EarlyCOD

Webinar:

How can nutritional strategies affect the development of farmed cod?

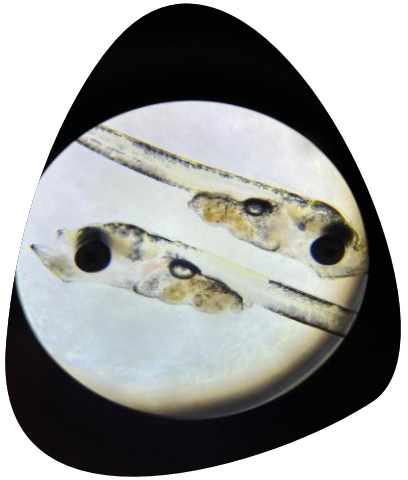
COD CLUSTER

Novel feeding protocols & microdiets for Atlantic cod larvae

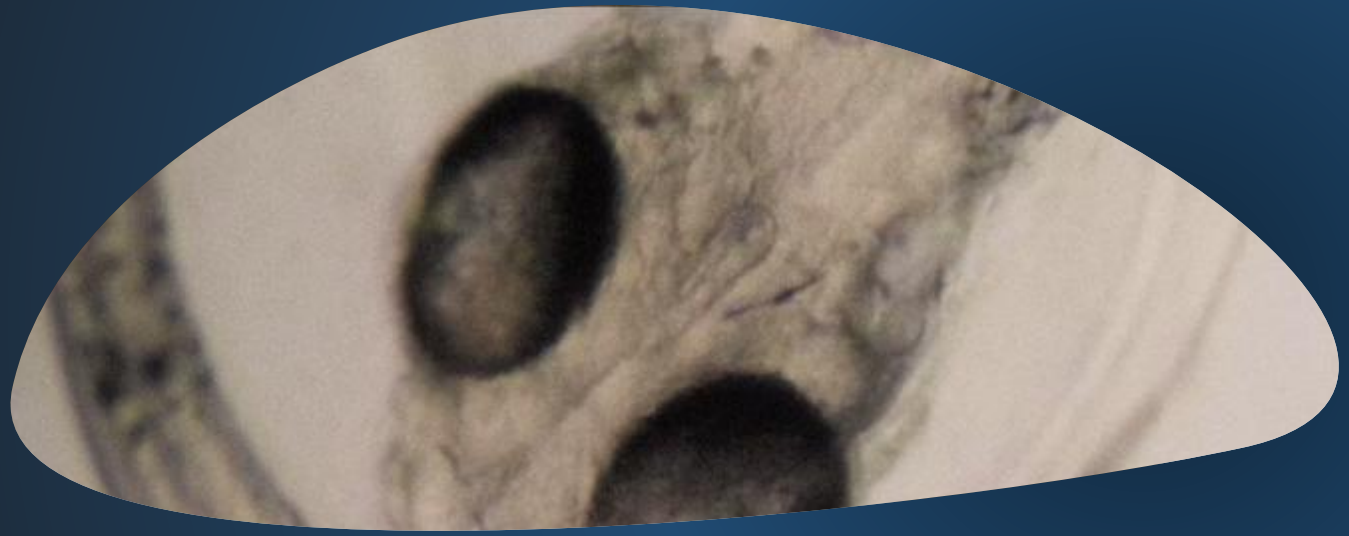
planktonic
sparos I&D nutrition in aquaculture
ciimar
2030 ALGARVE
COMPETE 2030
PORTUGAL 2030
Cofinanciado pela União Europeia
eurostars
eureka innovation beyond borders

EarlyCOD trials:

- Trial **Cod3** (EarlyCOD project)
- Trial **Cod4** (EarlyCOD project)
- Trial **Cod5** (Aquaexcel project - NTNU)



New feeding protocols combining Cryoplanton and microdiets



Trial Cod3

Trial: Cod3

Objective:

- Test the effect of a new live feed regime and two novel microdiets on Atlantic cod biological performance.

Trial features:

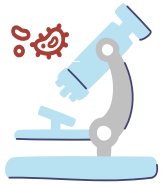
- Atlantic cod larvae from 3-66 dph

CTRL	Rotifers + Cryo-L + CONTROL diet
D1	Rotifers + Cryo-µ + Cryo-S + Cryo-L + D1 diet
D2	Rotifers + Cryo-µ + Cryo-S + Cryo-L + D2 diet

Live Feeds → 3-45 dph
Co-feeding → 27-45 dph
Inert Feeds → 46-66 dph

- Microdiets: **D1** – enhanced in Vegetable phospholipids (Veg PL);
  D2 – enhanced in Marine phospholipids (Mar PL);
  CTRL – SK Gemma Micro

