Asian-Pacific Aquaculture 2016
Profitability, Sustainability, and Responsibility for the Future
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WORLD AQUACULTURE Society

# Increased Use of Local Feed Ingredients for the Production of more Ecologically & Environmentally Sustainable Aquaculture Feeds so as to strengthen the Indonesian Feed Industry

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AQUATIC FARMS

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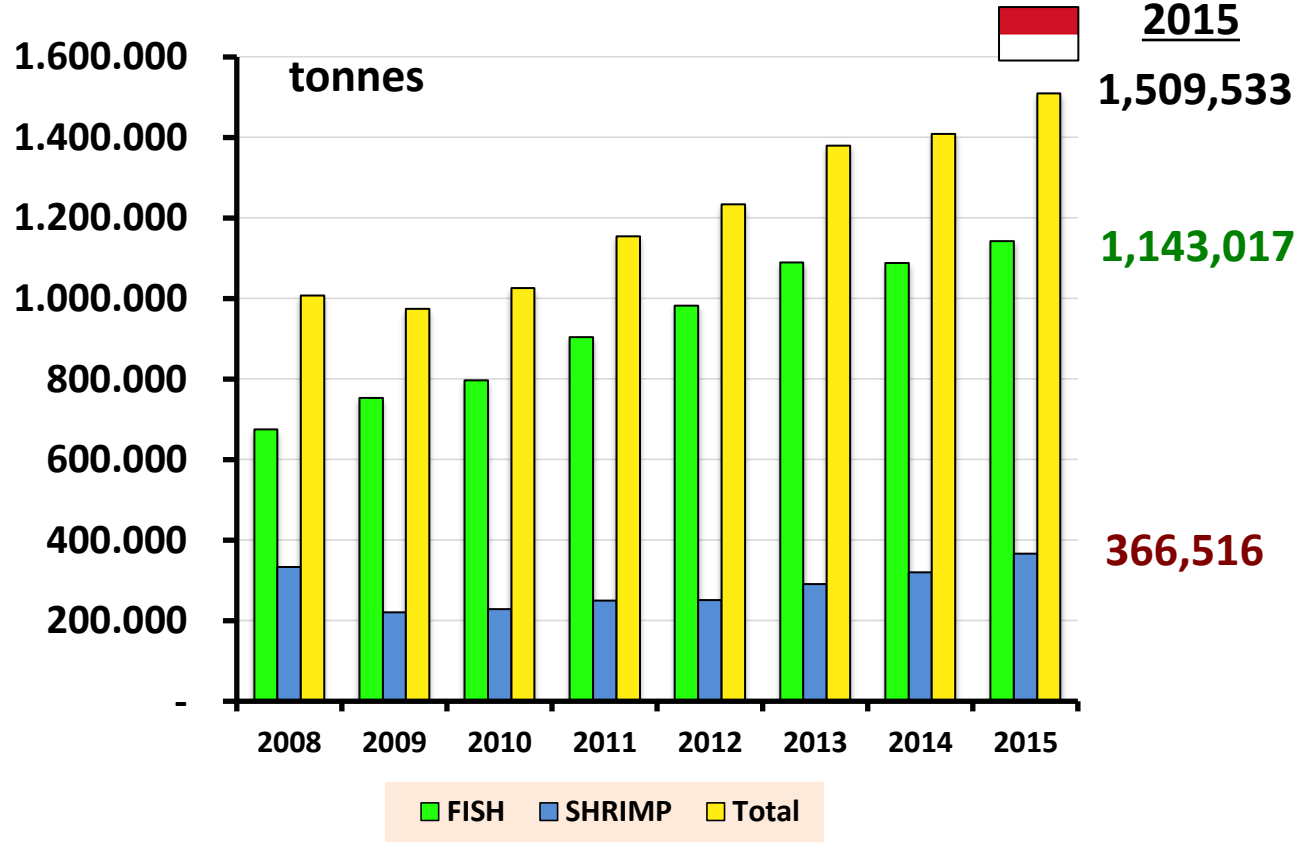
# *Indonesian Aquaculture in 2014*

*(FISHSTAT FAO, 2016)*

**INDONESIA** is currently the world's 2nd largest aquaculture producer at 14.37 million tonnes (Mt), with total production valued at US $ 10.56 billion and the sector growing at 21.0%/year since 2000 (the highest growth of the top 20 country producers in 2014);

- The worlds 2nd largest producer of Aquatic plants at 10.1 Mt
- The worlds 3rd largest producer of Fish at 3.64 Mt
- The worlds 2nd largest producer of Tilapia at 1.04 Mt
- The worlds 2nd largest producer of Catfish at 1.10 Mt
- The worlds 2nd largest producer of Shrimp at 598,000 tonnes
- The worlds 1st producer of Milkfish at 578,000 tonnes
- The worlds 6th largest producer of Carps at 497,000 tonnes

**Despite the nutritional & economic importance of the aquaculture sector in Indonesia**
**the finfish and crustacean production sector is still highly dependent upon the use of aquaculture feeds**
**composed primarily of imported feed ingredients**




**Indonesia – fish and shrimp aquaculture feed consumption (GPMT data 2016)**

| Pakan IKAN - Fish Feed | | | | Pakan UDANG - Shrimp Feed | | | |
|---|---|---|---|---|---|---|---|
| Bahan Pakan | Formula | Bahan Baku (%) | | Bahan Pakan | Formula | Bahan Baku (%) | |
| | | Local | Import | | | Local | Import |
| Fish Meals | 10% | 90 | 10 | Fish Meals | 20% | 30 | 70 |
| Meat Bone Meals | 15% | 0 | 100 | Meat Bone Meals | 10% | 0 | 100 |
| Poultry Meat Meals | 5% | 0 | 100 | Shrimp Meals | 3% | 10 | 90 |
| Soya Bean Meals | 20% | 0 | 100 | Squid Meals | 5% | 0 | 100 |
| Corn Gluten Meals | 10% | 0 | 100 | CGM | 7% | 0 | 100 |
| Wheat Flours | 10% | 70 | 30 | Wheat Flours | 30% | 30 | 70 |
| Rice Bran/Dedak | 10% | 100 | 0 | Attractant | 2% | 0 | 100 |
| Fish Oil | 5% | 10 | 90 | Fish & Squid Oils | 5% | 10 | 90 |
| CPO | 5% | 100 | 0 | Canola/Soya oils/CPO | 3% | 20 | 80 |
| Vit & Minerals | 5% | 0 | 100 | Vit & Minerals | 5% | 0 | 100 |
| Others & DDGS | 5% | 20 | 80 | Others & DDGS | 10% | 20 | 80 |
| Komposisi Total | 100% | 35 | 65 | Komposisi Total | 100% | 11 | 89 |

**Indonesia – fish and shrimp feed formulation – use of imported feed ingredients (GPMT data 2016)**


## Animal feed production in 2015
(million metric tonnes)

| | | |
|---|---|---|
| 1 | China | 179.93 |
| 2 | USA | 173.73 |
| 3 | Brazil | 68.70 |
| 4 | India | 31.54 |
| 5 | Mexico | 31.11 |
| 6 | Spain | 29.38 |
| 7 | Russia | 29.09 |
| 8 | Germany | 23.86 |
| 9 | Japan | 23.38 |
| 10 | France | 21.20 |
| 11 | Canada | 20.35 |
| 12 | Korea | 18.95 |
| 13 | Turkey | 18.22 |
| 14 | Thailand | 17.92 |
| 15 | Indonesia | 17.33 |
| 16 | Argentina | 15.50 |
| 17 | Vietnam | 14.75 |
| 18 | Italy | 14.15 |
| 19 | Netherlands | 14.01 |
| 20 | UK | 15.59 |
| 21 | Philippines | 12.78 |

NUMBER OF **FEED MILLS** GLOBALLY (ESTIMATE)
**32,341**

TOTAL GLOBAL **TONNAGE (MILLION)**
**995.6**

## TOTAL FEED BY SPECIES (MIL. METRIC TONS)

| | | | |
|---|---|---|---|
| PIGS | 253.53 | AQUA | 35.47 |
| RUMINANT | 201.30 | PETS | 22.59 |
| POULTRY | 463.69 | HORSE | 8.22 |

# Indonesian Feedlot Industries

*Agriculture by Products as Feeds*

Cassava chips

Copra meals

Cassava onggok

Rice straw

Rice bran

Corn sillage

**Indonesia is highly reliant on imported raw materials for animal feed, with 50-80% being imported.**

**As such locally produced feed is highly influenced by world commodity prices and currency exchange rates.**

**Food Sovereignty – government priority – with rice, corn & soybean identified as priority crops for self-sufficiency**

## Indonesia's Top Agricultural Crops - 2014

| | | |
|---|---|---|
| Oil palm, fruit | 126,591,790 tonnes – | Palm kernel meal, CPO |
| Rice, paddy | 70,846,465 tonnes – | Rice bran |
| Sugar cane | 28,600,000 tonnes | |
| Cassava | 23,436,384 tonnes | |
| Maize/corn | 19,008,426 tonnes | |
| Coconuts | 19,102,130 tonnes – | Copra meal |

FAOSTAT – Indonesia Food Balance Sheet

## Sources of some feed ingredients commonly used in animal feeds in Indonesia

| Feed Ingredient | Sources | |
|---|---|---|
| | Local (%) | Imported (%) |
| Corn/Maize | 90-95 | 5-10 |
| Fish meal | 5-10 | 90-95 |
| MBM/PBM | 0 | 100 |
| Soybean meal | 0 | 100 |
| Rapeseed meal | 0 | 100 |
| Corn gluten meal/DDGS | 0 | 100 |
| Feed additives/AA/vits/mins | 0 | 100 |
| Rice bran | 100 | 0 |
| Copra meal | 100 | 0 |
| Palm kernel meal | 100 | 0 |
| CPO | 100 | 0 |

