sparos

I&D nutrition in aquaculture

Tailoring your feeds

Development and optimization of a practical feed for wreckfish broodstock

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WRECKFISH KNOW-HOW TRANSFER WORKSHOP
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Tailoring
your feeds

SPAROS

Science and technology company dedicated to the development of new products and tailored nutritional solutions for the aquaculture market

Pilot-scale feed mill for custom made R&D aquafeeds


Nutrition trials with fish and shrimp

HATCHERY FEEDS by sparos

ZEBRAFEED by sparos

Premium feeds for specialty markets and species
(marine hatcheries, biomedicine)

FEEDNETICS

Advanced nutritional evaluation tools
(biomarkers, modelling)

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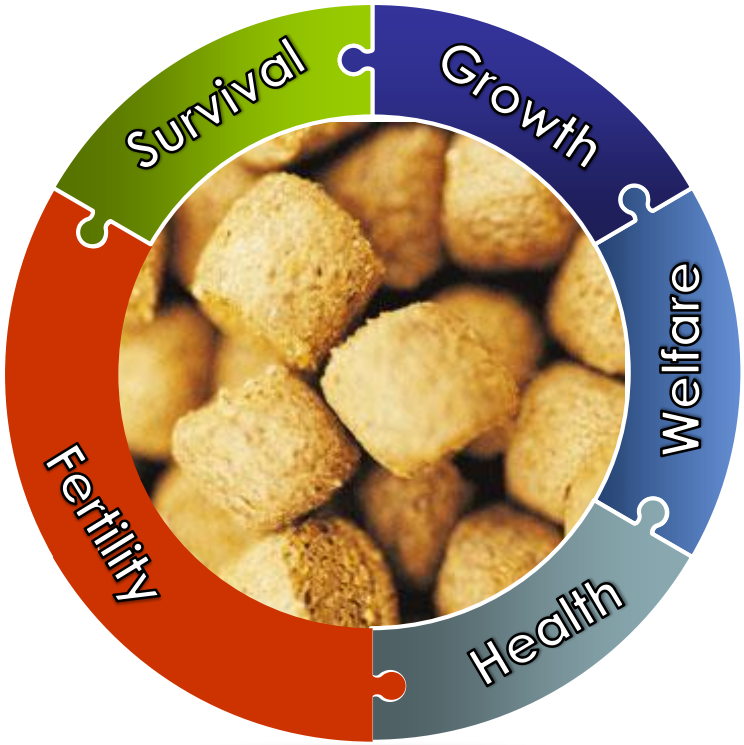
Optimal nutrition is key…

Survival
Growth
Size dispersion

Water quality
Physiological/Metabolic status



Spawning
Fecundity
Egg quality

Stress response
Disease resistance
Skeletal deformities

ZEBRAFEED
by sparos

Broodstock Nutrition

Key role towards the quality of marine fish eggs and larvae

An effective tool to modulate reproductive performance in terms of spawning ability and gamete quality

- Quantity of the eggs (fecundity)
- Quality of the eggs and sperm
- Fertilization

Consequently affecting

- Quality of larvae (disease resistance/malformation-free)
- Initial performance of first-feeding larvae or fry before they become established on feed