Trial: Cod3



❑ Histology Summary

15 DAH	D1	D2	CTRL
Anterior Intestine	3	2	2
Posterior Intestine	4	3	4
Liver	2	2	2
Eyes	3	3	3
Gills	3	3	1

30 DAH	D1	D2	CTRL
Anterior Intestine	4	3	4
Posterior Intestine	4	4	2
Liver	4	4	2
Eyes	4	3	3
Gills	3	2	2

66 DAH	D1	D2	CTRL
Anterior Intestine	5	4	3
Posterior Intestine	4	3	4
Liver	4	3	4
Eyes	3	3	3
Gills	4	2	4

Marine fish larval and juvenile quality scoring system (Pacorig et al, 2022):
Scale from 1 (very poor development) to 5 (very well developed)

❑ At 15dph, **combination of Cryo-µ, Cryo-S and Cryo-L seems to have a positive effect on organ ontogeny,** with earlier cell development/differentiation

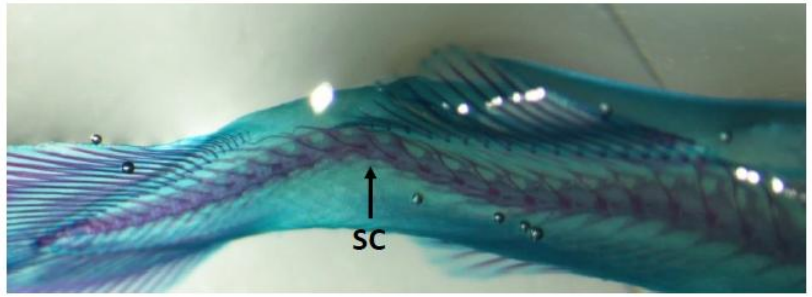
❑ At 66dph, **SPAROS D1 group showed overall improved organ ontogeny**

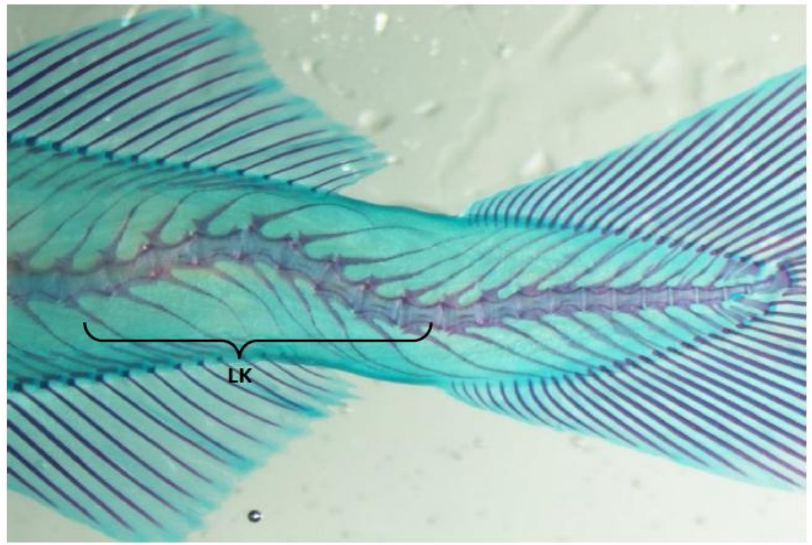
Synergistic effects
of live feed and novel microfeeds

Trial: Cod3

Types of Anomalies
Scoliosis
Lordosis
Kyphosis
Jaw deformities
Deformed or reduced operculum
Reduced dental / malformed pre-maxillary and / or maxillary
Multiple vertebral fusions (3 consecutive or more)
Vertebral fusion
Vertebral slipping
Vertebral body malformation
Malformed neural arch and / or spine
Malformed haemal arch and / or spine and / or rib
Malformed ray (deformed, absent, fused)
Malformed pterygiophores (deformed, absent, fused)
Malformed hypural (deformed, absent, fused)
Malformed epural (deformed, absent, fused)

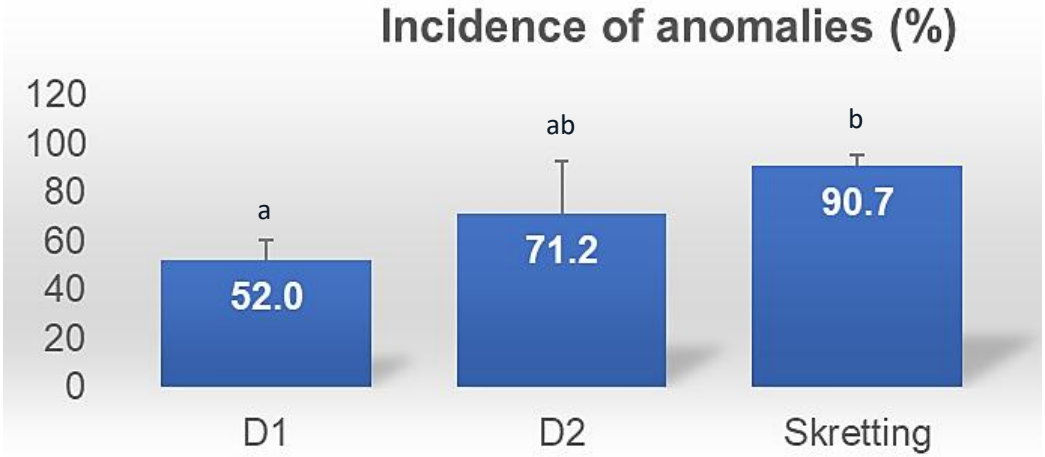
Severe anomalies: skeletal malformations that modify gross morphology and may lead to an impairment of commercialization



