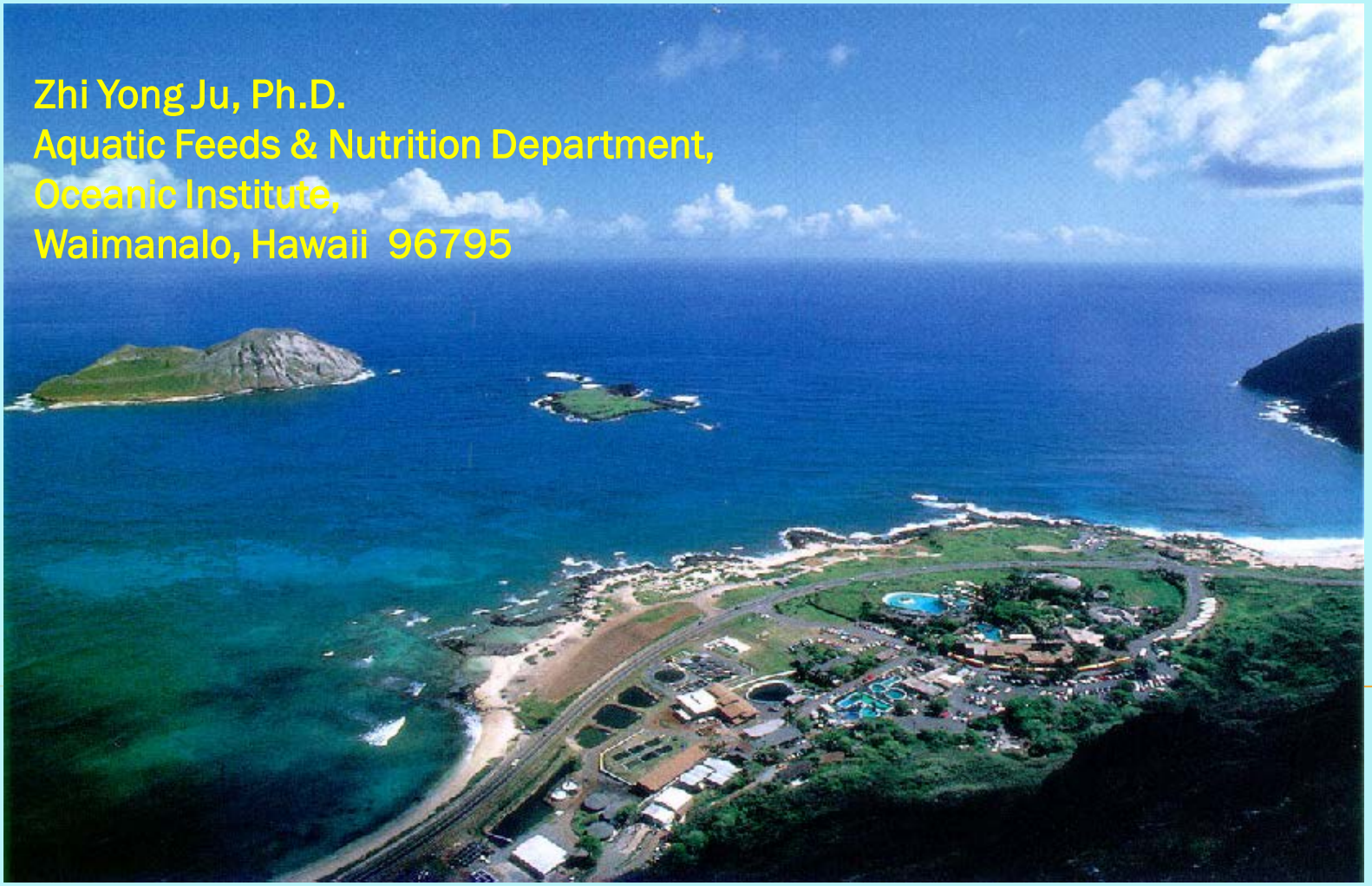
Adding a defatted algae byproduct (*Haematococcus pluvialis)* to diets on shrimp growth & pigmentation



Species of microalgae have been used for biofuel & nutraceutical productions, which results in defatted algal byproducts for feed.

