

PRESENT I FUTUR DE LA NUTRICIO AQÜICOLA. REPTES I NECESSITATS

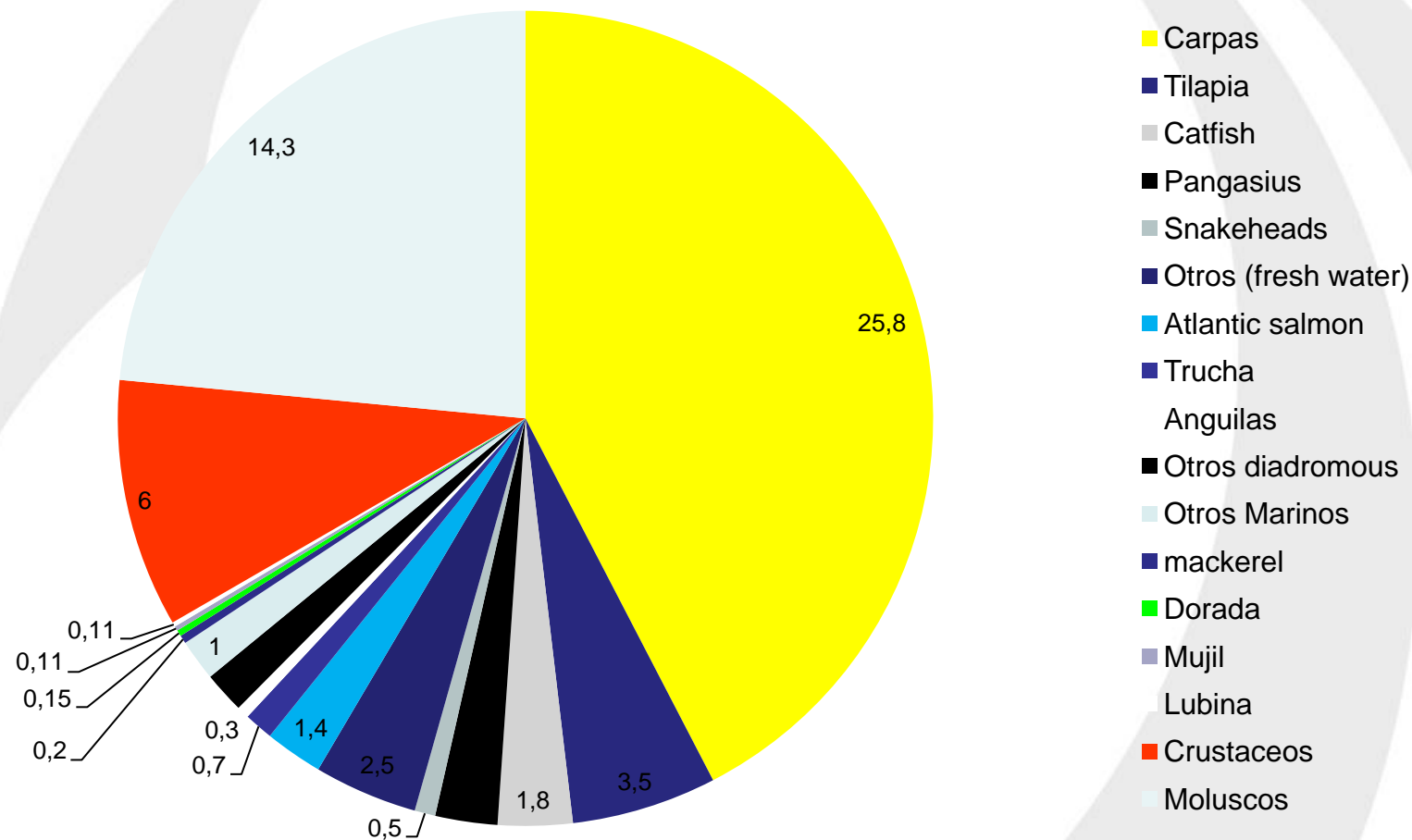
**Ramon Fontanillas, *Skretting Aquaculture Research Centre,
Stavanger, Norway***

Retos de futuro

- Independencia de materias primas de origen marino
- Interaccion Nutricion - Salud
- Desarrollo de nuevas especies

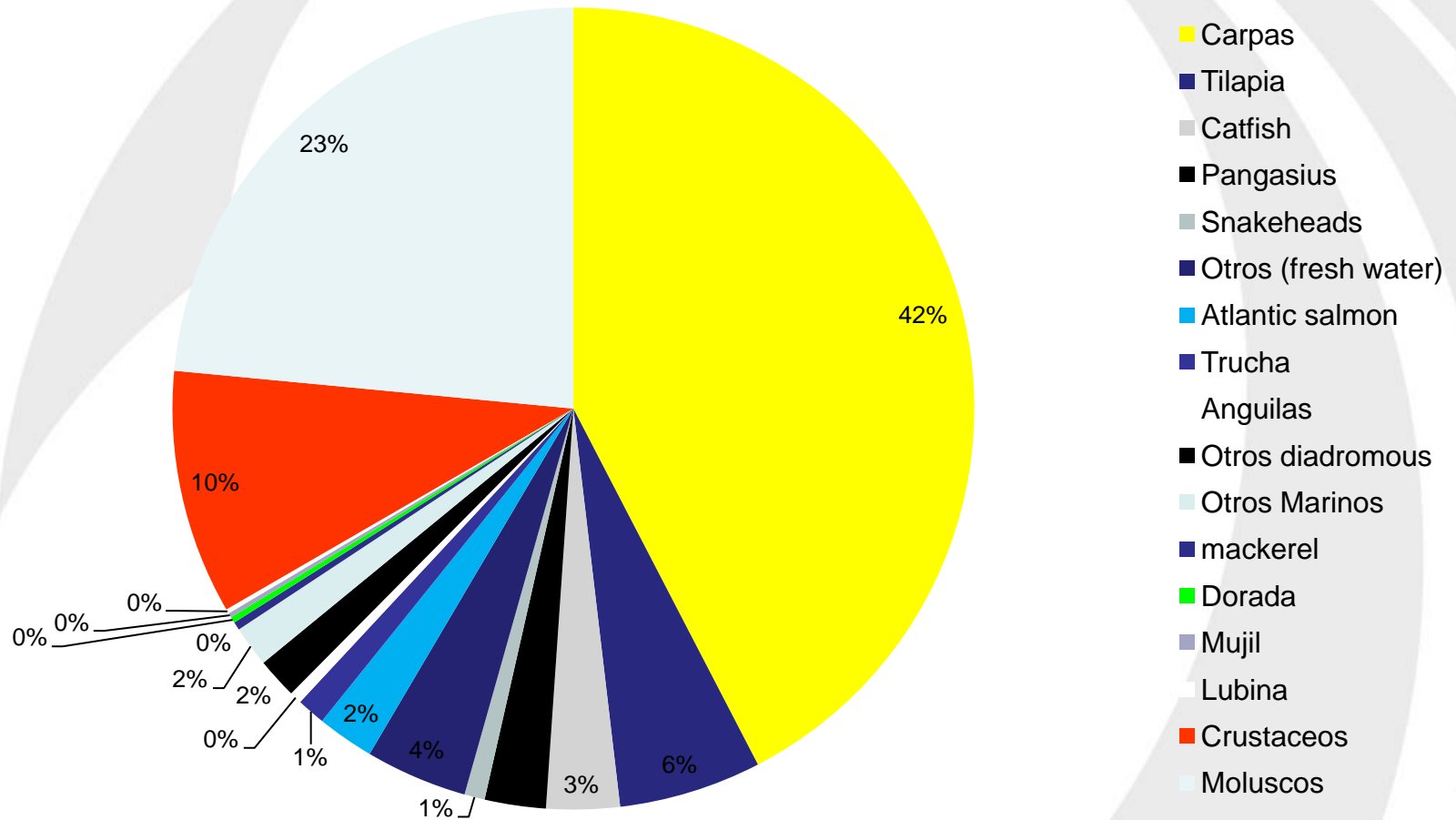
Produccion de especies en acuicultura en 2010 (MT)

