General Overview Usage of Animal Products in Aqua Feed

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Aquaculture overview

- More than 300 species
- Fish, crustaceans, shellfish, algae
- Extensive (no feeding), semi-intensive, intensive
- Environment: water (cold, warm, fresh-brackish-seawater)

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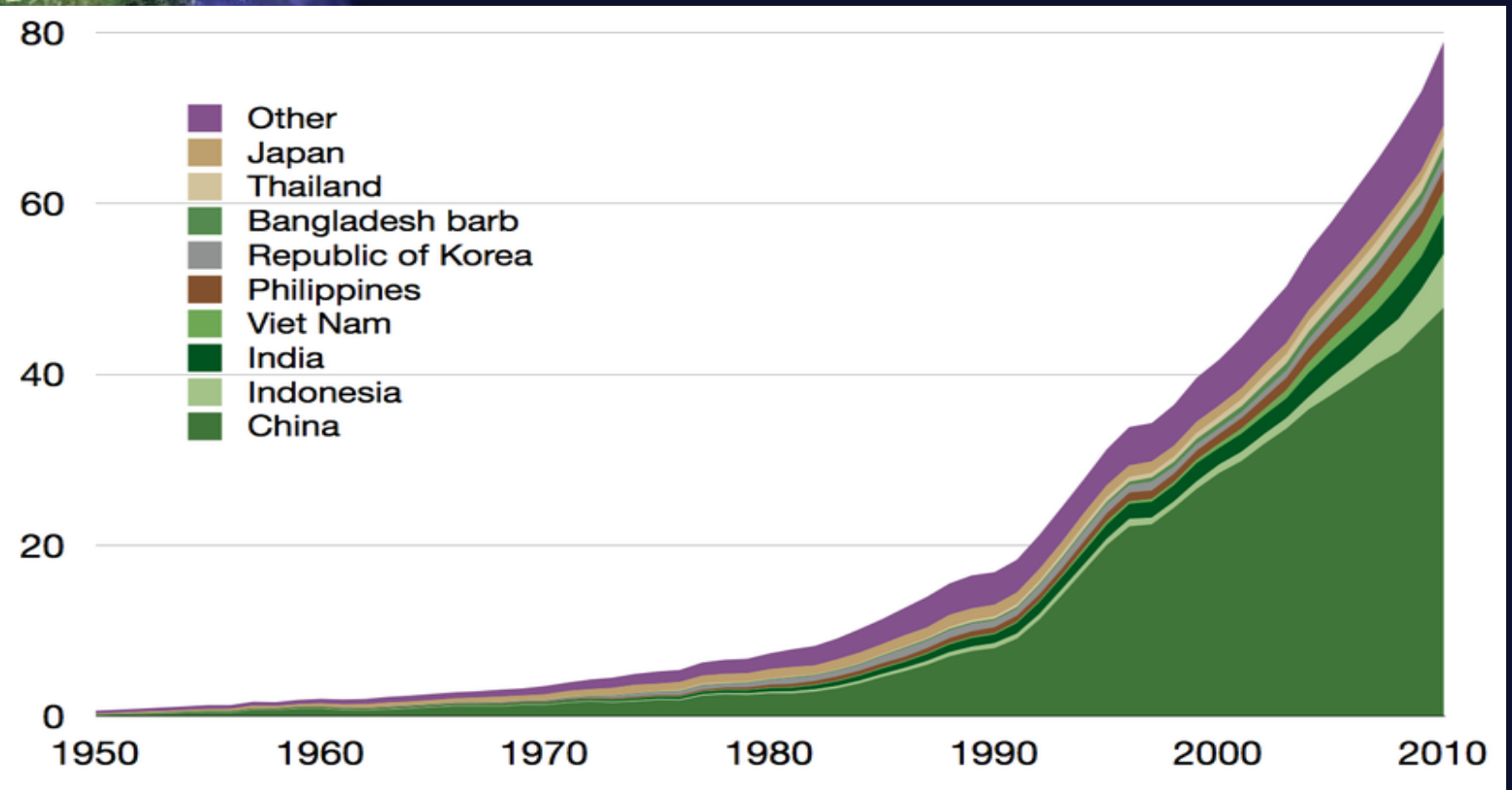
Aquaculture overview