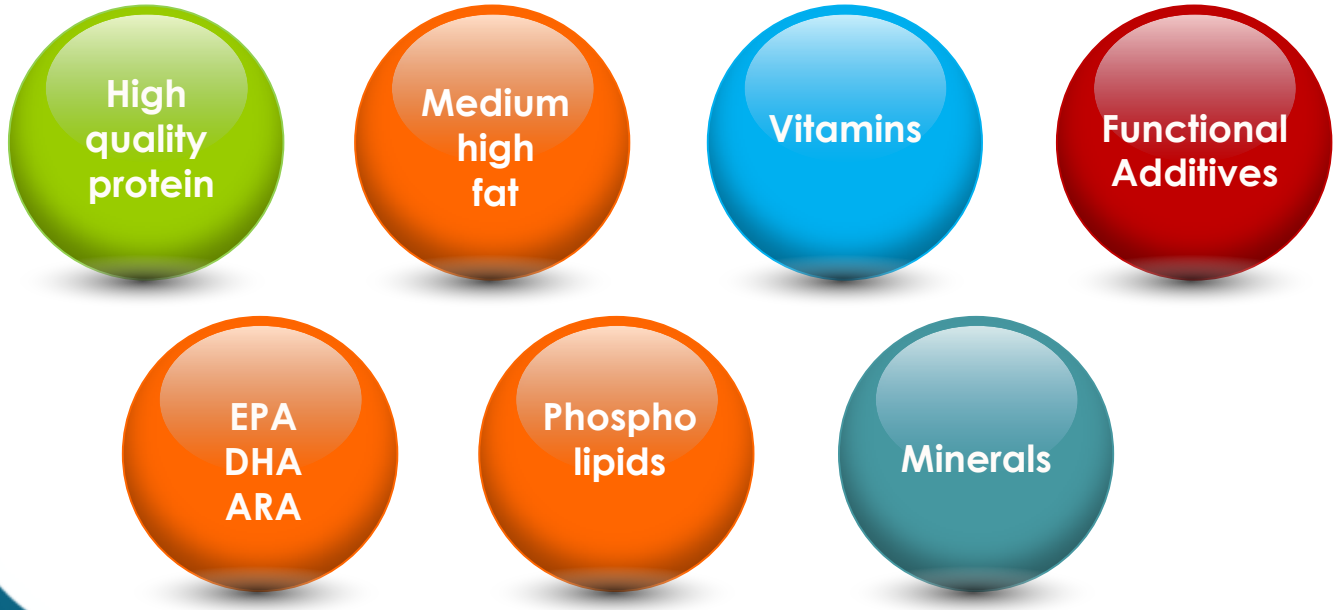
Tailoring your feeds

Nutritional requirements of broodstock fish

Knowledge is limited and fragmented

- Given their physiological state, the nutritional requirements are altered in broodstock fish

Some buzz-words commonly found in broodtstock feeds



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High level and premium quality proteins

Broodstock fish require high protein diets

- Preferential energy-yielding substrate
- Period of intense vitellogenin synthesis
- Transfer of aminos acids to yolk-reserves (main metabolic substrate for yolk-stage larvae)

Broodstock fish require high quality proteins

- Cuttlefish, squid and krill meals were found beneficial
  - Highly digestible and palatable proteins
  - Presence of polar and nonpolar lipid fractions
  - Dietary tryptophan, a precursor of the neurotransmitter serotonin (commonly found in premium marine proteins), was found to positively affect gonad maturation

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Lipids are key nutrients for reproduction

Broodstock fish require medium to high fat diets

- Avoid excessive mobilization of body reserves towards gonad maturation

- Transfer of fatty acids to yolk-reserves (energy substrate for yolk-stage larvae and key elements for organogenesis)

The fatty acid profile is extremely relevant

- n-3 HUFAs (**EPA** and **DHA**) are highly beneficial
  - Selective retention of DHA during embryogenesis
  - EPA regulate eicosanoid production (PGE3), which is involved in the synthesis of steroid hormones and ovulation
- **ARA** (20:4n-6) is a percursor of PGE2 which shows higher potency for steroidogenesis than PGE3

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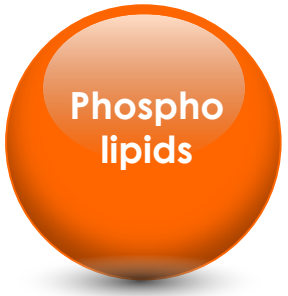
Phospholipids: key component of cell membranes



Phospholipids also have shown beneficial effects

- Intestinal lipid emulsification and micelle formation
- Privileged carriers of ARA and EPA
- Transport of hydrophobic substances (triglycerides, carotenoids)

- Inclusion of marine phospholipids (krill or copepods oil) have been associated to improved ovarian cell growth and increased fertility

- In some fish species, phospholipids are important during larval development, being preferentially catabolized after hatching and prior to first feeding

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Optimal dietary lipid profile is key for reproduction

	Recommendations
Ratio n-3/n-6 HUFAS	5 to 8
Ratio DHA/EPA	3
Ratio ARA/EPA	0.7 to 1.1
Total n-3 HUFAs	2% of feed
Phospholipids	> 1.5

Excessive levels of dietary n-3 HUFA levels can cause yolk sac hypertrophy and decrease larval survival in some species

