



**UNIVERSITÀ
DEGLI STUDI
DI UDINE**

hic sunt futura

SUSHIN in pillole

Novel ingredients and underexploited feed resources to improve sustainability of farmed fish species

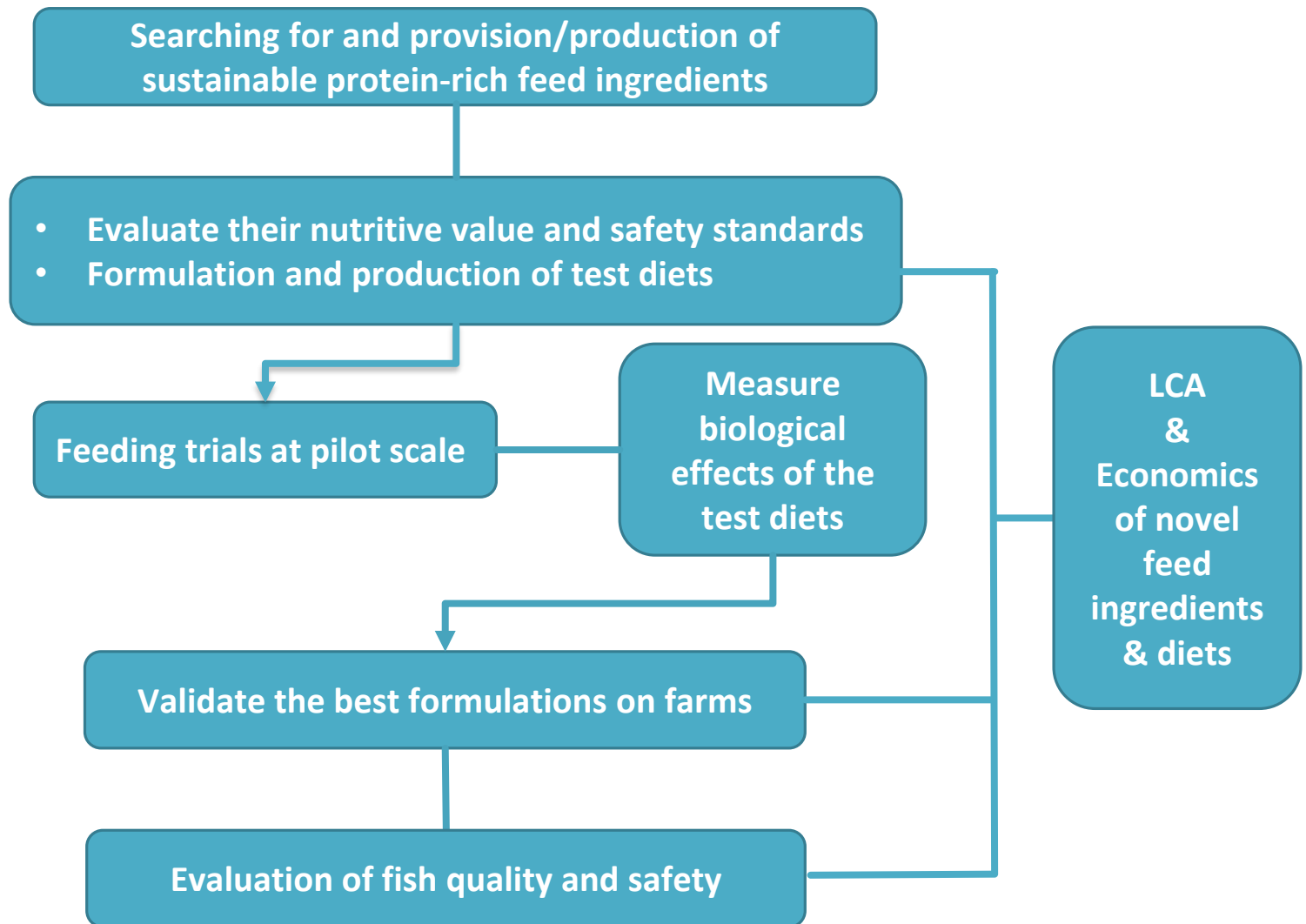




- messo in cantiere nel 2015 con lo scopo di **valutare e valorizzare alimenti proteici nuovi o sottoutilizzati nell'alimentazione delle specie ittiche**
- nasce all'indomani di progetti europei e nazionali che avevano dimostrato la sostenibilità di larghe sostituzioni di farine ed oli di pesce con controparti di origine vegetale nella dieta delle principali specie ittiche carnivore allevate.....

Con Sushin abbiamo cambiato paradigma

nuovi ingredienti proteici alternativi alle proteine vegetali in diete minimizzate per derivati da pesce ritenendo questa la via per assicurare un futuro “meno insostenibile” all’acquacoltura intensiva.



Ricerca e valutazione di fonti proteiche sostenibili nell'alimentazione di trota , orata e branzino

Orientati verso quelle più conformi ai principi della bioeconomia circolare e meno contese tra alimentazione umana ed animale.

Alimenti studiati



PAPs Processed animal proteins

Description

- | | PAPs Processed animal proteins | Description |
|---|-----------------------------------|-------------------------------------|
| 1 | PBM Poultry by-product meal | 100% chicken leftovers low ash |
| 2 | PBM Poultry by-product meal | 100% chicken leftovers regular |
| 3 | PBM Poultry by-product meal | 90:10 chicken:turkey leftover ratio |
| 4 | PBM Poultry by-product meal | 80:20 chicken:turkey leftover ratio |
| 5 | PBM Poultry by-product meal | 65:35 chicken:turkey leftover ratio |
| 6 | BSFD Black soldier fly pupae meal | Protix (NL) |
| 7 | BSFD Black soldier fly pupae meal | Innovafeed (F) |
| 8 | RCM Red claw crayfish meal | Experimental |

Cyanobacteria dried biomass

- | | | |
|----|-----------------------|---|
| 9 | Arthrospira platensis | Whole-cell produced in photobioreactors |
| 10 | Nostoc spheroides | Whole-cell produced in photobioreactors |

