Function and practical implementation of algal addition to grey mullet larval rearing tanks

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Background

- Adding algae ("greening") to larval rearing tanks to improve performance part of protocol to farm marine species world-wide.
- Unclear how algae addition contributes to larval growth and survival and if species specific.

✓ Algae produced turbidity(back-lighting) improves contrast of prey against background leading to better hunting success?

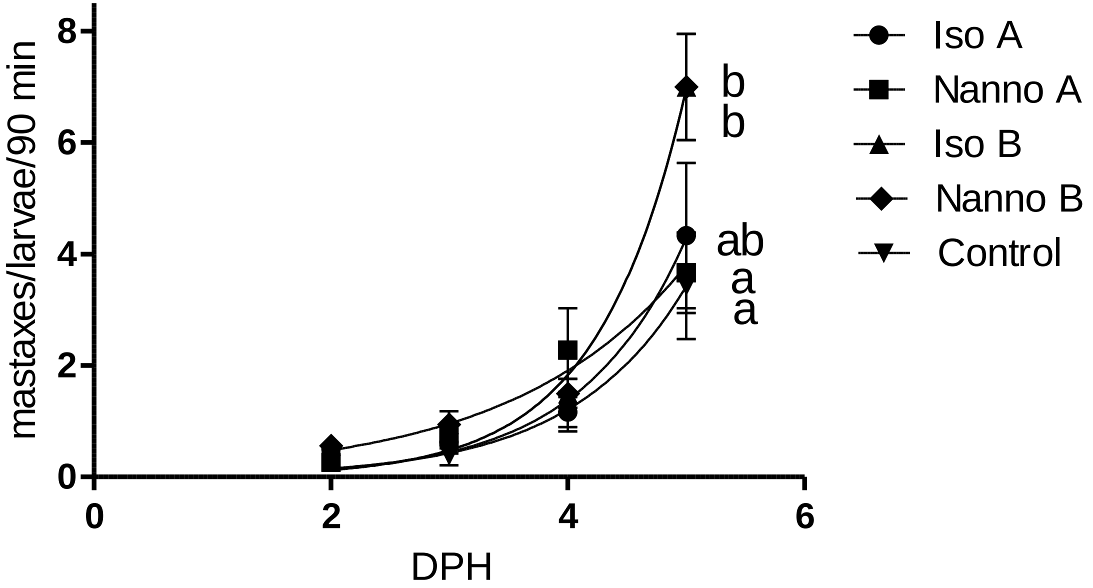
✓ Specific algal compounds stimulate the immune response and/or improve digestion and absorption?

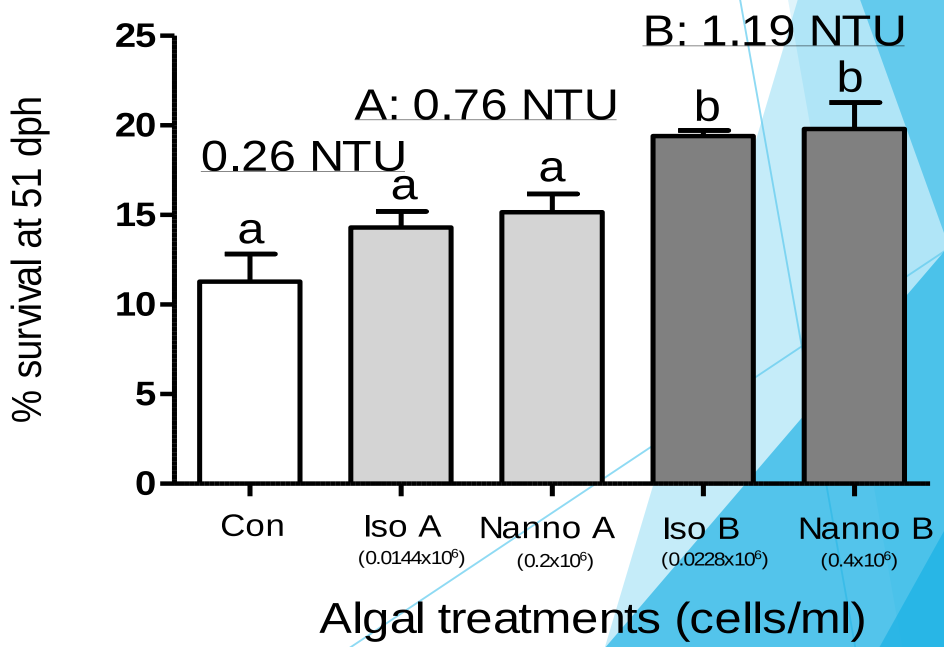
Aims

- Determine the effect of algae type (*Nannochloropsis oculata*, *Isochrysis galbana*) and turbidity on larval rotifer ingestion, growth and digestive tract enzyme ontogeny.
- Determine if the benefit of algal addition is due to it’s biochemical composition and/or resultant turbidity on larvae hunting success and performance

