CENTER FOR
TROPICAL AND SUBTROPICAL
AQUACULTURE

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Letter from the Director

Aloha,

As we head deeper into the summer, the CTSA development process is beginning to heat up! Earlier this month, CTSA held our annual Industry Advisory Council and Technical Committee joint meeting to discuss and vote on the pre-proposals submitted for FY22 funding consideration. I would like to take this opportunity to express my sincerest gratitude to our committees for their volunteer efforts to help guide the CTSA program. Their participation and expertise is essential to carrying out CTSA's industry-driven mission. This is especially true for our IAC and TC Chairs and Co-Chairs, who have spent countless hours assisting CTSA program development.

Every three years, CTSA holds elections for the IAC and TC Chair and Co-Chair positions during the joint meeting. This year, members elected the current IAC Chair (Ron Weidenbach) and TC Co-Chairs (Harry Ako and Alan Everson) to continue serving in their positions for another 3-year term; the IAC elected Anthony Mau to serve as Co-Chair and succeed John Corbin, who kindly declined his nomination this year, A big mahalo to these aquaculture experts for lending their expertise and time to our program; the Chairs and Co-Chairs attend several meetings throughout the year and bear a significant responsibility in our development cycle. I hope all of our readers and stakeholders will join me in thanking John for his commitment to our program, including the last several years as IAC Co-Chair. I would also like to acknowledge and thank the other members who were nominated and participated in the elections; their dedication to the program is deeply appreciated.

This year, CTSA received 17 pre-proposals that were up for discussion and ranking at the annual meeting. Based on the IAC and TC votes and comments, ten pre-proposals received support to move forward and were subsequently asked to submit full proposals. It is important to note that funding is not guaranteed for any project at this stage, but we are looking forward to seeing the detailed plans for each proposal. Seven pre-proposals were not selected, and PI's were notified accordingly. I would like to thank all of the PI's who submitted pre-proposals for FY22 funding consideration. I especially appreciate the innovative project ideas this year, and want to encourage those PIs who were not selected this round to rethink, revise and resubmit. The selection process at CTSA is very competitive; our IAC and TC care deeply about the investments of the CTSA program, and accordingly they scrutinize each pre-proposal with their essential industry insight and research expertise. Our committees are well connected to the local and regional aquaculture industries, which helps them understand which projects have the greatest potential for industry acceptance and success. While they appreciate creative ideas, their main goals for CTSA development are to support projects that are economically feasible for our region and that contribute to the success of small farms and/or multiple aquaculture operations; they also prioritize keeping our region free from disease outbreaks. While we do not share every comment made during the meeting, we attempt to capture the most significant input on each pre-proposal and share it with PIs in the hopes of improving future submissions to CTSA and/or other programs.

The most important mandate of the CTSA mission is to support the commercial development of aquaculture in our region. Our committees and administrators want to see projects that will have direct impacts on current operations and/or support the development of important innovative technologies. The success of this mission depends on industry, researchers, and government working together, and our collaboration with you, our valued stakeholders.

Mahalo,
Dr. Cheng-Sheng Lee
Executive Director, CTSA

CTSA Project Update: Upgrading Black Soldier Fly Larvae for Aquatic Feed

by Dr. Winston Su, University of Hawaii

Figure 1. BSFL meal before and after 4 days of solid-state fungal fermentation.

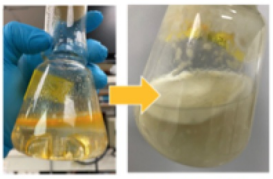


Figure 2. Fungal growth in a liquid medium containing the BSFL fat as the sole carbon source. Left is at inoculation (day 0); Right is after three days of culture.

Figure 3. A commercial proofer is retrofitted with sensors and controllers (image insert) to produce fermented BSFL meals in an array of flasks for fish trials.

Finding an affordable and sustainable fish feed alternative is essential for the innocuous expansion of aquaculture. An important fish feed ingredient is fishmeal and fish oils (FMFO), which is very unsustainable and also exceedingly expensive due to increasing demand and depleted fisheries. Approximately 20% of the total wild catch worldwide are not being caught for direct consumption but are caught to be processed into fish feed for aquaculture. Aquaculture production has doubled within the past 15 years, at the rate that it is growing it is imperative to find more sustainable and cost-effective ingredients to replace FMFO in fish feeds.

