ACE Animal/Consumer/Environment

Keeping Aquaculture Sustainable *…naturally*

Jorge E Arias

Alltech Inc.

Who is Alltech?

Leader in improving animal health and performance by adding nutritional value to food

Our Difference

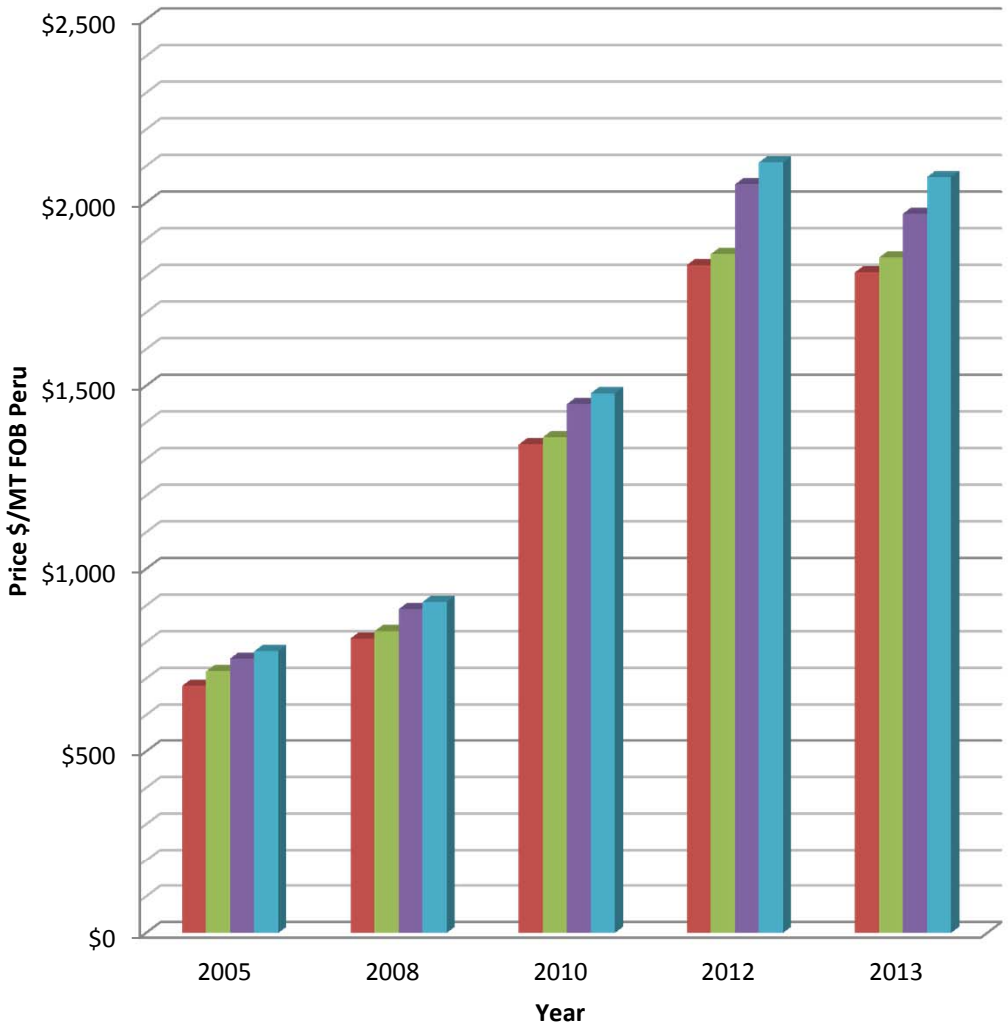
- **Top 10 animal health company**
- **Only company that is:**
  - Privately-held
  - Non-pharmaceutical
- **Growing consistently over 33 years**
- **Moving towards a $1bn company**


4 Burning Issues
• Fish health & performance
• Financial health
• Environmental health
• Human health


Problems are all
OPPORTUNITIES
If you look at them
from a different
direction

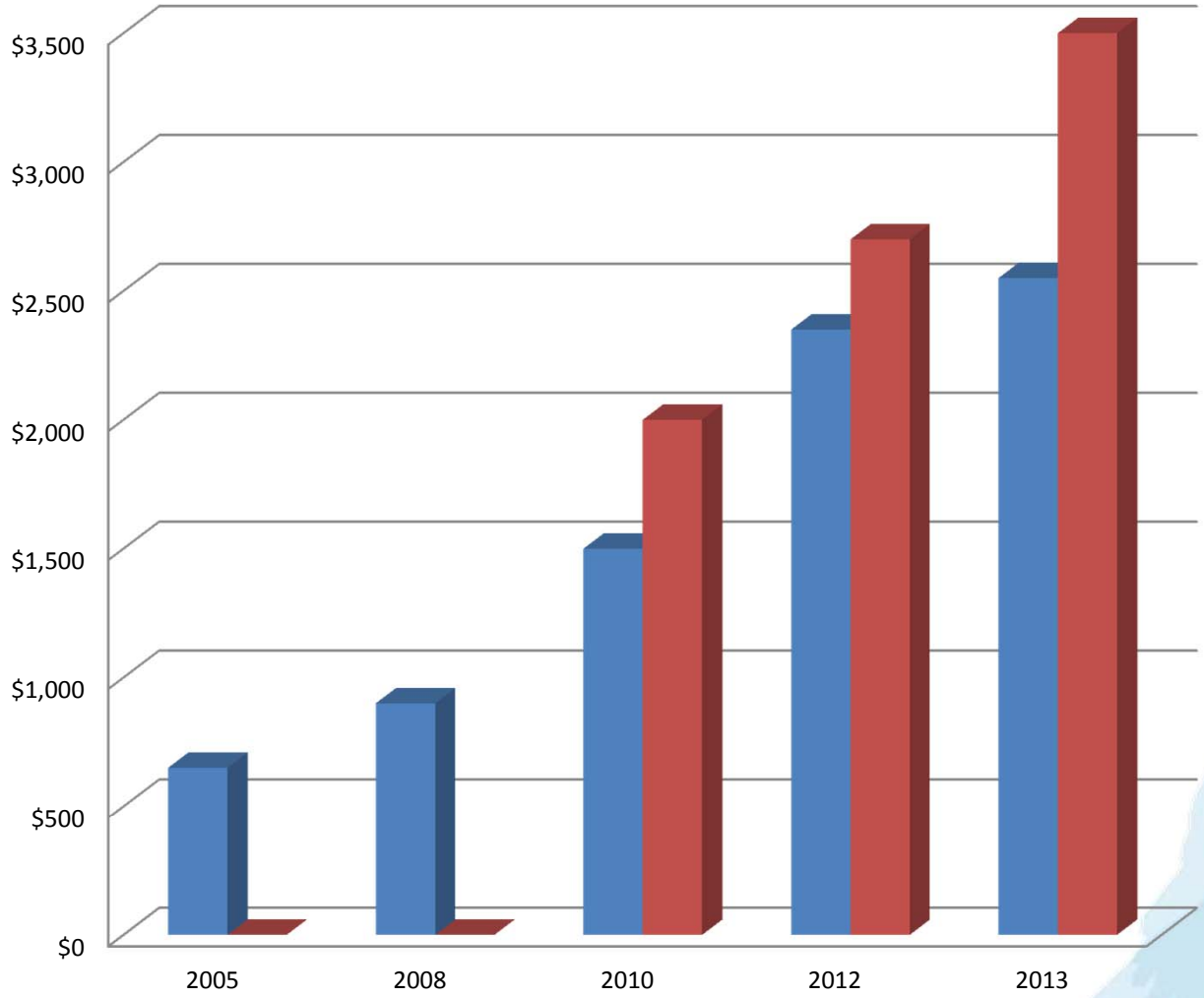
LIMA Thu Nov 1, 2012 3:42pm EDT

LIMA (Reuters) – “Peru has slashed its commercial fishing quota as warmer water temperatures and controversial practices deplete stocks of anchovy in one of the world's richest fisheries.”



