

Growth promoting impacts of marine watersoluble N-compounds in feed for Atlantic salmon

Biomarint Industriseminar, December 2008

Nofima: Anders Aksnes, Eyolf Langmyhr, Katerina Kousoulaki
BioMar AS: Paddy Campbell, Hanne Jorun Olsen

SOURCES: Marine water solubles

- **FISHMEAL Stickwater fraction**
- **Fish by-products Hydrolysates**

Properties & attributes to farmed animals

- Fishmeal and Fishoil replacement, ↑ (Gilthead seabream)
- ↑ nutrient absorption, ↑ enzyme activity, ↑ survival, ↑ growth rates & ↓ malformation rates in fish larvae fry or adults (Atlantic salmon, halibut, European sea bass)
- Non-specific immune system responses (Japanese sea bass, Coho salmon)

Cytosolic peptidases,
hydrolysing peptides to
free amino acids

Special marine water soluble Compounds

- Taurine
- Anserine
- Creatinine
- Carnosine
- Nucleotides
- Free amino-acids
- Peptides
- Small proteins
- Minerals
- Water soluble vitamins

(Aksnes, 2005)



Experiment

- **SCOPE:** Documentation of the importance of MWS for fish performance
- **METHOD:** Extraction/removal of fishmeal WS fraction: Stickwater (SW) + Presscake (PC) & Reintroduction at graded levels

Raw Materials

Herring Fish meal:

- Heating (90 °C)
- Press/filter/centrifuge
 - Press cake (solids)
 - Sludge
 - **Stickwater** (water solubles) (+ Ultrafiltration)
 - Oil

Stickwater (SW)

- 20-50% (raw material weight)
- 30% fish meal solids
- High collagen content (33.3%, Zarkadas et al., 1986)
- Special physicochemical characteristics

Experimental design

- 10 week Atlantic salmon trial (137-410 g)
- High fish meal control diet (30% in the diet)
- 7 High plant protein experimental diets (10% fish meal in the diet)/ graded levels of whole SW or fractions (<>10,000 Da)
- Diets: 42% P, 25% L, 23 MJ kg⁻¹ E

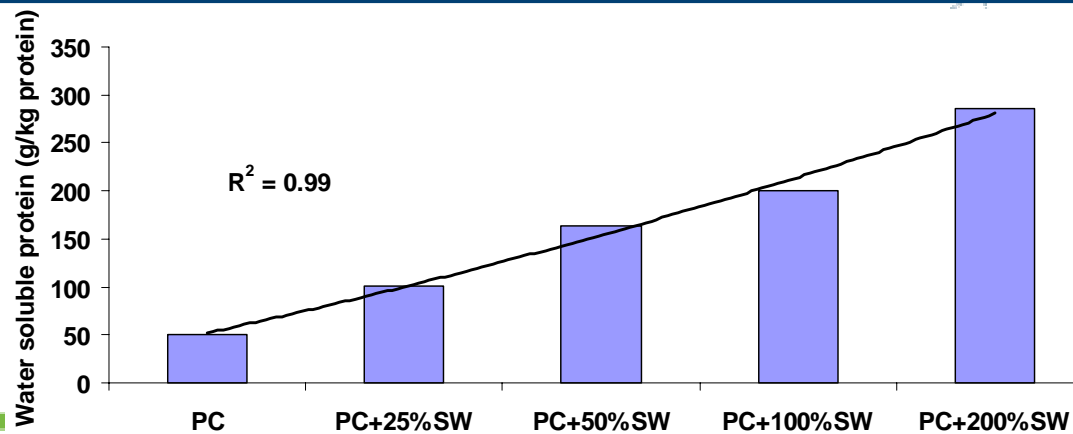
» 10% fishmeal

diet	FM control	PC	PC+ 25%SW	PC+ 50%SW	PC+ 100%SW	PC+ 200%SW	PC+ 100%RSW	PC+ 100%PSW
Standard fish meal	30	5	5	5	5	5	5	5
Experimental fish meal		5	5	5	5	5	5	5