Total: > 60 MT

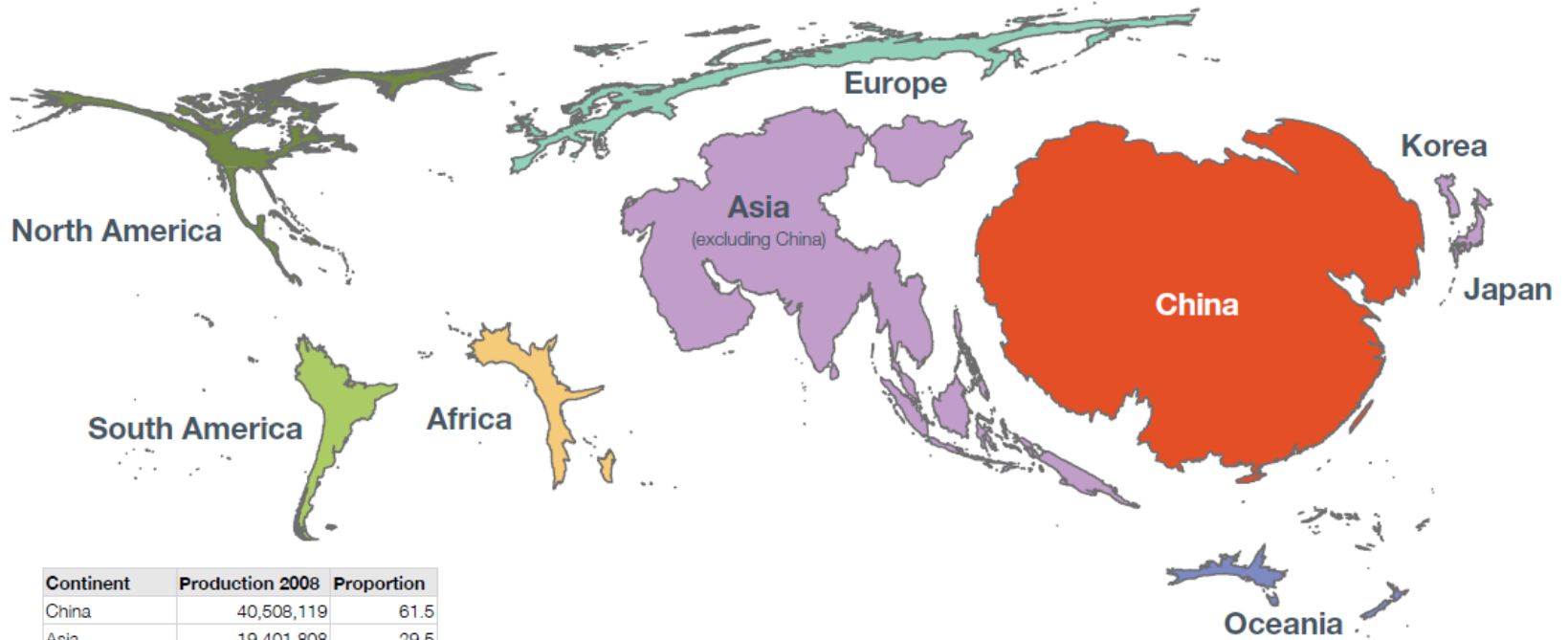


FAO, 2012

Produccion de especies en acuicultura en 2010 (%)



