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REGIONAL NOTES

CENTER FOR TROPICAL AND SUBTROPICAL AQUACULTURE

Aquaculture development advances in American Samoa

It's been an encouraging year for American Samoa's nascent aquaculture industry. A long-awaited giant clam hatchery is nearly complete, and a leading producer of the U.S. territory's top aquaculture crop, tilapia, began extensive expansions to his operation.

And that's not all. John Gonzales, the Sea Grant extension agent in American Samoa, sounds the most excited when he talks about helping tilapia farmers convert their farms to integrated aquaculture-agriculture systems through either aquaponics — which combines aquaculture with hydroponics, or the growing of plants without soil — or the use of fish waste as a fertilizer in traditional agriculture practices. Gonzales, six months into his role as the junior aquaculture extension agent for the University of Hawaii Sea Grant College Program, is also teaching his students at the American Samoa Community College (ASCC) about aquaponics as part of a general focus on sustainable aquaculture.

"Since agriculture is a socially and economically important component to the Samoan lifestyle, they can see the conversion from fish waste to plant growth," Gonzales says. "Sustainability is very important to them."

Extension agent John Gonzales, Troy Fiaui, and ASCC interns at Fiaui's farm in Auto village in American Samoa.

Producers are also introducing better management practices, such as techniques that control breeding. Yet Gonzales is most proud of the few farmers who are already adopting integrated techniques. Troy Fiaui of Auto village, for example, is retrofitting his two cement raceways with pumps and plans to use fish effluence to irrigate taro, bananas, and other fruit and vegetable crops.

Another producer, Alailepa Fiti from Western Samoa, has a farm down a long bumpy road on land in American Samoa granted to him by a high chief. "He's implementing net cage technology even though others scoff at him," says Gonzales. "To see someone work hard and be productive with little resources is inspiring."

Change is never easy. And a switch to aquaponics for two farmers accentuates the greatest challenge faced by aquafarmers in American Samoa: nutrition, including a lack of access to low-cost feeds. Even so, aquaponics culture systems should eventually result in production that is not only greater but also more reliable than production experienced with traditional green water systems, Gonzales says.

Local tilapia production has yet to fill consumer demand, but the industry grows. The man who some credit with jumpstarting the tilapia industry in American Samoa by providing other farmers with fingerlings is expanding his operation. President of the Samoan Family Sunfish Cooperative, Alosina To'omalatai is adding six cement tanks to his farm, which already has two raceways and about eight tanks. He's receiving up to $25,000 in materials to complete construction of the new tanks from the Vocational Rehabilitation and Employment Service of the Department of Veterans Affairs, says Selina Higa, of the Veterans Affairs Regional Office in Honolulu. The program helps veterans with service-connected disabilities pursue education or self-employment.

"We can't buy fish or shrimp for him, but we can buy — directly from vendors — food, supplies, or more tanks for growing the fish," Higa says. In most cases, the agency hires contractors, but To'omalatai opted for materials in order to maximize funding. The VA is helping a few other veterans with aquaculture ventures in American Samoa, Higa says.

To'omalatai also hopes to make his operation more integrated, adds Gonzales. Plans include making his own feed and adding a house on site. He wants to start selling fish and other crops directly to end customers and is looking for an outlet akin to a roadside stand.

What about the giant clam hatchery? It is nearly operational and almost ready to start spawning trials. Years in the making, the hatchery in Aloa village will provide clam seed for growout by villages on the islands of Tutuila and Manu'a.

Giant clams are a delicacy in American Samoa. Some of the cultured clams will be raised as food or used for stock enhancement near depleted coral reefs, but most clams will be sold to the aquarium trade.

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Letter from the director

Happy Holidays. As the year ends, I'm proud to say that CTSA delivered on our promise to improve the quality of our program. Thank you to all our industry and technical advisors and to the researchers and all the others who contributed to our success. The current term for the IAC and TC will end in January, so I want to acknowledge the help members gave in raising the value of the proposals that CTSA funds. Mahalo.

One outgoing member has expressed concern about the accountability within our program, so I'm making a call to returning and new members and also to the principal investigators (PIs) of our funded projects to help. It all comes down to teamwork: the IAC identifies real industry problem areas, the TC defines the best research approach to solving these problems, and the IAC liaisons and the CTSA administrative staff assist PIs in making good on the outcomes they proposed for their projects. Here's to a productive 2007!

