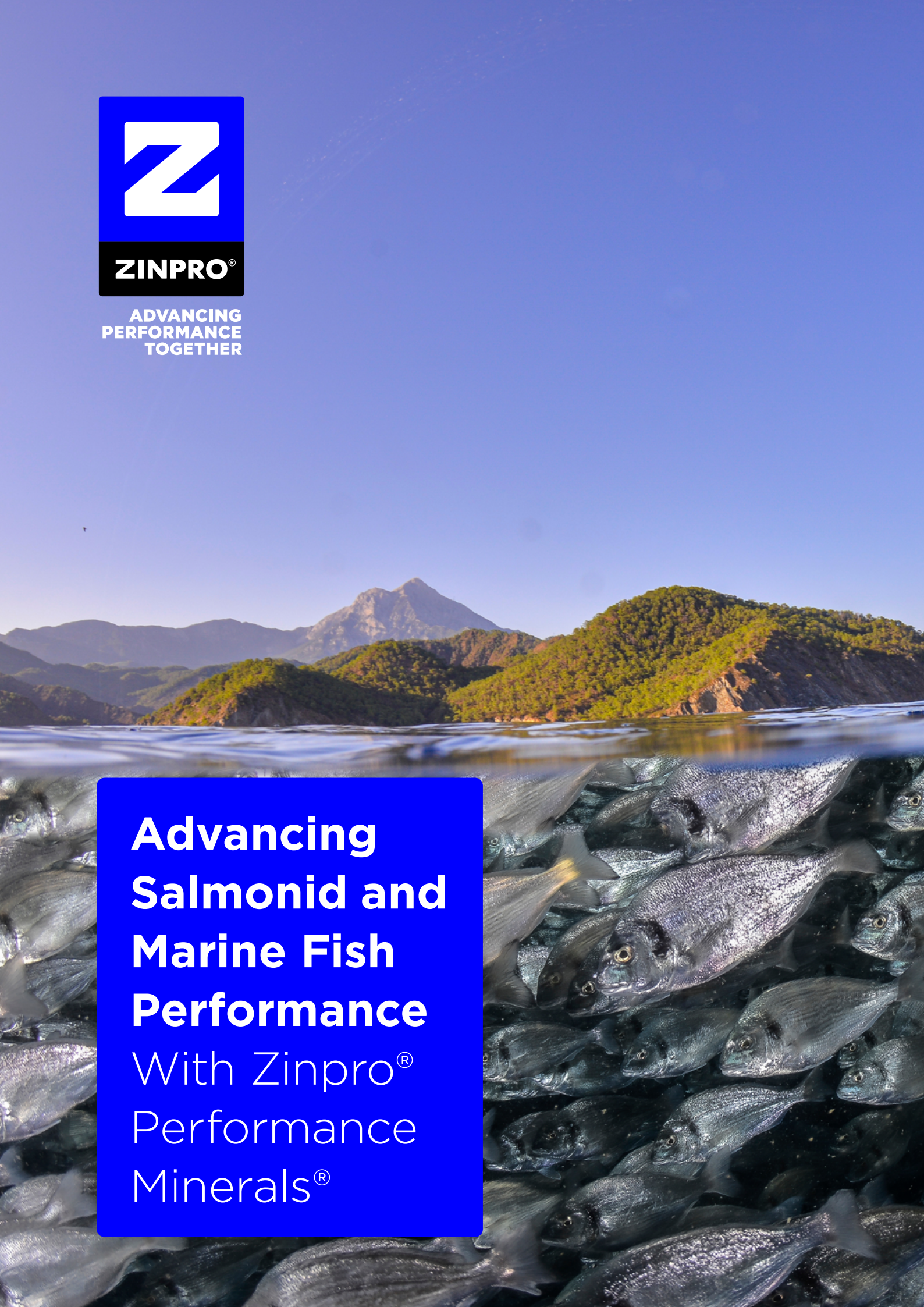
ZINPRO®

ADVANCING PERFORMANCE TOGETHER



Advancing Salmonid and Marine Fish Performance

With Zinpro® Performance Minerals®

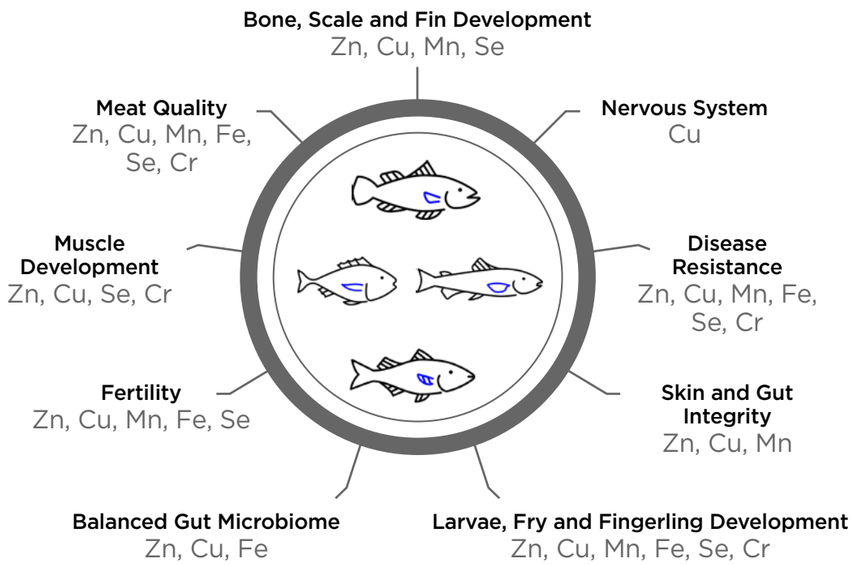
Zinpro Performance Minerals Deliver Proven Benefits for Salmonid and Marine Fish Performance, Health and Meat Quality

Trace minerals are fundamental to cellular function and metabolic activity, making them essential for the nutrition, performance and overall health of salmonids and other marine fish.

Zinpro Performance Minerals (ZPM) are uniquely designed to deliver key trace minerals — including zinc, manganese, copper, iron, selenium and chromium — in forms that fish can absorb and utilize efficiently. Extensive research demonstrates that incorporating ZPM into aquaculture diets supports optimal growth, strengthens immune function and enhances product quality.

Providing the right source of trace minerals, with high bioavailability, is critical to meeting the nutritional needs of finfish throughout the life cycle in a sustainable and productive way.

Targeted trace mineral support is essential to fish performance, health and meat quality.



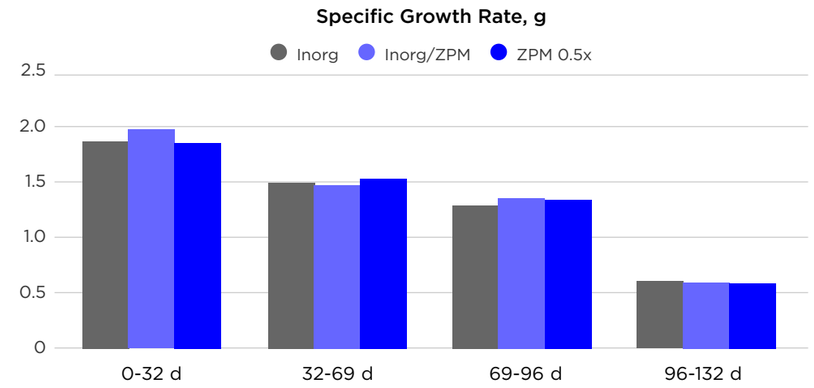
Study 1

Growth Performance and Health Response of European Sea Bass Receiving Inorganic Minerals or 50% Zinpro Performance Minerals

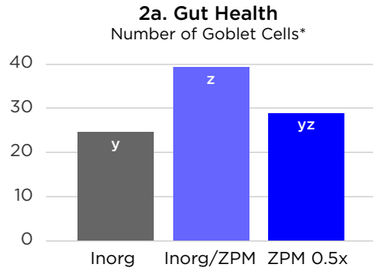
Key Findings

- Zinpro Performance Minerals (ZPM) supplemented at 50% of inorganic mineral levels maintained growth performance indices in European sea bass (Fig. 1), indicating that ZPM is the more effective trace mineral source.
- Half or full replacement of inorganic trace minerals with ZPM significantly ($P < 0.05$) increased the number of skin and intestinal goblet cells of European sea bass (Fig. 2), demonstrating defense against pathogens.
- Glutathione peroxidase (GPx) activity increased significantly ($P < 0.05$) in fish supplemented with ZPM at 50% of inorganic trace mineral levels (Fig. 3), indicating ZPM (in particular Zinpro® Availa® Se vs. selenite) is more effective at sustaining antioxidant capacity of European sea bass.

