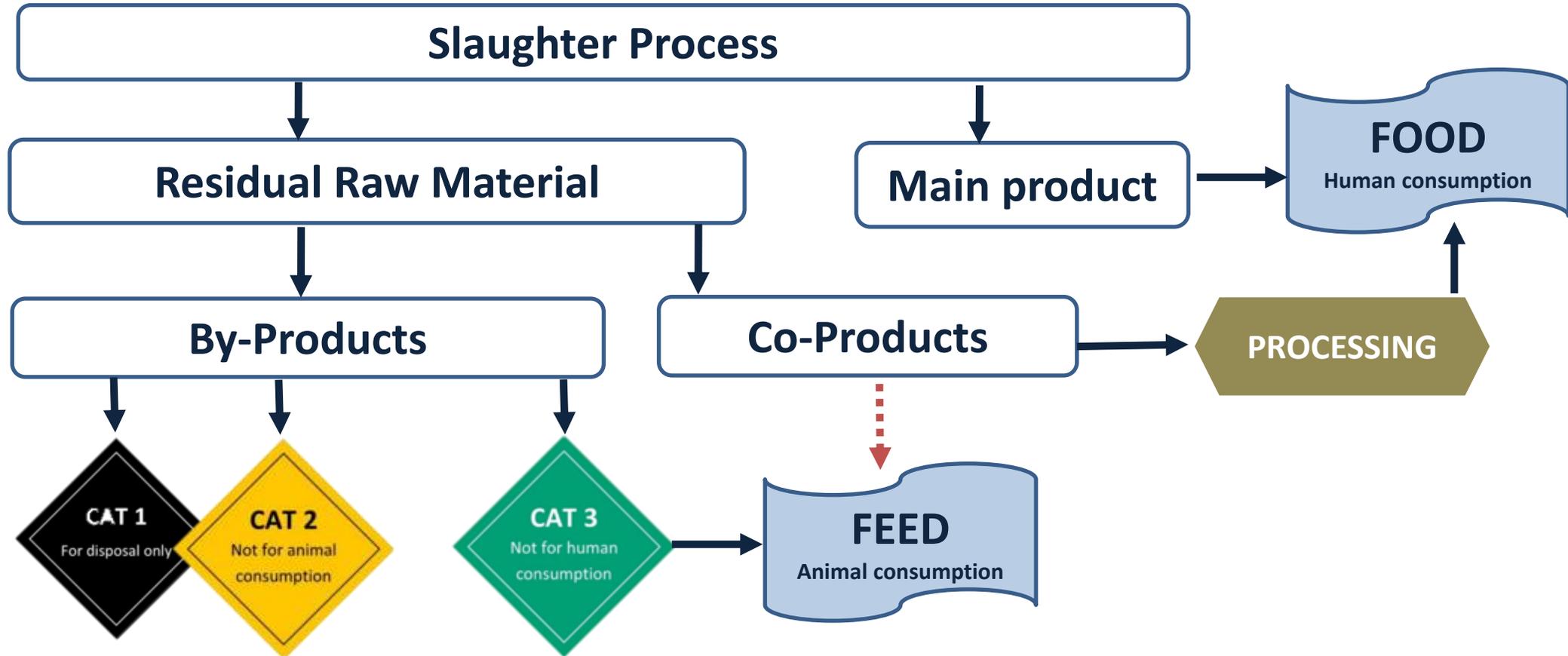
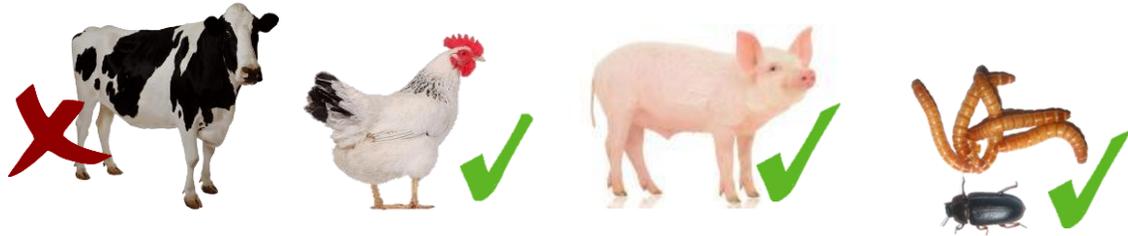


# *Animal Proteins*

**Luisa M.P. Valente**  
**CIIMAR - University of Porto**  
**Portugal**



# Terrestrial Animal Proteins



In the European Union (EU) since 2013 non-ruminant processed animal proteins (PAP) are again permitted to be used in aquafeeds.

# ***Terrestrial - Vertebrate***



- Meat meal (MM)
- Meat and bone meal (MBM)
- Blood meal (BM)
- Feather meal (HFM)
- Poultry by-product meal (PBM)
- Milk by-product
- Gelatin



