

Algae Co-Products as Potential Alternative Ingredients for Sea Urchins

**Biofuels Co-Products Workshop
Waimanalo, Hawaii
December 1-2, 2011**

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2, 2011



Sea Urchin



**Texas AgriLife Research
Mariculture Laboratory
at Port Aransas**

Texas A&M System

1300 Port Street





Dallas



Austin



Houston



San Antonio



Corpus Christi-
Port Aransas



do

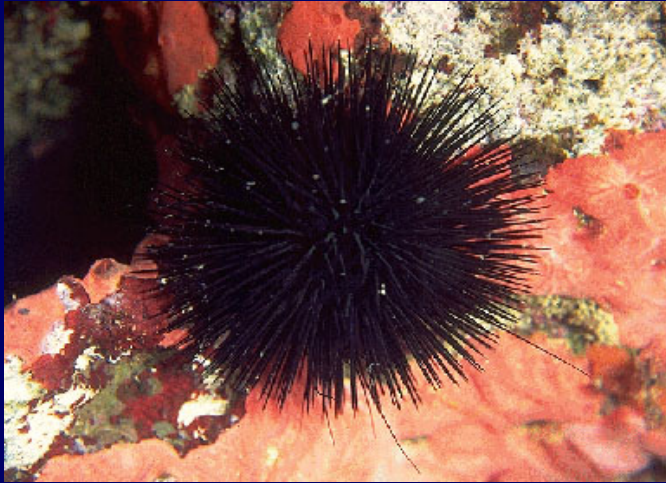


*Agri*LIFE **RESEARCH**

Texas A&M System

Cultured Sea Urchins

Arbacia punctulata



Strongylocentrotus franciscanus



Strongylocentrotus purpuratus



Strongylocentrotus intermedius *Strongylocentrotus drobachiensis*

Tripneustes ventricosus

December 1-2, 2011 Waimanalo, Hawaii

Lawrence Urchin Algae in Diets

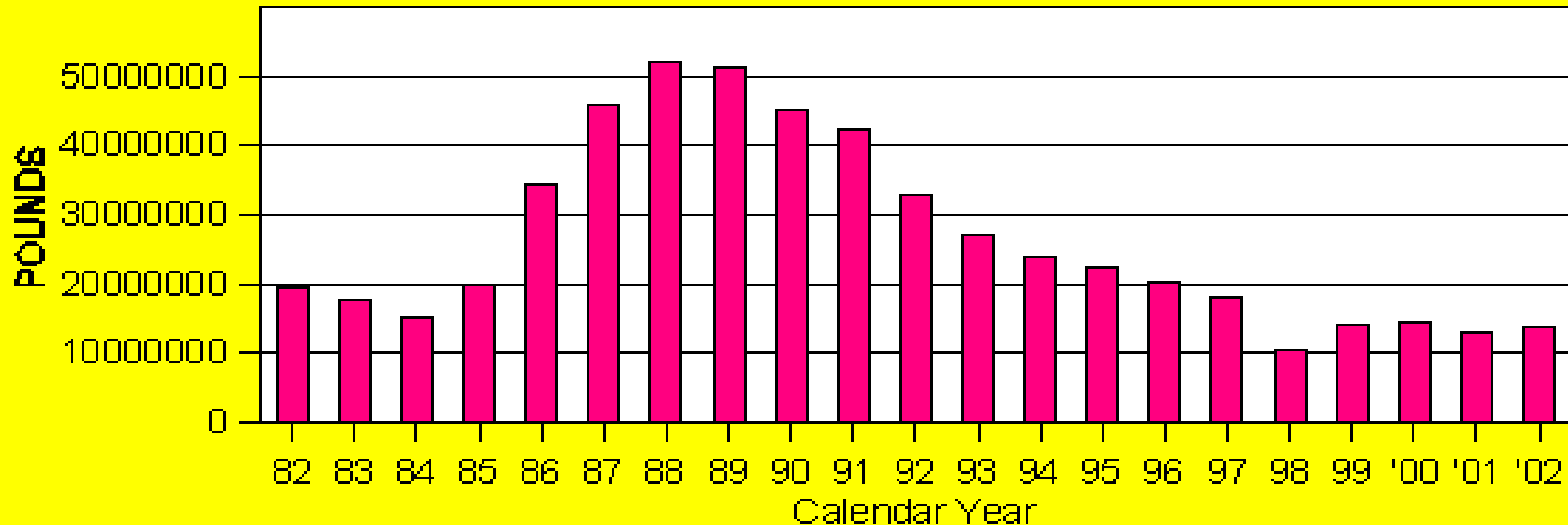
Sea Urchin Aquaculture

- Not just for human consumption!
- Also for medical research – human development!
- Stock enhancement programs! Fisheries!
- Ecotoxicological



California Sea Urchin Landings

(Strongylocentrotus spp. & Lytechinus sp.)



