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SUSTAINABLE INSECT CHAIN

Insect processing technologies investigated in the H2020 project SUSINCHAIN

Van Campenhout, L., Van Der Borght, M., Vandeweyer, D.

EAAP, Davos, Switzerland, 2 September 2021

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement nº 861976. This document reflects only the author's view and the Commission is not responsible for any use that may be made of the information it contains.

Introduction

Objective of WP3:

To prove for a number of existing post-harvest technologies that they are applicable for insects at industrial scale, incl. demonstrations

- Some with a cost analysis
- Safety analysis in WP6
- Sustainability analysis in WP7

Introduction

Task	Technology	Insect species
3.1	Controlled atmosphere package (CAP) and storage (CAS)	BSF
3.2	Microwave drying (MW) and radio frequency (RF) drying	BSF, MW
3.3	Low energy electron e-beam (LEEB) radiation	BSF, MW
3.4	High moisture extrusion (HME)	BSF, MW
3.5	Protein recovery using enzyme treatment plus tricanter centrifugation	BSF
3.6	*Production of insect meals for animal trials in WP4 - not discussed -*	*BSF*

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TASK 3.1:

Controlled Atmosphere Packaging (CAP) and Storage (CAS)

Lead: KU Leuven
Partner: Nutrition Sciences

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Task 3.1: Controlled atmosphere packaging and storage

Living larvae, killed larvae

Vacuum packaging (+ control: only sealed)
Storage at RT and 15°C

O_2 and CO_2 concentration

Survival

Task 3.1: Controlled atmosphere packaging and storage

More information: see presentation D. Vandeweyer at 14h30 and publication

insects MDPI

Article

Potential of Fermentation and Vacuum Packaging Followed by Chilling to Preserve Black Soldier Fly Larvae (*Hermetia illucens*)

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TASK 3.2:

Microwave and Radio Frequency drying

Lead: KU Leuven
Partners: Dymotec, MEAM, Nutrition Science

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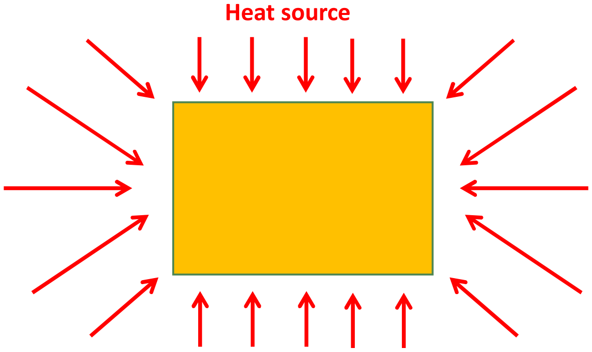
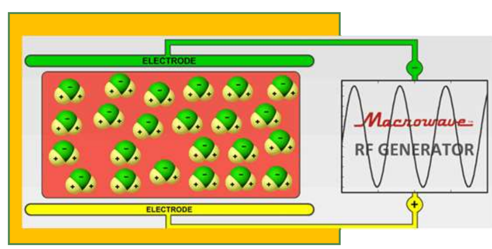
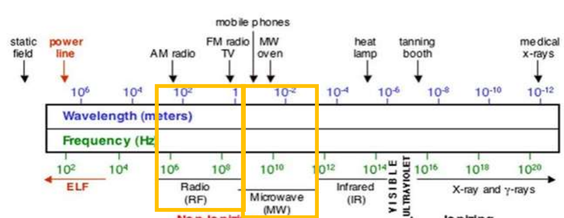
Task 3.2: Microwave and radio frequency drying

Conventional heating:



Dielectric heating (MW and RF):





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Task 3.2: Microwave and radio frequency drying