HAMMERSMITH MARKETING LTD Ingredients Broker

Fish Oil Prices $/MT FOB Peru



HAMMERSMITH MARKETING LTD Ingredients Broker

Common Sources : Fatty Acids and Protein

Fish Meal and Fish Oil

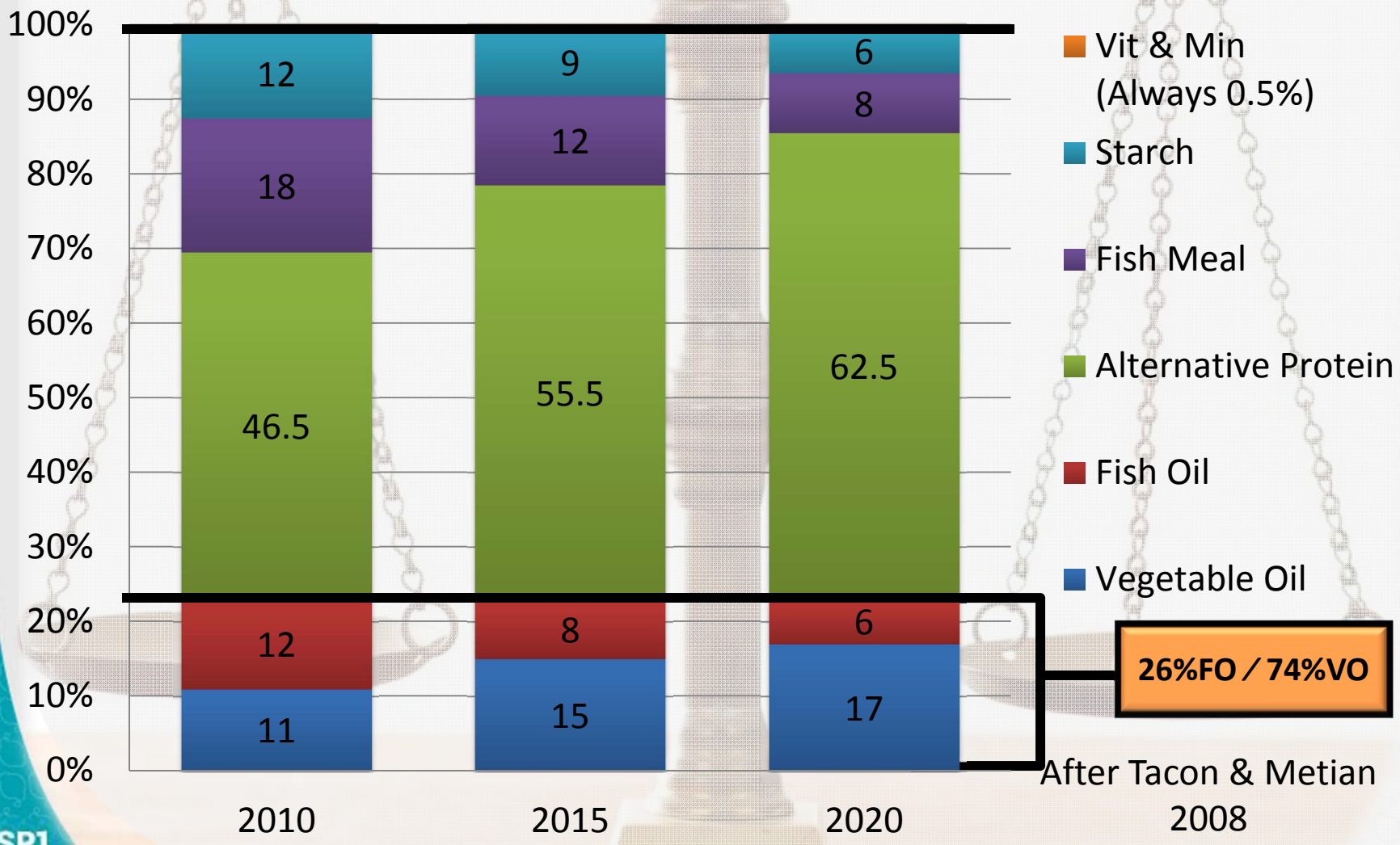
- Inconsistent
- Unsustainable
- Questionable quality (some times)

How will you supply the needed nutrients?

Trout Diet and Fillet Composition

Supermarket standard	2005	2008
Minimum marine product (Fishmeal + fish oil)	50%	20%
Fishmeal (min.)	30%	-
Fish oil substitution	40%	75%
EPA + DHA (%fat)	>15%	>6%
Omega 3 (%fat)	>18%	>10%
ω-3 /ω-6 ratio	>2	>0.7

Trends in Modern Salmon Feed Formulation



Alltech SP1

Oil Profiles

		HUFA	SAFA	MUFA	PUFA
Fish Oils	AVG Atlantic Oil	36	34	23	3
	Menhaden Oil	32	35	26	3
	Salmon Oil	31	22	37	6
Vegetable Oils	Palm Oil	0	49	41	10
	Rapeseed Oil	0	5	72	22
	Soybean Oil	0	15	22	63
Algae	Alltech SP1	32	63	3	2

Fatty acid profile of major oils in aquafeeds (as % of total FA)

But what are you REALLY getting…

		HUFA	EPA	DHA	Difference
Fish Oils	AVG Atlantic Oil	36	15	10	11
	Menhaden Oil	32	13	6	13
	Salmon Oil	31	9.5	9	12.5
Vegetable Oils	Palm Oil	0	0	0	0
	Rapeseed Oil	0	0	0	0
	Soybean Oil	0	0	0	0
Algae	Alltech SP1	32	0.5	28.5	3

Fatty acid profile of major oils in aquafeeds (as % of total FA)

- Environmental conditions
- Contamination
  - –Microbial, Chemical, Physical
- Downstream processing
- Inconsistency

Autotrophic Algae Production

Heterotrophic Algae Production

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

Alltech Quality System

Meeting & Exceeding
Globally Accepted Standards

Our Facility

Alltech® SP1

Natural, pure, sustainable source of **fatty acids** and high quality **proteins**

Alltech® SP1

"How do we apply the science we have"

- **Knowledge**
- **Practical Solutions**

1. Dimitroglou, A., D.L. Merrifield, R. Moate, S.J. Davies, P. Spring and J. Sweetman et al., Dietary mannan oligosaccharide supplementation modulates intestinal microbial ecology and improves gut morphology of rainbow trout, Oncorhynchus mykiss (Walbaum), J Anim Sci 87 (2009), pp. 3226–3234.
2. Dimitroglou, A., D.L. M ifie S ing Swe n, P. Moate and S. Davies (20). Effe ma n o go ide (MOS) supplementation on growth performance, feed utilisation, in ina histol y ta of d se (aurata), A ture ( ), pp. 182–188.
3. Dimitroglou A, Davies , we ch , D , ch , C atz S. (2010) Dietary supplementation of mannan oligosaccharide on white sea bream (Diplodus sargus L.) larvae: effects on development, gut morphology and salinity tolerance. Aquaculture Research, 41 (9), e245-e251. Article first published online: 28 JUN 2010, DOI:10.1111/j.1365-2109.2010.02513.x
4. Dimitroglou A, Daniel L. Merrifield, Oliana Carnevali, Simona Picchietti, Matteo Avella, Carly Daniels, Derya Güroy and Simon J. Davies (2010). Microbial manipulations to improve fish health and production – A Mediterranean perspective. Fish & Shellfish Immunology Article in Press, Uncorrected Proof. doi:10.1016/j.fsi.2010.08.009
5. Fountoulaki E, Morgane H, Rigos G, Antigoni V, Mente E, Sweetm 10). Evaluation of zinc supplementation in E sea bass (Dicentrarchus labrax) juvenile diets. Aquaculture Research, 41 (9), e208-e216. DOI: 1 .02503.x
6. Merrifield, D.L., G.M. Harper, A. Dimitroglou, E. R ssible influence of probiotic a the activity and morphology of rainbow trout (Oncorhynchus my rch, 41, 1268-12 V 2009, DOI: 10.1111/j.1365-2109.2009.02397.x
7. Merrifield, D.L., A. .M. Baker and J. Bøgwald ure focus of probiotic and prebiotic applications for salmonids, Aquac 30 8.
8. Nordgreen A Pe mre A manuscript – Controlled inc Se, Zn Cu and Mn in rotifers (Brachionus plicatilis).
9. Penglase , Ham weetman, J.W., Nordgre se and maintain the concentration of selenium in rotifers (*Brachionus*spp.), *Aquaculture* (2010), doi: 10.1016/j.aquaculture.2010.09.007
10. Penglase S, Nordgreen A, van der Oisvik weetm JW, Baeverfjord G, Helland S and K Hamre (2010). Increasing the level of selenium in rotifers (Brachionus plicatilis'Cay and activity of glutathione peroxidase
11. Rider, S.A., Davies, S Fi A., Knight, J., Sweetman J.W., 2009a. Supranutritional die (Oncorhynchu ykiss) mplications on selenium status and health responses. Aquaculture
12. Rider, S.A., Davies, S.J. a, A.N., Clough, R., Sweetman, J.W., 2009b. Bioavailability of cosupplemen rainbow trout (Oncorhynchus mykiss) diet. Journal of Animal Physiology and Animal Nutritio
13. Rodriguez-Estrada U, Satoh S, Haga Y, Fushimi H and J Sweetman. (2009). Effects of single and combi polyhydroxbutyrate acid on growth performance and immune response of rainbow trout On
14. Sweetman JW, Silvia Torrecillas, Arkadios Dimitroglou, Sebastien Rider, Simon J Davies and Marisol aquaculture species. Aquaculture Research, 41 (3), 345–355. Article first published online : 6
15. Torrecillas, S., A. Makol, M.J. Caballero, D. Montero, R. Ginés, J. Sweetman and M. Izquierdo. (2010 parameters in sea bass (Dicentrarchus labrax) fed mannan oligosaccharides (MOS), Aquac Nu DOI: 10.1111/j.1365-2095.2009.00730.x

Trout

- Replace fish oil
- Increased DHA
- Improved growth performance

Impact of 15% Algae on Rainbow Trout

Two diets (0, 15% Alltech SP1) for 14 weeks

Treatment	Average Weight of Trout (g)				
	Week 0	Week 5	Week 7	Week 10	Week 14
7% F.O./25% F.M.	6.0	20	29	52	97
15% algae/18% F.M.	6.0	21	30	53	111

Treatment	Average Weight Gain of Trout (g)				
	Week 5	Week 7	Week 10	Week 14	DHA
7% F.O./25% F.M.	14	22	45	91	17mg/g
15% algae/18% F.M.	15	23	47	105	30mg/g

F.O.= Fish Oil; F.M.= Fish Meal

Filer, 2012

- Increased weight gain
- DHA increase
- Premium product offering

Tilapia

Impact of Alltech SP1 on Tilapia

Four Diets (0, 0.2, 0.4, 0.8% Alltech SP1)

Treatment	Average Fish Weight (g)					DHA
	Week 0	Week 3	Week 8	Week 10	Week 13	(mg/g)
No Algae	9.8	15.4	25.3	28.6	33.1	1.76c
0.2%	9.8	15.8	25.9	29.1	36.7	1.78c
0.4%	9.7	16.0	25.4	28.3	34.3	2.27b
0.8%	9.8	16.0	26.4	30.2	35.9	2.93a
P value	0.95	0.61	0.69	0.65	0.38	0.001

Alltech® SP1

Clean and consistent source of Omega-3 fatty acids and high quality protein to sustainably support the growing population.