- **Biodiesel production:**
  - ***Chlorella,***
  - ***Nannochloropsis,***
  - ***Chaetoceros,***
  - ***Dunaliella species.***
- **Carotenoid pigment production:**
  - ***Haematococcus pluvialis (astaxanthin),***
  - ***Dunaliella salina (β-carotene) ,***
  - ***Muriellopsis sphaerica (lutein).***
- **Algae oil or omega-fatty acids production:**
  - ***Odeontella aurita,***
  - ***Phaedactylum tricomutum,***
  - ***Isochrysis galbana.***

These defatted algal byproducts contains many nutrients for aquatic feeds, such as:

- Proteins,
- Carbohydrates,
- Minerals,
- Water-soluble vitamins,
- Phospholipids
- Pigments,
- Many bioactive compounds for animal health.

Research Objective

To determine the effect of the defatted *H. pluvialis* meal in diet on shrimp growth performance and pigmentation.

Defatted microalgae meal (DMM)

From Cyanotech Corporation (Kona, Hawaii), after super-critical CO_2 extraction of astaxanthin from dried *H. pluvialis*.

- **Diet formulation and preparation**

A control diet (32% crude protein, 8.9% crude lipid) was added DMM to replace 12.5%, 25.0%, 37.5%, & 50.0% of the fish meal protein

	Diet with replacement level of fishmeal protein				
Diet ingredient	D-0%	D-12.5%	D-25.0%	D-37.5%	D-50.0%
Menhaden fishmeal[a]	15.00	13.12	11.24	9.36	7.48
Defatted microalgae meal[b]	0.00	3.00	6.00	9.00	12.00
Whole wheat (hard red winter)[c]	37.80	36.25	34.71	33.16	31.61
Soybean meal (47%)[d]	25.00	25.00	25.00	25.00	25.00
Squid meal[e]	6.00	6.00	6.00	6.00	6.00
Dicalcium phosphate[f]	4.50	4.50	4.50	4.50	4.50
Soy Lecithin (liquid)[g]	2.00	2.00	2.00	2.00	2.00
Cholesterol[f]	0.12	0.12	0.12	0.12	0.12
Potassium Chloride[f]	2.50	2.50	2.50	2.50	2.50
Calcium Carbonate[f]	1.00	1.00	1.00	1.00	1.00
Magnesium Oxide[f]	1.60	1.60	1.60	1.60	1.60
Mineral/Vitamin Premix #1[h]	0.23	0.23	0.23	0.23	0.23
Mineral/Vitamin Premix #2[h]	0.21	0.21	0.21	0.21	0.21
Stay C-35[i]	0.04	0.04	0.04	0.04	0.04
Menhaden Oil[j]	2.00	2.18	2.35	2.53	2.71
Soybean oil[k]	2.00	2.00	2.00	2.00	2.00

Nutrient Composition of DMM & Test diet

Table 2: Proximate composition (in dried sample) of the five tested diets, commercial feed, and defatted microalgae (*Haematococcus pluvialis*) meal (DMM).

Composition	Test Diets						DMM
	D-0%	D-12.5%	D-25.0%	D-37.5%	D-50.0%	Commercial Feed	
Proximate (%)							
Dry matter	92.8	92.1	92.6	92.7	93.3	89.8	94.5
Ash	14.9	14.9	14.7	14.5	14.4	9.1	12.8
Crude Protein	32.3	32.2	31.4	31.7	31.3	39.9	40.3
Crude lipid	8.9	9.1	9.3	9.4	9.3	8.5	0.9
Crude fiber	1.5	2.6	3.7	4.9	6.1	2.7	39.5
Gross energy (cal/g)	4045	4042	4097	4112	4162	4349	4082
Macro minerals (%)							
Phosphorus	1.71	1.63	1.49	1.44	1.41	1.40	0.95
Potassium	2.09	2.06	2.05	2.03	2.24	0.91	0.43
Calcium	2.49	2.30	2.13	2.01	1.92	2.33	0.48
Magnesium	1.15	1.17	1.19	1.23	1.25	0.20	0.82
Sodium	0.12	0.11	0.11	0.11	0.11	0.40	0.20
Micro-Minerals (ppm)							
Boron	15	16	16	17	17	10	23
Copper	32	35	29	47	15	24	11
Iron	557	577	594	672	797	259	1287
Manganese	62	72	70	59	65	142	87
Zinc	106	113	132	137	146	120	396