Microwave drying

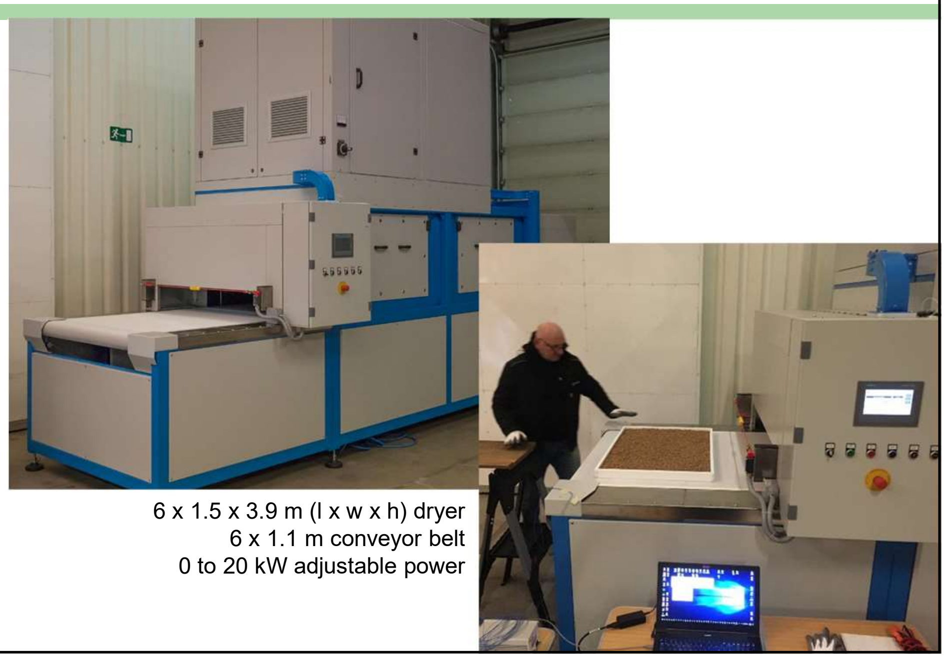
- Started from existing equipment
- Optimalisation of process parameters ready for BSF and MW
- Research on microbiological and chemical quality of dried insects ongoing
- Cost analysis to be done

✓Maximum power of 32 kW, expected to reach a capacity of 70 kg/h
✓maximum surface temperature of 90°C (avoid local burning)
✓layer thickness of 2 cm

Task 3.2: Microwave and radio frequency drying

Radio frequency drying

- Prototype building finished
- Optimalisation of process parameters ongoing
- Cost analysis to be done
- Comparing MW and RF of same batch of larvae

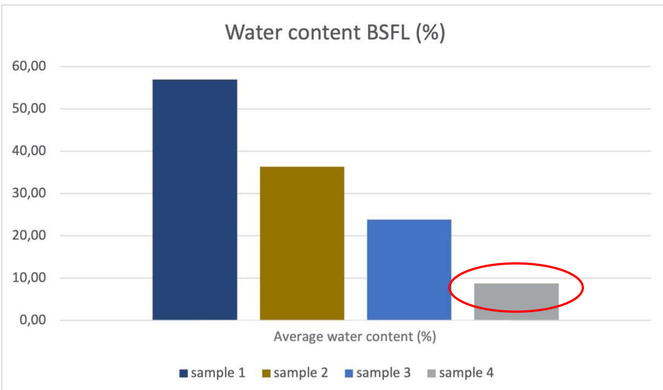


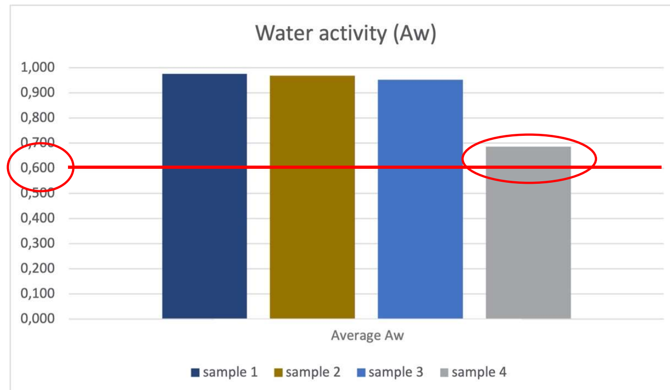
6 x 1.5 x 3.9 m (l x w x h) dryer
6 x 1.1 m conveyor belt
0 to 20 kW adjustable power

Task 3.2: Microwave and radio frequency drying

Preliminary results for RF drying:

first trial with four "transits"