Potential competition with humans

Inclusion level usually quite low

Source: Adapted from the Indonesian Feed Millers Association (GPMT)

## Reported factors limiting feed millers from sourcing locally available feed ingredients sources, include:

- ✧ Low protein content of available meals such as palm kernel meal, copra meal & rice bran (12-22% CP);
- ✧ High fiber content of available meals (12-20% CF);
- ✧ Variable lipid content of available meals (1-12% EE);
- ✧ Possible oxidation and rancidity of lipid-rich meals;
- ✧ Presence of anti-nutritional factors within the meals;
- ✧ Generally sub-optimal post-harvest management of many harvested crops with resultant variable moisture levels and possible mycotoxin contamination;
- ✧ Possible contamination of locally available ingredient sources with adulterants by unscrupulous traders


# bungkil inti sawit

## Palm kernel meal & by-products

## *Elaeis guineensis*

**Palm kernel meal 4.55 Mt in 2015/16**

**Palm kernel oil 3.75 Mt in 2015/16**

| | CP | EE | CF |
|---|---|---|---|
| Palm kernel cake – PKC | 17.1 | 8.6 | 16.1 |
| Palk kernel meal – PKM | 17.5 | 1.4 | 19.6 |

| EAA REQUIREMENT RATIO – FISH |
|---|
| EAA REQUIREMENT RATIO – SHRIMP |

| | Arg | Cys | Met | Thr | Iso | Leu | Lys | Val | Tyr | Try | Phe | His |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PKM | 238 | 122 | 72 | 67 | 100 | 103 | 37 | 101 | 85 | 135 | 97 | 77 |
| PKM | 143 | 161 | 92 | 89 | 91 | 98 | 59 | 105 | 67 | 127 | 93 | 86 |

Feedipedia - Animal Feed Resources Information System - INRA CIRAD AFZ and FAO

Proximate & EAA values – Tacon et al. 2009; Copra meal/oil production – GAIN ID1606

# Copra meal & coconut by-products

## *Cocos nucifera*

**Copra meal 515,000 tonnes in 2015/16**

**Coconut oil 970,000 tonnes in 2015/16**

| | CP | EE | CF |
|---|---|---|---|
| Coconut oilcake - COC | 20.7 | 7.6 | 12.2 |
| Coconut oilmeal - COM | 21.5 | 3.5 | 14.8 |

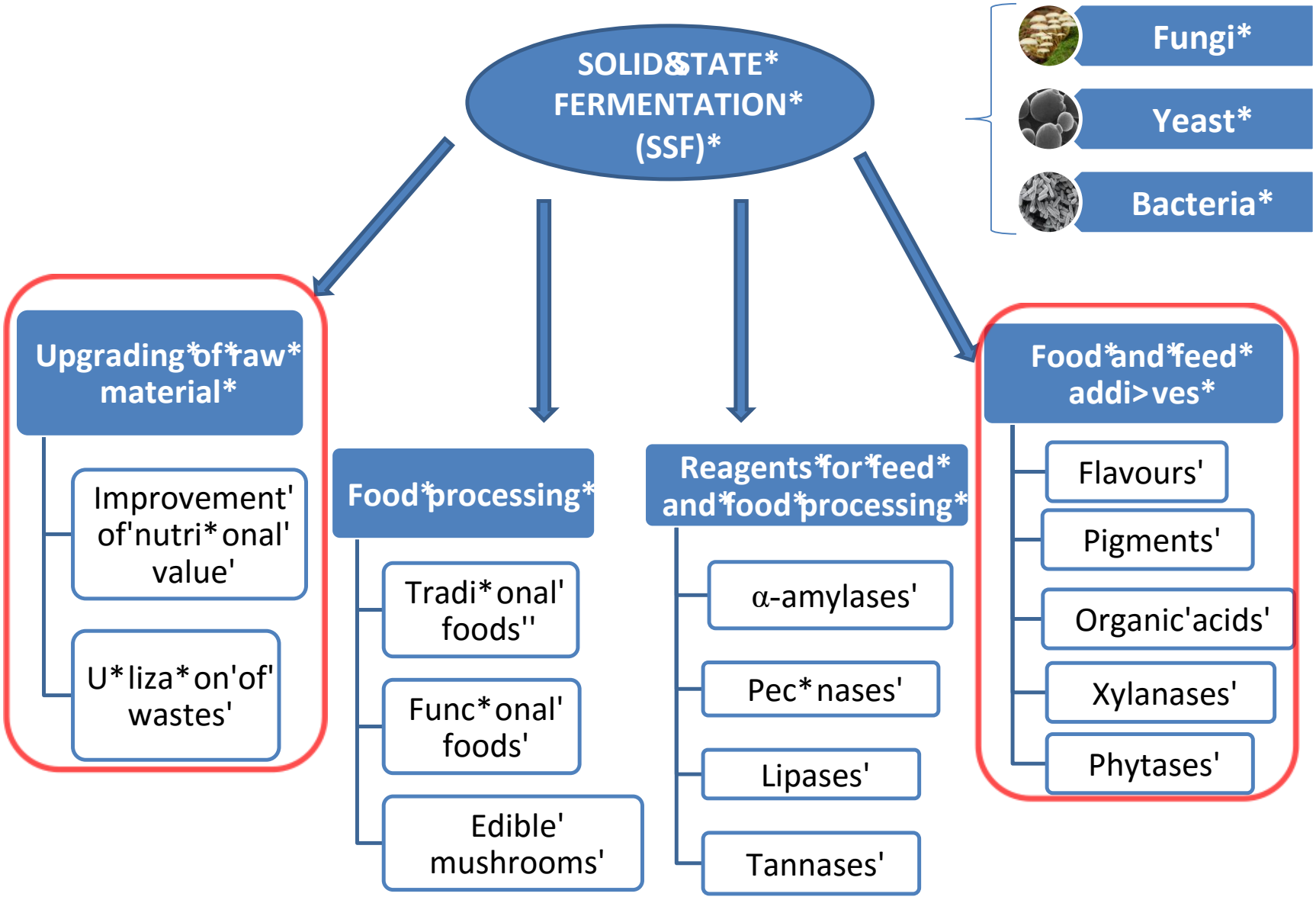
| EAA REQUIREMENT RATIO – FISH |
|---|
| EAA REQUIREMENT RATIO – SHRIMP |

| | Arg | Cys | Met | Thr | Iso | Leu | Lys | Val | Tyr | Try | Phe | His |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COC | 219 | 104 | 65 | 67 | 117 | 108 | 38 | 116 | 85 | 123 | 95 | 79 |
| COC | 131 | 136 | 82 | 89 | 107 | 103 | 60 | 121 | 67 | 116 | 91 | 88 |
| COM | 217 | 96 | 61 | 65 | 116 | 112 | 37 | 115 | 92 | 123 | 95 | 83 |
| COM | 130 | 127 | 78 | 87 | 106 | 106 | 59 | 120 | 73 | 116 | 91 | 93 |

Feedipedia - Animal Feed Resources Information System - INRA CIRAD AFZ and FAO

Proximate & EAA values – Tacon et al. 2009; Copra meal/oil production – GAIN ID1606

# SOLID*STATE*FERMENTATION*FOR*FOOD*AND*FEED*APPLICATION*



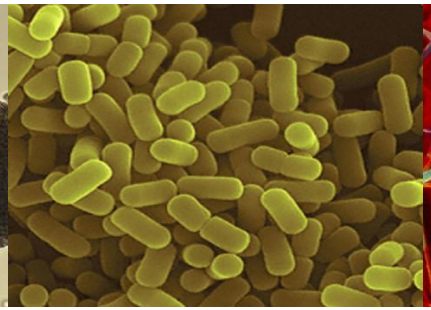
# Use of **Solid State Fermentation** to better utilize locally available agricultural feed & food wastes, & for the reduction of the anti-nutritional factors present in plant proteins such as soybean, rapeseed, lupin & pea

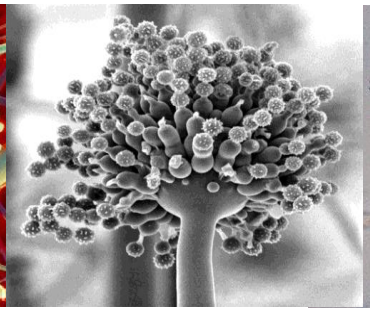
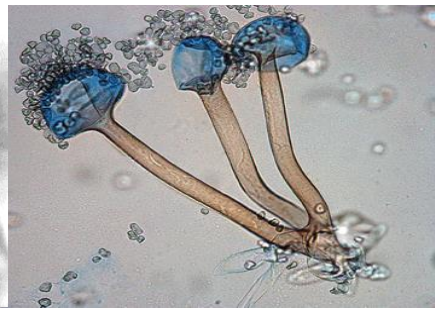


