Functional effects of yeast paraprobiotics on fish health and performance in the context of reduced fish meal diets

Otavio Castro[1], Nadege Richard[2]

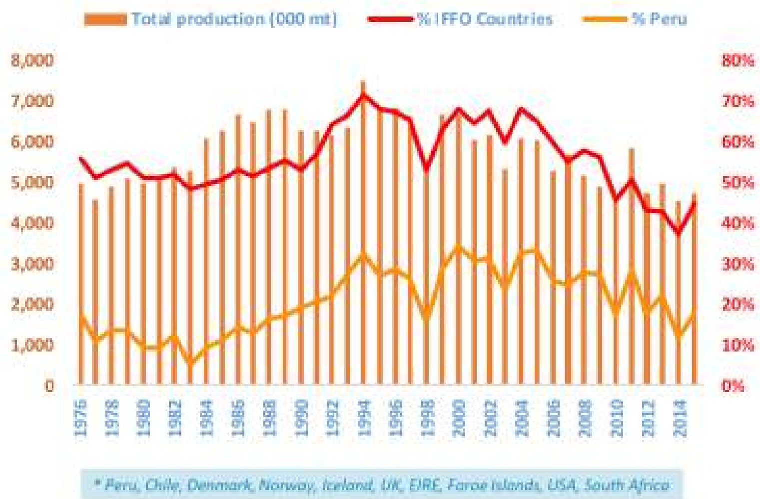
[1]Global Specie Manager – Aqua, [2] R&D Manager – Aqua

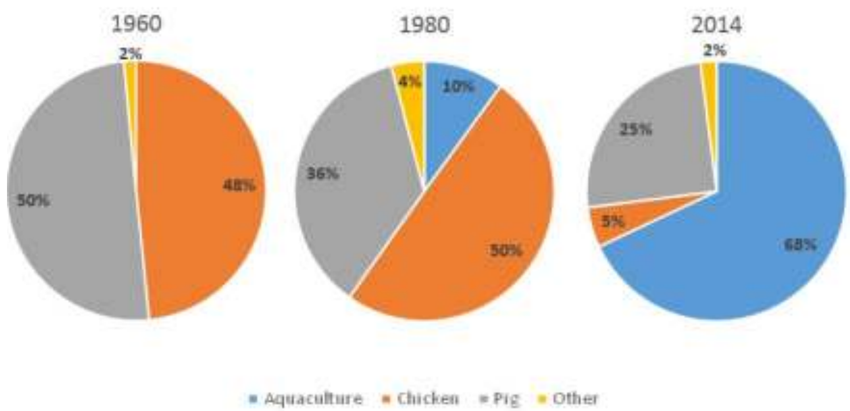
Phileo
LESAFFRE ANIMAL CARE

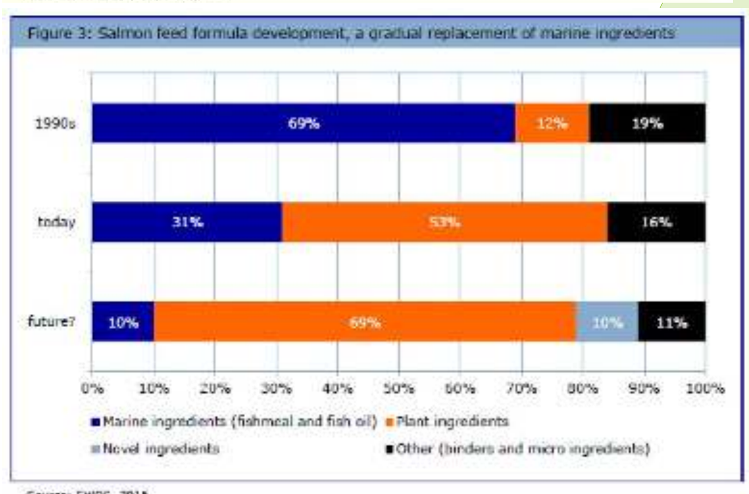
18th International Symposium
on Fish Nutrition and Feeding
40 Years of Research in Fish Nutrition

Las Palmas de Gran Canaria, Spain
June 3rd - 7th, 2018

Protein and fish meal market scenario
Trade & Supply







Source: IFFO 2017

Phileo LESAFFRE ANIMAL CARE

Protein and fish meal market scenario
Sustainability

The Fish Site

Breeding & genetics · Farm management · Health & welfare · Nutrition · Environment

ENVIRONMENT · SUSTAINABILITY · POST-HARVEST · ECONOMICS

Sustainability Issues Still Remain in Fish Oil, Fish Meal Fisheries

Lucy Towers
26 August 2016, at 1:00am

The Economist

Topics · Current edition · More

Fish farming

Antibiotic resistance in fish farms is passed on from fish food

WATTAgNet.com

News and analysis on the global poultry and animal feed industries

Market Information · Poultry · Feed Strategy · Industria Avicola · Blogs · Animal Agric

Home » Is fishmeal production sustainable for the future?