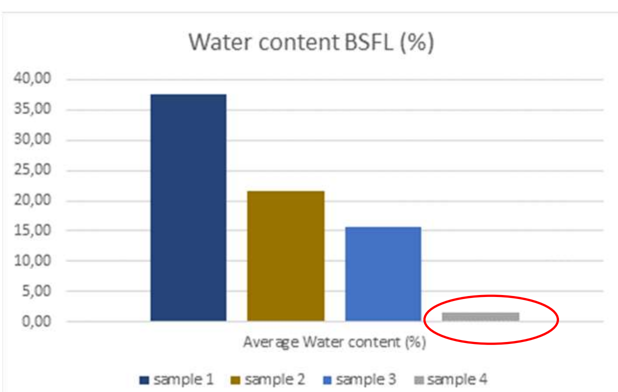


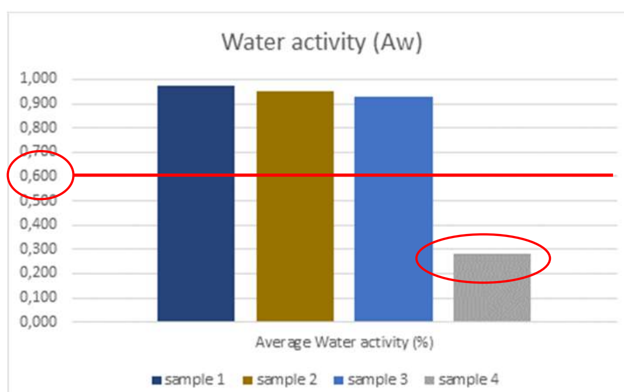


Task 3.2: Microwave and radio frequency drying

Preliminary results for RF drying:

second trial with four "transits"





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TASK 3.3:

Low Energy Electron Beam for insect decontamination

Lead: ETH Zürich
Partners: KU Leuven, BITS

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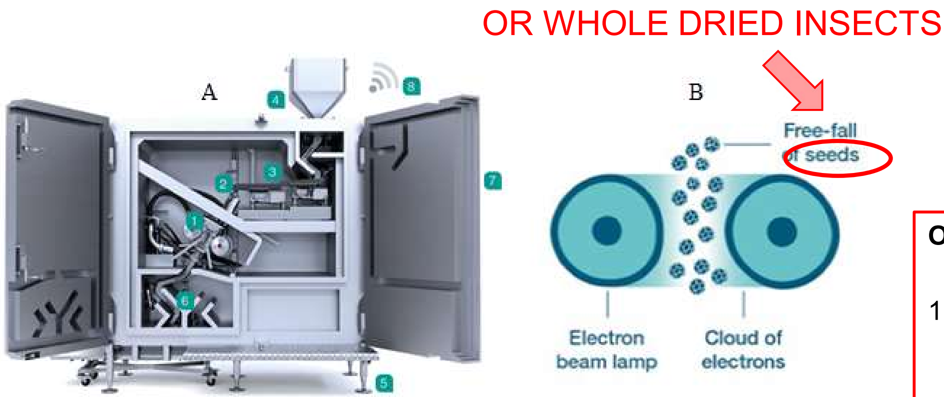
Task 3.3: Low energy electron beam irradiation

What is LEEB?

- novel non-thermal surface decontamination technology for dried products
- ionizing radiation with low evergy (<300 keV)
- electrons receive energy and damage the DNA of micro-organsisms
- penetration depth of micrometers
- applied for herbs and spices
- continuous system

Hertwig, C., Meneses, N., Mathys, A. (2018) Cold atmospheric pressure plasma and low energy electron beam as alternative nonthermal decontamination technologies for dry food surfaces: A review. Trends Food Sci Techn, 77, 131-142. https://doi.org/10.1016/j.tifs.2018.05.011