- Increased production
- Increased demand for feeds
- Increased demand for raw materials



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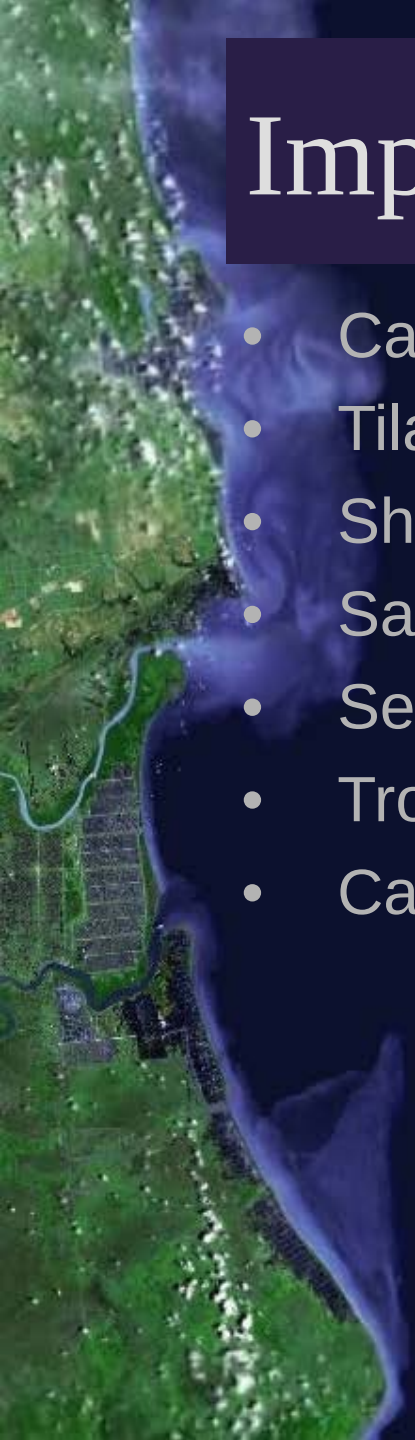
Important aquaculture species

- Carps in India and China
- Tilapia (global)
- Shrimp in South-East Asia and South America
- Salmon in Northern Europe and Chili
- Sea bass and bream in Southern Europe
- Trout (global)
- Catfish (US, Vietnam, Nigeria) – different species



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Feed

- Provide nutrients to the fish/shrimp
- Supplement what he can find in his environment
- Know the nutritional requirements
- Essential nutrients: without them no growth: vitamins, some amino acids
- Limiting nutrients: the fish can assemble them, but it will grow faster if provided: nucleotides, astaxanthin, hydroxyproline
- Nutrients requirements can be influenced by presence of other nutrients: effect on digestibility, inhibiting, similar function
- Digestibility of nutrients/ingredients
- Effect of production method (temperature and time)
- Effect of feed management (frequency of feeding/leaching)

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Salmonids : trout and salmon

- Carnivorous: Moderate Protein feeds, High energy (lipids)
- High Requirement for HUFA (Fish oil), can be partly replaced by vegetable oils (rapeseed) and possibly poultry fat (taste!)
- Fishmeal main source of proteins (>60% proteins!)
- Extrusion with vacuum coating is the only possible technology
- High protein ingredients: blood meal, feather meal, Low ash PBM and MBM, hydrolysate can replace partially the fishmeal

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Marine carnivorous fish: turbot, seabream, seabass, cobia, barramundi

- Carnivorous: High Protein feeds, moderate energy (lipids)
- Requirement for HUFA (Fish oil, EPA and DHA),possibility to use some vegetable oils and poultry fat in high energy diets
- Fishmeal main source of protein, soybean meal also used.
- Extrusion is the best technology (slow sinking feeds)

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Carnivorous fish, warm water, fresh water: catfish, perch, eels, snakehead