LIVESTOCK FEED MANUFACTURING / ANIMAL FEED ADDITIVES / AQUACULTURE RESEARCH

BY IOANNIS MAVROMICHALIS ON SEPTEMBER 14, 2017

Is fishmeal production sustainable for the future?

An extremely valuable ingredient that has become the exclusive privilege of aquafeeds is now considered too expensive to be used in most farm animal diets.

INDEPENDENT

News · InFact · Politics · Voices · Indy/Life · Sport · Business · Video · Culture · IndyBest · Subscribe

News › Science

Antibiotic-resistant genes are being spread all over the world in animal feed, scientists discover

Ten million people could die every year by 2050 if the rise of superbugs is not checked, experts have warned

DAILY SCIENCE

Fishmeal could be seeding ocean sediments with drug-resistant bacteria

by Emma Bryce | Sep 22, 2017

WWF Global

Our ambition · Our work · Get involved · Latest · Knowledge Hub

Responsible fishmeal: the key to sustainable Thai fisheries

What's the deal with responsible fishmeal?

Phileo LESAFFRE ANIMAL CARE

Main technical drivers to develop fish meal replacement strategies

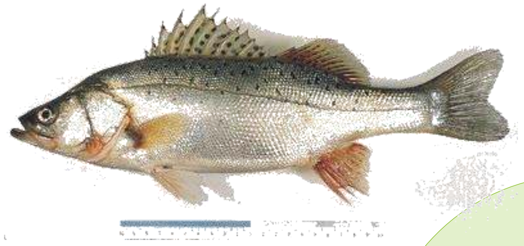
- Fish Meal

  - Origin and source
  - Nutritional profile
  - Freshness
  - Price
  - Targeted usage

- Substitute ingredients

  - Antinutritional factors
  - Nutritional imbalances
  - Feed processing technology
  - Price

- Targeted species



  - Digestive physiology
  - Life-stage
  - Production system
  - Nutritional requirements

Challenges limiting fish meal replacement in aquafeeds

- Reduced attractiveness & palatability
- Reduced feed intake
- Impaired digestion
- Reduced digestibility
- Feed processing limitations
- Logistics & supply chain
- Price

Picture: cdn.shape.com

- **Field challenges:**
  - Stress factors (crowding, temperature, salinity, etc.)
  - Feeding procedures
  - Pathogen pressure

Japanese Seabass case 1


Animal Feed Science and Technology 229 (2017) 1–12

Contents lists available at ScienceDirect

Animal Feed Science and Technology

journal homepage: www.elsevier.com/locate/anifeedsci

ELSEVIER

Substitution of fish meal by fermented soybean meal affects the growth performance and flesh quality of Japanese seabass (*Lateolabrax japonicus*)

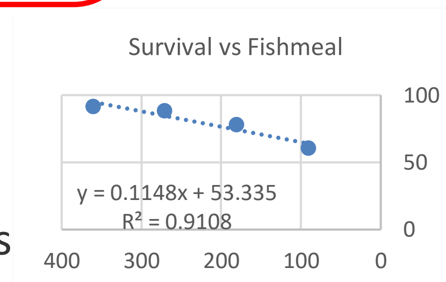
X.F. Liang, L. Hu, Y.C. Dong, X.F. Wu, Y.C. Qin, Y.H. Zheng, D.D. Shi, M. Xue, X.F. Liang

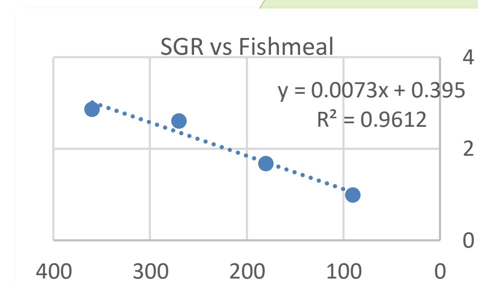
- Fermented Soybean

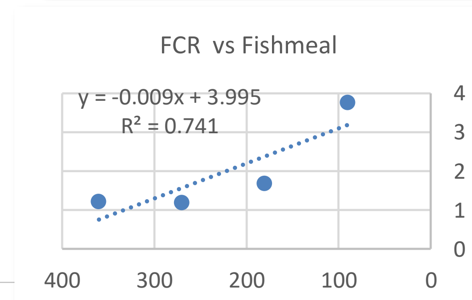
0 - 8 weeks	Control	1	2	3
FISH MEAL LEVEL	360	270	180	90
FERMENTED SOYBEAN MEAL	0	110	220	330
SOYBEAN MEAL	180	180	180	180
FR (% body weight)	2.8	2.52	2.13	1.43
FCR 0 - 8	1.22	1.2	1.69	3.76
Survival 0- 8	91.11	87.78	77.78	60
Specific Growth rate (day)	2.86	2.6	1.67	0.99
Specific Growth rate (% to control)		-9.09	-41.61	-65.38
Specific Growth rate (% to T)		-9.09	-35.77	-40.72