Washed PC

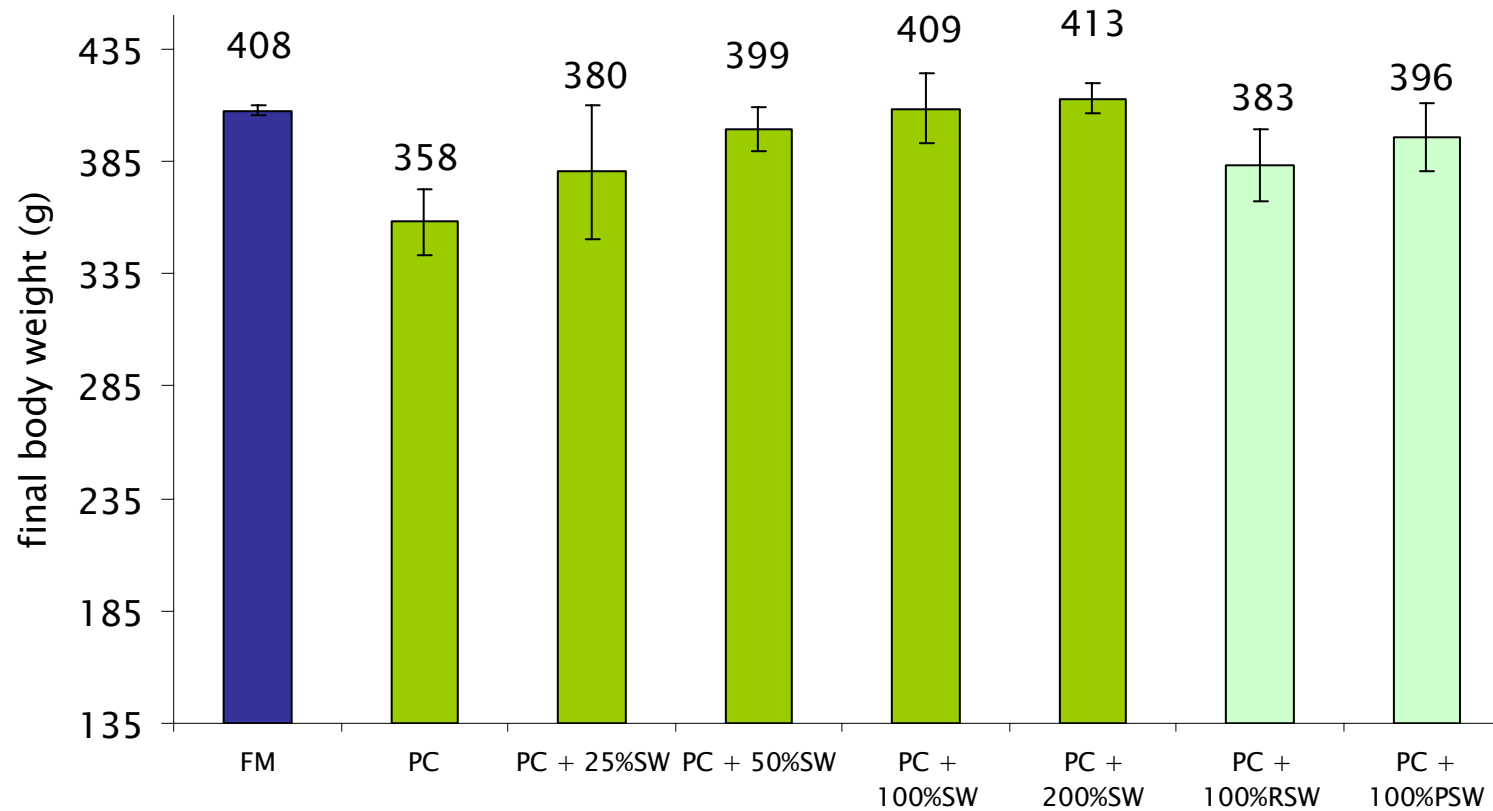
Experimental fish meals

	PC Diet 2	PC+ 25%SW Diet 3	PC+ 50%SW Diet 4	PC+ 100%SW Diet 5	PC+ 200%SW Diet 6	PC+ 100%RSW Diet 7	PC+ 100%PSW Diet 8
Protein, crude	817	768	761	750	754	795	813
Moisture	43	72	78	86	76	71	34
Ash	93	96	105	106	117	98	126
Lipid	63	78	77	77	77	66	57
Water soluble protein	<u>50</u>	<u>101</u>	<u>164</u>	<u>200</u>	<u>286</u>	<u>201</u>	<u>137</u>