**ABP –Animal By-Product**

**LAP –Land Animal Product**

**PAP – Processed Animal Protein**

# Changing Ingredient Base in Diets

■ Vitamins/Minerals/Additives

■ Novel Oils

■ Novel Proteins

■ Land Animal Oils

■ Land Animal Proteins

■ Carbohydrates

■ Plant Oils

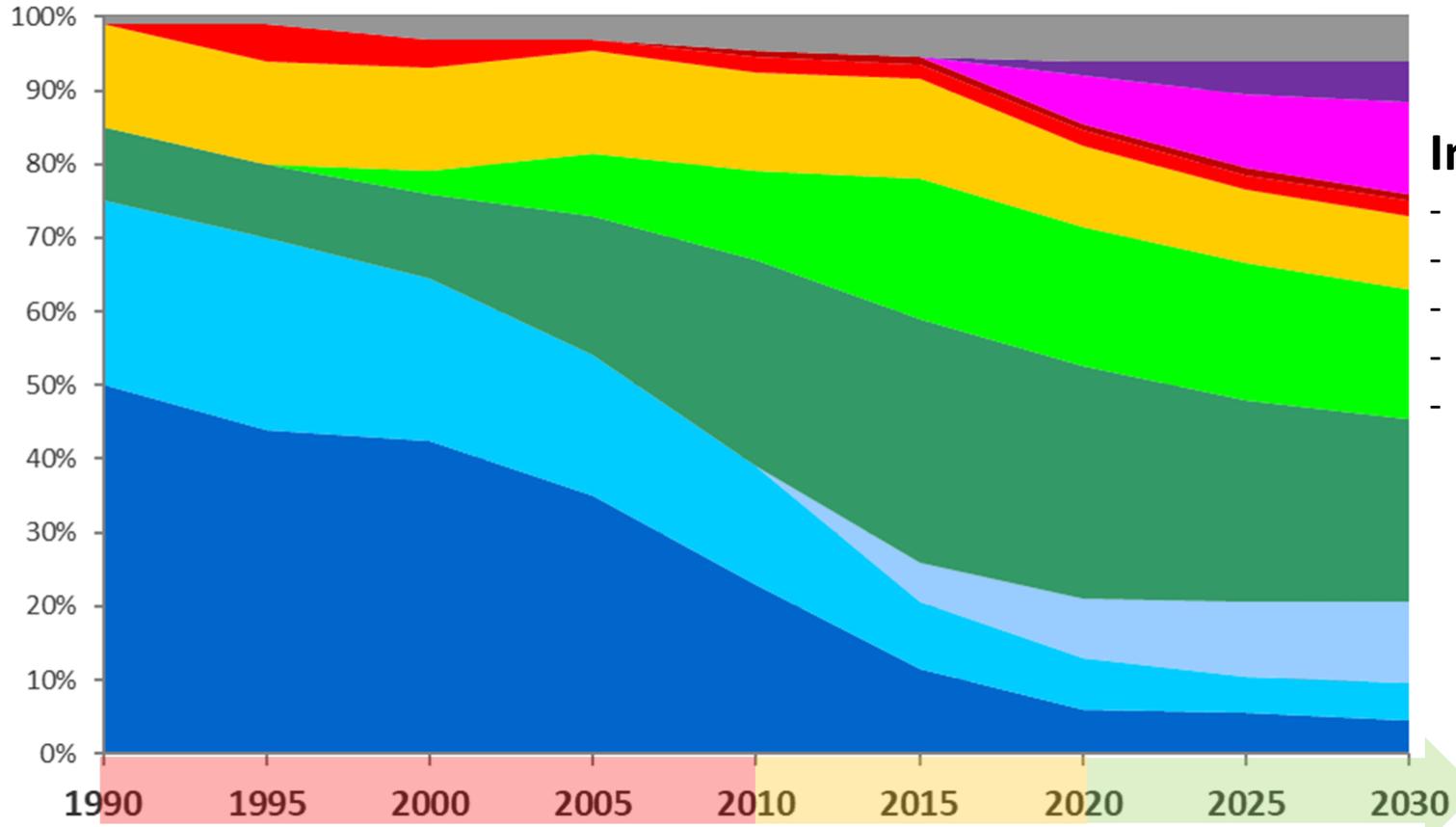
■ Plant Proteins

■ Marine By-Products

■ Fishoil

■ Fishmeal

## Raw Material Use by Salmon Feed Sector



**Increasing Expectations**

- Nutritious
- Enhanced Qualities
- Safe
- Responsible
- Low Cost

# SWOT ANALYSIS

## STRENGTHS

- Availability
- Price
- **Rich protein sources**
- **Well balanced essential amino acids:**
  - EAA of Diptera close to FM
  - EAA of Coleoptera close to soybean
- **Potential prebiotic effect/immunomodulator**

## WEAKNESSES

- **Need processing prior use**
- **Lack Omega-3 HUFA**  
Variable nutritional value depending on species, season and latitudes
- **Low social acceptance**

## OPPORTUNITIES

- Increasing demand
- Local economy trend associated with lower carbon footprint
- High technological development (TRL)
- Renewable energy

## THREATS

- Legal issues
- Fraud/Adulteration with lower quality products
- Safety issues
- Energy costs
- Religious limitations

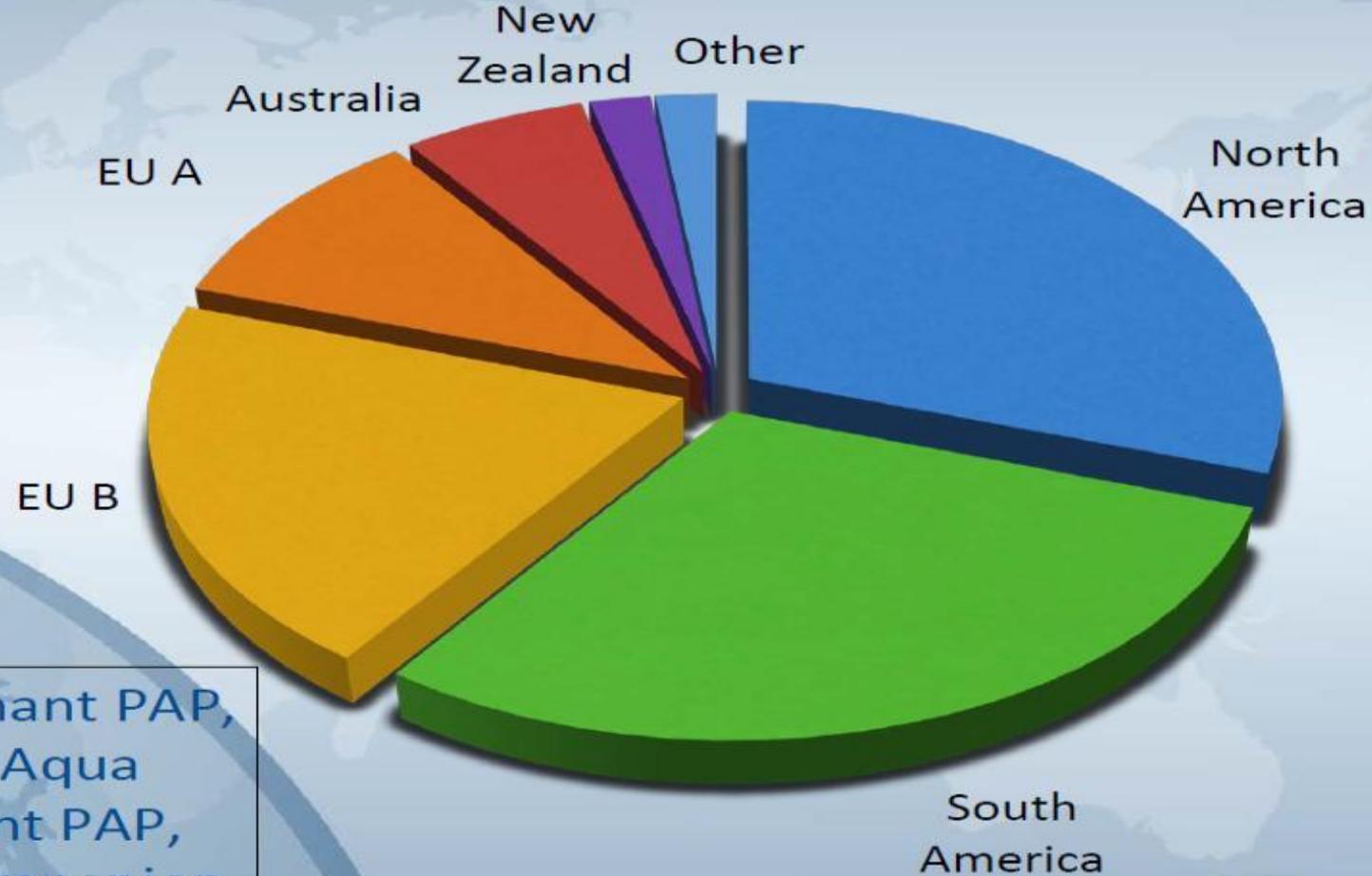
# High Availability

## Production of PAP around the World

Total PAP  
for Aqua  
~ 10 million  
tonnes pa

ALL PAP =  
>14 million  
Tonnes pa

EU A = non ruminant PAP,  
approved for Aqua  
EU B = Ruminant PAP,  
approved for Companion