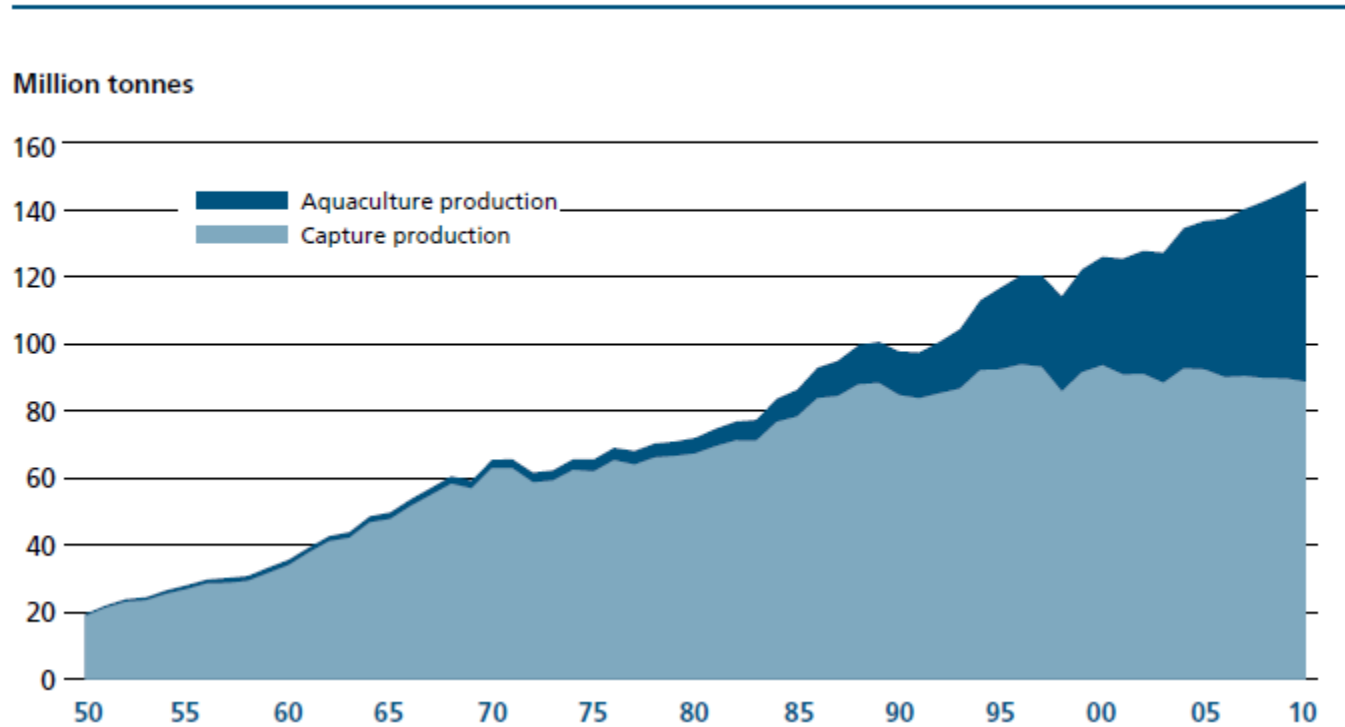
Donde se produce



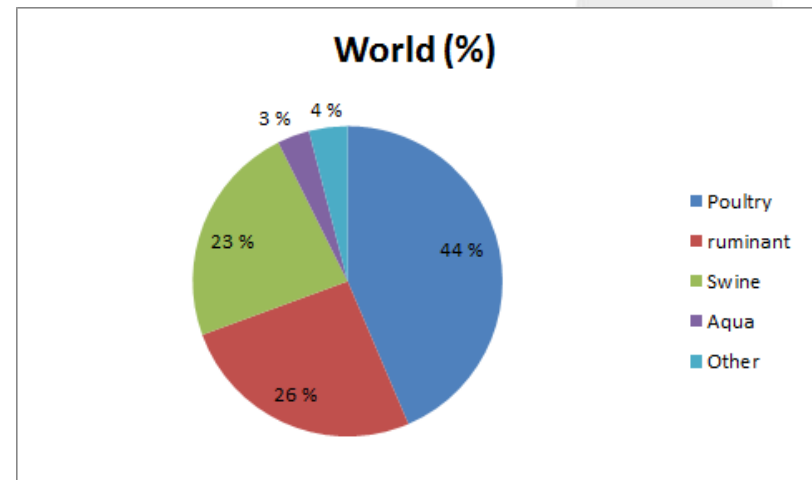
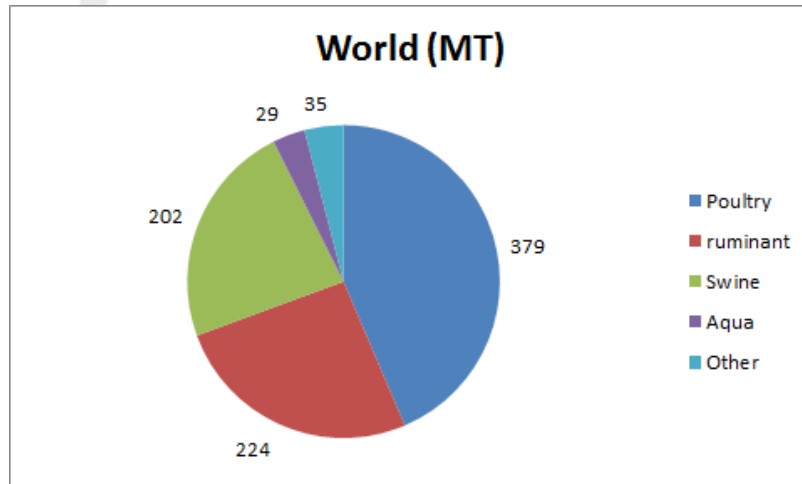
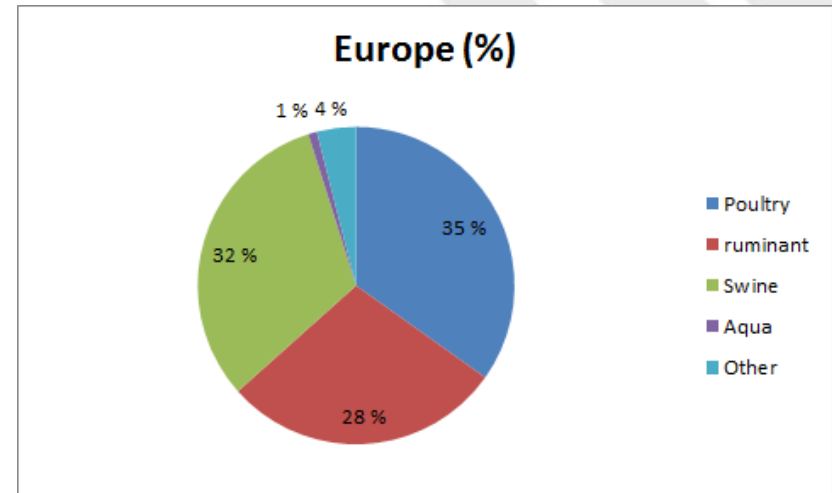
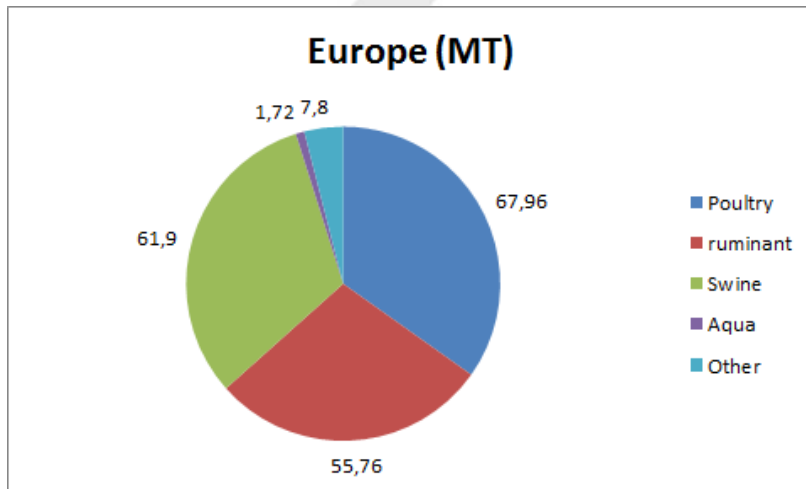
Continent	Production 2008	Proportion
China	40,508,119	61.5
Asia	19,401,808	29.5
Europe	2,341,646	3.6
South America	1,461,061	2.2
North America	965,792	1.5
Africa	952,133	1.4
Oceania	176,181	0.3

Contribucion de la acuicultura al consumo de pescado

World capture fisheries and aquaculture production

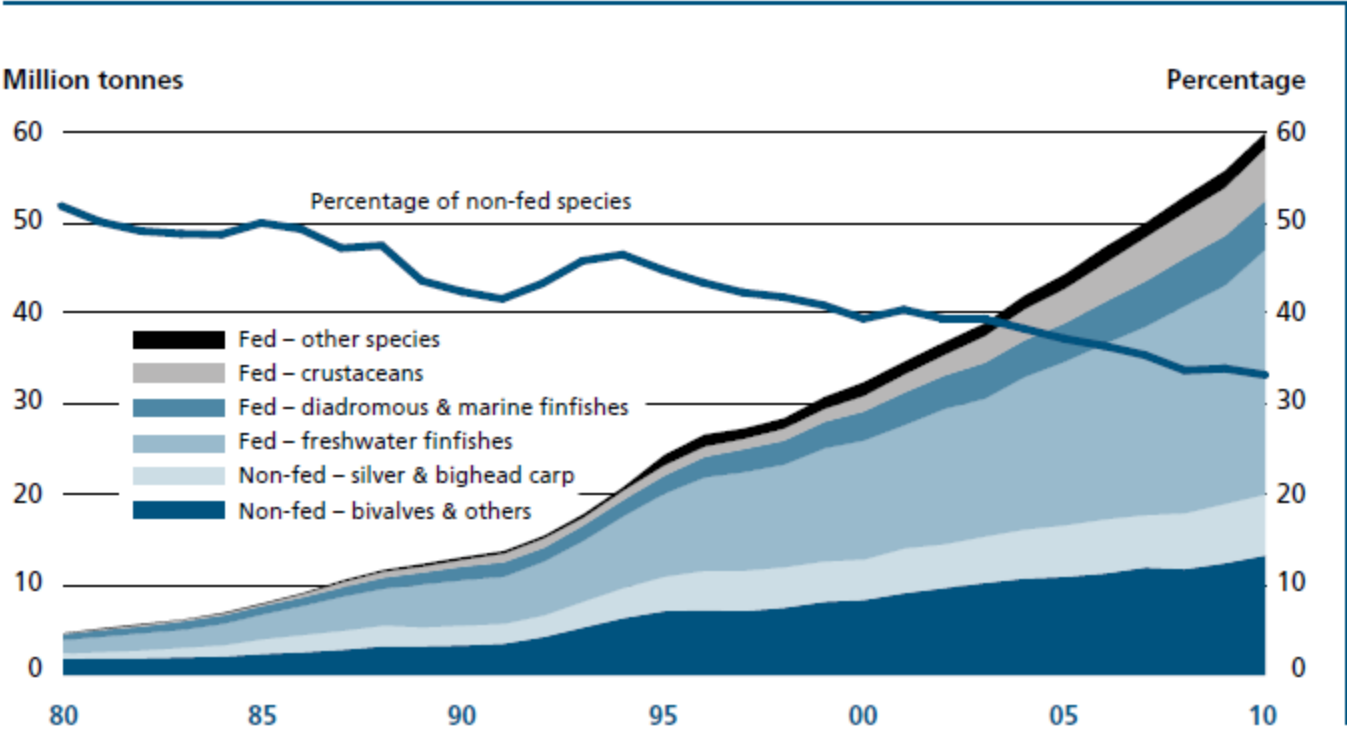


Produccion de Pienso (2011)



Produccion acuicola fed/non fed

World aquaculture production of non-fed and fed species



Take home

- Especies producidas en acuícultura representan un 40%
- Existe un gran potencial en el desarrollo de nuevas especies
- En la actualidad el 70% de las especies producidas ya se alimentan con pienso compuesto (potencial para el desarrollo de nuevos piensos pero también mayor presión sobre materias primas)