Effect of turbidity treatments on first feeding mullet larval prey ingestion and juvenile survival

Treatments	Designation	Turbidity (NTU)
Control (no microalgae)	Control	0.26 ± 0.01[a]
Isochrysis galbana A (0.0144 x 10^6 cell/ml)	Iso A	0.77 ± 0.01[b]
Nannochloropsis oculata A (0.2 x 10^6 cells/ml)	Nanno A	0.75 ± 0.01[b]
Isochrysis galbana A (0.0288 x 10^6 cell/ml)	Iso B	1.18 ± 0.02[c]
Nannochloropsis oculata A (0.4 x 10^6 cells/ml)	Nanno B	1.20 ± 0.02[c]





- No effect of algae turbidity treatments on the ontogeny of DT enzymes
- But some DT enzyme levels were affected by diet.

Pancreatic enzymes-Lipase

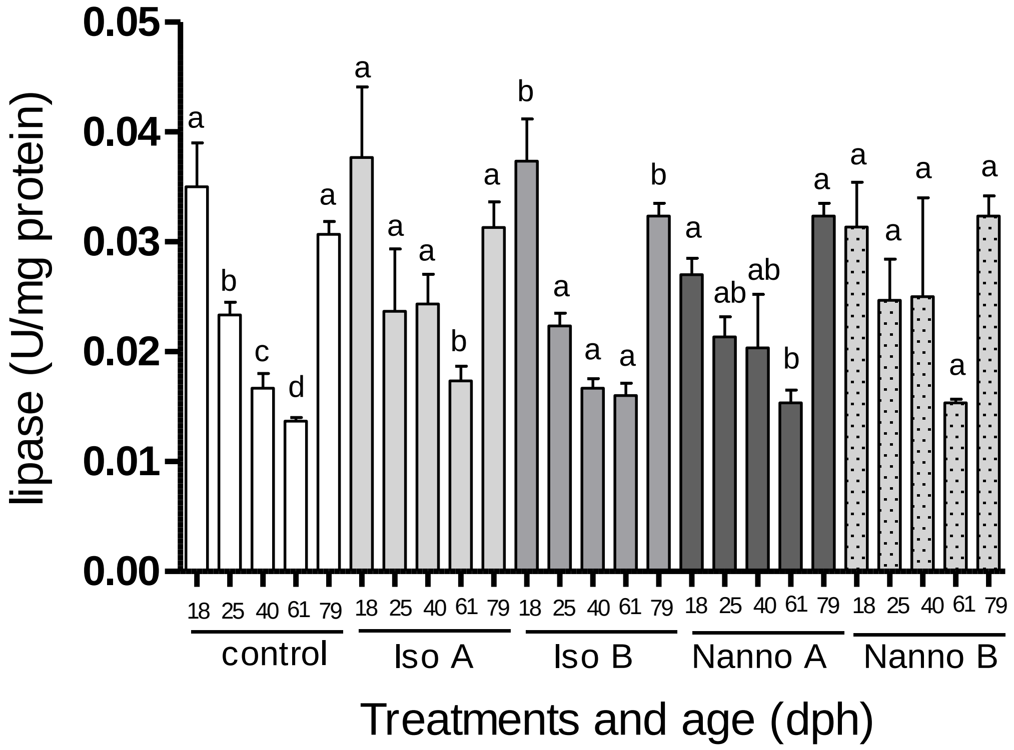


Table 19.1.5 Composition (%) of food used to feed the grey mullet at different stages of development.

Feed	Enriched Rotifers*	Unenriched *Artemia***	Enriched *Artemia****	Caviar (Bernaqua, Belgium) †	*Ulva lactaca* (IOLR, Israel)****	Ranaan Dry feed (RDF, Israel)†
Days fed (dph)	1-23	15	16-24	25-50	25-50	50-79
Protein	48.2	56.2	53.1	55	34	56
Lipid	14.0	17.0	28.7	15	7.4	14
Carbohydrate	18.5	3.6	3.5	8	56	1
Ash	9.3	7.6	2	12	2.6	14.8

*Demir and Diken 2011, **Garcia-Ortega et al. 1998, ***Koca et al 2015, ****analysis at IOLR, †according to manufacturer

- Mullet lipase production largely followed dietary lipid.