Apparent digestibility coefficients of processed agro-food by-products in European seabass (*Dicentrarchus labrax*) juveniles

I. Campos<sup>1,2</sup>  | E. Matos<sup>3</sup>  | C. Aragão<sup>4</sup>  | M. Pintado<sup>5</sup>  | L.M.P. Valente<sup>1,2</sup> 

Aquaculture 521 (2020) 735085



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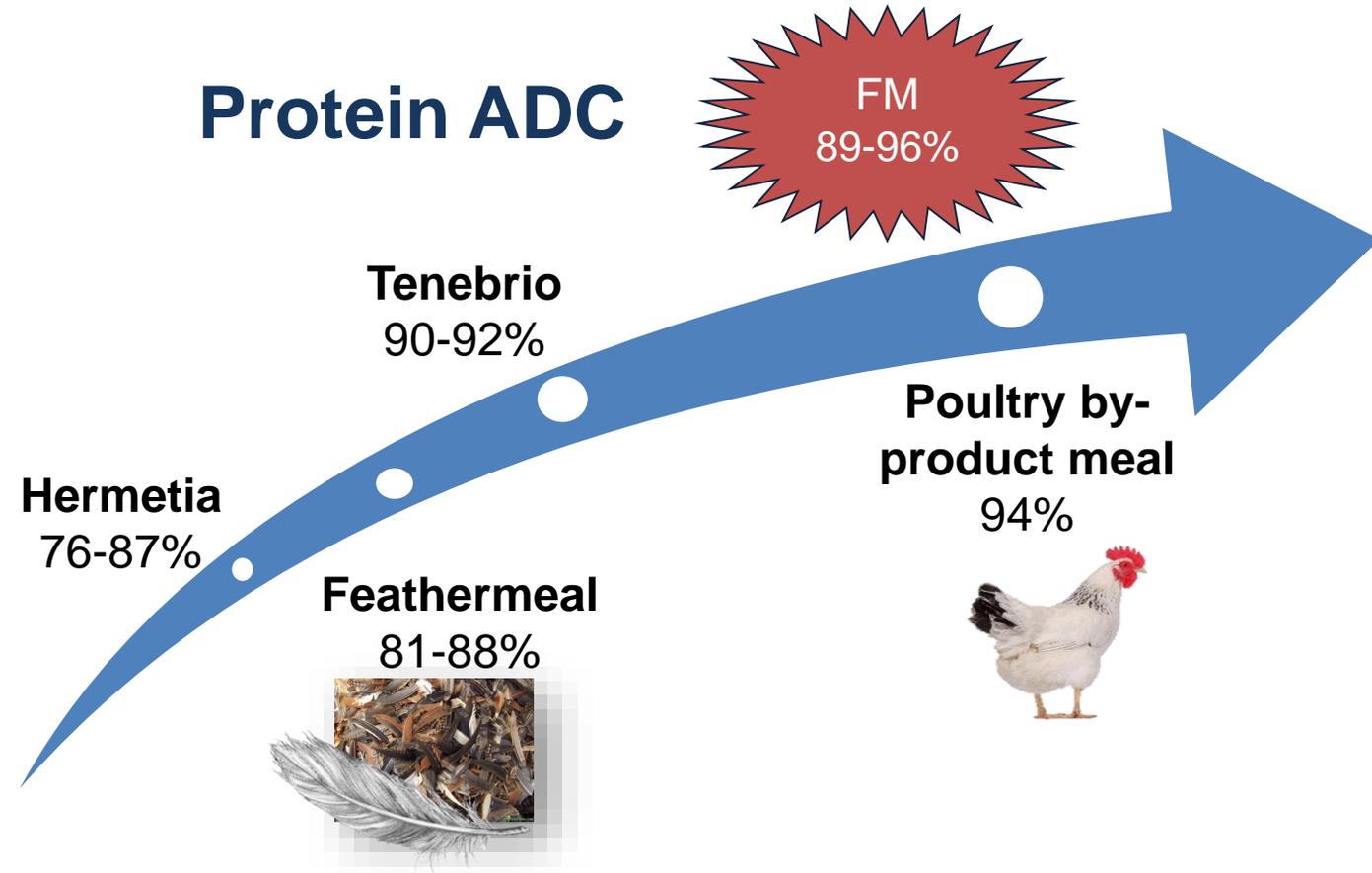
Nutritional value of different insect larvae meals as protein sources for European sea bass (*Dicentrarchus labrax*) juveniles

Ana Basto<sup>a,b</sup>, Elisabete Matos<sup>c</sup>, Luisa M.P. Valente<sup>a,b,\*</sup>



# Rich Protein Sources

## Protein ADC



The inclusion of insect protein in aquafeeds was authorized by the European Union (EU) in 2017



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76% (HF12.5)

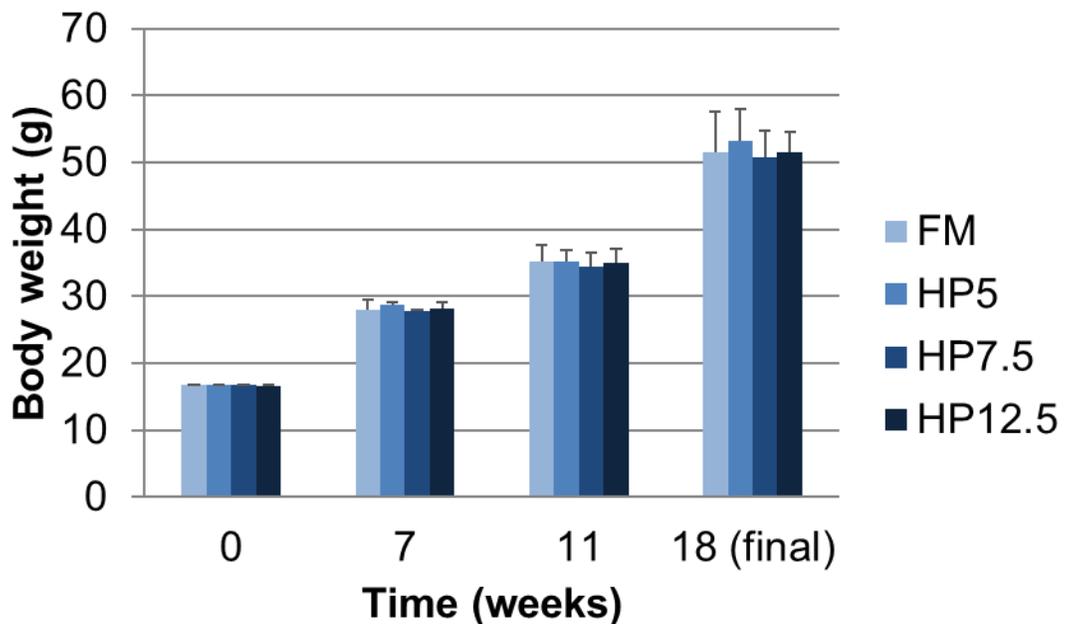
## Hydrolyzed feather meal as a partial fishmeal replacement in diets for European seabass (*Dicentrarchus labrax*) juveniles