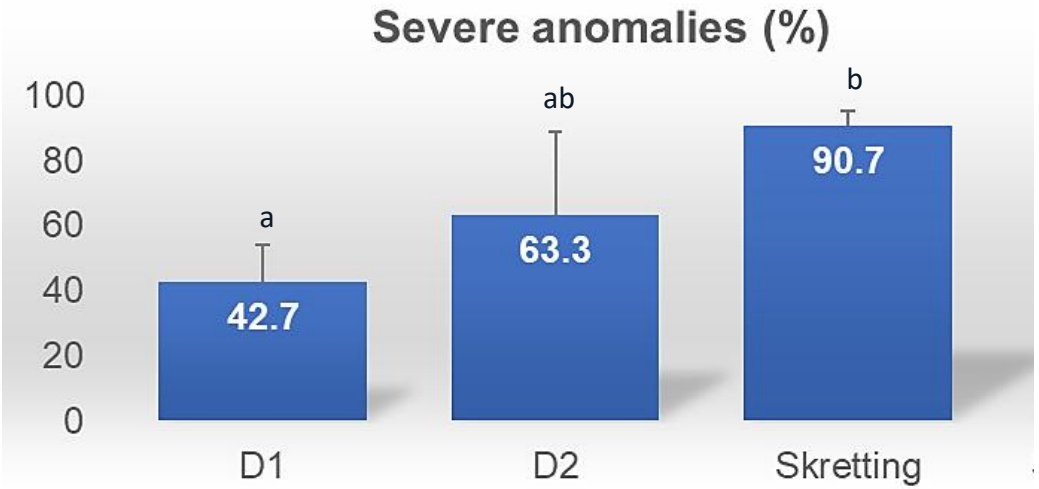


Trial: Cod3

DEFORMITIES



D1 had lower proportion of individuals with at least one skeletal anomaly, when compared to fish fed CTRL diet



D1 presented a lower incidence of severe anomalies, in comparison with CTRL group

Final remarks – Cod3

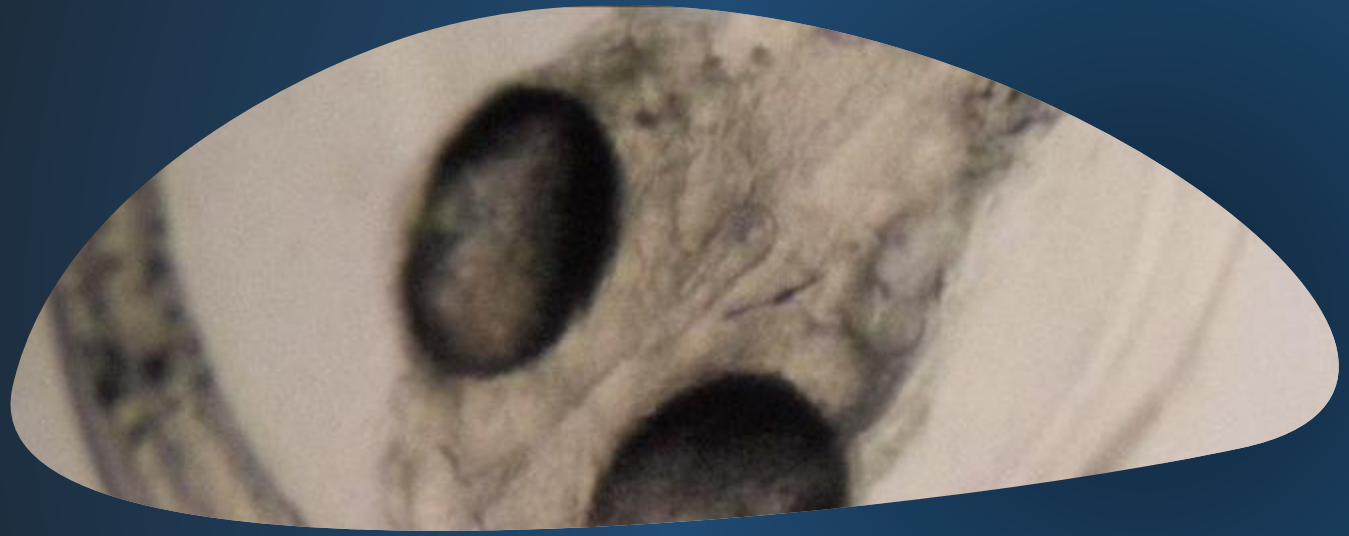
HISTOLOGY

- ❑ **Cryo-µ, Cryo-S and Cryo-L** seems to have a positive effect on organ ontogeny
- ❑ **Diet D1** (Veg PL) lead to better organ ontogeny, than diet D2 or CTRL

DEFORMITIES

- ❑ Cod larvae fed the **D1 diet** presented the lowest incidence of skeletal anomalies

New feeding protocols combining Cryoplanton and microdiets



Trial Cod4

Trial: Cod4

Objective:

- Test the effect of two novel microdiets on Atlantic cod biological performance.