Cheng-Sheng Lee

REGIONAL NOTES

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AQUA CLIPS

UH scientists dispute tuna predictions

By Staff, Pacific Business News, December 14, 2006

A new study by several University of Hawaii scientists disputes the idea published in prominent science journals that the world's tuna fish population will completely disappear by 2040 thanks to global overfishing.

"Recent claims of catastrophic reduction in the biomass of top-level predators and the collapse of oceanic food chains have attracted widespread attention and provoked alarm among the lay public," the scientists state in a paper appearing in tomorrow's *Science* magazine.

The authors of the paper, who work at UH's Pelagic Fisheries Research Program, called those articles' methodologies "half-baked," explaining that their data was not comprehensive enough. "Part of the reason our analysis has credibility in the fisheries scientific community is because we considered all the available data for these stocks rather than just picking and choosing the data that suits our cause," said Mark Maunder, one of the UH report's authors.

The authors acknowledged a decrease in overall tuna populations and called for more regulation by international and national organizations. But they said the situation is not nearly as gloomy as previously reported.

'It's a Silicon Valley of aquaculture'

By Karin Stanton/Staff, Associated Press/Pacific Business News, December 10/11, 2006

KAILUA, KONA, Hawaii — U.S. Commerce Secretary Carlos Gutierrez promised administration support for the aquaculture industry during a weekend visit to the Natural Energy Laboratory of Hawaii Authority (NELHA), where he toured 17 commercial aquaculture operations, including Kona Blue Water Farms.

Gutierrez yesterday praised Kona Blue for its success in open-ocean fish farming, saying similar aquaculture businesses would play a key role in helping the nation fight overfishing and battle a seafood trade deficit. He said U.S. aquaculture looks likely to become a more important industry and is a focal point of President Bush's Ocean Action Plan.

"Over 70 percent of the seafood Americans consume annually is imported, and half of those imports come from foreign aquaculture operations," he said. "The U.S. annual seafood trade deficit is $8 billion."

Hawaii is among the leading marine aquaculture locations in the United States. Experts say Hawaii's annual fish farm sales may grow fivefold to $200 million in the next five to 10 years. The industry will provide Hawaii with high-tech, long-term jobs, Gutierrez said.

"The people they put together here — the marine biologists, hatcheries management, chief officers — it seems like it's a Silicon Valley of aquaculture."

American Samoa continued from Page 1

Owned by nonprofit Native Resources Developer Inc., the hatchery also will provide education and training for local people. "Creating more opportunities and increasing the capacity of people on the islands is critical to the future of aquaculture here," Gonzales says.

In another step toward that end, Kevin Hopkins, Ph.D., professor of aquaculture at the University of Hawaii at Hilo, and Gonzales have developed an aquaculture certificate program at ASCC that will enable students to continue on to the aquaculture program at UH Hilo and/or to start their own business or take over another business in American Samoa, says the extension agent.

Gonzales is optimistic about aquaculture development in the territory. He points to the strong support from Congressman Eni Hunkin Faleomavaega, ASCC President Adele Satele Galea'i, Ph.D., and the matai or chiefs — some of whom are farmers themselves. "Villagers look up to their chiefs and follow their example," Gonzales says.

—KD

AQUA TIPS

Microalgae production for aquaculture in Hawaii and the U.S.-affiliated Pacific Islands

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Finfish Department, Oceanic Institute

This article was written as part of the work for the project titled, "Intensive Microalgae Production," which was funded in part by the Center for Tropical and Subtropical Aquaculture under a grant from the U.S. Department of Agriculture Cooperative State Research, Education, and Extension Service.

Introduction

The mass production of microalgae is a critical and often the rate-limiting step for aquaculture operations in Hawaii. Besides forming the base diets for rotifers, copepods, and other live prey consumed by small-mouthed larval fish and shrimp, microalgae are used extensively in green-water rearing systems to improve larval growth and survival. Marine algae production varies from pond-based systems that leverage the low cost and other advantages of natural productivity to intensive indoor tank systems. Little changed in 30 years, intensive tank systems require large investments in infrastructure, labor, and time, and they're prone to unpredictable ouput and occasional crashes. Research groups point to a promising alternative: Photobioreactor systems can provide higher algae densities, a smaller footprint, continuous or semi-continuous product delivery, longer production cycles, less contamination, greater stability, and lower labor requirements. Yet, few reactor systems are commercially available, and the obtainable few have unproven records. This article summarizes efforts over the last few years at the Oceanic Institute to test prototype photobioreactor systems for algal production.