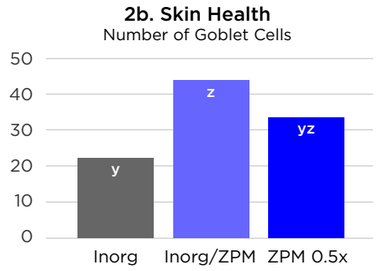
Growth Performance Fig. 1



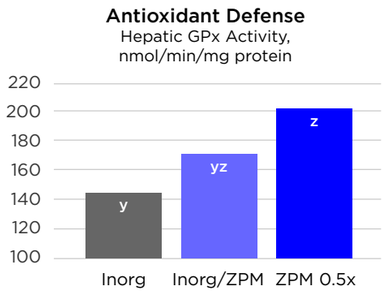
Health Fig. 2



*Longitudinal intestinal section



Health Fig. 3



Study Criteria

This study compared the efficacy of ZPM (metal-amino acid complexes) with inorganic minerals (sulfates) in the diet of European Sea bass. Growth performance and health biomarkers were evaluated.

Mineral, ppm	Inorg	Inorg/ZPM		ZPM 0.5x
Zn	100	50	50	50
Cu	6	3	3	3
Mn	24	12	12	12
Fe	80	40	40	40
Se	0.24	0.12	0.12	0.12

Initial body weight: 15 g
Stocking density: 1.24 kg/m^3
Replications: 4
Duration: 120 days
Salinity: 34 ppt

46% CP/18% Fat
19% fish meal
8% fish oil
Feeding: 2x/day to satiation

Location:
Hellenic Centre for Marine Research
Crete, Greece

Source: Figueiredo-Silva et al., 2019. Aquaculture Europe, October 7-10, Berlin, Germany. | 20177021

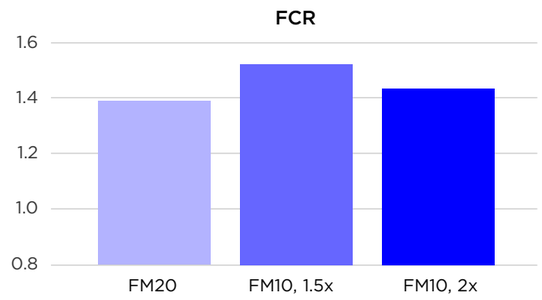
Study 2

Zinpro Performance Minerals Are a Cost-Effective Solution for Reducing Fish Meal in European Sea Bass Diets

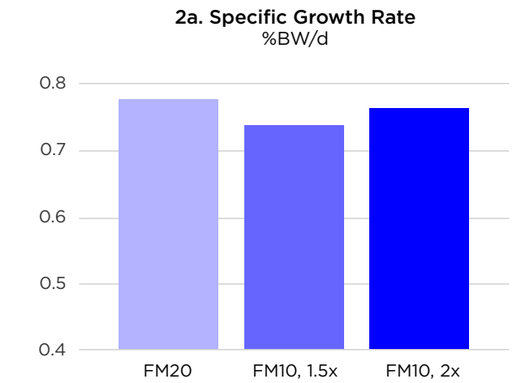
Key Findings

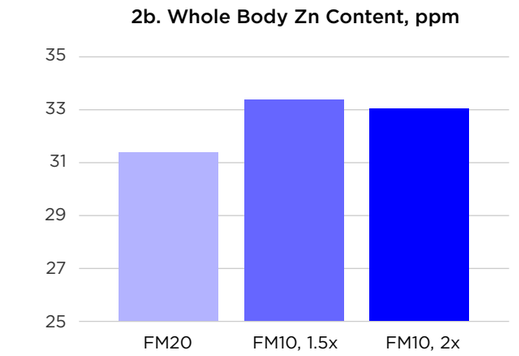
- Supplementation with Zinpro Performance Minerals contributes to a cost-effective reduction of fishmeal (FM) in sea bass feeds from 20 to 10%, while respecting the upper limits for TM levels in the EU.
- One study limitation was that dietary Se level could not be maintained at or below 0.5 ppm. The combined contribution of Se from feed ingredients, especially FM and other marine-derived materials, makes it practically impossible to formulate aqua feeds that meet the EU's allowable Se limits.
- Decreasing FM in the diet by half, while raising the ZPM premix level to 1.5 or 2x the TM level included in the Control (FM20) diet, maintained growth performance of European sea bass through feed conversion ratio (FCR; Fig. 1) and specific growth rate (SGR; Fig. 2a). Additionally, a slight numerical increase in whole body Zn content (Fig. 2b) was observed for both treatments including ZPM.
- Decreasing dietary FM level by 50% revealed that European sea bass performance was better sustained when 2x the previous mineral level was included from ZPM. FCR and SGR improved by 3 and 5%, respectively, when ZPM was included at 2x vs 1.5x the mineral inclusion level of FM20.
- While lower nutrient availability in FM10 diets, as a result of higher plant protein and antinutritional factor content, likely played a role in performance observed, there was an economic benefit to the study. This strategic approach to formula modification resulted in an 8.5% feed cost savings, which supports a more sustainable, cost-efficient option for the aquaculture industry.

Growth Performance Fig. 1



Growth Performance Fig. 2





Study Criteria

This study evaluated a cost-effective 50% reduction of FM in European sea bass diets through increasing the dietary ZPM premix by 1.5x or 2x.

Mineral, ppm	FM20	FM10, 1.5x	FM10, 2x
Zn	50.1	75.0	100.0
Cu	3.0	4.5	6.0
Mn	12.0	18.0	24.0
Fe	40.1	60.0	80.0
Se	0.12	0.18	0.20

Initial body weight: 47 g
Density: 3.5 kg/m^3
Replications: 4
Duration: 12 weeks
Salinity: 34 ppt

48% CP/16% Fat
Feeding: 2x/day to satiation

Location:
Hellenic Centre for Marine Research
Crete, Greece

Source: Figueiredo-Silva et al., 2021. Aquaculture Europe, October 4-7, Madeira, Portugal. | 20197036

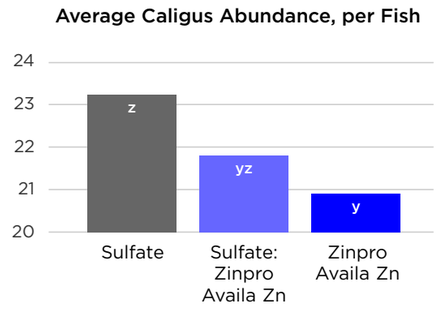
Study 3

Zinpro® Availa® Zn Improves Atlantic Salmon Growth and Resistance to Sea Lice

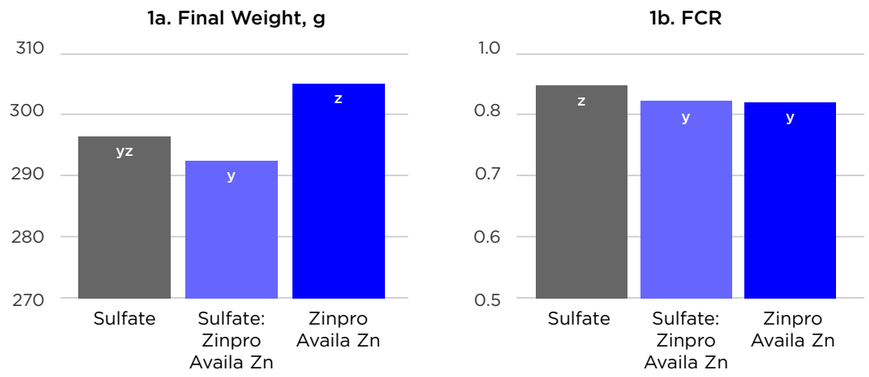
Key Findings

- Zinpro Availa Zn supplemented at 50% the level of inorganic zinc (60 vs. 120 ppm) resulted in numerically higher final weight and significantly ($P < 0.05$) improved FCR of Atlantic salmon (Fig. 1).
- Zinpro Availa Zn supplemented at 50% of inorganic zinc was significantly ($P < 0.05$) more efficient in reducing Caligus abundance on salmon (Fig. 2).
- Skin score evaluation indicated fish fed Zinpro Availa Zn had better skin integrity than fish fed either diet containing inorganic zinc.
- In this study, the best performance and health outcomes for Atlantic salmon were reached with 20% fishmeal and 60 ppm supplemental Zn from Zinpro Availa Zn.
- It is important to remember that necessary supplemental levels of Zn and other essential trace minerals are expected to rise as the amount and availability of trace minerals in plant based diets do not match that of fishmeal. Progressive and sustainable aquaculture will require downward shifts in dietary FM and more extensive use of plant proteins.

