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

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Texas A&M System

3rd International Conference on Algal Biomass, Biofuels and Bio-products, Toronto, Canada --- June 16-19, 2013

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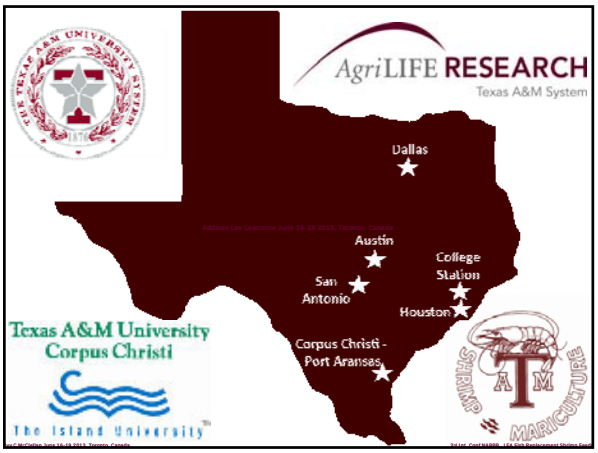
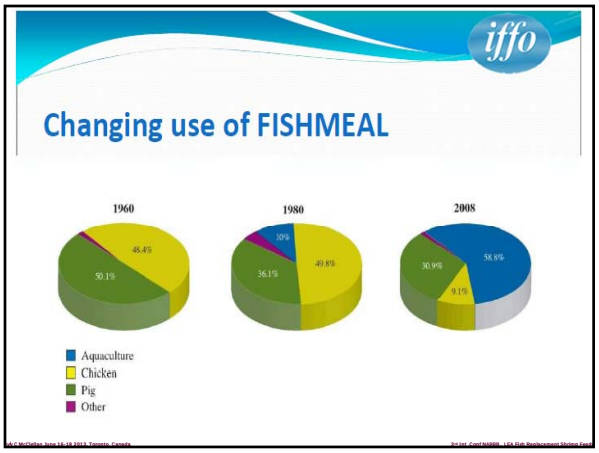
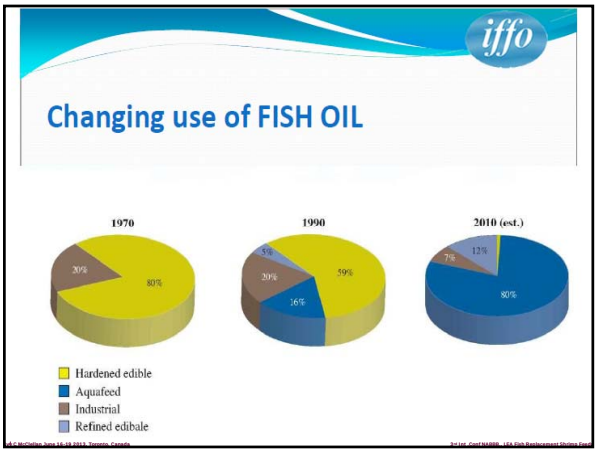
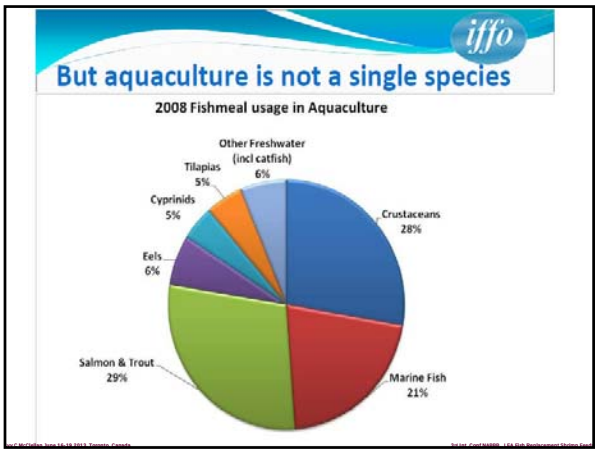