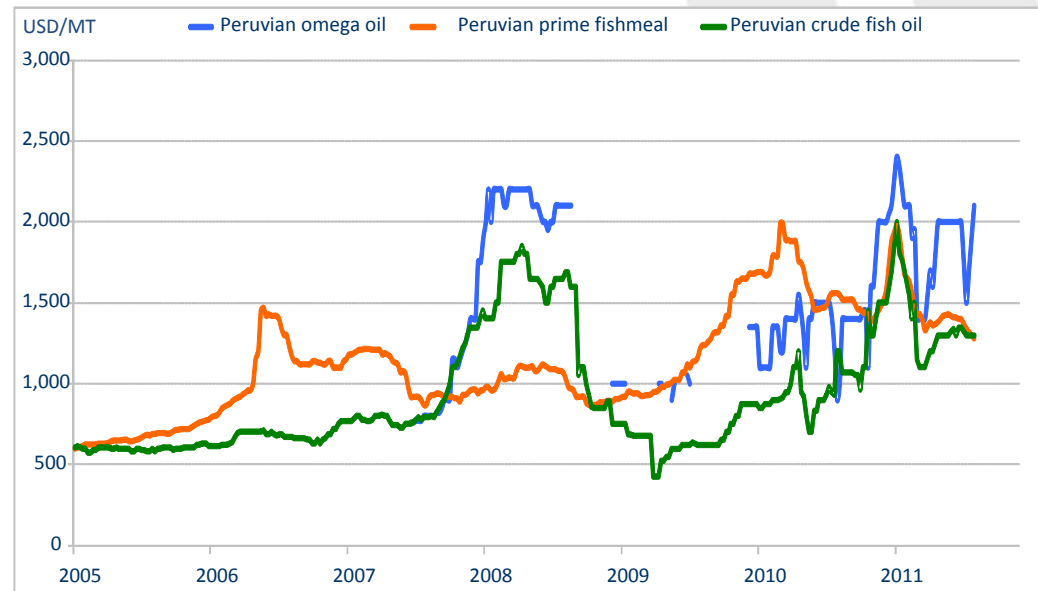
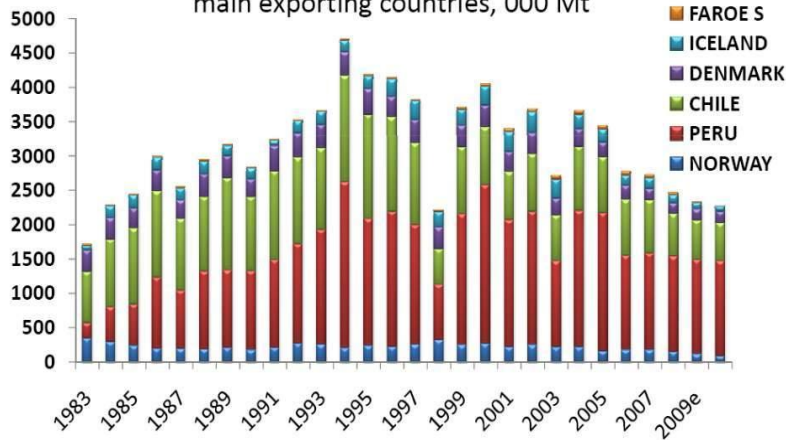
The background features several thick, grey, curved lines that sweep across the frame from the top and right sides, creating a sense of motion and depth. The lines are layered, with some appearing closer than others, and they all curve towards the left side of the image.

Move away from marine resources

Piensos para Acuicultura

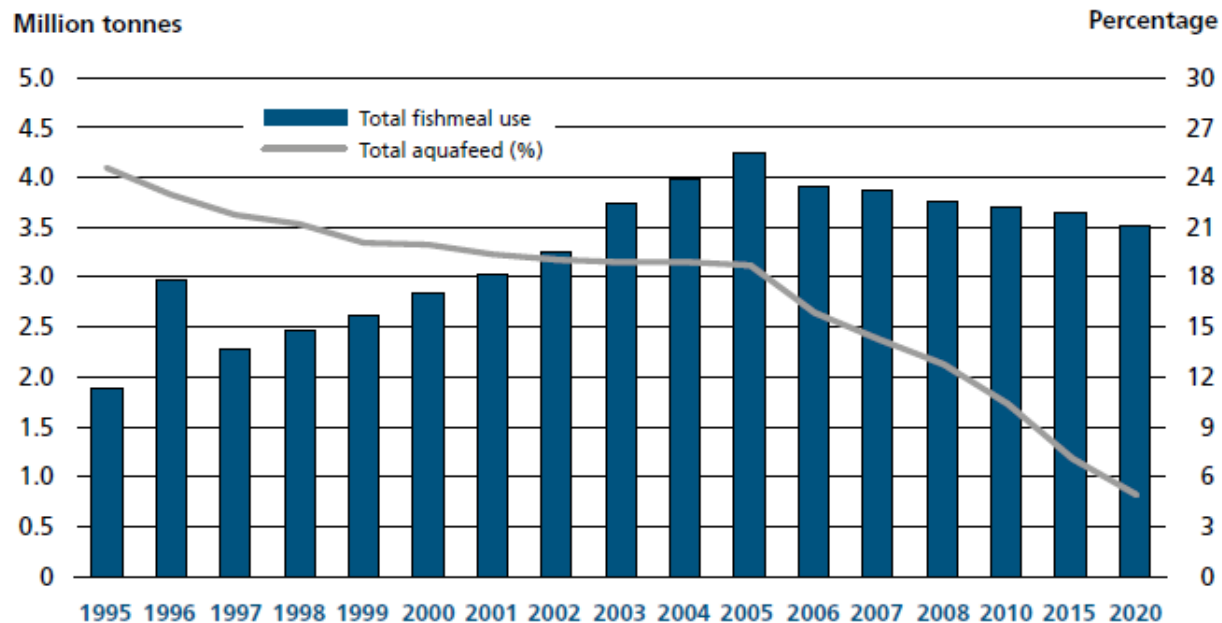
- La harina y aceite de pescado han sido tradicionalmente las materias primas principales. Desde el punto de vista nutricional son dos materias primas excelentes.
- Pero son recursos limitados y sometidos a fluctuaciones de precios

World fish meal production
main exporting countries, 000 Mt



Uso de harina de pescado en acuicultura

Actual and predicted reduction in fishmeal use relative to the global production of compound aquafeed



Source: Adapted from Tacon, A.G.J., Hasan, M.R. and Metian, M. 2011. *Demand and supply of feed ingredients for farmed fish and crustaceans: trends and prospects*. FAO Fisheries and Aquaculture Technical Paper No. 564. Rome, FAO. 87 pp.

Uso de harina de pescado en acuicultura

Reduction in fishmeal inclusion in compound aquafeed of different fish species and species groups

Species/species group	Fishmeal inclusion in compound aquafeed		
	1995	2008	2020*
Fed carp	10	3	1
Tilapias	10	5	1
Catfishes	5	7	2
Milkfish	15	5	2
Miscellaneous freshwater fishes	55	30	8
Salmons	45	25	12
Trouts	40	25	12
Eels	65	48	30
Marine fishes	50	29	12
Marine shrimps	28	20	8
Freshwater crustaceans	25	18	8

* Projected.