Task 3.3: Low energy electron beam irradiation

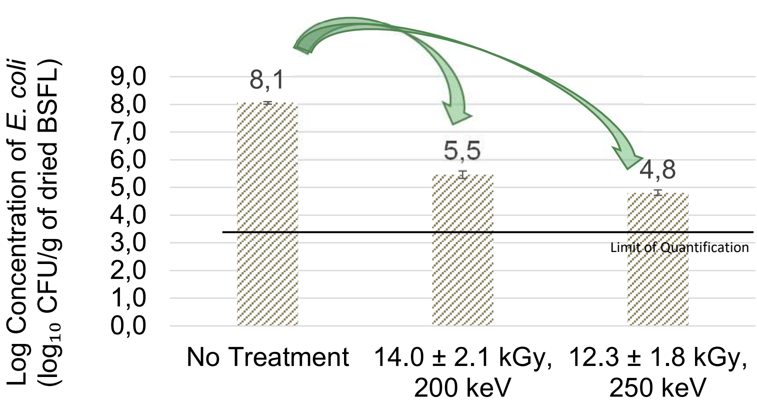


(A) Laatu by Bühler AG and (B) Schematic of electron beam lamps where product passes through and is treated by the electrons emitted (source: Bühler AG)

Objectives:

1. Microbial inactivation of *E. coli* by 3-5 log
2. Evaluate effect on shelf life of whole insects

Task 3.3: Low energy electron beam irradiation



- Inoculation with non-pathogenic *E.coli* followed by LEEB treatment
- Reduction:
  - 2,6 log at 200 keV
  - 3,3 log at 250 keV
- Experiment at 250 keV was repeated two times and average reduction for three biological replicates was 3.34 ± 0.46 log cfu/g
- Currently shelf-life studies ongoing

- See presentation D. Peguero at 15h45

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TASK 3.4:

High Moisture Extrusion

Lead: DIL
Partners: KUL, BITS

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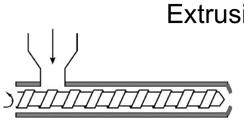
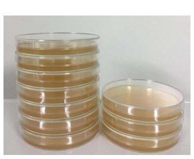
Task 3.4: High moisture extrusion

Mixtures of soy or pea protein hydrolysates with living or frozen MW or BSFL at 30g/100g

Extrusion at 150 to 180 °C peak barrel temperature

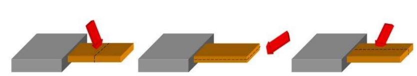




Microbial inactivation:

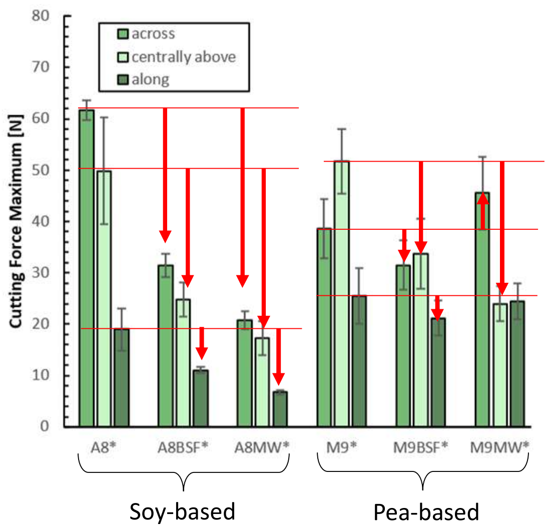
4 to 5 log cfu/g reduction of Total Viable Count

Texture analysis:



Task 3.4: High moisture extrusion

Texture of extrudates obtained with **frozen** insects



- Incorporation of frozen insects generally led to an reduction of product firmness, yet it was still acceptable for further product development and research
- Shelf life experiments with extrudates planned

- See presentation L. Leonhardt at 15h00

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TASK 3.5:

Protein recovery by enzyme treatment followed by tricanter centrifugation

Lead: LEITAT
Partner: BioflyTech

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Task 3.5: Enzymes + tricanter centrifugation

Objective: production of protein-rich meals with low fat content via aqueous enzymatic treatment and then centrifugation