Alltech® SP1

Functional nutrients from yeast: *sustainable* source of protein

- **45% Crude protein**

Highly digestible & consistent

- **5-7% Nucleotides**

Improves immunity & GIT development

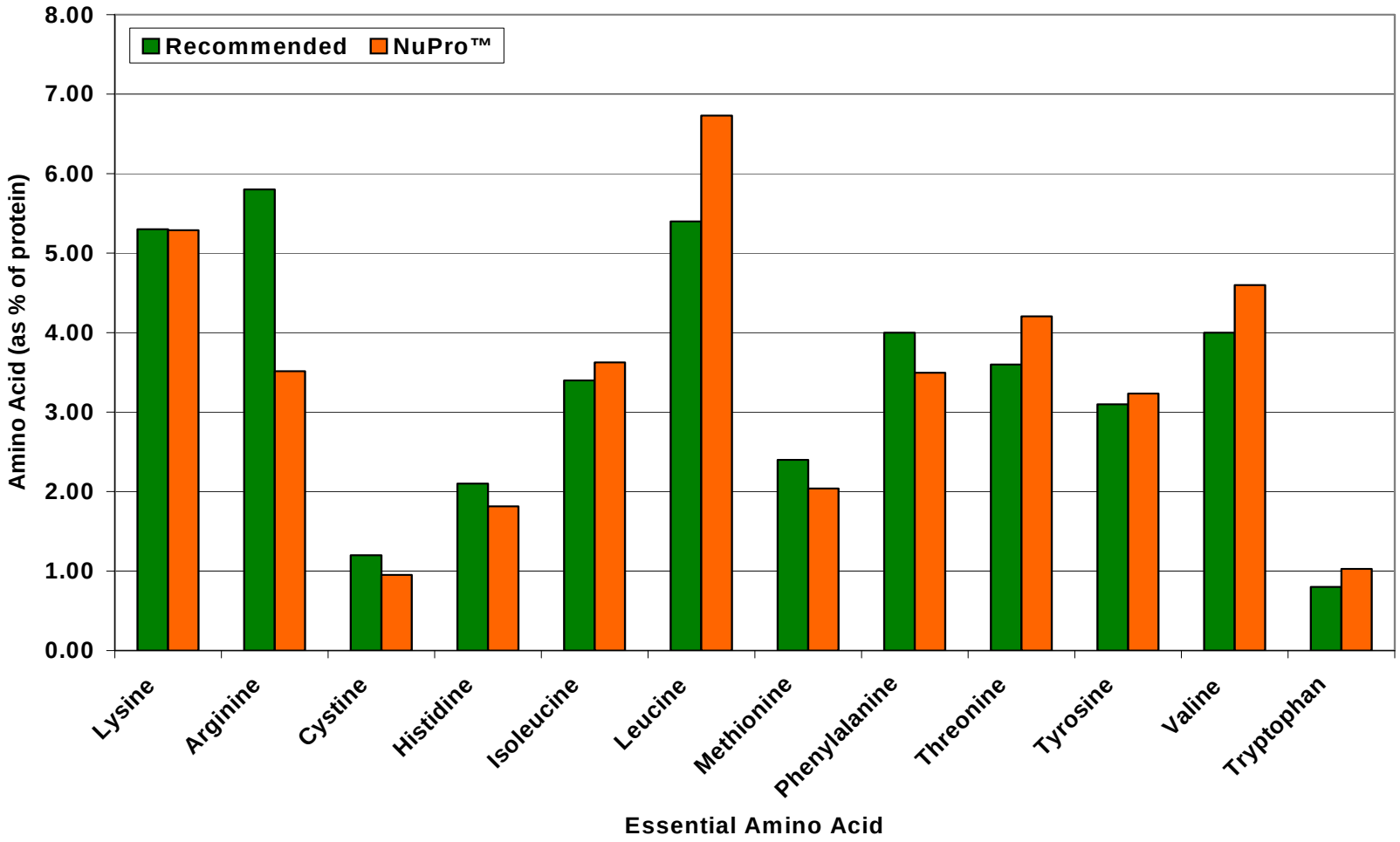
- **Rich source of glutamic acid, amino acids**

Improves palatability and intestinal growth

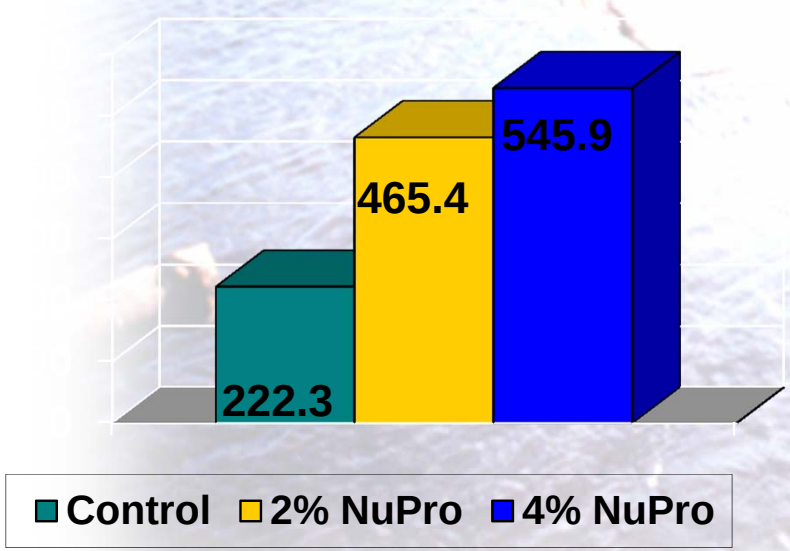
- **Rich source of Inositol**

Improves cell growth & repair

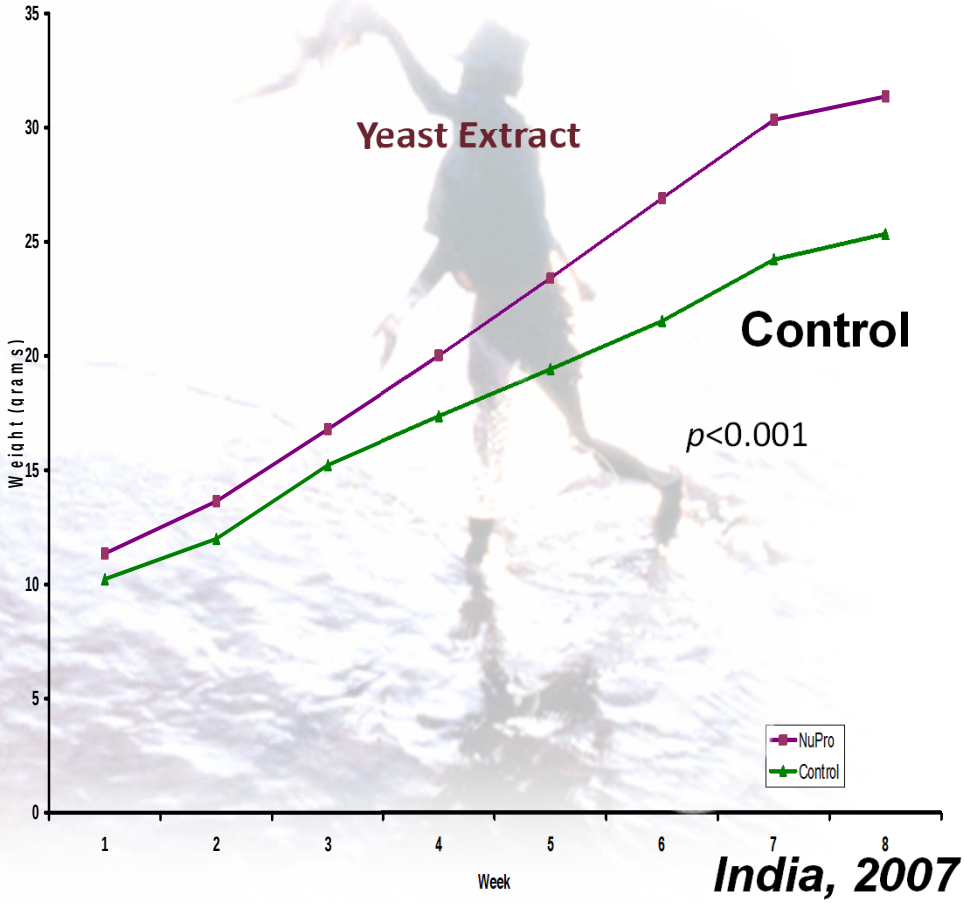
Shrimp amino acid requirement



Better performance (increase in weight gain)