Sea Urchin Roe (gonad, tongue, uni, etc.) Market

- ~\$300 – \$400 million/year
- Japan: 65%
- Southern Europe: 25%
- Rest of World: 10%
- \$10 - \$200 per kg uni (roe)

Whole and Defatted Algae as a Meal for Sea Urchins

➤ ADVANTAGES of WHOLE ALGAE

1. Algae, a natural food of sea urchins.
2. Carotenoid, mineral, micronutrients, fatty acid, unknown growth factors.
3. % protein levels at minimum level.

➤ ADVANTAGES OF DEFATTED vs. WHOLE ALGAE

1. Protein, carbohydrate, fatty acid, mineral and carotenoid levels more optimum.

What is a Sea Urchin

Organ	Sea Urchin	Sea Star	Shrimp
Gut,Ext.Skeleton	Yes	Yes	Yes
Muscle Organ	No	No	Yes
Hepatopan.(DG)	No	Yes	Yes
Gonad, Gametes	Yes	Yes	Yes
Gonad, Nutrient	Yes	No	No

Sea Urchin Reproductive Cycle

- Gonad phagocytic NUTRIENT cells developed to:
 1. 20% - 30% of body weight
 2. 30% - 40% glycogen
- Gonad gametes develop after gonad NUTRIENT cells develop to maximum



- **72 Tanks**
- **4 Urchins/Tank**
- **288 Urchins**
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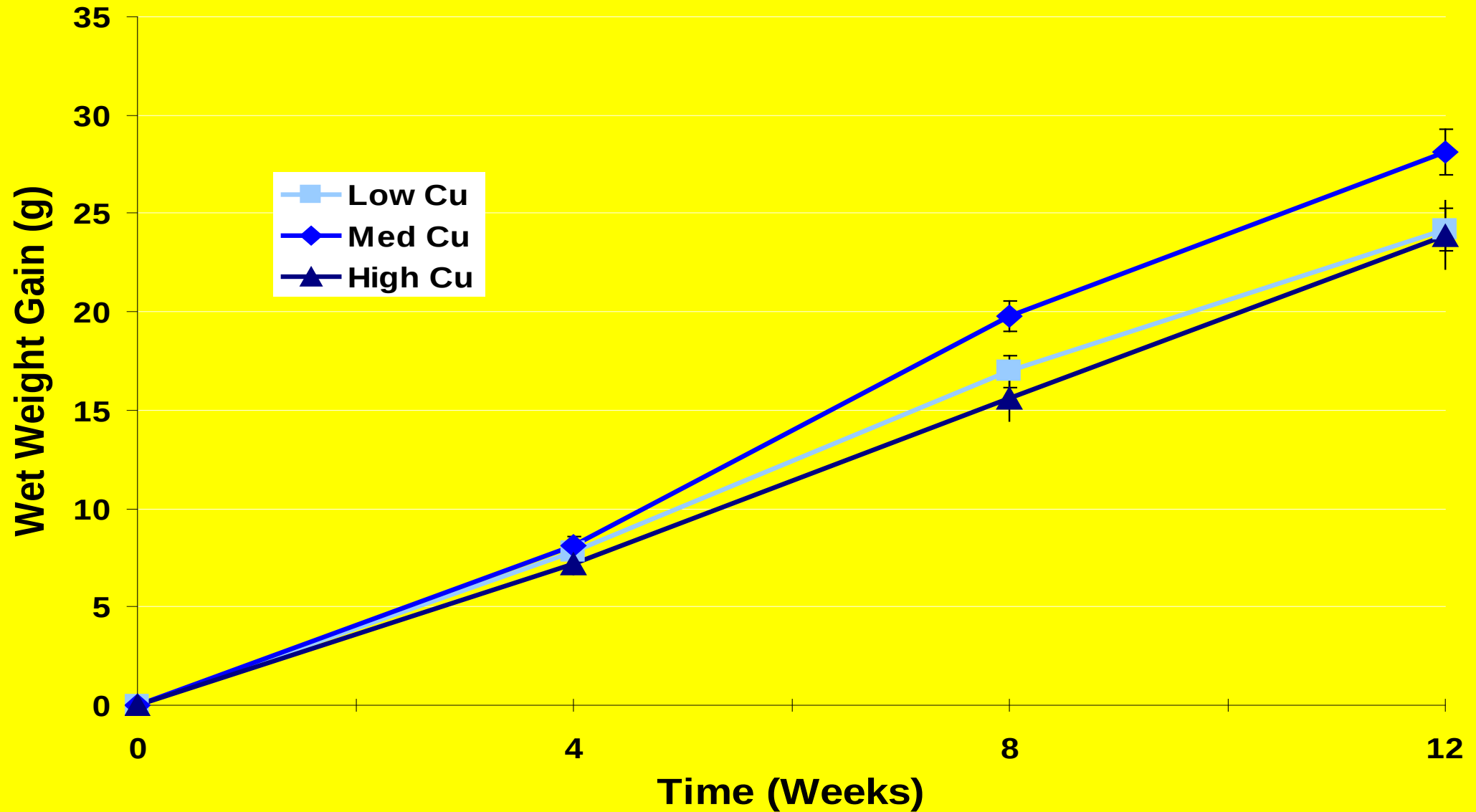