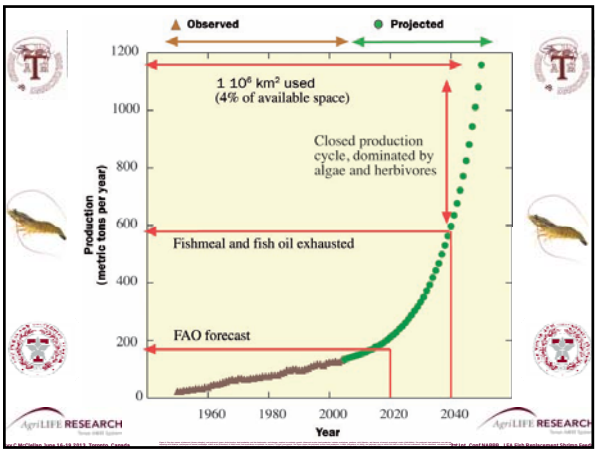
Fish Meal vs Shrimp Feed Information

- Major ingredient in shrimp feeds (10% to 30% inclusion levels)
- 1st or 2nd greatest ingredient cost in shrimp feeds
- Major justification for fish meal inclusion into shrimp feeds are the levels of protein, lipids, minerals and unknown growth factors
- Present 64-75% fish meal cost is $1,500 to $2,000/metric ton (m.t.)



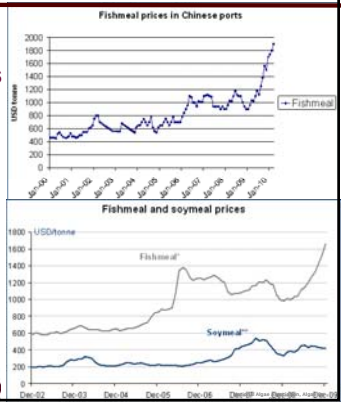






Fish Meal, Aquaculture Feed Dilemma

- A major protein source in aquaculture feeds is fish meal
- Expensive (~US$1,500 to ~2,000/MT)
- Environmentally unsustainable
- Availability will limit animal aquaculture and agriculture growth in the future



Fish Meal in Shrimp Feeds

- ADVANTAGES: source of dietary protein, minerals, highly unsaturated fatty acids, phospholipids, cholesterol and unknown growth factors.
- DISADVANTAGES: Expensive/ supply not sustainable.

Objectives

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

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

Methods

- Recirculating system with 136% exchange/day
- Seawater source: Corpus ship channel
- 24-L, 0.1-m² aquaria
- 12:12 light/ dark cycle
- 8 replicates/ treatment

Methods (continued)

- Shrimp stocking density: 60/m^2 or 300/m^3
- 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_3, NO_2, and NO_3 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.

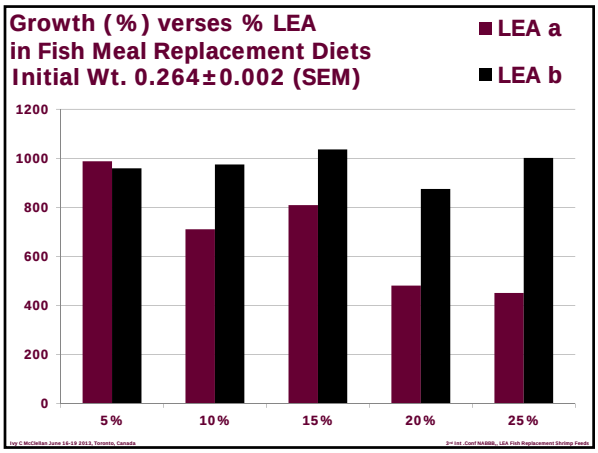
No information available on oil extraction methods or chain of custody information.

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 Fish Meal 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



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.
- 25% co-product Batch B replaced ~40% of soybean and fish meals 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 34% to 64% were used.

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 (LEA) Value as Fish Meal Replacement in Shrimp Feeds

- Assuming algae co-product protein level is equal to protein level of fish meal (64%) being replaced:
- LEA maximum value replacing 39% to 60% of fish meal in shrimp feeds is $800 to $1000/metric ton (m.t.).

SUMMARY (page one)

- Algae co-product, aka lipid extracted algae (LEA)(64% protein), can replaced 39 to 60% of the fish meal in shrimp feeds.
- LEA maximum value replacing 39% to 60% of fish meal in shrimp feeds is $800 to $1000/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!