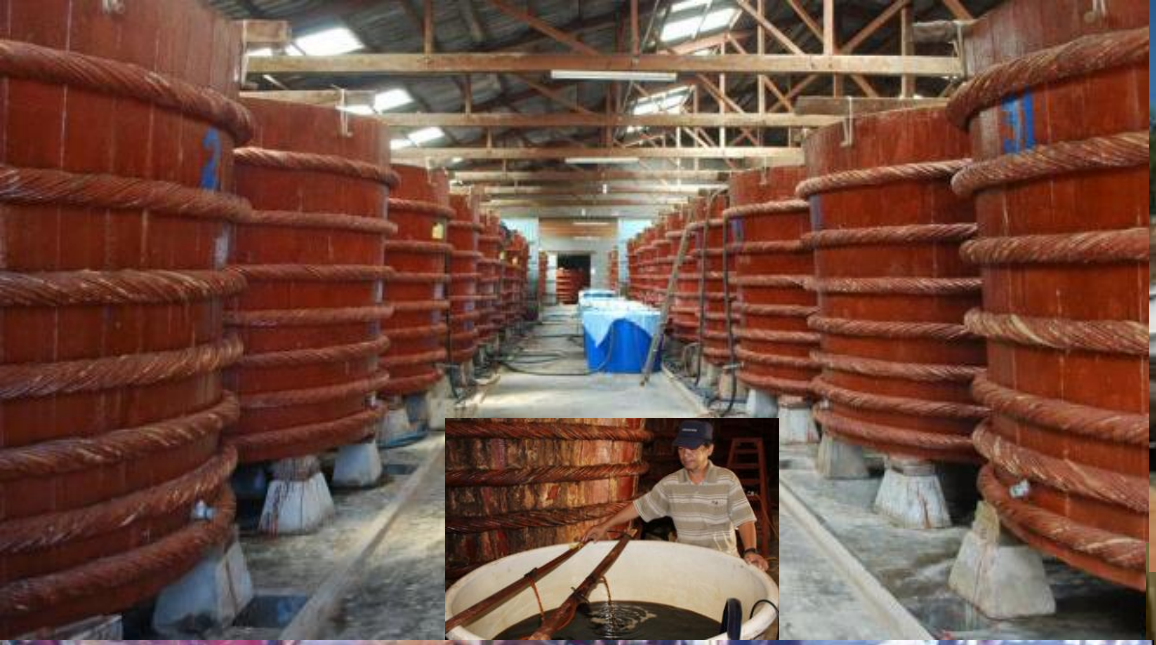













TIPAROS
FISH SAUCE


FISH SAUCE

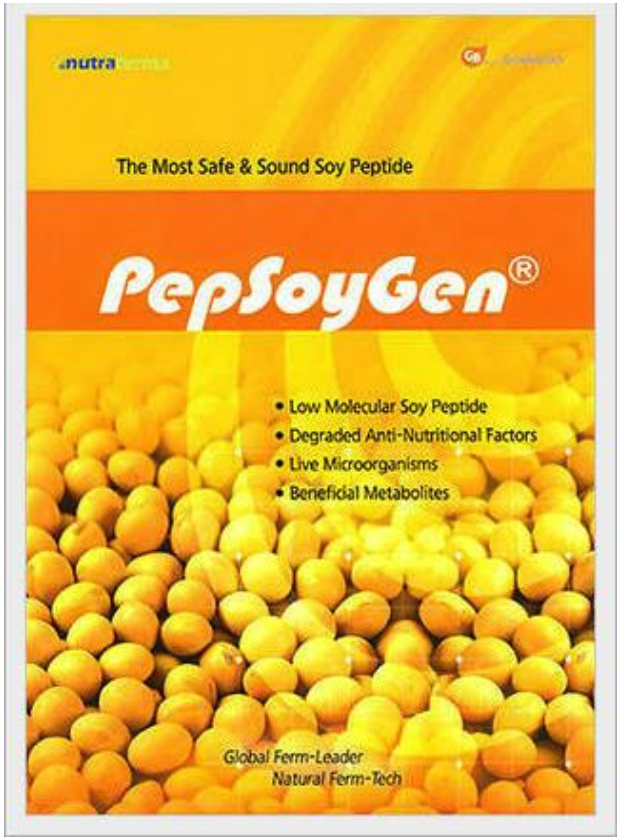

FISH SAUCE
GOLDEN BOY BRAND
SINCE 1914
HACCP
NET WT. 725 ML. (24 FL.OZ.)
POIDS NET 725 CC. (1PT. 8FL.OZ.)


NUOC MAM NHI
Viet Huong
FISH SAUCE


FISH SAUCE
GOLDEN BOY BRAND
HACCP
TIPAROS
FISH SAUCE
NET: 23 FL.OZ.
(1PINT 7 FL.OZ.)
PRODUCT OF THAILAND


## Comparison of physicochemical properties between soybean meal and fermented soybean meal

| items | common soybean meal | soybean meal fermented by mixed fermentation of P23 and TP6 strains | soybean meal fermented by single fermentation of TP6 strain |
|---|---|---|---|
| dry matter, DM (%) | 88.04 | 91.01 | 89.68 |
| CFU/g DM | N.D. | $6.6 \times 10^9$ | $2.0 \times 10^9$ |
| lactic acid(g/kg DM) | N.D. | 74.3 | N.D. |
| pH | 6.7 | 4.75 | 8.19 |
| crude protein(%) | 48.5 | 56.2 | 56.4 |
| trypsin inhibitor(TI) | 9.01 | 0.64 | 0.47 |
| KOH solubility | 84.97 | 61.3 | 59.21 |
| total carbohydrate(%) | 32.5 | 23.99 | 25.29 |
| Raffinose(%) | 1 | 0.05 | 0.82 |
| Stachyose(%) | 3 | 0.1 | 2.19 |
| poly-γ-glutamic acid(%) | N.D. | 0.5 | 0.6 |




# Fermented feed ingredients as fish meal replacer in aquafeed production

**Dr.N. Felix, Associate Professor and R. Alan Brindo, Post Graduate Research Scholar**
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**Vol.2, No.4, 234-243 (2012)**
http://dx.doi.org/10.4236/ojas.2012.24033
**Open Journal of Animal Sciences**

# An initial investigation replacing fish meal with a commercial fermented soybean meal product in the diets of juvenile rainbow trout

**Michael E. Barnes[1*], Michael L. Brown[2], Kurt A. Rosentrater[3], Jason R. Sewell[4]**


## COPRA CAKE MEAL ENHANCEMENT PROJECT

**Reported problems of copra meal:**

- Low protein content, dark brown, yellow color, bad odor
- Occurrence of aflatoxin
- Rigid structure, low digestion values for monogastric animals.

## BIO-TREATMENT OF COPRA MEAL (BTCM)

- The raw material copra meal is bio-treated with the filamentous fungus called *Aspergillus Oryzae* through fermentation to enhance the protein content of the meal, which can now be used as dietary substitute for imported soybean meal and making it to be more attractive to European markets.
- Crude protein content increases from 21.60% to 48.30% producing a light yellow colored meal with a pleasant odor
- Zero aflatoxin content.
- Increased essential amino acid content.

# Analysis of raw copra meal compared to fermented bio-treated copra meal

| COMPONENT (%) | Raw Copra Meal (% DM) | Bio-treated copra meal (% DM) |
|---|---|---|
| Crude protein | 21.60 | 43.30 |
| Crude fiber | 11.27 | 7.58 |
| Crude fat | 7.10 | 8.42 |
| Ash | 7.30 | 8.01 |
| Carbohydrate | 64.00 | 39.17 |
| Aflatoxin , ppb | 126 | Not detected |

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**Reported successful feeding trails with tilapia, shrimp & milkfish**

**www.fao.org/uploads/tx_chcforum/Fish%20Feed%20Project.doc**

# Nutritional evaluation of fermented palm kernel cake using red tilapia

**F. B. Iluyemi[1], M. M. Hanafi[2]*, O. Radziah[1] and M. S. Kamarudin[3]**

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[2]Institute of Tropical Agriculture, Universiti Putra Malaysia, 43400-Serdang, Selangor, Malaysia.
[3]Department of Aquaculture, Faculty of Agriculture, Universiti Putra Malaysia, 43400-Serdang, Selangor, Malaysia.

*Internat. J. of Waste Resources, Vol. 1(2):15-17, Sept. 2011, Y. Priabudiman et al.*

## The influence of Palm Kernel Cake and Rice Bran Fermentation Product Mixture to the Broiler Carcass Quality

Yadi Priabudiman[#2] and Yana Sukaryana [#2]

[#] *Animal Husbandry-Lampung State Polytechnic, Jl.Soekarno-Hatta 10, Bandar Lampung, Indonesia.*

*J. Trop. Agric. and Fd. Sc. 36(2)(2008): 000 – 000*

## Protein quality of *Aspergillus niger*-fermented palm kernel cake

(Kualiti protein hampas isirung kelapa sawit terfermentasi dengan *Aspergillus niger*)

A.M. Marini*, M.Y. Ayub**, B. Abd. Salam**, H. Hadijah***, E.A. Engku Azahan* and S. Ahmad Tarmizi***

# Improving Nutritional Values of Palm Kernel Cake (PKC) as Poultry Feeds: A Review

**Sharmila[1], A., Alimon[1,2], A.R., Azhar[1], K., Noor[3], H.M. and Samsudin[1,2]*, A.A.**
[1]Department of Animal Science, Faculty of Agriculture, [2]Institute of Tropical Agriculture,
[3]Department of Pre-Clinical Veterinary Science, Faculty of Veterinary Medicine, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia.
*Corresponding author: anjas@upm.edu.my

Table 6. Proximate composition (% dry matter) of raw and treated PKC

| Ingredient | Proximate composition | | | | | |
|---|---|---|---|---|---|---|
| | Moisture | Crude protein | Crude fat | Crude fiber | Ash | Nitrogen free extract |
| PKC | 11.43 | 16.86 | 6.82 | 15.12 | 6.58 | 54.62 |
| Enzyme-treated PKC | 10.15 | 17.11 | 5.15 | 14.59 | 5.40 | 57.75 |
| Fermented PKC | 6.67 | 31.27 | 3.36 | 14.51 | 11.34 | 39.52 |