Low Cu 6 ppm
Med Cu 47 ppm
High Cu 160 ppm

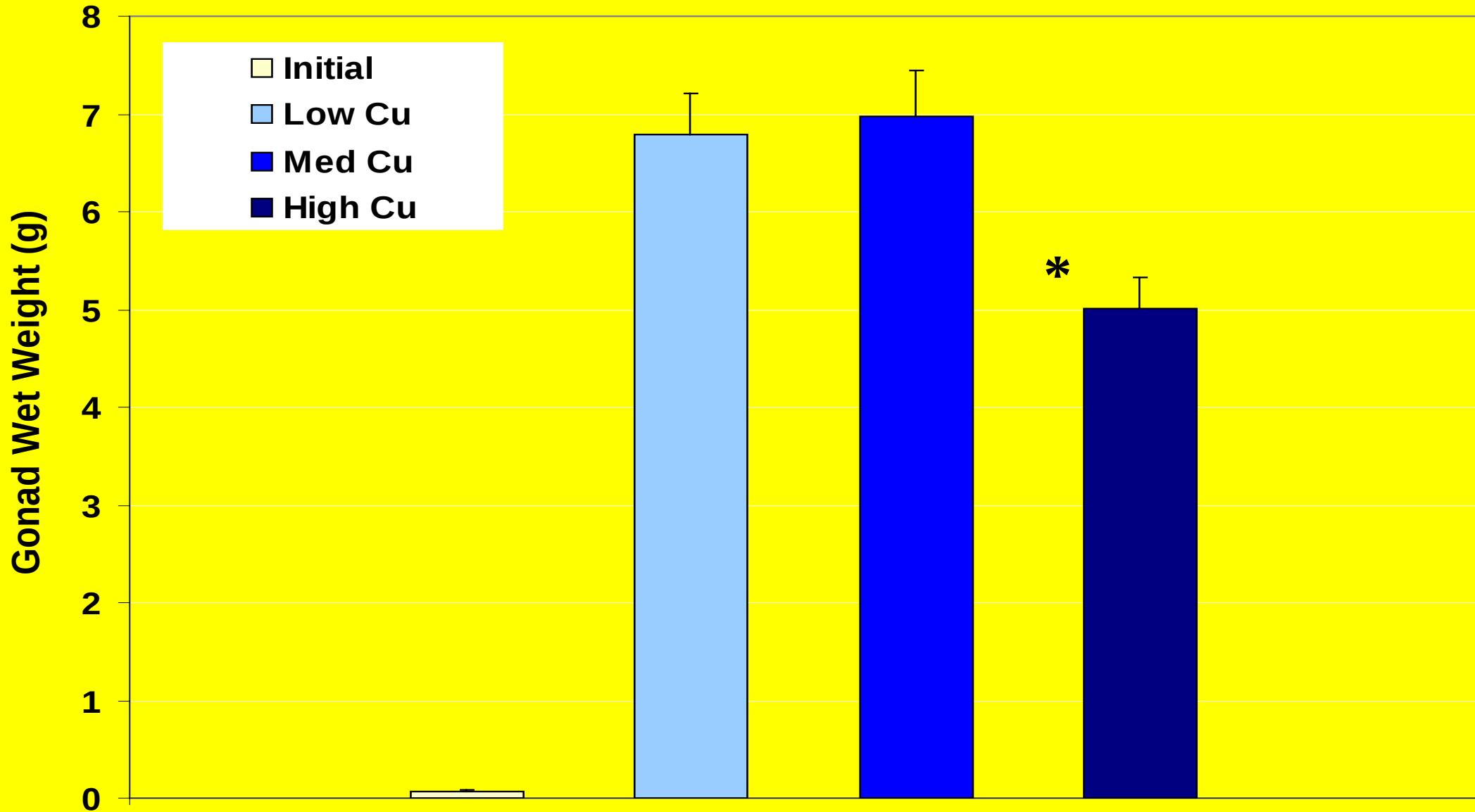
16 urchins/treatment
Juveniles
Minimal gonad