Microalgae dried biomass

- | | | |
|----|----------------------------|---|
| 11 | Chlorella sorokiniana FM | Whole cell produced in photobioreactors |
| 12 | Chlorella sorokiniana IAM | Whole cell produced in Photobioreactors |
| 13 | Nanochloropsis oceanica FM | Whole cell Produced in Photobioreactors |
| 14 | Tetraselmis suecica | Whole cell Produced in Photobioreactors N-starved |
| 15 | Tetraselmis suecica | Whole cell Produced in Photobioreactors Regular |
| 16 | Pheodactylum tricorutum | Whole cell Produced in Photobioreactors |
| 17 | Porphyridium cruentum | Whole cell Produced in Photobioreactors |
| 18 | Tisochrysis lutea | Whole cell Produced in Photobioreactors |

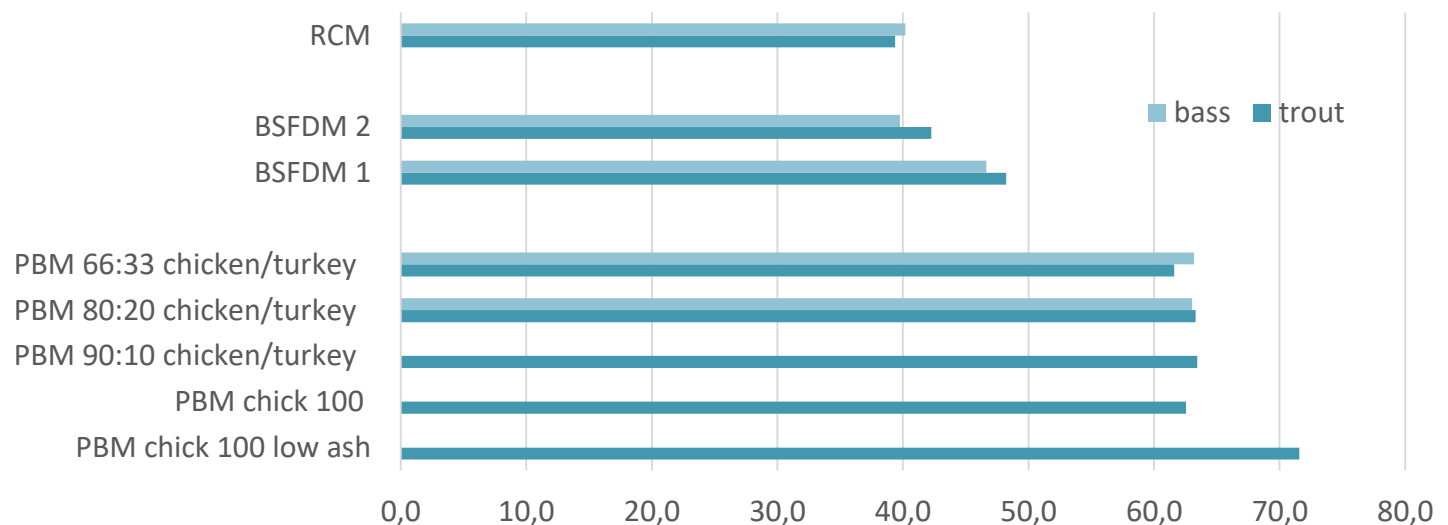
- Caratterizzazione chimico-nutrizionale
- Digeribilità dei nutrienti ed energia (Trout/E. sea bass)
- Sicurezza alimentare (Diossine, PCBs, HM, pesticidi organo-clorurati, Microbiologia)
- LCA e analisi mercato

PAPs *(Processed Animal Proteins)*

Tutti alimenti proteici ottimi o quasi per le specie ittiche studiate

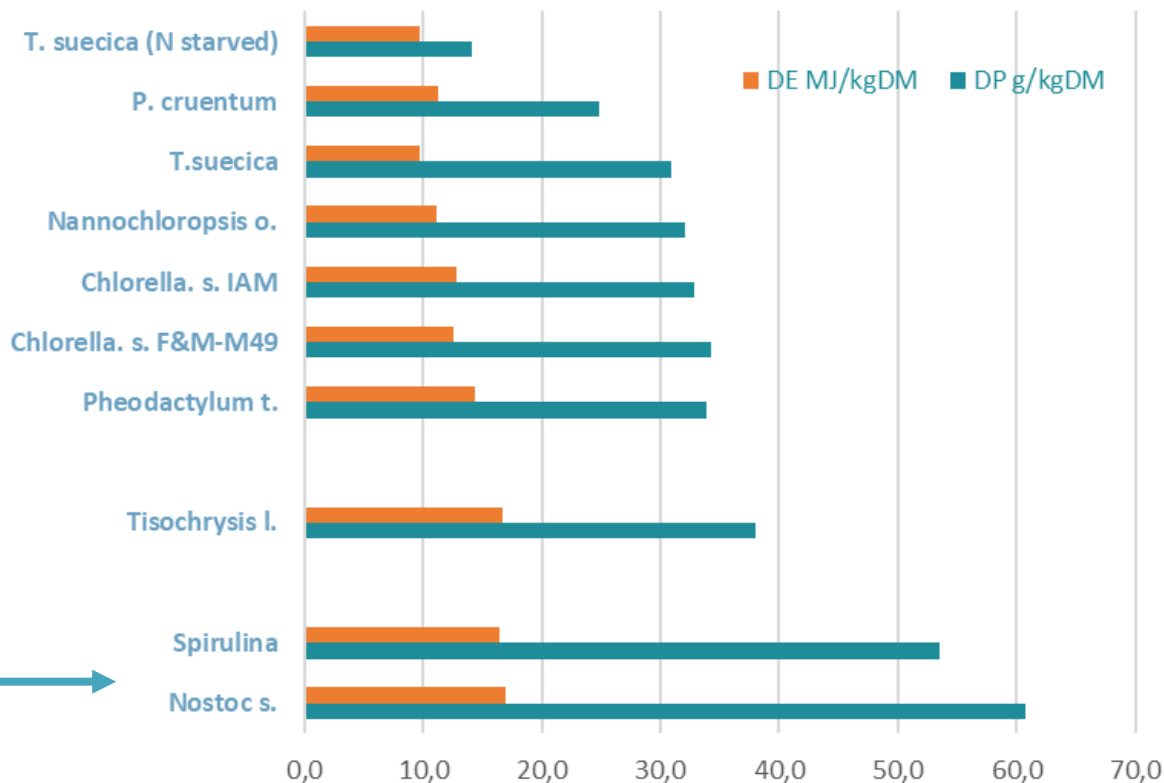
- **BSFM** simili per composizione ma diverse per lavorazioni post-raccolta presentano digeribilità diverse
- **BSFM** meno digeribili nel branzino rispetto alla trota
- **PBM**: ottime fonti di taurinatendenza ad una leggero declino della digeribilità in risposta all'aumento della proporzione di scarti di tacchino su quelli di pollo
- **RCM**: Relativamente povero di proteine ma altamente digeribile *(necessarie implementazioni nel processo di produzione)*

DP content of various PAPs in trout and sea bass



Microalghe e Cianobatteri

Ranking in base a VN nella trota



.....migliori i Cianobatteri !!!!

