

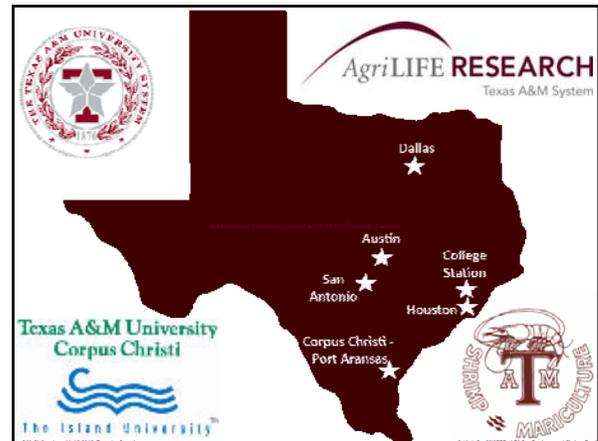
## Soybean Meal Replacement by and Value of Lipid Extracted Algae in Shrimp Feeds



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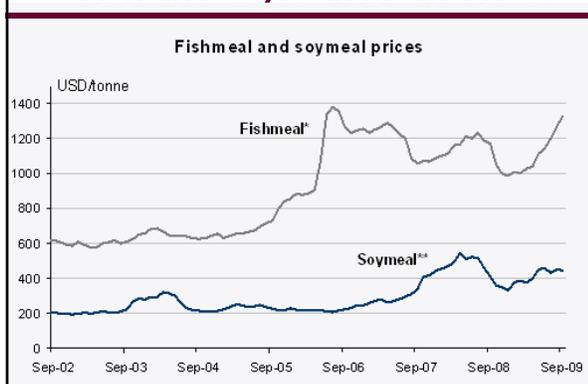


## Defatted, Dehulled Soybean Meal

- Major ingredient in shrimp feeds (20% to 45% inclusion levels)
- 1<sup>st</sup> or 2<sup>nd</sup> greatest ingredient cost in shrimp feeds
- Major justification for inclusion into shrimp feeds is that it is cheapest protein ingredient source with protein levels above 45%
- Present 47-49% soybean meal cost is \$350 to \$450/metric ton



## Fish and Soybean Meals Prices



## Biofuel Co-Products in Aquaculture

- Co-products high in protein
- Possible replacement for soybean meal and other feedstuffs in aquaculture diets
- Increasing the nutrient quality of aquaculture feeds
- Decreasing cost of aquaculture feeds



## Objectives

For Algae Co-Products (Lipid Extracted Algae, LEA) to evaluate:

1. LEA as a replacement of soybean meal in shrimp feeds
2. Value of LEA as a soybean meal replacement in shrimp feeds



## Methods

- Recirculating system with 136% exchange/day
- Seawater source: Corpus ship channel
- 24-L, 0.1-m<sup>2</sup> aquaria
- 12:12 light/dark cycle
- 8 replicates/treatment



## Methods (continued)

- Shrimp stocking density: 60/m<sup>2</sup> or 300/m<sup>3</sup>
- Stocking size: 0.264 g
- Tanks siphoned daily
- 42-day trial



## Methods (continued)

- Temperature 30 ± 1°C.
- Salinity 25 – 37 ppt
- Selected tanks monitored for temperature, D.O., salinity daily
- Selected tanks monitored for total NH<sub>3</sub>, NO<sub>2</sub>, and NO<sub>3</sub> nitrogen weekly
- Feeding frequency: 15 times/daily using automatic feeders

## Algae Information

- Species of Algae: *Nanochloropsis salina*
- Production Method: Texas A&M Agrilife Research Station, Pecos
- Oil Extraction Method: ???
- Chain of Custody: ???



## Experiment used two batches of lipid extracted *Nanochloropsis salina*

Both batches (A and B) were produced in outdoor ponds at one site using as identical procedures and methods as possible but at different times.

No information available on oil extraction methods or chain of custody information.