Shrimp Biotechnology Business Unit (SBBU) and Mahidol University, Thailand, 2003



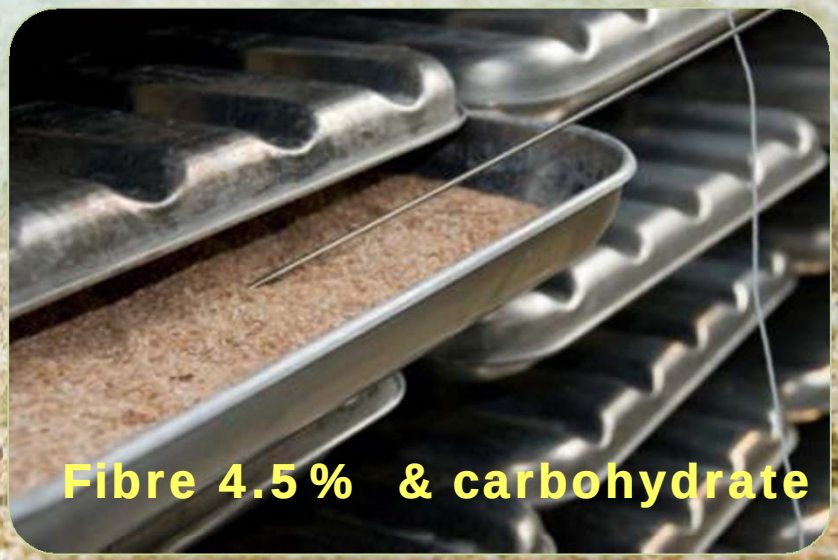

Use Fibre not Corn
Reduced waste

Nutrient Access

Termites

synergen
powered by SSF technology

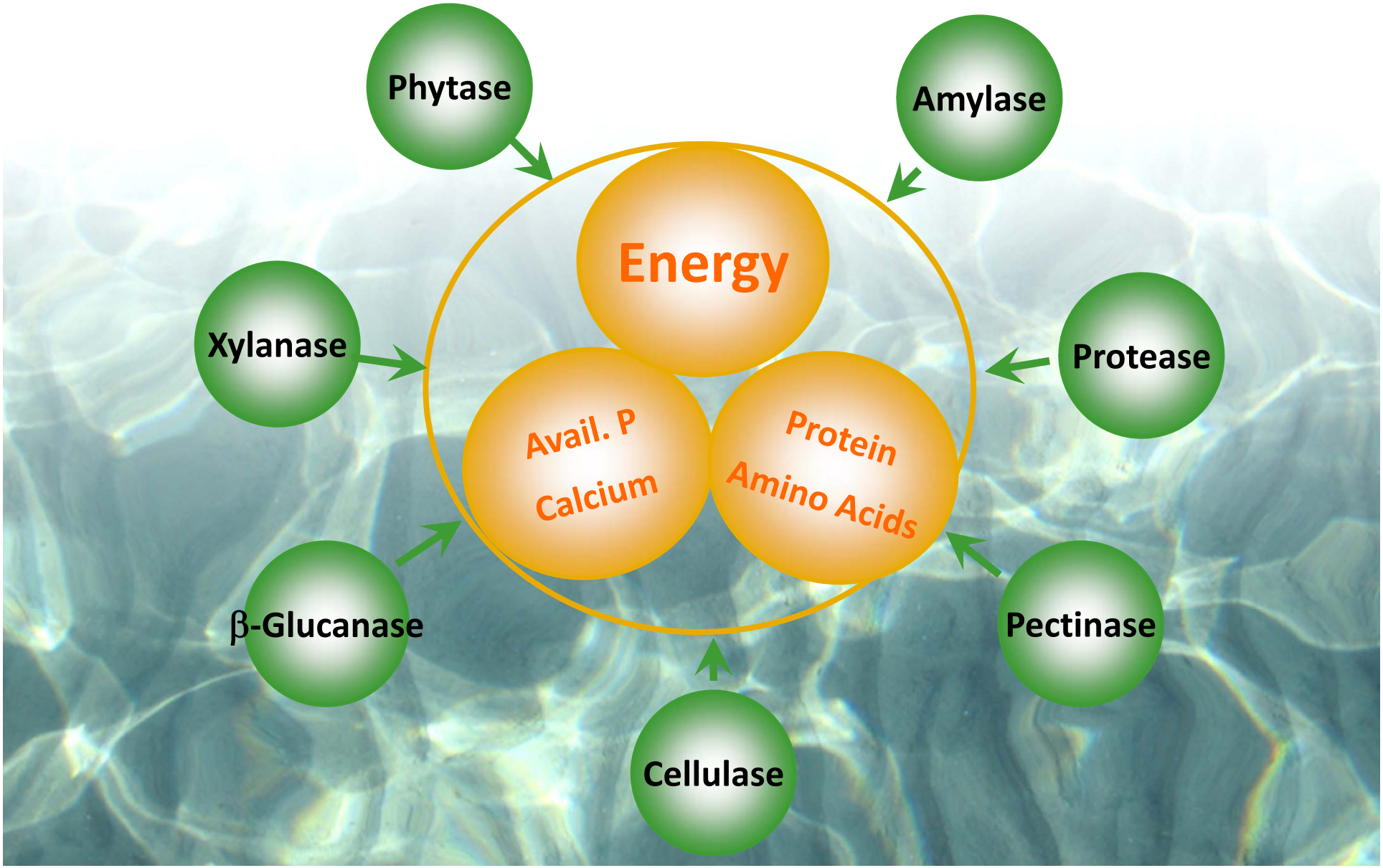
Fungus Garden



Tray with
Alltech's Fungus Garden

Both breaking down fiber

An enzyme complex: hundreds of enzymes from one source



Digestibility study in Pacific white shrimp using 75% plant ingredients

A shrimp diet was formulated with

- 40% pea protein flour (PPF)
- 30.5% wheat flour
- 4.8% wheat gluten
- Fishmeal only 12.6%

	DM	CP	Lipid	Fiber	Ash	NFE	P	Phytate
PPF	87.11	39.45	3.0	2.61	5.66	36.35	0.89	2.07
Chilean Fishmeal	92.68	67.55	10.25	0.09	13.94	0.85	2.24	0
Chilean Shrimp Meal	90.70	39.34	11.84	0.11	23.91	5.49	1.29	0
Wheat Gluten	92.04	80.02	0.55	0.94	1.15	9.38	0.259	ND

Cruz-Suárez et al.

Shrimp diet formulation

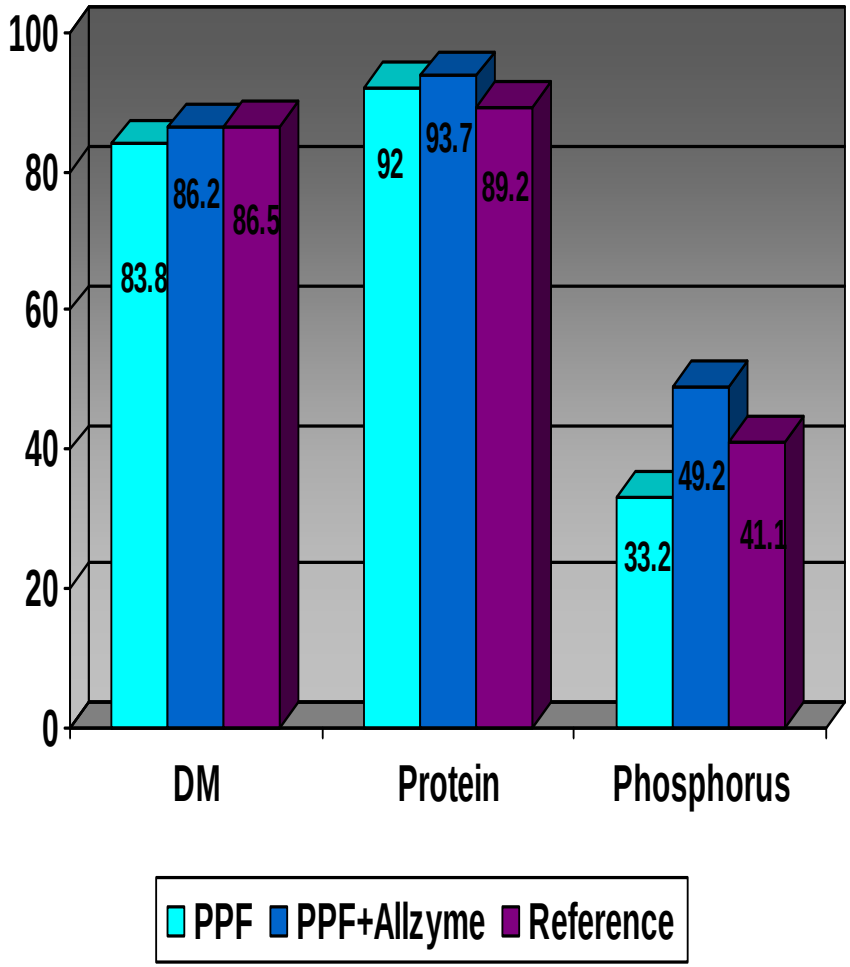
	T1 PPF Control	T2 PPF/Allzyme®SSF	Reference (PPF Free)
Allzyme® SSF	--	1	--
PPF	400	400	--
Fishmeal	126.2	126.2	210.4
Shrimp Meal	60	60	100
Wheat Gluten	48	48	80
Wheat Starch	305.8	304.91	521.7
Fish Oil	39.2	39.2	65.3
L-Methionine	2.8	2.8	4.6
Choline	0.4	0.4	0.4
Vitamin C[1]	0.7	0.7	0.7
Vitamin Premix[2]	2.5	2.5	2.5
Mineral Premix[3]	2.5	2.5	2.5

(g/kg, g wet basis)