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Aquaculture

journal homepage: www.elsevier.com/locate/aquaculture



Chemical composition and apparent digestibility of a panel of dried microalgae and cyanobacteria biomasses in rainbow trout (*Oncorhynchus mykiss*)

R. Cerri^a, A. Niccolai^b, G. Cardinaletti^{3a*}, F. Tulli^a, F. Mina^a, E. Daniso^a, T. Bongiorno^a, G. Chini Zittelli^c, N. Biondi^b, M.R. Tredici^b, E. Tibaldi^a

Tutti gli alimenti studiati sono risultati ampiamente sicuri sotto i profili igienico e della concentrazione di POPs

Per ulteriori informazioni sul valore nutritivo e sulla sicurezza alimentare degli ingredienti in esame, è a vostra disposizione il manualetto a lato edito dal CREA pdf. disponibile per partecipanti....

Novel ingredients and underexploited feed resources to improve sustainability of farmed fish species: growth, quality, health and food safety issues - SUSHIN



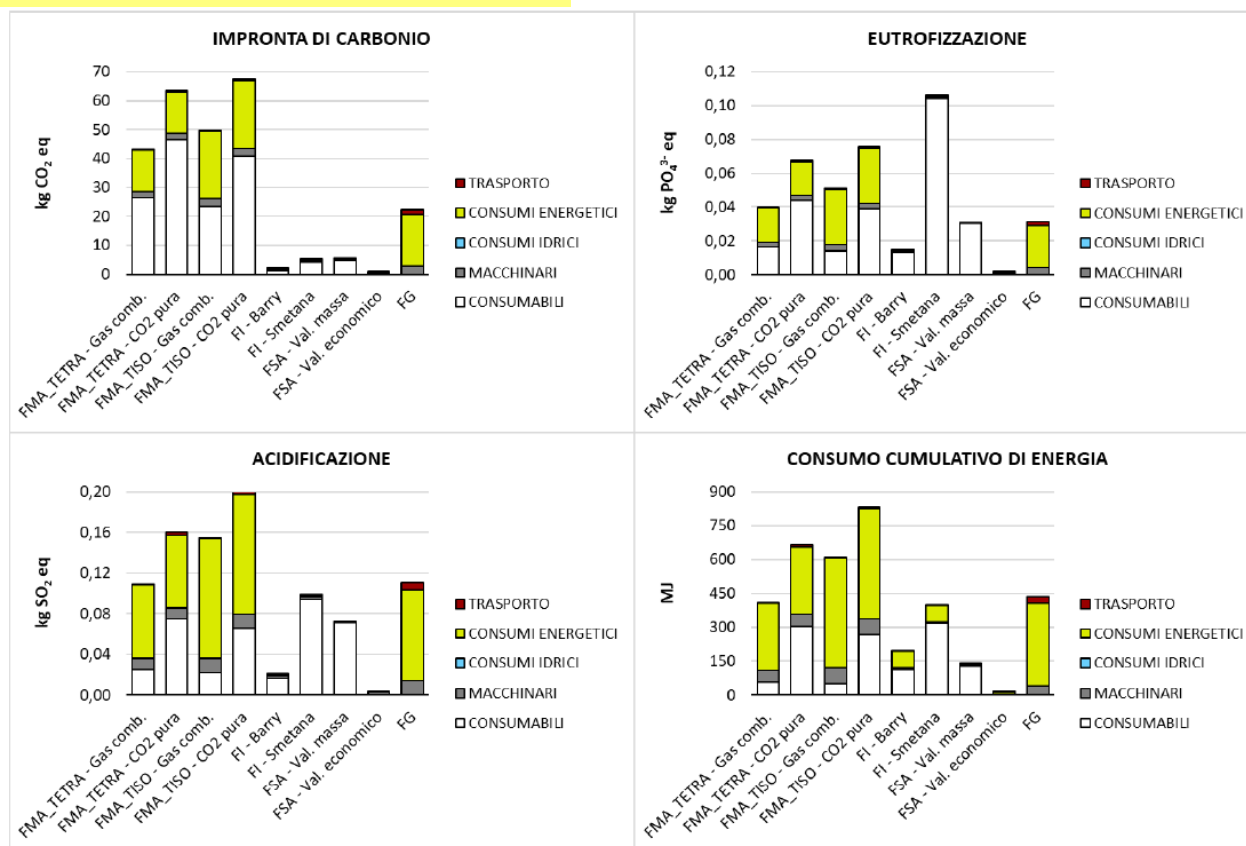
Valore nutritivo e sicurezza alimentare di ingredienti innovativi o sotto-utilizzati di interesse per l'acquacoltura



LCA degli alimenti saggiati (impatti per produrre 1 kg di proteina)

- PAPs 😊

- Microalghe in fotobioreattori ☹️



The International Journal of Life Cycle Assessment
<https://doi.org/10.1007/s11367-020-01759-z>

LCA FOR ENERGY SYSTEMS AND FOOD PRODUCTS



Fishmeal partial substitution within aquafeed formulations: life cycle assessment of four alternative protein sources

Silvia Maiolo¹ • Giuliana Parisi² • Nascasia Biondi² • Fernando Lunelli³ • Emilio Tibaldi⁴ • Roberto Pastres¹

Valutazione complessiva

		Valore nutritivo	Impronta ambientale	Disponibilità Mercato	Prezzo FM prime =100	
					Pre-Covid	Attuale
😊	PBM's	Molto buono	Medio-bassa	elevata	42	49
	BSFM	buono	Medio-bassa	crescente	390	270
😞	RCM	buono	bassa	incerta	?	?
	Cianobatteri	Molto buono	medio-alta	Medio scarsa	650	650
	Microalghe	Variabile tra specie e ceppi	medio-alta	scarsa	>1000	>1000
	<i>Fish meal Prime</i>	<i>eccellente</i>	<i>Medio bassa</i>	<i>stable</i>	100	102
	<i>Fish trimmings</i>	<i>Molto buono</i>	<i>Medio alta</i>	<i>stable</i>	79	73
	<i>Rapeseed meal</i>	<i>medio</i>	<i>Medio-bassa</i>	<i>calo-stabile</i>	17	22
	<i>Soybean meal</i>	<i>medio-buono</i>	<i>Medio-bassa</i>	<i>calo-stabile</i>	28	46
	<i>Wheat gluten</i>	<i>buono</i>	<i>Media</i>	<i>calo-stabile</i>	89	91