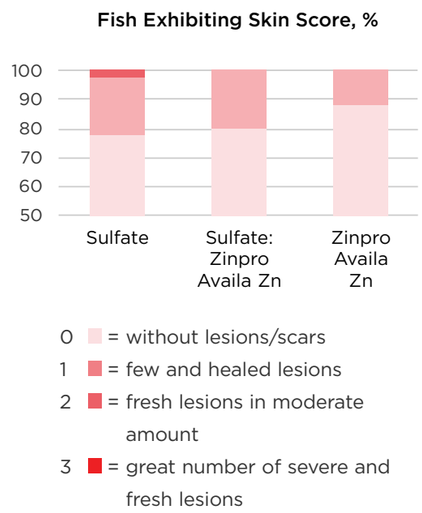
Health Fig. 2



Growth Performance Fig. 1



Health Fig. 3



Study Criteria

The objective of this study was to evaluate the impact of supplemental zinc source and level on growth performance and the resistance of Atlantic salmon (*Salmo salar*) against sea lice (*Caligus rogercresseyi*).

	Zn Supplementation, ppm	
	$ZnSO_4$	Zinpro Availa Zn
Sulfate	120	-
Sulfate: Zinpro Availa Zn	60	60
Zinpro Availa Zn	-	60

Initial body weight: 118 g
Stocking density: 45 fish/tank (600 L)
Replications: 4
Duration: 80 days
(60 d growth + 20 d Caligus challenge)
Salinity: 32 ppt

47% CP/20% Fat
20% fish meal
6% fish oil
Feeding: 2 times/day to satiation

Location:
Fundación Chile
Puerto Montt, Chile

Source: Sun et al., 2017. World Aquaculture Society LACQUA, November 7-10, Mazatlán, Mexico. | 20167017

Study 4

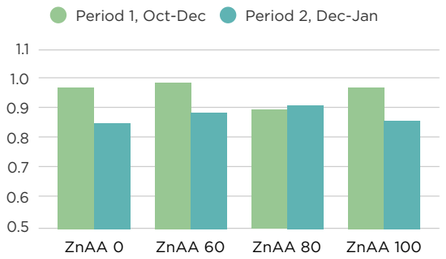
Zinc Deposition in Atlantic Salmon Responds Linearly to Zinc Supplementation During Smoltification Phase

Key Findings

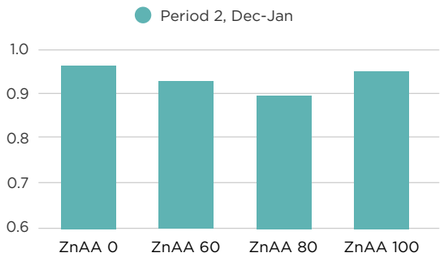
- Basal diets contained 60 ppm Zn from contribution of raw material.
- Zinc supplementation maintained SGR during the 8-week feeding period (Period 1). During the 4-week smoltification period (Period 2), SGR and FCR were numerically improved with Zn supplementation. Supplementing with 80 ppm Zn increased SGR by 7% (Fig. 1a) and reduced FCR by 6.5% (Fig. 1b) compared to the Control.
- Supplementing salmon diets with 60, 80, or 100 ppm Zn from Zinpro® ProPath® Zn, significantly ($P < 0.05$) but moderately increased dietary Zn digestibility (ADC) by up to 16% (Fig. 2a). Supplementation with 100 ppm Zn increased whole body and skin Zn content by 1.7 and 2.5x, respectively (Fig. 2b). Though greater absorption of Zn was evidenced in higher tissue Zn, lack of significant improvement in fish performance indicates that Zn digestibility is not the best indicator of fish response to Zn supplementation.
- Whole body and skin Zn deposition increased linearly from 60 to 100 ppm supplemental Zn. These results suggest that Atlantic salmon may benefit from evaluating even higher Zn inclusion levels during smoltification.

Growth Performance Fig. 1

1a. Specific Growth Rate
%BW/d

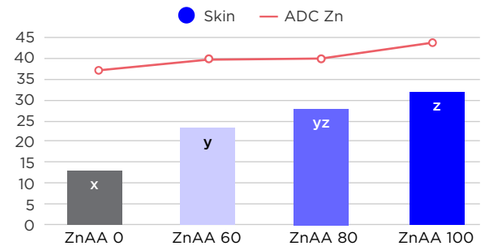


1b. FCR

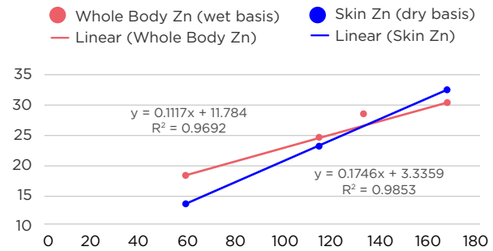


Digestibility & Nutrient Retention Fig. 2

2a. Skin Zn Deposition and Dietary Zn Digestibility (ADC)
ppm (dry basis)



2b. Relationship Between Dietary Zn Level and Zn Content in Whole Body and Skin, ppm



Study Criteria

This study was designed to assess the optimum level of supplemental Zinpro ProPath Zn in the diet of Atlantic salmon during the smoltification period. ProPath Zn was evaluated based on zinc deposition in skin and whole body.

Treatment	Zn, ppm Zinpro ProPath Zn
ZnAA 0	0
ZnAA 60	60
ZnAA 80	80
ZnAA 100	100

Initial body weight: 43 g
Density: 60 fish/0.5 m^3 tank
Replications: 4
Duration: 12 weeks
- Period 1: Oct-Dec (8 wks)
  L:D, 24:0 2 wks
  L:D, 12:12 6 wks, winter signal
- Period 2: Dec-Jan (4 wks)
  L:D 24:0, smoltification

Salinity: 0 ppt

45% CP/20% Fat
16% FM, 21% SPC, 12.5% CGM, 12% WG
Feeding: in excess to allow max feed intake from auto-feeders

Location:
Nofima
Sunndalsøra, Norway

Source: Zinpro Corporation, 2021. Effect of Zinpro ProPath on Salmon Smoltification. Internal Report. | 20187027

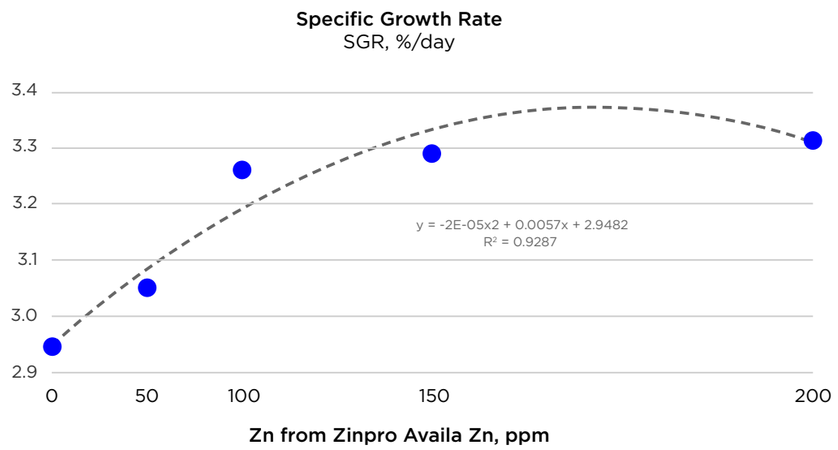
Study 5

Effects of Zinpro Availa Zn on Asian Sea Bass Growth Performance And Zinc Deposition

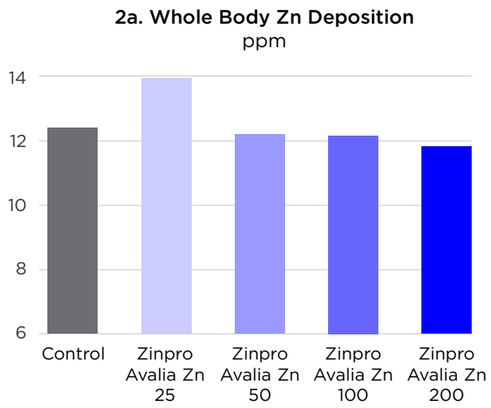
Key Findings

- Increasing the level of supplemental Zn as Zinpro Availa Zn from 0 to 50 ppm significantly ($P < 0.05$) improved SGR (Fig. 1).
- Zinpro Availa Zn supplementation increased whole body and bone zinc content (Fig. 2).
- Results suggest that 50 ppm zinc from Zinpro Availa Zn is the minimum supplemental level for Asian sea bass under the conditions of this study which were used to promote growth performance and deposition of zinc for body reserves.