One promising solution is the use of black soldier fly (*Hermetia illucens*) larvae, or BSFL. Black soldier fly is an insect species native to the Americas, which has recently spread to all continents. These flies roughly lay between 200-600 eggs at a time and are considered neither pests nor vectors. In fact, black soldier fly larvae are significant decomposers, much like worms, and are often used to consume food wastes on farms. The larvae of this fly can feed on an immense variety of low value organic material, with little water demand and they also generate low greenhouse gas emissions. In addition, BSFL offers a promising alternative source of protein for aquaculture. BSFL have already been used in fish feeds for carnivorous fish but the extent to which FMFO can be replaced by BSFL without negative consequence depends on several factors, including fish species, life stages, and BSFL processing, and feeding methods.

Depending on the rearing substrates used, the fat contents of BSFL could be as high as 30-37% [1, 2]. This high fat-content prevents incorporation of high proportions of the BSF meals in aquaculture feeds as it could negatively affect meal digestibility, trigger undesirable immune-responses, cause potential liver damage from long-term intake of high-fat diets, and/or alter microbiota in the fish to affect fish health [1]. Furthermore, the high fat content in the meal makes it less conducive to use in manufactured aquatic feed pellets or crumbles [3]. For comparison, fish meals of good quality have fat content about 8 to 11%. Thus, it is highly valuable to further improve the nutritional profile of the BSFL meal by converting its undesirable high fat content into proteins at low costs. By meeting such need, high-quality BSFL meal can be made with less stringent requirement on insect food sources to become a truly competitive sustainable protein source for aquaculture.

To do this, we are proposing a fungal fermentation process which can break down the fats within the BSFL while simultaneously increasing the protein level. The broad spectrum of secreted enzymes that the fungus produces is used to break down the BSFL's high fat content, and the resulting fungal cell mass increases the overall protein levels in the fermented BSFL meal. A commercial proofer retrofitted with sensors and controllers has been developed to have greater control of the SSF environment in studying various factors affect the process. A series of experiments have been conducted using flasks incubated in the retrofitted proofer to optimize the fungal fermentation of BSFL. Factors that have been investigated in these flask experiments include particle size, initial moisture content, substrate bed height, inclusion of inorganic nitrogen, temperature, humidity, duration of SSF, aeration flow rate and several aeration methods. To date, we can routinely achieve over 40% crude proteins in the fermented BSFL meal after 3-4 days of SSF, while the residual fat decreases from over 30% initially to below 20%. Extensive fungal growth on the BSFL meal after fermentation can be seen in Figure 1. We further proved that the fungus can use BSFL oil as the main/sole carbon source (Figure 2) and could not grow well in defatted BSFL. The reported fungal fermentation process is very simple, low cost and more environmentally friendly than solvent extraction of the BSFL fats. It also does not require large processing equipment such as industrial extractors and solvent recovery systems such as distillation columns.

Fish feeding trials are underway to determine how this new feed affects fish. We have already produced over 2 kg of fermented BSFL for the fish feeding trial. This was done using an array of flasks at the optimal determined particle size, moisture level, humidity and temperature. These flasks were incubated in the

retrofitted bakery proofing cabinet. It has an esp32 microcontroller encoded to power all sensors and equipment and log all data (Figure 3). The proofing cabinet has a built-in air heating and circulation system which is used as the heating method for these flasks. A DHT22 temperature and humidity sensor has been placed inside of the proofer. Based on the received temperature and humidity values, the microcontroller signals relays to turn on or off the proofer's heater to actualize the encoded heat. The proofer is also retrofitted with an inexpensive ultrasonic humidifier which is powered on and off by the microcontroller to achieve a target humidity.

A simple bioreactor is being constructed to control and maintain a set temperature, moisture and oxygen level. This reactor is also equipped with an off-gas CO_2 sensor to monitor culture CO_2 evolution rates as an indirect measure of fungal growth during solid-state fermentation of BSFL meals. Sample readouts from the CO_2 sensor monitoring a BSFL fungal fermentation, along with proofer temperature and humidity are shown in Figure 4 below. This reactor will allow larger batches of BSFL to be easily and quickly defatted via fungal fermentation and ready for formulation into fish feeds.

