

Research Proposal:
Developing Feeds for Hawaii Abalone Using
Local Algae & Algae Co-products



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Introduction

- Abalone is one of the most highly prized seafoods in the world.
- Over ten species of abalone are cultured in the world with shell colors from white, brown, red, green, and dark brown to dark-red (black).
- Big Island Abalone Corporation (BIAC) cultures Ezo mainly for Japan's or Asian markets.



- **Ezo (*Haliotis discus hannai*) is a dark brown to dark-red shelled abalone favored by Japanese markets (Fig. 1 left).**
- **Currently, BIAC imported commercial feeds from South Africa or Australia. These feeds could result in abnormal color if no seaweeds are fed.**



Figure 1: Normal (left) and abnormal (right) colored-shells of Ezo abalone from BIAC.

Proposal Objectives

To develop feeds for Hawaii cultured abalone with normal shell color and high growth performance using local algae and their co-products.



Research Team

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- Cecilia Viljoen, Nursery & R/D Director, Big Island Abalone Corporation, Kona, Hawaii,
- Peter Hutchinson, Abalone Feed Extrusion Specialist, Director, EN Hutchinson Ltd., New Zealand.
- Vernon Sato, Algae production expert

Year 1 Goal: Investigate shell pigment composition and nutrient content of Ezo abalone, local algae and feed ingredients, and to screen formulated test diets.

- **Objective 1:** Identify pigments and analyze the nutrient content contained in Ezo abalone shell, local seaweeds and/or algae co-products and feed ingredients used in making the abalone test diets.
- **Objective 2:** Formulate two abalone test diets to be fed in combination with and without Pacific dulse.
- **Objective 3:** Conduct a feeding trial and evaluate the test diets based on growth and pigmentation of Ezo abalone shell.

Year 2 Goal: Develop commercially viable abalone feed that results in good growth and normal shell color for Ezo abalone.

- Objective 1: Reformulate abalone test diets to commercial viable feeds without feeding Pacific dulse.
- Objective 2: Formulate two abalone test diets to be fed in combination with and without Pacific dulse.
- Objective 3: Conduct a workshop on pigments in abalone shell, seaweed, algae and feed ingredients, abalone feed formulation using local whole algae and algae defatted co-products and abalone feed manufacturing technology.

Worldwide Commercial Feeds

■ ABFEED

Developed by Rhodes University and a company called Sea Plant Products for a red abalone - *Haliotis midae* in South Africa, with good growth and water stability.

■ ADAM AND AMOS FEED

Produced by Adam and Amos Abalone Food company in Australian, in variety of grades and forms (crumb, pellets, sheets) and colors for terracotta red abalone - *Haliotis rubra*.

■ HALO FEED

A new feed introduced by the international feed company Skretting, based on fish and plant protein sources.

Nutrient contents for Imported Abalone Feeds & Hawaii Seaweeds

Table 1: Proximate contents of five abalone feeds and five seaweeds from BIAC

Samples	DM (%)	CP (%)	EE (%)	Ash (%)	Carb ¹ (%)	GE ² (cal/g)
BIAC Abalone feeds						
Abfeed (South Africa)	91.17	35.65	1.57	6.02	47.93	4126
Adam & Amos (Australia)	87.25	28.25	1.11	4.71	53.18	3908
Weaner powder (China)	90.25	40.53	3.25	21.48	24.99	3439
Nutroscience (South Africa)	93.00	39.01	2.27	9.84	41.88	4187
Research Diet (OI, Hawaii)	91.84	29.35	4.67	7.27	50.55	4312
BIAC Seaweeds						
ULVA (A)	91.00	15.64	1.26	36.87	37.23	2174
ULVA (B)	91.60	16.44	1.06	35.65	38.45	2217
Dulse P- 5	96.40	19.43	1.95	42.80	32.22	2225
Dulse P-10	94.90	25.72	2.48	31.46	35.24	3002
Dulse M-15	94.53	21.20	1.81	41.29	30.23	2302

¹Carbohydrate (Carb) content was estimated by subtraction of CP%, EE% and Ash% from DM%.

²GE = gross energy.

Abalone culture style in Japan and China

Most abalone farms in Japan and China produce abalone seeds on the land first and stock abalone seeds in nets or boxes of ocean water to grow out.



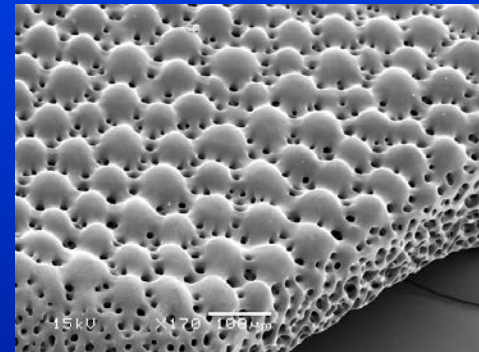
Abalone Shell Pigments

- **The metabolism of abalone shell color is unknown.**
- **Shell pigmentation is related to diet.**
- **At BIAC, Pacific dulse results in a dark-red or black colored Ezo shell. Imported commercial feeds resulted in an abnormal yellow, green or light-red lined shell .**
- **Pigments: including carotenoids, phycobilins and chlorophylls, have been reported in abalone shells.**
- **We separated a blue pigment from Ezo shell.**



Difficulty of Pigment Extraction from Abalone Shell

- The shell of abalone is formed by layers of calcium carbonate (as calcite) and organic matrix that glues the calcite layers together, like mortar in a brick wall.



- Extracting and isolating shell pigments requires techniques to dematerializing the shell, which will result in the degradation of pigments.

Thank You