Growth Performance Fig. 1



Growth Performance Fig. 2



2b. Tissue Zn Deposition
ppm

Treatment

	Control	Zinpro Availa Zn 25	Zinpro Availa Zn 50	Zinpro Availa Zn 100	Zinpro Availa Zn 200
Bone	47.03	47.97	51.85	53.45	52.68
Liver	12.20	16.55	19.27	18.62	18.22
Fillet	5.22	5.95	6.38	6.76	7.36

Study Criteria

This study was designed to assess the optimum level of supplemental Zinpro Availa Zn in the diet of Asian sea bass (*Lates calcarifer*). Zinpro Availa Zn was evaluated based on parameters measured for Zn deposition and growth performance.

Treatment	Zn, ppm Zinpro Availa Zn
Control	0
Zinpro Availa Zn 25	25
Zinpro Availa Zn 50	50
Zinpro Availa Zn 100	100
Zinpro Availa Zn 200	200

Initial body weight: 3.5 g
Density: 40 fish/tank (500 L)
Replications: 4
Duration: 8 weeks

47% CP/8% Fat
Feeding: 3x/day, 2-3.5% BW

Location:
Kasetsart University
Bangkok, Thailand

Source: Jintasataporn et al., 2016.
ISFNF, June 5-10, Sun Valley, Idaho, USA.

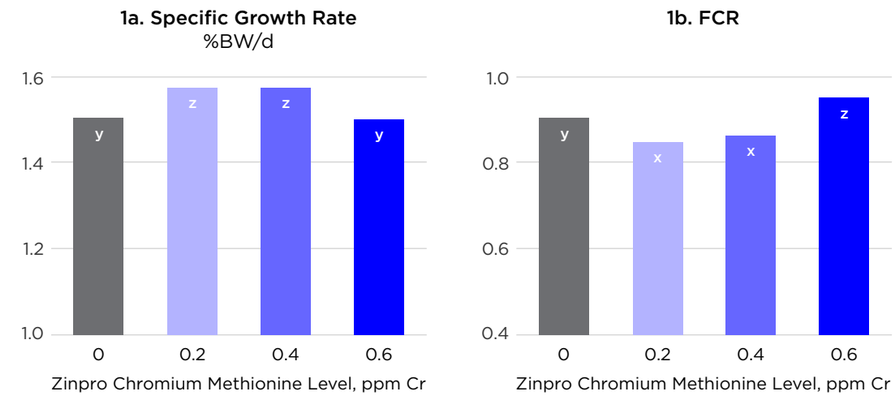
Study 6

Zinpro® Chromium Methionine* Improves Performance and Protein Retention of Atlantic Salmon

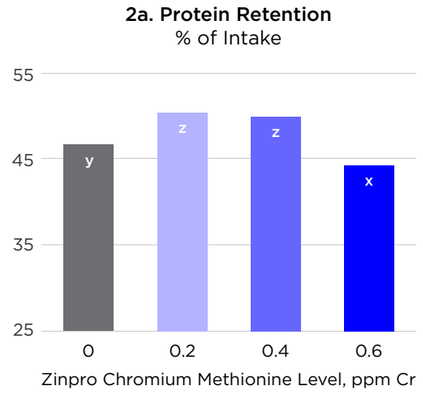
Key Findings

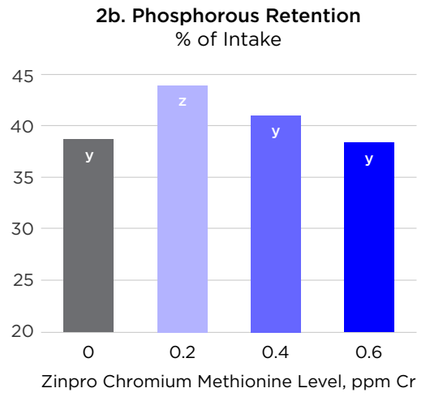
- Supplementation with Zinpro Chromium Methionine complex did not affect salmon survival rate, which was at or above 98%.
- Supplementation with Zinpro Chromium Methionine complex at 0.2 ppm:
  - Resulted in a 6% economic advantage over Control
  - Increased SGR (Fig. 1a) by 3% and FCR (Fig. 1b) by 7%
  - Increased retention of protein (N; Fig. 2a) by 7% and phosphorous (P; Fig. 2b) by 13%
  - Increased carcass yield by 19% and fillet yield up to 3% (Fig. 3)
- Performance effects are associated with better glucose (energy) utilization, which was indicated by increased glucokinase activity and glycogen content in liver (data not shown).

Growth Performance Fig. 1

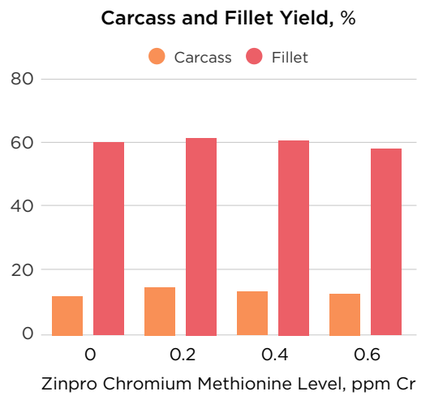


Nutrient Retention Fig. 2





Meat Quality Fig. 3



* Zinpro Chromium Methionine is sold as either Zinpro® Availa® Cr or Zinpro® MICROPLEX® depending on the region.

Study Criteria

Evaluate efficacy of Zinpro Chromium Methionine complex on survival, performance and nutrient retention of Atlantic salmon.

Supplemental Chromium Methionine Level, ppm Cr

0	0.2	0.4	0.6

Initial body weight: 57 g
Density: 25 fish/tank
Replications: 4
Duration: 95 days

42% CP/22% Fat
Feeding: 3x/day

Location:
RIASEARCH (SPAROS)
Portugal

Source: Figueiredo-Silva et al., 2024. WAS AQUA 2024, August 26-30, Copenhagen, Denmark. | 20206014

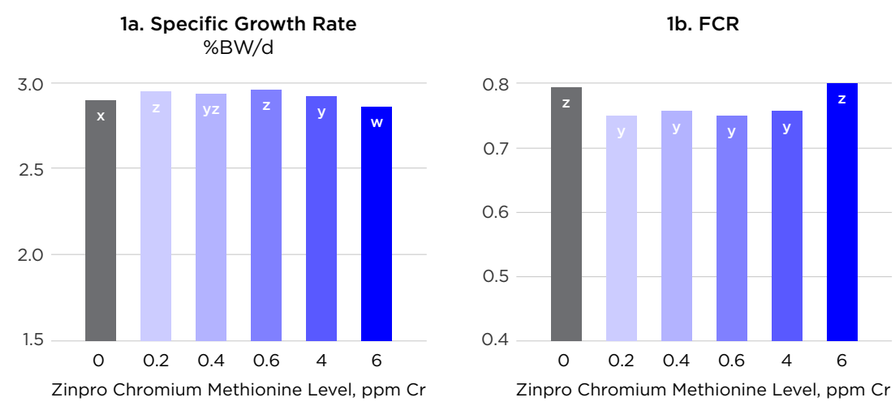
Study 7

Efficacy and Tolerance of Zinpro Chromium Methionine* on Survival, Performance and Nutrient Retention of Rainbow Trout

Key Findings

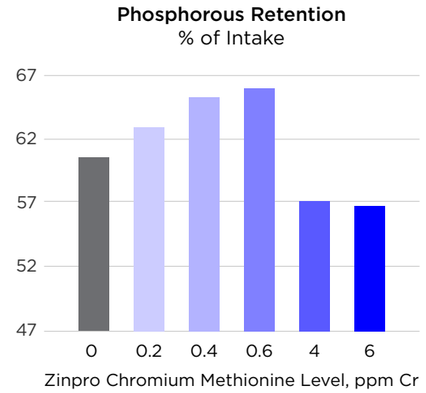
- Supplementation with Zinpro Chromium Methionine complex from 0 up to 4 and 6 ppm (tolerance levels) did not affect trout survival rate (100%) or health-related parameters of hematology or clinical chemistry (data not shown).
- Supplementation with Zinpro Chromium Methionine complex at 0.6 ppm:
  - Resulted in a 7% economic advantage over Control
  - Increased SGR (Fig. 1a) by 2%, final body weight by 5% (data not shown) and FCR (Fig. 1b) by 6%
  - Numerically increased retention of protein by 5% (data not shown) and phosphorous by 10% (Fig. 2)
- Performance effects are associated with better glucose (energy) utilization, which was indicated by increased glucokinase activity in liver (Fig. 3a) and muscle glycogen (Fig. 3b) content.

