



Manufacturing Aquafeeds in Hawai'i – Is It Feasible?

Armando García-Ortega





Presenter Bio

- **Biologist**, National Autonomous University, Mexico
- **M.S. in Aquaculture**, Ghent University, Belgium
- **Ph.D.** Wageningen University & Research, The Netherlands

Associate Professor of Aquaculture at UH Hilo

Research interests:

- Aquaculture, Fish Nutrition
- Land-based production of marine fish and seaweeds
- Use of algae meals in feeds for carnivore/omnivore fish

Overview

Introduction

Least cost approach in aquafeed formulation

Aquafeed ingredients research in Hawai'i

Current work

Question

Introduction

- The State of Hawai'i ranks **#8** in U.S. aquaculture (2017 Census of Agriculture)
- Hawai'i aquaculture sales in 2021: \$79.7 million (2022 NASS, USDA)
 - Algae: \$36.7 million
 - Ornamentals: \$3.62 million
 - "Other": \$39.3 million
- **Hawai'i county is a top aquaculture producer: #3 in the country**

Commercial feeds support the production of aquaculture products worth ±\$40 million?

2017 CENSUS OF AGRICULTURE *County Profile*

Market Value of Agricultural Products Sold

	Sales (\$1,000)	Rank in State ^b	Counties Producing Item	Rank in U.S. ^b	Counties Producing Item
Total	269,188	1	4	320	3,077
Crops	160,040	1	4	256	3,073
Grains, oilseeds, dry beans, dry peas	-	-	3	-	2,916
Tobacco	-	-	-	-	323
Cotton and cottonseed	-	-	-	-	647
Vegetables, melons, potatoes, sweet potatoes	15,581	2	4	154	2,821
Fruits, tree nuts, berries	92,832	1	4	44	2,748
Nursery, greenhouse, floriculture, sod	50,289	1	4	56	2,601
Cultivated Christmas trees, short rotation woody crops	(D)	1	4	(D)	1,384
Other crops and hay	(D)	2	4	(D)	3,040
Livestock, poultry, and products	109,148	1	4	462	3,073
Poultry and eggs	118	3	4	1,006	3,007
Cattle and calves	23,289	1	4	693	3,055
Milk from cows	(D)	1	1	(D)	1,892
Hogs and pigs	(D)	4	4	(D)	2,856
Sheep, goats, wool, mohair, milk	523	2	4	329	2,984
Horses, ponies, mules, burros, donkeys	417	1	4	515	2,970
Aquaculture	59,261	1	4	3	1,251
Other animals and animal products	14,244	1	4	10	2,878

The Big Island is a national leader in Aquaculture, we should praise the achievement more often.



Least cost approach in feed formulation

- Animals in intensive aquaculture are farmed using commercial feeds
- Ingredients need to fulfill three requirements:
 - a) Nutritional quality** (good to high, right mix of nutrients)
 - b) Availability** (high, enough to sustain the industry)
 - c) Cost** (low)

Aquafeed ingredients research in Hawai'i

Oceanic Institute

- In 2012 published manuals for the manufacture of tilapia feeds using local ingredients (CTSA, USDA)
- Abalone feed formulation (CTSA, USDA)

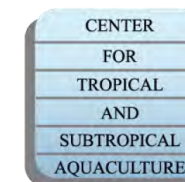
CTSA Publication #156.

Manufacturing Tilapia Feed A Manual Using Local Feedstuff Resources for Fish Farming in American Samoa

Warren Dominy, Lindon Hansink, Lytha Conquest, Ward Kashiwa and Gavin Nague
*Aquatic Feeds and Nutrition Department
Oceanic Institute, Makapu'u Point, Waimānalo, USA*

Darren Okimoto and Ephraim Temple
*University of Hawai'i Sea Grant College Program
School of Ocean and Earth Science and Technology
University of Hawai'i at Mānoa, Honolulu, USA*

Francis Leiato
*Community and Natural Resources
American Samoa Community College
Pago Pago, AS*



<https://repository.library.noaa.gov/view/noaa/41174>

Oceanic Institute

- In 2014, 17 ingredients from Oahu and the Marshall Islands tested for tilapia feeds (94% local ingredients) (CTSA, USDA)
- In 2017, 30 ingredients were tested for use in shrimp feeds (CTSA, USDA)

Table 1. Proximate contents and gross energy values for selected local feed ingredients.