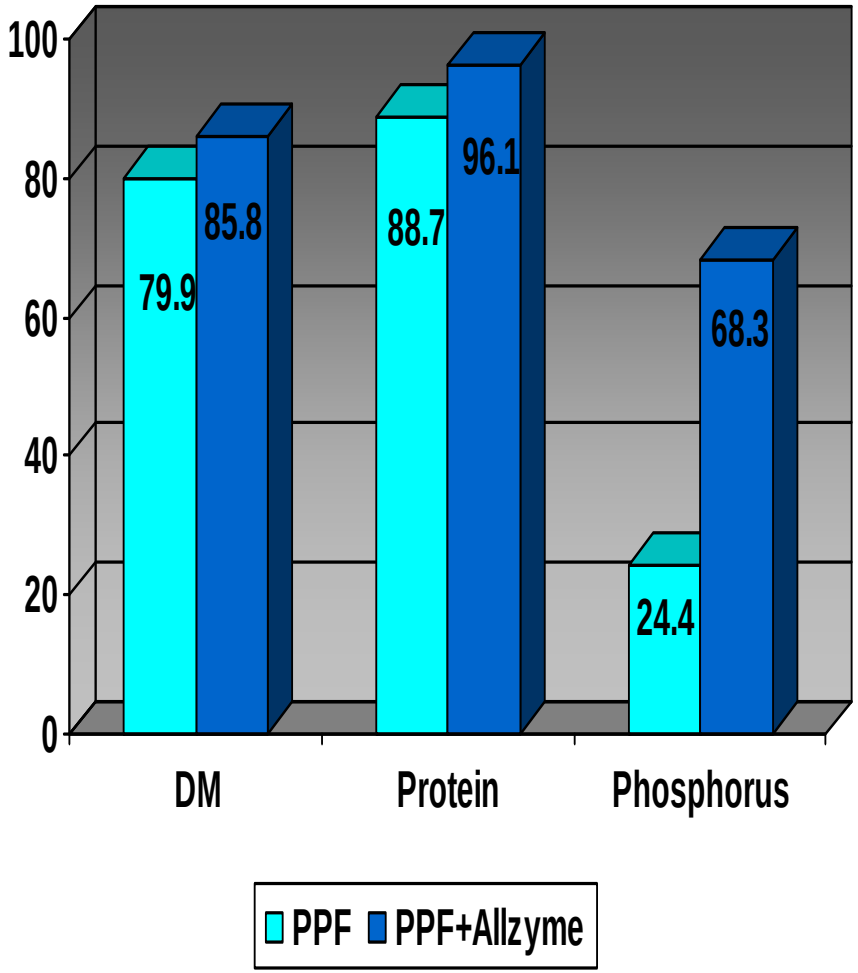
1. Stay-C 35 (DSM).
2. Composition (mg/kg) Vit. A, 4000 IU/g; B1, 24000; B2, 16000; DL Ca pantothenate, 30000; B6, 30000; B12, 80; C, 60000; K3, 16000; D3, 3200 IU/g; E, 60000; H, 400; Niacin, 20000; folic acid, 4000
3. Co, 2000; Mn, 16000; Zn, 40000; Cu, 20000; Fe, 1; Se, 100; I, 2000 mg/kg
4. Chromic oxide is used as marker

Cruz-Suárez et al.

Apparent diet digestibility (%)



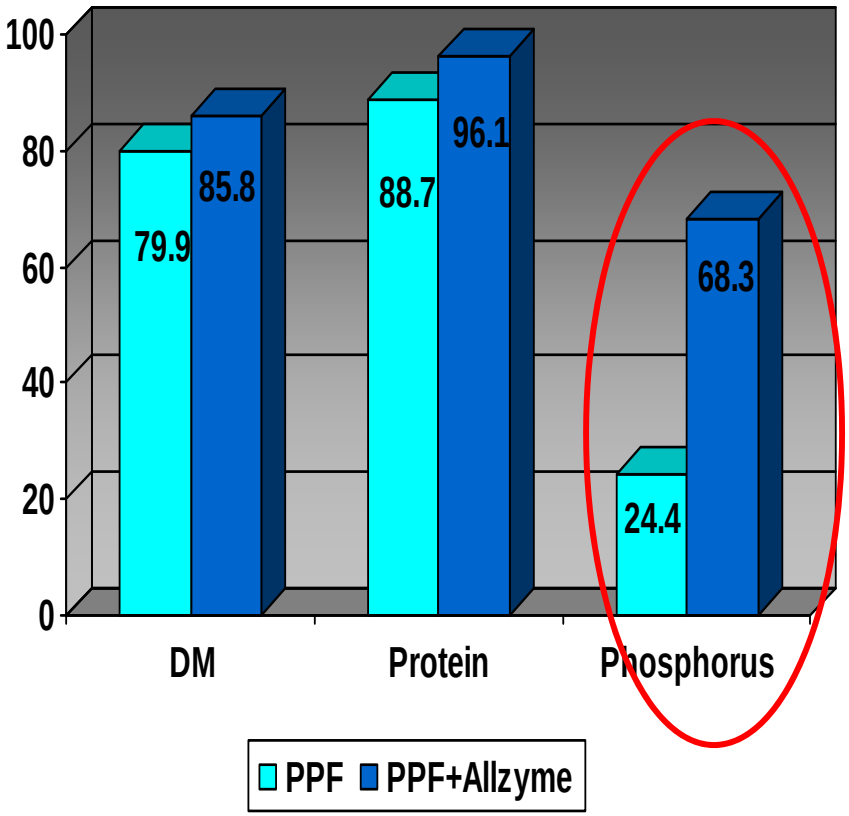
Pea protein flour digestibility (%)



Cruz-Suárez et al.

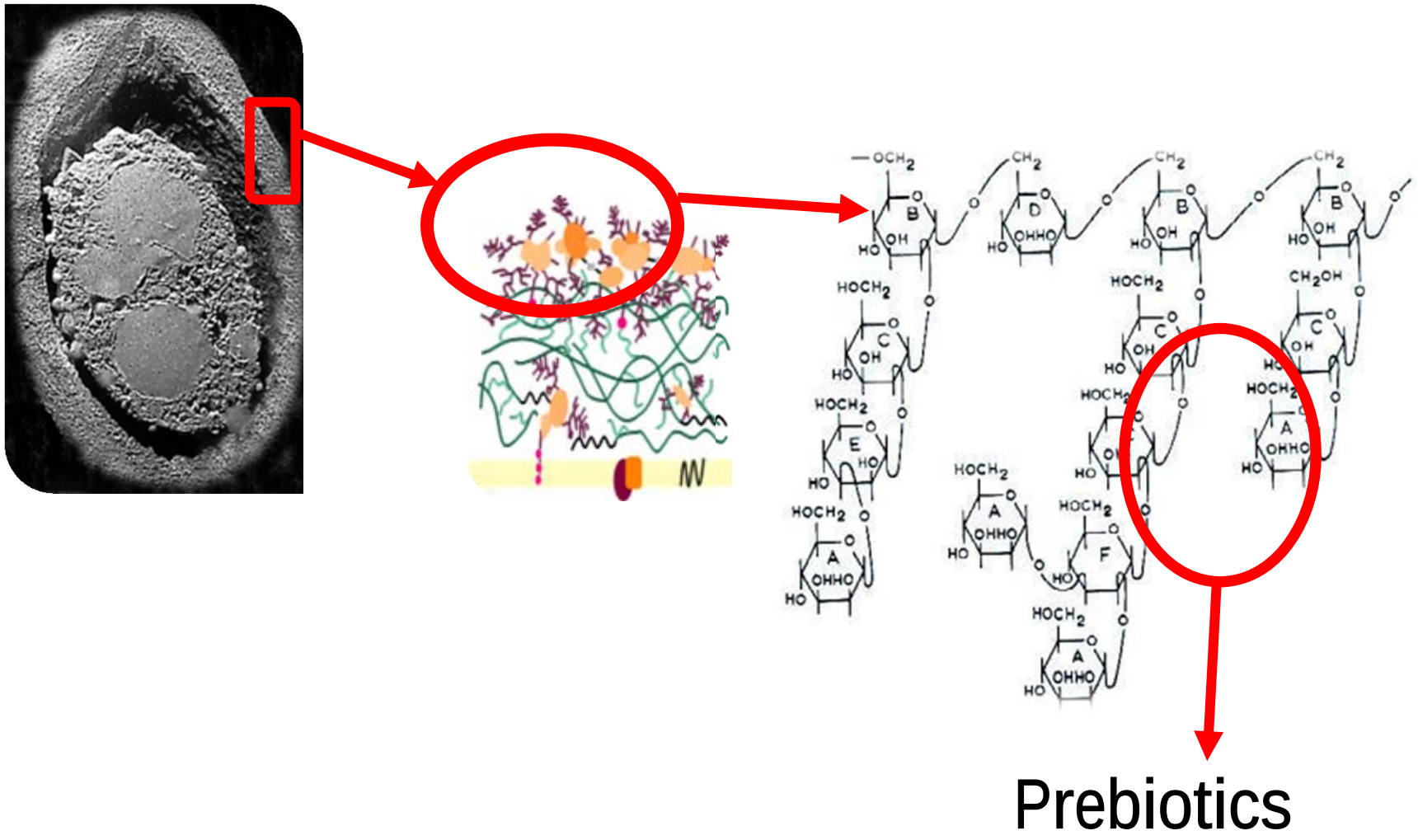
Reduce P pollution

Pea protein flour (PPF) digestibility (%)



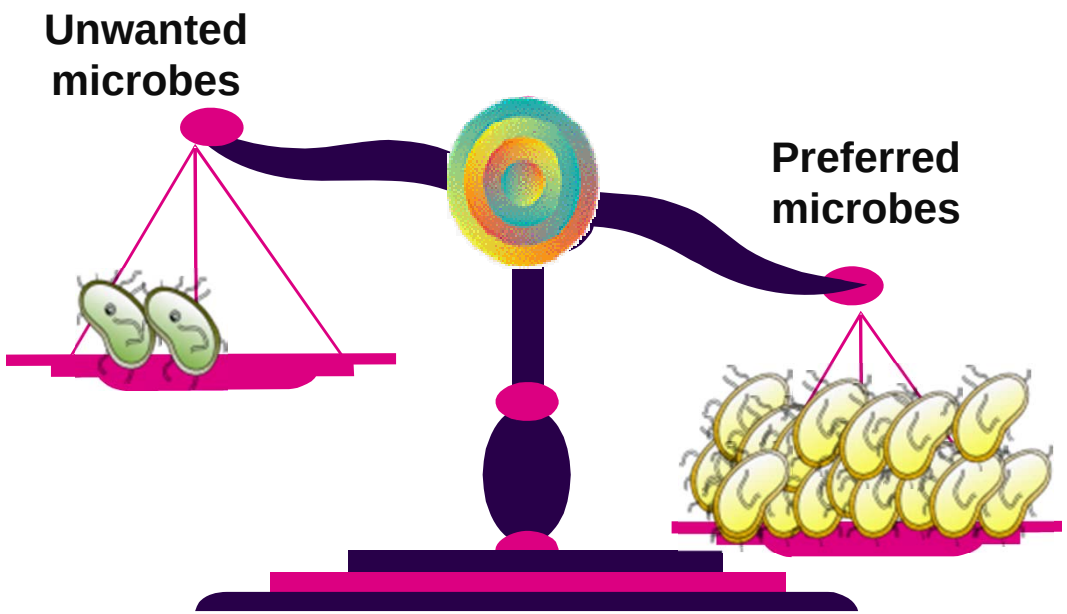
Enzyme complex increases the bio-availability of phytate bound P to shrimp by 180% improvement in P digestibility of PPF.

