



# Corso di Dottorato di Ricerca in Scienze della Vita e dell'Ambiente - Ciclo XXXVII

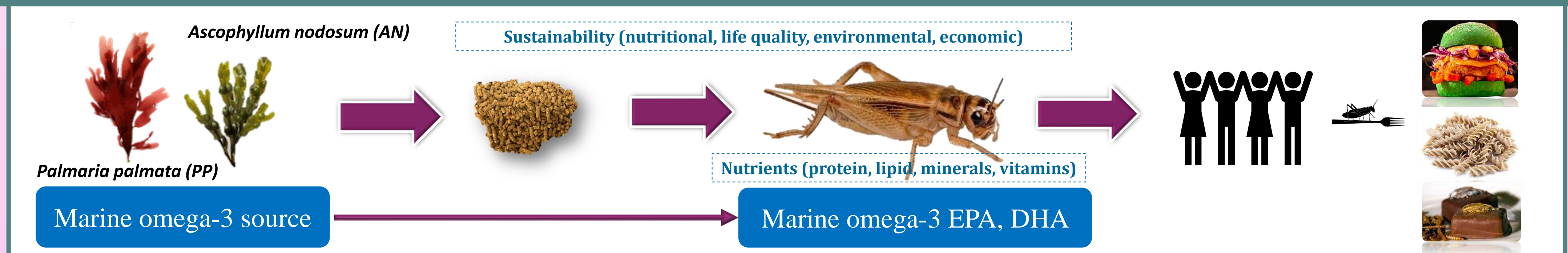
## Omega-3 enriched insect (*Acheta domesticus*) as a novel and eco-sustainable food in Europe

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### INTRODUCTION

The house cricket (*Acheta domesticus*, AD, Orthoptera: Gryllidae), recently authorized by the European Commission as novel food (EU 2022/188), is one of the most nutritious insect species, being rich in protein, lipid, and both macro- and micronutrients [1]. However, being a terrestrial species, it lacks omega-3 fatty acids (FAs) like the eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which are health-promoting nutrients for human consumption. In general, there are some potential health risks associated to the use of crickets as food and as food ingredient for humans. Potentially Toxic Elements (PTEs) represent a potential chemical hazard of insects, as they enter in the food chain through the insect's growth substrate [2].

### AIM OF THE PROJECT



- 1° year**
  - Bibliographic research for the best species of seaweed that could enrich the lipid profile of AD in omega-3 fatty acids in terms of: i) fatty acid composition and ii) chemical risk associated to the presence of potentially toxic elements.
  - Evaluation of the use of seaweed as food supplement for AD.
  - First experiment with the inclusion of *P. palmata* in AD standard feed.
  - Determination of the proximate composition and fatty acids profile of AD reared with feed enriched in different percentages of PP.
- 2° year**
  - Second experiment with the inclusion of *A. nodosum* in AD standard diet.
  - Determination of the proximate composition and fatty acids profile of AD reared with feed enriched in AN.
  - Investigation of the presence of Potentially Toxic Elements (PTEs) Cd, Pb, Ni, As, Al, Cr and Hg in experimental diets and in *A. domesticus* fed with diets included different percentages of PP and AN.

### EXPERIMENTAL DIETS AND DESIGN

Sample	1° experiment 20°-27° dph				2° experiment 14°-29° dph		
	Ctrl	PP5	PP10	PP20	Ctrl	AN20	AN40
Seaweed, %	0	5	10	20	0	20	40
Standard diet, %	100	95	90	80	100	80	60

### ANALYTICAL METHODOLOGY

#### Protein/Amino acids profile

Alliance HPLC + Water AccQ-Tag column, Waters 2475 fluorometer detector

#### Fatty acids

Agilent 6890 GC + 5973N quadrupole selective detector.

#### PTEs

240Z AA  
The analysis of Cd, Ni, Al, As, Cr, Pb were carried out by a graphite furnace atomic absorption spectrometer.

DMA-1 (FKV)  
Hg content was determined by thermal decomposition amalgamation atomic absorption spectrometry (TDA AAS).

### RESULTS AND DISCUSSIONS

#### Proximate composition and fatty acid composition

	Ctrl_AD	AD_PP5%	AD_PP10%	AD_PP20%
Dry matter	93.440±2*	92.0010±76*	91.8910±30*	92.3310±04*
Crude protein	51.281±09*	49.311±59*	53.924±04*	54.2310±8*
Total lipids	16.442±55	17.094±38	16.634±03	12.994±98
Ash	5.942±70	6.125±77	6.481±39	6.674±37
Crude fiber	8.879±08*	7.188±130*	8.858±137*	9.295±42*
Carbohydrate	17.42±3.31	14.15±3.27	15.50±0.46	16.53±1.39
Chitin	8.44±0.21	8.56±1.30	9.59±0.95	10.14±1.48
Gross Energy (MJ/kg)	21.304±048*	22.09±1.17*	21.67±0.28*	20.55±0.29*

The inclusion of PP in AD feed reported a high protein content, with a good presence of essential amino acids and an increase up to 54.2±0.8 g/100 g dry weight (dw) at 20% inclusion of *P. palmata* vs 51±1 g/100 g dw of the control group.