Wet Weight Gain



Gonad Wet Weight

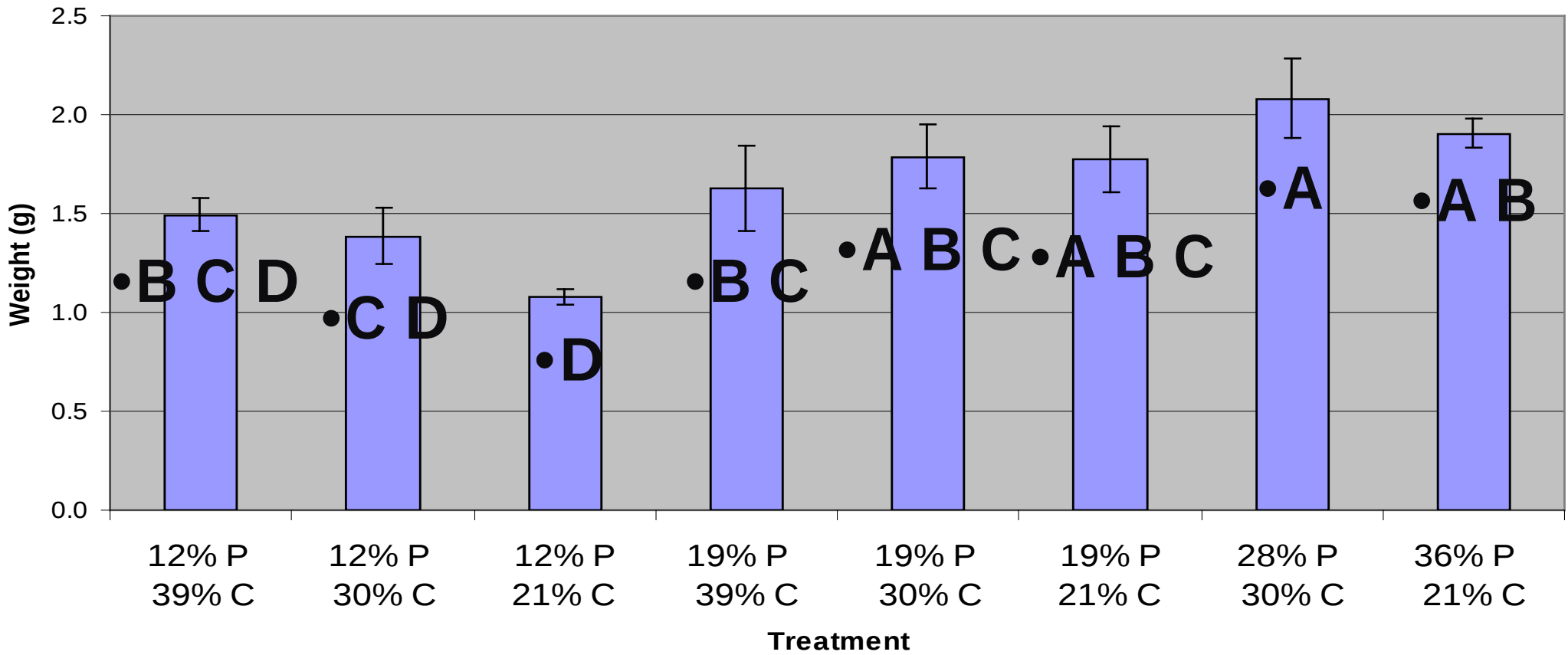




Diet Treatments

Protein (%)	Carb (%)	Total Energy (cal/g)	P:E (mg/Kcal)
36 ²	21	3749	95
28 ¹	30	3299	76
19 ³	21	2783	68
19 ³	30	3130	60