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Vitamins requirements are higher during reproduction

Broodstock feeds are generally fortified in vitamins

- **Vitamin E** antioxidant role relevant for sperm motility and cell differentiation. Recently vitamin E has been found to stimulate the secretion of gonadotropin hormone
- Requirement of **Vitamin C** of broodstock fish is higher than that of grow-out fish
- **Thiamin (vitamin B1)** is needed in broodstock diets for normal embryo and larval development (reduction of early mortality syndrome
- **Pyridoxine (vitamin B6)** is important in the synthesis of steroid hormones and folic acid. Its deficiency may impair synthesis of DNA and RNA and condition hatching rate

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Little knowledge on the role of minerals on reproduction

- Trout broodstock fed a low **manganese** diet resulted in poor egg hatchability
- Gonadal **zinc** levels are fast depleted during maturation and strongly dependent on dietary intake
- Seabream and seabass broodstock fed diets fortified with **zinc** and **selenium** showed a higher percentage of viable sperm and a significant reduction of lipid peroxidation in cryopreserved sperm

Since broodstock feeds are generally rich in marine ingredients, we don't expect any significant deficiency in broodfish

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Functional additives are generally added

- Carotenoids (e.g. **astaxanthin**) have a wide variety of functions in eggs and larvae, including provitamin A source, photoprotection and antioxidant
- Natural carotenoids from **paprika oleoresin** significantly improved egg fertilization rates in seabream, suggesting an important sperm cell's protective role by reducing the risk of lipid peroxidation
- **Nucleotides** are also commonly used in broodstock diets, since they are the building blocks essential for cell differentiation in periods of fast cell division and growth (embryo and larvae)
- **Taurine** has been associated to successful larval metamorphosis and pigmentation (high levels in yolk reserves)
- Various **immunostimulants** are used to reinforce the immune system of broodfish during this sensitive period

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Broodstock feeds

Ingredients, %	
Fishmeal LT70	**Premium protein source**
Fish protein hydrolysate	**Palatability enhancer**
Squid meal	**Premium protein source** **Palatability enhancer** **Low fat**
Krill meal	**Premium protein source** **Palatability enhancer** **LC PUFA n-3 rich phospholipids**
Wheat gluten	**Highly digestible protein**
Wheat meal	**Pellet structure**
Tuna oil	**LC PUFA n-3-rich oil**
Tuna oil (70% DHA)	**70% DHA**
Fish oil (DHA 500 TG)	**LC PUFA n-3-rich oil**
VEVODAR oil (40% ARA)	**40% ARA from Mortiella alpina**
Soy lecithin	**Mainly phosphatidylcholine**
Vitamin & mineral premix	
Additives: Vit E, Se-yeast, AOX, ASTA, taurine	**Reduce oxidative status**
Macroalgae mix	**Pellet binder + palatability**

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Broodstock feed WRECK 2014

Ingredients, %	WRECK 2014
Fishmeal 70 LT	50.00
Fish protein hydrolysate	7.50
Squid meal	12.50
Krill meal	6.00
Wheat gluten	6.00
Wheat meal	4.94
Tuna oil	2.00
Fish oil (DHA 500 TG)	2.00
VEVODAR oil (40% ARA)	3.00
Vitamin and mineral premix	2.00
Vitamin E	0.06
Soy lecithin	2.00
Macroalgae mix	1.00
Natural antioxidant	0.40
Se-yeast	0.02
Astaxanthin	0.05
Nucleotides	0.03
L-Taurine	0.50

Crude protein: 60%
Crude fat: 16%

Too much fat!!!