Growth Performance Fig. 1

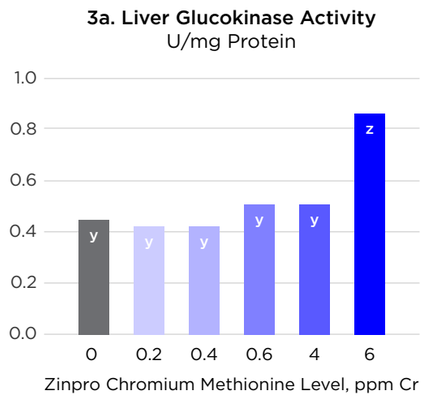


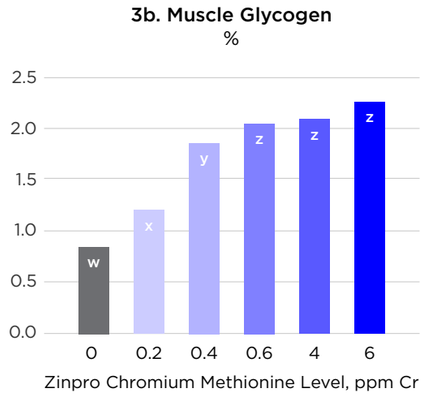
* Zinpro Chromium Methionine is sold as either Zinpro Availa Cr or Zinpro MICROPLEX depending on the region

Nutrient Retention Fig. 2



Health / Glucose Utilization Fig. 3





Study Criteria

Evaluate efficacy and tolerance of chromium methionine complex on survival, performance and nutrient efficiency of rainbow trout.

Supplemental Chromium Methionine Level, ppm Cr

0	0.2	0.4	0.6	4.0	6.0

Initial body weight: 16 g
Density: 40 fish/tank
Replications: 4
Duration: 90 days

41% CP/24% Fat
Feeding: 3x/day

Location:
RIASEARCH (SPAROS)
Portugal

Source: Moffitt, et al., 2024. ISFNF 2024, May 27-31, Puerto Vallarta, Mexico. | 20206015

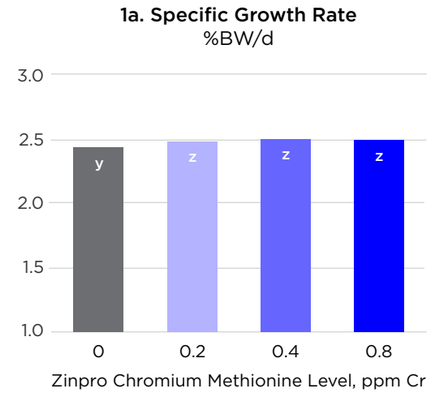
Study 8

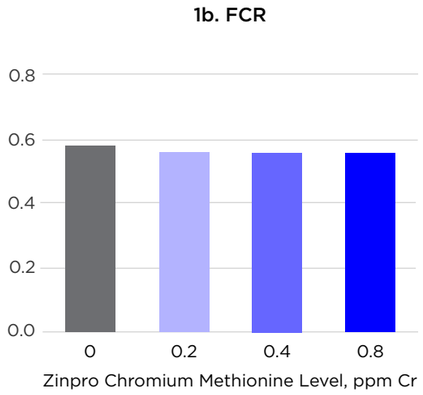
Supplementation with Zinpro Chromium Methionine* Modulates Insulin Signaling Pathway in Rainbow Trout

Key Findings

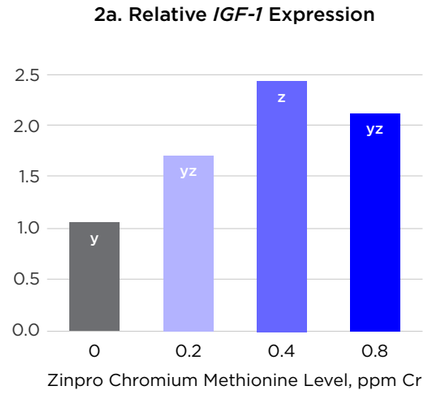
- Supplementation with Zinpro Chromium Methionine complex did not affect trout survival rate, which was at or above 98%.
- Trout performance was significantly improved with the supplementation of Zinpro Chromium Methionine complex from 0.4 to 0.8 ppm.
- Supplementation with Zinpro Chromium Methionine complex at 0.4 ppm increased SGR (Fig. 1a) by 2%, final body weight by 5% (data not shown) and FCR (Fig. 1b) by 3%.
- Performance effects exerted by Zinpro Chromium Methionine complex were associated with the modulation of insulin signaling pathway.
- Zinpro Chromium Methionine complex enhanced mRNA levels of IGF-1 (Fig. 2a), insulin receptor (IRb; Fig. 2b) and the transmembrane glucose transporter GLUT 2 (Fig. 2c).
- These results corroborate the modulatory effect of Zinpro Chromium Methionine complex in the uptake and utilization of glucose in fish.

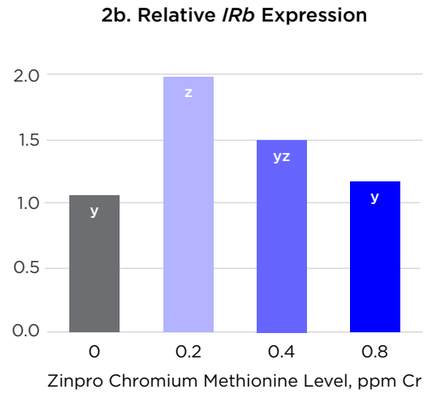
Growth Performance Fig. 1

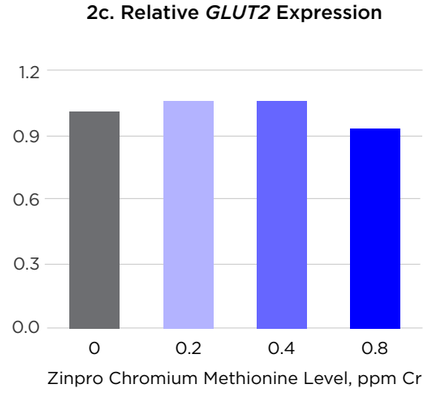




Glucose Utilization Fig. 2







* Zinpro Chromium Methionine is sold as either Zinpro Availa Cr or Zinpro MICROPLEX depending on the region

Study Criteria

Evaluate effect of chromium methionine complex on performance and insulin signaling pathway in rainbow trout.