19,5

8,7

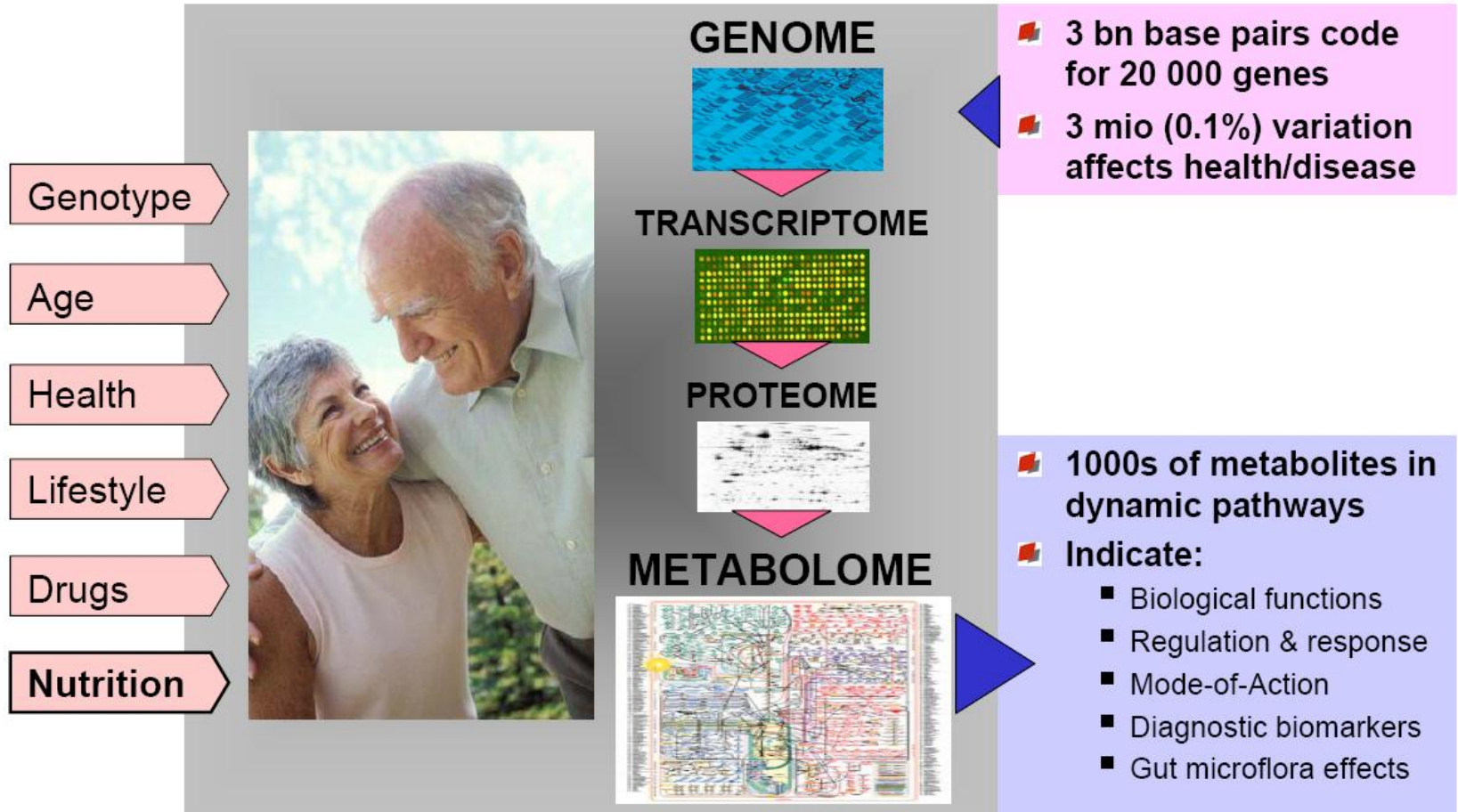
Source: Adapted from Tacon, A.G.J., Hasan, M.R. and Metian, M. 2011. *Demand and supply of feed ingredients for farmed fish and crustaceans: trends and prospects*. FAO Fisheries and Aquaculture Technical Paper No. 564. Rome, FAO. 87 pp.

Sustitucion de harina de pescado

- La harina de pescado se puede sustituir por:
 - Proteinas de origen animal (Canada, Australia, Chile, Japan, EU en 2013)
 - Proteinas de origen vegetal
- La sustitucion con ingredientes vegetales se ha demostrado mas dificil.
 - El nivel min. de harina de pescado en salmonidos es 10-15%.
 - Se ha podido vencer obstaculos (ANFs, disponibilidad de nutrientes), pero no podemos llegar a < 10% de forma consistente

Metabolomics

Metabolome: Assessing the “State of the Organism”