Production Methods and Prototypes

Most farms use simple batch production systems composed of a series of tanks or bags illuminated with fluorescent or natural light. Almost all facilities use active aeration to facilitate mixing and gas exchange, and most supplement cultures with nutrients and a carbon (CO_2) source. Muller-Feuga et al. (2003) illustrated the potential benefits of improving algal production, showing that a typical large farm operates at a production cost of about $1,400/kg of algae, whereas industrial photobioreactors come closer to $200/kg. A separate literature review revealed significant progress in the development of bench-top photobioreactors (Pulz 2001). Those units can control pH, temperature, aeration, carbon dioxide and nutrient supplies, and culture dilution.

Figure 1. Large-scale photobioreactor systems, including (left) *a 500-L flat-panel bioreactor at OI,* (center) *an OI cylinder-based air-lift bioreactor design, and* (right) *a tubular photobioreactor system.*

Scale up, however, brings constraints: reduced light penetration, as well as increased mixing requirements and distances for gas diffusion.

In general, these challenges have been approached using three main types of systems: (1) flat-panel bioreactors, (2) column or cylinder bioreactors, and (3) tubular bioreactors (Tredici 2004). A number of commercial hatcheries in Europe use tubular bioreactor systems that follow a patented design with an array of horizontal tubes connected to manifolds in a "fence-like" configuration. Although relatively expensive to construct, this system provides excellent light gathering capacity and potential for hatchery-level scale up. The biofence™ system was distributed commercially (Tredici 1999), but its current availability is uncertain. Also not available for project activities were the cellpharm® bioreactor and HISTAR™, a system under final design by AST.

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AQUA TIPS

Shrimp-head processing alternatives can improve industry sustainability

Daniel M. Jenkins, PingSun Leung, Wai Kit Nip, and Vadim Kostyukhin

University of Hawaii at Manoa

This article was written as part of the work for the project titled, "Feasibility Analysis of Shrimp Waste Processing Alternatives," which was funded in part by the Center for Tropical and Subtropical Aquaculture under a grant from the U.S. Department of Agriculture Cooperative State Research, Education, and Extension Service.

Introduction

Aquaculture represents one of the fastest growing sectors of the economy in Hawaii. Meanwhile, competition from Asian shellfish producers has driven profit to a level that threatens the sustainability of the industry. Thus, efforts must be taken by local producers to both improve production methods and seek alternative revenue streams from existing production. Developing new products from waste materials, such as shrimp heads, can provide a new revenue stream and help improve industry sustainability.

Objective and Methodology

The objective of this study was to identify economically viable products that can be developed from shrimp heads under the prevailing conditions in Hawaii and other islands in the Pacific. These communities have unique constraints: limited shrimp production capacity, high transportation costs to the global market, and limited infrastructure to meet stringent regulations for production of medical and food-grade materials. A growing number of nutraceutical and pharmaceutical Hawaii ventures demonstrate a growing infrastructure in this area, but business in Hawaii is also constrained by high land, labor, and utility costs. These factors are all critical in determining appropriate alternatives.

A comprehensive technical and economic approach was used to identify opportunities for capitalizing on shrimp waste produced in Hawaii. Industry representatives were consulted to better understand their needs and expectations. Scientific literature was reviewed to identify products that can be derived from processing shrimp heads. In tandem, markets for these products in Hawaii, on the mainland, and abroad were researched to determine which ones hold the greatest potential value to the industry. Analysis, using a capital budgeting model (CAPM), of processes and combinations of processes helped identify economically viable opportunities for processing aquacultural wastes in Hawaii.

Results and Discussion

The only type of shrimp waste available in Hawaii is shrimp heads. All estimates for this study assumed that the amount of raw material currently available for processing is 100 tons per year and the maximum possible available is 200 tons per year. These figures were based on industry feedback about waste volume production from recent years.

Initial research focused on identifying existing processing alternatives for shrimp heads. At this stage of research, the processing requirements and probable yields for each case were determined. We concluded that if shrimp heads are fractionated effectively, valuable products such as chitin (and its derivatives), proteins, and flavorings could be obtained (Table 1).