Source: Ng, 2004

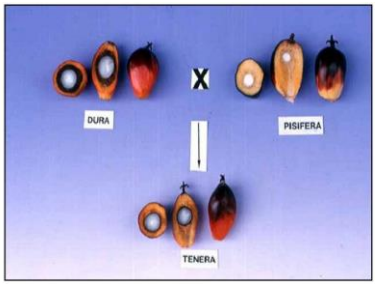



Figure 1. *E. guineensis* fo. *dura*, *E. guineensis* var. *pisifera* and *E. guineensis* fo. *tenera*.
Source: Cheng Hai, 2011

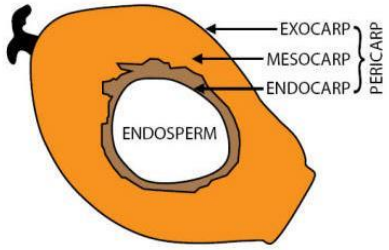



Figure 2. The oil palm fruit and its shells
Source: from http://www.etawau.com/OilPalm/Elaeis_guineensis.htm

# The potential use of palm kernel meal in aquaculture feeds

Wing-Keong Ng, PhD

*Fish Nutrition Laboratory, School of Biological Sciences, Universiti Sains Malaysia, Penang 11800, Malaysia.*

AQUACULTURE ASIA January-March 2003 (Vol. VIII No. 1)

Ng, W.K. and Chong, K.K. 2002. The nutritive value of palm kernel meal and the effect of enzyme supplementation in practical diets for red hybrid tilapia (*Oreochromis* sp.). Asian Fisheries Sci. 15:167-176

Ng, W.K., Lim, H.K., Lim, S.W. and Ibrahim, O. 2002. Nutritive value of palm kernel meal pretreated with enzyme or fermented with *Trichoderma koningii* (Oudemans) as a dietary ingredient for red hybrid tilapia (*Oreochromis* sp.). Aqua Resc. 33: 1119-1207.

Ng, W.K. 2004. Researching the use of palm kernel cake in aquaculture feeds. Palm Oil Developments. 41: 19-21.

Ng, W.K. and Chen, M.L. 2002. Replacement of soybean meal with palm kernel meal in practical diets for hybrid Asian-African catfish, *Clarias macrocephalus* x *C. gariepinus*. J. Appl. Aquacult. 12 (4): 67-76.

Palm Fatty Acid Distillates

Crude Palm Oil

Bleaching

Deodorization

Distillation

RBD Palm Olein

Palm Kernels

Crude Palm Kernel Oil

Palm Kernel Meal

Wing-Keong Ng & Cheong-Yew Chong

# An added human health benefit of using palm oil in tilapia feeds:

Possible beneficial effects of natural antioxidants such as vitamin E in crude palm oil when deposited in tilapia fillets.



✓ Palm tocopherols and tocotrienols significantly improve oxidative stability of tilapia fillets that will translate to longer shelf life and freshness for seafood products.


# Human health benefits of palm tocotrienols:

- Higher anti-oxidant potency.
- Hypocholesterolaemic effects.
- Anti-cancer properties.
- Prevention of cardiovascular diseases.

Local raw material for Commn carp

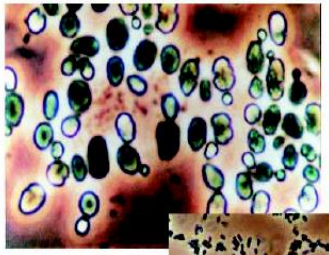
Proximate of kapok seed, Cassava skin, Kopra, Rubber seedand Palm kernel meal Before (NF) and after fermentaion (F) with Saccharomises c

Protein, Energi and Total digestibility of Local Raw Material with (F) and without Fermentation with sacharomises carrevise (NF) by Common carp *Cyprinus carpio*

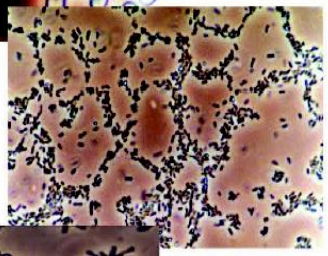
| Parameter | Jenis | Pakan | | | | |
|---|---|---|---|---|---|---|
| | | Kapok Seed | Cassava Skin | Kopra | Rubber Seed | PKM |
| Protein Digestibility (%) | NF | 86,22±1,58 | 76,94±0,46 | 84,66±0,61 | 83,77±2,67 | 75,59±1,25 |
| | F | 84,45±0,87 | 83,90±0,37 | 87,95±1,20 | 89,01±1,11 | 84,50±0,45 |
| Energy Digestibilty (%) | NF | 67,08±1,91 | 68,43±0,42 | 71,63±0,09 | 72,57±0,35 | 65,53±0,51 |
| | F | 61,70±0,30 | 75,44±0,40 | 73,21±1,03 | 77,53±0,63 | 71,84±0,51 |
| Total Digestibiltiy (%) | NF | 36,27±6,84 | 37,37±1,54 | 54,86±0,31 | 41,01±1,43 | 35,88±1,76 |
| | F | 17,62±1,07 | 64,63±1,44 | 56,86±3,74 | 65,64±2,48 | 54,13±1,83 |

Keterangan : Nilai yang tertera merupakan nilai rata-rata ± standar deviasi dari perhitungan duplo. TF= tanpa fermentasi, F= fermentasi, P= persentase perubahan (%)

**Dr M. Agus Suprayudi**, Laboratory of Fish Nutrition, Department of Aquaculture, Bogor Agricultural Institute, Bogor, Indonesia: agus.suprayudi1965@gmail.com



**Yeast:** Ferment organic matter and contain vitamins and amino acids. They are used for making bread, beer and wine.



**Lactic acid bacteria:** Ferment organic matter and produce organic acids that inhibit pathogens. They are used for making yogurt and pickles.

**Phototrophic bacteria (Photosynthetic bacteria):** Work as a key component in EM. They help maintain the balance with the other beneficial microorganisms, allowing them to coexist and work together.


A probiotic is defined as:

- a live microbial adjunct
- which has a beneficial effect on the host
- by modifying the host-associated or ambient microbial community
- by ensuring improved use of the feed
- or enhancing its nutritional value
- by enhancing the host response towards disease
- or by improving the quality of its ambient environment

# USE OF PROBIOTICS

700 ha shrimp farm


Use of liquid probiotics for the fermentation of feed ingredients to increase their nutritional value
329
Ojai - Mexico


Fermentated Soybean Meal

# 4 x 0.1 ha ponds, 120-d, density 22/m2, 28 Oct 2008

Ojai shrimp farm - Mexico

| Diet | Final body wt (g) | Growth (g/wk) | FCR | Survival (%) |
|---|---|---|---|---|
| 35 CP pellet | 26.3 | 1.14 | 0.94 | 92.9 |
| Pellet + Bokashi mash | 23.4 | 1.02 | 0.64 (F) | 93.5 |
| Bokashi mash | 11.9 | 0.49 | 3.19 | 63.9 |
| Fermented soybean mash | 17.1 | 0.70 | 1.57 | 82.6 |

Source: Vererasun Prayotamornkul - Biomimicry


Vererasun Prayotamornkul
Biomimicry
Sustainable Organic Shrimp Farming
"Biomimicry" is the imitation of the models, systems, and elements of nature for the purpose of solving complex human problems.
Ancient Greek

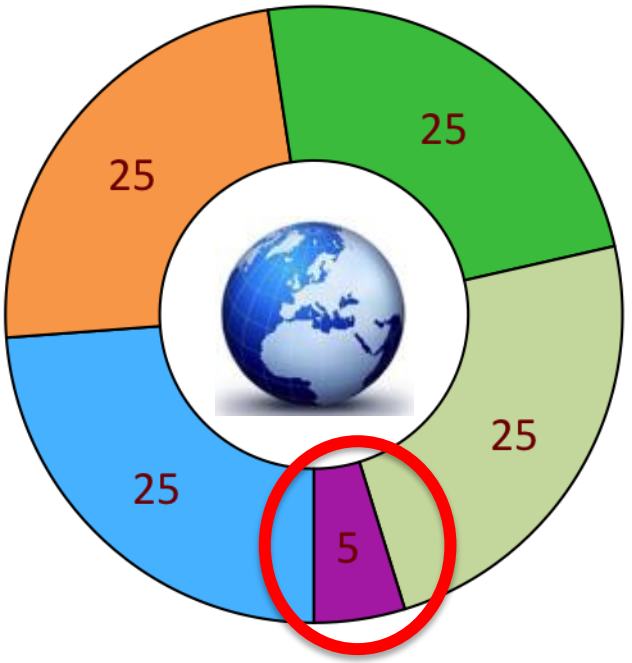
# Major ingredient groups commonly used in AQUACULTURE FEEDS

| Aquatic protein meals & oils | 1-25% |
|---|---|
| Fishmeals & oil: wild & farmed | |
| Squid meal, krill meal | |
| Seaweed meals & products | |
| Cultured microbial SCP | |

| Terrestrial animal proteins & oils | 1-25% |
|---|---|
| Poultry by-products | |
| Porcine by-products | |
| Ruminant by-products | |
| Terrestrial invertebrates | |

| Terrestrial plant proteins & oils | 1-25% |
|---|---|
| Oilseed protein by-products | |
| Cereal protein by-products | |
| Pulse protein by-products | |
| Other plant proteins | |

| Other plant meals & fillers | 1-25% |
|---|---|
| Cereal meals & by-products | |
| Root meals & extracts | |
| Fruit meals & by-products | |
| Forage & leaf meals | |




| Feed additives | 0-5% |
|---|---|
| Vitamins, antioxidants, pigments, emulsifiers | |
| Minerals, trace elements, salt | |
| Amino acids, nucleotides, feeding attractants | |
| Enzymes, gut modifiers, prebiotics, probiotics, acidifiers | |
| Immune enhancers, anti-fungal, anti-viral, anti-parasitical | |
| Binders, growth promoters, hormones, antibiotics | |