- Feeding trial

Flow through system

4 replicate tanks /diet

12 shrimp /tank

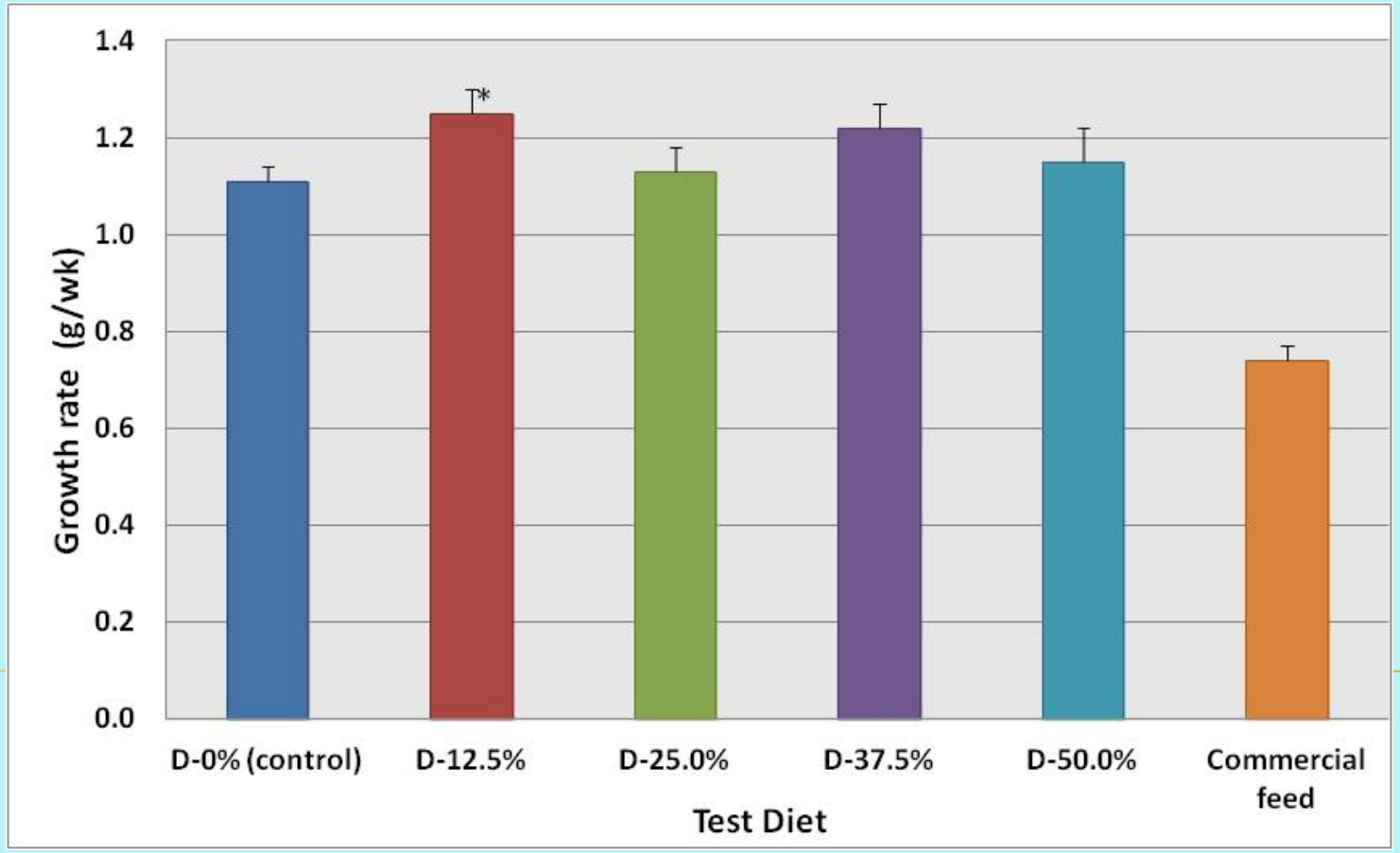