We are measuring physiology

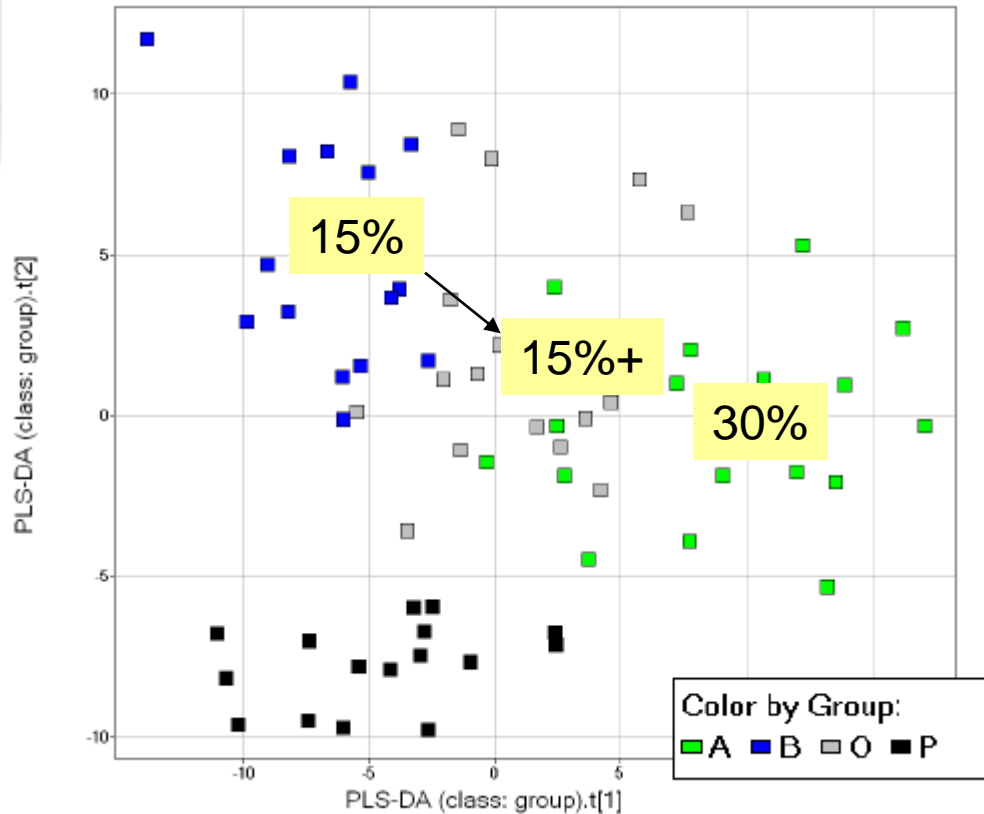


Perfil Metabólico

Group	15 %	15% +	15 %	15% +	Group	15 %	15% +	15 %	15% +	Group	15 %	15% +	15 %	15% +
Tank	all	all	all	all	Tank	all	all	all	all	Tank	all	all	all	all
Reference group	30 %	30 %	30 %	30 %	Reference group	30 %	30 %	30 %	30 %	Reference group	30 %	30 %	30 %	30 %
Outlier	all data	all data	all data	all data	Outlier	all data	all data	all data	all data	Outlier	all data	all data	all data	all data
Metabolite	ratio of median	ratio of median	p-value of t-test	p-value of t-test	Metabolite	ratio of median	ratio of median	p-value of t-test	p-value of t-test	Metabolite	ratio of median	ratio of median	p-value of t-test	p-value of t-test
Arginine	0.723	0.850	1.40E-03	2.71E-03	Taurocholic acid	0.565	0.427	6.61E-01	4.37E-01	Phosphatidylcholine (C18:0, C22:6) (proposed)	0.974	0.995	1.52E-03	3.92E-01
Aspartate	1.296	1.100	2.56E-02	9.45E-01	14-Methylhexadecanoic acid	0.617	0.761	3.64E-11	5.66E-07	Phosphatidylcholine (C18:1, C18:2) (proposed)	1.058	1.156	1.67E-03	2.87E-07
Cysteine (minor: Cystine)	1.563	1.207	4.78E-04	4.29E-02	Arachidonic acid (C20:cis[5,8,11,14]4)	0.801	0.878	2.56E-05	1.57E-03	Phosphatidylcholine No 02 (proposed)	1.000	0.997	4.45E-01	3.71E-01
Glutamate	1.651	1.248	3.94E-05	3.55E-03	Behenic acid (C22:0)	0.637	0.865	1.81E-05	2.37E-01	Phosphatidylcholine No 03 (proposed)	1.013	1.023	8.66E-02	3.33E-02
Glutamine	1.574	1.483	6.86E-03	1.50E-02	Docosahexaenoic acid (C22:cis[4,7,10,13,16,19])	0.728	0.948	1.69E-07	3.08E-01	Serine, lipid fraction	0.834	0.906	1.56E-01	2.38E-01
Glycine	0.933	0.874	4.32E-01	1.97E-01	Eicosadienoic acid (C20:2) No 02 (plausible)	0.734	1.058	1.19E-05	2.1E-01	Ceramide (d18:1, C24:0) (proposed)	0.646	0.716	1.42E-05	1.60E-02
Histidine	1.407	0.930	1.24E-01	3.55E-01	Eicosanoic acid (C20:1) No 02 (plausible)	0.736	1.040	3.74E-07	2.06E-01	Ceramide (d18:1, C24:1) (proposed) (minor: Ceramide)	0.805	0.846	1.91E-04	2.87E-03
Isoleucine	1.165	0.991	2.58E-01	8.82E-01	Eicosanoic acid (C20:0)	0.634	0.894	5.30E-07	1.78E-01	erythro-Dihydrosphingosine	0.686	0.990	8.01E-05	5.60E-01
Leucine	1.209	1.026	1.67E-01	9.03E-01	Eicosapentaenoic acid (C20:cis[5,8,11,14,17])	0.795	0.956	7.95E-07	2.90E-01	erythro-Sphingosine (minor: Sphingolipids)	0.767	0.898	1.71E-05	3.65E-01
Lysine	1.044	0.991	3.60E-01	7.53E-01	Etoicenoic acid (C20:cis[11])	0.627	0.830	3.97E-08	1.26E-02	D-Methylsphingosine No1 (plausible) (minor: Sphingosine)	0.687	0.902	1.74E-05	4.06E-01
Methionine	0.964	0.739	8.95E-01	6.62E-02	Elaidic acid (C18:trans[9])	0.723	0.974	1.33E-05	1.64E-01	D-Methylsphingosine No2 (plausible) (minor: Sphingosine)	0.717	0.897	9.04E-06	3.01E-01
Phenylalanine	0.936	0.809	7.63E-01	3.69E-01	Heptadecanoic acid (C17:0)	0.684	0.888	9.05E-09	6.75E-02	Sphingomyelin (d18:1, C16:0) (proposed)	1.056	1.098	1.80E-01	7.66E-02
Proline	1.710	2.130	1.11E-05	1.97E-04	Lignoceric acid (C24:0)	0.588	0.851	6.42E-07	1.42E-01	Sphingomyelin No 02 (proposed)	0.834	0.976	5.95E-06	2.20E-01
Serine	0.910	0.793	2.38E-01	1.76E-01	Linoleic acid (C18:cis[9,12]2)	0.696	1.062	8.59E-04	2.37E-02	Sphingosine-1-phosphate	0.713	1.032	2.51E-04	7.39E-01
Threonine	1.014	0.706	2.61E-01	1.23E-01	Linolenic acid (C18:cis[9,12,15]3)	0.626	0.875	8.29E-05	8.64E-01	2-3-Sphingosine (minor: Sphingolipids)	0.797	0.863	3.89E-05	2.52E-01
Tyrosine	0.892	0.862	7.91E-02	2.76E-01	Myristic acid (C14:0)	0.678	0.832	1.25E-04	5.84E-02	2-Hydroxybutyrate	1.236	1.342	3.44E-03	1.94E-04
Valine	1.144	0.972	3.39E-01	2.98E-01	Nervonic acid (C24:cis[15]1)	0.642	0.788	4.08E-10	1.18E-04	Citrate (minor: Isonitrate)	1.716	1.652	1.36E-07	5.09E-08
5-Oxoproline (minor: Folic acid, Glutamate)	1.438	1.196	1.30E-04	5.76E-03	Oleic acid (C18:cis[9]1)	0.697	0.947	6.57E-05	8.46E-01	Fumarate (minor: Maleate)	1.516	1.382	1.13E-04	1.22E-03
Citrulline	0.927	0.906	5.95E-01	6.36E-01	Palmitic acid (C16:0)	0.710	0.957	4.39E-07	4.49E-01	Glycerate	0.922	0.934	1.05E-03	1.17E-02
Cystathionine	1.558	1.164	1.39E-04	4.88E-02	Palmitoleic acid (C16:cis[9]1)	0.685	0.915	2.06E-03	8.26E-01	Laetaldehyde (plausible)	1.131	1.325	5.50E-01	3.04E-01
Cystine	1.515	1.367	1.04E-01	1.73E-01	Stearic acid (C18:0)	0.766	0.989	1.19E-05	3.51E-01	Lactate	1.595	1.375	1.10E-11	4.06E-08
Indole-3-lactic acid (proposed)	1.061	0.869	9.48E-01	2.76E-01	DAG (C18:1, C18:2) (proposed)	0.650	0.634	7.63E-10	5.68E-09	Malate	1.984	1.664	1.65E-06	1.86E-04
Ketoleucine (proposed)	0.817	0.893	7.79E-01	5.95E-01	TAG (C16:0, C16:1) (proposed)	0.873	0.878	1.21E-01	9.58E-02	Pyruvate (minor: Phosphoenolpyruvate) (PEP)	1.113	1.187	3.27E-01	2.86E-01
O-Phosphotyrosine	0.906	0.942	7.18E-02	2.65E-01	TAG (C16:0, C18:2) (proposed)	0.979	1.026	6.66E-01	5.74E-01	Succinate (proposed)	0.994	0.999	7.07E-01	8.67E-01
Ornithine (minor: Arginine, Citrulline)	0.823	0.701	4.72E-02	2.79E-02	TAG (C18:1, C18:2) (proposed)	1.000	1.114	5.61E-01	6.35E-01	Cortisol	1.057	1.397	3.34E-01	6.00E-02
trans-4-Hydroxyproline	0.684	0.673	3.30E-08	4.83E-08	TAG (C18:2, C18:2) (proposed)	0.976	1.103	3.76E-01	1.01E-01	Axanthin	1.140	0.678	3.30E-01	4.55E-04
Urea	0.680	0.548	3.74E-06	6.64E-07	TAG (C18:2, C18:3) (proposed)	0.944	0.959	1.28E-01	4.17E-01	beta-Alanine (minor: Pantothenic acid)	1.255	0.999	2.00E-02	7.14E-01
Erythrol	0.856	0.981	1.47E-03	4.63E-01	3-O-Galactosylglycerol (plausible)	1.686	1.318	2.92E-06	1.80E-03	beta-Aminoisobutyrate	0.551	0.404	4.59E-07	1.39E-06
Erythronic acid	0.885	0.920	7.49E-03	6.04E-03	Digalactosylglycerol (plausible)	7.398	3.393	1.24E-10	5.75E-09	beta-Gitosterol	0.908	0.975	1.62E-01	8.59E-01
Glucose	1.087	1.107	1.47E-01	1.09E-01	Galactose, lipid fraction	0.825	0.952	7.63E-03	1.88E-01	Campesterol	0.761	0.746	1.51E-03	2.56E-02
Glucose-1-phosphate (minor: Glucose)	1.422	1.281	2.84E-03	3.17E-02	Glucose, lipid fraction	0.739	0.989	5.51E-02	7.63E-01	Creatine	1.398	1.168	6.77E-03	7.68E-02
Glucose-6-phosphate (minor: Fructose)	0.892	0.608	3.78E-01	6.16E-07	mgo-Inositol, lipid fraction	0.838	0.942	1.1E-04	5.30E-02	Creatinine	0.384	0.329	1.73E-06	6.50E-05
Glucuronic acid	1.011	1.175	3.90E-01	6.36E-03	N-Acetylneuraminic acid, lipid fraction	0.673	0.901	2.43E-05	1.54E-01	Glycerol, polar fraction	1.507	1.335	7.22E-06	3.20E-04
Maltose	1.210	0.885	7.94E-02	4.57E-01	Choline plasmalogen (C18, C20:4) (proposed)	0.807	0.906	7.37E-04	5.43E-02	Glycerol-3-phosphate, polar fraction	0.857	0.712	7.38E-01	1.21E-03
Mannose	1.090	1.130	2.07E-01	2.67E-01	Glycerol phosphate, lipid fraction	0.751	0.901	2.44E-11	1.22E-02	Glycolate	0.936	0.986	4.42E-01	8.29E-01
mgo-Inositol	0.861	1.690	2.01E-03	3.82E-07	Lysophosphatidylcholine (C16:0) (proposed)	0.930	0.972	1.07E-05	6.53E-02	Hippuric acid	1.684	2.211	1.92E-03	1.60E-04
mgo-Inositol-2-phosphate (minor: mgo-Inositol)	0.466	0.660	2.15E-08	3.41E-04	Lysophosphatidylcholine (C18:0) (proposed)	0.823	0.856	7.31E-06	3.22E-03	O-Phosphoethanolamine	0.586	0.424	4.02E-03	1.18E-06
Ribose	0.974	0.763	6.18E-01	4.64E-02	Lysophosphatidylcholine (C18:1) (proposed)	0.729	0.843	1.33E-07	3.45E-04	p-Coumaric acid	0.977	1.151	9.90E-01	1.24E-01
scglio-Inositol	0.487	0.929	1.89E-15	1.74E-01	Lysophosphatidylcholine (C18:2) (proposed)	0.891	0.958	1.41E-05	5.35E-03	Phosphate (inorganic and from organic phospholipids)	0.741	0.628	1.08E-04	5.12E-10
Sorbitol (minor: Galactitol, Mannitol)	1.356	1.778	8.16E-05	2.09E-09	Lysophosphatidylcholine (C20:4) (proposed)	0.808	0.865	5.62E-05	6.81E-05	Pinitol	1.023	1.347	4.02E-01	8.03E-04
Sucrose	0.785	0.849	8.64E-02	9.46E-02	mgo-Inositol-1-phosphate, lipid fraction	0.806	0.870	3.79E-04	3.85E-02	Putrescine (minor: Argmatine)	1.236	1.077	4.60E-03	2.61E-01
Cholesta-2,4-dien (plausible)	0.676	0.917	8.95E-08	5.06E-02	mgo-Inositol-2-phosphate, lipid fraction	0.840	0.931	9.14E-03	1.69E-01	Sarcosine	1.029	1.110	4.29E-01	9.93E-02
Cholestenol No 02 (proposed)	0.696	0.878	1.96E-06	1.33E-01	Phosphate, lipid fraction	0.758	0.900	2.40E-12	9.89E-03	Taurine	0.867	0.563	1.68E-01	6.40E-05
Cholesterol	0.772	0.928	4.59E-06	3.09E-01	Phosphatidylcholine (C16:0, C16:0) (proposed)	1.194	1.064	5.05E-03	4.52E-01	Zearanthin	0.847	1.621	7.60E-02	1.27E-02
Glycerol, lipid fraction	0.785	0.982	1.30E-03	5.97E-01	Phosphatidylcholine (C16:0, C18:2) (proposed)	1.106	1.256	2.40E-06	8.14E-14	2'-Deoxygypidine	0.044	0.030	6.13E-24	7.22E-25
Hentriacontane	0.702	0.898	4.40E-07	1.35E-01	Phosphatidylcholine (C16:0, C20:4) (proposed)	1.064	1.024	4.17E-07	6.14E-03	Hypoxanthine (minor: Inosine)	1.749	1.810	6.05E-09	4.65E-07
Hexadecanol	0.747	0.891	8.33E-05	2.83E-01	Phosphatidylcholine (C16:1, C18:2) (proposed)	1.140	1.163	8.92E-05	1.24E-04	Inosine	1.557	1.640	1.39E-06	3.91E-07
Pentadecanol	0.681	0.815	6.90E-05	1.06E-02	Phosphatidylcholine (C18:0, C18:1) (proposed)	0.942	1.006	4.35E-02	6.67E-01	Uracil	1.752	1.561	1.42E-05	1.04E-03

