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Postprandial kinetics of digestive function in rainbow trout (*Oncorhynchus mykiss*): genes expression, enzymatic activity and blood biochemistry as a practical tool for nutritional studies

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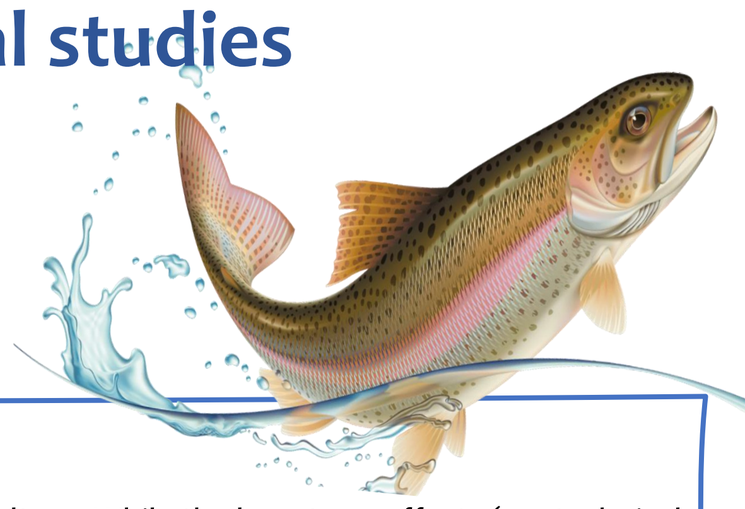
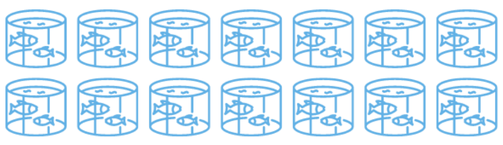


AIM

Understanding the physiological mechanisms regulating digestion in fish is crucial for optimizing feeding strategies in aquaculture. While the long-term effects (zootechnical parameters/biometric indices) of different feeds have been extensively studied, postprandial dynamics, characterized by rapid changes at the molecular, enzymatic, and metabolic levels, remain less explored (Yamamoto et al. 1998; Larsen et al. 2012; Borey et al. 2016), especially in rainbow trout (*Oncorhynchus mykiss*).

This study aims to deepen our understanding of the physiological response of rainbow trout to a meal by analyzing the gene expression, enzymatic activity, and metabolic profile of the gastrointestinal tract and plasma/serum at different postprandial times. The results obtained will allow us to define an optimal sampling protocol for future studies and to identify the main factors regulating digestion and nutrient absorption in this species, thus providing a significant contribution to aquaculture research.

MATERIAL AND METHODS



Rainbow trout allocated among **14 tanks** (2 tanks per sampling time), each consisting of **10 fish** (weight of 121.4 ± 25.2 g)

After 3 weeks adaptation

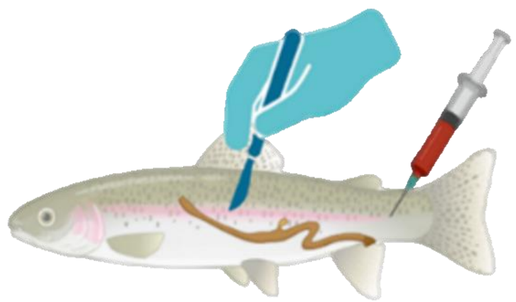
Aquaculture facilities of the University of Udine (Pagnacco, Italy)

Fish fed a single meal

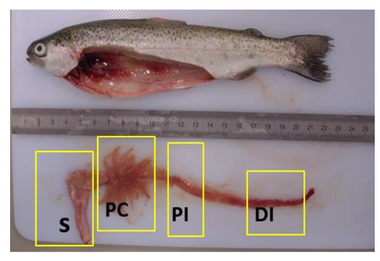
Fish starved for 72 hours

1.5 h · 3 h · 6 h · 9 h · 12 h · 24 h

Hours after the single meal for tissues collection



Stomach + Intestine + Blood



Brush Border Membrane activity and **Gene expression** of the most important digestive enzymes and nutrient transporter

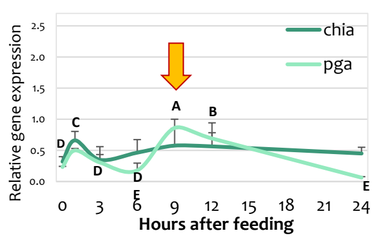
Plasma enzymatic assay (Spectrophotometer)

Serum metabolomic (Nuclear Magnetic Resonance)

RESULTS

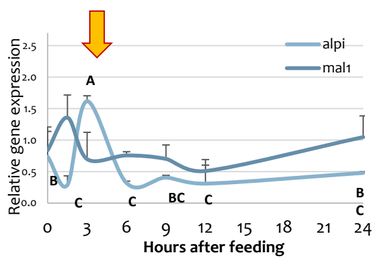
Postprandial relative normalized expression in rainbow trout after a single meal. Data expressed as mean (n=4) ± SEM and analyzed by One-way ANOVA followed by Duncan's post hoc test.

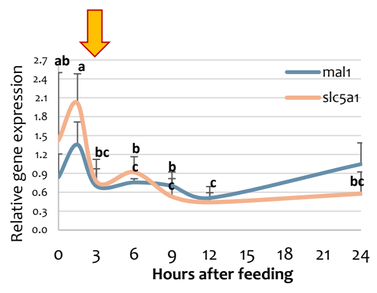
STOMACH



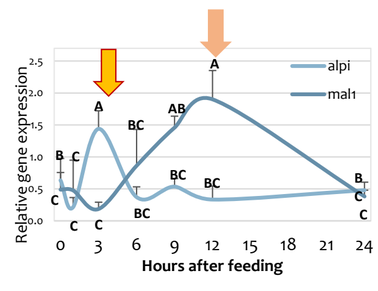
The expression of most genes peaked by 3 hours after meal except gastric pga (pepsinogen) and mal1 (maltase) in distal intestine that peaked at T9 and T12, respectively.