# Improving the utilization of feed ingredients

*Use of renewable nutrient sources*

## *EXOGENOUS MICROBIAL ENZYMES*

- **Improved nutrient digestibility**
- **Improving feed efficiency**
- **Release of trapped nutrients**
- **Breakdown of anti-nutritional factors**
- **Improved gut health**
- **Reducing environmental impacts (N, P)**

| | | | | |
|---|---|---|---|---|
| Phytase | β – glucanase | Amylase | Lipase | Mannanase |
| Xylanase | Cellulase | Protease | Micotoxinase | α - galactosidase |

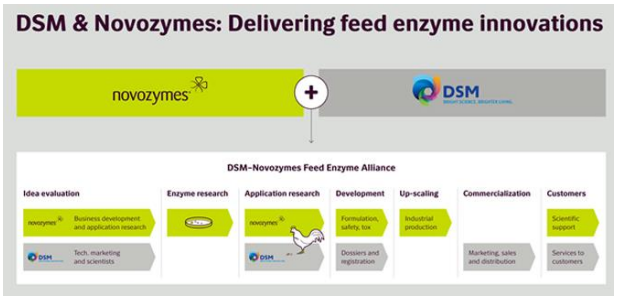
# Improving the utilization of feed ingredients

*Use of renewable nutrient sources*

## *SOME ENZYMES USED WITHIIN AQUAFEEDS*

| *Enzyme* | *Common source organism* |
|---|---|
| • **Amylases:** | ***Aspergillus* spp., *Bacillus* spp.,** |
| • **Phytases:** | ***Aspergillus* spp.,** |
| • **Proteases:** | ***Aspergillus* spp., *Bacillus* spp.,** |
| • **Fiber degrading:** | ***Aspergillus* spp; *Trichoderma longibrachiatum*** |

Allzyme SSF




Jefo
Species-specific additives

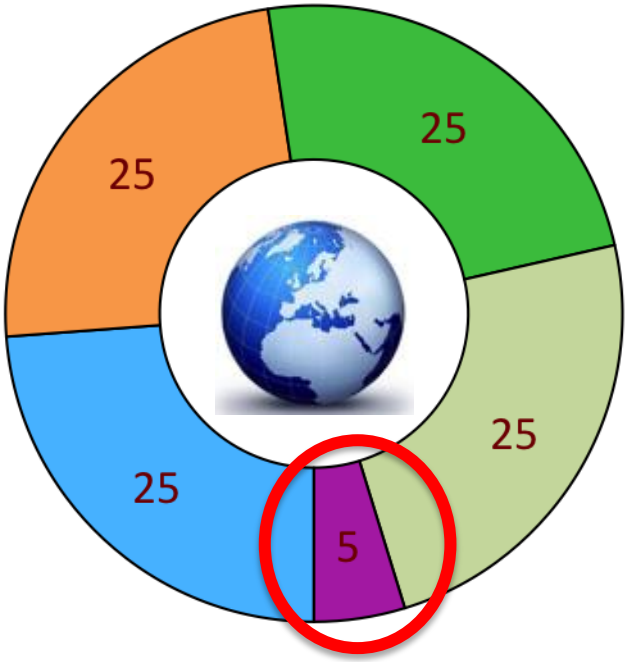
# Major ingredient groups commonly used in AQUACULTURE FEEDS

| Aquatic protein meals & oils | 1-25% |
|---|---|
| Fishmeals & oil: wild & farmed | |
| Squid meal, krill meal | |
| Seaweed meals & products | |
| Cultured microbial SCP | |

| Terrestrial animal proteins & oils | 1-25% |
|---|---|
| Poultry by-products | |
| Porcine by-products | |
| Ruminant by-products | |
| Terrestrial invertebrates | |

| Terrestrial plant proteins & oils | 1-25% |
|---|---|
| Oilseed protein by-products | |
| Cereal protein by-products | |
| Pulse protein by-products | |
| Other plant proteins | |

| Other plant meals & fillers | 1-25% |
|---|---|
| Cereal meals & by-products | |
| Root meals & extracts | |
| Fruit meals & by-products | |
| Forage & leaf meals | |



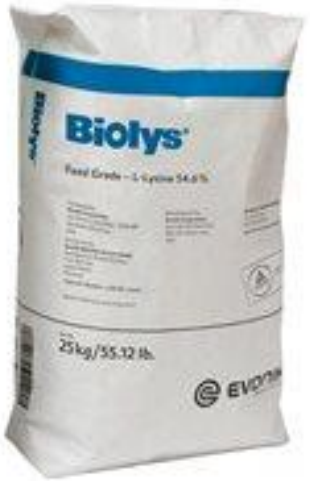

| Feed additives | 0-5% |
|---|---|
| Vitamins, antioxidants, pigments, emulsifiers | |
| Minerals, trace elements, salt | |
| Amino acids, nucleotides, feeding attractants | |
| Enzymes, gut modifiers, prebiotics, probiotics, acidifiers | |
| Immune enhancers, anti-fungal, anti-viral, anti-parasitical | |
| Binders, growth promoters, hormones, antibiotics | |

# Using amino acids to reduce fishmeal use

*Use of renewable nutrient sources*

***AMINO ACIDS PRODUCED BY FERMENTATION***

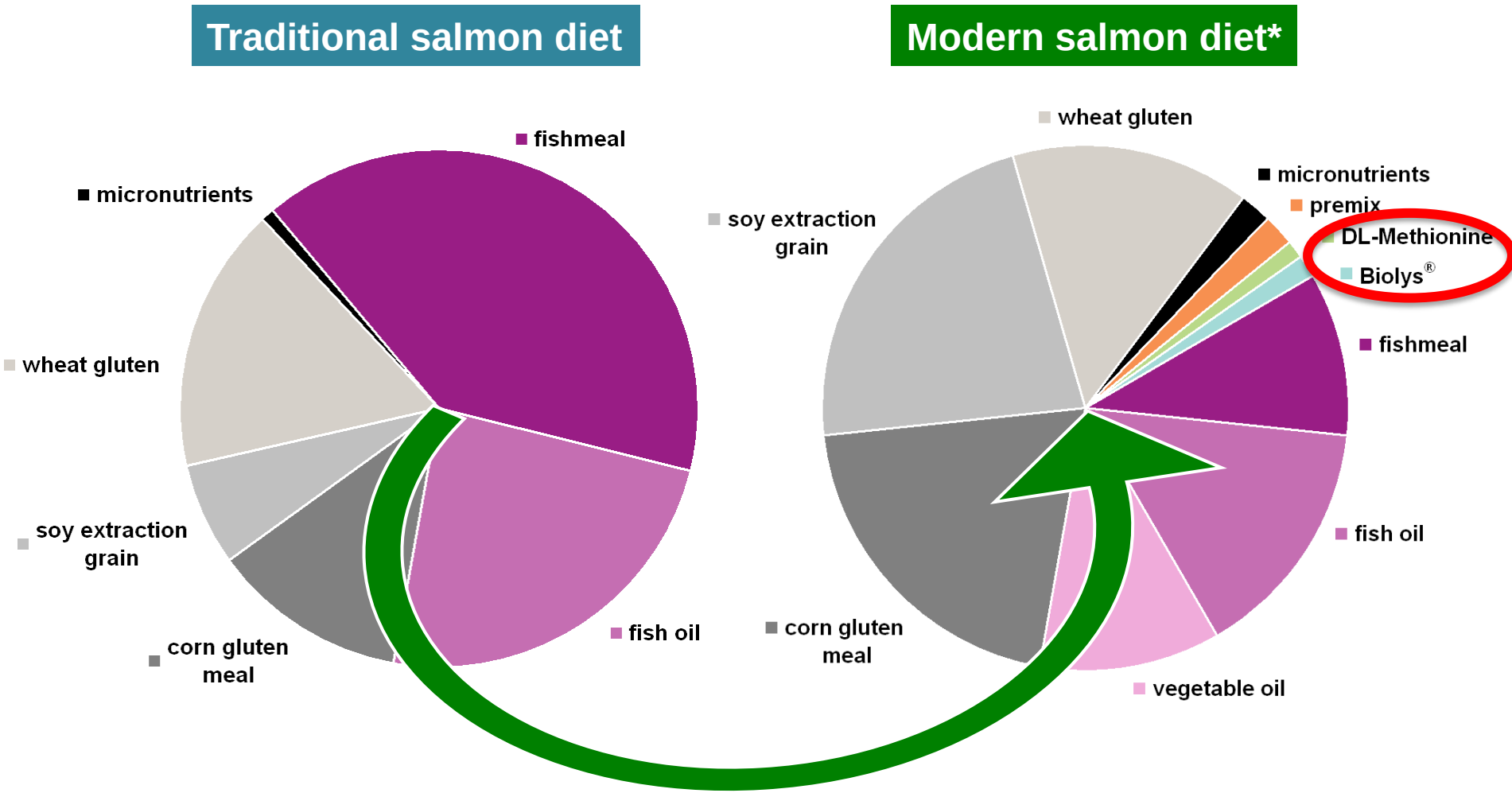
- **Arginine**
- **Glutamine/MSG**
- **Histidine**
- **Isoleucine**
- **Leucine**
- **Lysine**




***AMINO ACIDS PRODUCED BY FERMENTATION***

- **Phenylalanine**
- **Proline**
- **Serine**
- **Threonine**
- **Tryptophan**
- **Valine**