La risposta integrata dei pesci alle diete di nuova concezione

- Performance zootecnica
- Bilancio dei nutrienti e dell'energia
- Gut health e metagenomica intestinale
- Profilo metabolico, stress e immunità



New insights on the macromolecular building of rainbow trout (*O. mykiss*) intestine: FTIR Imaging and histological correlative study

Elisabetta Giorgini^{a,1}, Basilio Randazzo^{a,1}, Giorgia Gioacchini^a, Gloriana Cardinaletti^b, Lisa Vaccari^c, Emilio Tibaldi^b, Ike Olivotto^{a,*}



Physiological response of rainbow trout (*Oncorhynchus mykiss*) to graded levels of *Hermetia illucens* or poultry by-product meals as single or combined substitute ingredients to dietary plant proteins

Basilio Randazzo^a, Matteo Zarantoniello^a, Giorgia Gioacchini^a, Gloriana Cardinaletti^b, Alessia Belloni^a, Elisabetta Giorgini^a, Filippo Faccenda^c, Roberto Cerri^b, Emilio Tibaldi^b, Ike Olivotto^{a,*}



Article

***Hermetia illucens* and Poultry by-Product Meals as Alternatives to Plant Protein Sources in Gilthead Seabream (*Sparus aurata*) Diet: A Multidisciplinary Study on Fish Gut Status**

Basilio Randazzo¹, Matteo Zarantoniello¹, Gloriana Cardinaletti², Roberto Cerri², Elisabetta Giorgini¹, Alessia Belloni¹, Michela Contò³, Emilio Tibaldi² and Ike Olivotto^{1,*}



Article

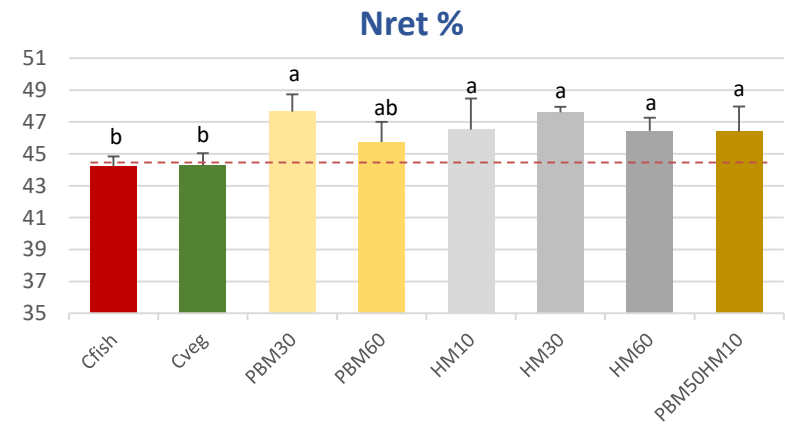
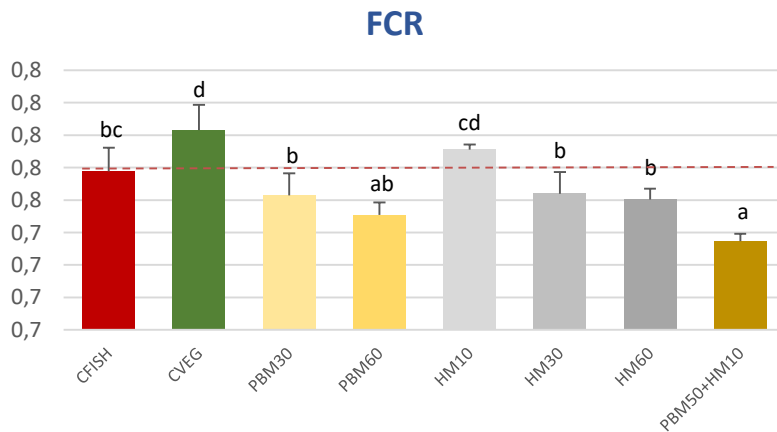
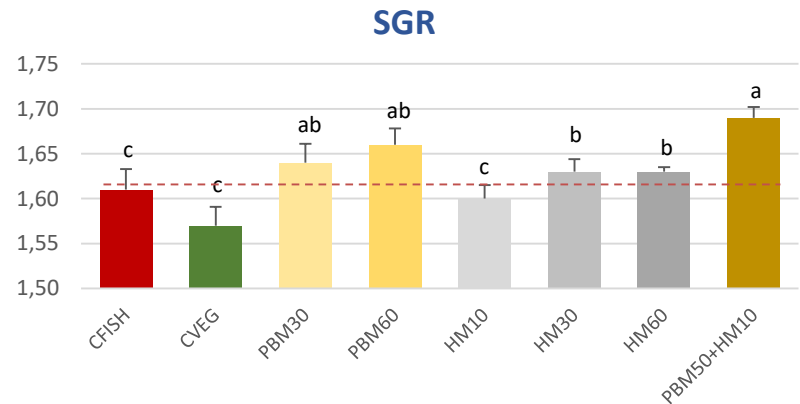
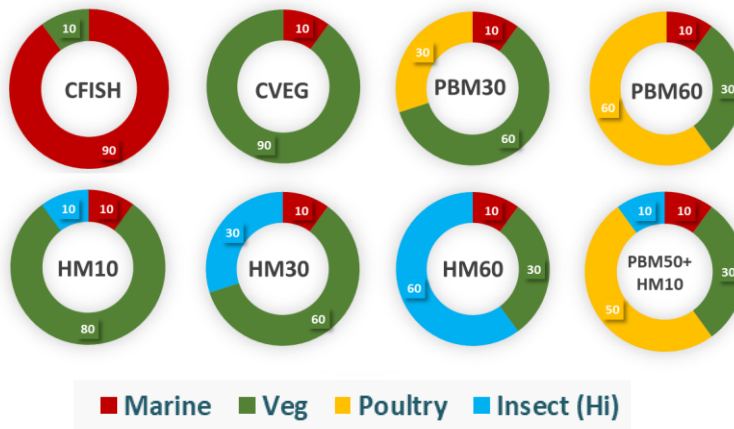
Processed Animal Proteins from Insect and Poultry By-Products in a Fish Meal-Free Diet for Rainbow Trout: Impact on Intestinal Microbiota and Inflammatory Markers

