Mealworm biorefinery and processing for food products

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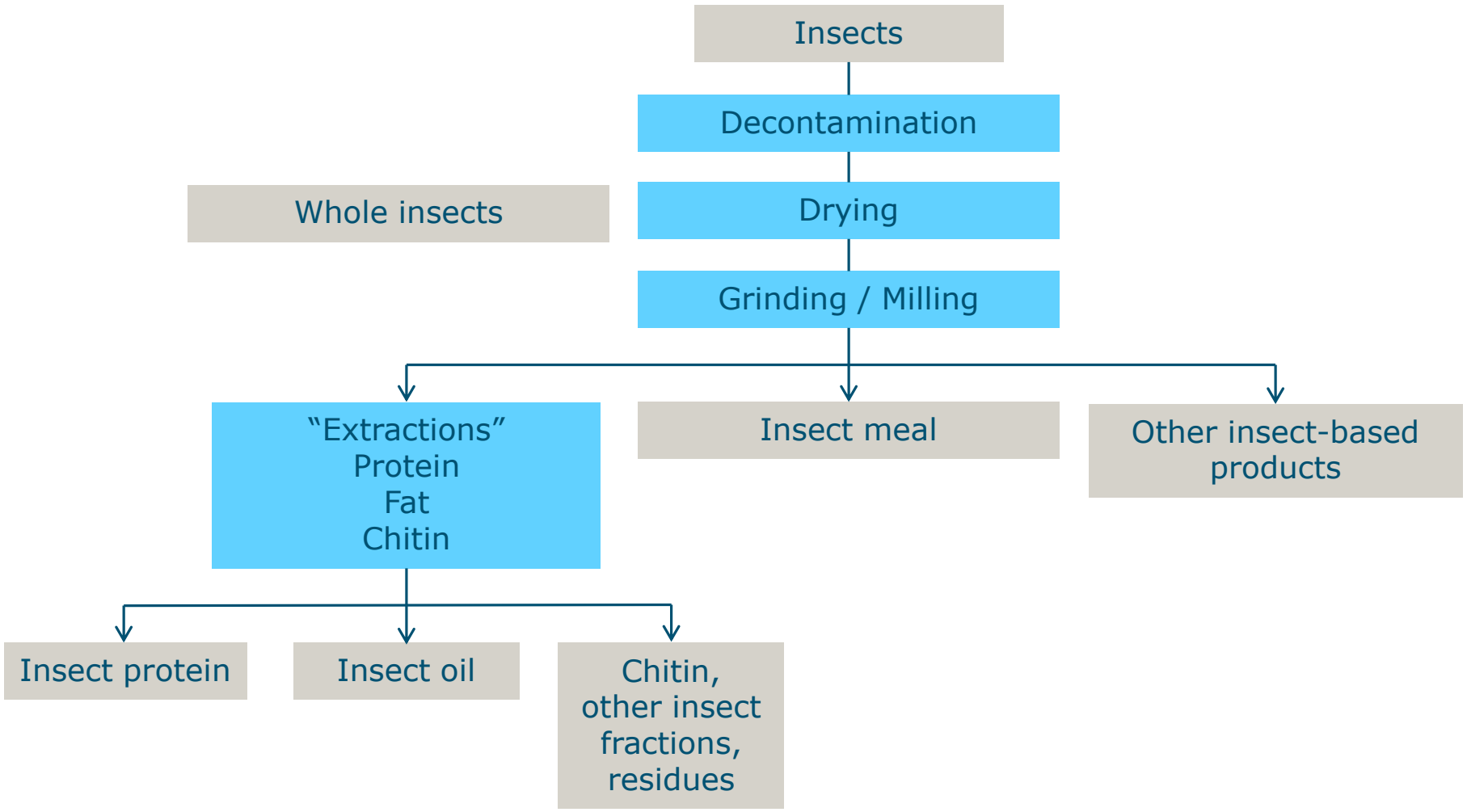
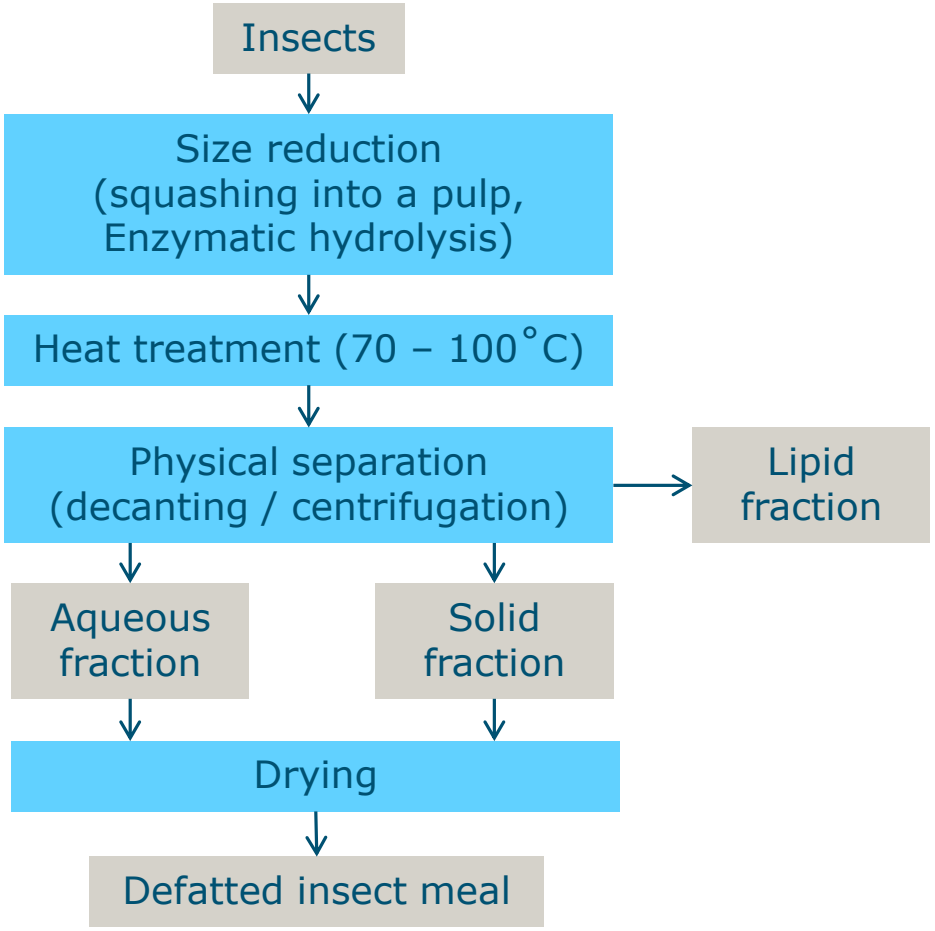
Elaborate insect processing