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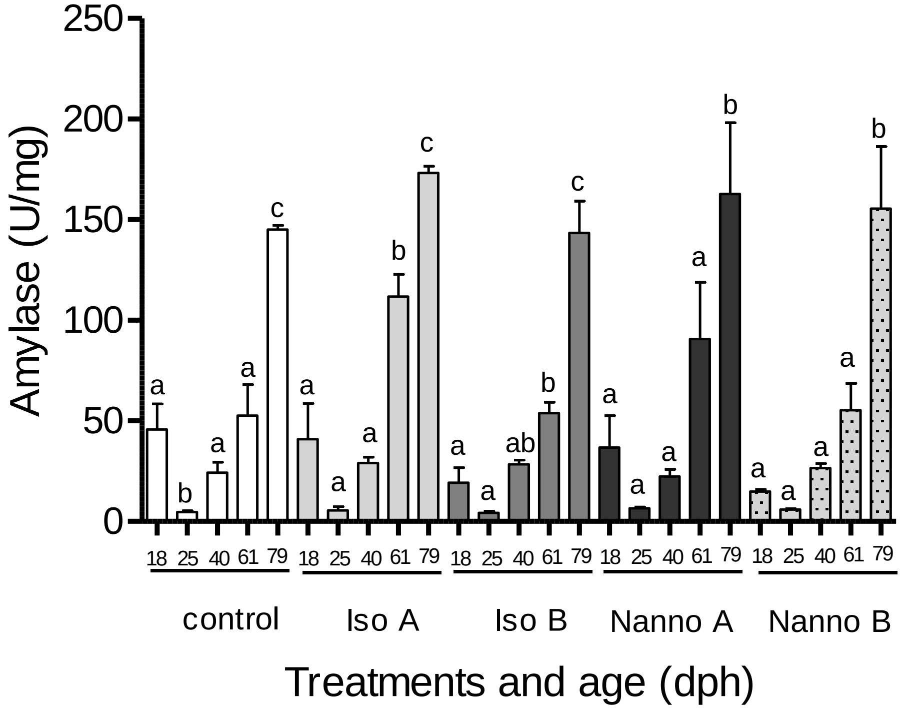
Pancreatic enzymes-amylase



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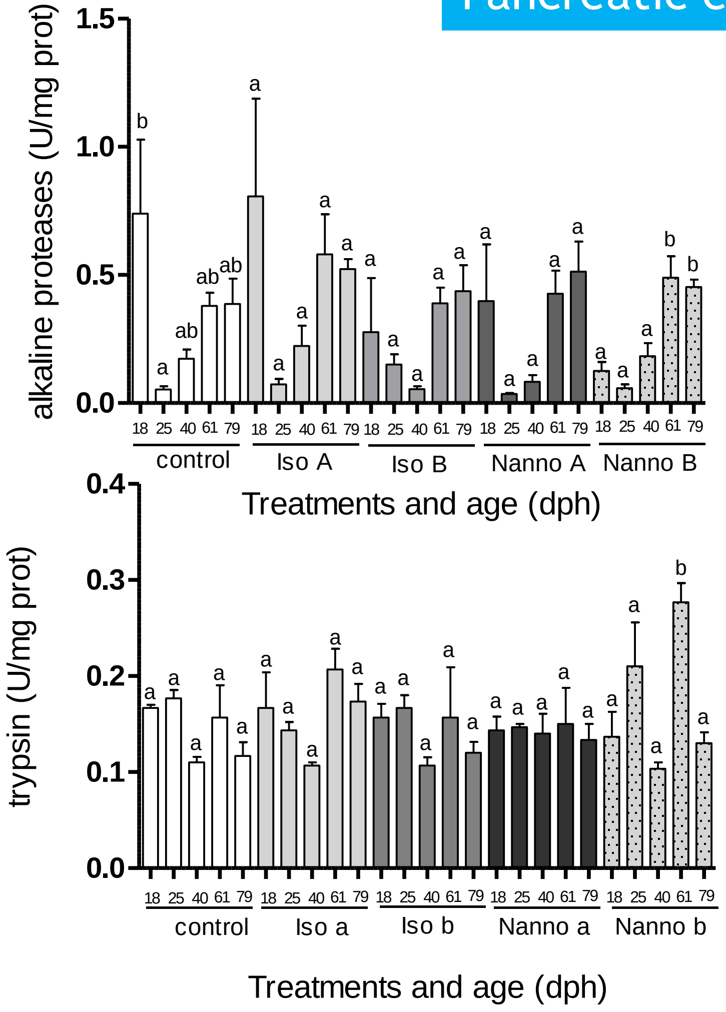
- Mullet amylase production largely genetically programmed.