## Defatted *Nanochloropsis salina*, batches A and B

### Proximate Analysis Data

Nutrient	Values (%) on "as is basis"	A	B
Crude Protein		43.5	43.5
Crude Fiber		8.80	8.89
Crude Fat		2.49	9.30
Total Ash		24.3	24.5

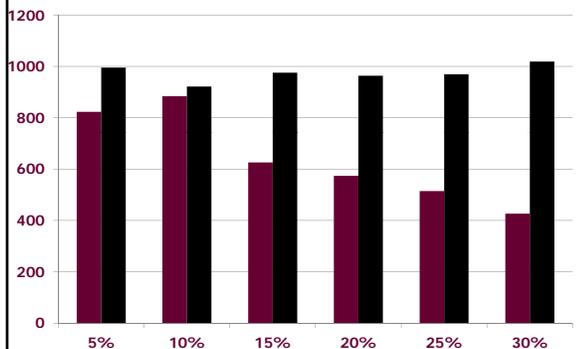


Defatted Algae (Algae Co-Product) as a Replacement for Isolated Soy 90% Protein Meals Shrimp Feeds. (values in % of diet on an "as-fed basis" for LEA, fish and soybean meals)

Ingredient (%)	Exp.	Exp.	Exp.	Exp.	Exp.	Exp.
Batches A or B	5.00	10.0	15.0	20.0	25.0	30.0
Fish, Menhaden	25.0	25.0	25.0	25.0	25.0	25.0
Soybean-90%	17.3	14.9	12.5	10.0	7.62	5.20



Growth (%) versus % LEA in Soy Bean Meal Replacement Diets  
Initial Wt. 0.264±0.002 (SEM)



## SUMMARY AND CONCLUSIONS

(For Conditions of this Experiment, Batch B)

- No significant effect on survival.
- No significant effect on growth.
- High growth and survival (93% to 100%) was obtained.
- 30% co-product Batch B replaced ~67% of soybean meal in the shrimp feed.



## Estimation of value of algae co-products using Least Cost Formulation Computer Programs

- A commercial shrimp feed formulation was used.
- Commercial values for ingredients as of February, 2013 were used.
- Nutrient values for algae co-products with crude protein levels of 20% to 48% were used.



The effect of the value of LEA in \$/MT versus % protein in LEA on percent replacement of 48% protein soybean meal (SBM) (values are % replacement of SBM)

LEA Value \$/MT	LEA % Protein				
	20%	27%	34%	41%	48%
200	9	26	54	78	100
250	0	23	47	69	89
300	0	20	40	60	77
350	0	16	34	50	66
400	0	13	27	41	55

## Estimation of Algae Co-Product (LEA) Value as a Replacement for Soybean Meal in Shrimp Feeds

- Assuming algae co-product protein level equal to protein level of soybean meal being replaced:
- LEA maximum value replacing soybean meal in shrimp feeds is \$350 to \$400/metric ton (m.t.).



## SUMMARY (page one)

- Algae co-product, aka lipid extracted algae (LEA), can be replaced up to ~67% of soybean meal in shrimp feeds.
- Maximum LEA value for replacement of soybean meal in shrimp feeds is \$350 to \$400/metric ton (m.t.).



## SUMMARY (page two)

- Algae co-product, aka lipid extracted algae (LEA), quality is very important for determined value of LEA in shrimp feeds.
- LEA QUALITY will depend upon:
  - algae species/strain – method of production – method of lipid (oil) extraction and – chain of custody quality.