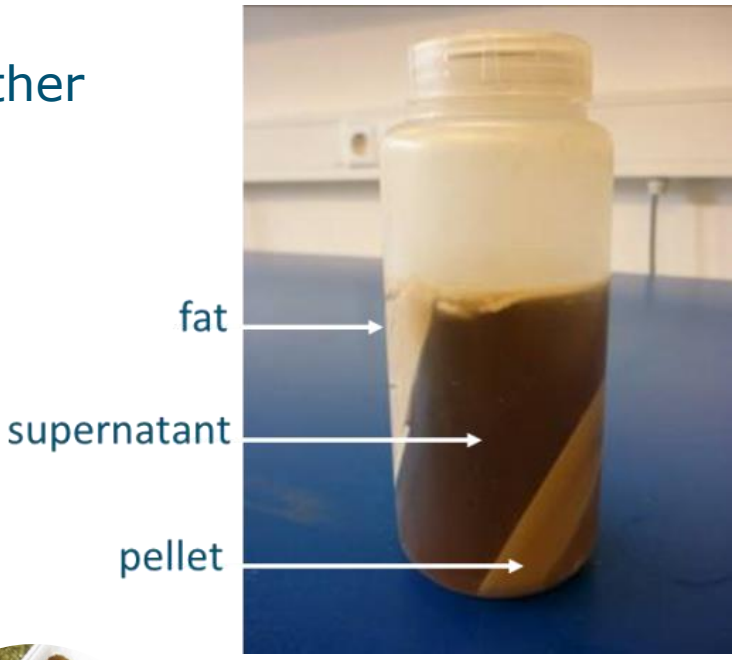
Simple separation

- Lipid and meal as products
- Protein quality?
- Lipid removal might be complicated by emulsifying agents present in the insects
- Patented method (Arsiwalla & Aarts 2015)