Local Ingredient	Dry Matter %	Crude Protein %	Crude Lipid %	Ash %	Gross Energy Cal/g
Ahi byproduct	92.9	67.8	14.1	13.1	4957
Azolla	94.1	19.9	1.8	11.6	3869
Banana with skin	92.0	2.3	1.9	5.0	3576
Banana without skin	92.4	2.8	0.2	2.9	3598
Bread Fruit with skin	93.4	2.9	1.3	2.9	3691
Breadfruit w/out skin	93.0	1.8	1.0	2.9	3651
Camelia Presscake	91.1	36.7	15.4	4.1	4797
Cassava	94.9	1.6	0.4	1.3	3821
Cassava internal	98.9	3.3	2.7	2.9	3990
Cassava skin	99.0	10.1	4.5	4.1	4145
Copra meal	94.6	23.0	11.3	5.6	4576
Defatted Hematococcus	94.5	40.3	0.9	12.8	4082
Dried restaurant waste	97.0	24.9	12.3	12.7	4813
Duckweed	94.3	12.8	5.8	23.5	3416
Fish byproduct	98.8	69.7	6.2	21.9	4413
Macadamia nut	98.6	10.0	70.3	1.0	7474
Pongamia oil seed	94.3	20.8	33.6	2.3	5870
Pongamia presscake	92.3	28.4	11.7	3.3	4690
RMI Breadfruit Raw	98.1	7.0	1.7	2.0	3373
RMI Fermented Breadfruit	99.9	1.8	1.4	1.5	4101
RMI Fishmeal	97.3	58.9	8.6	21.4	4344
RMI Rabbitfish	96.9	62.2	9.7	15.7	4436
RMI Swamp Taro	98.3	6.6	2.4	8.5	4161
Salvinia	95.2	28.2	4.5	9.4	4258
Samoa Fishmeal	92.6	63.0	7.6	19.6	4409
Spirulina	91.9	53.7	3.5	9.4	4251
Taro Hawaii	98.4	3.7	0.9	2.3	3916
White fish byproduct	94.3	64.4	16.5	14.9	5005
Whole Camelia seed	89.9	29.3	15.9	5.4	4603

Aquafeed.com

- In 2018, a supplemental tilapia feed made with fish processing waste to replace up to 50% of dietary protein (S-K, NOAA)

Hawaii Feed & Fertilizer LCC

- In 2020, local fishmeal plant using fish processing waste (S-K, NOAA)





UH Hilo

- In 2016, up to 15% of total feed weight from **defatted *Haematococcus pluvialis*** successfully tested in *Seriola rivoliana* (kanpachi) (PBARC, USDA)

OI and UH Hilo

- In 2018, two tilapia feeds made with low and high fat content (>50% locally sourced ingredients) (CTSA, USDA)
- Two sinking feeds and two floating feeds for moi were tested (CTSA, USDA)
- **First feeds made at the OI feed mill in Hilo**



Tilapia small scale trial results at UH Hilo 2018

	OI Tilapia Feed #1	OI Tilapia Feed #2	Rangen commercial feed
Feed cost \$/lb	\$0.43*	\$0.44*	\$1.06
Feed protein content (%)	37%	37%	35%
Initial fish weight (g)	1.4	1.4	1.1
Final fish weight (g)	27.3	37.4	34.7
Weight gain (g)	25.9	36.0	33.6
Specific growth rate (%/day)	4.3	4.8	4.9
Growth rate (g/day)	0.4	0.5	0.5
FCR	1.1	1.0	1.1
Survival (%)	100	100	100

*Costs only include the ingredients

Garcia-Ortega and Ju, 2018



UH Hilo and CTAHR

- In 2020 reported 75% replacement of FM, SPC and FO by algal meals (*Spirulina*, *Schizochytrium*) in feeds for tilapia (PBARC, USDA)
- That is **61% of total feed weight**



CTAHR and UH Hilo

- In 2021, **yeast** made with papaya waste was tested in feeds for tilapia (CTSA, USDA)
- Up to 25% of FM can be replaced by yeast
- That is **12% of the total feed weight**



Current work



- Double-hydrolyzed **black soldier fly larvae meal**
(CTAHR and UH Hilo)
- **Seaweed** extracts, whole seaweed meals
(Ocean Era)
- **Economic feasibility** of aquaculture feeds in Hawai'i
(Hawaii Sea Grant and CTSA)
- Locally made abalone feeds
(UH Hilo and Big Island Abalone)

Are we there yet?

- Adequate nutritional quality in some local ingredients ✓
- Availability is still a challenge
(limited agriculture production in Hawai'i)
- Lack of feedstuffs **processing** (e.g. drying, grinding) and **storage facilities**
- Cost of ingredients may still be high
(need for Ag grade products e.g. *Spirulina*)
- Keep in mind manufacturing commercial aquafeeds **is a business!**



Thanks to our collaborators and funding agencies



UNIVERSITY
of HAWAII®
HILO

CENTER FOR
TROPICAL AND SUBTROPICAL
AQUACULTURE

Cyanotech

BIG ISLAND
ABALONE
HAWAII



Altech®



COLLEGE OF TROPICAL AGRICULTURE
AND HUMAN RESOURCES
UNIVERSITY OF HAWAII AT MĀNOA

USDA
Agricultural
Research
Service



SIU Southern Illinois
University
CARBONDALE



Mahalo for your attention

Armando García-Ortega, Ph.D.

College of Agriculture, Forestry and Natural Resource Management
University of Hawai'i at Hilo
(808) 932-7031
agarciao@hawaii.edu