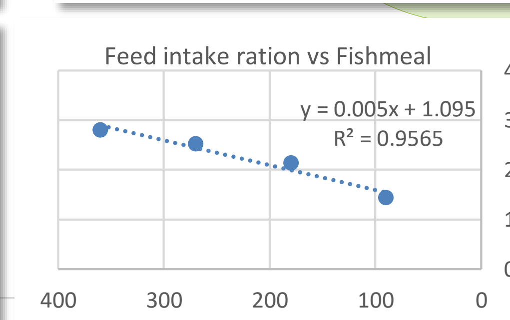
Main limiting factors:

- Decreased palatability
- Reduced intake of essential amino acids









Japanese Seabass case 2

- Animal protein blend


Aquaculture 372-375 (2013) 52-61
Contents lists available at SciVerse ScienceDirect
Aquaculture
journal homepage: www.elsevier.com/locate/aqua-online

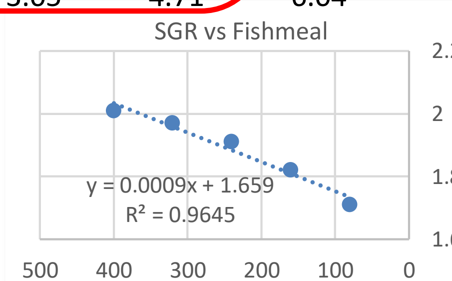
Effects of fish meal quality and fish meal substitution by animal protein blend on growth performance, flesh quality and liver histology of Japanese seabass (*Lateolabrax japonicus*)

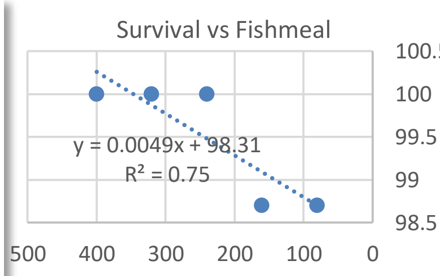
Liang Hu [a,1], Biao Yun [c,1], Min Xue [a,b,*], Jia Wang [a], Xiufeng Wu [a], Yinhua Zheng [a], Fang Han [a]

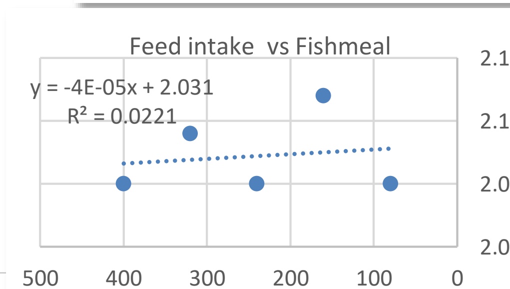
	Control	2	3	4	5
FISH MEAL LEVEL	400	320	240	160	80
ANIMAL PROTEIN BLEND	0	80	160	240	320
SOYBEAN MEAL	210	210	210	200	200
SQUID MEAL	**50**	**50**	**50**	**50**	**50**
FISH OIL	50	46	44	49	41
Feed intake (%day)	2.0	2.0	2.0	2.1	2.0
Feed efficiency ratio	0.91	0.88	0.88	0.81	0.79
Survival	100	100	100	98.7	98.7
Specific Growth rate (% day)	2.01	1.97	1.91	1.82	1.71
Final Weight (g)	235	229.9	222.8	211.6	198.3
Specific Growth rate (% to control)		-1.99	-4.98	-9.45	-14.93
Specific Growth rate (% to T)		-1.99	-3.05	-4.71	-6.04

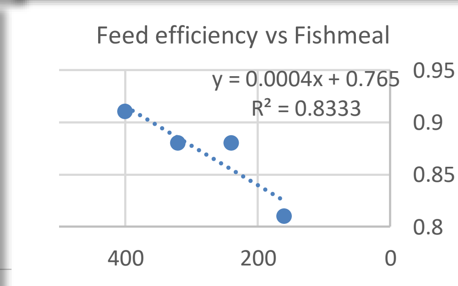
Main limiting factors:

- lower dietary n−3 highly unsaturated fatty acids (HUFA) levels









Growth & performance – the danger zone

40	38	36	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	0

picture:journaldemontreal.com

Paraprobiotics *vs.* Probiotics

- **DEFINITION**:

"'Paraprobiotic' (or 'ghost probiotics'): 'non-viable microbial cells (intact or broken) or crude cell extracts (i.e. with complex chemical composition), which, when administered (orally or topically) in adequate amounts, confer a benefit on the human or animal consumer"*

Taverniti & Guglielmetti (2011)

- **EFFICACY**:

- Strains
- Type of fractions
- By-product *vs*. Primary culture
- inactivation method (heat, chemical, mechanical disruption etc.)
- immunological target (system; specie etc.)
- route of administration