Pancreatic enzymes-alkaline protease, trypsin



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- Mullet alkaline protease falls from 18-25 dph when fish are weaned from high protein rotifers and Artemia to 1:1 caviar: ulva diet to 50 dph. Less access to plant protein.
- Similar increase as amylase (25-79 dph)
- Increasing amylase activity exposing more plant protein for digestion
- Mullet trypsin independent of diet and not significantly different at all ages.

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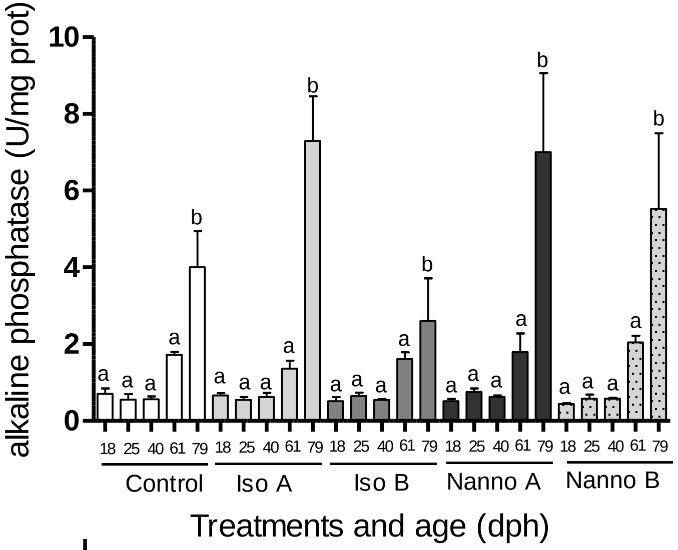
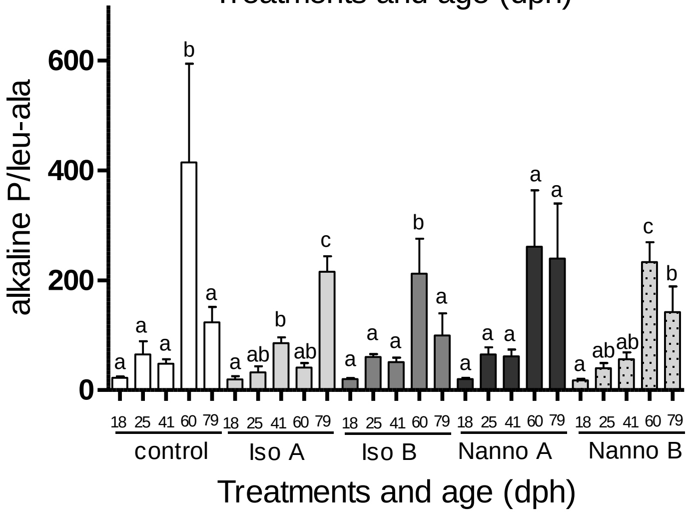
BBM enzymes





- Mullet BBM Alkaline phosphatase (AP) is a marker for nutrient absorption e.g. lipid, glucose, calcium and inorganic phosphate. Peaked at 79 dph.
- Mullet AP/leu-ala ratio (indicator of gut maturation) peaked at 61 dph but then declined in 79 dph.

- BBM production largely genetically programmed

Summary

- Most effective turbidity level was 1.2 NTU (prey consumption and survival).
- Rotifer feeding, due to turbidity, has long term effects on older larvae and juveniles.
- Ontogeny of enzymes genetically based. But diet composition can influence specific activity of lipase and total alkaline proteases.
- Late age of the carnivorous-herbivorous shift supported by steadily increasing activity (ca 30x) of amylase (25-79 dph).
- 61-79 dph grey mullet juveniles (*ca* size of juvenile mullet moving to estuaries) capacity to digest protein and starch -exploit starch rich micro- and macroalgae as well as benthic organisms.
- This study appears to suggest that turbidity plays an important role in prey consumption and larval performance or does it?