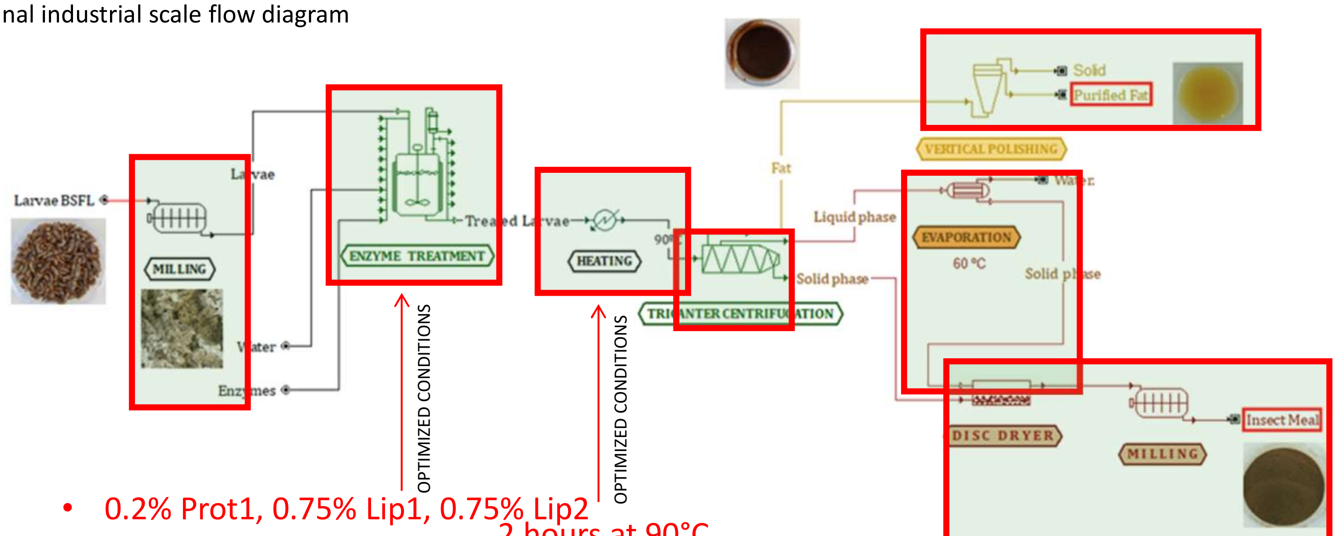
Current protein recovery: drying → defatting (solvent extraction) → protein solubilization → isoelectric precipitation → protein solubilization → drying

=> not eco- or food-friendly

- Step 1: selection and validation of optimal process parameters:
  - Which enzymes and which conditions for enzyme treatment?
  - Which centrifugation conditions?
- Step 2: scale up to industrial scale

Task 3.5: Enzymes + tricanter centrifugation

Final industrial scale flow diagram



- 0.2% Prot1, 0.75% Lip1, 0.75% Lip2 at low pH and mid temperature for 4 hours
- 2 hours at 90°C
- also comparison with scenario without enzymes

Task 3.5: Enzymes + tricanter centrifugation

Enzyme treatment

Centrifugation

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Pictures: BioflyTech

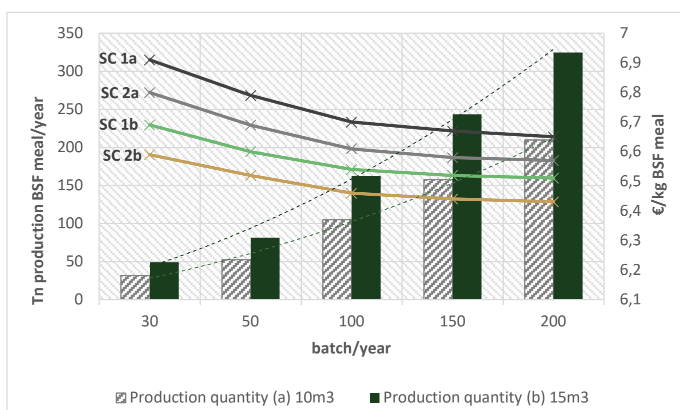
Task 3.5: Enzymes + tricanter centrifugation

Final product quality:

currently under investigation

Cost analyses performed including investment and operational costs:

Enzyme cost is critical and product quality will learn whether it is justified



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Conclusions

- ✓ **Past:** focus on establishing prototypes and process conditions
- ✓ **Present and future:** collect for all technologies data on product quality (chemical, microbiological, allergenicity)
- ✓ **Deliverables** will be industrial guidelines with suggestions for equipment to use and corresponding processing parameters (SOPs)

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