- Carnivorous: High Protein feeds, moderate energy (lipids)
- Low requirement for HUFA (Fish oil) and PUFA (vegetable oils: n-3 and n-6), possible inclusion of poultry fat (max. 50%)
- Extrusion or pelleting
- Protein ingredients: Fishmeal, soybean meal, blood meal, feather meal, PBM and MBM, other vegetable proteins

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Omnivorous fish, warm water, fresh water: channel catfish, tilapia, carp, pangasius

- Omnivorous: Low Protein feeds, energy (starch)
- Requirement for PUFA (vegetable oils), possibility for poultry fat
- Low inclusion of fishmeal, Soybean meal main protein source
- Extrusion (floating) or pelleting
- Calcium and Phosphate requirement (bone ash)

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Crustaceans carnivorous, brackish water & seawater: Penaeid shrimp, crabs

- Carnivorous/Omnivorous: moderate Protein, low energy (starch/lipids), low lipid content
- Small but essential requirement for HUFA (fish oil), phospholipids, cholesterol
- Inclusion of fishmeal and soybean meal as protein source + squid and shrimp meal (protein+attractant)
- Mainly pelleting (some extrusion)
- Alternative protein ingredients: blood meal, feather meal, PBM and MBM, insect meals, SCP
- Short digestive system: Hydrolysates!
- Calcium to be avoided
- Water stability: binding (starch, gluten, gelatin)
- Leaching: avoid highly watersoluble ingredients

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Crustaceans omnivorous freshwater: Macrobrachium, Crayfish

- Carnivorous/Omnivorous: Low Protein feeds, low energy (starch/lipids), low lipid content
- Very small but essential requirement for HUFA (fish oil), phospholipids, cholesterol, requirement for PUFA (vegetable oils)
- Inclusion of fishmeal and soybean meal as protein source + squid and shrimp meal (protein+attractant)
- Mainly pelleting (some extrusion)
- Short digestive system: Hydrolysates!
- Calcium to be avoided: Low ash PBM or concentrates
- Water stability: binding (starch, gluten, gelatin)
- Leaching: avoid highly watersoluble ingredients

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Aquaculture trends

- Aquafeed production is growing faster than aquaculture production:
  - intensification
  - shift from farm made feeds to commercial feeds
  - trend for higher value species (carnivorous species)

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Main challenges - disease

Disease outbreaks

- Infectious Salmon anaemia (ISA) in Chile
- EMS in South-East Asia

- Biosecurity (inflow water – larvae)

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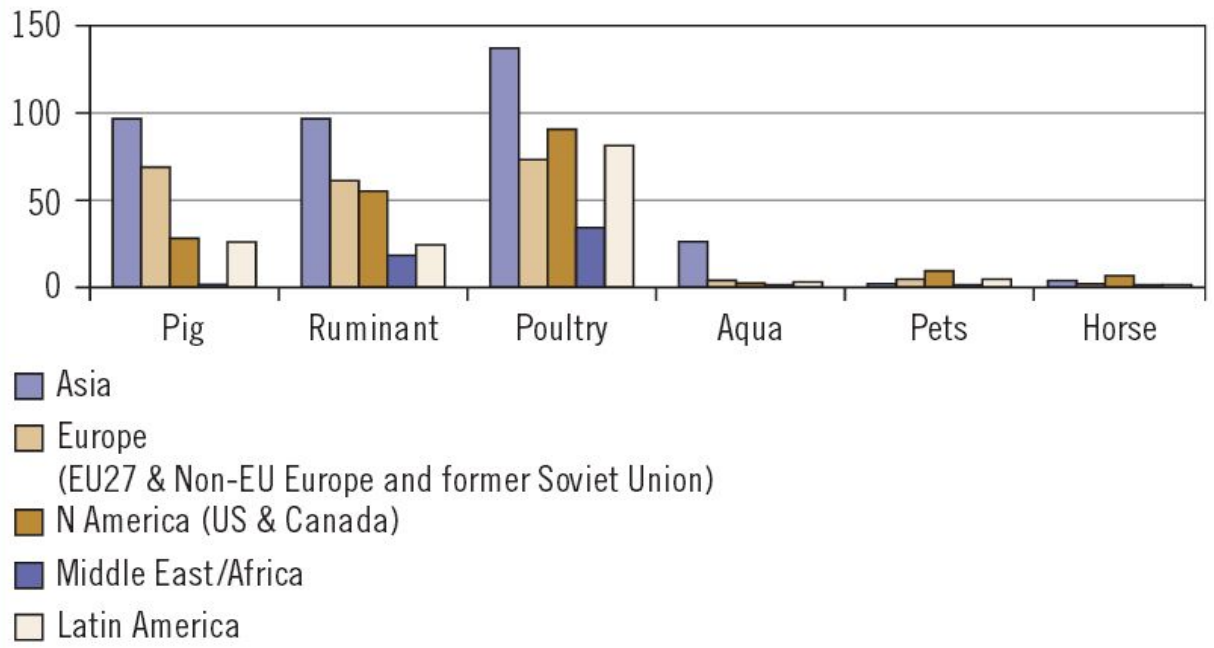
Main challenges – ingredients