- **Relevance and potential in aquaculture:**

- safety and stability
- industrial application
- antibiotic reduction

*Purified molecules of microbial origin or pure microbial cell products are omitted from the concept

Yeast solutions - targeted benefits

Cluster	Probiotics	Yeast fractions			Yeast proteins	Yeast ingredients
Category	Live yeast	Yeast cell wall	Yeast extract	Concentrated B-glucan	Inactive yeast	High Selenium inact. yeast
Growth	+		++		+	
Feed intake			++		+	
Gut health	++	++	++		+	
Pathogen prevention	++	++				
Immunity	+	++	+	+++		+
Antistress	+		+			++

Japanese seabass trial

Aquaculture 432 (2014) 217–224

Contents lists available at ScienceDirect

Aquaculture

journal homepage: www.elsevier.com/locate/aqua-online

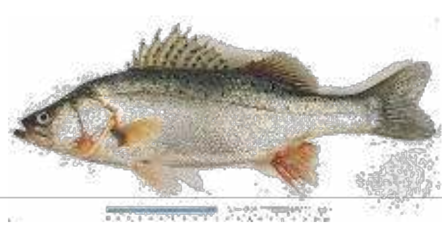
Efficacy and tolerance of yeast cell wall as an immunostimulant in the diet of Japanese seabass (*Lateolabrax japonicus*)

H.H. Yu [a], F. Han [a], M. Xue [a,b,*], J. Wang [a], P. Tacon [c], Y.H. Zheng [a], X.F. Wu [a], Y.J. Zhang [d]

Single strain parietal fractions from bakery yeast (primary culture)

- **Feed Research Institute, Beijing China,**
- Juveniles fish, 18g
- 10 weeks trial, followed by a bacterial challenge *Aeromonas veronii (CGMCC No. 4274) - intramuscular injection: 8 × 10^4 cells/100 g bw*
- Performance and immune parameters
- **4 Safmannan®dosages : 0.25 ; 0.5 ; 1; 2 kg/T on SBM diet**
- **Min 20% B-glucans**
- **Min 20% Mannans**
- **Max 25% Crude protein**
- Feed with 47-48% CP, 21,4 MJ/kg

Ingredients	FM	SBM
Fish meal	**38.5**	**25**
Soy protein concentrate	**20**	**20**
Soybean meal	**0**	**21**
Wheat flour	21	21
Fish oil	6	6.4
Monocalcium phosphate	1	2.1
Microcrystalline cellulose	10.1	1
Phospholipid (93%)	2	2
Choline chloride (50%)	0.4	0.4
Vitamin and mineral Premix	1	1
Methionine hydroxy analog	0	0.1
Safmannan® (mg/kg)	0	…



Japanese seabass trial

Aquaculture 432 (2014) 217–224
Contents lists available at ScienceDirect
Aquaculture
journal homepage: www.elsevier.com/locate/aqua-online

Efficacy and tolerance of yeast cell wall as an immunostimulant in the diet of Japanese seabass (*Lateolabrax japonicus*)

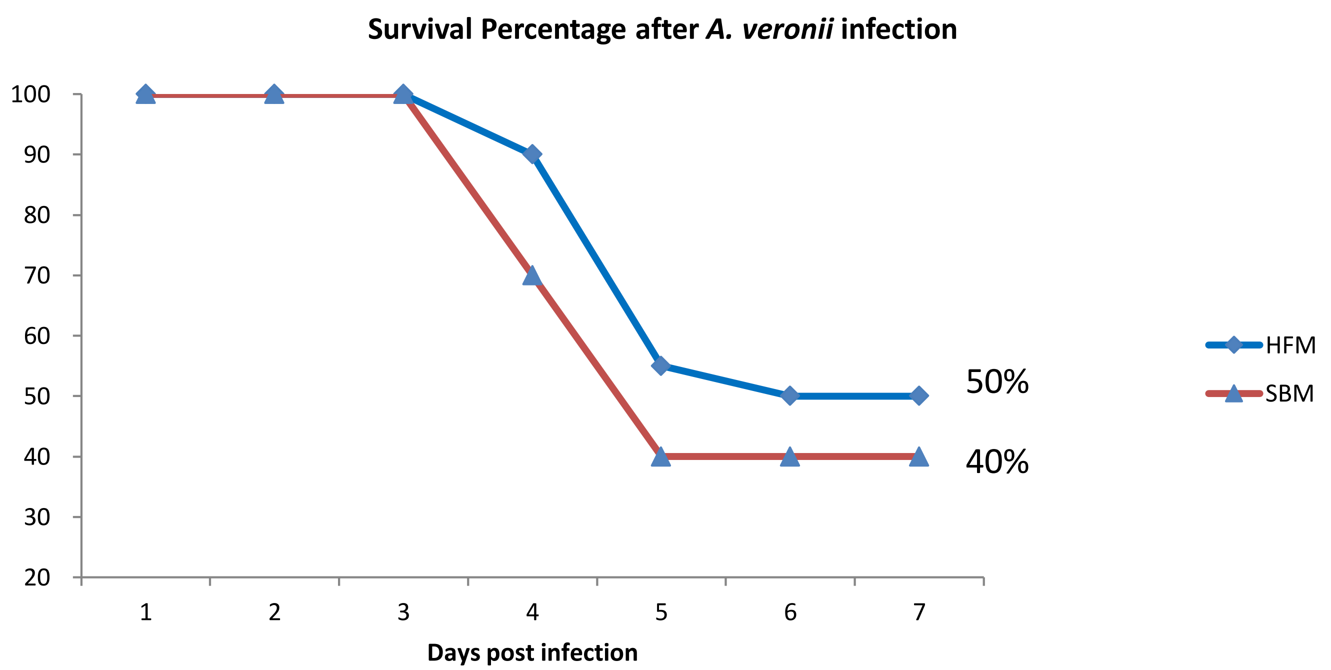
H.H. Yu[a], F. Han[a], M. Xue[a,b,*], J. Wang[a], P. Tacon[c], Y.H. Zheng[a], X.F. Wu[a], Y.J. Zhang[d]