How a prebiotic is made



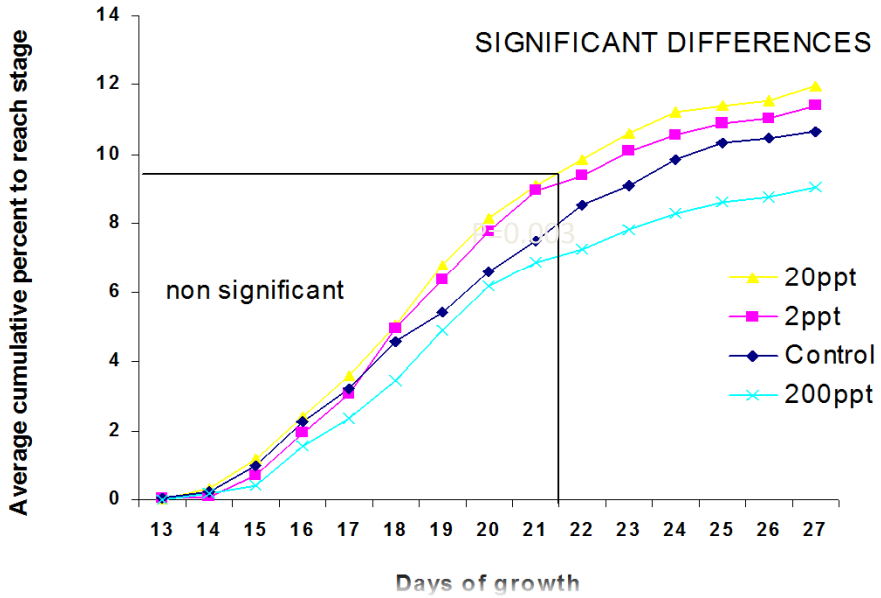
Agglutination and direct elimination of pathogens

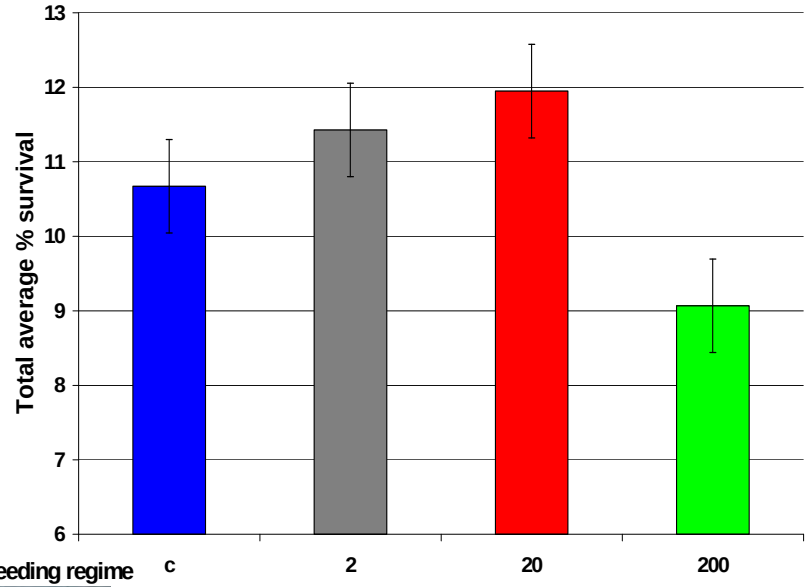
- Clumping of pathogens
- Reduce their colonisation
- Reduce disease incidence



Prebiotics on the growth and survival of European lobster (*Homaras gammarus*) larvae

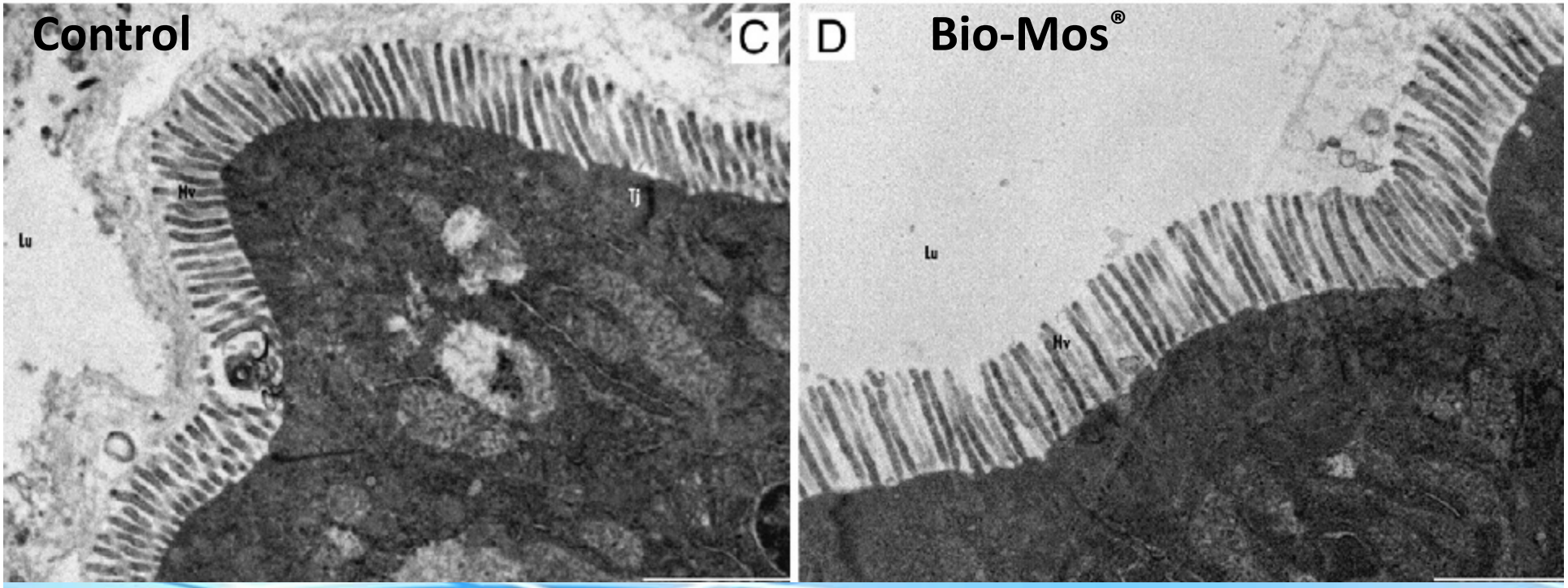
- **Location: National Lobster hatchery, Cornwall, UK**
- **Prebiotic supplement significantly improved larval survival to stage four of growth**





Daniels et.al., 2006

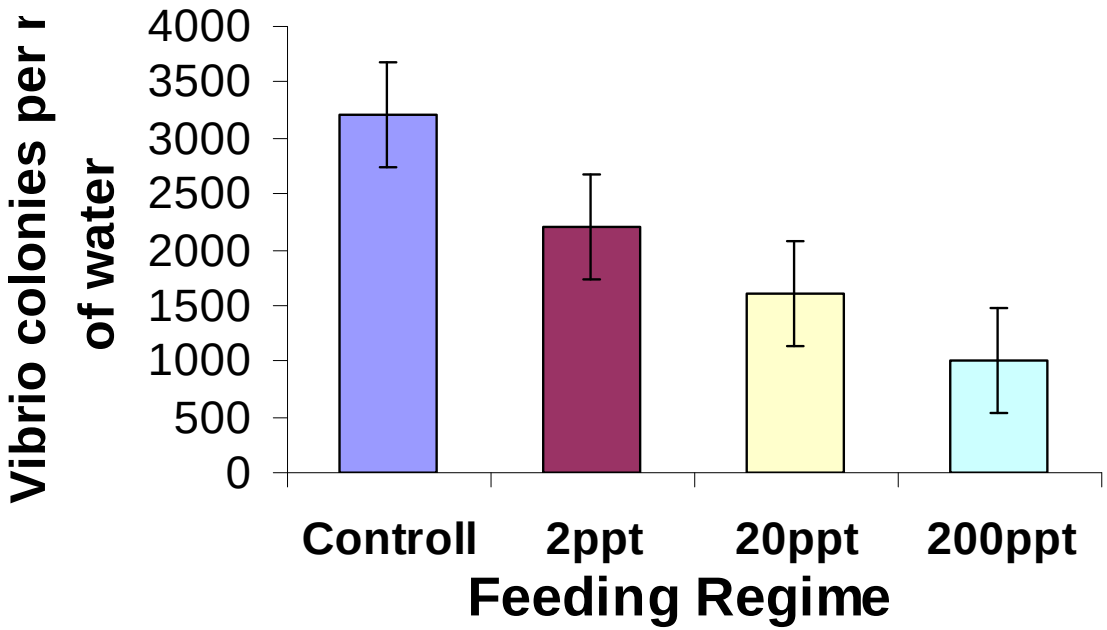
Prebiotic increases gut microvilli in lobster larvae



Daniels et al., 2010

Alltech®

Prebiotics reduces vibrio count in *Artemia* culture for rearing European lobster larvae



The addition of Bio-Mos® to Selco™ enriched Artemia lowers the total Vibrio count present in the water, 24 hrs after enrichment, potentially reducing the pathogenic bacterial loading in the live food organism.