**1° experiment:** The increasing inclusion of PP reported in the feed: No significant differences between FAs classes, except for n3 that was higher in the Ctrl feed.

**2° experiment:** The increasing inclusion of AN reported in AD: Statistically significant increase of SFA, MUFA, n3, n9. Statistically significant decrease of PUFA and n6.

#### PTEs (mg kg<sup>-1</sup> dw)

Cd content in AD reflects Cd concentration in feed. No bioaccumulation. Cd values below the legal limit for feed (0.5 mg kg<sup>-1</sup> ww) and for food (0.05 mg kg<sup>-1</sup> ww).

Pb content lower in AD compared to the experimental diets. No bioaccumulation. Pb values were below the legal limit for feed (5 mg kg<sup>-1</sup> ww) and for food (0.1 mg kg<sup>-1</sup> ww).

Cr content was lower in AD compared to the feed. No bioaccumulation. No legal limit for Cr in feed and in food.

Al content lower in AD compared to the feed. No bioaccumulation. No legal limit for Al in feed and in food.

Hg content low in AD. No bioaccumulation. Hg values below the legal limit for food (0.5 mg kg<sup>-1</sup> ww). No legal limit for feed.

As content was equal/lower in AD compared to the feed. No bioaccumulation. Values below the legal limit for As in food (0.20 mg kg<sup>-1</sup> ww). No legal limit for feed.

Ni content in AD were lower compared to the feed. No legal limit for Ni in feed and in food. No bioaccumulation.

### CONCLUSIONS

- The inclusion of seaweed in AD feed improve the nutritional composition of the insect. In particular, we found:
  - an improvement of AD lipid profile, enriched with LC-PUFA, both n6 and n3. The inclusion of higher percentages of AN (for a longer time) with respect PP inclusion led to a higher increase of EPA.
  - a significantly increase of the protein content in AD.
- AD did not accumulate PTEs. Moreover, Cd, Pb, Hg, and As concentrations were below the legal limit both for feed (2002/32/EC) and for food (2006/1881/EC), then AD fed seaweed-enriched diets is considered safe for the human health.

### FUTURE PERSPECTIVES

- To find other sources of PUFA to be used as feed supplement to obtain an AD rich in omega 3, which could moreover increase AD reproduction yield. In this regard, we plan on using by-products coming out from the process of extraction of alginates from seaweed, which are generally discarded, or by-products from microalgae production.

### REFERENCES

[1] Fernandez-Cassi, X., Supeanu, A., Vaga, M., Jansson, A., Bqvist, S., & Vagsholm, I. *Journal of Insects as Food and Feed* 2019 5 (2), 137-157.

[2] Van Huis, A., & Ooninx, D. G. *Agronomy for Sustainable Development* 2017, 37, 1-14.

### CONFERENCE CONTRIBUTIONS

7 MS Food Day, Florence 5-7 October 2022. Omega-3 enriched house cricket (*Acheta domesticus*) as novel and eco-sustainable food product in Europe. Behixhe Ajdini\*, Irene Biancarosa, Silvia Illuminati, Anna Annibaldi, Federico Girolametti, Matteo Fanelli, Francesca Tulli, Gloria Cardinaletti, Cristina Truzzi.

In progress:

- TUMA 2023. Up-take of Potentially Toxic elements in the novel food *Acheta domesticus* grown of seaweed-enriched media: risk assessment for human health. B. Ajdini, I. Biancarosa, S. Illuminati, A. Annibaldi, F. Girolametti, M. Fanelli, C. Truzzi.
- XXX Congresso della Divisione di Chimica Analitica della Società Chimica Italiana (SCI). Nutritional value of house cricket (*Acheta domesticus*) fed diets supplemented with different levels of seaweed *Palmaria palmata*. B. Ajdini, I. Biancarosa, G. Cardinaletti, S. Illuminati, A. Annibaldi, F. Girolametti, M. Fanelli, G. Pascon, M. Martinoli, C. Truzzi.

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- Girolametti, F. et al 2022. Dissolved Potentially Toxic Elements (PTEs) in Relation to Depuration Plant Outflows in Adriatic Coastal Waters: A Two-Year Monitoring Survey. *Water* 2022, 14(4):569. DOI: 10.3390/w14040569.
- Fanelli, M et al 2022. Impact of Depuration Plants on Nutrient Levels in the North Adriatic Sea. *Water* 2022, 14(12):1930. DOI: 103390/w14121930.



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