Single strain parietal fractions from bakery yeast (primary fermentation)

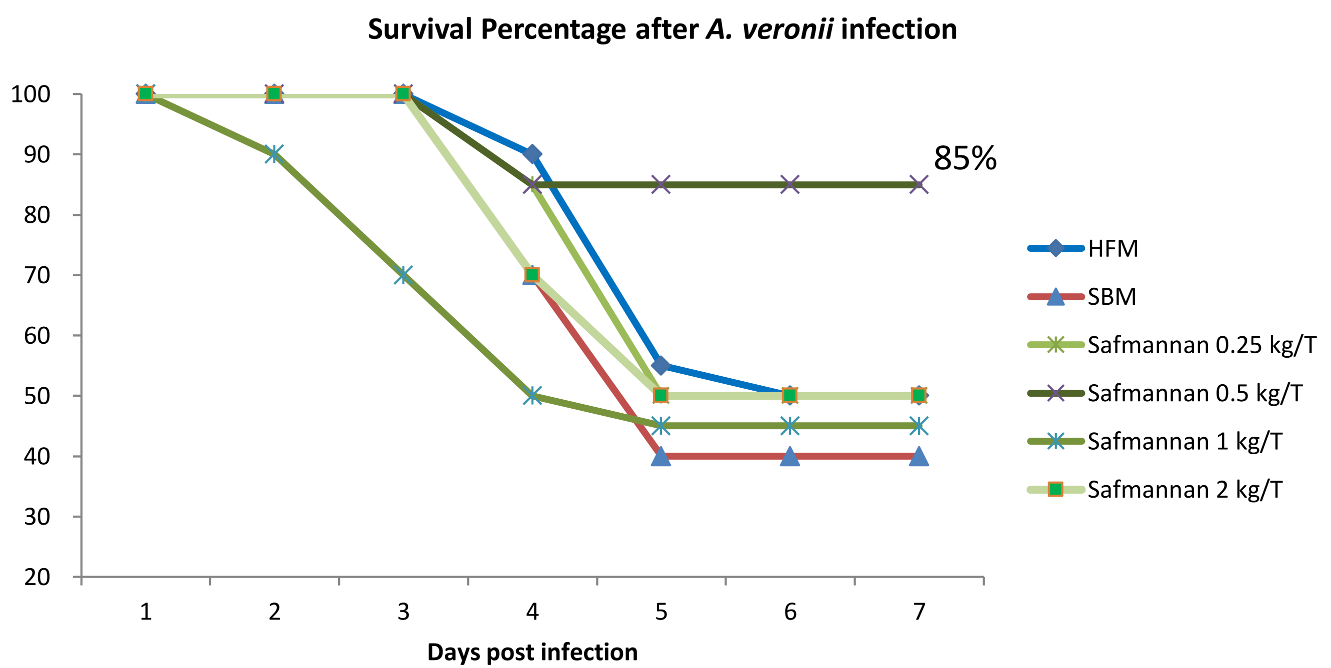
	FM	**SBM**	S 0.25	S 0.5	S 1.0	S 2.0	S 20
FISH MEAL	385	250	250	250	250	250	250
SPC	200	200	200	200	200	200	200
SOYBEAN MEAL	0	210	210	210	210	210	210
Safmannan (mg/kg)	0	0	250	500	100	2000	20000
Feed intake (feeding rate: % bw day)	1.71	1.75	1.81	1.8	1.84	1.85	1.82
FCR	0.95	1.03	1.05	1.07	1.07	1.06	1.04
Survival (%)	100	98.3	97.8	98.9	98.3	98.4	97.8
SGR (% day)	2.13	1.99	2.02	1.97	2.02	2.08	2.06
Specific Growth rate (% to control)		-6.57	-5.16	-7.51	-5.16	-2.35	-3.29
Specific Growth rate (% to T)		-6.57	1.51	-2.48	2.54	2.97	-0.96

Phileo
LESAFFRE ANIMAL CARE

Aeromonas Challenge



Aeromonas Challenge



Best Immune stimulation obtained with Safmannan® at 0.5 kg/T

(Production of IgM, resistance to bacterial challenge).