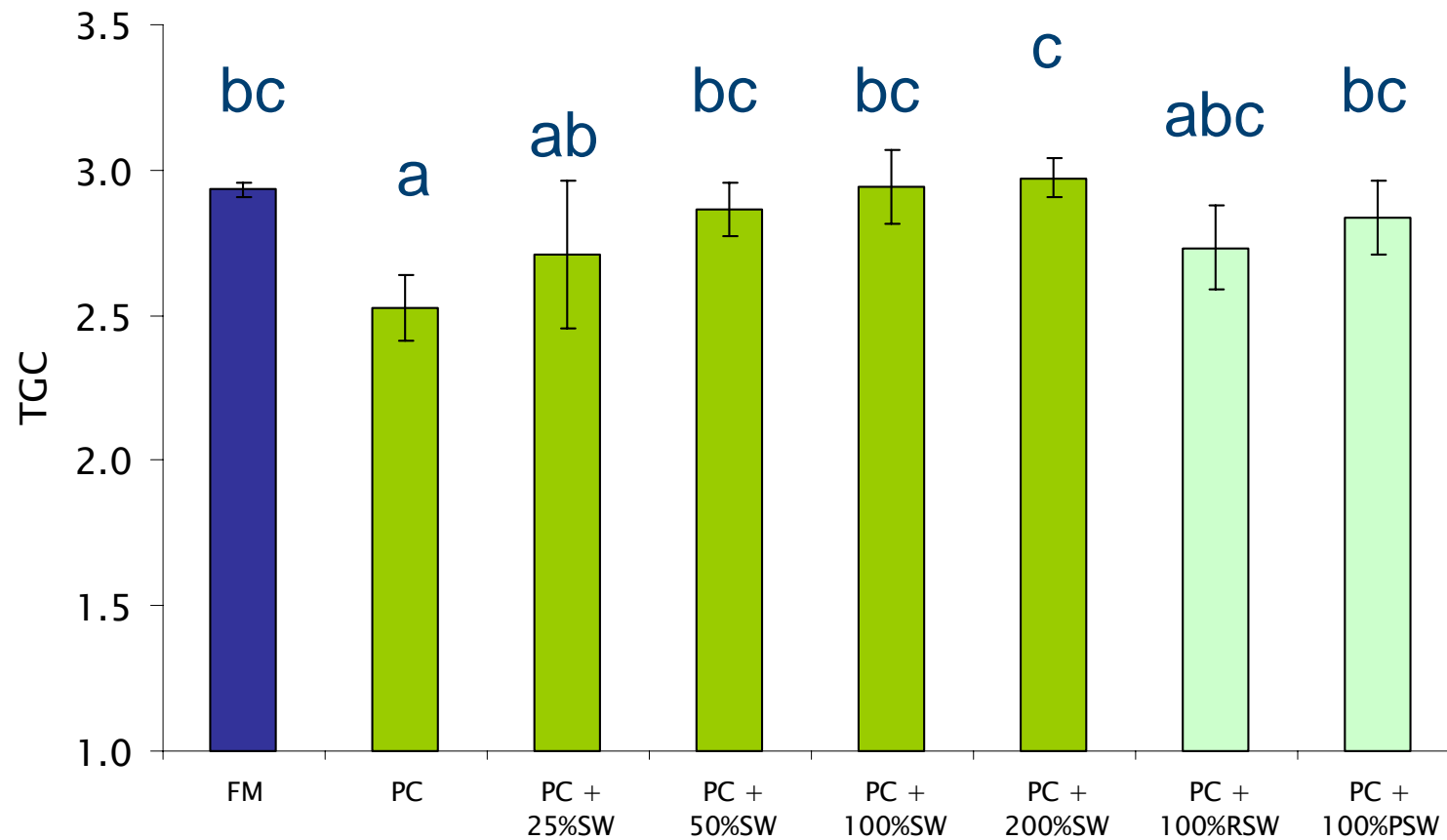


Results

GROWTH



GROWTH



$P < 0.05$

More Results

Morphometry

ns

Feed intake

ns

Feed efficiency

ns

Protein efficiency

ns

Whole body composition

no effects

ADC

no effects

SW inclusion level

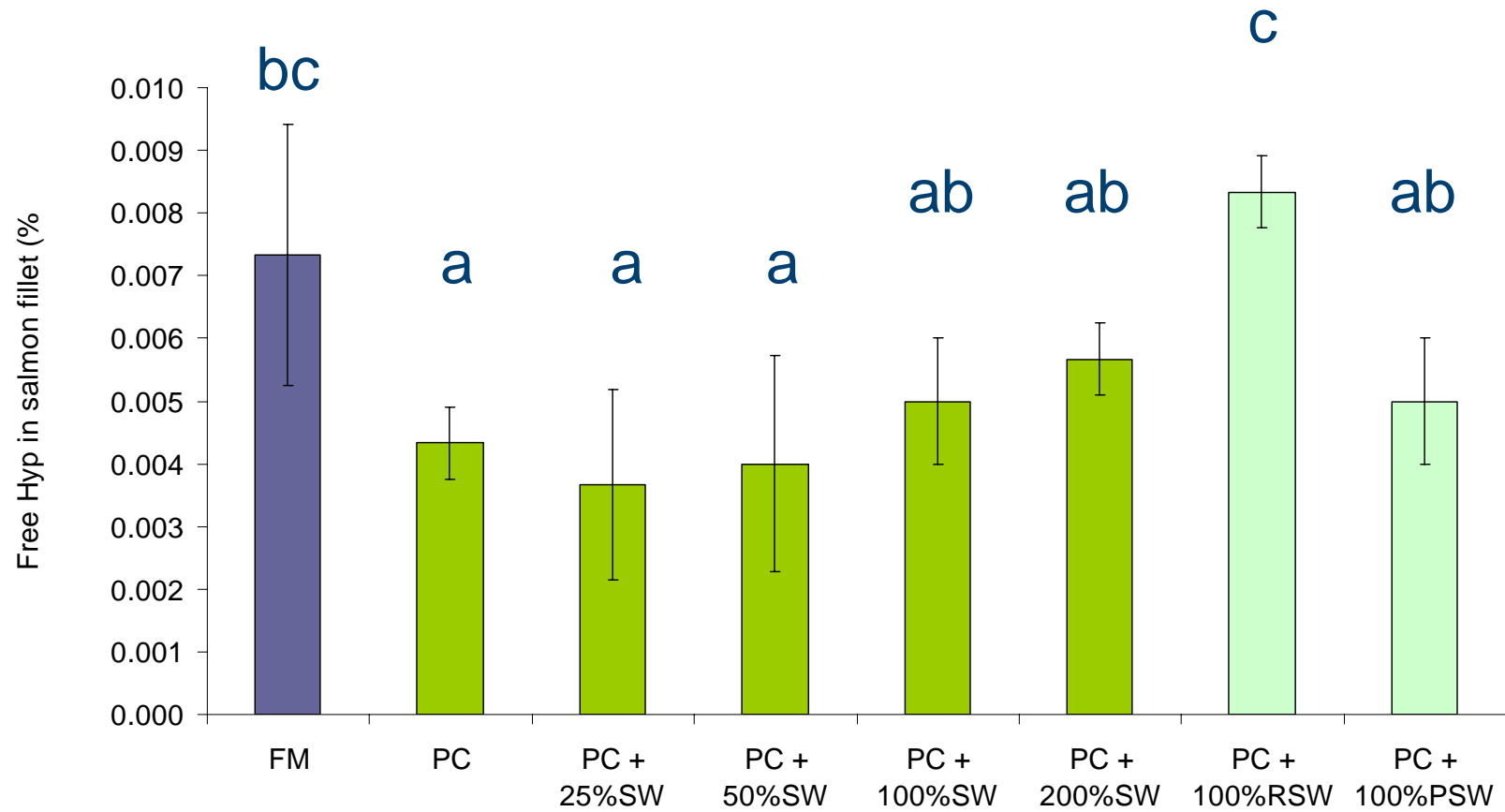
Correlation	R^2	n	P
<i>BW x SW inclusion level</i>	0.64	15	<0.01
<i>SGR x SW inclusion level</i>	0.64	15	<0.01
<i>TGC x SW inclusion level</i>	0.64	15	<0.01
<i>FI x SW inclusion level</i>	0.37	14	ns
<i>FE x SW inclusion level</i>	0.36	15	ns
<i>FI x BW</i>	0.70	15	<0.01

