Letter from the Director

Aloha,

As we reflect on all that we are grateful for this year, I would like to express my sincere appreciation to the many stakeholders who continuously donate their time to help CTSA achieve our annual program goals, especially our Industry Advisory Council, Technical Committee, Board of Directors, and outside expert proposal reviewers. These dedicated people work together to ensure that CTSA-supported projects solve critical aquaculture issues and have meaningful impacts throughout the Pacific region.

The contributions from our PI's and their host institutions are essential to completing our mission, and I would like to thank them as well for their diligent work to improve regional aquaculture through research, demonstration, and outreach activities. We recently completed our bi-annual project update conference calls with PI's and their industry liaisons. These conference calls have allowed us to monitor project progress on a more personal level, and have also facilitated partnerships between researchers and industry stakeholders; I am pleased with the cooperation of all participants.

Partnership is the cornerstone of the Regional Aquaculture Center program, and I am very grateful for the partners we have throughout the region and beyond, including you! I hope you are enjoying a happy Thanksgiving holiday with your family and friends.

Mahalo,
Cheng-Sheng Lee
Executive Director, CTSA

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CTSA Project Update: Potential of Black Soldier Fly as a Feed Ingredient to Produce Aquafeeds

Submitted by Oceanic Institute Aquatic Feeds and Nutrition Department
Project PI: Zhi Yong Ju, Ph.D.

Rising prices for fishmeal and oil and the demand for a fishmeal substitute have led to a search for ingredients that can provide similar nutrition without detrimental side-effects on aquatic animal performance. CTSA is supporting a project to investigate the possibility of using Black Soldier Fly larvae as an aquatic feed ingredient. Under the project, the larvae of the Black Soldier Fly *Hermetia illucens* (BSF) are being cultured using food waste materials, and results thus far have shown they have high potential as a fishmeal replacement.

Black Soldier Fly larvae (Fig.-1) were collected from Prota Culture Company, who raised the larvae with restaurant food waste. The BSF sample was then dried by hot-air (60C) and stored at -80C for analysis, storage testing, and feed production. Its nutritional composition including proximate contents, gross energy, and amino acid and fatty acid profiles has been determined by the Nutritional Biochemistry Laboratory of Aquatic Feeds & Nutrition Department at Oceanic Institute of Hawaii Pacific University (OI).

The BSF sample was found to have notably high protein content (44.9%, Fig. 2) and lipid content (36.0%). The very high lipid content (>30%) is not fit for inclusion in aquatic feeds and lipid extraction is necessary. From previous research experience, using an oil pressing machine could not effectively remove lipids from BSF meal: its residue contained over 20% lipid, which means only one third of lipids could be removed by mechanical pressing. Therefore, hexane extraction has been conducted to remove lipid from BSF meal. Optimal extraction conditions such as temperature, time, ratio of hexane to grams BSF sample, and number of extraction steps have been determined by experimentation. Our optimized method resulted in sufficiently low lipid levels (~5-8%) in the defatted meal (Fig. 2 & 3) while also using the minimal amount of solvent and heating temperature/time for cost benefits. The hexane solvent was able to be recycled for repeated extractions. This defatting process produces a defatted BSF larvae meal that is suitable for addition to aquaculture feeds.

Fig.1: Raw BSF larvae after being dried.

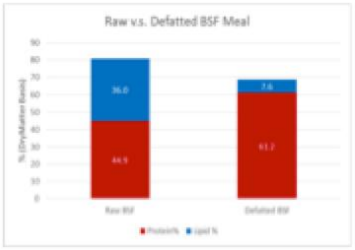

Fig. 2: Protein and Lipid contents of raw and defatted BSF meals.

Fig. 3: Defatted BSF larvae meal.

The amino acid analysis showed that the BSF protein is of high quality for the BSF larvae meal: its contents of methionine and lysine are quite high, which frequently are limiting amino acids in many plant-based feed ingredients. The fatty acid analysis shows that the BSF larvae does not contain essential long chain fatty acids such as EPA or DHA, but contains many short chain fatty acids such as C12:0 (40% of total fatty acids).

A digestibility diet was prepared with 30% BSF meal inclusion and a digestibility trial was conducted on feeding tilapia. The BSF diet was found to be palatable for tilapia. The apparent digestibility of dry matter, crude protein, and gross energy was calculated. The BSF diet had slightly lower digestibility parameters than control diet and commercial feed, but the difference is not significant ($P<0.05$), except the crude protein was less digestible, probably due to content of chitin, a nitrogen-containing molecule, in the BSF larvae sample.