- Limited availability of fish meal and oil
  - Competition for vegetable proteins with livestock sector

Figure 5 – Feed tonnage by species by region



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Main challenges - environment

Environmental concerns :

- Water use
- Effluent from semi-intensive farming
- Waste from cages
- Land use

Protein sources

Fishmeal supply limited and getting more expensive.

alternatives:

- Unutilized fish sources (by-catch/by-products)
- Soybean and other vegetable proteins: processing to concentrate the proteins/make them more digestible
- By-products from Biofuel production (DDGS, Canola meal)
- Entoproteins: Silkworm pupae meal, worm meal, other insect meals
- Processed Animal Proteins: Blood meal, Poultry By-product meal, Meat and bone meal, feather meal, hydrolyzed proteins
- Single Cell Proteins: algae, yeast, bacteria, funghi
- Crystalline amino acids (availability to fish & shrimp)

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Lipid sources

- Fish oil (rich in HUFA: EPA and DHA), protect against rancidity !
- Vegetable oils: rich in linoleic acid (n-6), which is good for freshwater fishes, moderate level of n-3
- Animal fat (saturated, only as energy, melting point !)

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Differences between animal and vegetable proteins sources

- Higher protein content
- Amino Acid balance
- Digestibility
- Partially soluble proteins
- Phosphorus and Calcium availability
- Low Fiber content
- Presence of nutrients like Taurine, Nucleic acids, Hydroxyproline

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Higher protein & amino acid balance

	Poultry meal 70	Feather meal	Hemoglobin powder	Salmonids	Gilthead Seabream
Crude protein	70	85	92	35-45	38-46
Amino acids (in % of protein content)					
Arginine	6,3	7,0	4,0	3,3-5,1	5,0
Histidine	1,7	0,8	7,8	1,6-1,8	
Isoleucine	3,4	4,9	0,5	2,0-2,3	
Leucine	6,3	8,2	13,5	3,6-4,0	
Valine	4,2	7,4	9,2	2,9-5,3	
Lysine	5,2	2,4	9,0	4,0-5,0	5,0
Phenylalanine	3,5	4,9	6,9	4,1-5,3	
Meth+Cyst	2,8	4,9	1,4	2,4-4,0	4,0
Threonine	3,6	4,8	3,1	1,8-2,2	
Tryptophan	0,9	0,7	1,4	0,5-1,4	0,6

Digestibility

	Rainbow trout (in vivo)		Gilthead seabream (in vivo)	
	ADC	ADP	ADC	ADP
LT Fish meal	72,6	90,5	71,8	87,5
Porc meal	55,9-72,0	83-89		35-79
Poultry meal	59,8-77,0	83-91		80-89,9
Soybean meal	29,5-75,3	95,9		86-90,9
Soy Protein Concentrate	53,2	90,4		

Digestibility varies a lot between different PAP's and is affected by quality of raw materials before drying and drying method.

We can observe that good quality PAP's show digestibility levels which are as high as the highest quality fish meals.