Straw and seed meal valorisation by insects

- Insect refinery to obtain oils, proteins & other valuable biomolecules
- Shredding & centrifugation
  - With added water
  - No enzymes



H2020 EU-COSMOS: Camelina and crambe Oil crops as Sources for Medium-chain Oils for Specialty oleochemicals

Coordinator:
Wageningen Research (WFBR)

18 partners in 9 countries

Budget: € 10.8 million

Duration: 4.5 years (2015–2019)

Reduce Europe's dependence on **imported tropical oils** (palm kernel, coconut, castor) as sources for medium-chain-length oleochemical surfactants, lubricants, polymers and other high-value products, by:

- turning **camelina & crambe** into profitable oilseed crops
- creating and optimizing sustainable value chains

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COSMOS: the Crops

Crambe abyssinica

Camelina sativa

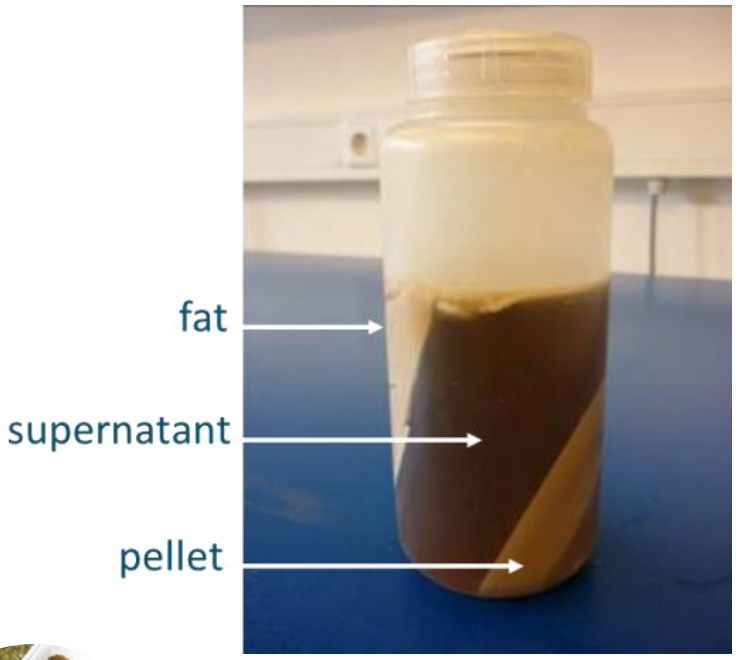
DOI: 10.1051/ocl/2016021

Crambe meal (top) & Camelina meal (bottom)

DOI: 10.1051/ocl/2016021

Straw and seed meal valorisation by insects

- Insect refinery to obtain oils, proteins & other valuable biomolecules
- Shredding & centrifugation (with added water)
- Does the special oil composition of the corps translate to the insects?

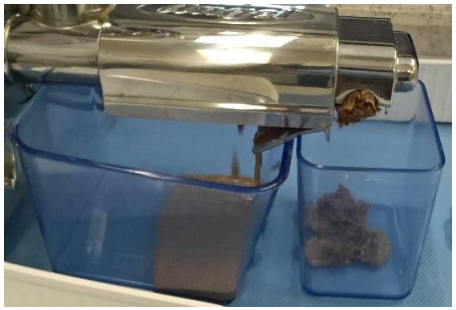


Biorefinery of Black Soldier Fly Larvae & Buffalo: no added water

Overview part extraction process:

Blanched BSF

Angel Juicer



Juice

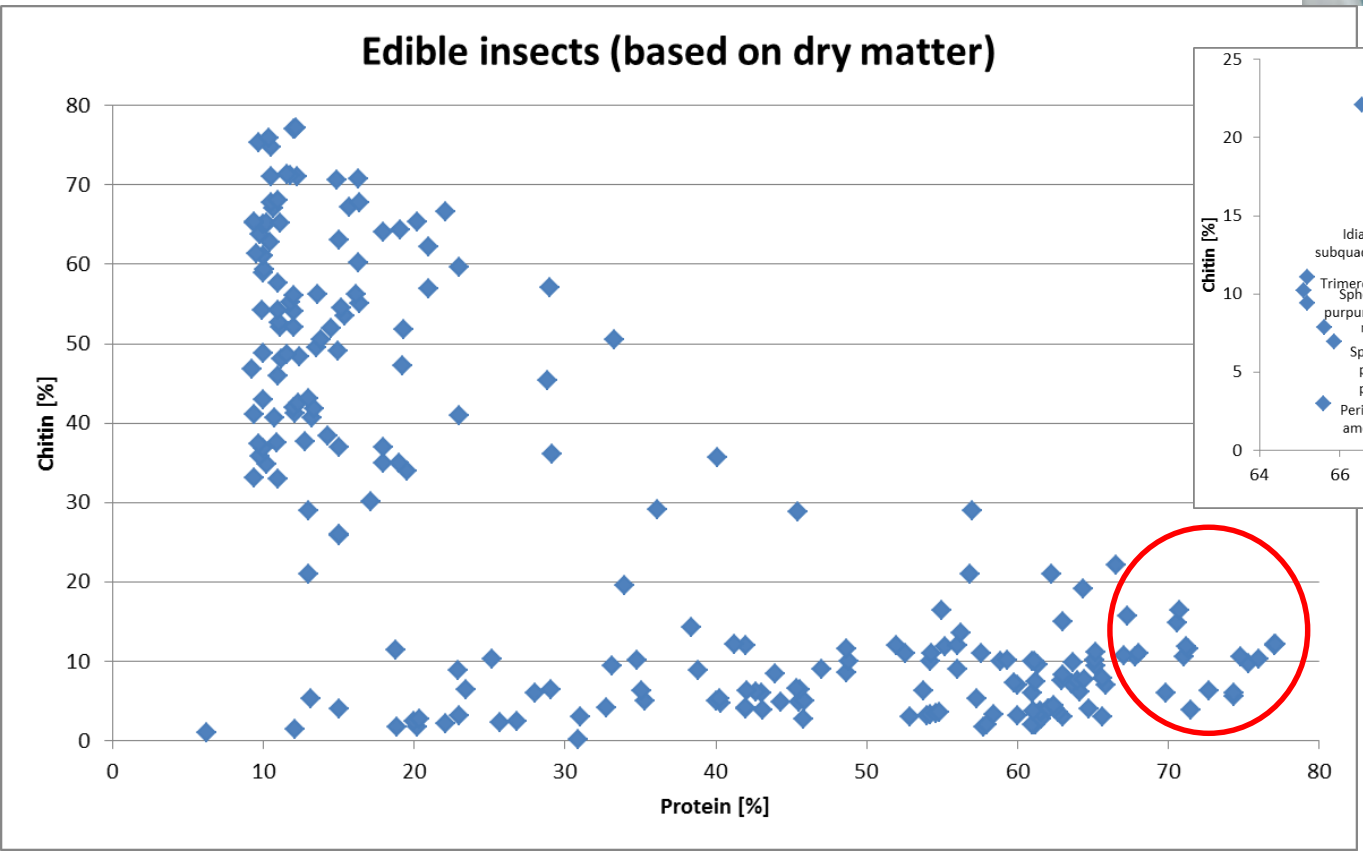
Fibre

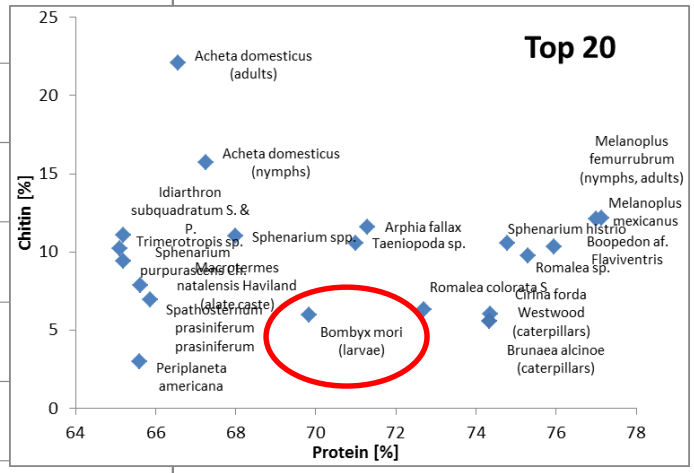
<u>Extraction / Purification protocols available</u>

Can it be even more simple?