El "Perfil Metabólico" muestra que los metabolitos circulantes cambian en la dirección correcta

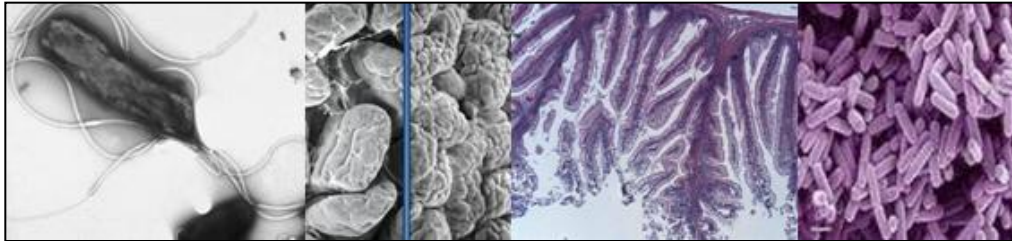
238 metabolitos analizados en total



Indicadores de Salud

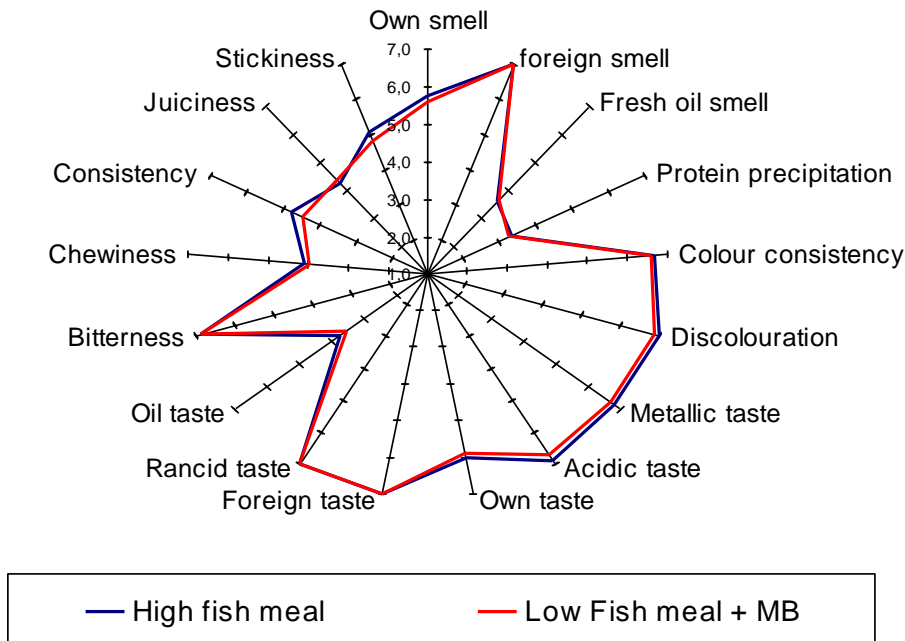
No se observaron efectos negativos sobre:

- Histología
- Microflora intestinal
- Fosfatasa Alcalina
- Coenzima Q10
- Colesterol
- ASAT
- ALAT
- Trigliceridos
- Proteina
- Albumina
- Urea
- Minerales (P, Ca, K, Cl)



Calidad de filete

- Evaluación sensorial
- Pigmentación y color
- Grasa filete
- Textura



Proximos retos

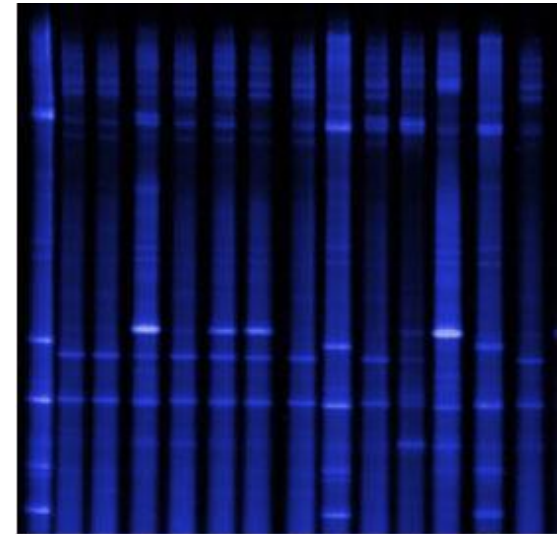
- Diseño de dietas independientes de materias primas de origen marino, para la mayoría de especies
 - Utilización de materias primas proteicas de origen animal
 - Nuevas materias primas vegetales concentradas
- Desarrollo de materias primas ricas en acidos grasos esenciales (EPA & DHA)
- Nuevas especies (desde la reproduccion hasta el pienso final)

The background features several thick, grey, curved lines that sweep across the frame from the top and right sides, creating a sense of motion and depth. The lines are layered, with some appearing closer to the viewer than others.

