Mass Production of Insects for Aquaculture

Market Perspectives for a Sustainable Protein Source

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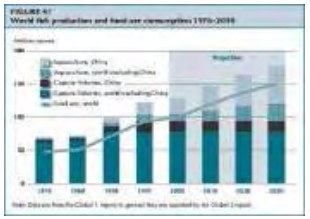
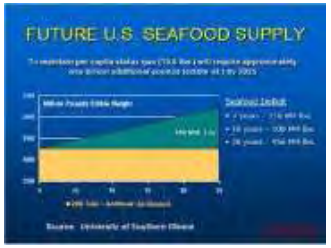
Aquaculture Production Outlook 2030

- **40 billon pound/year shortage of seafood?**
- **Wild stocks fully exploited and declining**
- **World aquaculture increases to 75% of all seafood consumed?**
- **Quality feed ingredients to sustain industry growth?**
  - **Fishmeal and fish oil ?**





Current Dependency on Fishmeal

Production
Fishmeal: 5 major producing countries

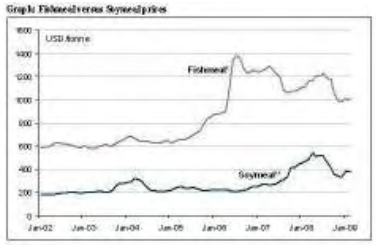
	2003	2004	2005	2006	2007	2008
	(1000 tonnes)					
Peru/Chile	1886	2918	2941	2232	2120	2063
Denmark/Norway	442	471	376	388	317	302
Iceland	271	204	179	162	135	251
Total	3388	3593	3496	2783	2717	2688

Source: IFFO * excluding solubles ** estimates

- **The major source of dietary protein for fish, cattle, hog, poultry and mink diets.**
- **10 countries produce 80% of world supply.**
  - **3 are net importers**
- **Production down 20% in 2006, 5% in 2007, and another 4% in 2008**
- **30% of world fish production goes to fishmeal and fish oil**
  - **Effect on wild stocks ??**

The Economic Impact of Fishmeal

- Fishmeal prices have forced many fish and livestock growers to seek alternative proteins
- Every metric tonne of meal travels an average of 5,000 km before it reaches the end user:
  - Enormous economic implication in supplying global markets
  - Large carbon footprint
- Baitfish stocks are down significantly while demand continues to grow



Right Space, Right Time

- Current Industry Bottlenecks
  - Lack of Sustainability
  - Diminishing Fishmeal Supply
    - Increasing Fishmeal/Feed Cost
  - Increasing Protein Demand
  - Increasing Carbon Footprint and Cost
  - Competing Non-food Uses for Grain Feeds
- Severe Ecological Consequences

Ento-Protein™

Cutting Edge Food Science Technology

- **Ento-Protein™ is created through a patent-pending process of producing high-grade protein meal from commercially grown insects.**
- **Ento-Protein™ will be used to replace fishmeal in aquaculture and livestock diets**

Ento-Protein™

"It all starts with insects....."

Mississippi State University

- 18 months of cooperative research completed with Mississippi State University.
- Integrated research with Dept of Entomology; Dept. of Wildlife and Fisheries; and Dept. of Food Science & Technology.

Research Trials

- Species identification/qualification parameters
  - Reduced to 4 primary insect species
- Feeding trials conducted on hybrid striped bass, a carnivorous freshwater fish.
  - Feed acceptability
  - Feed conversion
  - Digestibility
  - Survival
- Post trial testing
  - Independent taste testing
  - Off flavor

Research Data
Ento-Protein™

- No significant difference in diet acceptability
- FCR at 87% of fishmeal at 100% replacement.
- Digestibility at 97%
- Survival at 97%
- Taste tests indicated a preference for fish fed Ento-Protein™.

Ento-Protein™
Comparison to other protein sources

Table 1a. Limited amino acid comparison of Poultry meal vs Fishmeal (as % of sample)

	Fishmeal*	Ento-protein**	Soybean meal ^	Poultry meal^
Crude Protein	62-67	41.58 - 62.47	47	67
Fat	8-12	20.21 – 51.48	1.56	10.87
Ash	16-21	2.41 – 9.03	5.80	13.98
Omega 6	0.89	3.90 – 10.74	0.40	2.00
Omega 3	2.02	0.15 - 0.39	0.05	0.10
Limiting Amino Acid (%)				
Methionine	1.75	0.55 – 1.02	0.68	0.86 – 1.03
Lysine	4.88	2.01 – 3.60	3.03	2.65 – 2.81
Arginine	4.24	1.94 - 3.68	3.51	2.28 – 3.69

* Menhaden meal analysis from Eurofin Scientific, 4/2007
** Initial analysis of 4 selected spp. from Eurofin Scientific, 4/2007
^ Analysis courtesy of Zeigler Bros.

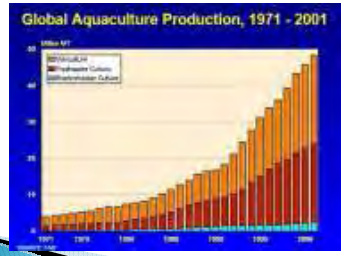
Initial Nutritional Comparison to Fishmeal

Table 2. Comparison of the nutritional characteristics of selected insect species with common fish meals.

Species	Ash (A, %)	Minerals (M, %) Ca	P	Lipids Total (L, %)	Linoleic (% L)	Crude Protein (C P, %)	Amino Acids (AA, % PR) Arg	Met+ Cys	Lys
A	4.7(0.2)	0.2(0.0)	0.9 (0.0)	21(1)	34(-)	66(1)[a]	7.1(-)	2.7(-)	6.3(-)
B	3.1(0.2)	0.06(-)	0.7(-)	34(2)	29(-)	49(1)	5.9(-)	2.4(-)	6.2(-)
C	16(1)	5.2(0.2)	1.2(0.3)	32(3)	3.3(-)	43(1)	5.1(-)	3.3(-)	6.4(-)
D	2.3(0.5)	0.04(-)	0.4(-)	57(2)	6.0(-)	36(2)	5.6(-)	2.6(-)	6.2(-)
Menhaden	20(-)	5.7(-)	3.3(-)	10.2(-)	1.1(-)	68(-)	5.9(-)	3.8(-)	7.7(-)
Herring	----[c]	2.6(-)	1.9(-)	9.9(-)	1.5(-)	73(-)	5.9(-)	4.0(-)	8.0(-)
Anchovy	17(-)	4.3(-)	2.8(-)	8.6(-)	3.4(-)	70(-)	5.7(-)	4.0(-)	7.9(-)

All entries are Mean(SEM) with N = 1-4 based on dry weights; SEM missing for N = 1.
[a]Bold format: 0.75·MIN[fish meals] ≤ Mean ≤ 1.25·MAX[fish meals].
[b]Italic format: Estimated.
[c]No data.

Benefits to Global Aquaculture Industry



- Sustainability of feed.
- Allow unhindered growth of industry.
- Creates all-natural and certifiable organic feed.
- Insect species and diets can be altered to create species specific diets.