Supplemental Chromium Methionine Level, ppm Cr			
0	0.2	0.4	0.8

Initial body weight: 33 g
Density: 30 fish/tank
Replications: 4
Duration: 84 days

47% CP/17% Fat
Feeding: 3x/day

Location:
University of Idaho
Idaho, United States

Source: Moffitt, et al., 2024. ISFNF 2024, May 27-31, Puerto Vallarta, Mexico. | 20216005

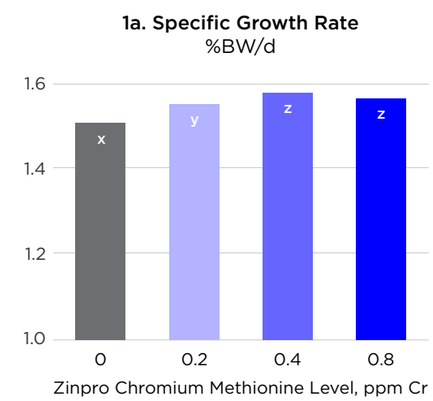
Study 9

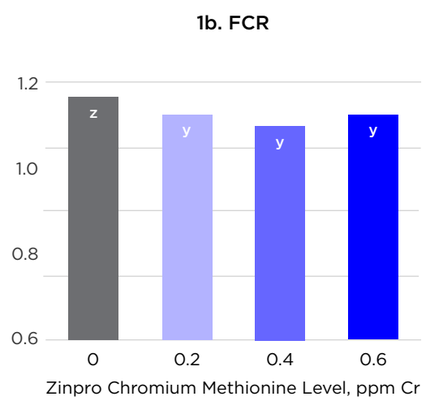
Effect of Zinpro Chromium Methionine* on Performance and Nutrient Retention in Gilthead Sea Bream

Key Findings

- Supplementation with Zinpro Chromium Methionine complex did not affect sea bream survival rate (100%).
- Supplementation with Zinpro Chromium Methionine complex at 0.4 ppm:
  - Resulted in a 7% economic advantage over Control
  - Increased SGR (Fig. 1a) by 5%, final body weight by 7% (data not shown) and decreased FCR (Fig. 1b) by 7%
  - Increased protein retention (N; Fig. 2) by 15%
- Supplementation with Zinpro Chromium Methionine at 0.6 ppm:
  - Increased retention of P by 16% and selenium by 26% (data not shown)
  - Upregulated the hepatic activity of glycolytic enzymes hexokinase (HK; Fig. 3a) and glucokinase (data not shown) by 66% and 36%, respectively
  - Downregulated the hepatic activity of gluconeogenic enzyme phosphoenolpyruvate carboxykinase (PEPCK; Fig. 3b) by 29%
  - Increased glycogen content by 55% in the liver and 60% in the muscle of gilthead sea bream
- Performance effects are associated with improved glucose utilization and protein sparing, as indicated by the upregulation of glycolytic and downregulation of gluconeogenic enzyme activity (PEPCK, HK, GK).

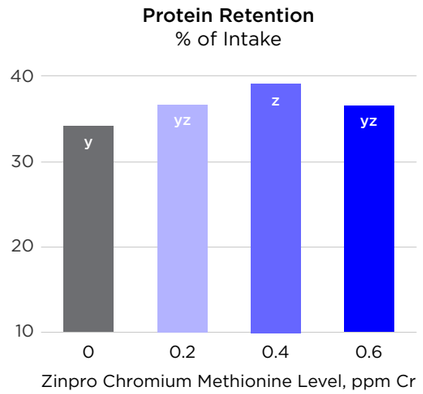
Growth Performance Fig. 1



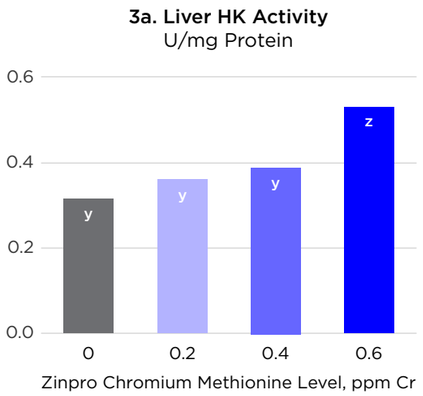


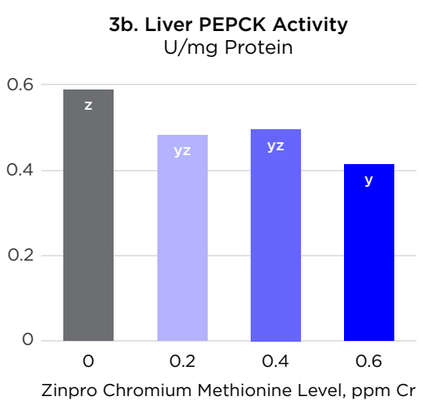
* Zinpro Chromium Methionine is sold as either Zinpro Availa Cr or Zinpro MICROPLEX depending on the region

Nutrient Retention Fig. 2



Health / Glucose Utilization Fig. 3





Study Criteria

Evaluate effect of chromium methionine complex on performance and nutrient retention in gilthead sea bream.

Supplemental Chromium Methionine Level, ppm Cr			
0	0.2	0.4	0.6

Initial body weight: 32 g
Density: 50 fish/tank
Replications: 4
Duration: 91 days

42% CP/16% Fat
Feeding: 3x/day

Location:
RIASEARCH (SPAROS)
Portugal

Source: Figueiredo-Silva et al., 2025. Aquaculture Europe, September 23-25, Valencia, Spain. | 20216004

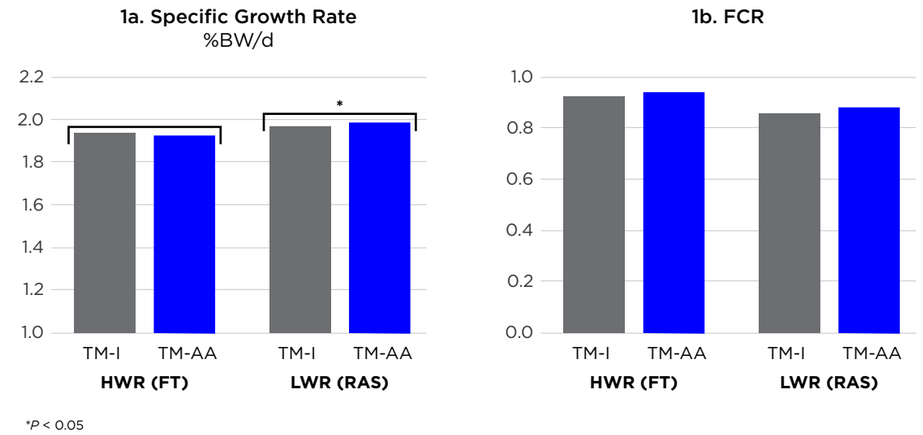
Study 10

Replacement of Inorganic Minerals with Zinpro Performance Minerals Reduces Mineral Losses in Rainbow Trout

Key Findings

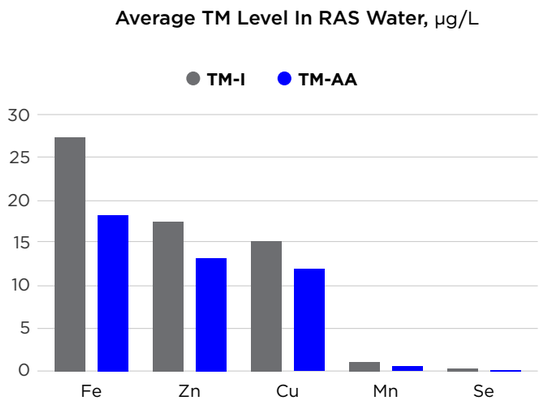
- Rainbow trout SGR (Fig. 1a) was 3.4% higher in RAS vs FT system. Feed conversion ratio (Fig. 1b) was numerically reduced by 6% in RAS vs FT system.
- Neither diet nor water refreshment rate / system affected activity of key antioxidant defense system enzymes (data not shown).
- Zinpro Performance Minerals at 0.5x the level of inorganic trace minerals (TM-AA vs TM-I):
  - Did not affect fish performance or health in either water system
  - Improved digestibility of P, Zn, Mn and Se
  - Significantly increased Cu (32%) and Se (38.6%) retention efficiency in RAS-raised trout
  - TM-AA numerically increased Fe (43.5%), Zn (13.2%) and Mn (8.9%) retention in RAS-raised trout
  - Significantly reduced total losses (branchial + urinary and fecal) of Zn, Cu, Mn, Fe and Se, regardless of water system; RAS losses are illustrated in Fig. 3a-c. In RAS, the effect of TM-AA vs TM-I on total TM losses was corroborated by analyzed average TM levels in water (Fig. 2); TM loss was less for Fe (22.21%), Zn (26%), Cu (20.4%), Mn (37.4%) and Se (45.5%).
- These results show that replacing inorganic TM with 50% Zinpro Performance Minerals offers a unique opportunity to reduce environmental TM losses, while respecting legislative bounds for total TM levels in aqua feed and maintaining health and performance.