# Move from traditional fishmeal and fish oil based diets to plant-based diets for salmonids




Source: Evonik

Beneficial use of using supplemental limiting amino acids

| Aquatic protein meals & oils | 1-25% |
|---|---|
| Fishmeals & oil: wild & farmed | |
| Squid meal, krill meal | |
| Seaweed meals & products | |
| Cultured microbial SCP | |

| Terrestrial animal proteins & oils | 1-25% |
|---|---|
| Poultry by-products | |
| Porcine by-products | |
| Ruminant by-products | |
| Terrestrial invertebrates | |

| Terrestrial plant proteins & oils | 1-25% |
|---|---|
| Oilseed protein by-products | |
| Cereal protein by-products | |
| Pulse protein by-products | |
| Other plant proteins | |

| Other plant meals & fillers | 1-25% |
|---|---|
| Cereal meals & by-products | |
| Root meals & extracts | |
| Fruit meals & by-products | |
| Forage & leaf meals | |

## OTHER INGREDIENT OPTIONS

### Aquatic protein meals & oils

**Derived from capture fishery processing wastes**
- tuna, small-pelagics, by-catch
- meals, oils, hydrolysates

**Derived from aquaculture processing wastes**
- shrimp, tilapia, catfish
- meals, oils, hydrolysates

**Derived from farmed seaweeds**
- meals, hydrolysates

**Derived from cultured invertebrates**
- marine polychaetes, artemia biomass

**Derived from cultured aquatic micro-organisms**
- Algal SCP
- Yeast SCP
- Bacterial SCP
- Mixed bacterial flocs

**ACTIPAL**

# HC 6

**Krill Hydrolysate Concentrate for Aquafeed**

**ACTIPAL** Shrimp

# SL 11

**Squid Hydrolysate Liquid for Shrimp**

**ACTIPAL**

# HP 1

**Shrimp Hydrolysate Powder for Fish and Shrimp**

**ACTIPAL**

**Can be produced locally**

# HP 2

**Tilapia Hydrolysate Powder For Fish and Shrimp**

**ACTIPAL** Shrimp

# SL 11

**Squid Hydrolysate Liquid for Shrimp**

## NUTRITIONAL ANALYSIS

### PROXIMAL ANALYSIS

| | |
|---|---|
| - Moisture: | 56 % |
| - Protein: | 23 % |
| - Fat: | 13 % |
| - Ash: | 7.5 % |
| - pH: | 2.7-3.1 |
| - Crude energy | 2540 kcal/Kg |

### MINERALS

| | |
|---|---|
| - Calcium: | 0.03 % |
| - Phosphorus: | 1.74 % |
| - Sodium: | 0.45 % |
| - NaCl: | 0.90 % |

### DIGESTIBILITY

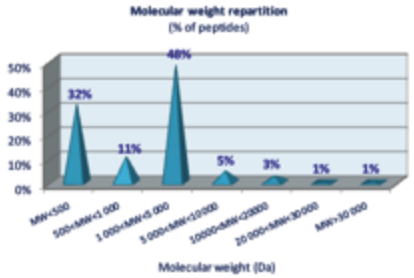
| | |
|---|---|
| - Ileal Digestibility: | 99 % |

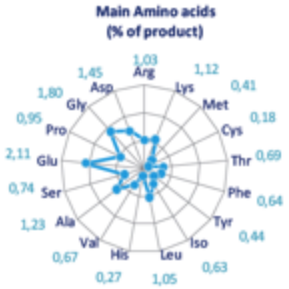
### BACTERIOLOGICAL ANALYSIS

| | |
|---|---|
| - Salmonella: | abs/25g |
| - Enterobacteria: | < 10 CFU/g |

### PROTEIN QUALITY

- Soluble Protein: 80 % of total protein
- Total Amino acids: 78 % of protein







Information Sheet – Ref: SL 11 0480234 V5 Date: 19/06/2012 Cancels and replaces the former version

Marine seaweed hydrolysates & meals

# Microbial ingredients in aquafeeds

Bacteria
*Methylococcus capsulatus*

Yeast/Fungus
*Kluyveromyces*

Microalgae
*Phaeodactylum, Chlorella,*

Source: Margareth Øverland, 2013

## Bacterial meal or SCP

# Many possible substrates

| Microbe | Substrate |
|---|---|
| Bacteria | Natural gas, methane, methanol |
| Yeast | By-products from forestry and agriculture |
| Microalgae | Sunlight, $CO_2$ |

Margareth Øverland, 2013

# Bacterial meal

## Value chain from natural gas to high-value feed resources for the production of human food

*Methylococcus capsulatus*

| | |
|---|---|
| Crude protein (including 10% nucleic acids) | 70% |
| Crude lipids (phospholipids) | 10% |
| Carbohydrates | 12% |
| Ash | 7% |

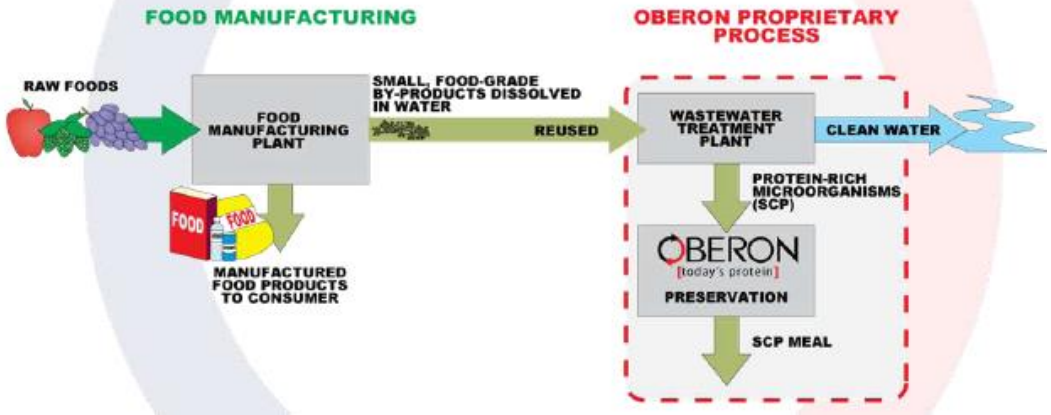
(Source: Øverland et al., 2010, Archives of Anim. Nutr)

Margareth Øverland, 2013

**Bacterial meal (BM) produced by aerobic fermentation:**

- Methanothroph bacteria and helper bacteria
- Methanol or Methane from natural gas
- Oxygen, ammonia, minerals

# Re-tuned Operation Converts Food-Grade Waste into SCP




Source: Nutrinsic

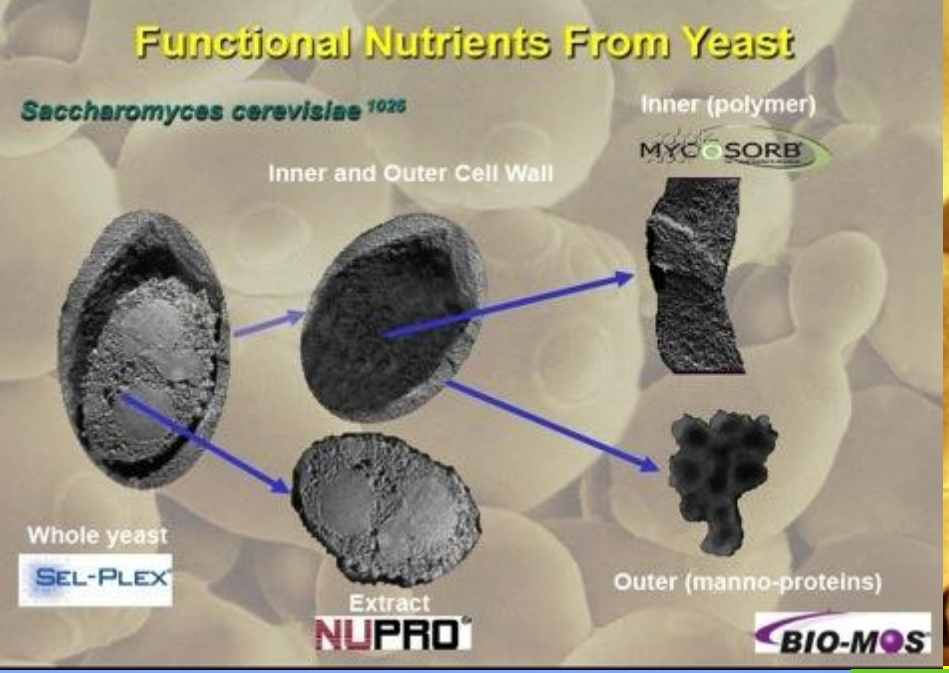
## Nutritional Data

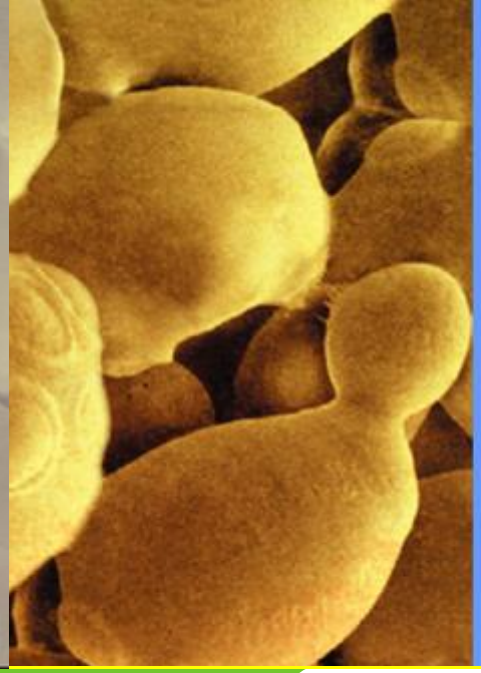
| Composition | % |
|---|---|
| Crude protein | 65-67 |
| Crude fat | 6.5 |
| Mineral material | 12.5 |
| Crude fiber | 1-2 |
| Carbohydrate | 13-14 |

| Vitamins | |
|---|---|
| Niacin | 83.3 mg/kg |
| Thiamine B1 | 7.7 mg/kg |
| Riboflavin | 39.0 mg/kg |
| Vitamin B12 | 12.0 mg/kg |
| Vitamin E | 29.8 IU/kg |

| Other | |
|---|---|
| Fatty acids | Monday 3/1 |
| Co Q10 | Monday 3/1 |
| Moisture | <5% |
| Color | Light brown |

| Minerals | |
|---|---|
| Calcium | 6.1 g/kg |
| Iron | 0.26 g/kg |
| Potassium | 5.1 g/kg |
| Magnesium | 2.5 g/kg |
| Sodium | 6.9 g/kg |
| Phosphorus | 11.1 g/kg |
| Zinc | 33.0 mg/kg |
| Copper | 55.0 mg/kg |
| Boron | 2.0 mg/kg |
| Cobalt | 2.5 mg/kg |
| Manganese | 8.0 mg/kg |