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Partially soluble proteins

Both fish meal and PAP's contain important amounts of water soluble proteins, in the form of peptides or longer chains. These water soluble proteins are highly digestible, but also will improve the attractability and palatability of aquafeeds. Highly digestible protein sources are essential in formulating larval and starter diets for fish. Palatability of diets becomes increasingly important when diets are formulated to contain less fish meal, but more vegetable proteins.

Hydrolyzed Animal Proteins are able to “mask” the taste of feeds high in vegetable proteins.

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Presence of digestible Phosphorus and Calcium

Phosphorus digestibility is a major problem in aquafeed formulation. The phosphorus present in vegetable proteins is mostly trapped in Phytine and is not available for the fish. The Phosphorus present in Porc and Poultry meal have a higher availability. As a consequence, the faeces of fish containing more animal proteins will contain less phosphorus which will find its way into the environment and cause eutrophication. This is particularly a problem for cage farming, and trout farming in flow through ponds.

Better availability of P reduces pollution in sea cages and effluents

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Low fiber content

Most commercial fish species, cultured in Europe for human consumption are carnivorous species. Their ability to digest fibers is limited .

Vegetable protein source are generally high in fiber content, while animal proteins contain very little amounts of fibers.

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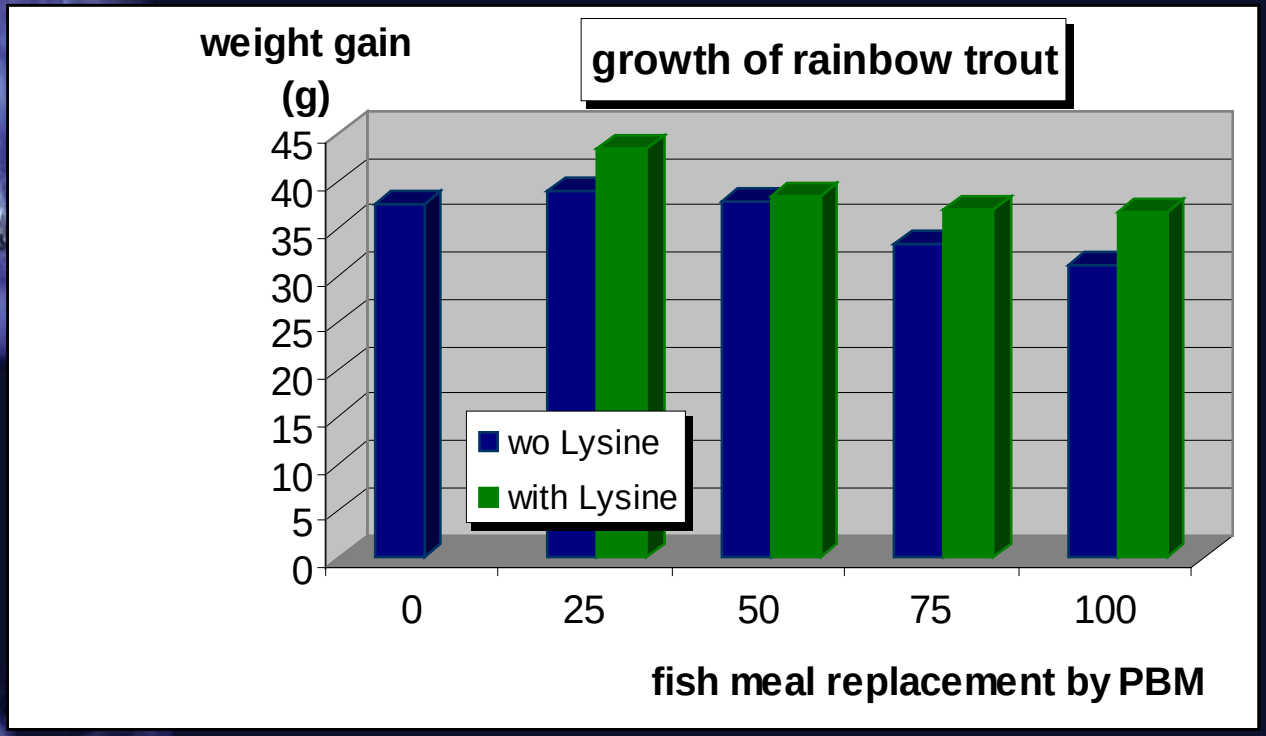
Replacement of fish meal by PBM in diets for rainbow trout



Cheng et al (2002) showed a growth improvement when fish meal was replaced by Poultry By-product meal (PBM) at a low level. At a higher replacement level, addition of Lysine to balance the amino acids resulted in similar growth.