3 times of feeding

25 C Temperature

32 ppt Sea water

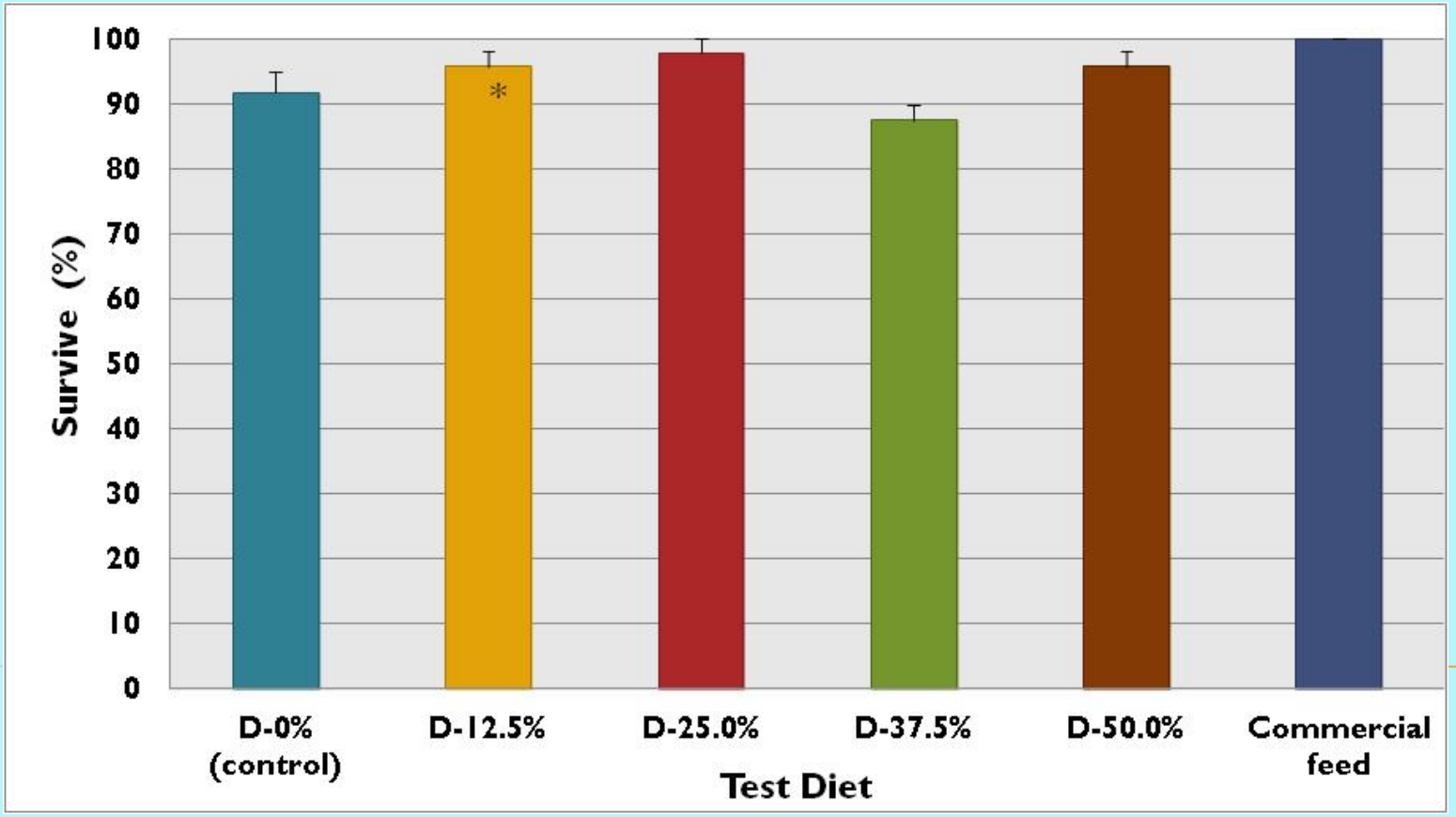
Trial Results

- Growth rate (g/wk)