<0.1

<0.1

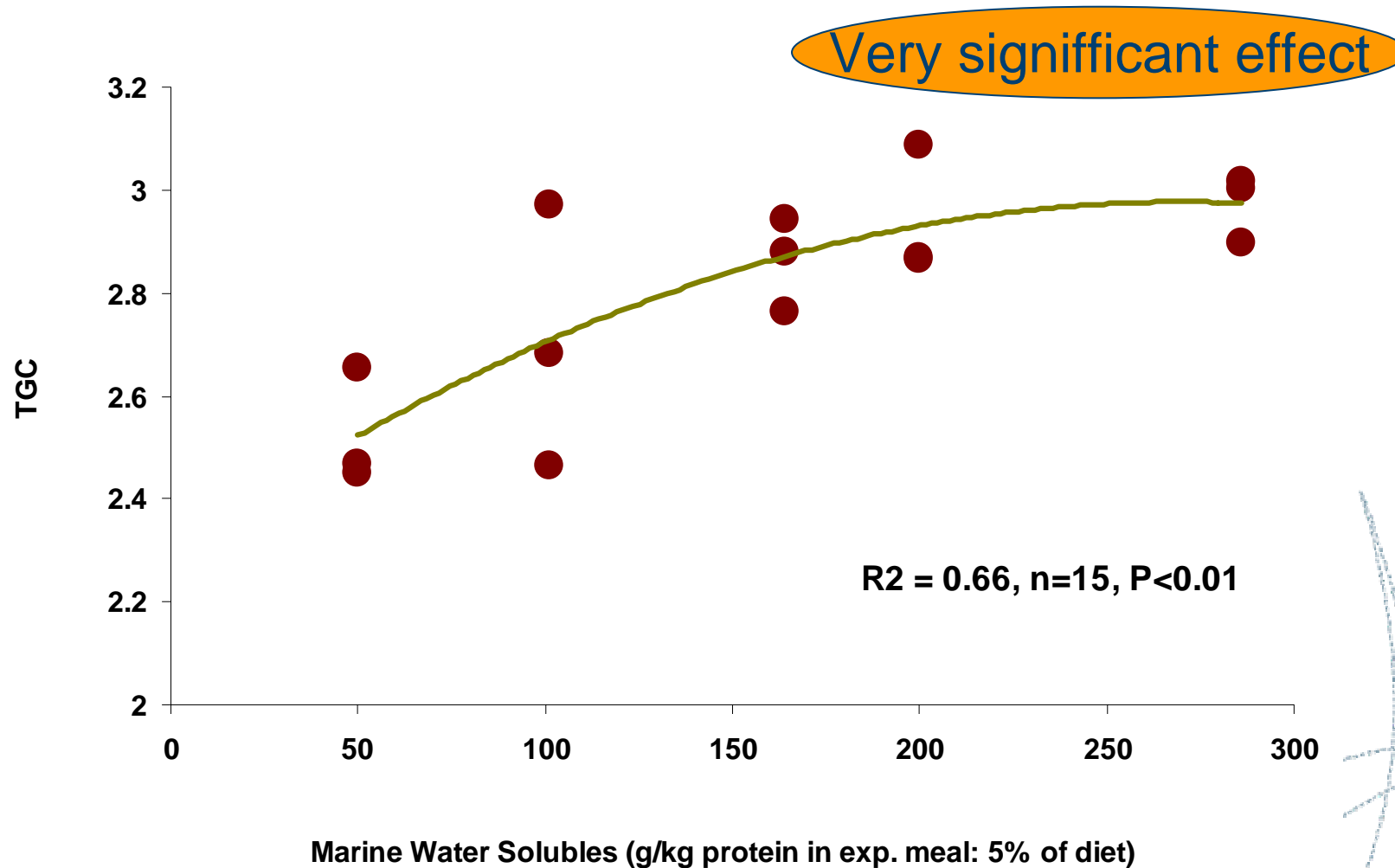


FILLET AA COMPOSITION: Hyp

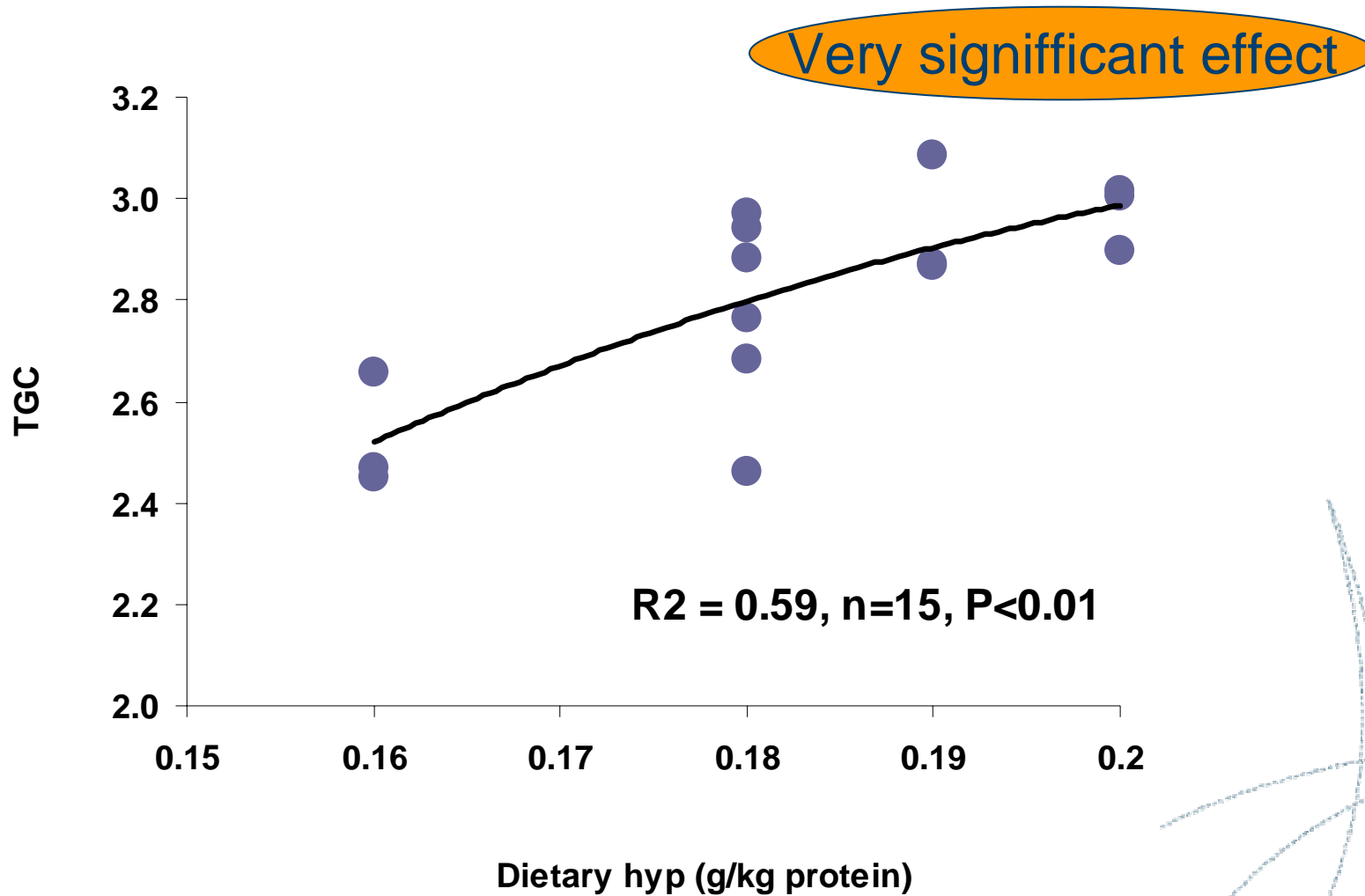


Potential factors in MWS affecting fish growth...