Processed shrimp heads are usually converted into shrimp meal or chitin by drying and chemical processing, respectively. However, the same products may be derived using fermentation

Table 1. Byproducts and applications.

Industry	Product	Application
Aquafeed	SWM, SHM, protein hydrolysate	Feed additives
Animal food	Co-dried product	Flavorings and attractants
Pet food	Protein hydrolysate, natural pigment	Protein supplements and flavorings Antioxidant and pigment enhancement
Nutraceuticals	Chitin, glucosamine, NAG	Health promotion
Industrial compounds	Chitin	Paper making, water purification
Human food	Seafood derivatives	Flavoring, chitin
Organic food industry	Compost	Plant nutrition
Pharmaceuticals	Specialty products	Drug delivery, arthritis treatment, biotechnology

processes, which increase production yields and allow simultaneous recovery of proteins and flavors. By developing products from protein and chitin fractions of shrimp heads, a zero-waste scenario is envisioned. Integration of fermentation processes would help reduce dependence on caustic chemicals and the handling and disposal costs associated with them.

Market research for identified shrimp waste byproducts was conducted during the second stage of the project. Primary goals were to identify the product(s) that would have the highest earning potential and to evaluate market trends in order to predict demand. Based on the SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis that was conducted for each product, a select group was chosen for further feasibility analysis.

Given the scale of shrimp-head waste that could realistically be expected in Hawaii, there are four products that might have favorable prospects for successful commercialization. These products are shrimp flavorings, shrimp protein hydrolysate, food-grade chitin (and related derivatives such as N-Acetylglucosamine or NAG), and compost. All of these products have high sales potential in Hawaii, as well as nationally and internationally. All of them can be produced using relatively simple processing technologies, and they can command prices high enough to justify production costs.

Table 2. Predicted breakeven price (BP), net present value (NPV), and internal rate of return (IRR) for shrimp flavor production for various annual volumes of shrimp heads.

Waste (tons)	BP ($/kg)	NPV ($ million)	IRR (%)
100	29.40	0.04	23.6
150	23.07	0.49	113.8
200	19.90	0.94	201.4

In the last stage, investment analysis was used to determine the economic feasibility of selected alternatives. Four products and two combinations of these products were evaluated: flavoring, shrimp protein hydrolysate (SPH), chitin, flavor and chitin, SPH and chitin, and compost. All methods except composting involved a combination of processes, including tissue/shell separation, fermentation with enzymes or lactobacteria, liquid/solid separation, and drying. Many issues were addressed, such as operating requirements, regulations, equipment specifications, costs, and time value. Analysis included an examination of production cost structure for each product, operating cash flow, profitability, and sensitivity analysis of overall profit to individual costs and revenues. Return on investment was estimated using a combination of criteria. Net present value (NPV), internal rate of return (IRR), and payback period were applied to estimated annual after-tax cash flow for an investment over a 10-year planning horizon. To ensure the greatest benefit, it was assumed that processing could be incorporated into an existing shrimp farm's operation.

Feasibility analysis revealed that under certain scenarios processed shrimp heads could provide a new revenue stream for the industry in Hawaii. However, it was determined that a project would be highly sensitive to changes in overhead costs, labor costs, fixed costs, capital investment, finished product prices and input costs. A significant scale effect was observed in the modeling (Figure 1 and Table 2), indicating that processors would benefit greatly by availability of large waste volumes.

Production of shrimp flavor was identified as the most promising alternative for using shrimp wastes in Hawaii. To successfully market shrimp flavor, a producer must have a high degree of quality control, since flavor is volatile and sensitive to minor changes in processing conditions.

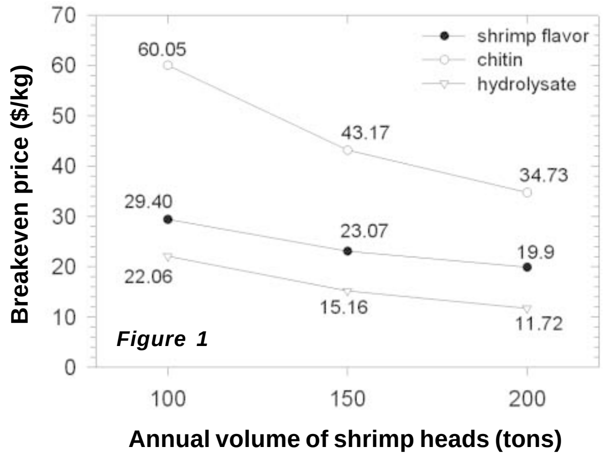

Figure 1

To distribute fixed overhead costs among a wide array of revenue streams, it is preferable that shrimp-head processing be a part of a shrimp farm's operation. Breakeven prices and costs are on average 20–25% lower for scenarios in which a processor is a part of a shrimp farm operation.