Growth Performance Fig. 1

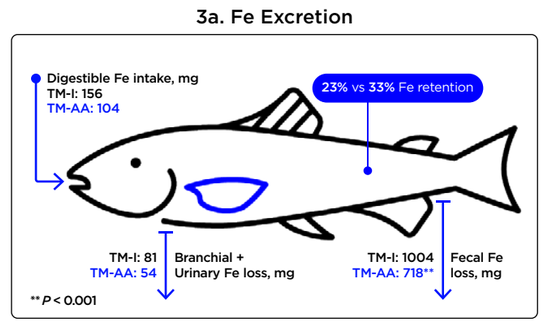


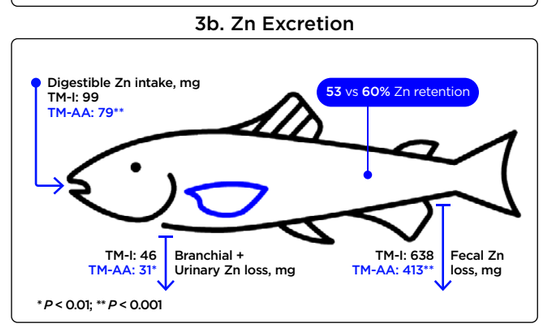
*$P < 0.05$

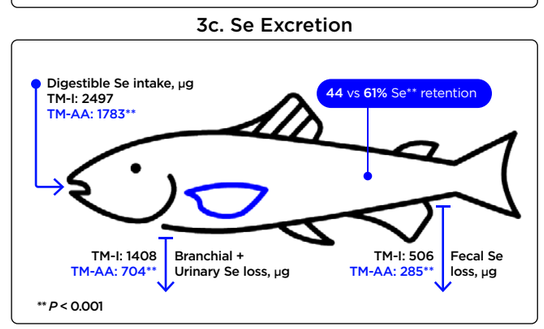
Nutrient Retention Fig. 2



Excretion in RAS Fig. 3







Study Criteria

This study investigated two factors that can affect TM retention and excretion in fish: trace mineral (TM) premix (inorganic vs. TM-AA complexes) and water refreshment rate / system. Low water refreshment (LWR; ±311 L/kg feed) was tested in a recirculating aquaculture system (RAS) and high water refreshment (HWR; ~11600 L/kg feed) was tested in a flow-through (FT) system.

Treatments	TM-I*	TM-AA**
LWR (RAS)	120 ppm Zn, 10 ppm Cu, 30 ppm Mn, 100 ppm Fe, 0.3 ppm Se	60 ppm Zn, 5 ppm Cu, 15 ppm Mn, 50 ppm Fe, 0.15 ppm Se
HWR (FT)		

*Zn, Cu, Mn and Fe from sulfates; Se as selenite
**Zn, Cu, Mn and Se from Zinpro Availa line; Fe as Zinpro ProPath

Initial body weight: 78 g
Density: 30 fish/tank
Replications: 3
Duration: 8 weeks

41% CP/18% Fat
Feeding: 3x/day

Location:
Wageningen University
The Netherlands

Source: Figueiredo-Silva et al., 2024. WAS AQUA 2024, August 26-30, Copenhagen, Denmark. | 20223506

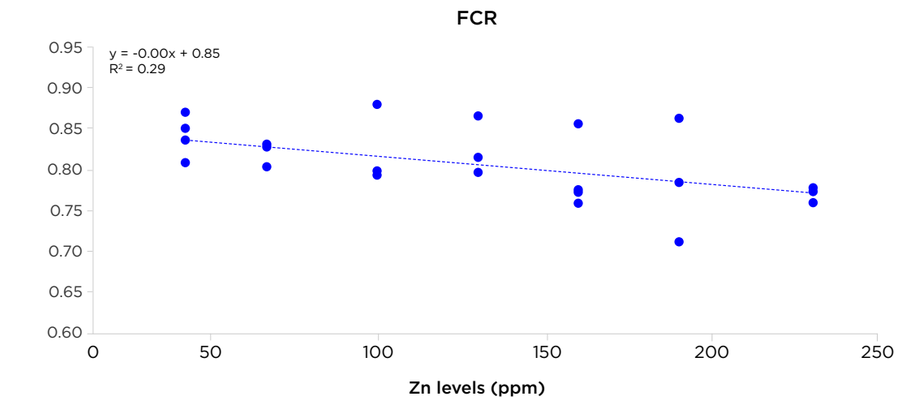
Study 11

Supplementation with Zinpro Availa Zn Improves Post-Smolt Atlantic Salmon Mineral and Protein Retention and Enhances Wound Healing

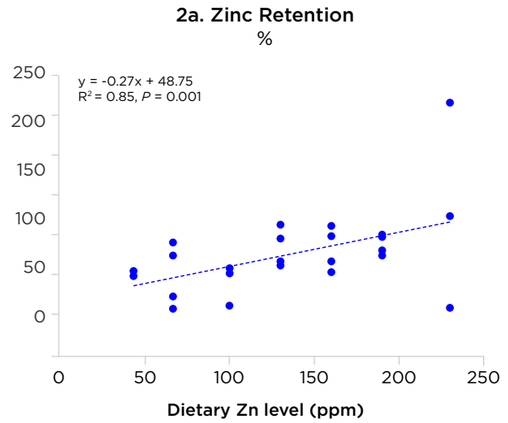
Key Findings

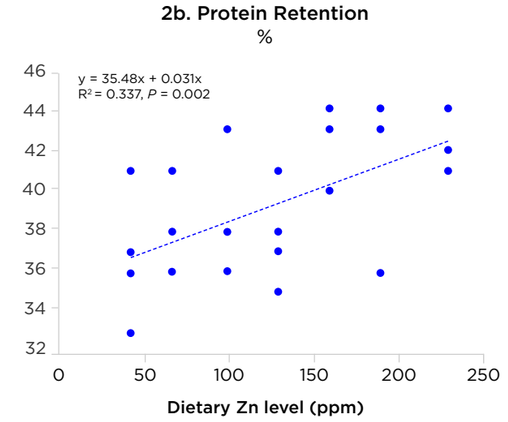
- Increased dietary intake of Zinpro Availa Zn significantly improved FCR, as shown by the regression analysis of FCR by dietary Zn level (Fig. 1).
- Zinpro Availa Zn enhanced zinc (Fig. 2a) and protein (Fig. 2b) retention, supporting improved metabolic efficiency.
- Zinpro Availa Zn intake increased whole body (data not shown) and vertebral retention of Zn, Se and Mn (data not shown) with no evidence of a plateau within the tested range.
- Fish supplemented with 140 (190 total) and 180 (230 total) mg Zn/kg feed showed faster wound healing and consistently lower wound scores (Fig. 3).
- At 190 and 230 total mg Zn/kg feed, Zn modulated key wound-healing genes, promoting controlled inflammation and faster tissue regeneration (data not shown).

Growth Performance Fig. 1

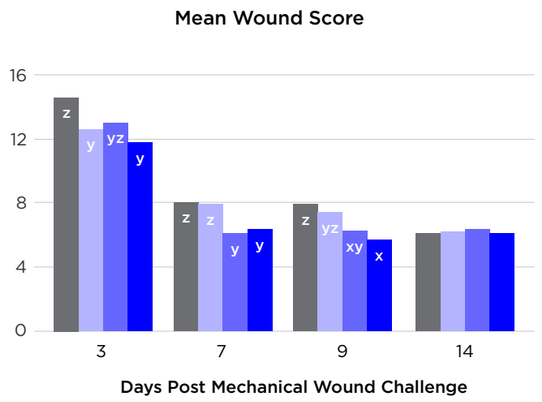


Nutrient Retention Fig. 2





Health Fig. 3



Study Criteria

This study aimed to evaluate the dose-dependent effects of Zn amino acid complex on performance, protein and nutrient retention and wound healing in post-smolt Atlantic salmon.

	Zn, mg/kg feed	
Treatment	**Dietary (analyzed)**	**Supplemental**
Zinpro Availa Zn 0	**43**	**0**
Zinpro Availa Zn 40	**67**	**40**
Zinpro Availa Zn 60	**100**	**60**
Zinpro Availa Zn 80	**120**	**80**
Zinpro Availa Zn 100	**160**	**100**
Zinpro Availa Zn 140	**190**	**140**
Zinpro Availa Zn 180	**230**	**180**

Initial body weight: 200 g
Density: 50 fish/1 m³ tank
Replications: 4
Duration: 58 days

43% CP/27% Fat
5% fishmeal
Feeding: *ad libitum* from 0900 to 1600 h

Location:
Aquaculture Technology
Center Patagonia
Lenca, Los Lagos, Chile

Source: Valdenegro Vega et al., 2022. ISFNF, June 5-9, Sorento, Italy.