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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

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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

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Fish Meal for Shrimp

ADVANTAGES

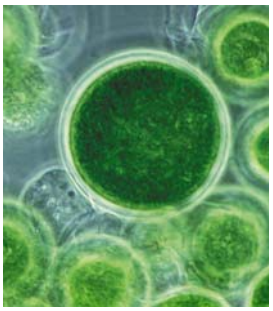
Source of dietary protein --- minerals highly unsaturated fatty acids, chemoattractants, and unknown growth factors

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,Stable35%	0.04
Oil, Fish Menhaden	0.60	Wheat Starch	29.5

Methods

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Methods (continued)

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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_3, NO_2, and NO_3 nitrogen weekly
- Feeding frequency: 15 times/daily using automatic feeders

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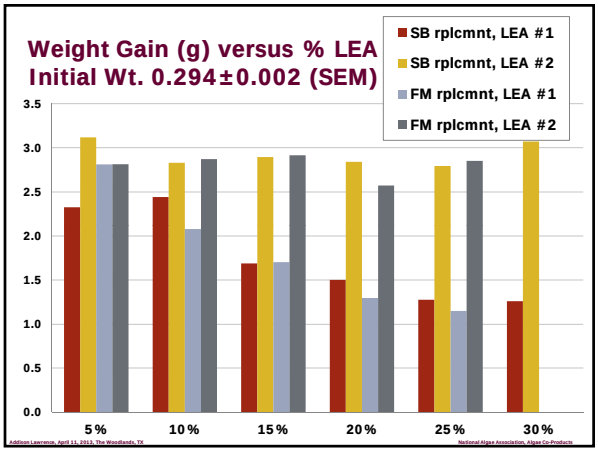
Survival(%), final weight(g), and growth(g/wk) values for *L. vannamei* fed diets using Batch A as feed ingredients. FM: Fish meal; SB: Soybean meal

LEA	FM	SB	Survival	Fnl 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

Weight Gain (g) versus % LEA Initial Wt. 0.294±0.002 (SEM)



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

- No significant effect on survival.
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- 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)

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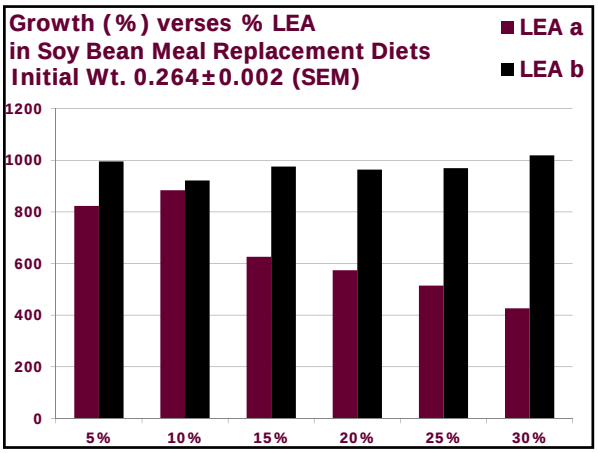
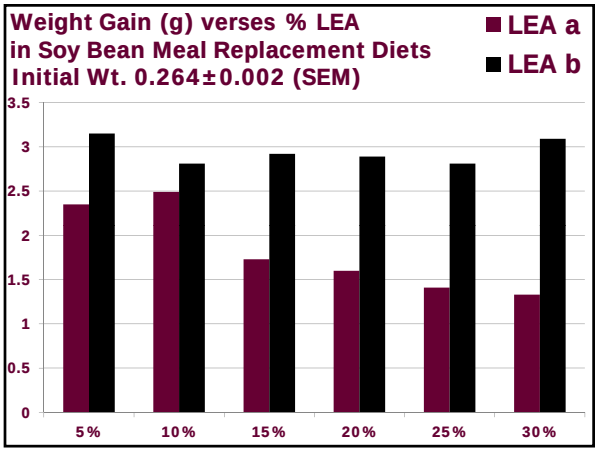
Estimation of Algae Co-Product Value as a Feed Grade Ingredient for Shrimp Feeds

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.**





Algae Co-Product (defatted algae) in Shrimp Feeds

- **Economic value**
- **High nutritional value**
- **Fish meal replacement**
- **Fish oil replacement**
- **Cholesterol/Phospholipid replacement**
- **Unknown growth factors**