Better survival after *Vibrio* infection

Injected with 20µl of *Vibrio mimicus* at 0.53 x 10^6 cfu/ml

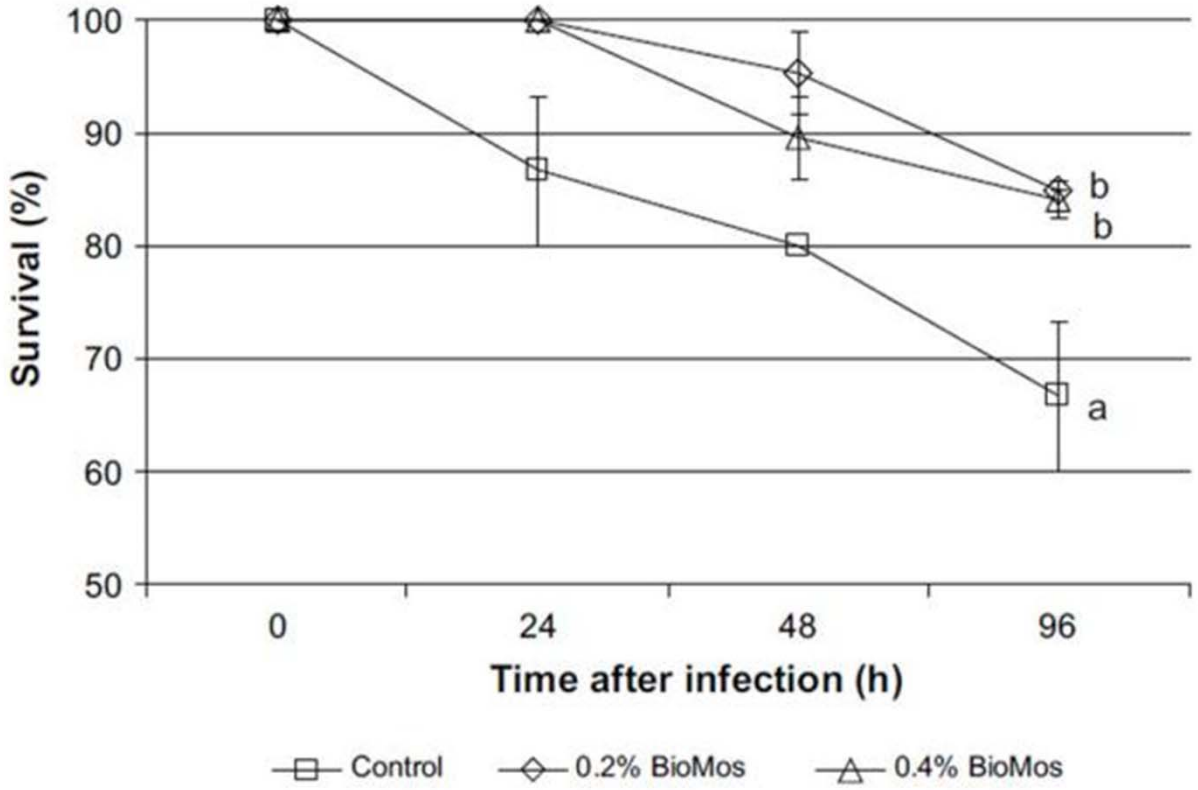


Fig. 1. Mean ± SE survival of marron challenged with *Vibrio mimicus*. Different letters indicate significantly different means at each time at $P < 0.05$ ($n = 18$).

Sang, Ky & Fotedar, 2009

Better survival after NH_3 challenge

NH_4^+ : 20ppm
=1.37 ppm of NH_3
at pH 8.4, 16.8°C

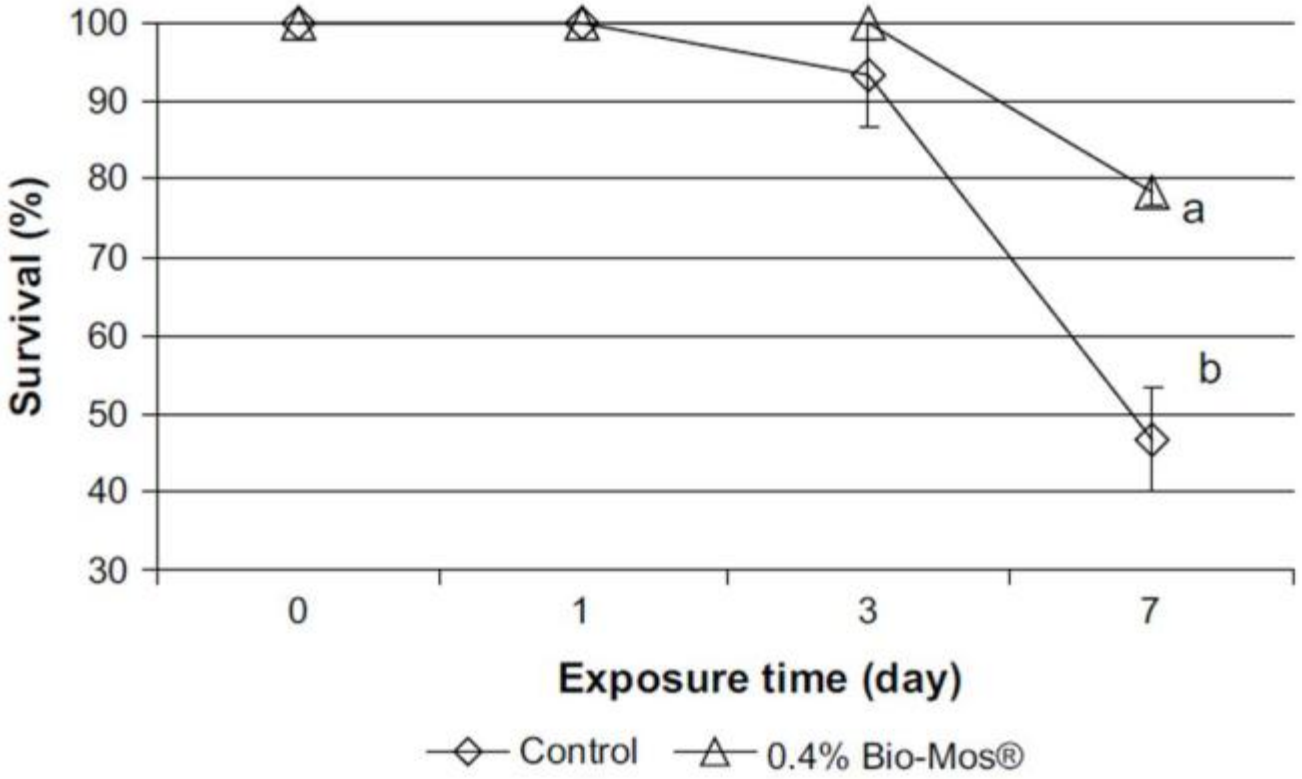


Fig. 2. Mean ± SE survival of marron challenged with NH_3. Different letters indicate significantly different means at each time at $P < 0.05$ ($n = 21$).

Sang, Ky & Fotedar, 2009


Curiosity about
The Gene
Chip
INTUITION IS THE SOURCE OF SCIENTIFIC KNOWLEDGE.
ARISTOTLE

SEEKING SOLUTIONS AT THE CELLULAR LEVEL

Using the Gene Chip®: a DNA Microarray

IS:

A collection of all the genes for an organism. Each gene represented by DNA fragments (probes). Each chip or microarray can have MANY (10s of 1000s) probes.

USED TO:

- Measure gene expression
- Detest SNPs
- Genotype/screen

A CHANGE IN PERSPECTIVE

minerals, vitamins, CHO, protein…

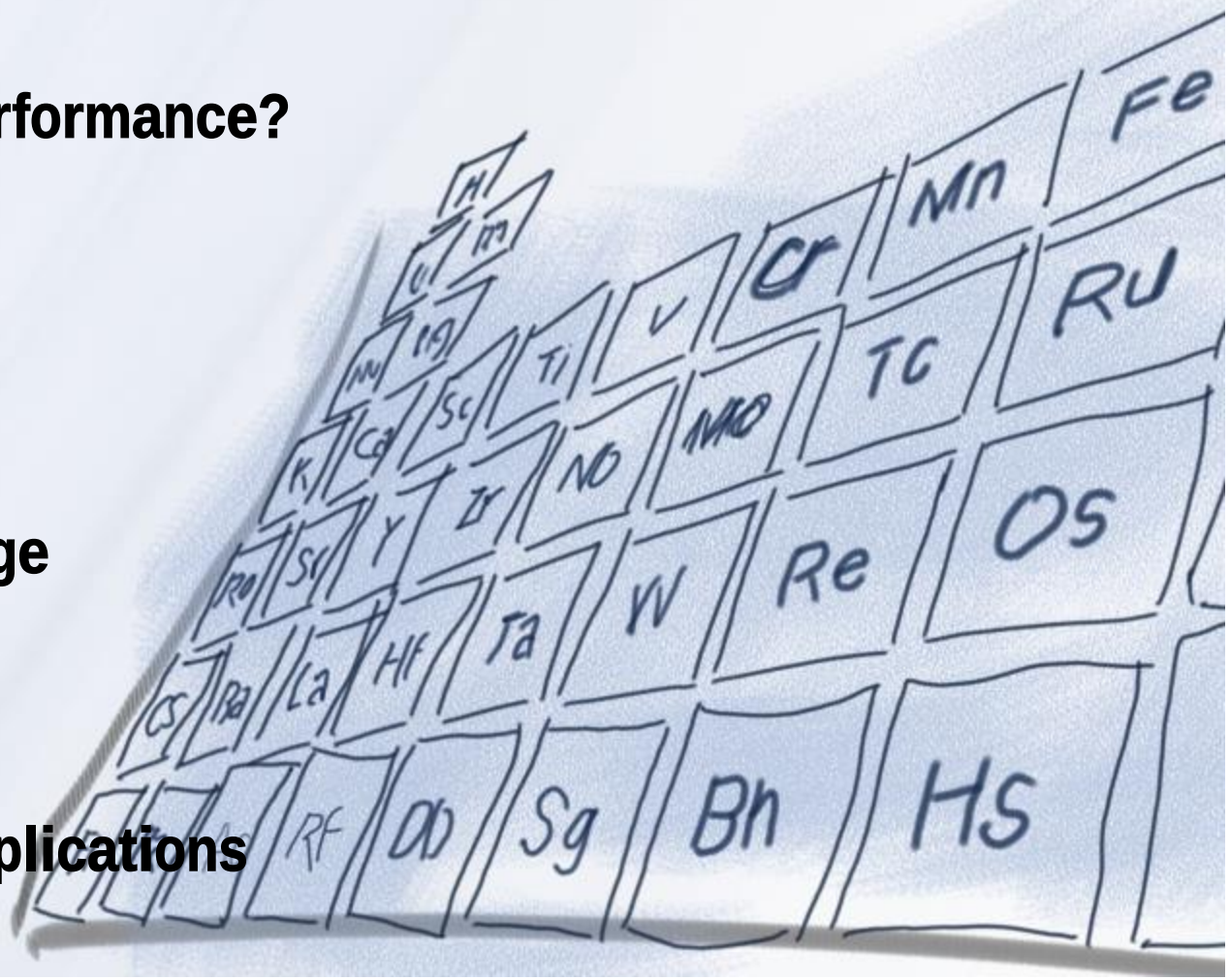
Yesterday…

Want to increase performance?
Add a 'stress pak'

Today…

<u>FORM</u> is the key –

- **To function, storage**
- **To level**
- **To health**
- **Carcass quality**
- **Environmental implications**

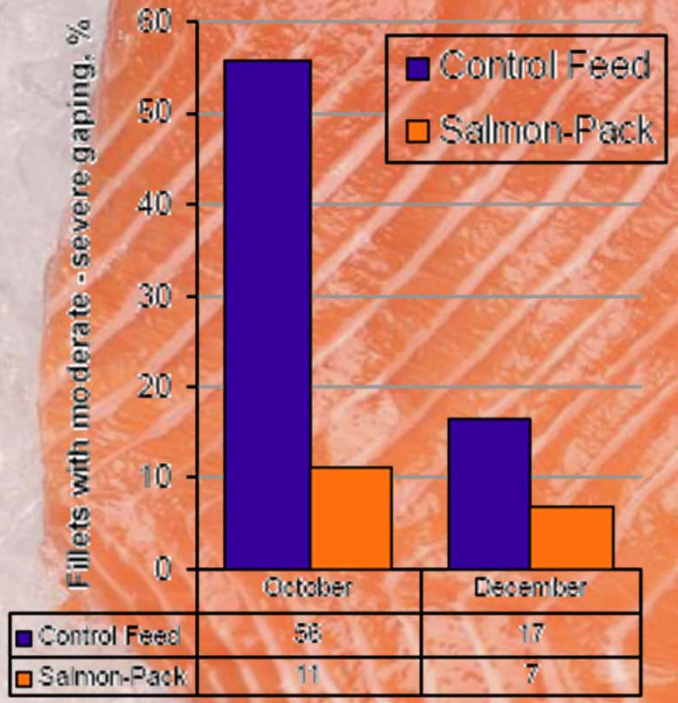


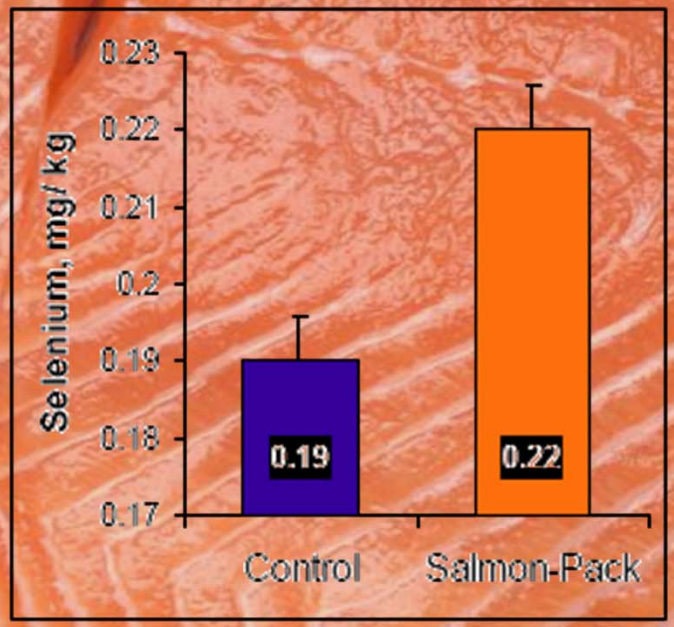
Potential of Epigenetic Imprinting and Nutritional Conditioning

- Disease Resistance
- Enteric ecosystem
- Nutrient Utilization
- Performance efficiency
- Meat yield
- Meat quality
- Reproductive efficiency
- Behavior

Ashwell 2007

Reduced Fillet Gaping

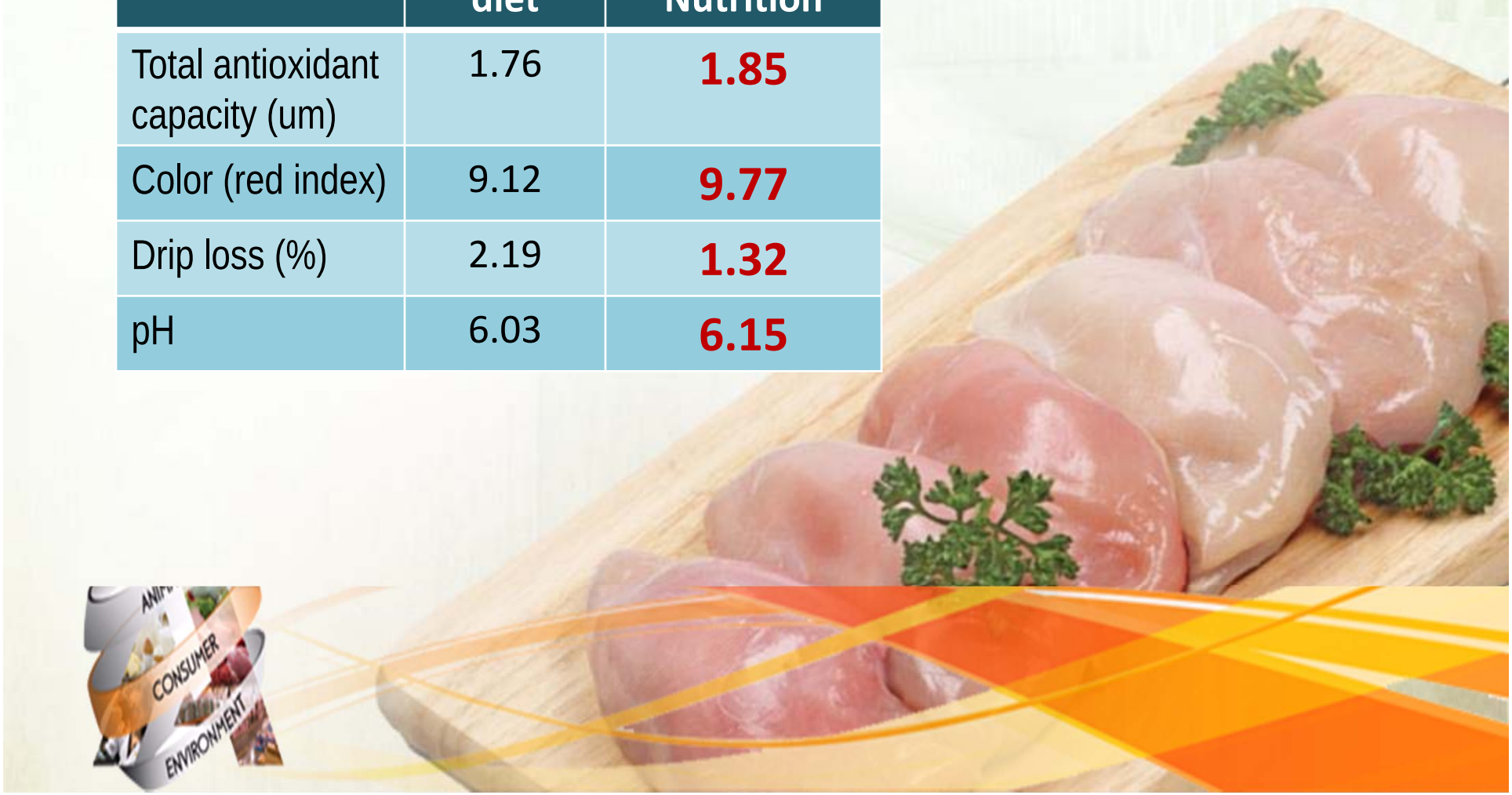




Nofima

Improved Meat Quality

Item	Standard diet	Programmed Nutrition
Total antioxidant capacity (um)	1.76	**1.85**
Color (red index)	9.12	**9.77**
Drip loss (%)	2.19	**1.32**
pH	6.03	**6.15**



Who is asking for these meats?

Revolutionary nutritional processes for superior quality products

LYONS FARM

Taste the Difference.


Take control
of your own future

Conclusions

- There are many challenges. Raw material supply almost reaching crisis levels, and certainly prices; but there are opportunities
- There are ways to replace fishmeal and fish oil with sustainable sources. Other benefits have to be included in the equation.
- There are technologies available to improve utilization of plant proteins and to use low cost ingredients without losing performance
- Solutions to improve immunity and resistance to diseases
- Algae technology can revolutionize the way we eat
- The Gene Chip and its application on PROGRAM NUTRITION