Blue Goo and the Healthy Heart

by Michelle Delio

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The healing technology of traditional Hawaiian culture was based on making use of the nutritional and medicinal properties of plants from the land and ocean.

Now a modern Hawaiian company, Aquasearch, has developed a new way to grow and extract heart-healthy substances from microscopic, single-cell, photosynthetic water plants known as microalgae.

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Aquasearch said Wednesday that it has initiated a clinical trial for patients with coronary heart disease -- one of the leading causes of death in Hawaii and throughout the United States.

The randomized, double-blind trial will evaluate Astaxanthin's ability to reduce blood serum levels of C-reactive protein (CRP). Astaxanthin is a natural antioxidant that is found in

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many marine fish, crustaceans, and algae.

CRP is an indicator of low-grade arterial inflammation and the single strongest predictor of risk of future heart problems in apparently healthy men and women.

The trial will be conducted at the Thoracic and Cardiovascular Healthcare Foundation in Lansing, Michigan, in association with Michigan State University. Approximately 100 patients with documented coronary artery disease will receive either a placebo or "AstaFactor," Aquasearch's astaxanthin-rich algal extract.

According to David Watumull, Aquasearch's executive vice president, microalgaes make up half of the plant kingdom -– "the unexploited half."

There are an estimated 30,000 species of these single-celled plants. You can find them in water –- any water –- from the depths of the ocean to the polar ice caps.

Microalgae, like other plants, can be used to make foods and medicines. The only reason that really hasn't happened yet, said Watumull, is because until recently there has been no way to produce microalgae on a commercial scale.

That's where Aquasearch comes in. The company's "Aquasearch Growth Module," or "photobioreactor," allows microalgae to be produced in large amounts.

It was designed in the mid-1980s by the co-founders of Aquasearch, a group of

scientists and engineers who were then working at Scripps Institution of Oceanography: Dr. Mark Huntley, Dr. Donald Redalje, James Jordan, and Charles "Rocky" Booth.

"It all started over a beer at Scripps' traditional TGIF night," said Huntley, CEO of Aquasearch.

"A friend of my wife's approached me and said 'I've got a problem, and maybe you can help. My father makes a living importing Spirulina algae from Mexico. Health food, you know. Problem is, the FDA just declared Mexican Spirulina the most contaminated foodstuff ever imported into the U.S. They've shut down my dad's business. I'm worried about next year's tuition!'"

"He figured that one of us 'smart scientists' should know how to grow non-contaminated algae."

Huntley contacted a few colleagues at Scripps and, in their spare time, they began designing the Growth Module. Eventually they came up with a workable model.

But when the law student's father offered the group $5,000 for their design, the scientists balked.

"The design process had put fire in our bellies about the commercial potential of microalgae. We decided to form Aquasearch," Huntley said.

The Aquasearch Growth Module photobioreactor is simple in concept. To grow microalgae, you cannot just use the technology for growing plants, and you cannot just use the technology for growing

microbes. You need a hybrid system –- a closed, controlled container with both light and water.

Huntley says that the biggest challenge the scientists faced was scaling up the system. The standard laboratory version of the photobioreactor is about five gallons. The Aquasearch Growth Module is a thousand times larger.

"As every engineer knows, systems behave differently at large scales. Just because you can build a bridge across the stream in your back yard doesn't mean you know what's necessary to build the Golden Gate," Huntley said. "The 5,000-gallon system behaves very differently than the five-gallon system, and exactly how it behaves is a mystery until you study it carefully."

So each time the scientists scaled-up the module, they compared the new model's behavior to the standard five-gallon system. They kept making adjustments to the materials, the physics, or the chemistry until they could exactly replicate the behavior of the five-gallon system.

Now they have a large-scale, commercial photobioreactor that works as dependably as the much smaller laboratory version.

"Simple in concept but, as we found out after years of research and development, a real challenge to build and operate effectively," Huntley said.

Aquasearch's Growth Module's mainframe is powered by Windows/NT. Attached to this system is an array of distributed e-proms, A/D

converters, relays, and other hardware that are dedicated to specific growth modules. All the process control is done locally.

"The Win/NT platform serves only to re-program the local microprocessor and to collect and store data," Watumull said. "The software we use is a process-control developer's package made by WonderWare. It's a very powerful tool. We've customized the system for our applications. Much of the operation has been reduced to point and click, which is easy for our employees, and saves time for everyone."

Huntley points out that out of the 30,000 microalgaes, only a few thousand species have been isolated and grown in the laboratory. Most have not been looked at very carefully for medicinal properties.

"The lack of cultivation technology was one of the main reasons for this apparent lack of interest," Huntley said. "If you can only grow very small quantities of a unique species, then why bother examining it for pharmaceutical potential? Even a standard pre-clinical trial can require more material than can be grown in a typical laboratory cultivation system."

Huntley believes that now that Aquasearch's photobioreactor technology has made microalgae cultivation viable on a commercial scale, there will be a real effort to consciously exploit these plants for medicinal use.

"If our current knowledge of microalgae is any indication, there are thousands of discoveries that still await us,"

Huntley said.

"Just as the discovery of plant life along the Amazon was one of the great adventures in biodiversity, so the discovery of the remaining half the plant kingdom will be the next great adventure."

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