Giulia Gaudioso^{1,2}, Giulia Marzorati¹, Filippo Faccenda³, Tobias Weil¹, Fernando Lunelli³, Gloriana Cardinaletti⁴, Giovanna Marino⁵, Ike Olivotto⁶, Giuliana Parisi⁷, Emilio Tibaldi⁴, Kieran Michael Tuohy¹ and Francesca Fava^{1,*}

Pilot scale trials



Comparing 8 iso-proteic (42 %) iso-lipidic (25%) diets varying in the source of crude protein as follows



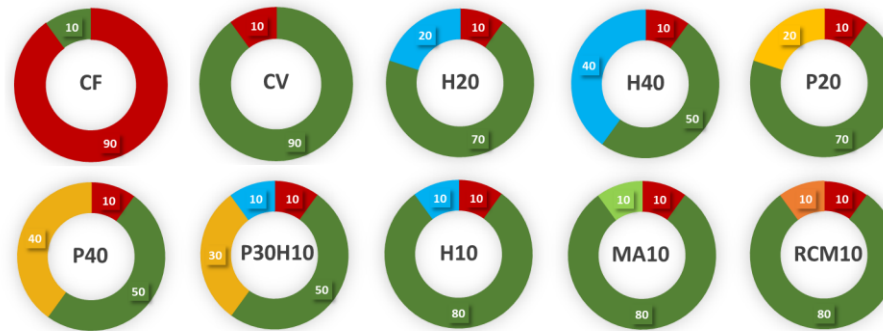
Fish were kept at $13.4 \pm 0.03^\circ\text{C}$ and fed nearly to satiety two daily meals 6 days a week over 13 weeks



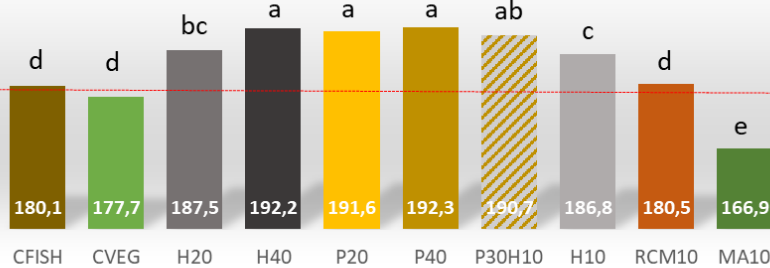
Comparing **10** iso-proteic (45 %) iso-lipidic (20%) **diets** varying in the source of crude protein as follows

Source (%) of dietary crude protein

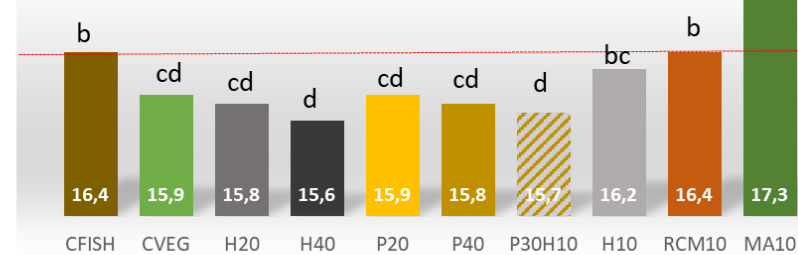
- Marine
- *Hermetia illucens*
- Vegetable
- MicroAlgae
- Poultry by-product
- Red swamp Crayfish Meal



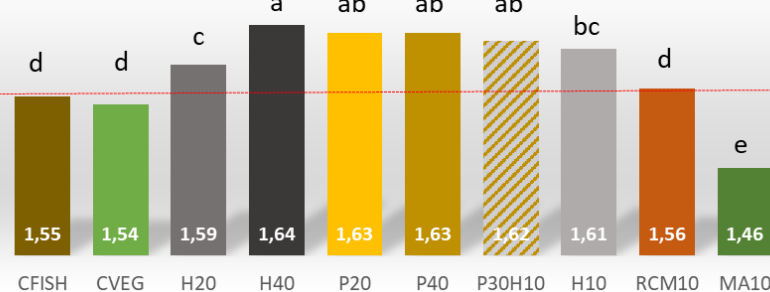
Av. Final weight g (initial 48,9 g)



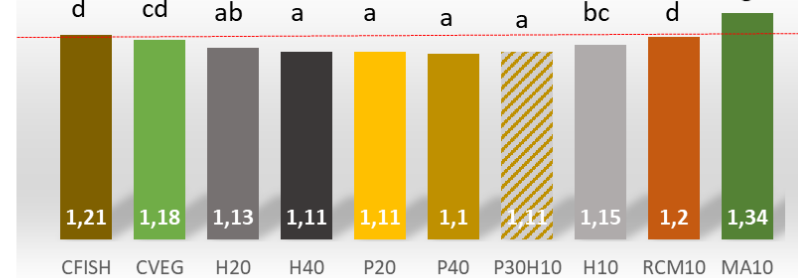
Feed intake g/kg ABM/day



SGR



FCR

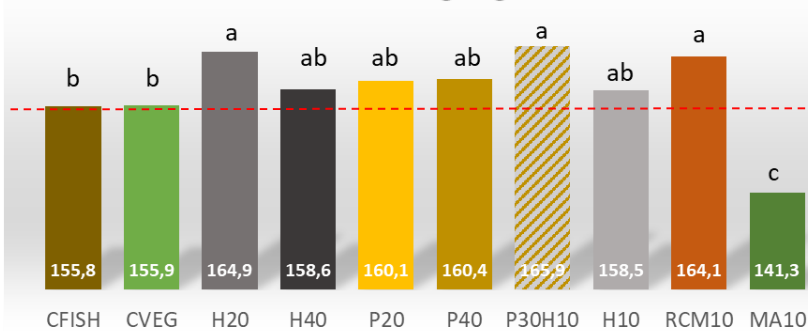


Fish were kept at $23.4 \pm 0.75^\circ\text{C}$ and fed nearly to satiety two daily meals 6 days a week over 12 weeks