Recently a pre-trial was performed to determine the palatability of a BSF diet for Pacific white shrimp. Three diets were prepared containing 0%, 15%, and 30% defatted BSF meal respectively (Fig. 4). These diets plus a commercial feed were fed to the test tanks each containing 20 shrimp. It was observed that all the BSF diets were readily consumed by the shrimp. Although this was just a short pre-trial to determine palatability, the shrimp weight growth was also measured. The BSF-added diets (15% and 30%) showed comparable growth performance to the 0% BSF diet, and better growth than the commercial feed. The tails of shrimp fed the BSF diets all had similar crude protein levels (87.8% to 88.6% crude protein), while tails of shrimp fed the commercial feed had only 84.1% crude protein. The major purpose of this test was to check palatability of BSF-added diets, and the research team did not set up repetitive tanks. A feeding trial with repetitive tanks will be conducted for BSF-added diets on shrimp performance in next year, where BSF proteins will replace up to 75% fishmeal proteins in control shrimp diet.

Fig. 4: Experimental diet containing the defatted BSF larvae meal.

The shelf life of black soldier fly larvae was determined by storing three repetitive samples in each of three different locations (refrigerator ~5C, air conditioned room ~18C, and room temp ~25C) for 1, 3 or 6 months. Nutrient changes were monitored after each of the storage periods. It was found that the proximate composition of the samples only slightly changed over the six month storage period, with the refrigerated samples losing 0.9% protein and 1.2% lipid, while the air conditioned samples lost 2.4% protein and 2.7% lipid, and the room temperature samples lost 2.0% protein and 2.6% lipid comparing to initial BSF meal. However, these changes were due to absorption of moisture, and when the data was converted to dry matter basis statistical analysis revealed that the differences in proximate contents were not significant ($P > 0.05$), and this may be due to the relatively short trial period of 6 months. The amino acid and fatty acid profiles of the samples did not change significantly, suggesting that the remaining protein and lipid contents were not degraded. These results may suggest that dried BSF larvae can be stored at any temperature below 25C for

half a year, as long as samples are thoroughly dried first and well packaged to protect from moisture/humidity.

This study has demonstrated the suitability of BSF larvae meal to be used as an effective protein ingredient in aquaculture feeds for shrimp and tilapia, as both species readily consumed diets containing BSF in feeding trials. Furthermore, an effective defatting process has been developed to increase the usefulness of BSF larvae meal in aquatic diets, and the effects of long term storage of this ingredient have been analyzed.

New Video Highlights Hawaii's Marine Ornamental and Aquarium Industry

A new video highlighting Hawaii's marine ornamental industry has been released on YouTube. The 15-minute documentary, titled "Hawaii's Aquarium Fishery: Regulated, Valuable, Sustainable" was produced by the Big Island Association of Tropical Fishermen. Click here or on the photo below to watch the video.

AquaClip ~ The need for feed

by Hawaii Business. November, 2016.

The high cost of animal feed has long hindered the meat, poultry, dairy and seafood industries in the Islands, but local efforts on several fronts aim to reduce those expenses.

Shipping feed from the Mainland costs about $150 to $200 per ton - often doubling the total price of feed to local companies, according to Jesse Cooke, a senior investment associate with Ulupono Initiative. And, since feed contributes 50 to 70 percent of the total cost of raising animals in the Islands, it is currently difficult for Hawaii companies to compete on price with Mainland or foreign producers.

Years ago, according to Shaun Moss, president of Hawaii Pacific University's Oceanic Institute, "There was this recognition that if we're going to grow our own animal meat here in Hawaii for human consumption we need to find a way to reduce the financial burden of getting feed for those animals."

For over 10 years, the Oceanic Institute has looked at using local ingredients to produce animal feed, including crops grown specifically for feed ingredients, waste products from the agriculture and biofuel industries, and slaughterhouse and fish-processing waste. The result was a database of nutrition profiles - analyses of protein (amino acids), lipids (fatty acids) and carbohydrates - of potential ingredients for nutritionists to match to the requirements of the species they're looking to feed.

This work led to the testing of feeds with by- and co-products of papaya and algae. Moss says about 40 percent of papaya grown in Hawaii never go to market because the fruit has flaws and ends up in landfills. Using waste papaya, the institute grew fungal protein that was effectively used as a high-quality protein in feeds for shrimp and fish. In another recipe, the institute used a protein

cake left behind from Kona-grown, single-celled algae to effectively replace fish meal in aquatic animal feeds.

Full article

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 grants 2012-38500-19566 and 2014-38500-22241. 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 Oceanic Institute and the University of Hawaii.