- Direct use in food

Insects in food





- → silkworm *(Bombyx mori)* is one of the best choices (very low chitin, high protein)

Choice of insects

- Mostly studied: mealworm (Tenebrio molitor)
  - Adult: Protein: 10-16 %, fat: 38-50%, chitin: 16-68 %
  - Larvae: Protein: 11-18 %, fat: 35-43 %, chitin: 5-63 %
- More logical insect choice:
  - high protein %, low fat %, low chitin %
  - high protein %, high fat %, low chitin %

  (excess of chitin from crab waste)
- Prerequisites for industrial scale insect:
  - suitable for breeding
  - Available whole year in large quantities

Water, ground buffalo worms (14%), vegetable oil (sunflower oil) (14%), wheat gluten (13%), wheat flour (13%), salt, white pepper, chicken egg protein in powder, inulin, wheat starch, potato fibers, starch (corn, wheat), emulsifier (guar gum), yeast, paprika powder, turmeric.

Blanched & Freeze-dried
Nice colour
Texture from egg protein and wheat gluten

New products with (meal)worms

- Innova database (2010-2015)
- Savoury spread (4%)
- Pet food (100%)
- Worm snacks (99%)
- Burger (14%)
- 20 euro/kg, higher for snacks due to small package size

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Impact of processing on enzymatic browning and texturization of yellow mealworms

Mealworm products with tailor made texture

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L. Tonneijck-Srpová, E. Venturini, K.N.P Humblet-Hua, M.E. Bruins (in press) Journal of Insects as Food and Feed
https://doi.org/10.3920/JIFF2018.0025

Context and Aim

- Insects are processed for microbial food-safety & against chemical degradation
- Freeze drying & blanching
- Prevention of browning during processing with high pressure (HP) as an alternative
- Influence on texture

- Material: Yellow mealworm
- Methods: HP, T, freeze drying (blanc)

Starting materials and experimental set-up

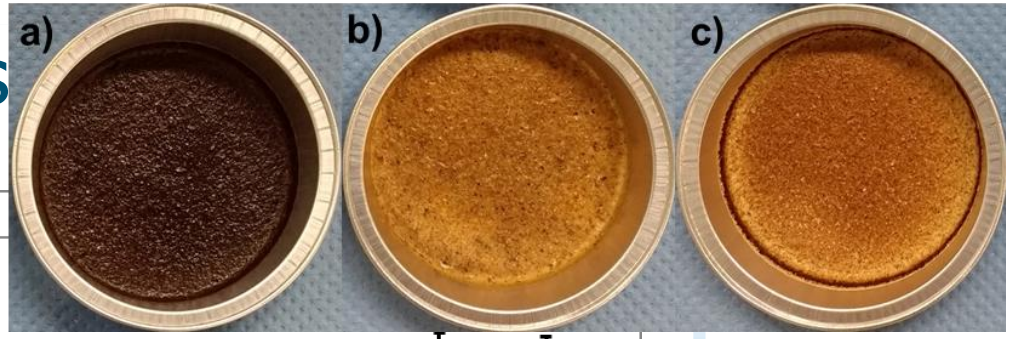
Treatment	Sample code	Starting material
None (fresh)	F1 (3 days after delivery) F2 (10 days after delivery)	
Freeze drying	FFD	F1
Blanching	B	F1
Blanching followed by freeze drying	BFD	F1
High pressure	HP + pressure applied	F2