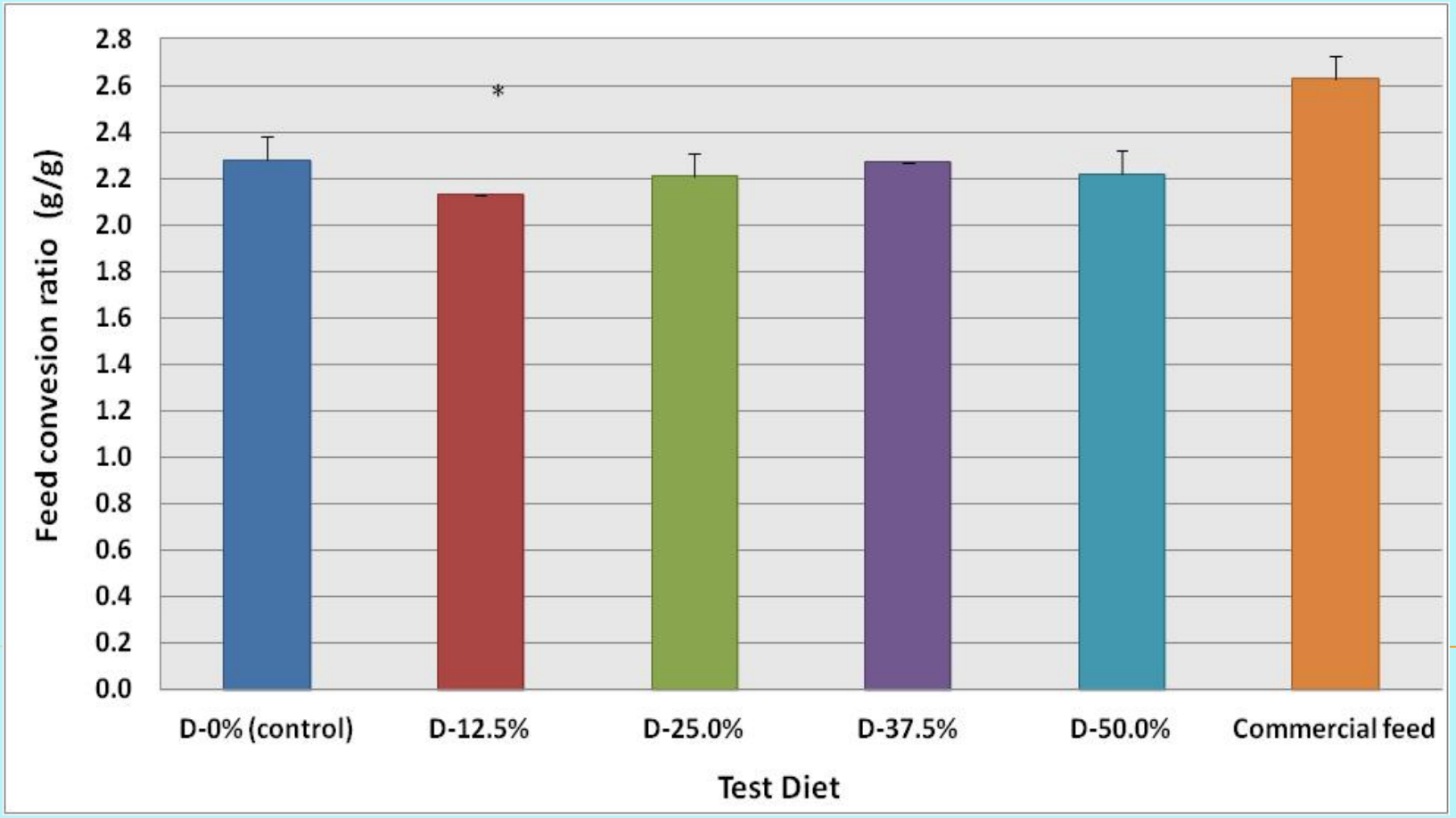
Trial Results

- Shrimp survive (%)