Trial features:

- Atlantic cod larvae from 3-67 dph

CTRL	Rots + Cryo-µ + Cryo-S + Cryo-L + CTRL diet
D3	Rots + Cryo-µ + Cryo-S + Cryo-L + D3 diet
D4	Rots + Cryo-µ + Cryo-S + Cryo-L + D4 diet

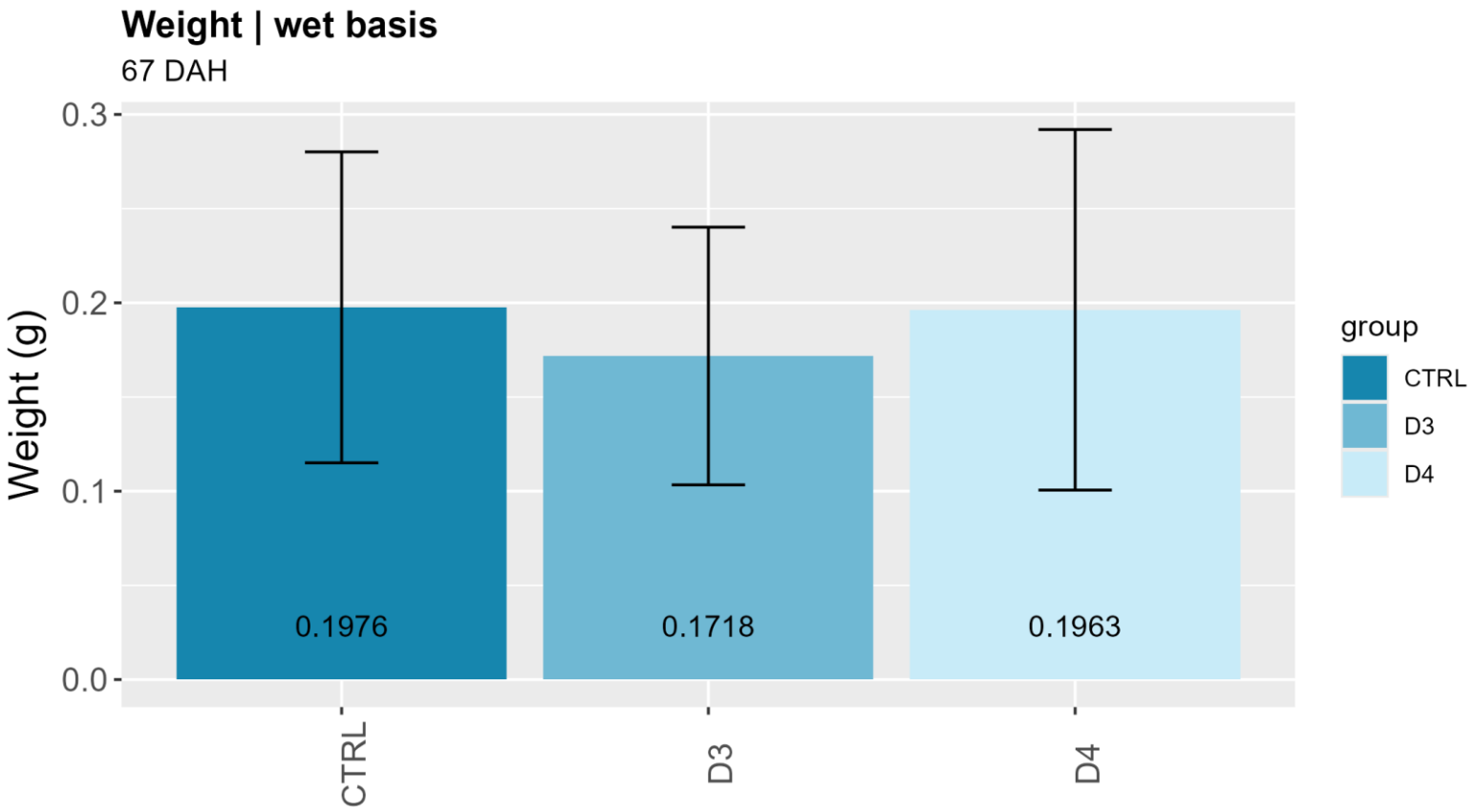
Live Feeds → 3-27 dph
Co-feeding → 20-45 dph
Inert Feeds → 46-67 dph

→ Earlier intro of inert diets: *7 days earlier than previous trial*

- Microdiets: **D3** slightly higher in Veg PL
  D4 slightly higher in Mar PL
  D3 & **D4** with moderate fat level (12-13%), in comparison with D1 & D2 (14-16%)