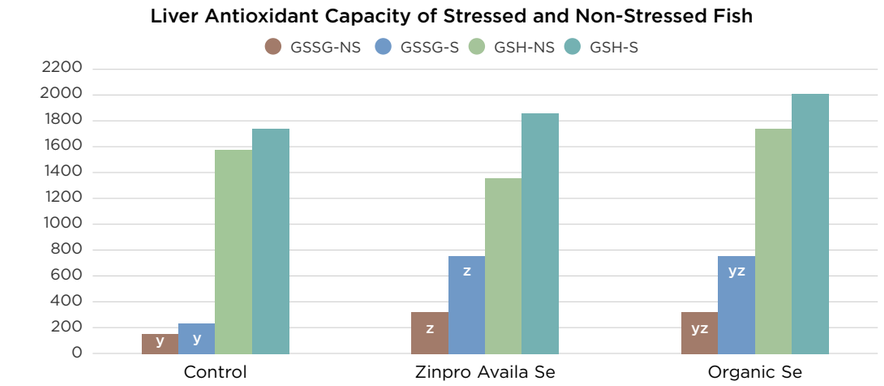
Study 12

Comparative Study of Dietary Se Sources on Gilthead Sea Bream Growth, Nutrient Utilization, Stress Response and Final Product Quality

Key Findings

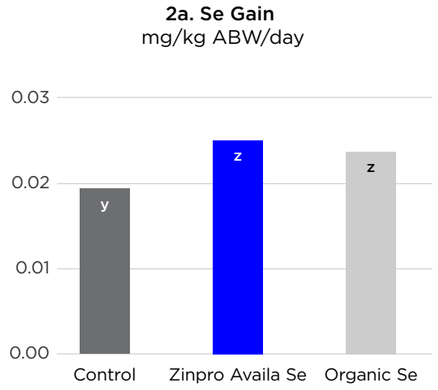
- Regardless of Se source, supplementation with 0.2 mg Se/kg feed maintained good growth performance and low FCR.
- Fish fed Zinpro Availa Se exhibited significantly higher whole body protein content compared to those on the Control diet (data not shown).
- The post-feeding period acute stress challenge induced increased content of reduced (GSH) and oxidized (GSSG) glutathione in liver (Fig. 1). The Zinpro Availa Se treatment had the highest GSSG content, in stressed or non-stressed fish, suggesting a quicker stress response in this group of fish.
- Increased Se retention and gain (Fig. 2a-b) in fish fed Zinpro Availa Se and Organic Se diets was greater than those receiving the Control diet.
- Supplementation with the Zinpro Availa Se diet resulted in significantly increased muscle Se deposition (Fig. 2c), compared to other Se sources. Product quality parameters and overall consumer acceptance did not reveal significant differences among Se sources (data not shown).
- This study revealed that supplementing 0.2 mg/kg of Se as Zn-L-SeMet, EFSA's maximum allowed level for organic Se, positively enhanced the stress response and nutritional profile of Gilthead sea bream. The Se content of muscle was improved, providing 34% of recommended daily Se intake per 100 g fillet. This is important to aquaculture, as more highly bioavailable mineral sources promote fish health and product quality, offering consumers a sustainable and efficient industry.

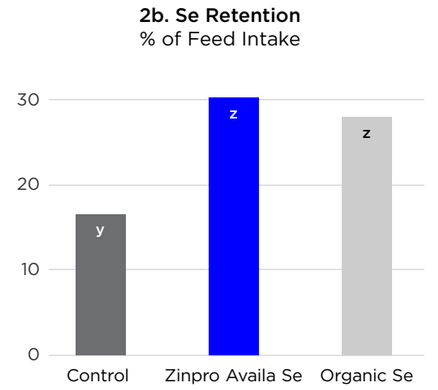
Health Fig. 1

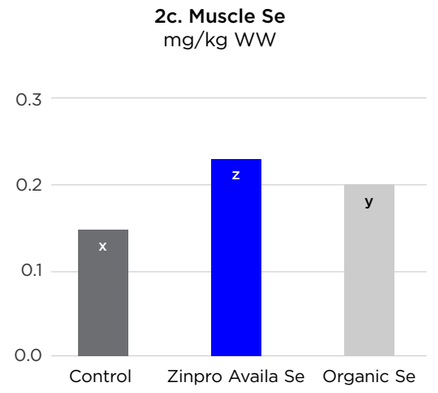


Superscript letters refer to differences between treatments / Stress effect, $P < 0.05$ for GSSG and GSH / Diet Effect, $P < 0.05$ for GSSG

Meat Quality Fig. 2







Study Criteria

This study was to designed to assess performance, stress resistance and product quality of gilthead sea bream in response to diets supplemented with 0.2 ppm of three Se sources. This experimental level is an effort to align with the European Food Safety Authority's (EFSA) maximum allowed organic Se supplementation level of 0.2 ppm.

	Control	Zinpro Availa Se	Organic Se
Supplemental Se, mg/kg feed	0.2		
Se Source	Na_2SeO_3	Zn-L-SeMet	OH-Se-Met

At the end of the feeding period, fish were exposed to an acute stress challenge aimed to simulate overcrowding followed by air exposure, which normally occurs in farming conditions. Fish were stocked in a bucket under high density (100 k/m^3) and aeration for 5 minutes and then exposed to air for 1 minute.

Initial body weight: 75 g
Density: 20 fish/tank (250 L)
Replications: 4
Duration: 137 days

48% CP/17% Fat
Feeding: 3x/day

Location:
CIIMAR/CIMAR-LA
University of Porto
Portugal

Source: Filipa-Silva et al., 2025. Aquaculture, Volume 595, Part 1, 741508. | 20213503

Essential Trace Minerals for Salmonids and Marine Fish

BENEFIT	TRACE MINERALS	HOW THEY WORK
Disease Resistance	Zinc, Copper, Manganese, Iron, Selenium, Chromium	• Humoral immunity • Cell-mediated immunity • Non-specific immunity • Anti-oxidant activity to remove free radicals and protect cell membranes • Reduced mortality, prevent and treat anemia
Bone, Scale and Fin Development	Zinc, Copper, Manganese, Selenium	• Bone matrix development and maintenance • Cell division and protein synthesis for normal tissue mineralization
Skin and Gut Integrity	Zinc, Copper, Manganese	• Improves wound healing • Skin and gut integrity • Optimize goblet cells, villus height and intestinal barrier
Fertility	Zinc, Copper, Manganese, Iron, Selenium	• Reproductive hormone synthesis: steroidogenesis • Helps avoid or reduce nutritional anemia • Female maturity and fertility • Egg development • Egg viability • Hatching rate • Sperm maturation and quality • Key to normal ovarian function
Muscle Development	Zinc, Copper, Selenium, Chromium	• Insulin signaling pathway activation • Energy and protein metabolism • Cell membrane protection from peroxides • Influences glucose, lipid and protein metabolism
Larvae, Fry and Fingerling Development	Zinc, Copper, Manganese, Iron, Selenium, Chromium	• Energy and protein metabolism • Cell proliferation • Normal tissue mineralization • Cell membrane protection • Hemoglobin synthesis and tissue oxygenation
Meat Quality	Zinc, Copper, Manganese, Iron, Selenium, Chromium	• Influences lipid and protein content • Enhanced meat color • Reduced drip loss • Improved product shelf-life
Balanced Gut Microbiome	Zinc, Copper, Iron	• Reduction of pathogenic bacteria • Shift the balance of intestinal bacteria in favor of beneficial species

Feeding Recommendations

Mineral	Zinpro Performance Minerals Products	Zinpro Recommendations Minimum Requirement ZPM, mg/kg diet Salmonids and Marine Fish
Zn	Zinpro Availa Zn Zinpro ProPath Zn	80
Cu	Zinpro ProPath Cu	10
Mn	Zinpro Availa Mn Zinpro ProPath Mn	30
Fe	Zinpro Availa Fe Zinpro ProPath Fe	100
I[a]		1
Se[b]	Zinpro Availa Se	0.3
Cr[c]	Zinpro MICROPLEX Zinpro Availa Cr	0.2 Atlantic Salmon 0.4 Other marine fish 0.6 Rainbow Trout

[a] Not a current ZPM source
[b] Note upper limit allowed in EU is of 0.2 ppm, provided as organic source
[c] Use where commercially available

Zinpro Performance Minerals solutions for salmonid and marine fish production.

Zinpro Performance Minerals Fulfill Today's Demands and Anticipate Tomorrow's Challenges.

ZINPRO®

For more information: contact your Zinpro representative or visit **zinpro.com/aquaculture**

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