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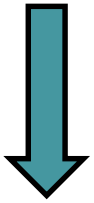
Broodstock feed WRECK progress

Ingredients, %	WRECK 2014	WRECK 2016
Fishmeal 70 LT	50.00	**25.00**
Fish protein hydrolysate	7.50	**10.00**
Squid meal	12.50	**34.20**
Krill meal	6.00	**7.50**
Wheat gluten	6.00	**7.00**
Wheat meal	4.94	**7.25**
Tuna oil	2.00	**1.00**
Tuna oil (70% DHA)		**0.20**
Fish oil (DHA 500 TG)	2.00	**1.00**
VEVODAR oil (40% ARA)	3.00	**1.30**
Vitamin & mineral premix	2.00	**2.00**
Lutavit E50	0.06	**0.05**
Soy lecithin	2.00	**1.50**
Macroalgae mix	1.00	**1.00**
Natural antioxidant	0.20	**0.20**
Se yeast	0.02	**0.02**
Astaxanthin	0.05	**0.05**
Nucleotides	0.03	**0.03**
L-Taurine	0.50	**0.50**

Crude protein: 60%
Crude fat: 16%



Crude protein: 66%
Crude fat: 12%

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Broodstock feed WRECK 2017

Composition	WRECK 2017
Tau, % feed	0.9
Se, mg/kg	2.5
Vit A, IU/kg	40248
Vit C, mg/kg	2000
Vit E, mg/kg	650
Vit D, IU/kg	2902
Astaxanthin,mg/kg	50

Composition, % feed	WRECK 2017
C14	0.55
C16	2.10
C18	0.44
C18:1n9	1.65
LNA (C18:2n6)	1.08
ALA (C18:3n3)	0.18
ARA	0.51
EPA	0.72
DHA	1.66
EPA+DHA	2.38
ARA/EPA	0.70
Total phospholipids	2.40

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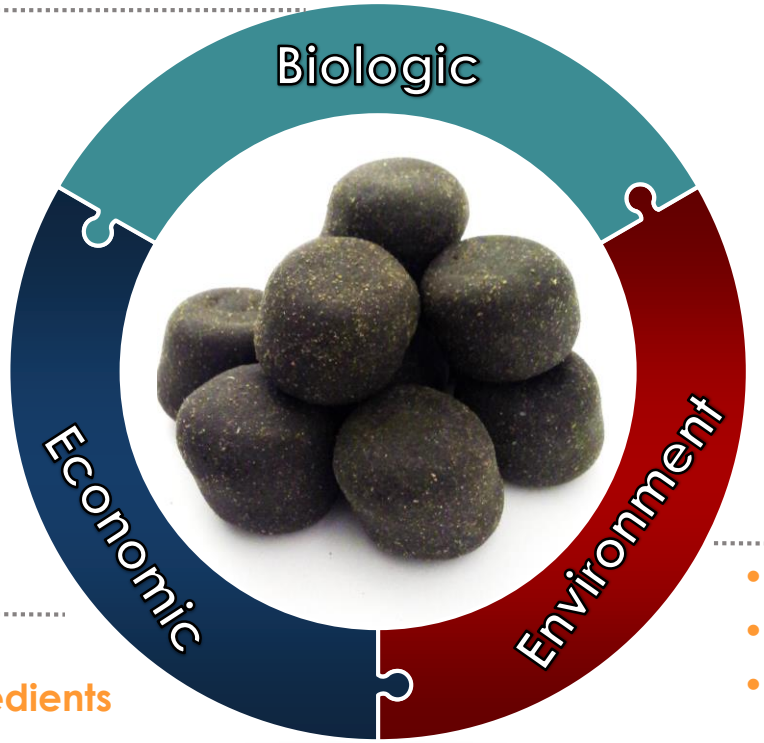
Challenges for a practical aquafeed

- Cover the nutritional requirements of species and developmental stage
- Adequacy to the feeding behaviour
- Promote well-being and optimal functionalities



- Cost
- Market availability of ingredients
- Technology constraints
- Legal contraints

- Highly digestible
- Optimal metabolism
- Low-impact on water quality

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Technology constraints

Large size pellets are difficult to manufacture

- high pressure extrusion to guarantee physical quality
- drying costs are high
- hard pellets are sometimes not well accepted by wild brood fish

New process based on cold-extrusion

- Soft texture pellets = stable semi-moist feeds (18-22% moisture, but lower Aw)

7 mm

14 mm

22 mm

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The impact of WRECK feed for us

HATCHERY FEEDS by sparos

BROODFeed LEAN

A complete feed for broodstock fish

Balanced nutritional composition

- Enhanced spawning performance
- Improved larval quality

High palatability also for wild-caught fish

- Soft texture

COLD-EXTRUSION for maximum freshness

- High water stability

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Lead by innovation...

Thank you for your attention

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