Trial: Cod4

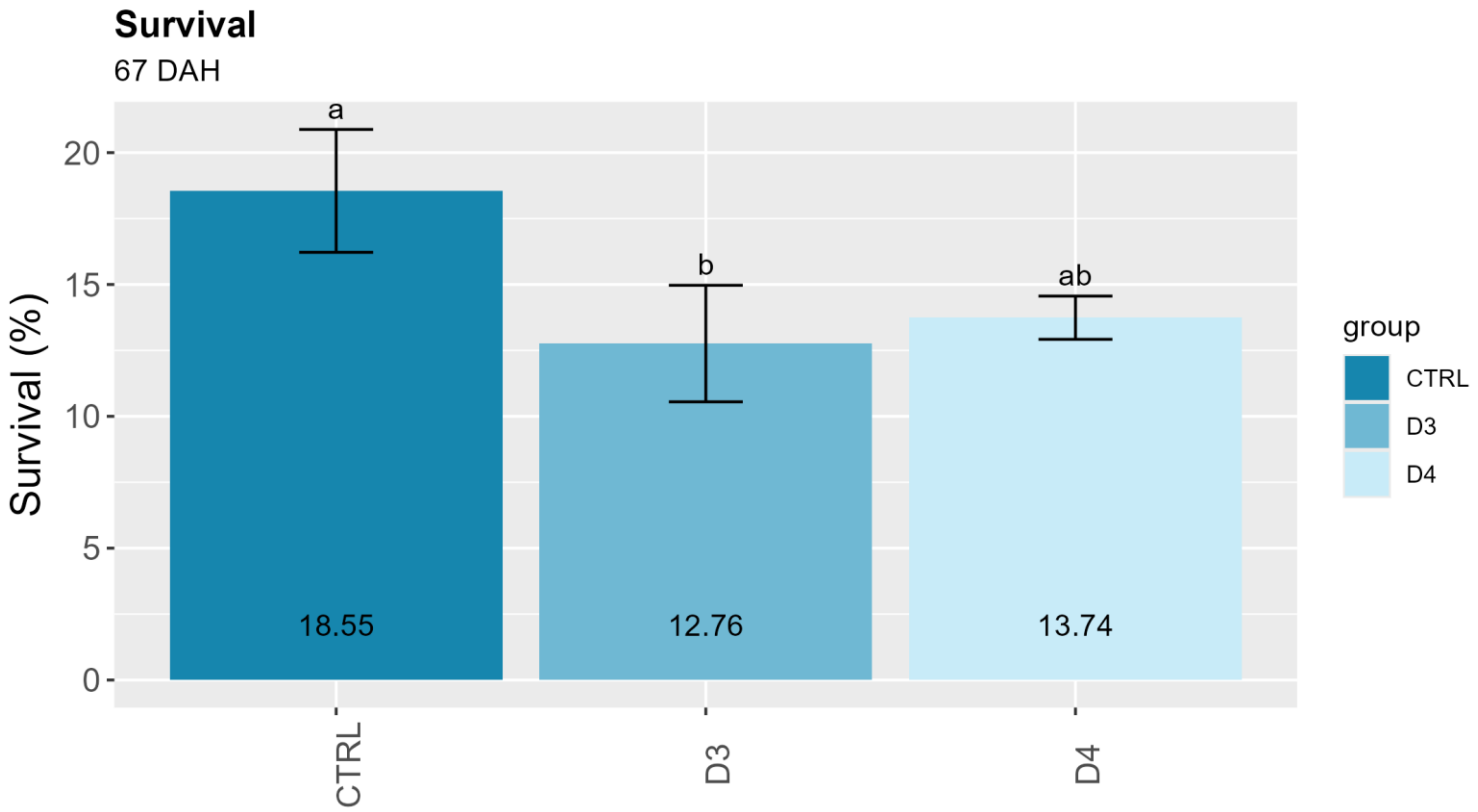
ZOOTECHNICAL



❑ At 67dph there were no significant differences in WW between treatments

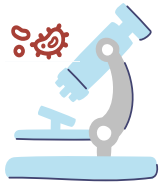
Trial: Cod4

ZOOTECHNICAL



❑ CRTL group showing slightly higher survival but not statistically significant from D4 group

Trial: Cod4



❑ Histology Summary

35 DAH	Control	D3	D4
Anterior Intestine	3	5	2
Posterior Intestine	3	4	3
Liver	2	4	3
Eyes	3	4	3
Gills	3	4	2

67 DAH	Control	D3	D4
Anterior Intestine	3	5	3
Posterior Intestine	3	4	3
Liver	3	4	2
Eyes	3	4	3
Gills	3	4	2

Marine fish larval and juvenile quality scoring system (Pacorig et al, 2022):
Scale from 1 (very poor development) to 5 (very well developed)