Nutricion-Salud

El objetivo esta en la prevencion

- De la terapia a la profilaxis
- Multifactorial:
 - Epidemiologia
 - Bioseguridad
 - Sweleccion genetica
 - Vacunas
 - **Dietas funcionales**
 - Management integral



CURIOSITY
FOR A
SUSTAINABLE
AQUACULTURE



NUTRICIÓN DENTRO DE GESTIÓN SANITARIA



¿Nutrición adaptada?

A medioambiente y salud

Óptima: Condiciones normales de cultivo

Funcional: “Dietas salud”

- **Preventiva:** Preparación ante estrés, riesgo de enfermedad o condiciones ambientales adversas
- **Específica:** Apoyo nutricional para superar enfermedades o condiciones ambientales adversas

SOPORTE NUTRICIONAL EN PISCICULTURA

¿Cómo podemos ayudar al pez **nutricionalmente** para **prevenir** enfermedades y/o **minimizar** sus efectos adversos?

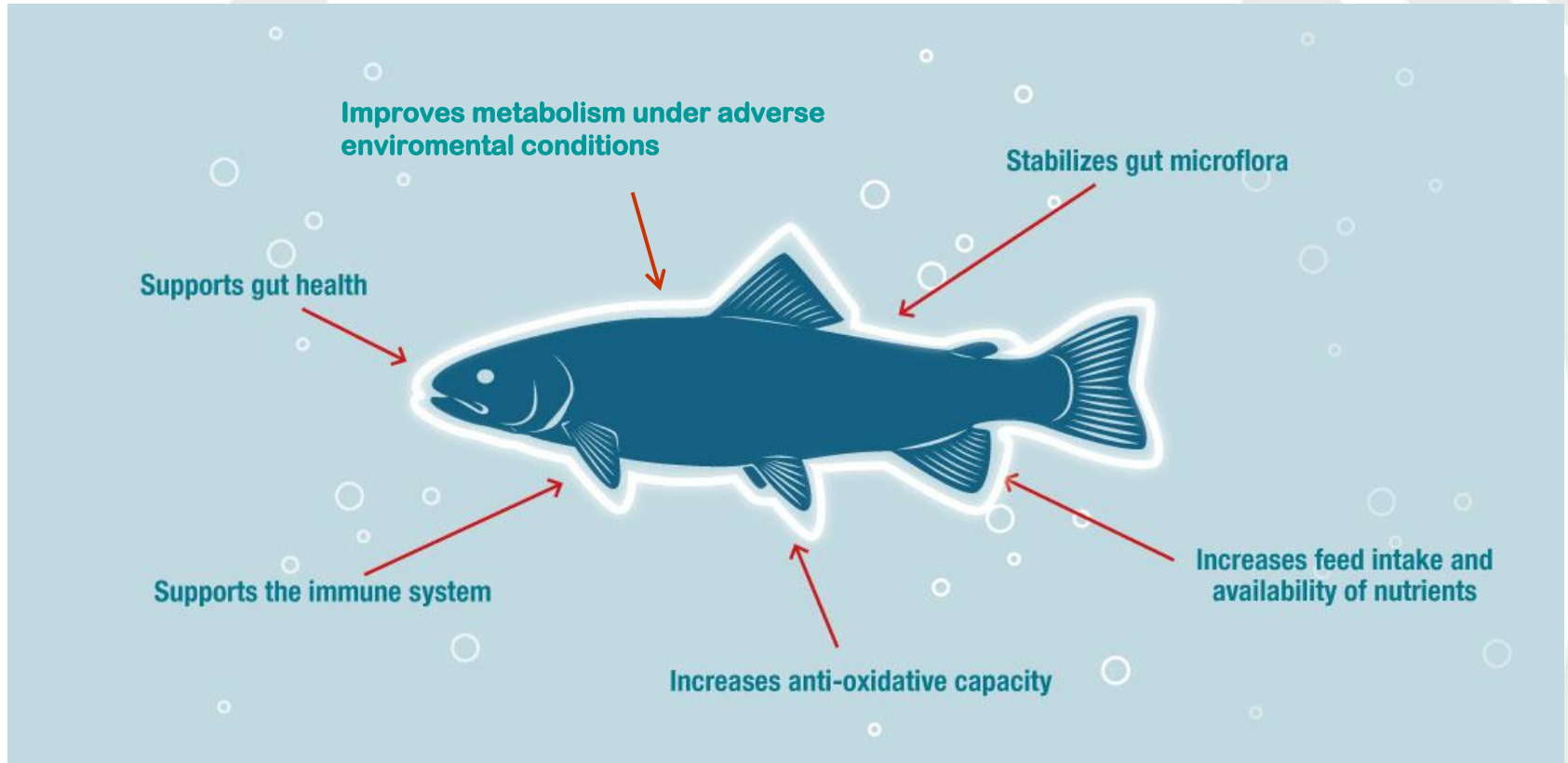
- **Conocimiento** de respuestas fisiológicas de los animales ante situaciones de enfermedad y ambientales adversas (frío, calor)



- **Investigación** básica sobre la actividad de diferentes nutrientes, aditivos y compuestos funcionales

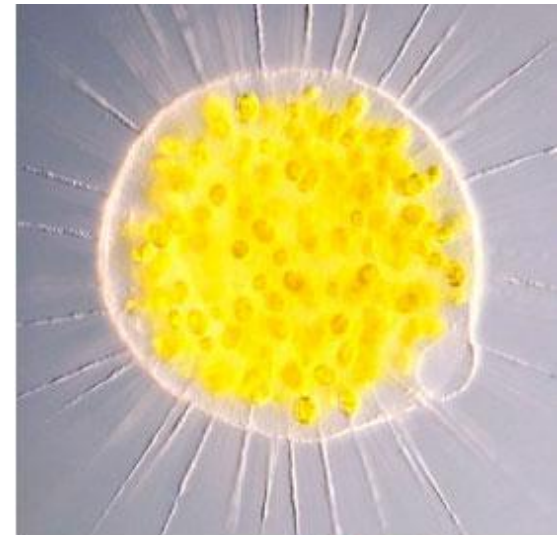
Desarrollo de dietas salud preventivas

Modos de accion



Desarrollo de una dieta Salud

1. Screening *in vitro*
2. Screening *in vivo*
3. Ensayos de documentacion:
 - Efectos
 - Resistencia a enfermedades
4. Ensayos de campo



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ADITIVOS FUNCIONALES

Una amplia lista

- ✓ Probióticos
- ✓ Prebióticos: MOS, FOS
- ✓ Inmunoestimulantes: Betaglucanos, LPS, alginatos
- ✓ Nucleótidos
- ✓ Ácidos orgánicos: Cítrico, fórmico, acético, láctico
- ✓ Extractos de plantas
- ✓ Vitaminas: A, B, C, E
- ✓ Minerales

ADITIVOS FUNCIONALES

Requieren registro para su uso industrial ...

European Union Register of Feed Additives pursuant to Regulation (EC) No 1831/2003

Appendixes 3b & 4.
Annex : List of additives

(Status: Released 17 January 2011.)

Edition  109

Directorate D - Animal Health and Welfare

Unit D2 – Feed

UNA COSA MÁS

Las “alegaciones salud” de los piensos deben justificarse

REGLAMENTO (CE) N° 767/2009 DEL PARLAMENTO EUROPEO Y DEL CONSEJO

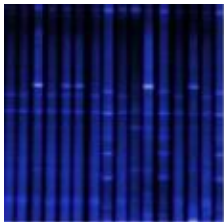
de 13 de julio de 2009

sobre la comercialización y la utilización de los piensos, por el que se modifica el Reglamento (CE) n° 1831/2003 y se derogan las Directivas 79/373/CEE del Consejo, 80/511/CEE de la Comisión, 82/471/CEE del Consejo, 83/228/CEE del Consejo, 93/74/CEE del Consejo, 93/113/CE del Consejo y 96/25/CE del Consejo y la Decisión 2004/217/CE de la Comisión

➤ Necesidad de Dossier Técnico

Investigación y documentación son imprescindibles para el desarrollo y validación de dietas salud

GRACIES!



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