Conclusions

Based on our analysis we recommend that a potential processor do the following to ensure project viability:

1. Partner with a shrimp farm operation to reduce overhead costs.
2. Use industry consultants and bidding to find used equipment at competitive prices.
3. Increase the volume of available shrimp heads.
4. Secure local markets and contracts for their product.
5. Find an industrial building that meets FDA standards for such operations.
6. Solve issues with disposal of wastewater into the local sewer.
7. Develop a flavor or flavor product in consultation with known distributors/consumers.

If these issues can be addressed, an investment in the operation of a facility to process shrimp waste into value-added products represents a potentially attractive financial investment in Hawaii and is likely to repay all investment capital and interest. In cases where a processor desires to produce pharmaceutical-grade chitin derivatives or flavor/hydrolysate in a semi-liquid form, consideration should be given respectively to additional investment and transportation costs.

Acknowledgements

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Since we were unable to find readily available commercial products, we built and tested two simple prototype systems: a plexiglass plate bioreactor and a columnar air-lift bioreactor (Figure 1). We are currently constructing a prototype tubular system with off-the-shelf parts.

Plate bioreactor design. Our first design was a 500-L plexiglass plate bioreactor with a 20-cm light path based on the designs of Amos Richmond (Zhang et al. 2001). The OI system was fitted with UV-treated water, 1 µm filtered air supply, and equipped with pH control to help maintain system sterility. Although not achieving anywhere close to the 400–800 million cells/mL densities described in the literature (Zhang et al. 2001), it did attain relatively high algal densities (> 70 million cells/mL) in several runs (Figure 2), although average densities (26.5 million cells/mL) were not substantially different from those seen in outdoor tank systems.

The less-than-expected system performance was attributed to a lack of sufficient temperature control, a longer light path (20 cm vs. 10 cm in the system described by Zhang et al.), and challenges in maintaining necessary system sterility. Panel bioreactors have been scaled successfully to volumes as great as 2,000 L for producing

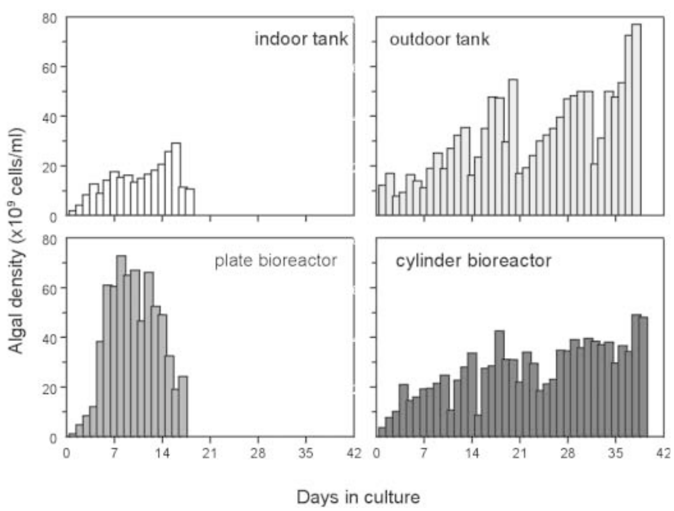

Figure 2. Average harvest (cells/mL/day) of Nannochloropsis *sp. from tanks, air-lift cylinder, and plate algal culture systems.*

Nannochloropsis sp. and other algal species. Narrow widths and hydrostatically limited heights restrict their practical capacity, and large internal surface areas hinder system cleaning and maintenance.

Cylinder air-lift bioreactor. Our second design was a 12-cylinder air-lift bioreactor system using readily available sunlight tubes. Columnar systems provide greater culture volumes and less light accumulation than thinner plate bioreactors, but they offer much improved gas exchange and culture mixing and are preferred by some for scaling up microalgae cultivation (Sanchez Miron et al. 1999).