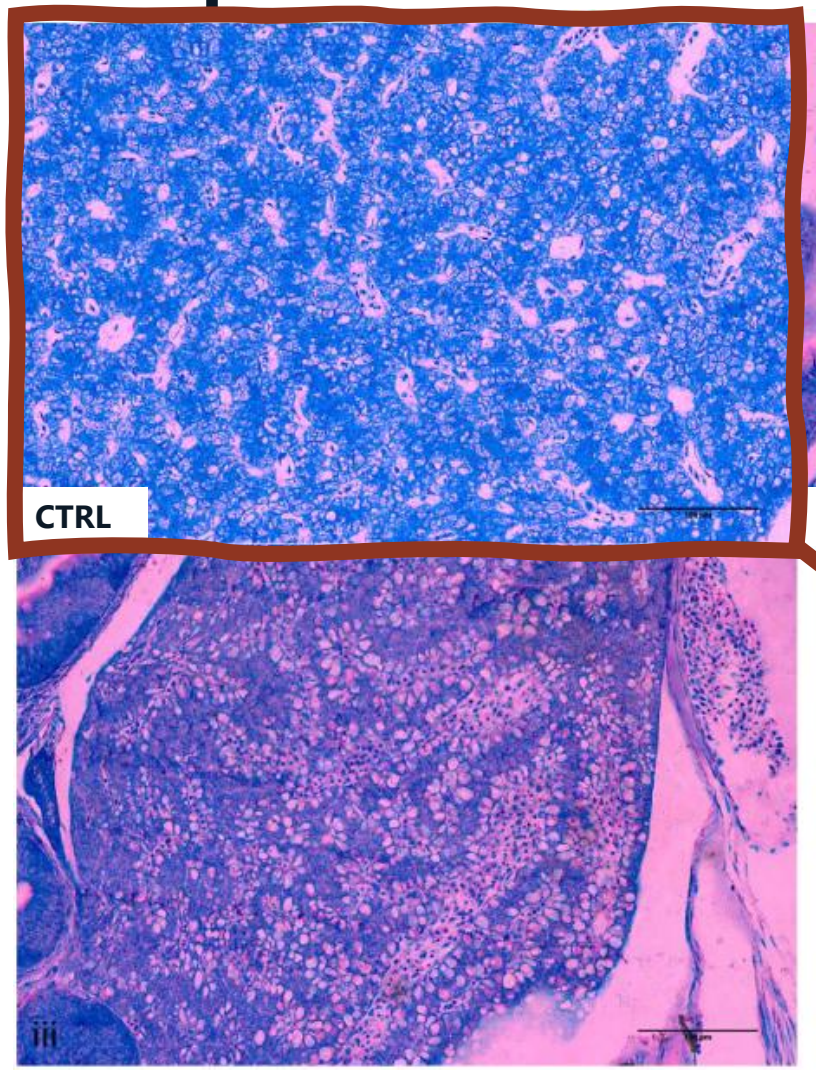
❑ At 35dph, introduction of **SPAROS D3** (15 days co-feeding) already associated with improved organ ontogeny.

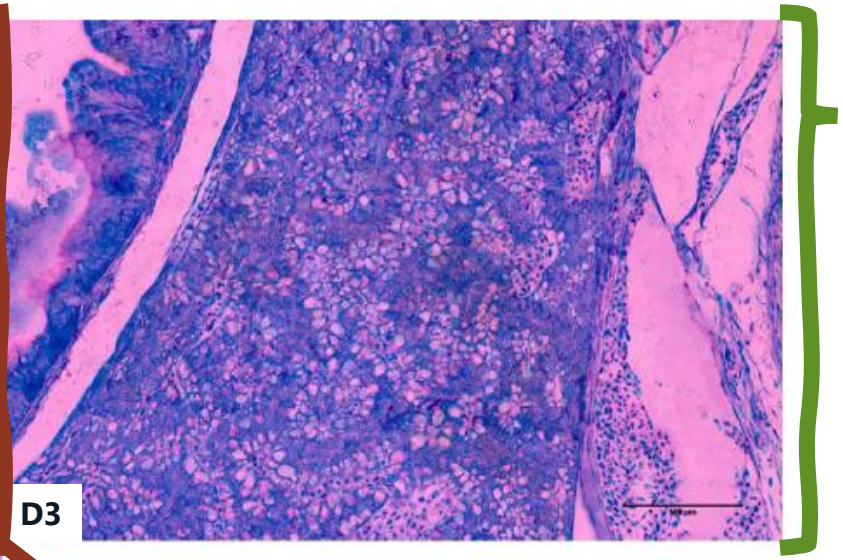
❑ At 67dph, **D3 group showed overall the best organ ontogeny.**

Trial: Cod4

HISTOLOGY

❑ 67dph – Liver





❑**D3 group** showing:

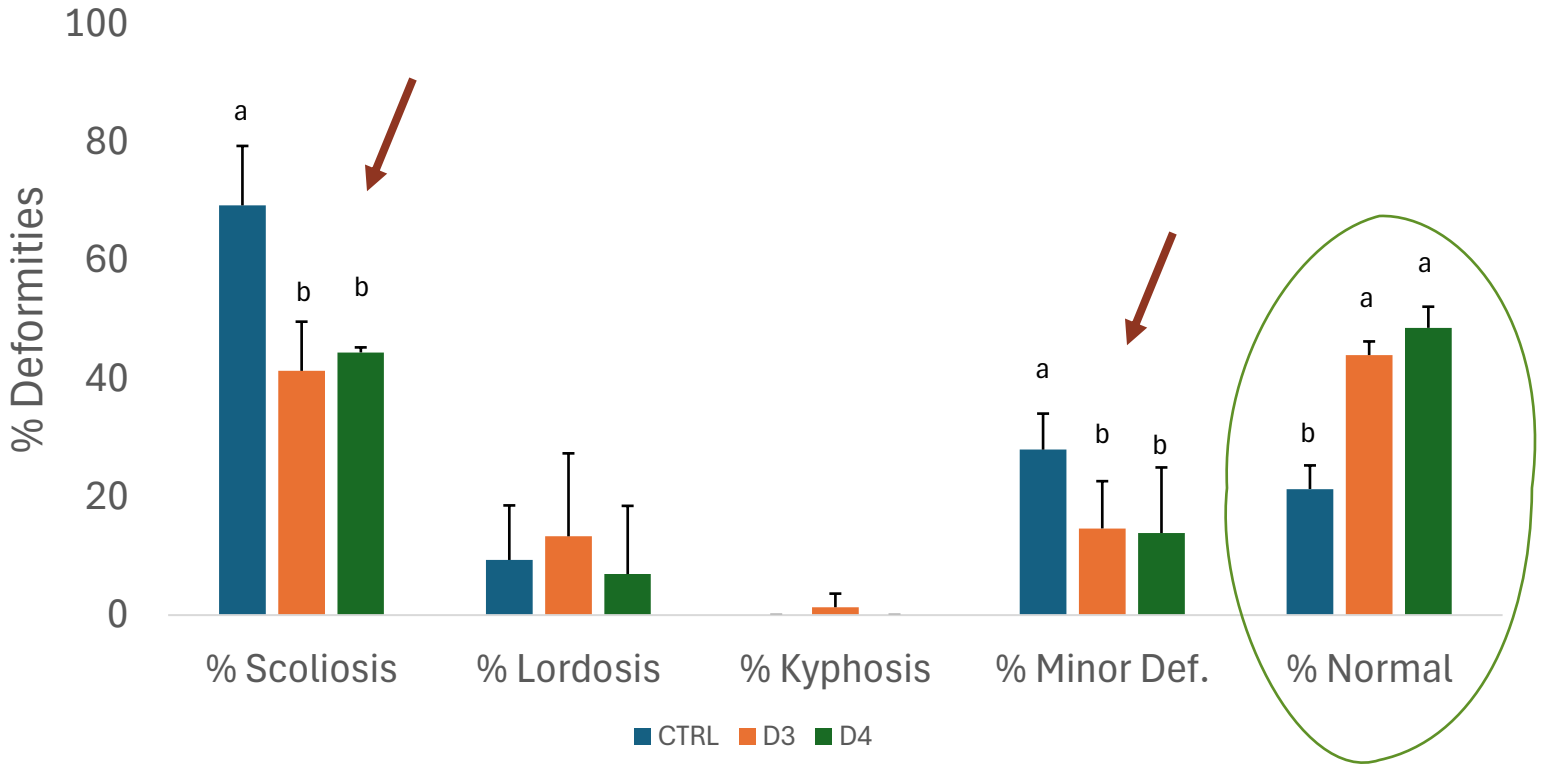
- normal fat deposition in the liver (~33%)
- uniform hepatocyte distribution
- no signs of cell degeneration

❑**CTRL** showing:

- ~27% lipid accumulation;
- some uneven cell distribution
- potential necrotic areas

Trial: Cod4

DEFORMITIES



- D3 and D4 groups showing significantly higher % of normal fish when compared to CTRL (44 & 49% vs 21%)

Final remarks – Cod4

ZOOTECHNICAL

- ❑ Cod larvae fed on both SPAROS diets showed good growth performance parameters
  - ❑ **CTRL group** with slightly higher survival, but high deformity % → **Increased eFCR** & **higher losses**