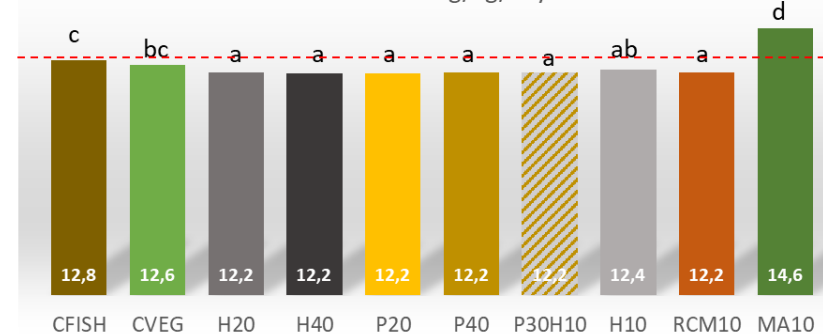




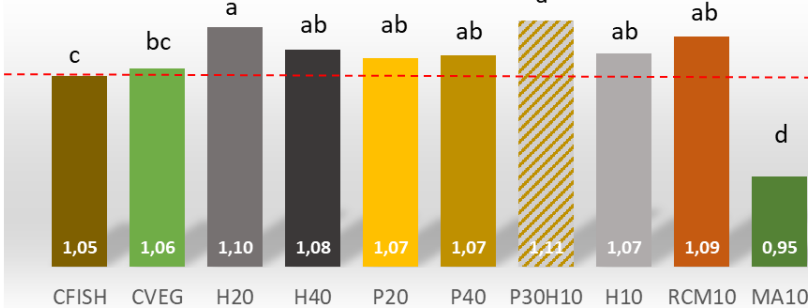
Av. Final weight g (initial 41,4 g)



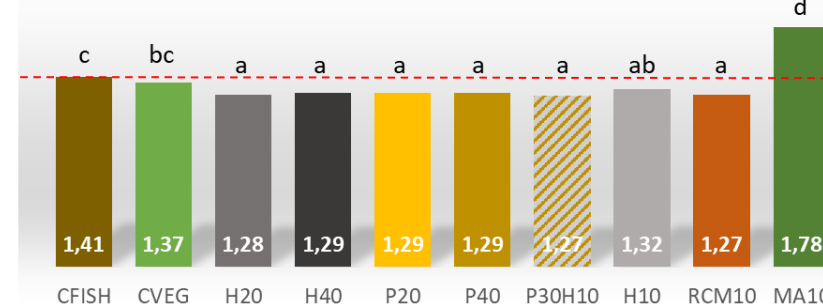
Feed intake g/kg/day



SGR



FCR

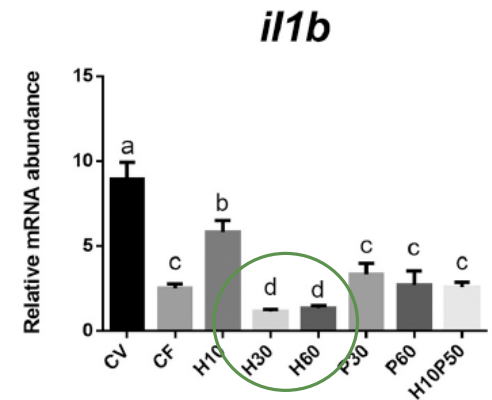
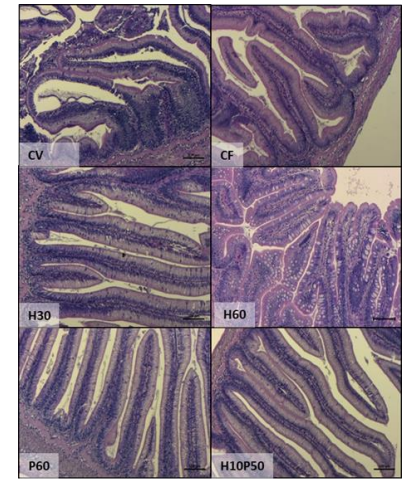


Fish were kept at $23.6 \pm 0.86^{\circ}\text{C}$ and fed nearly to satiety two daily meals 6 days a week over 15 weeks

Generalised physiological response to the novel diets

In all species replacing plant proteins (SBM) for PAPS resulted in improved distal gut mucosa structure relative to that of fish fed Veg diets

- **STOMACH:** upregulation of gastric chitinase gene expression mirroring increasing dietary levels of insect meal
- **PYLORIC CAECA and PROXIMAL INTESTINE:** Oligopeptide transporter 1 and neutral amino acid-transporter solute carrier both upregulated by increasing levels of PAPS in the diet
- **DISTAL INTESTINE** Down-regulation of inflammatory genes pathway (*il1b*; *tnf-a* NF- κ B, *tlr1* & *MyD88*) and *pcna* with diets including PAPS. **Insect meal more effective than PBM or RCM both in trout and bream**
- Clinical chemistry and serum cortisol levels suggested no diet-induced stress in fish.
- **LIVER** *hsp70* gene was down-regulated and the respiratory burst activity of head kidney leukocytes was lowered as dietary levels of PAPS increased in the diet compared to diet Veg
- **GUT MICROBIOTA:** Veg diets resulted in diminished α -diversity. Moderate to high levels of dietary H. *illucens* and PBM, singly or combined, partially restored the higher diversity observed in fish fed diet Fish.



Qualità e risposta del consumatore.

Rese commerciali alla dissezione e proprietà nutrizionali carni simili tra le diete di nuova concezione

Es. Orata n-3/n-6=1.1-1.4



animals



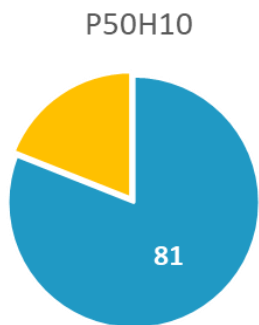
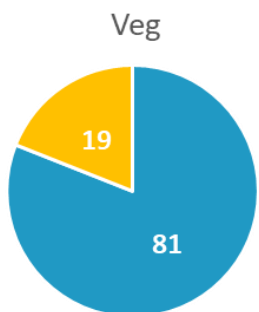
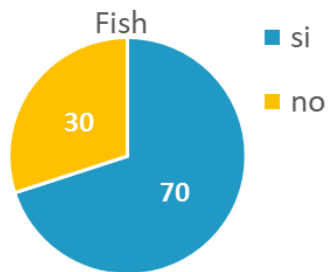
Article

Appetite Regulation, Growth Performances and Fish Quality Are Modulated by Alternative Dietary Protein Ingredients in Gilthead Sea Bream (*Sparus aurata*) Culture