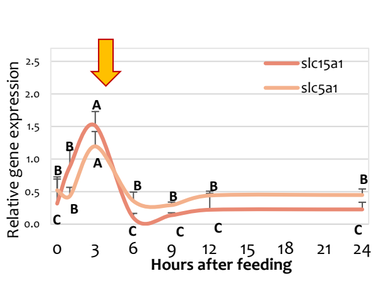
PROXIMAL INTESTINE





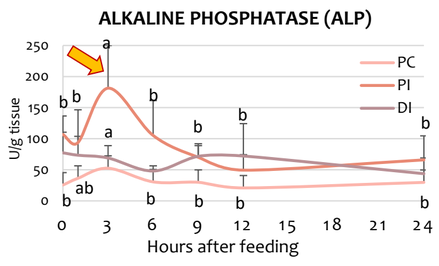
DISTAL INTESTINE

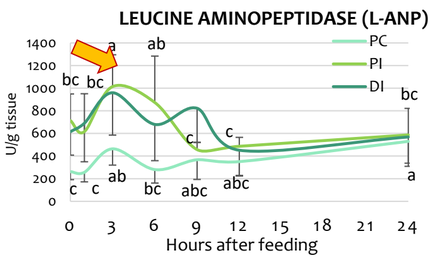


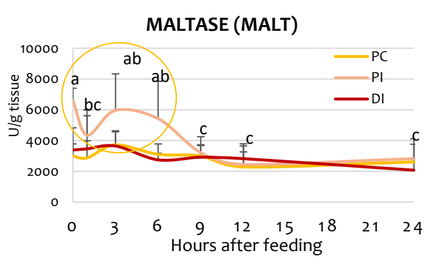


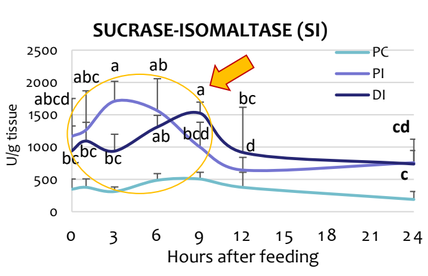
Legend
- ***Chia:*** chitinase
- ***Pga:*** pepsinogen
- ***slc15a1***: oligopeptide transporter 1
- ***slc5a1:*** sodium-glucose Transporter
- **mal1**: maltase
- **alpi**: alkaline phosphatase

Postprandial pattern of intestinal enzymes activity (U/g tissue) in rainbow trout after a single meal. Data are reported as mean ± SD and analyzed by One-way ANOVA followed by Duncan's post hoc test.





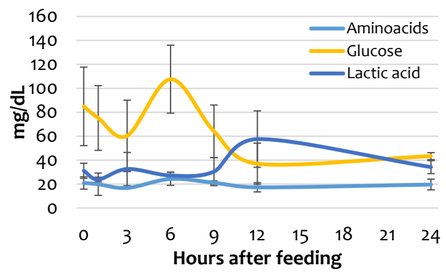




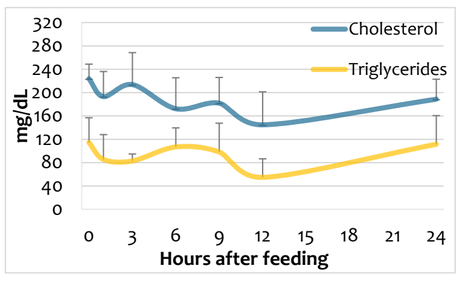
The activity of BBM enzymes were stimulated differently based on the intestinal tract. The PC showed minor activity respect the other intestine tracts.
ALP: ↑ 3h in PC and DI
L-ANP: ↑ 3h in PC and DI
MALT: ↑ 0-6h in PI
SI: ↑ 0-9h in PI and ↑ 6-9h in DI

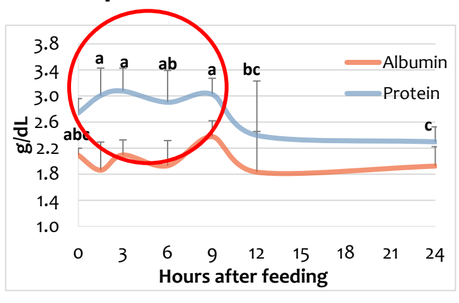
(n=8; a,b,c= p<0.05; A,B,C= p<0,001)

Postprandial patterns of serum glucose, amino acids and lactic acid in rainbow trout after a single meal. Data are reported as mean + SD and analyzed by One-way ANOVA followed by Duncan's post hoc test.



Postprandial kinetics of plasma metabolic parameters in rainbow trout after a single meal. Data are reported as mean + SD and analyzed by One-way ANOVA followed by Duncan's post hoc test.





Regarding the blood parameters only total proteins in plasma, **increased significantly from T1.5 until T9.**

(n=8; a,b,c= p<0.05)

DISCUSSION AND CONCLUSION

The present study elucidated the temporal patterns of gene expression, enzyme activity, and metabolite blood concentrations in rainbow trout following feed intake. These findings highlight the dynamic nature of postprandial physiology and emphasize the importance of considering time-dependent factors in aquaculture feed management. The observed sequential activation of digestive processes suggests a coordinated response to nutrient ingestion.

Future research could explore the effects of different aquafeeds on postprandial responses to optimize sampling strategies also in others aquaculture species.

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