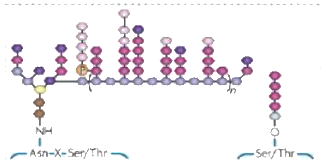
## Yeast Biomass Composition

- 45% Protein 45.0
- 8.4% Glycogen
- 0.8% Trehalose
- 13.1% Mannan
- 18.4% Other carbohydrates
- Free amino acids 1.1
- Lipid 2.9
- Ash 5.0

## Alltech, Brasil

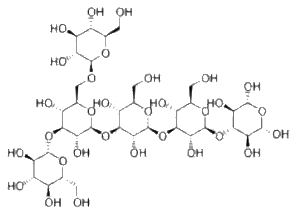
Yeast fractions and immunity

## Yeast has specific active components

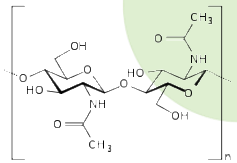



Mannoproteins

(From'Netea'et'al''2008)'



β-(1,3 -1,6) Glucans

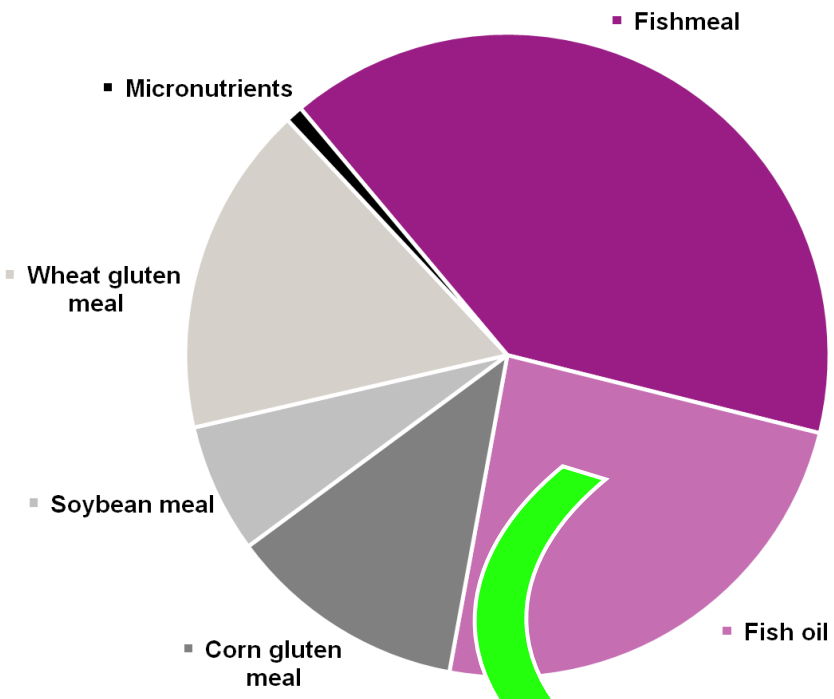
Chitin

# Heterotrophic algae - *Schizochytrium*
# 70% Fat containing 28% DHA

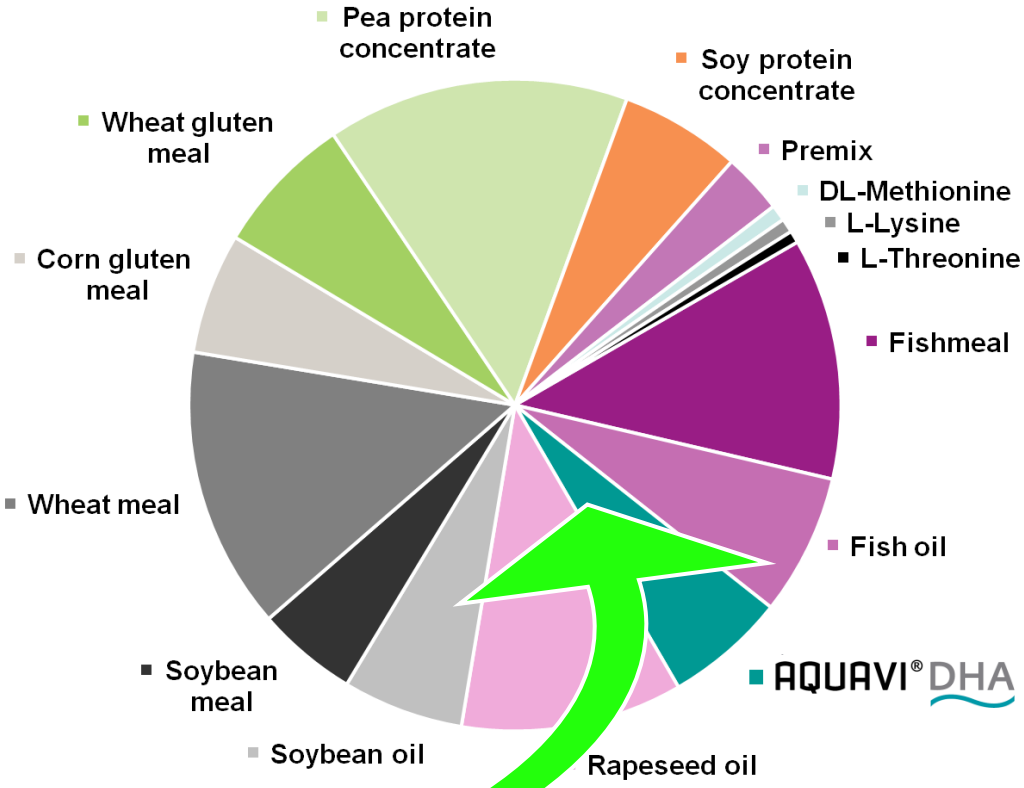
Source: Alltech

# Objective: More sustainable fish feeds

## Traditional salmon diet




## Modern salmon diet*




**Use of dried biomass of micro algae as fish oil replacer**

Source: Evonik

## Heterotrophic Algae Production

- Closed, controlled system
- Traceable
- Pure
- Higher level of consistency
- Protected by AQS

Alltech Quality System

Meeting & Exceeding Globally Accepted Standards

Alltech

# ALL-G-RICH

Natural, pure, sustainable source of high quality **DHA.**

**Source: Alltech**

## Trout

- Replace fish oil
- Increased DHA
- Improved growth performance

## Salmon

### Alltech-Nofima Research Alliance

- Healthier smolt transition
- Replace fish oil
- Improved growth performance

Alltech ...naturally

Nofima

## Tilapia

- Increased weight gain
- DHA increase in filet
- Premium product offering

## Alltech-Nofima Research Alliance: Trial Design

- The objective of the study was to evaluate the nutritional and flesh quality impacts and functional activities in commercial Atlantic salmon diets with increasing levels of All-G-Rich (50% fat, 14% DHA).
- A feeding trial with 4 levels of All-G-Rich (0%, 1%, 6% and 15%) was performed.
- A total of 480 fish were divided into 4 treatment groups with 3 reps per treatment and 40 fish per tank.
- 12 week feeding trial

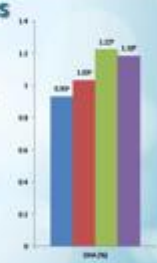
Alltech Nofim

## Catfish

- Increased weight gain
- DHA increase
- Premium product offering

## Alltech-Nofima Research Alliance: Results

- The 6% All-G-Rich treatment group had the highest DHA percent in the fillet with the 15% All-G-Rich treatment group slightly less.
- The 6% All-G-Rich treatment had the highest total of PUFA omega 3 as well as EPA plus DHA.



Alltech Nofim

## Hybrid Striped Bass

- Increased weight gain
- DHA increase
- Premium product offering

## Alltech-Nofima Research Alliance: Conclusions

- All-G-Rich has a positive effect on Atlantic salmon performance 1% supplementation level.
- At a 6% supplementation level growth and fillet quality were improved over the control.
- The highest fillet DHA level occurred at 6%.
- At a 15% level no reduction in performance occurred.