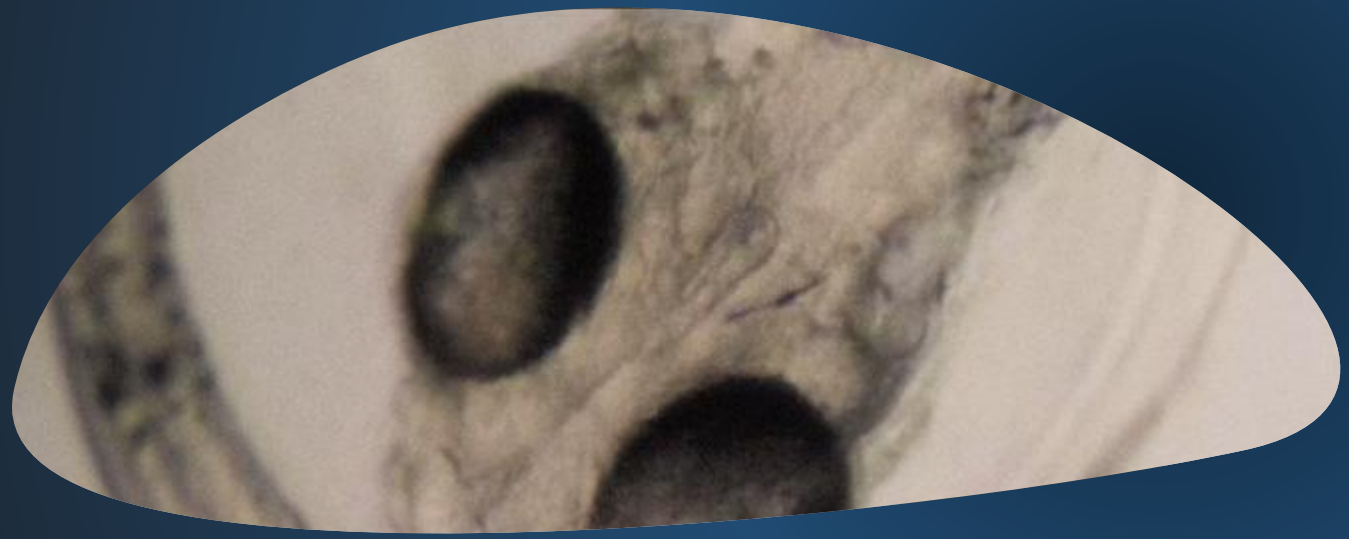
HISTOLOGY

- ❑Overall, **D3** presented the best organ ontogeny (67dph)

DEFORMITIES

- ❑**D3 and D4** groups presented the highest % of normal fish

Dietary levels of Calcium , Phosphorus and Ca:P ratio,:impact on cod larvae skeletal development



Trial Cod5

Trial: Cod5

@NTNU SeaLab

Objective:

- Study the effect of **dietary levels of Calcium (Ca), Phosphorus (P) and Ca:P ratio** on cod larvae skeletal development.

Trial features:

- Atlantic cod larvae from 3-50 dph

CTRL	Rotifers + Artemia AF + P2/0.6 diet
P2/0.4	Rotifers + Artemia AF + P2/0.4 diet
P2/0.8	Rotifers + Artemia AF + P2/0.8 diet
P1.5/0.4	Rotifers + Artemia AF + P1.5/0.4 diet
P1.5/0.6	Rotifers + Artemia AF + P1.5/0.6 diet

Live Feeds → 3-30 dph
Co-feeding → 15-30 dph
Inert Feeds → 31-50 dph

→ Earliest intro of inert diets in all trials;
Cod3: 27dph
Cod4: 20dph

- Microdiets: two levels of **P** (1.5 and 2.0%) and three **Ca:P ratios** (0.4, 0.6, 0.8)

Trial: Cod5

MAIN HIGHLIGHTS

- Tested **phosphorus** levels and **Ca:P** ratios have no impact on growth of Atlantic cod larvae

- **Ca:P ratio seems to have little impact** on skeletal mineralization and skeletal anomalies of cod

- Dietary Phosphorus level of 2% in feed is recommended to **improve skeletal mineralization** and **reduce skeletal anomalies**

Final remarks – Cod trials (EC & AQEXCEL)

ZOOTECHNICAL

- ❑ **Combination of CryoPlankton & SPAROS diets linked to** good growth performance in Atlantic cod larvae, *in line with commercial hatchery production.*

HISTOLOGY

- ❑ **Live feed: Cryo-µ, Cryo-S and Cryo-L** show a positive effect on organ ontogeny, when compared to Cryo-L only.
- ❑ **Microdiets: SPAROS D1 and D3 associated with** overall better organ ontogeny (namely gut, eye and liver), in comparison with SKRETTING diet.

❑ DEFORMITIES

- ❑ There was a clear reduction in skeletal deformities in cod fed SPAROS diets.
- ❑ 2% Phosphorus in feed is recommended for improved bone mineralization.

Final remarks – Cod trials (EC & AQEXCEL)

ZOOTECHNICAL

- **Combination of CryoPlankton & SPAROS diets linked to** good growth performance in Atlantic cod larvae, *in line with commercial hatchery production*.

HISTOLOGY

- **Live feed:** Cry… -L… on organ ontogeny, when compared to Cryo…
- **Microdiets:** SP… ass… better organ ontogeny (namely gut, eye and liver) in comparison wi… diet.

DEFORMITIES

- There was a clear reduction in skeletal deformities in cod fed SPAROS diets.
- A 2% Phosphorus in feed is recommended for improved bone mineralization.

There's NO "one size fits all…"

TAILORED NUTRITION for fish larvae is key!