References:
1. Spranghers T, Ottoboni M, Klootwijk C, Ovyn A, Deboosere S, De Meulenaer B, Michiels J, Eeckhout M, De Clercq P, De Smet S: Nutritional composition of black soldier fly (Hermetia illucens) prepupae reared on different organic waste substrates. *J Sci Food Agric* 2017, 97:2594-2600.
2. Caligiani A, Marseglia A, Leni G, Baldassarre S, Maistrello L, Dossena A, Sforza S: Composition of black soldier fly prepupae and systematic approaches for extraction and fractionation of proteins, lipids and chitin. *Food Research International* 2017, 105.
3. Ju ZY: Potential of black soldier fly as a feed ingredient to produce aquafeeds. *CTSA e-Notes* 2016, Nov.

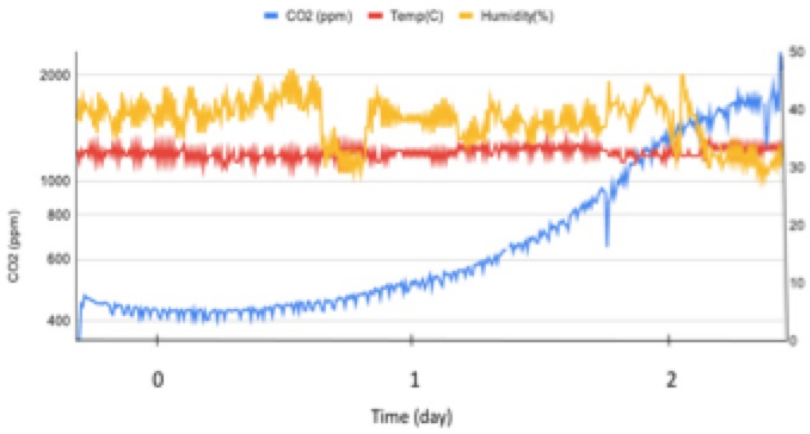
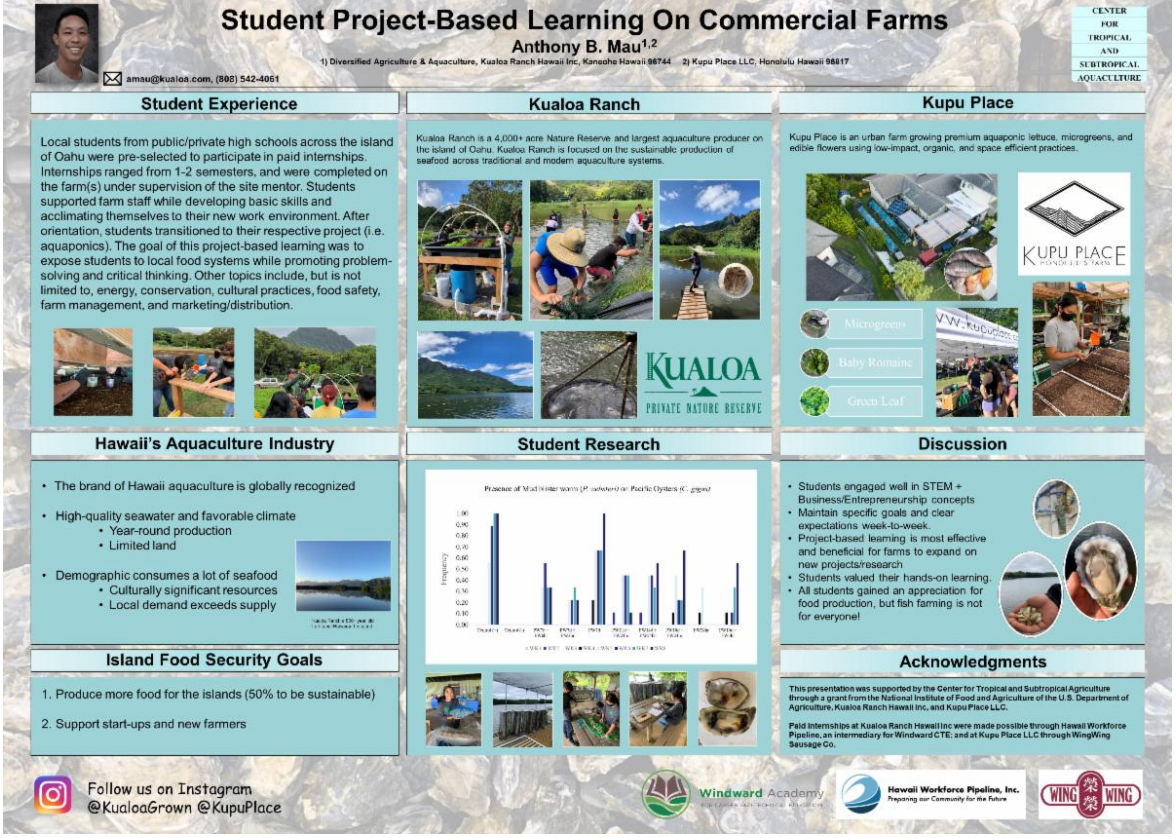