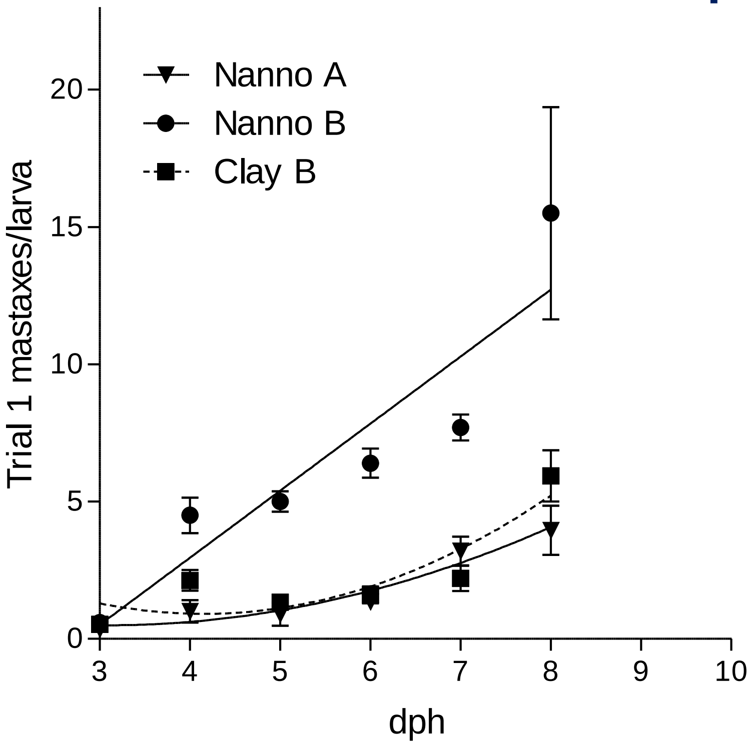
Aim

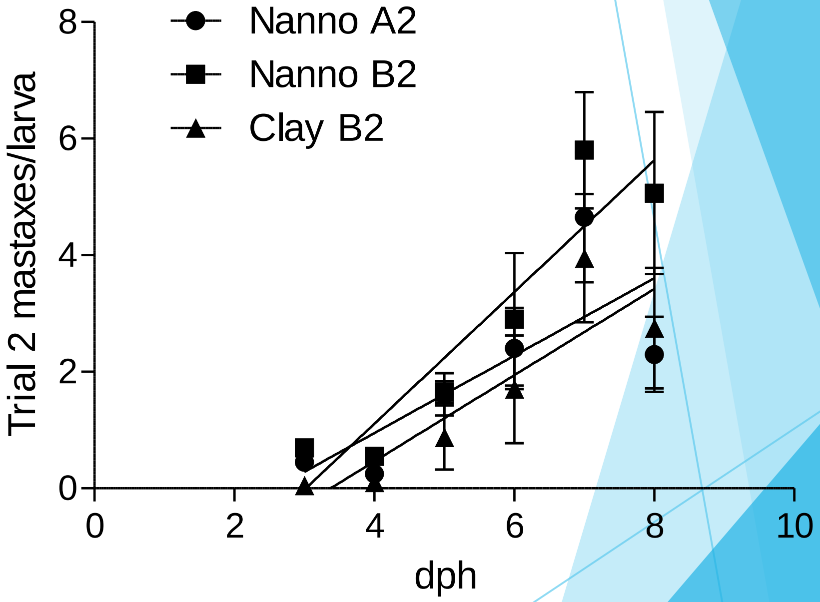
Determine if the benefit of algal addition is due to it’s biochemical composition and/or resultant turbidity on larvae hunting success and performance.

Hypotheses

- Algae produced turbidity is the main factor improving larval rotifer ingestion, growth and survival. Inert clay produced turbidity should be equally effective.
- Algae biochemical composition is the main factor improving larval rotifer ingestion, growth and survival. Clay produced turbidity is less effective than algae produced turbidity.