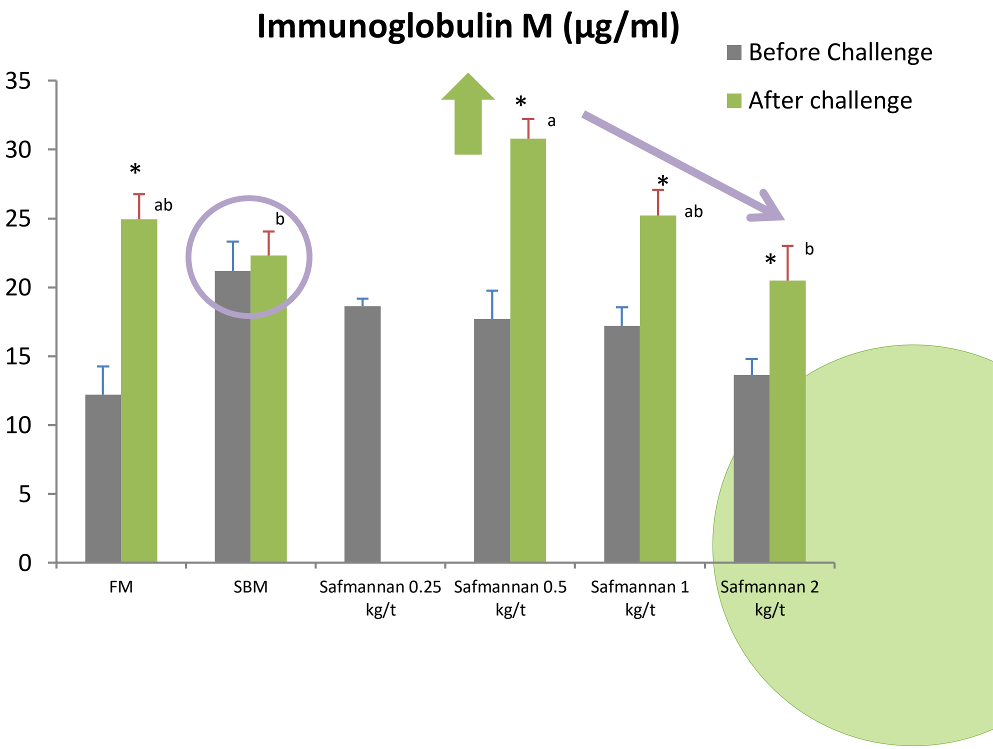
Immune parameters - Before and After Challenge (BC – AC)

IgM :

Levels already elevated for SBM control BC – enteritis effect?

A significant increase in Safmannan®0.5 kg/T, after challenge

A decrease of production of IgM with the increase of the dose



- **Safmannan® at 0.5 kg/T best to stimulate IgM production.**

Grouper trial

NutriSaf

Single Strain Autolyzed Bakery Yeast (primary culture)

- **Guangdong Ocean Univ., China,**
- Juveniles fish, Orange-spotted grouper (*Epinephelus coioides*) with initial weight of 10g ± 0.05 g
- 8 weeks trial, followed by a bacterial challenge (*Vibrio harveyi* - pectoral fin injection 1.6 x 10^8CFU)
- Performance and immune parameters
- **4 dosages of autolyzed yeast Nutrisaf®: 1%; 2%; 3% and 5% on fish meal reduced diets**
- Feed with 47-48% CP, 21,4 MJ/kg

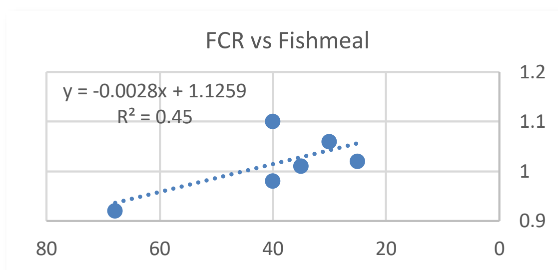
Ingredients	FM	SBM	N1	N2	N3	N5
Fishmeal	68	40	40	35	30	25
Dehulled soybean meal	-	18	17	19	20	21
Corn gluten meal	-	5	5	8	11	14
Nutrisaf 501	**-**	**-**	**1**	**2**	**3**	**5**
Wheat gluten meal	-	9	9	9	9	9
Wheat flour	20	16	16	16	16	16
Fish oil	1.6	3.5	3.5	3.8	4.1	4.3
Methionine	-	0.15	0.15	0.20	0.24	0.29
Cellulose	5.0	2.8	2.9	1.9	0.9	0
Others*	5.5	5.5	5.5	5.5	5.5	5.5
Nutrient composition						
Crude lipid	8.8	9.0	9.0	9.1	9.2	9.3
Crude protein	51.8	50.5	50.9	50.7	51	51.1