Figure 4. Sample sensor readout during a fungal fermentation run on BSFL meals.

National Aquaculture Extension Conference Poster: Student Project-Based Learning on Commercial Farms

As reported in the June issue of e-Notes, CTSA-supported researchers and aquaculture professionals from Hawaii and the Western Pacific Islands traveled to Portland, Maine for the National Aquaculture Extension Conference and Continuing Education Workshop. The conference was co-sponsored by the Regional Aquaculture Centers and the NOAA National Sea Grant Program. CTSA IAC Co-Chair Anthony Mau presented the following poster at the conference:



Aquaculture Announcements

USDA NIFA FY23 SBIR/STTR Phase1 RFA

USDA NIFA has now released the FY23 SBIR/STTR Phase 1 RFA.The SBIR program supports US-based small businesses solving issues (with commercial potential) related to food and agriculture. This program has and continues to support an Aquaculture priority area (SBIR 8.7). Click here to learn more; anyone interested in applying can email timothy.sullivan@usda.gov for requisite information.

Reminder: Sign Up For 2022 Census of Aquaculture

The 2022 Census of Agriculture is right around the corner and USDA NASS is making every effort to count all aquaculture producers in the United States. If you produce any aquaculture products and want to make sure that you are counted in the 2022 Census of Agriculture and the 2023 Census of Aquaculture, please sign up your operation using this online form: https://www.agcounts.usda.gov/cgi-bin/counts/. Once you have signed up, you might receive a short survey in the next two years to further categorize your operation. Most likely, you will not receive a survey until the 2022 Census of Agriculture in January or February, 2023

AquaClip: FDA to increase funding for feed ingredients reviews

The U.S. House of Representatives passed a fiscal 2023 “minibus” package of six appropriations bills, which includes a key amendment offered by Jim Baird and other bipartisan cosponsors to dedicate $8 million to the Food and Drug Administration’s Center for Veterinary Medicine to help with expediting reviews for new feed ingredients.

On average, studies have shown that it takes companies 3-5 years to get new ingredients through the FDA’s rigorous review process, which prevents innovation from making it to farmers and ranchers in a timely way.

Constance Cullman, AFIA president and CEO, said that “it is important for the United States to have a regulatory framework that offers a timely and predictable path to the marketplace for feed ingredients and can keep pace with the evolving science of animal nutrition. The additional FDA funding for feed ingredient reviews in the House-passed spending bill is a huge win for the U.S. feed industry, putting us more on par

with other countries that continue to move forward with safe ingredients to enhance the safety, quality, environmental impact and nutrition of feed and pet food."

Source: Aquafeed.com // Full Article

This newsletter is written and prepared by the CTSA Information Specialist Meredith Brooks.
The Center for Tropical and Subtropical Aquaculture (CTSA) is one of five regional aquaculture centers in the United States established and funded by the U.S. Department of Agriculture's National Institute of Food and Agriculture (NIFA) under active grants 2016-38500-25751, 2018-38500-28886, and 2020-38500-32559. The regional aquaculture centers integrate individual and institutional expertise and resources in support of commercial aquaculture development. CTSA was established in 1986 and is jointly administered by the University of Hawaii and the Oceanic Institute of Hawaii Pacific University.

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