Inês Campos<sup>a,b</sup>, Elisabete Matos<sup>c</sup>, Alexandra Marques<sup>a</sup>, Luisa M.P. Valente<sup>a,b,\*</sup>

<sup>a</sup> CIIMAR, Centro Interdisciplinar de Investigação Marinha e Ambiental, Universidade do Porto, Terminal de Cruzeiros do Porto de Leixões, Av. General Norton de Matos, S/N, 4450-208 Matosinhos, Portugal

<sup>b</sup> ICBAS, Instituto de Ciências Biomédicas de Abel Salazar, Universidade do Porto, Rua de Jorge Viterbo Ferreira, 228, 4050-313 Porto, Portugal

<sup>c</sup> SORGAL, Sociedade de Óleos e Rações, S.A., Estrada Nacional 109 Lugar da Pardala, 3880-728 S. João de Ovar, Portugal

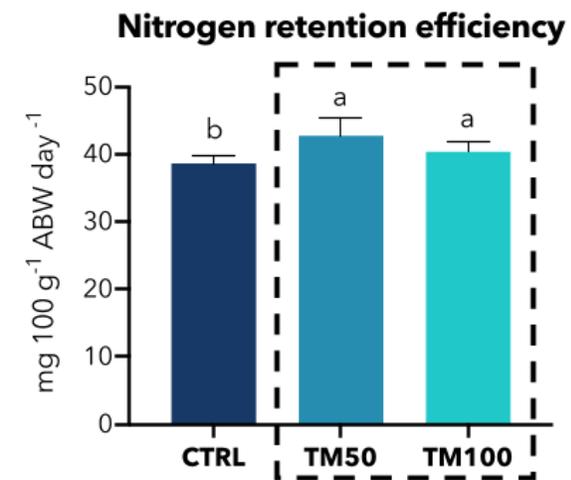
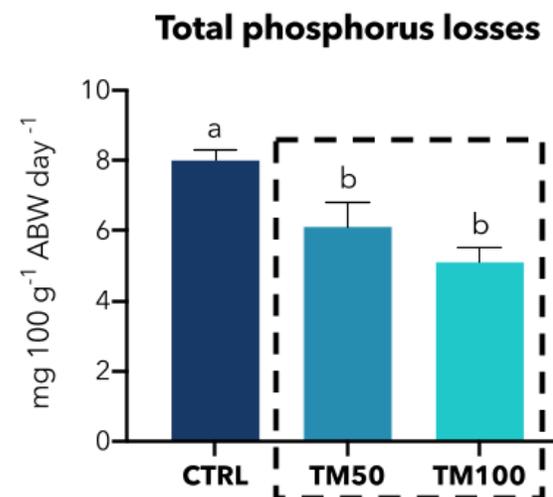
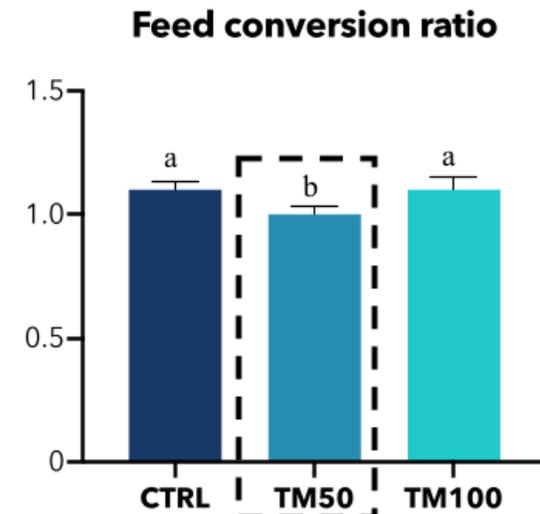
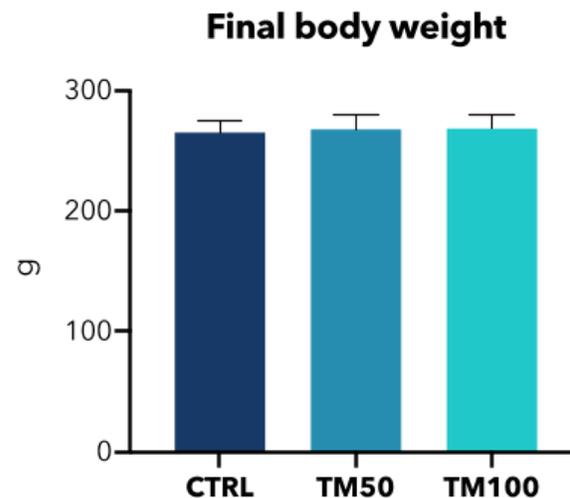


	FM	HP5	HP7.5	HP12.5
Feed Conversion Ratio	1.6	1.6	1.6	1.6
Daily Growth Index (g.day <sup>-1</sup> )	0.9	1.0	0.9	0.9
Voluntary Feed Intake (%)	1.2	1.1	1.2	1.2
Protein Efficiency Ratio	1.3	1.2	1.3	1.3