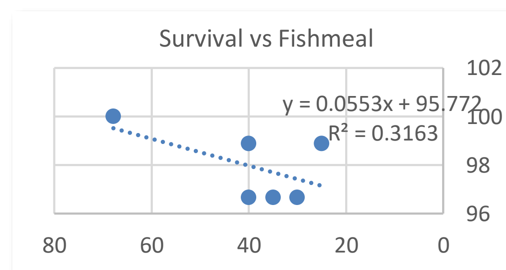
* Standard inclusion: lecithin; CaH_2PO_3; vitamin and mineral premix ; antioxidant; vitamin C and choline chloride

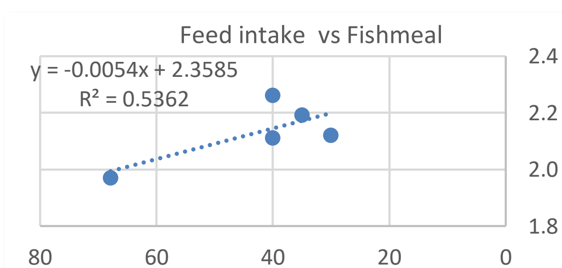
Grouper trial - performance

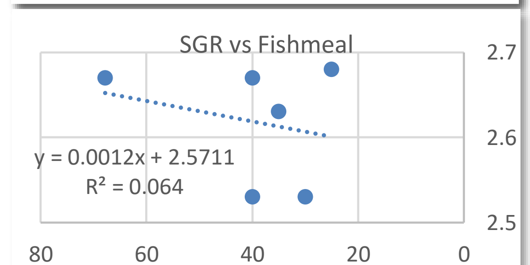
NutriSaf

	FM	SBM	N1	N2	N3	N5
Fish meal	67.85	40	40	35	30	25
Soybean meal	0	18.06	17.02	18.67	20.31	20.89
Gluten	0	5	5	8	11	14
Nutrisaf	0	0	1	2	3	5
Fish oil	1.61	3.49	3.49	3.77	4.06	4.34
Feed intake (%day)	2.0	2.1	2.3	2.2	2.1	2.11
FCR	0.92	0.98	1.1	1.01	1.06	1.02
Survival	100	98.89	96.67	96.67	96.67	98.89
Specific Growth rate (% day)	2.67	2.67	2.53	2.63	2.53	2.68
Final Weight (g)	2.14	2.01	1.75	2.14	1.91	2.02
Specific Growth rate (% to control)		0.00	-5.24	-1.50	-5.24	0.37
Specific Growth rate (% to T)		0.00	-5.24	3.95	-3.80	5.93







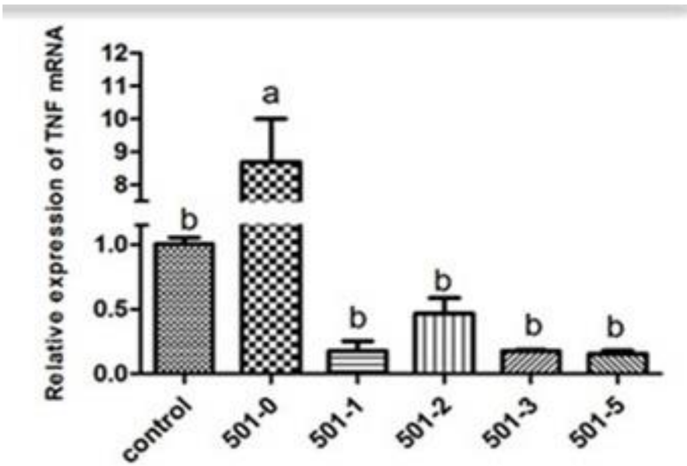


Phileo LESAFFRE ANIMAL CARE

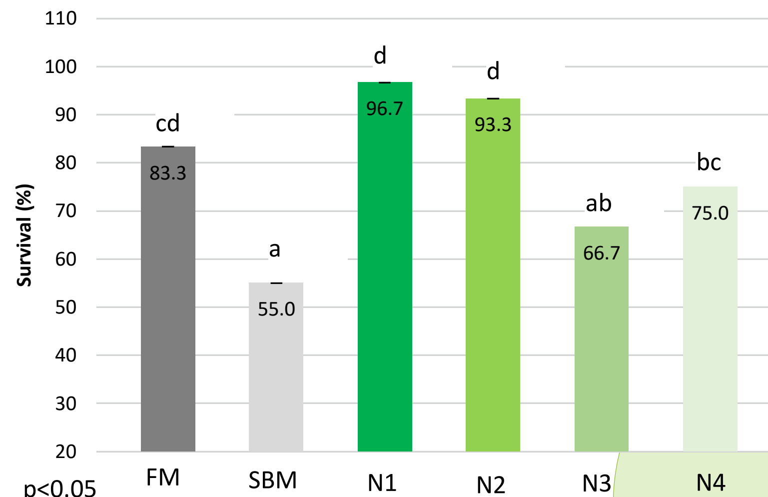
Grouper trial – TNF-α & survival

NutriSaf

TNF-α mRNA relative expression in fish intestine*



Survival, 7 days after *Vibrio harveyi* infection



Increased survival when challenged with *Vibrio harveyi* at 1 and 2% inclusion (Reduced TNF-a expression in fish intestine).