## Acknowledgements

- Funded in part by US Department of Energy under contract DE-EE0003046 awarded to the National Alliance for Advanced Biofuels and Bio-products and by Texas AgriLife Research, Texas A&M University System
- Staff of the Texas AgriLife Research Mariculture Laboratory at Port Aransas, Texas A&M University System



# From Texas A&M University

## Thank You!



## Questions Asked By A&M???????

- What ingredients should be replaced? – criteria: volume and cost – chose soybean, fish, cottonseed, and DDGS meals
- What species should be evaluated? – criteria: volume and cost – chose fish, shrimp and cattle



## Algae Co-Product (defatted algae)

### Fish and Shrimp Feeds

- Economic value
- High nutritional value
- Fish meal replacement
- Fish oil replacement
- Soybean meal replacement
- Unknown growth factors



## Fish Meal for Shrimp

### ADVANTAGES

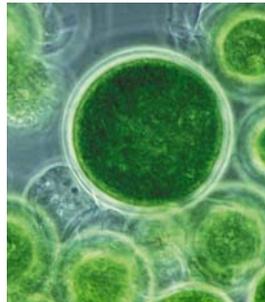
Source of dietary protein --- minerals highly unsaturated fatty acids, chemoattractants, and unknown growth factors

### DISADVANTAGES

Expensive with supply not sustainable

## Algal Biofuels:

- Algae produce oil that can be used as fuel
- Fast growing industry
- Need to find economical applications for co-products



## Alternative Feed Ingredient Program

- Grain ingredients (e.g. dehulled defatted soybean meal, canola, lupin, pea meals, etc.)
- Grain concentrates (e.g. soybean concentrate, wheat gluten, corn gluten, canola, etc.)
- Animal meals (e.g. poultry by-products, blood meal, meat and bone meal)
- Dried distiller grain with solubles (DDGS) by-product from brewery and biofuel industries
- Biofloc from aquaculture waste made by SBR's and MBR's
- Seafood processing by-products co-extruded with grain ingredients (e.g. soybean meal)
- Algae co-products (defatted algae)



## Base Diet Ingredient Levels (as-fed basis)

Ingredient	%	Ingredient	%
Alginate	2.00	Oil, Soybean	0.60
Ca Carbonate	2.50	Phospholipid, 97%	4.00
Cellulose	3.20	CaHPO4	4.20
Cholesterol	0.20	NaHexaMetaPO4	1.00
Diatomaceous Earth	3.80	PM Min/Vit LMCI	0.25
Fish, Menhaden	8.00	PM Min/Vit LMCI	0.21
KCl	1.90	Soybean-90%	5.70
MgO, feed grade	1.60	Squid, Muscle	30.0
NaCl	0.70	Vit C, Stable 35%	0.04
Oil, Fish Menhaden	0.60	Wheat Starch	29.5

## Methods

- Recirculating system with 136% exchange/day
- Seawater source: Corpus ship channel
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- 12:12 light/dark cycle
- 8 replicates/treatment



### Methods (continued)

- Shrimp stocking density: 50/m<sup>2</sup> or 300/m<sup>3</sup>
- Stocking size: 0.901 g
- Tanks siphoned daily
- 42-day trial



### Methods (continued)

- Temperature 30 ± 1°C.
- Salinity 25 – 37 ppt
- Selected tanks monitored for temperature, D.O., salinity daily
- Selected tanks monitored for total NH<sub>3</sub>, NO<sub>2</sub>, and NO<sub>3</sub> nitrogen weekly
- Feeding frequency: 15 times/daily using automatic feeders

**Defatted Algae (Algae Co-Product) as a Replacement for Fish (menhaden) and Isolated Soy 90% Protein Meals Shrimp Feeds. (values in % of diet on an "as-fed basis" for LEA, fish and soybean meals)**

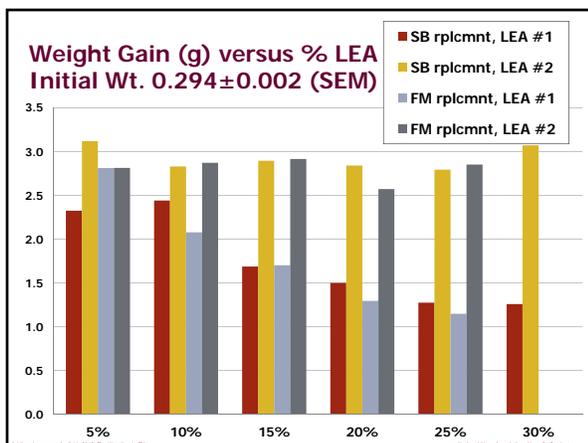
Ingredient (%)	Base	Exp.	Exp.	Exp.	Exp.	Exp.
Batches A or B	0.00	5.00	10.0	15.0	20.0	25.0
Fish, Menhaden	25.0	23.0	21.0	19.0	17.0	15.0
Soybean-90%	12.5	11.5	10.5	9.50	8.50	7.50