# Total replacement of Fish meal by *Tenebrio* in European sea bass



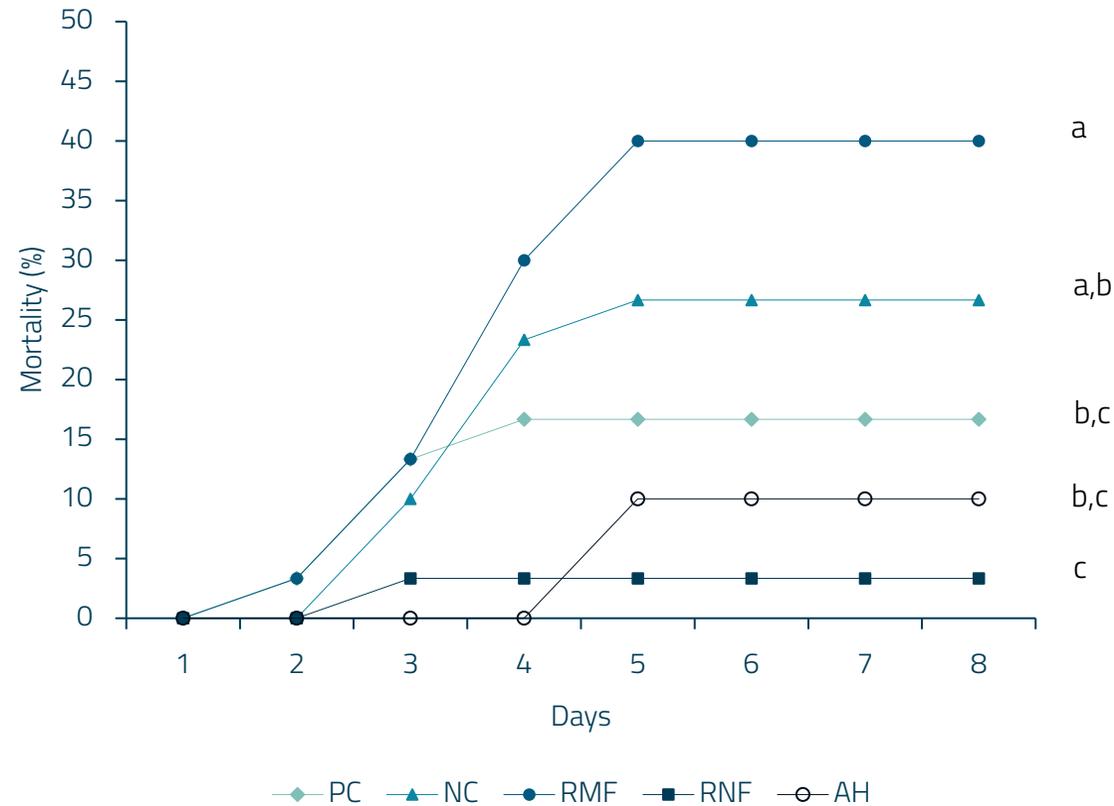
	CTRL	TM50	TM100
<b>Ingredients (%)</b>			
Fishmeal	40	20	-
Defatted <i>Tenebrio molitor</i> larvae meal	-	20	40
Plant protein sources	45	45	45
Fish oil	14	13	13
Vitamin and mineral premix	1	1	1
Vitamin C and E	0.2	0.2	0.2
Monocalcium phosphate	-	1	2
L-Lysine	-	-	0.2
L-Threonine	-	-	0.2
L-Tryptophan	-	-	0.1
DL-Methionine	0.1	0.2	0.3
<b>Chemical composition (% DM)</b>			
Dry matter	93	93	92
Protein	47	47	47
Lipids	20	20	19
Gross energy (kJ g <sup>-1</sup> DM)	23	23	24
Ash	10	8	6
Phosphorus	1	1	1



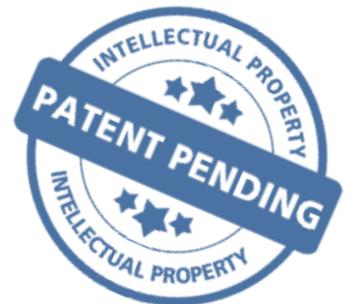
# Potential prebiotic effect/immunomodulator



## 3% Blood Hydrolysate in Sea bass diets:



RNF increases resistance to *T. maritimum*, resulting in mortality <5%



# Need Processing Prior Use

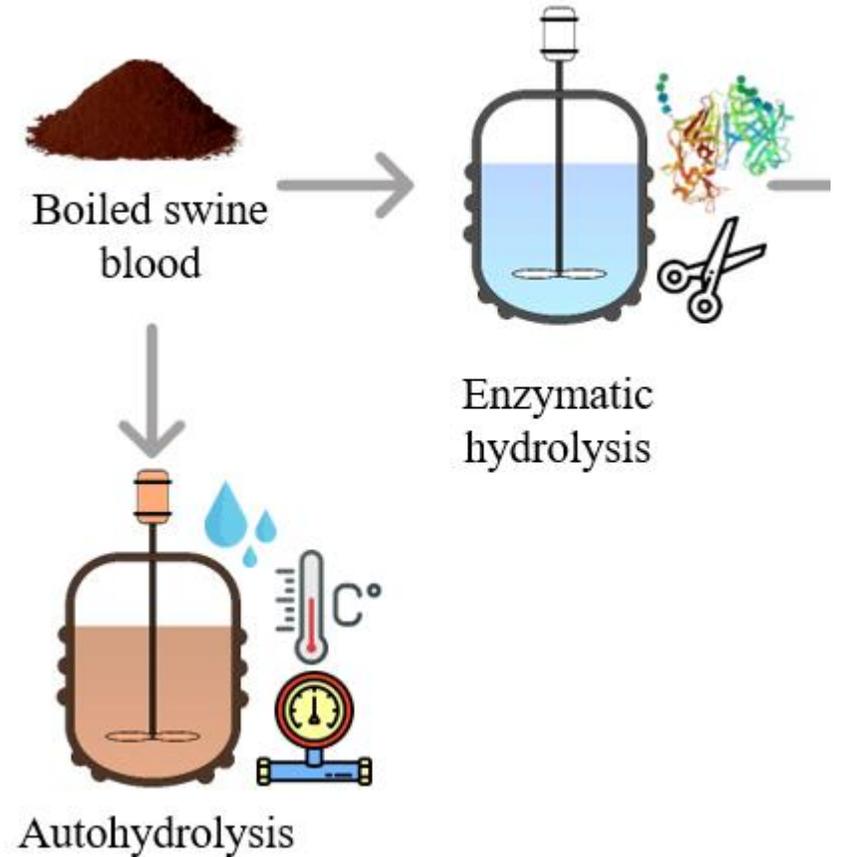
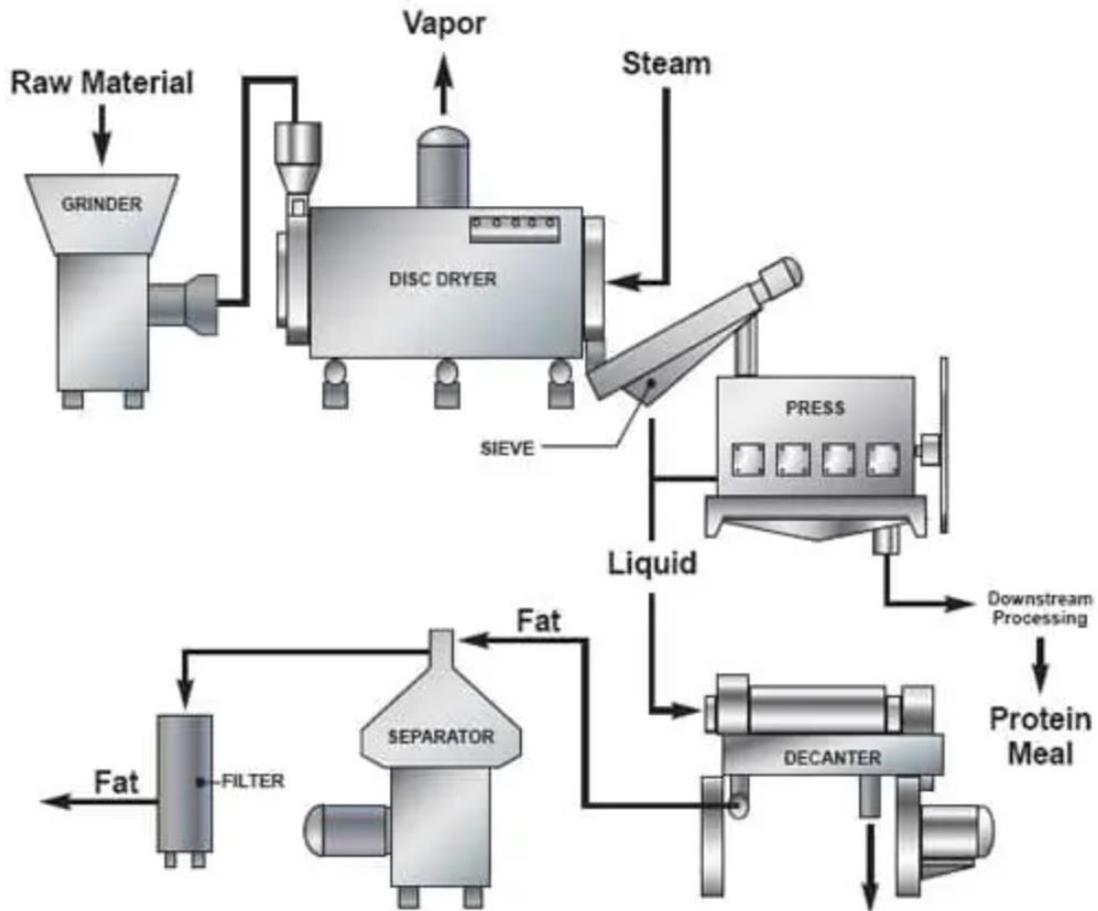
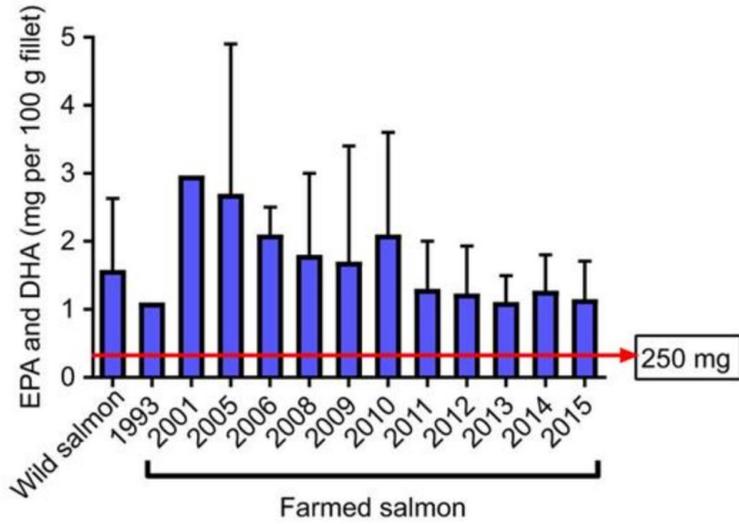