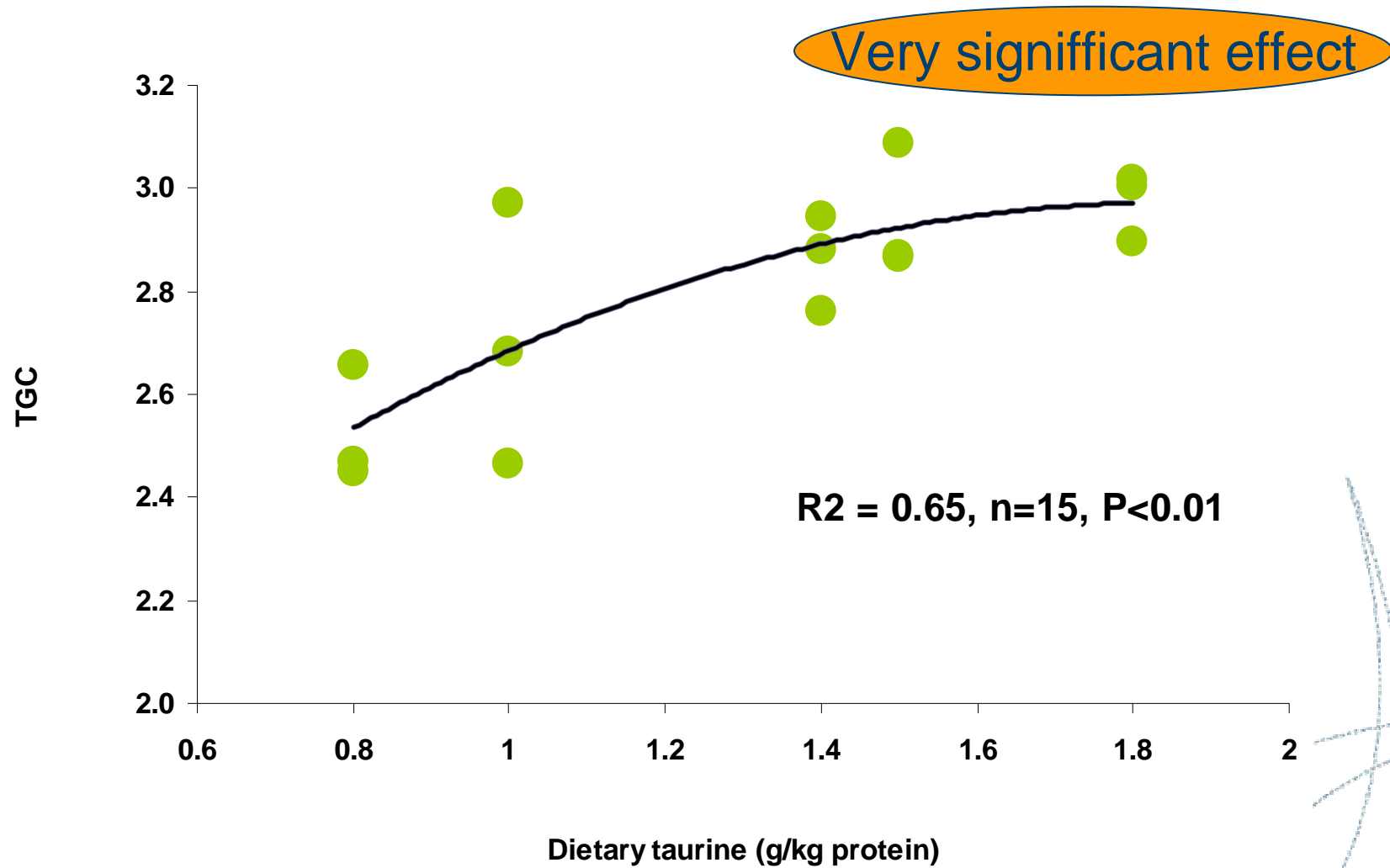
Dietary Marine Water Solubles level



Dietary **Hyp** level

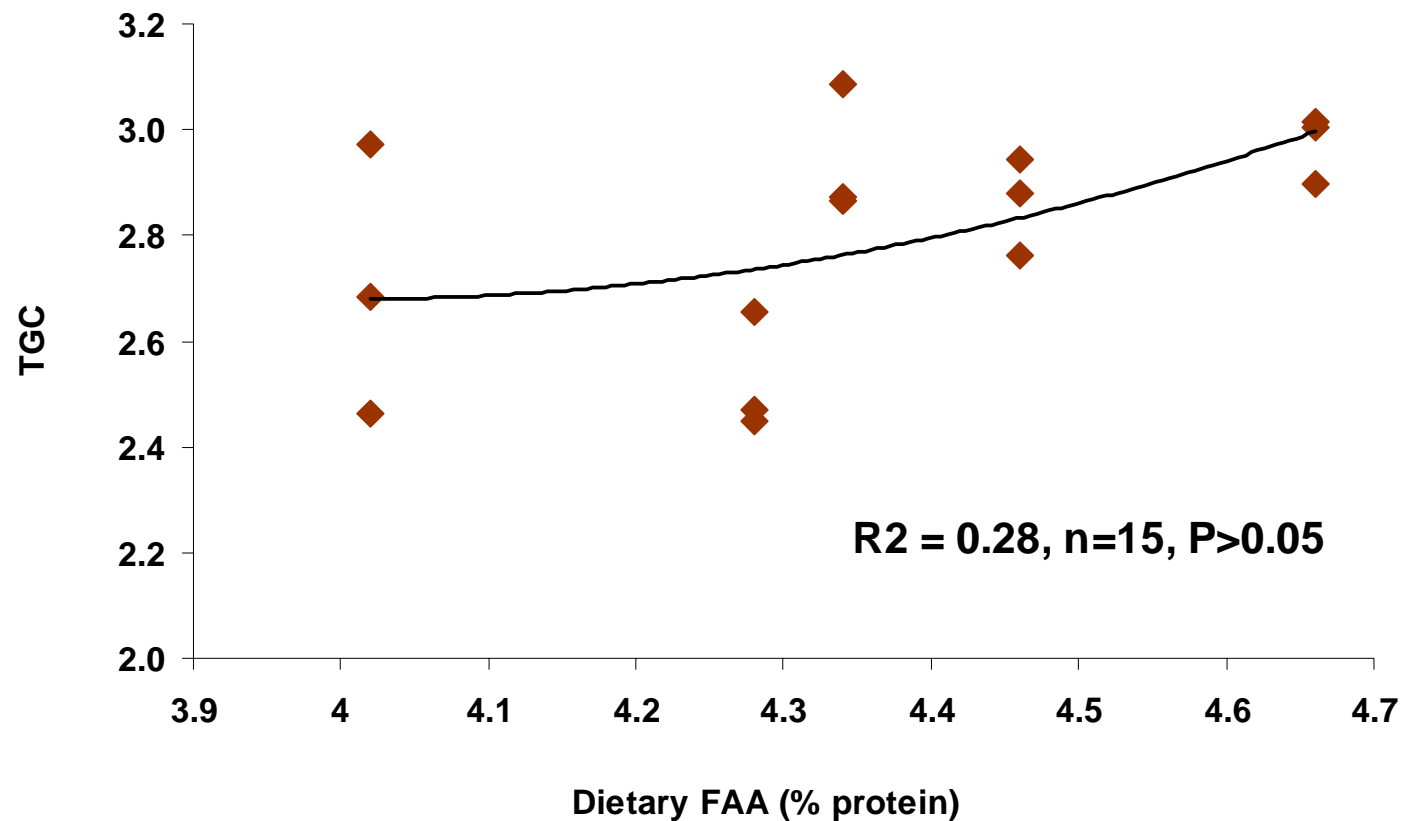


Dietary free Taurine level



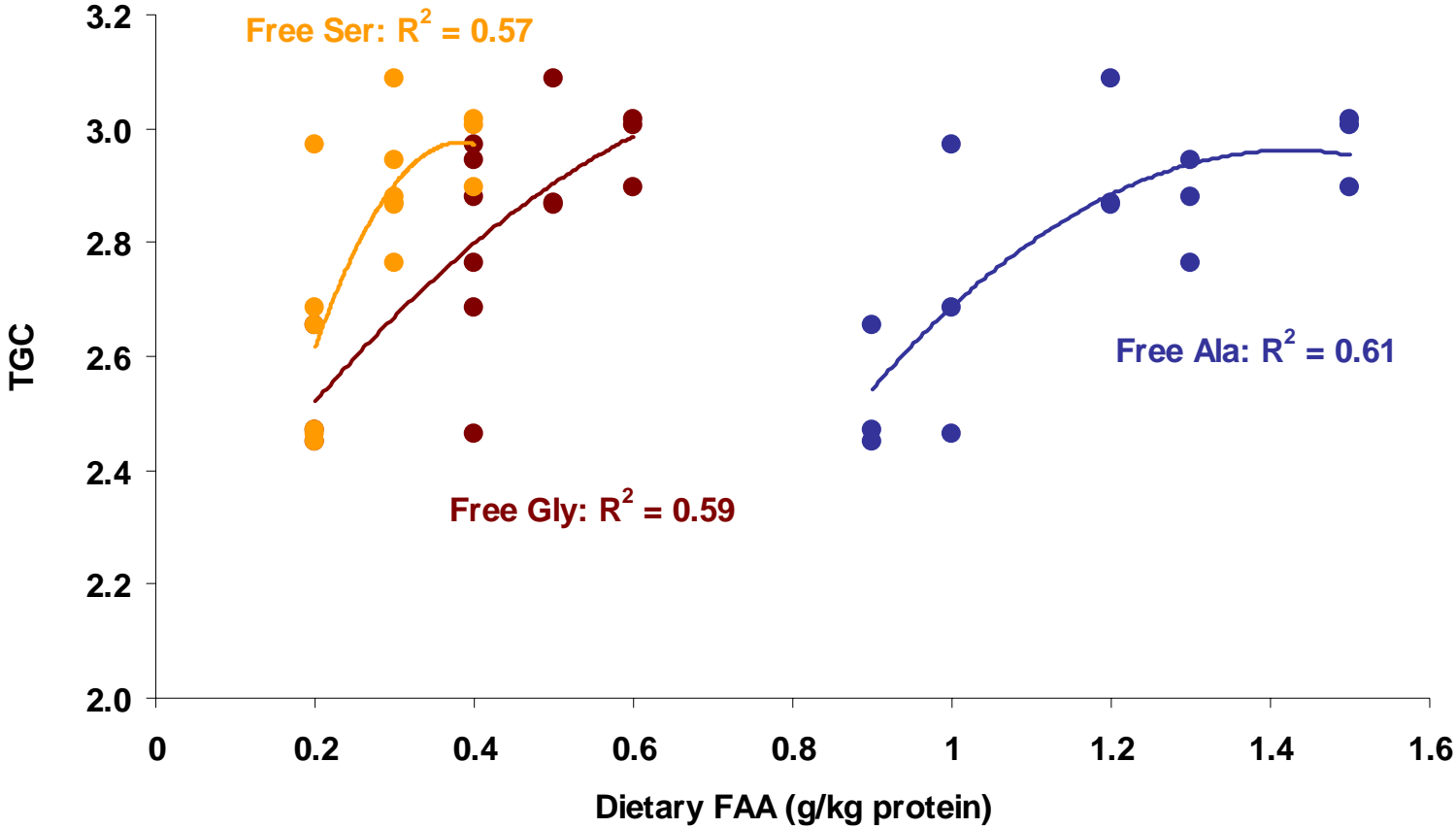
Dietary Total Free Amino Acid level

No significant effect



Dietary specific Free Amino acid level

Very significant effect



Candidate factors in marine water solubles affecting fish growth:

Hyp, Tau, Gly, Ser, Ala...