Alltech Nofi

| Aquatic protein meals & oils | 1-25% |
|---|---|
| Fishmeals & oil: wild & farmed | |
| Squid meal, krill meal | |
| Seaweed meals & products | |
| Cultured microbial SCP | |

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|---|---|
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| Terrestrial invertebrates | |

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| Pulse protein by-products | |
| Other plant proteins | |

| Other plant meals & fillers | 1-25% |
|---|---|
| Cereal meals & by-products | |
| Root meals & extracts | |
| Fruit meals & by-products | |
| Forage & leaf meals | |

# OTHER INGREDIENT OPTIONS

## Terrestrial animal protein meals & oils

**Produced from the processing of the offal of farmed livestock: pigs, chicken, beef etc**


**Represent the largest global source of <u>non-food grade</u> animal protein and fat/oils available to the terrestrial & aquafeed compounder: 8-10 Mt/an**

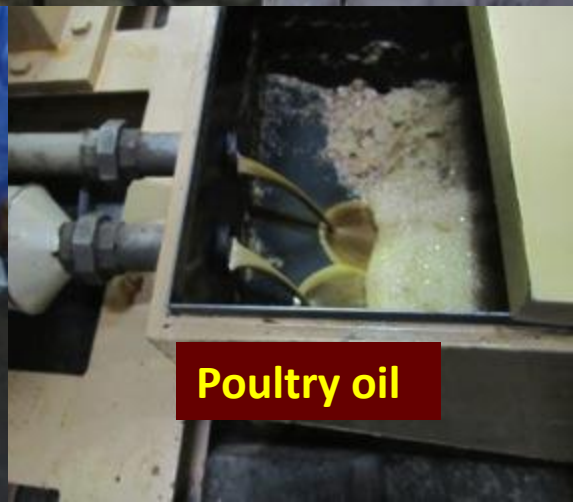
**In future more and more of these products will become available in Indonesia as the livestock sector grows**

**Terrestrial invertebrates – insect meals?**

Poultry rendering plant in Colombia

Poultry by-product meal

Blood meal



Poultry oil

ENTOLOGICS

entofood
A NEW SOURCE OF FEED

# PROXIMATE ANALYSIS & AA PROFILE, DEFATTED MEAL

## Executive Overview

| | |
|---|---|
| Investment size: | $300k → $1.4m |
| Timeline: | 12 – 18 months (phase 3) |
| Structure: | Private/Corporate Investor |
| Location: | Florianopolis, Brazil |
| Exit Strategy: | IPO |
| Target return: | $4m→$7m EBITDA (Y5→Y7) |
| Expected Stake: | Minority shareholder with preferential shares |
| Risk mitigation: | Existing demand<br>Local university support<br>Established strategy<br>Strong network in industry and government |


## Details

Entologics is a disruptive force in agriculture and the animal food chain. By growing insects on organic waste it offers:

- **Bio-residue recycling services** to food producers, processors and distributors, as well as to municipalities
- **Insectmeal** an alternative protein source for fish feed producers
- **Ento-Compost**, a natural fertilizer by-product of the insect's digestion of bio-residues for organic farmers


Brazil is the 3rd largest compound feed producer in the world. It currently produces 1.5 million tons of fish a year. It wishes to produce 20 million tons annually by 2030.


Brazil produces over 26 million tons of organic waste annually. It is about to implement laws 11.445/2007 and 12.305/2010 of a national waste policy coming in effect this August 2014.

With the creation of a 5 thousand ton insectmeal factory in Brazil, estimated annual EBITDA should range between 4 and 7 million dollars between financial years 5 and 7.

## PROXIMATE ANALYSIS

| | Unit | value |
|---|---|---|
| Moisture | % | 8.7 |
| Fiber | % | 6.9 |
| Fat | % | 13.3 |
| Protein | % | 57.8 |
| Ash | % | 8.5 |
| Ca | % | 2.56 |
| Cholesterol | mg/kg | 469.7 |

## AMINO ACID PROFILE

| | Unit | Value |
|---|---|---|
| Aspartic acid | % | 5.48 |
| Serine | % | 2.5 |
| Glutamin acid | % | 7.21 |
| Glycine | % | 2.94 |
| Histidine | % | 2.1 |
| Arginine | % | 3.27 |
| Threonine | % | 2.39 |
| Alanine | % | 4.02 |
| Proline | % | 3.49 |
| Cystine | % | 0.29 |
| Tyrosine | % | 3.89 |
| Valine | % | 3.85 |
| Methionine | % | 1.18 |
| Lysine | % | 3.53 |
| Isoleucine | % | 2.86 |
| Leucine | % | 4.11 |
| Phenylalanine | % | 2.51 |
| Tryptophane | % | 3.12 |
| Taurine | mg/kg | 1.72 |

Douramix NUTRIÇÃO ANIMAL

Mar & Terra

Hermetia

EPEA Brasil

Exile
Lead. Design. Evolve.

## Contact

François J. Rozwadowski
Email: francois.rozwadowski@entologics.com Telephone: +55 11 96436 5884; + 32 (0) 4 96 157 200 +33 (0) 6 58 39 66 26

## Guidelines concerning the development of a new fishmeal replacer or protein-rich feed ingredient (John Diener – personal commun., October 2015)

**1) Fishmeal replacements are only viable if they meet the following criteria:**

**a) available in commercial quantities and scalable to more than a million tonnes;**

**b) needs to have similar nutritional content and digestibility to fish meal, which means it's not likely to be a terrestrial plant based protein unless there is a cost effective way to eliminate anti nutrients and make phosphorous bioavailable;**

**c) the cost needs to be within range of fishmeal, ideally lower, but at least within 15% of the fishmeal price.**

**2) Supply reliability and sustainability have value to feed mills - the ability to secure reliable supplies of bioavailable proteins with consistent nutritional content and from a sustainable source are valuable to feed mills. There will always be some feed mills that are non compliant, but the leaders will adopt the product if it performs.**

**3) Attractant:** the replacement of fishmeal needs to have some attractant properties for the target species, otherwise, farmers won't buy it and the animals won't eat it.

**4) Early adopters should be given incentives to develop/test new formulations** It takes a lot of R & D to properly formulate with new ingredients. Production trial quantities should be made available to feed mills for formulation and testing at a lower than commercial rate if possible.

**5) The replacement needs to be accepted by consumers -** There is no benefit to replacing fishmeal with insect meal and then have the media reporting "shrimp farmers feeding roaches to your shrimp". The replacement needs to be something which consumers and environmental agencies will accept.

**6) It needs to be biosecure -** it's important to ensure that there is no biosecurity risk to using the raw material. Fungal spores for example can be pervasive and may be present in intermediate species or in microbial flocs.

**365 days with consistent quality depends upon use of quality ingredients**



# Importance of having own R & D facilities to test new feed ingredients & feeds


# Final feed ingredient choice considerations:

| Nutritional profile | Economic & market issues |
| --- | --- |
| ❖ Proximate composition<br>❖ Amino acid profile<br>❖ Fatty acid profile<br>❖ Energy content<br>❖ Mineral profile<br>❖ Vitamin profile<br>❖ Nutrient digestibility<br>❖ Anti-nutritional factors<br>❖ Contaminants<br>❖ Physical characteristics & processing requirements | ❖ Price & market availability<br><br>✧ Market acceptability & sustainability issues<br>• Animal protein use issues<br>• Use of GM ingredients<br>• Fishmeal & fish oil use issues<br>• Contaminant & food safety issues<br>• Environmental & climate change issues<br>• Social, religious, labor & possible food security issues<br>• Increased demand for transparency in feed & food production |

# NUTRITION is the cornerstone that effects the health & wellbeing of all people: both rich & poor

**Hunger** kills more people every year
than AIDS, malaria & tuberculosis combined.


# MALNUTRITION - THE GLOBAL FOOD DILEMA

## AQUACULTURE

**The Farming of Aquatic Animals & Plants has been the world's fastest growing food sector for 30 years & is considered as an important weapon in the global fight against Malnutrition as a much needed provider of high quality protein & essential fatty acids, minerals & vitamins**


# Per capita food supply in Japan & USA

(FAO Food Balance Sheets, 2016)

| | JAPAN | USA |
|---|---|---|
| Calories (kcal/day) | 2,719 | 3,639 +++ |
| Animal protein (g/day) | 49.1 | 70.7 +++ |
| Animal fats (g/day) | 33.9 | 68.3 +++ |
| Terrestrial meat (kg/year) | 48.8 | 117.6 +++ |
| Fish & seafood (kg/year) | 53.7 +++ | 21.6 |
| Aquatic animal fat (g/day) | 6.14 +++ | 1.42 |
| Aquatic plants (kg/year) | 0.99 +++ | 0 |

**it is not by chance that Japan, the country with the highest reported life expectancy and with one of the world's lowest incidences of obesity & deaths from heart related illnesses, is also one of the worlds top consumer of aquatic animal products & farmed aquatic plants: comparison made with the USA**





# Per capita food supply in Japan, USA & Indonesia

(FAO Food Balance Sheets, 2016)

| | JAPAN | USA | INDONESIA | WORLD |
|---|---|---|---|---|
| Calories (kcal/day) | 2,719 | 3,639 +++ | 2,712 | 2,870 |
| Animal protein (g/day) | 49.1 | 70.7 +++ | 17.4 | 31.8 |
| Animal fats (g/day) | 33.9 | 68.3 +++ | 10.5 | 37.0 |
| Terrestrial meat (kg/year) | 48.8 | 117.6 +++ | 12.9 | 42.4 |
| Fish & seafood (kg/year) | 53.7 +++ | 21.6 | 28.9 ++ * | 18.9 |
| Aquatic animal fat (g/day) | 6.14 +++ | 1.42 | 1.94 + | 1.2 |
| Aquatic plants (kg/year) | 0.99 +++ | 0 | 0 | 1.9 (to check) |
| Fish/seafood (g protein/d) | 18.6 | 5.2 | 9.6 + | 5.2 |
| Fish/Animal protein (%) | 38.0 | 7.4 | 54.8 +++ | 16.4 |

* In 2014 Indonesia produced 8.44 Mt of aquatic meat (60:40 from capture:aquaculture, w/w)





**In conclusion - it is vital that the Indonesian government continue its support toward the further development & use of locally available & new locally produced feed ingredient sources for the benefit & sustainable development of the Indonesian animal & aquaculture feed industry**

**Terima kasih**