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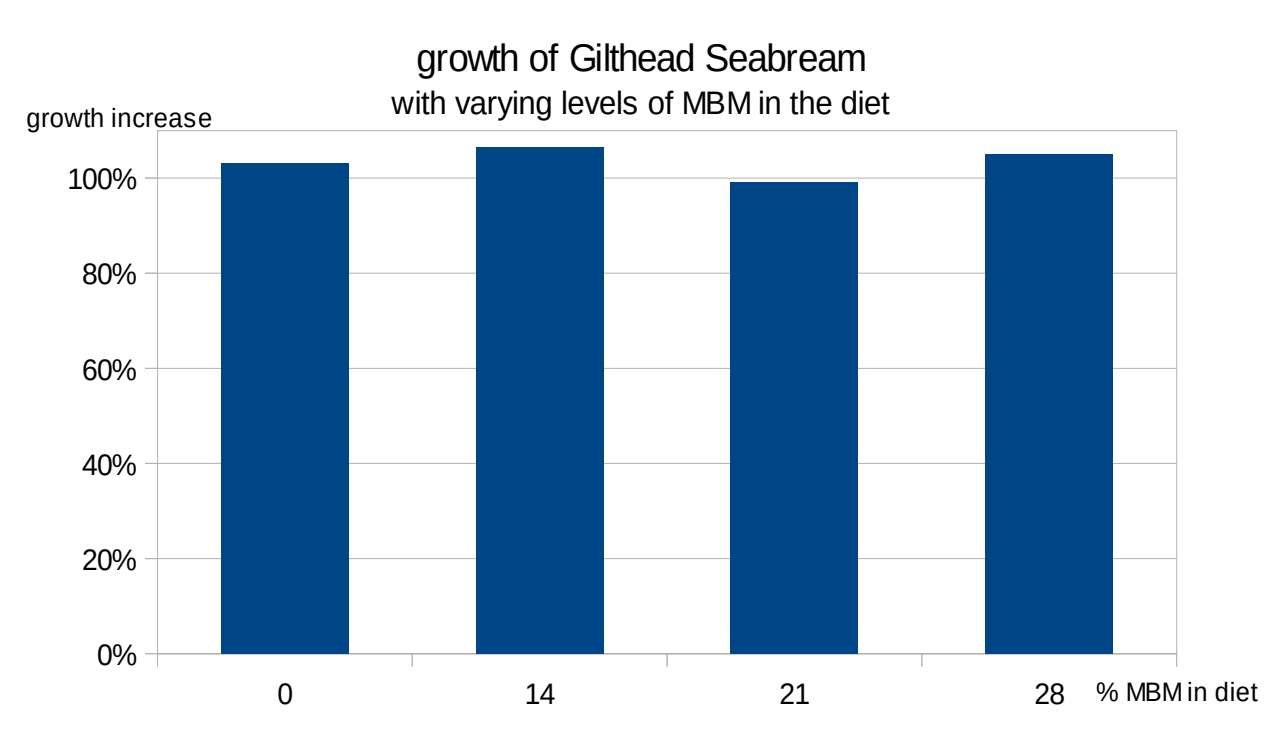
Replacement of fish meal by MBM in diets for seabream



Robiana et al 1997 could replace 40 % of the fishmeal in diets w-for Gilthead Seabream without growth loss.

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Conclusion – Future of Aquaculture

Future of Aquaculture will depend on
- species which can be cultured with a low amount of fish meal in their diets
- species which can be cultured with minimum effect on the environment (lower effluent load/better digestible feeds)
- Alternative protein sources are needed to produce more aquaculture products
- PAP's are a first choice to replace fish meal in diets

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Thank you !