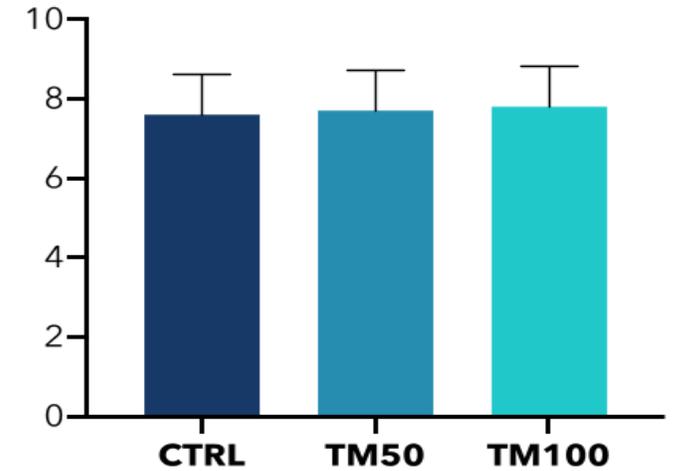
Figure 3. Schematic diagram of a continuous dry processing system.

# WEAKNESSES

## Lack Omega-3 HUFA



### Global acceptance



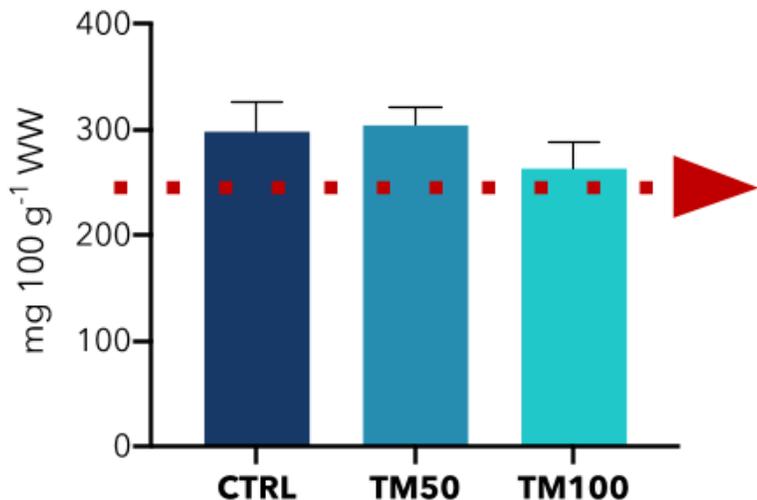
ORIGINAL RESEARCH article  
Front. Physiol., 15 April 2021 | <https://doi.org/10.3389/fphys.2021.659567>

The Use of Defatted *Tenebrio molitor* Larvae Meal as a Main Protein Source Is Supported in European Sea Bass (*Dicentrarchus labrax*) by Data on Growth Performance, Lipid Metabolism, and Flesh Quality

Ana Basto<sup>1,2</sup>, Josep Calduch-Giner<sup>3</sup>, Beatriz Oliveira<sup>1,2</sup>, Lisa Petit<sup>4</sup>, Tiago Sá<sup>1,2</sup>, Margarida R. G. Maia<sup>1</sup>, Susana C. Fonseca<sup>1</sup>, Elisabete Matos<sup>5</sup>, Jaume Pérez-Sánchez<sup>3</sup> and Luisa M. P. Valente<sup>1,2\*</sup>

<sup>1</sup>ICBAS, Instituto de Ciências Biomédicas Abel Salazar, Universidade do Porto, Porto, Portugal  
<sup>2</sup>CIMAR/CIMAR, Centro Interdisciplinar de Investigação Marinha e Ambiental, Universidade do Porto, Matosinhos, Portugal  
<sup>3</sup>IATS - CSIC, Instituto de Acuicultura Torre de la Sal, Castellón de la Plana, Spain  
<sup>4</sup>GreenUPorto, DGAOT, Faculdade de Ciências, Universidade do Porto, Porto, Portugal  
<sup>5</sup>SORGAL - Sociedade de Óleos e Rações, S.A., S. João de Ovar, Portugal