Trial Results

- Feed conversion ratio (g/g)

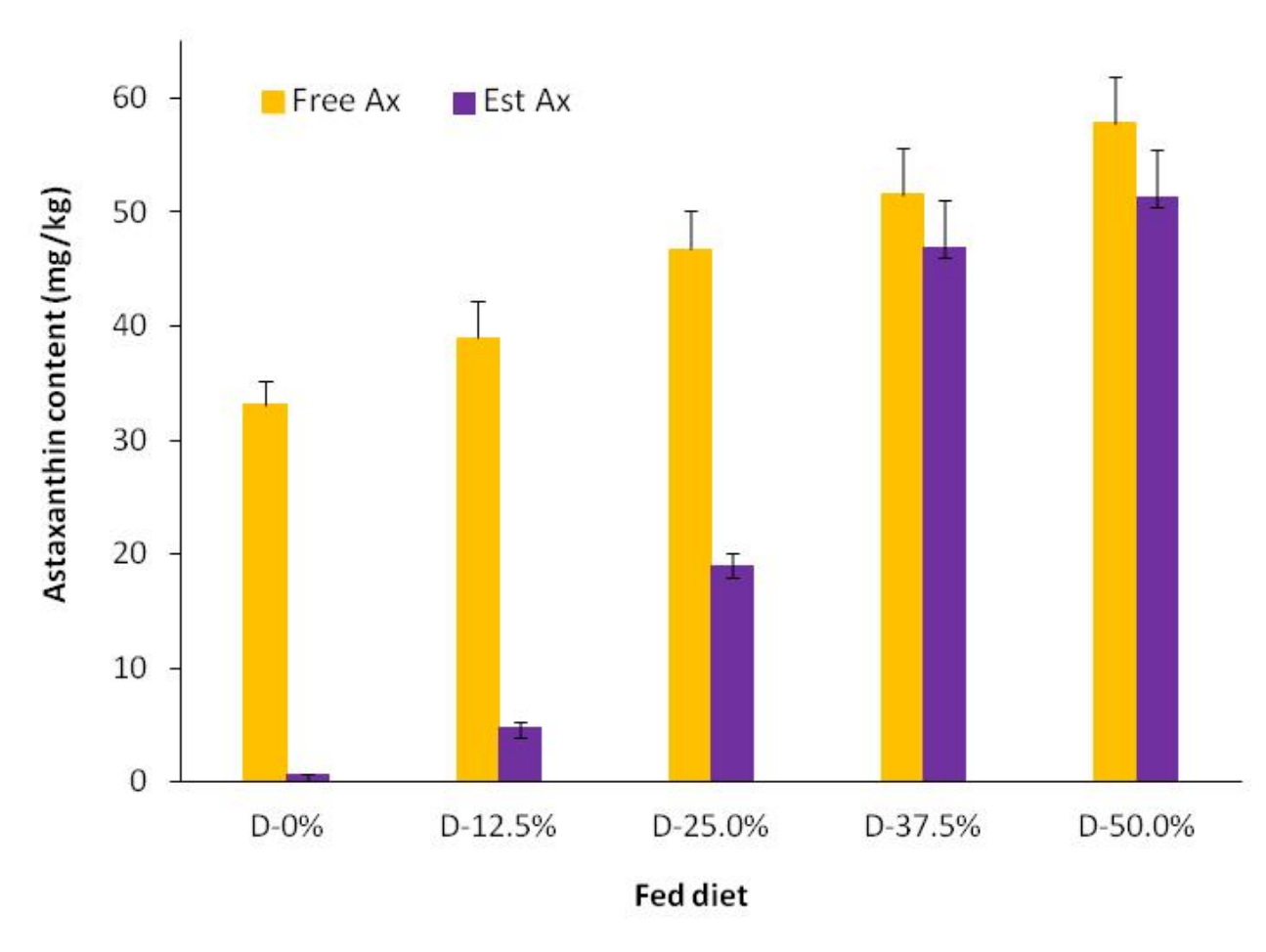


Trial Results

- Shrimp body color

Trial Results

- Total astaxanthin in shrimp body (mg/g)