**Survival(%), final weight(g), and growth(g/wk) values for *L. vannamei* fed diets using Batch A as feed ingredients. FM: Fish meal; SB: Soybean meal**

LEA	FM	SB	Survival	FnI Wt.	Growth
0.00	25.0	12.5	100.±0.0	12.6±0.8	2.19±0.17
5.00	23.0	11.5	94.7±5.4	11.9±0.6	2.07±0.07
10.0	21.0	10.5	95.3±6.5	11.5±0.6	1.97±0.10
15.0	19.0	9.50	93.8±5.2	12.0±0.5	2.15±0.15
20.0	17.0	8.50	100.±0.0	11.7±0.4	1.99±0.12
25.0	15.0	7.50	95.8±6.8	11.8±0.5	2.06±0.11



### SUMMARY AND CONCLUSIONS (For Conditions of this Experiment, Batch A)

- No significant effect on survival.
- No significant effect on growth.
- High growth and survival was obtained.
- 25% co-product Batch A replaced 40% fish meal and soybean meal in the shrimp feed.
- 30% co-product Batch A replaced ~75% of soybean meal in the shrimp feed.




**SUMMARY AND CONCLUSIONS** (For Conditions of this Experiment, Batch A)

- No significant effect on survival.
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- 30% co-product Batch A replaced ~75% of soybean meal in the shrimp feed.



The effect of the value of LEA in \$/MT versus % protein in LEA on percent replacement of 64% protein fish meal (FM) (values are % replacement of FM)

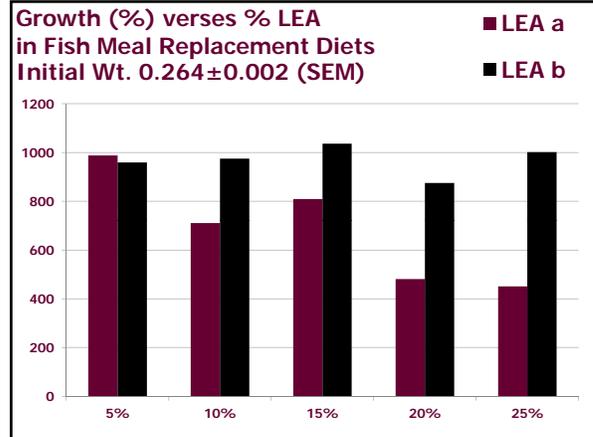
LEA Value \$/MT	LEA % Protein				
	34%	42%	49%	56%	64%
400	7	22	48	75	100
600	0	14	36	58	81
800	0	4	19	41	60
1000	0	0	6	21	39
1200	0	0	0	7	18

**Estimation of Algae Co-Product Value as a Feed Grade Ingredient for Shrimp Feeds**

Assuming algae co-product protein level equal to protein level of ingredient being replaced:

- Fish meal in shrimp feeds: \$1,200 to \$1,400/m.t. With 42% protein reduce to \$600 to \$900/m.t.
- Soybean meal in marine shrimp feeds: \$420 to \$480/m.t. or slightly above cost of soybean meal.

**Growth (%) versus % LEA in Fish Meal Replacement Diets**  
Initial Wt. 0.264±0.002 (SEM)



**Weight Gain (g) versus % LEA in Fish Meal Replacement Diets**  
Initial Wt. 0.264±0.002 (SEM)

