera. In the experiment, the biomass consists of the aerial parts of the plant – the stem and leaves – harvested for use.

Previous studies have concluded that in both hydroponic and aeroponic systems, the plant accumulates more of the compound in its shoots, rather than in the roots. In soil, however, the compound can be found in higher concentrations within the roots.

In the Natural Products Center's greenhouses, von Bieberstein seeded Withania somnifera in rockwool – a green, fuzzy growing medium composed of rock and often used in controlled environments – in two different systems.

In the hydroponic system, plant roots are submerged in a nutrient solution largely composed of water rather than in soil, whereas in the aeroponic system the roots are sprayed daily with the solution. Both systems are extremely water efficient compared with traditional crop production in fields where evaporation rates are high.

Since sprouting the seeds in the lab and installing them within each system, von Bieberstein has been monitoring the plants' growth by measuring average leaf size and height of each plant in each system. The plant material is harvested and weighed from both sets of plants, then dried and weighed again.

The research focuses on the relationship between biomass production and concentration of withaferin A within plant tissue. The results could

have applications in cultivating Withania somnifera with increased concentrations of withaferin A as well as in cultivating other medicinal plants with increased biomass. So far, von Bieberstein's data indicates that the hydroponic and aeroponic systems produce relatively equal biomass.

Von Bieberstein also is determining which system produces a higher concentration of the compound in the plant material. Plants from the aeroponic system are under more stress during growth as a result of their minimal daily misting of nutrient solution. As a result, von Bieberstein expects that withaferin A will be higher in the aeroponic system.

Plant material from each system is kept separate to ensure the experiment's validity and is processed to a fine particle size in a grinder. Withaferin A is extracted from the tissue using chemical techniques like suction filtration and centrifugation.

Throughout his independent study, von Bieberstein has gained experience managing a greenhouse and growing and harvesting medicinal plants. He is also gaining hands-on experience in the lab, where he isolates withaferin A from the plant material.

Von Bieberstein views student-initiated research projects as an essential part of an undergraduate's education.

"Unlike in a classroom setting, you learn by actually planning everything," he said. "Essentially you create your own course for the semester so you can make sure that you will be doing something that you will be interested in.

"The methods I learned while growing these medicinal plants from start to finish and the techniques used to extract the active compound are something that I would have never learned in a normal classroom."

Provided by University of Arizona