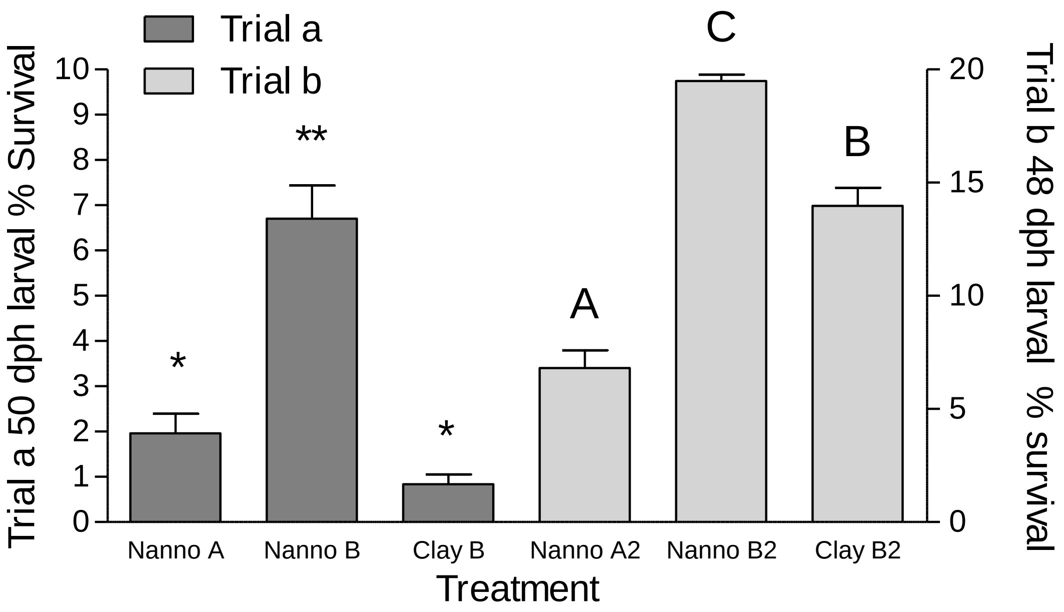
Effect of red (trial 1) or white (trial 2) clay on rotifer consumption (mastaxes/larva)

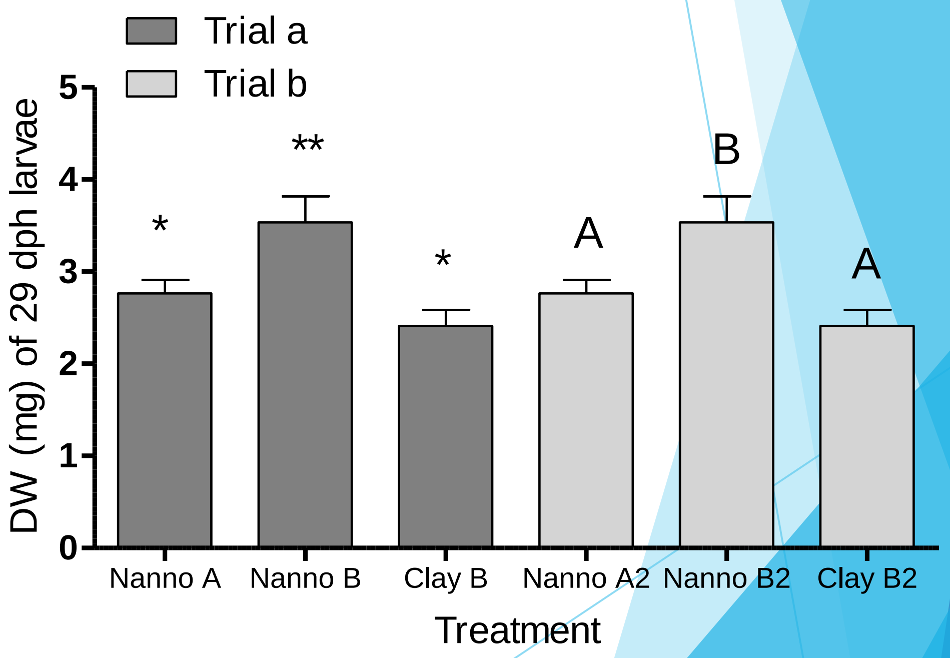




- curve of the Nanno B treatment was significantly different (P<0.05) than the curves of Nanno A(2) and Clay B(2) in trials a and b.

Effect of red (trial 1) or white (trial 2) clay on survival and growth





Summary

- A compound/nutrient in live algae may be the dominant factor improving larval performance and not turbidity in grey mullet.
- Clay turbidity replaced the use of algae in commercial culture of halibut suggesting this effect is species specific.
- Recommend the use of algae (*N. oculata* or *I. galbana*) to produce a turbidity of 1.2 NTU in the grey mullet rearing tanks.

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Thank you

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