Nutrient Composition of shrimp products

Table 5: Proximate composition (in dry matter, n=4) of whole shrimp body fed five tested diets with replacement protein levels (0 to 50%) of fish meal in control diets by a defatted microalgae meal (*Haematococcus pluvialis*).

Composition	Content in whole shrimp body (Mean±SD)					
	D-0%	D-12.5%	D-25.0%	D-37.5%	D-50.0%	C-Feed[1]
Proximate (%)						
Dry matter	93.3±0.9[a2]	93.5±0.5[a]	94.7±0.2[a]	93.7±0.9[a]	94.4±0.3[a]	93.9±0.4[a]
Ash	10.3±0.5[a]	10.5±0.3[a]	10.7±0.4[a]	10.5±0.3[a]	10.4±0.5[a]	10.4±0.2[a]
Crude Protein	71.8±0.6[a]	72.1±1.4[a]	71.4±1.3[a]	70.5±1.0[a]	71.6±0.3[a]	71.7±1.6[a]
Crude lipid	6.7±0.4[b]	6.9±0.2[b]	6.8±0.1[b]	6.7±0.4[b]	6.9±0.4[b]	6.0±0.2[a]
Macro-minerals (%)						
Phosphorus	1.1±0.0[b]	1.1±0.0[b]	1.1±0.0[b]	1.1±0.0[b]	1.2±0.1[b]	0.9±0.0[a]
Potassium	1.3±0.0[a]	1.3±0.0[a]	1.2±0.0[a]	1.2±0.0[a]	1.3±0.1[a]	1.2±0.0[a]
Calcium	2.7±0.4[a]	2.4±0.5[a]	2.4±0.5[a]	2.8±0.5[a]	2.6±0.6[a]	2.8±0.1[a]
Magnesium	0.3±0.0[a]	0.3±0.0[a]	0.2±0.0[a]	0.3±0.0[a]	0.3±0.0[a]	0.2±0.0[a]
Sodium	1.0±0.0[a]	1.0±0.0[a]	1.0±0.0[a]	0.9±0.0[a]	1.0±0.1[a]	1.0±0.0[a]
Micro-Minerals (ppm)						
Boron	2.4±0.5[a]	2.4±0.5[a]	2.4±0.3[a]	2.3±0.1[a]	2.7±0.3[a]	2.5±0.3[a]
Copper	102.3±4.9[a]	103.2±5.3[a]	102.4±6.4[a]	99.8±4.8[a]	100.7±6.7[a]	100.2±4.4[a]
Iron	16.4±5.1[a]	14.5±1.6[a]	16.3±5.6[a]	15.1±1.7[a]	16.9±1.8[a]	15.9±2.7[a]
Manganese	1.3±0.1[a]	1.5±0.1[b]	1.4±0.1[ab]	1.4±0.1[ab]	1.5±0.1[b]	1.5±0.1[b]
Zinc	52.3±12.7[a]	46.9±5.4[a]	44.9±1.5[a]	47.6±5.1 [a]	53.8±15.3[a]	45.8±1.7[a]

[1]C-Feed = commercial feed.

[2]Means not sharing a superscript in the same row are significantly different ($P<0.05$, n=4).

Conclusions

- DMM can be used as an alternative protein to replace 50% of fishmeal protein in the control diet.
- The inclusion of a small amount (3%) of DMM in the diets has an enhanced growth effect on shrimp.
- DMM in shrimp diets can enhance the color and thus improve shrimp appearance.


Thank You