19 ⁴	39	3478	54
12 ⁷	21	2380	50
12 ⁶	30	2727	44
12 ⁵	39	3075	39

Dry Gonad Final Weight

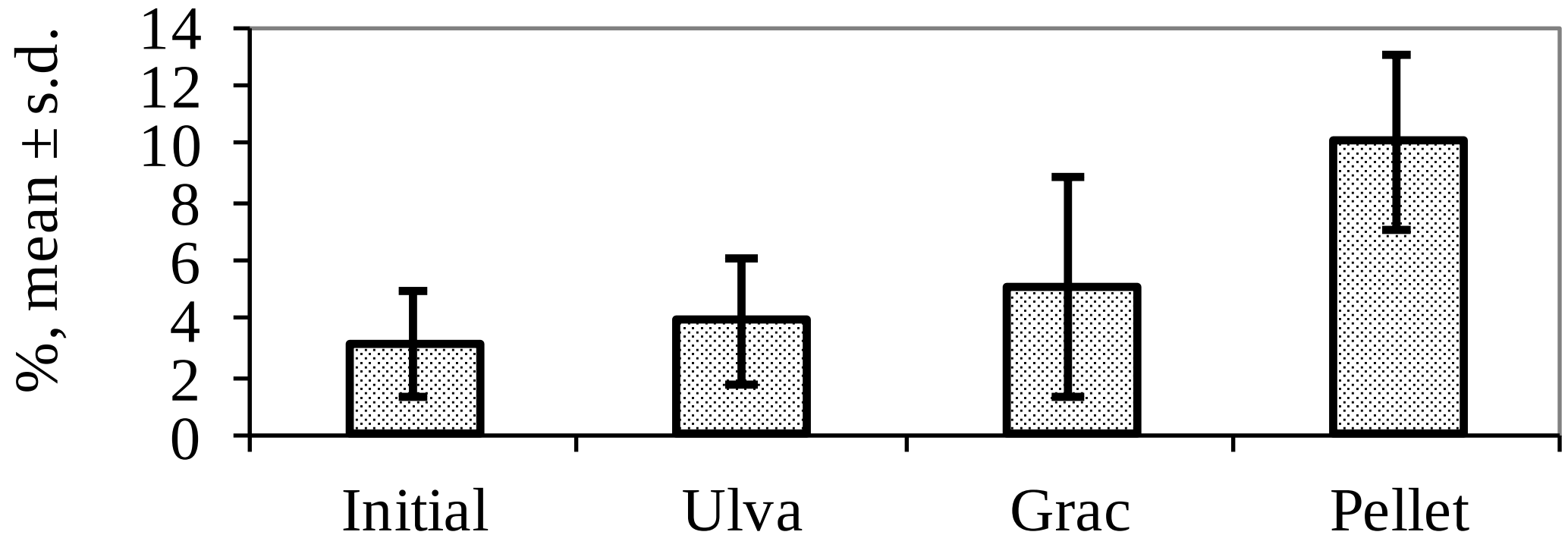


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Effect on Gonads?