In the OI prototype, each of the 12 cylinders had a diameter of 46 cm and maintained separate 400-L batches of algae under natural outdoor lighting. Each unit was provided with UV-sterilized water mechanically filtered down to 0.2 µm and supplemented with algal nutrients using an automatic dosing system. Air to each unit was also filtered down to 0.2 µm and automatically supplemented with CO_2 as a carbon source and to maintain system pH within the range of 8.0 to 8.4 using individual pH controller units for each cylinder. Temperature was controlled using a chiller with individual titanium coils in each cylinder. Only the overflow, created by continuous (or semi-continuous) addition of nutrient enriched water to each cylinder, was harvested.

Performance Evaluations

A series of evaluations of the two types of photobioreactors provided data on culture performance in terms of algal density, culture duration, costs of operation, and critical systems issues.

Batch vs. continuous culture. The first evaluation compared algal output under batch and continuous production methods. To make the comparison direct, the trial entailed an air-lift cylinder bioreactor system with six tubes operated under batch culture protocols (0% flow) and six cylinders operated under continuous flow (25% exchange per day). This setup provided more advanced system control than typically utilized for batch systems, as both treatments received the benefits of using filtered air and water, temperature control, and CO_2 supplementation. Results indicate two advantages of continuous culture: continuous cultures lasted significantly longer than the batch cultures and produced nearly six times the algae.

System comparisons. The next series of trials compared culture performance under semi-continuous modes of operation in the two prototype systems, as well as in indoor tanks under 1,000-W metal halide lighting (28,000 lux @ 24 h/d) and depth of 20 cm and in outdoor tanks under natural lighting (average daily peak of 44,000 lux) and depth of 40 cm. Moving cultures outdoors under natural sunlight brought significant increases in culture density and algal health over indoor cultures. Still, culture density varied widely in the outdoor systems (data not shown) dependent upon the time of year and local weather conditions and in response to changes in light intensity.

The plate photobioreactor, which has the greatest surface area to volume ratio — and the shortest light path — attained the highest peak algal densities (> 70 million cells/mL) and highest harvest yield per unit system volume of the tested systems. Yet, both the plate and cylinder systems had shorter culture durations on average than either the indoor or outdoor tank cultures, indicating a need for considerable improvement in temperature dispersion, gas exchange, and system sterility. The plate bioreactor (without temperature control) proved quite unstable over time, resulting in the highest frequency of crashes and shortest mean culture duration (10 days). The air-lift photobioreactor (with temperature control added) was generally more stable, yielding average culture durations of 14 days. Both the indoor and outdoor cultures lasted 18 to 19 days on average.

For future trials, then, we worked primarily with the air-lift reactor despite higher unit productivity in the plate system. Other factors were cost and footprint: A single 500-L reaction chamber in the plate bioreactor costs roughly $5,000, versus $300 per air-lift cylinder.

Algal species comparisons. Finally, using the same cylinder-based air-lift bioreactor system, OI researchers compared the performances of four species of marine microalgae commonly used in marine finfish and shellfish hatcheries. As expected, the smaller *Nannochloropsis* sp. attained the highest mean cell densities (28 million cells/mL), compared to the larger *Isochrysis* and *Chaetoceros* species (6 million cells/mL) and the even larger *Tetraselmis* species (1 million cells/mL). *Isochrysis* and *Chaetoceros* also demonstrated somewhat lower culture durations (17 days) than *Nannochloropsis* (27 days) and especially *Tetraselmis* (50 days).

Critical System Issues

Contamination. Most microalgae cannot be maintained for extended periods in outdoor open systems because of contamination by fungi, bacteria, protozoa, and other competing microalgae (Richmond 2004). In theory, closed environments should significantly increase culture longevity. The systems tested, however, did not fare much better than open culture systems. Many operators of closed tubular and plate systems (including OI) note that initial runs are more stable than later runs, an outcome likely due to contamination build up in hard-to-reach areas. Some systems, such as bag culture (not tested), allow for replacing containers for every run. Development of automated cleaning and disinfection systems could greatly facilitate culture sterility.

Oxygen toxicity. Although closed systems provide for improved culture biosecurity, they also reduce gas exchange, resulting in dissolved oxygen levels that inhibit algal growth. High oxygen levels can generate free oxygen radicals that can damage photosynthetic machinery. Thus, oxygen accumulation represents one of the main obstacles to the development of industrial-scale closed bioreactors (Richmond 2004).