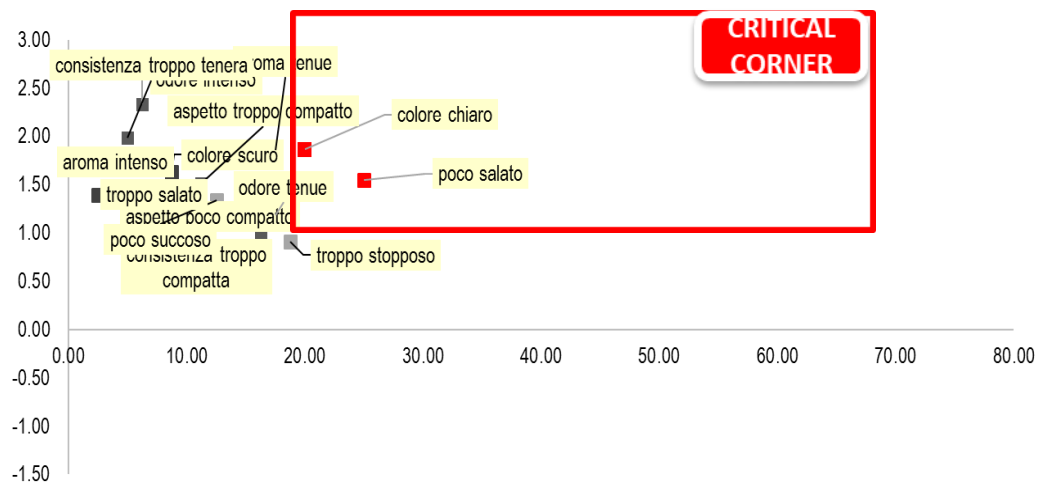
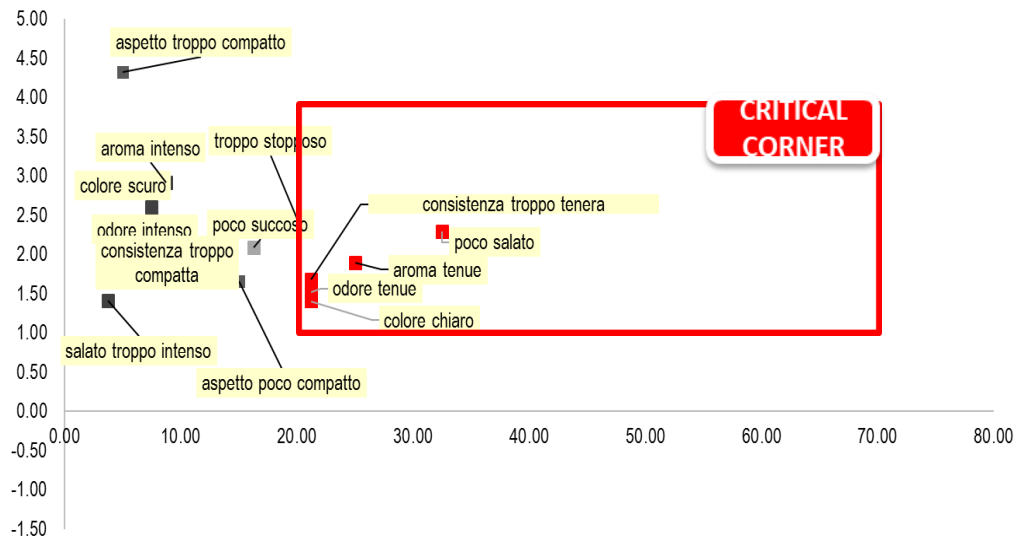
Lina Fernanda Pulido-Rodriguez ¹, Gloriana Cardinaletti ², Giulia Secci ¹, Basilio Randazzo ³, Leonardo Bruni ¹, Roberto Cerri ², Ike Olivotto ³, Emilio Tibaldi ² and Giuliana Parisi ^{1,*}

Giudizi degli assaggiatori es. trota

Propensione al ri-consumo



Penalty Analysis

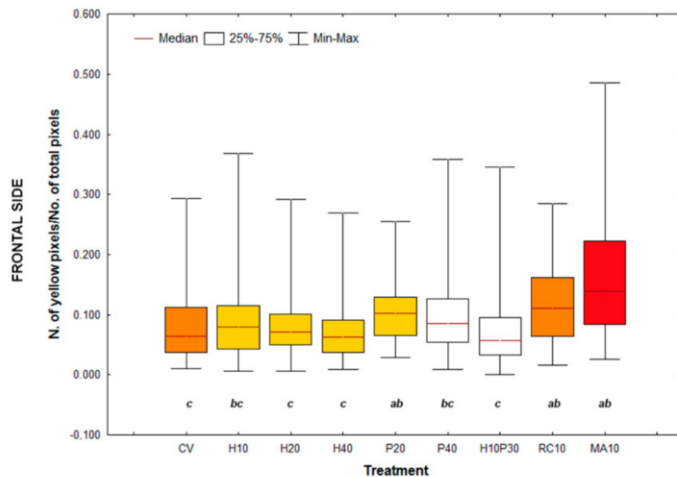
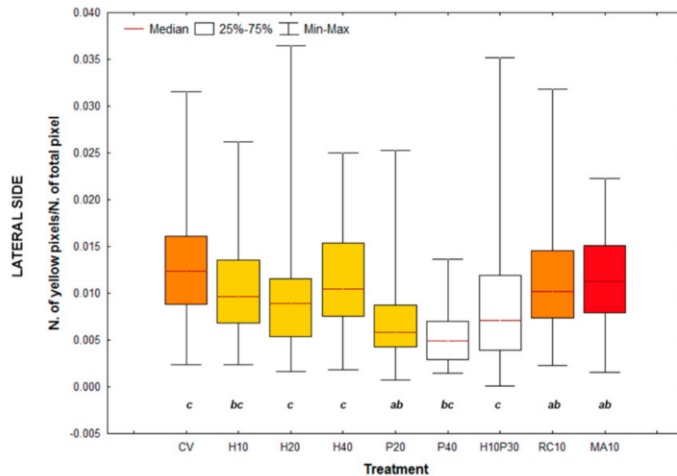


Sustainability indicators of the test diets:

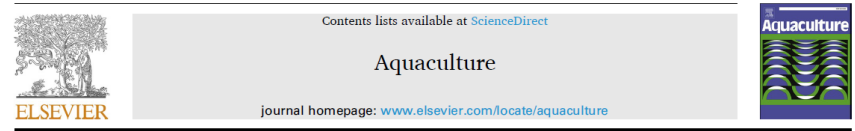
	CF	CV	H10	H30	H60	P30	P60	P50H10		
FCR	0.78	0.80	0.79	0.76	0.76	0.76	0.75	0.73		
Economic Conversion Ratio CF=100	100	83	97	133	193	65	59	80		
FIFO	1.82	0.26	0.26	0.25	0.25	0.25	0.24	0.24		
FFDRm	1.71	0.17	0.16	0.16	0.16	0.16	0.16	0.15		
FFDRo	2.36	0.71	0.70	0.67	0.67	0.67	0.66	0.65		
	CF	CV	H10	H20	H40	P20	P40	P30H10	RCM 10	MA10
FCR	1.25	1.18	1.15	1.16	1.15	1.15	1.16	1.14	1.24	1.39
ECRr	100	74	95	119	164	69	66	89	128	201
FIFO	2.94	0.48	0.46	0.47	0.46	0.46	0.47	0.46	0.50	0.56
FFDRm	3.55	0.41	0.36	0.32	0.24	0.35	0.32	0.29	0.42	0.89
FFDRo	2.15	1.46	1.43	1.44	1.43	1.43	1.44	1.41	1.54	1.72
	CF	CV	H10	H20	H40	P20	P40	P30H10	RCM 10	MA10
FCR	1.41	1.37	1.32	1.28	1.29	1.29	1.29	1.27	1.28	1.78
ECRr	100	77	97	116	162	69	66	88	116	229
FIFO	3.31	0.55	0.53	0.51	0.52	0.52	0.52	0.51	0.51	0.72
FFDRm	3.49	0.31	0.30	0.29	0.30	0.30	0.30	0.29	0.29	0.41
FFDRo	2.42	1.70	1.64	1.58	1.60	1.60	1.60	1.58	1.58	2.21

Microalge e RCM ingredienti funzionali ? :

- pigmentanti naturali efficaci per l'appearance della cute (orata)
- RCM efficace nella salmonatura del muscolo (trota)



CAROTENOID CONTENT (mg/kg d.w.)



Muscle pigmentation in rainbow trout (*Oncorhynchus mykiss*) fed diets rich in natural carotenoids from microalgae and crustaceans

Domitilla Pulcini^{a,*}, Fabrizio Capoccioni^a, Simone Franceschini^b, Marco Martinoli^a, Filippo Faccenda^c, Giulia Secci^d, Andrea Perugini^d, Emilio Tibaldi^e, Giuliana Parisi^d



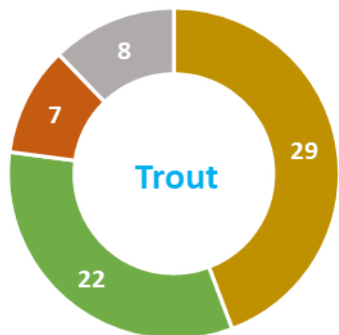
Article

Skin Pigmentation in Gilthead Seabream (*Sparus aurata* L.) Fed Conventional and Novel Protein Sources in Diets Deprived of Fish Meal

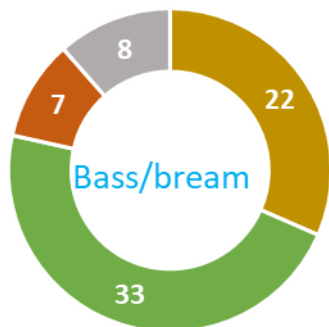
Domitilla Pulcini¹, Fabrizio Capoccioni^{1,*}, Simone Franceschini², Marco Martinoli¹ and Emilio Tibaldi³

Validazione in prove aziendali di confronto mangime Sushin vs. Commerciale

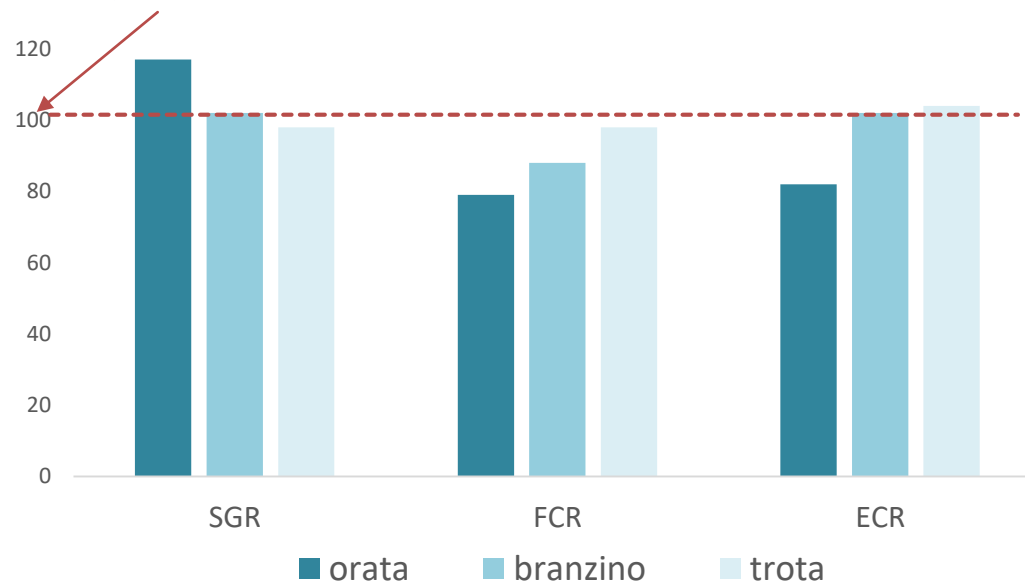
Mangimi sushin



■ PBM ■ Veg
■ Marine ■ Hermetia



140 *Risposte ai mangimi commerciali = 100*



Pesci tutti sicuri sul lato igienico-sanitario

CONCLUSIONI

**Le ricerche condotte ad ampio raggio di risposta
(pesce, consumatore, società)**

**offrono chiare indicazioni agli operatori del settore ed al consumatore
sulle favorevoli prospettive di impiego
di mangimi di nuova generazione
nutrienti e sicuri per l'intera filiera acquacolturale,**

**caratterizzati da minor impronta ambientale e da un uso meno
conflittuale delle risorse proteiche rispetto alle attuali formulazioni.**