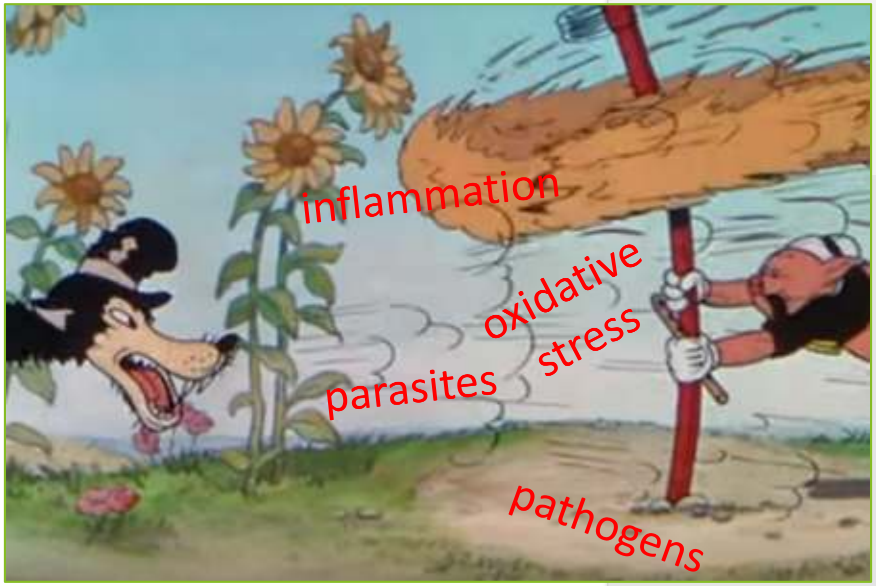
**Real-time quantitative PCR analysis of intestine; Calculated by the $2^{-\Delta\Delta CT}$ method*

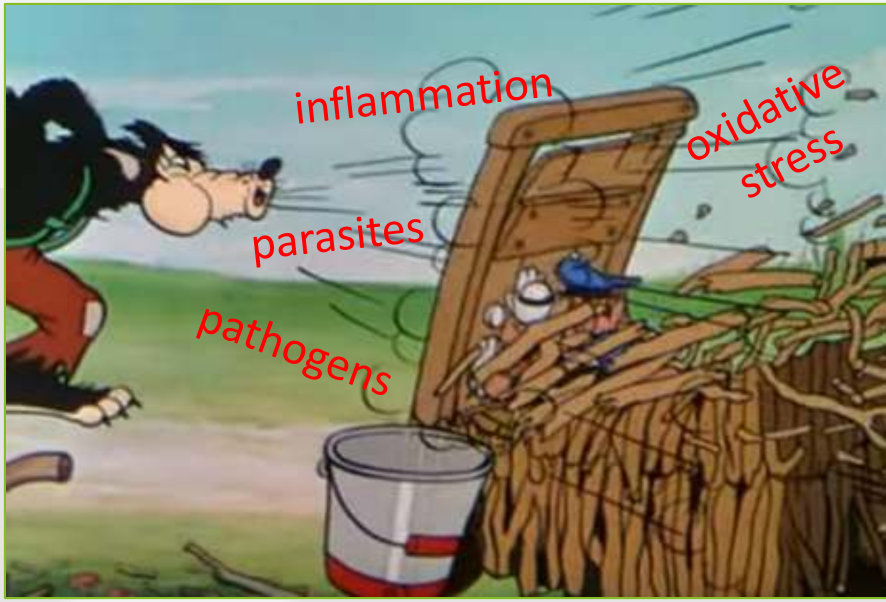
Phileo LESAFFRE ANIMAL CARE

Take home message

Yeast paraprobiotics in reduced fish meal diets:

- Effective tool to reduce/mitigate negative effects of substitute protein sources;
- Cost effective alternative to maintain health and performance
- Flexible application in aquafeed formulation
- Sustainable technology
- Consistency in supply





Phileo
LESAFFRE ANIMAL CARE

Thank you!!!

Gracias!!!

Merci!!!

Obrigado!!!

谢谢

धन्यवाद\

Danke!!!

Grazie!!!

Otavio Serino Castro, *MS/MBA*
Global Species Manager
Phileo Lesaffre Animal Care
o.castro@phileo.lesaffre.com

Phileo
LESAFFRE ANIMAL CARE