### EPA+DHA

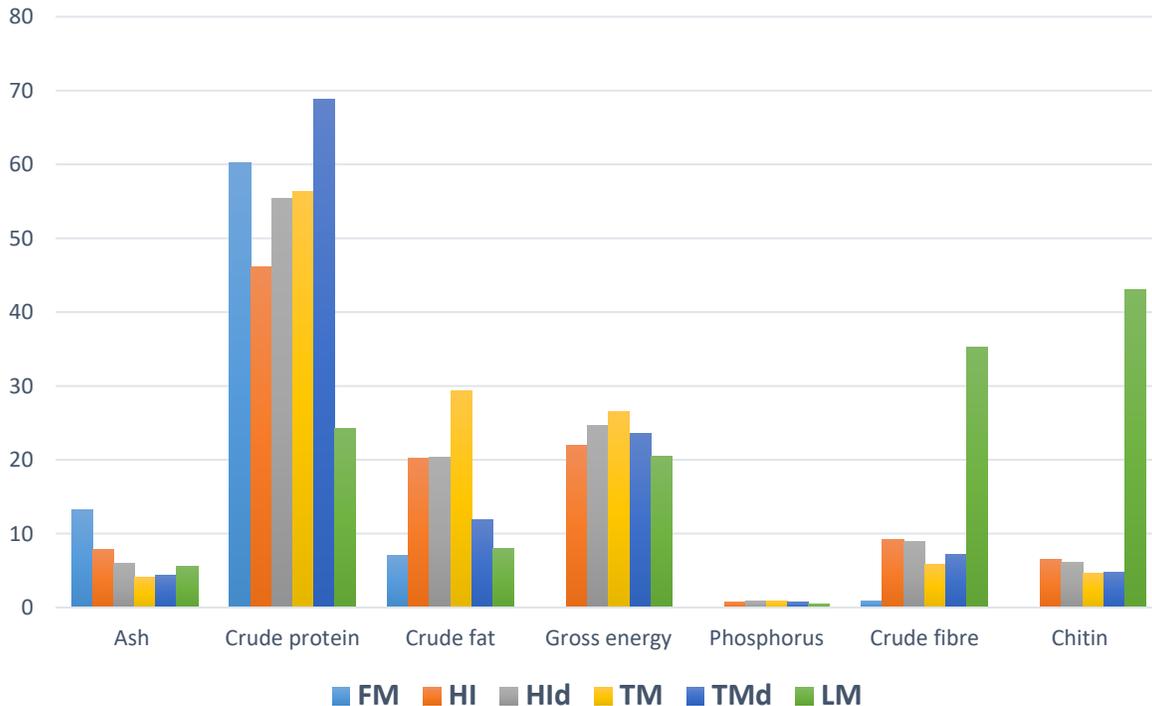


Included 13% sardine oil

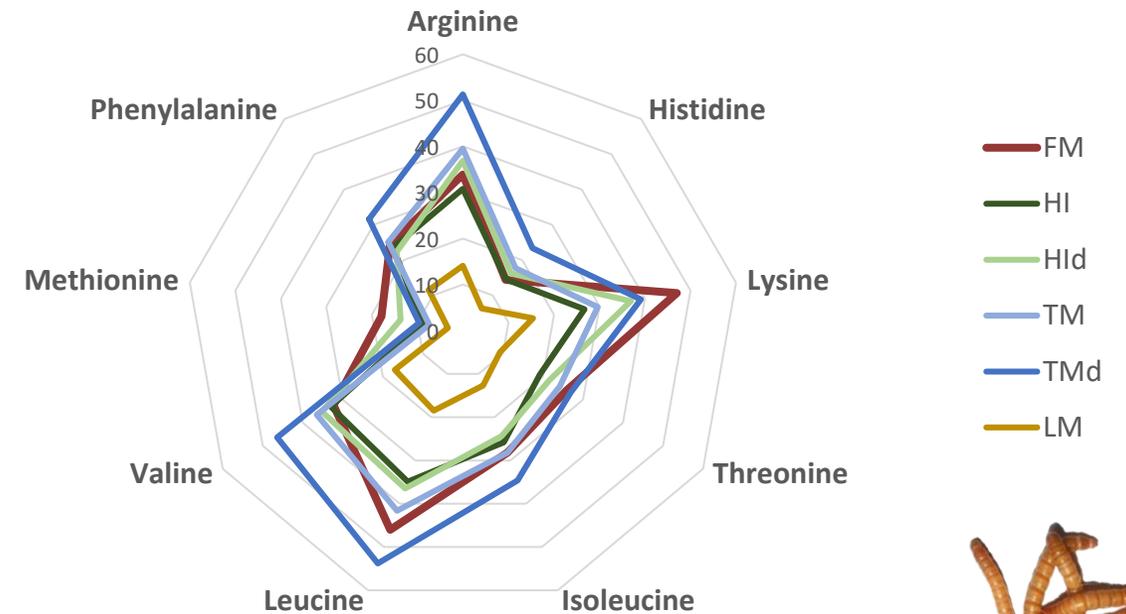
Recommended levels for human consumption (250-500 mg/day)

# Variable nutritional value depending on species, season and latitudes

## Proximate Composition of Insect Meals



## EAA in Insect Meals (mg/g DM)



# Low social acceptance

The Mail on Sunday JANUARY 27 • 2019

JANUARY 27 • 2019 The Mail on Sunday

# Salmon and Black Soldier fly, anyone?

## Bid to feed farmed fish bugs branded 'recipe for disaster'

By Julia Horton

SALMON farmed in Scotland could soon be fed a 'stomach-churning' diet of ground-up flies, under plans by a recycling body backed by the Scottish Government.

The Zero Waste Scotland quango has proposed the creation of insect farms where food waste would be used to fatten up millions of Black Soldier flies.

The larvae would then be harvested and fed to caged salmon in fish farms across the country.

Zero Waste Scotland believes it would cut financial and environmental costs for the fish-farming industry – worth nearly £2 billion a year – by providing a cheaper, more sustainable source of 'high-quality protein'.

But critics yesterday warned that many shoppers would be disgusted by the practice – and said it could lead to the spread of disease.

Don Staniford, director of Scottish Salmon Watch, said: 'Tinkering with Mother Nature is a recipe for disaster.'

'Scottish salmon is stomach-churning stuff already without the addition of insects to the feed. I don't think consumers would love the idea of eating farmed fish fed on insects.'

The proposal to feed salmon ground-



**ON THE MENU:** But should the Black Soldier fly be fed to farmed salmon?

Coming soon to a fish counter near you, the salmon that's truly fowl...

'REVOLTING': Our story back in 2016

up flies follows other controversies about fish-farming. In 2016, The Scottish Mail on Sunday revealed plans to make fish food from abattoir waste rich in protein from slaughtered poultry – including offal, blood and ground-up bone and feathers.

Mr Staniford said fish farmers who had previously turned to that 'revolting' idea were now 'scrapping the bottom of the barrel' with the insect proposal. But

quango chiefs said the idea, set out in a report published last week, could be a 'game-changer' for Scottish salmon and the wider economy and environment.

The move would have been impossible until recently because of a blanket ban on animal-sourced meal for livestock imposed by the EU in the wake of the mad cow disease crisis.

But the restriction on insect feed was lifted for fish farms in 2017 after the European Food Safety Authority concluded that – provided insects were not fed on, or in contact with, animal products – they posed no greater threat of disease than existing legal foodstuffs.