Gonad index for *Paracentrotus lividus* fed three experimental diets (*Ulva lactuca*, *Gracilaria conferta*).

Diet study

LMCI 75-0711



35.1 % protein
14.4 % carbohydrate
0.42 % carotenoid

LMCI 75-0712



29.08 % protein
22.2 % carbohydrate
0.42 % carotenoid

LMCI 75-0713



21.72 % protein
29.9 % carbohydrate
0.42 % carotenoid

LMCI 75-0714



14.97 % protein
37.6 % carbohydrate
0.42 % carotenoid

LMCI 75-0715



21.74 % protein
29.9 % carbohydrate
0.4 % carotenoid

LMCI 75-0716



22.0 % protein
29.9 % carbohydrate
0.45 % carotenoid

LMCI 75-0717



21.76 % protein
29.9 % carbohydrate
0.97 % carotenoid

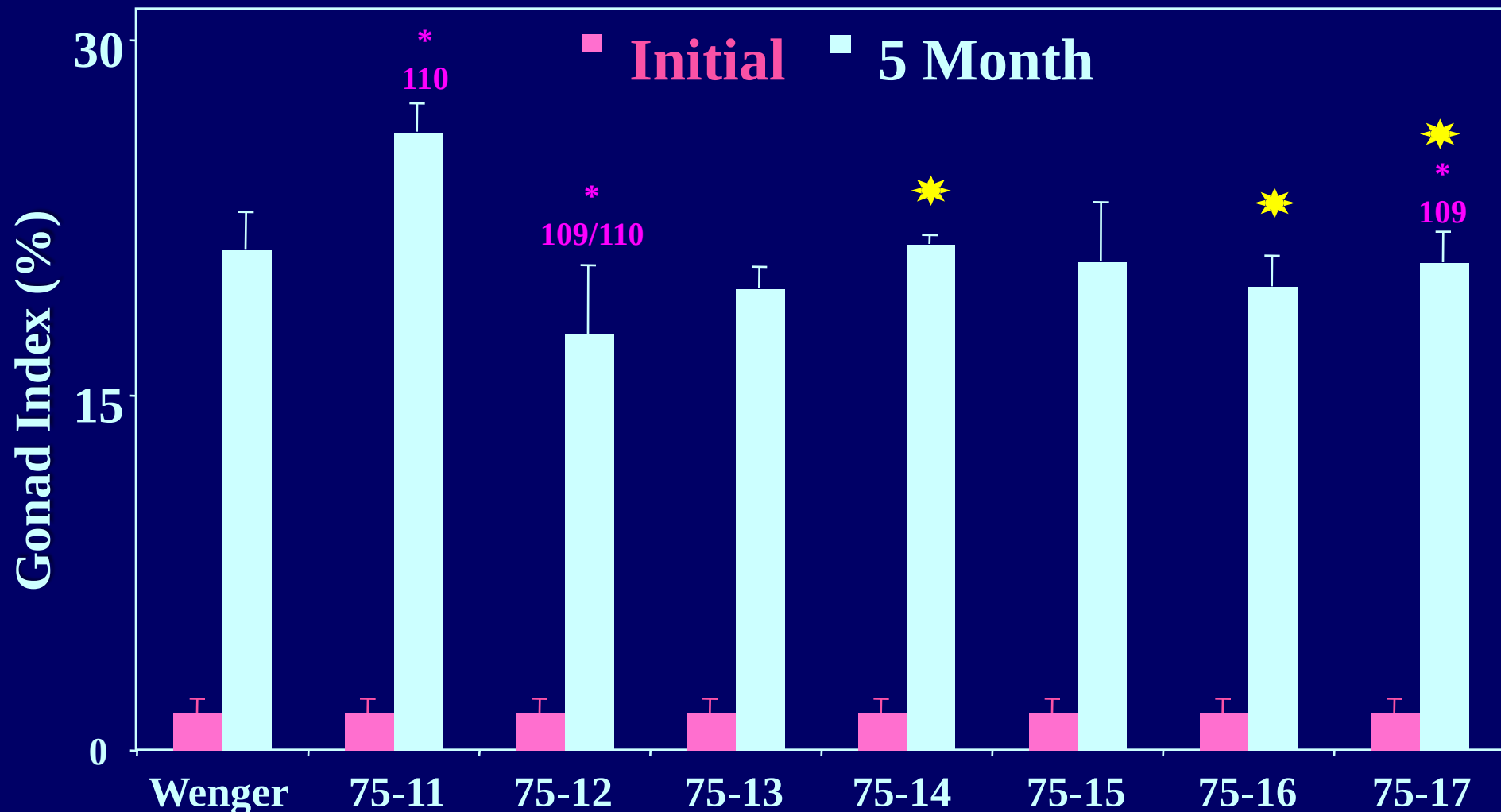
Wenger



Lawrence Urchin Algae in Diets



Gonad Indices



*** = consistent color; # = orange/yellow color on chart (during laboratory dissection)**

★ = deemed marketable by taste tester



Monthly gonad index of *S. intermedius*

Environmental Temperature	18	1	22	2	33	3	32	7
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Culture Temperature		30 March		28 April		28 May		27 June	
7	C	18	2	25	2	34	4	32	8
12	C	18	2	27	2	32	2	34	8
17	C	18	2	27	1	34	5	35	7
22	C	16	1	20	2	25	5	26	6

Ingredients of Diet 1 (lower protein) and Diet 2 (higher protein). Values are percent on “as fed” basis.

Ingredient	Diet 1	Diet 2
Marine ingredients	28.00	28.00
Wheat Starch	31.34	24.24
Diatomaceous earth	12.00	11.40
Mineral premix	17.76	17.76
Carotenoid premix	1.70	1.70
Lipid premix ¹	4.50	4.50
Casein	4.00	4.00
Isolated soy protein	0.00	7.70