Peptides...

Small proteins...

Combination of different compounds...

More research needed for identification of special growth promoting compounds in marine water solubles

METHODS

- Hydrolysis/ Extraction
- Fractionation
- Separation technology

SPECIES

Atlantic cod



Atlantic salmon



Zebrafish



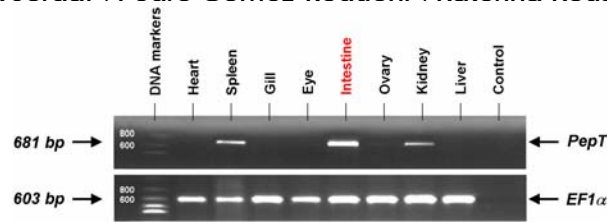
Terrestrial animals

Dietary protein hydrolysates affect spatial expression of peptide transporter PepT1 in the digestive tract of Atlantic cod, *Gadus morhua*.



Presented at *Transporters 2008*. Murten, Switzerland, August 27 – 30, 2008.

Snorre Bakke¹, Ann-Elise Olderbakk Jordal¹, Pedro Gómez-Reaueni¹, Katerina Kousoulaki², Tiziano Verri³ and Ivar Rønnestad¹



Ingredient (%)	FM	FH	UFR	NFR	FAA
Fish meal 268/06	51.8	35.3	35.1	35.1	34.6
Raw wheat 209/06	48.0	56.0	58.0	54.0	36.5
Fish hydrolysate	0.0	14.4	0.0	0.0	0.0
Ultra filtration retentive	0.0	0.0	13.2	0.0	0.0
Nano filtration permeate	0.0	0.0	0.0	13.0	0.0
Fish oil	12.2	14.1	14.1	14.1	14.0
Vitamin mix	1.0	1.0	1.0	1.0	2.0
Mineral mix	0.4	0.4	0.4	0.4	0.4
Betafine	0.4	0.4	0.4	0.4	0.4
Inositol	0.03	0.03	0.03	0.03	0.0

The goal of this study was to investigate how inclusion of peptides and free amino acids (FAA)

presen
PepT1
uptake
PepT1-
found

Dietary protein hydrolysates affect PepT1 mRNA expression in cod

(PepT1: small peptide transporter protein along the intestine)

Hypott

of available substrates for the peptide transporter in the intestinal lumen. In order to absorb the increased levels of peptides we expect an increase in PepT1 activity. If the absorptive capacity for peptides in the proximal part of the intestine becomes saturated we hypothesize that there will be additional mobilization of PepT1 in distal regions of the intestine that are normally less active in protein/peptide absorption.

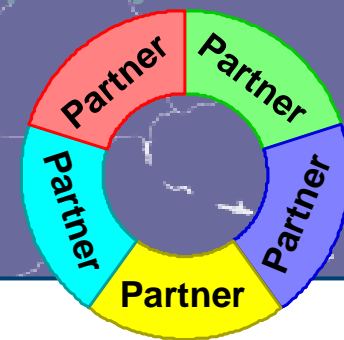
Conclusion: The results suggest that PepT1 mRNA expression is variably affected by dietary peptides as well as FAA. Further, that dietary hydrolysates, peptides in various chain length as well as free amino acids affect segments relative expression of PepT1 along the whole intestinal tract. The regulation of PepT1 mRNA seems to be highest in the pyloric caeca and proximal segments, where maximal peptide load and maximal peptide variety is experienced by the fish after meal ingestion.

	VFR		
Yield by fractionation (%)	100.0	57.0	29.0
Crude protein	913.0	972.0	959.0
Lipid	<1.0	<1.0	<1.0
Ash	78.0	15.0	64.0
Free amino acids (% of protein)	10.4	1.7	14.8
Peptides 10,000-20,000 Da	<1.0	<1.0	<1.0
Peptides 5,000-10,000 Da	35.9	35.0	19.7
Peptides 1,000-5,000 Da	9.7	25.8	12.4
Peptides 100-1,000 Da	36.1	28.0	58.8
Peptides <100 Da	16.0	6.7	9.0
Anserine (g/kg prot)	27.5	48.0	41.2
Taurine (g/kg prot)	11.0	17.0	17.0

Thank you very much
for your **ATTENTION!!!**

Møteplass Marin

Nettverk for
separasjonsteknologi



Åpent informasjons- og debattmøte om:

Etablering av et internasjonalt FoU-senter og industrinettverk for separasjonsteknolog

Mandag 8. desember kl. 18.00

Radisson SAS Hotel Norge, Ole Bulls Plass, Maartmannshaven 5. etg.