Photoinhibition. Ironically, getting more light to a photosynthetic apparatus actually lowers its efficiency. Photoinhibitory issues have led to active research on methods to obtain a more homogenous distribution of light in algal culture systems and better mixing without shearing cells (Richmond 2004), challenges that become more difficult with the scale up required to make photobioreactor technology practical.

System costs. Our preliminary cost estimates group systems with reactor vessel, water treatment, air filtration, and pH and temperature control into one of two categories. Low cost bioreactor systems (using tanks, bags, and cylinders) cost approximately $5,000 per m^3 of culture volume. Plate and tubular bioreactor systems cost closer to $15,000 per m^3 culture volume. The more expensive systems may be worth a higher initial investment if they attain consistently higher algal productivity and/or significantly reduced labor costs.

Conclusion

Closed photobioreactor systems demonstrate a number of key advantages over open-pond and tank-based algal production systems, including continuous harvest, extended production cycles, and significantly higher production volumes. Still, they come with limitations: overheating, oxygen accumulation, biofouling, and shear stress — all factors that are more difficult and more expensive to overcome with system scale up. At present, the adoption of continuous flow protocols provides a relatively easy approach to significantly increase output without investment in expensive infrastructure. Challenges in scaling up and operating closed systems, whether plate, air-lift, or tubular in culture chamber design, has clearly slowed the emergence of commercial photobioreactor units. Large-scale systems will require significant improvements in design, improved ease of operation, and cost reductions to make them a pragmatic addition to a small- or medium-scale hatchery operation. Large hatcheries can consider fabricating tubular systems like those currently used in European seabream and seabass hatcheries, but they should be prepared for continued investment in system design and optimization.

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Around the Pacific

John Corbin announced in mid-December that he would retire at the end of 2006 from his position as manager of the Aquaculture Development Program (ADP), Hawaii Department of Agriculture. Leonard Young will serve as acting manager until the post is filled. Leading ADP for more than 25 years, Corbin will leave behind an impressive legacy. He wrote the first state aquaculture plan in 1979 and helped grow Hawaii's aquaculture industry to more than $28 million in farm sales. "[Aquaculture] planning at the state level in Hawaii continues to happen at a higher level than in any other state," Corbin told me with less than two weeks before his last day.

Instrumental in introducing aquaculture to NELHA, he says he's also proud of establishing ADP's state aquaculture veterinarian position and disease program, as well as the marketing done to make producers aware of those services. As for open-ocean aquaculture, he points to the influence ADP and he have had in the development of Hawaii's ocean lease laws and pending national legislation.

Corbin has served on CTSA's board of directors since the center's start 20 years ago, and he'll be missed. But he's not likely to stay out of aquaculture all together. He says, "Aquaculture manager is a job. Aquaculture development is my passion, and that's forever. I'll always keep my fingers in it." L —*KD*

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INSIDE

This issue and past issues of the *Regional Notes* newsletter are available online as PDF files at the CTSA Web site: http://www.ctsa.org/NoteList.aspx.

The Center for Tropical and Subtropical Aquaculture (CTSA) is one of five regional aquaculture centers in the United States established by Congress in 1986 to support research, development, demonstration, and extension education to enhance viable and profitable U.S. aquaculture. Funded by an annual grant from the U.S. Department of Agriculture's Cooperative State Research, Education, and Extension Service (USDA/CSREES), the centers integrate individual and institutional expertise and resources in support of commercial aquaculture development.

CTSA currently assists aquaculture development in the region that includes Hawaii and the U.S.-affiliated Pacific Islands (American Samoa, Commonwealth of the Northern Mariana Islands, Federated States of Micronesia, Guam, Republic of Palau, and Republic of the Marshall Islands).

In its 19 years of operation, CTSA has distributed nearly $10 million to fund more than 195 projects addressing a variety of national aquaculture priorities.

Each year, the Center works closely with industry representatives to identify priorities that reflect the needs of the aquaculture industry in its region. After consultation with appropriate technical experts, CTSA responds with a program of directed research that has these pre-determined priorities as the focus of project objectives. The Board of Directors is responsible for overseeing CTSA's programmatic functions. The Center disseminates project results through its print publications, hands-on training workshops, and Web site.

CTSA is jointly administered by the Oceanic Institute and the University of Hawaii. The main office is located at the Oceanic Institute's Makapuu Point site on the island of Oahu in Hawaii.

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