Vitamin premix	0.70	0.70
Total.	100.00	100.00

Gonad indexes of *S. intermedius* fed Diet 1 (higher protein), Diet 2 (lower protein) or algae. Values with the same letter in a row are not significantly different.

	Diet 1		Diet 2		Algae	
28 February	10	3	10	3	10	3
30 March	18	2	21	3	15	1
28 April	27	1^a	28	3^a	20	3^b
28 May	34	6^a	31	6^a	24	2^b
27 June	35	7^a	35	5^a	27	3^b

Nutrient Values

**25% Protein Gonad Commercial Least
Cost Production Feed**

Values are calculated on “as fed” basis.

Na	1.29 %	Crude Protein	25.0 %
K	1.63 %	Crude Fat	7.00 %
Se	0.2ppm	Carotenoid	1.70 %
Ca	4.00 %	Crude Fiber	2.62 %
P	1.50 %	Total Ash	20.2 %
Mg	0.60 %	Moisture	9.63 %
Zn	96ppm	Arginine	1.73 %
Fe	158ppm	Methionine	0.52 %
Cu	32ppm	Lysine	1.56 %
Mn	71ppm	Tryptophan	0.32 %

Least Cost Commercial Production Feed for Sea Urchin Gonad Production

Ingredient	Level	Cost
Carotenoid Premix	1.7	0.51
Marine Source Meals*	27.0	0.26
Lipid (-Carotenoid)	4.5	0.15
Plant, Land, Meals	50.9	0.12
Mineral Premix	14.7	0.05
Other, vit, binder, antioxid.	1.2	0.04

*** Includes 20 % algae meal**

Cost = \$ / kg of feed

Level = % of feed on “as fed” basis

SUMMARY – for SEA URCHINS

➤ ADVANTAGES of WHOLE and DEFATTED ALGAE

- 1. Ideal nutrient values. A natural food.**
- 2. Of all sea urchins being farmed or to potential to be farmed – algae can be used at higher levels of 20 % to 50 % of diet.**

➤ DISADVANTGAGES of WHOLE and DEFATTED ALGAE

- 1. No market. No significant commercial sea urchin aquaculture at present time.**