The Zero Waste Scotland report states: 'Extensive testing has shown the flies do not carry human or livestock dis-

eases... previous studies found favourable attitudes towards using insect meal among fish farmers and consumers.'

Report co-author Michael Lenaghan said: 'This is a fascinating and potentially game-changing opportunity.'

Dr Richard Dixon, of Friends of the Earth Scotland, said: 'I'm pretty sure the fish-farming industry is somewhere near ready to embrace this food source, fearing a backlash that would damage their attempts to present farmed fish as a luxury, natural product.'

The Scottish Salmon Producers Organisation said flies were a natural food for fish, adding: 'We are monitoring these exciting developments closely to establish whether it might become commercially viable.'

ON

salmon could be mix of abattoir that have renewed food standards in

could see farmed rotator – made up of insects including well as ground up

ant Morrisons is 250,000 project – its and feed com: the idea and test on of consumers. saw fish farmers to a readily avail: into a cheap food es also say it will neatly friendly er salmon.

By pernal the use feed but although other parts of the consumers would be have always in the UK.

so if the six-month 4 by the Scottish ovation Centre, dated £41,000 – a has altered. lanned the idea. director of the gant Industrial 'Feeding chicken lmon is revoing: natural, a nutri- and compromises

be spoiled cottish ad on r t

at Stirling sw material pro-

ss release said: rotein could sig- feed costs and, in reduction costs. ception around found to be pos- s of the project tritional and fish

mitted that, while stralain salmon l poultry by-pro- a decade, 'there allenges around ace of introduc- into the UK'. are also used pe in feeds for marine aquacul-

# Coming soon to a fish counter near you, the salmon that's truly fowl...

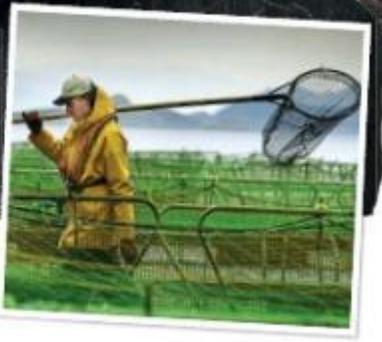


## Backlash over plan to feed farmed favourite on 'avian protein' to save money

'It's about having a grown-up conversation. We don't want to force consumers to do anything. The British people, Europeans in general, have been some of the most prolific of fish eaters through history – black pudding, haggis.'

birds not wanted for human consumption – including bones, feathers, blood and the guts – could be ground down and dried before further processing. The protein could then be incorporated into the pellets used to feed farmed salmon.

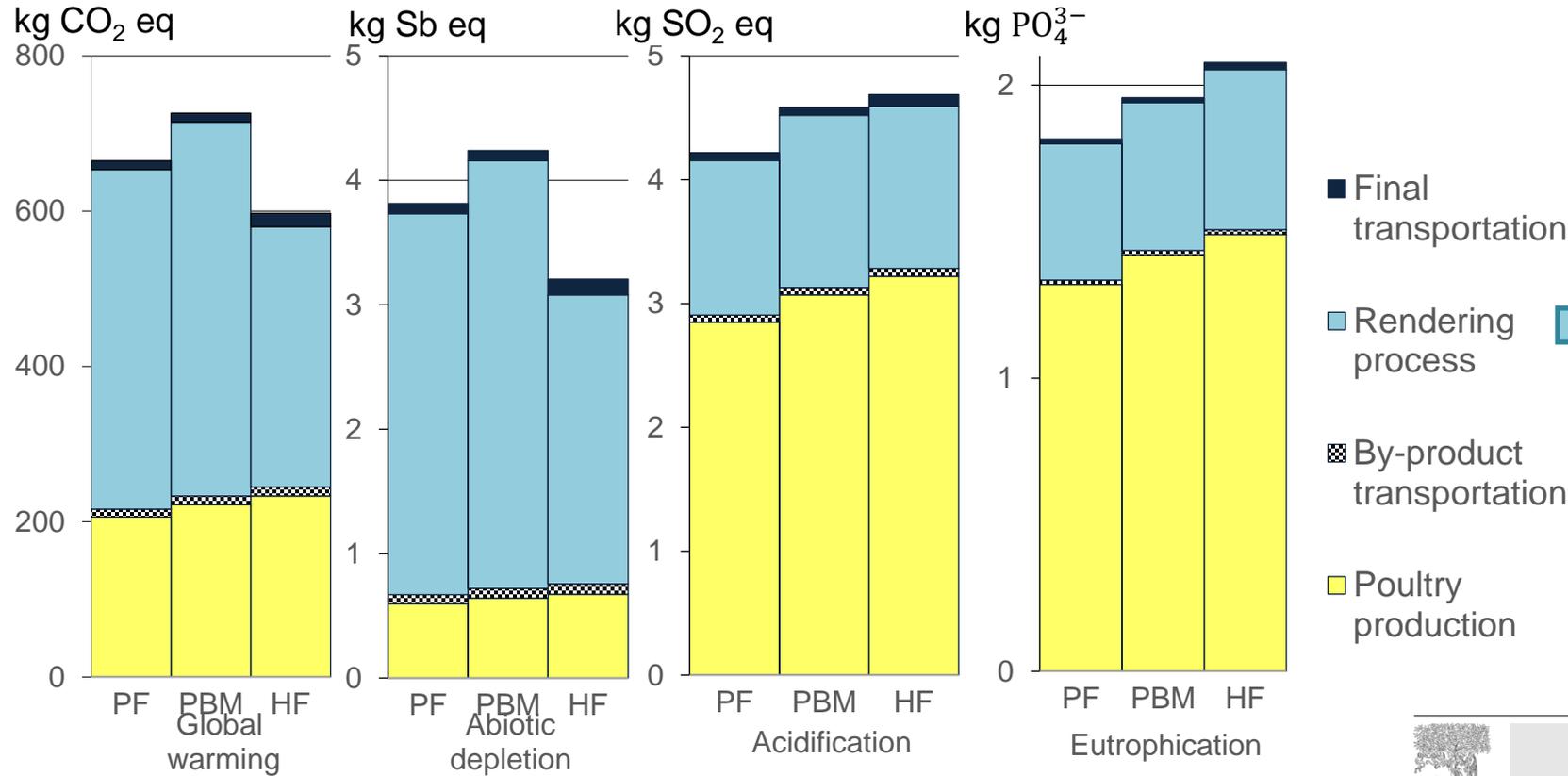
**NET VALUE:** Farmed salmon is worth £1bn a year to Scotland



# OPPORTUNITIES

- Increasing demand
- High technological development (TRL) available
- Local economy trend associated with lower carbon footprint
- Renewable energy

# Impacts of poultry fat (PF), poultry by-product meal (PBM) and hydrolyzed feather meal (HF)



**The energy used for rendering has a major impact**



# THREATS

- Legal issues
- Fraud/Adulteration with lower quality products
- Safety issues
- Energy costs
- Religious limitations



**Thanks!**  
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