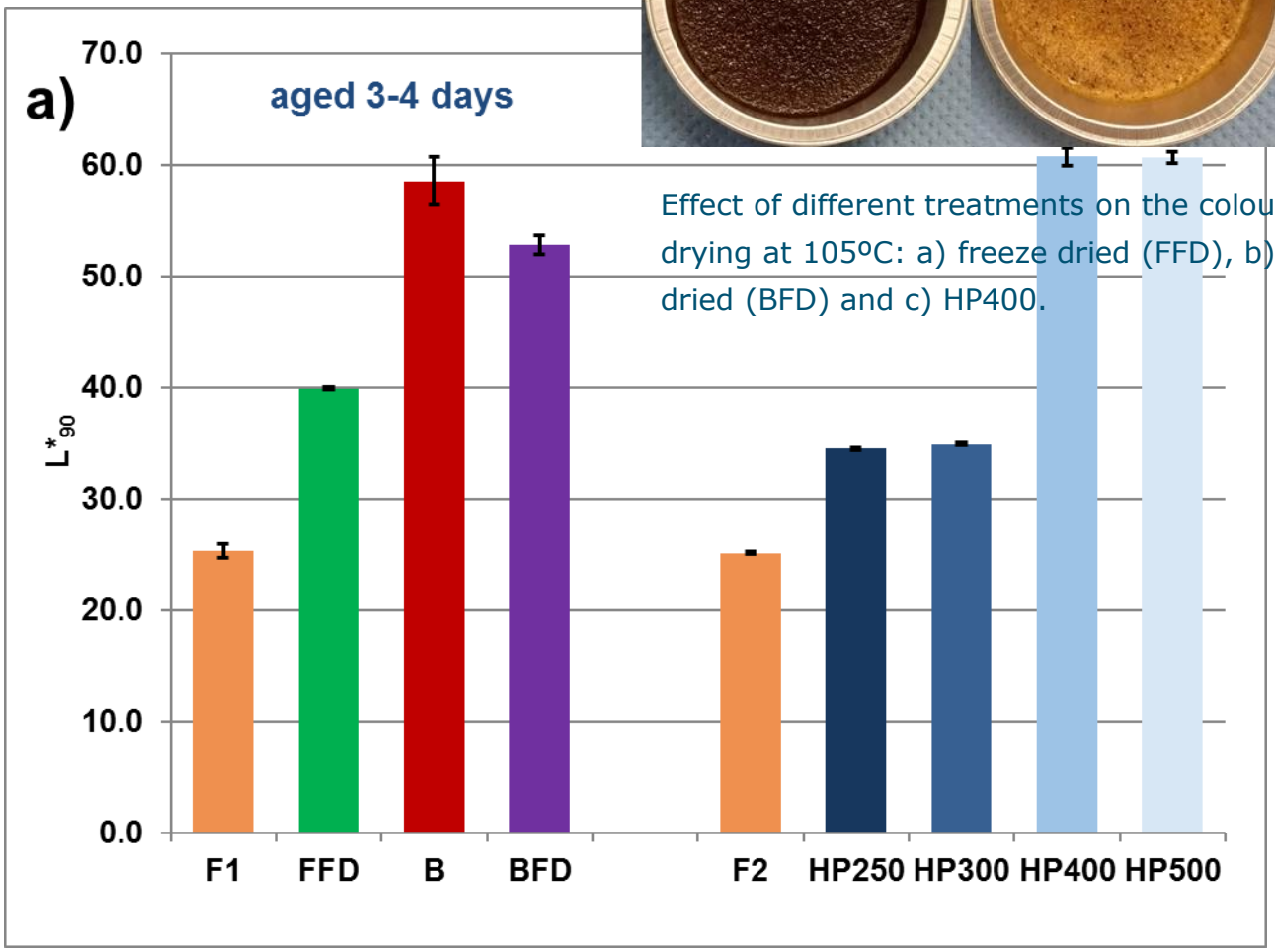
Treatment

Make a paste

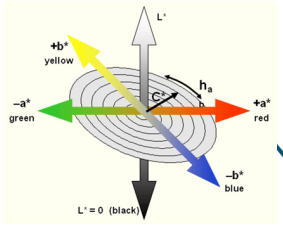
Measure
- Colour
- Texture
- Water holding capacity
- pH

Browning: Blacknes





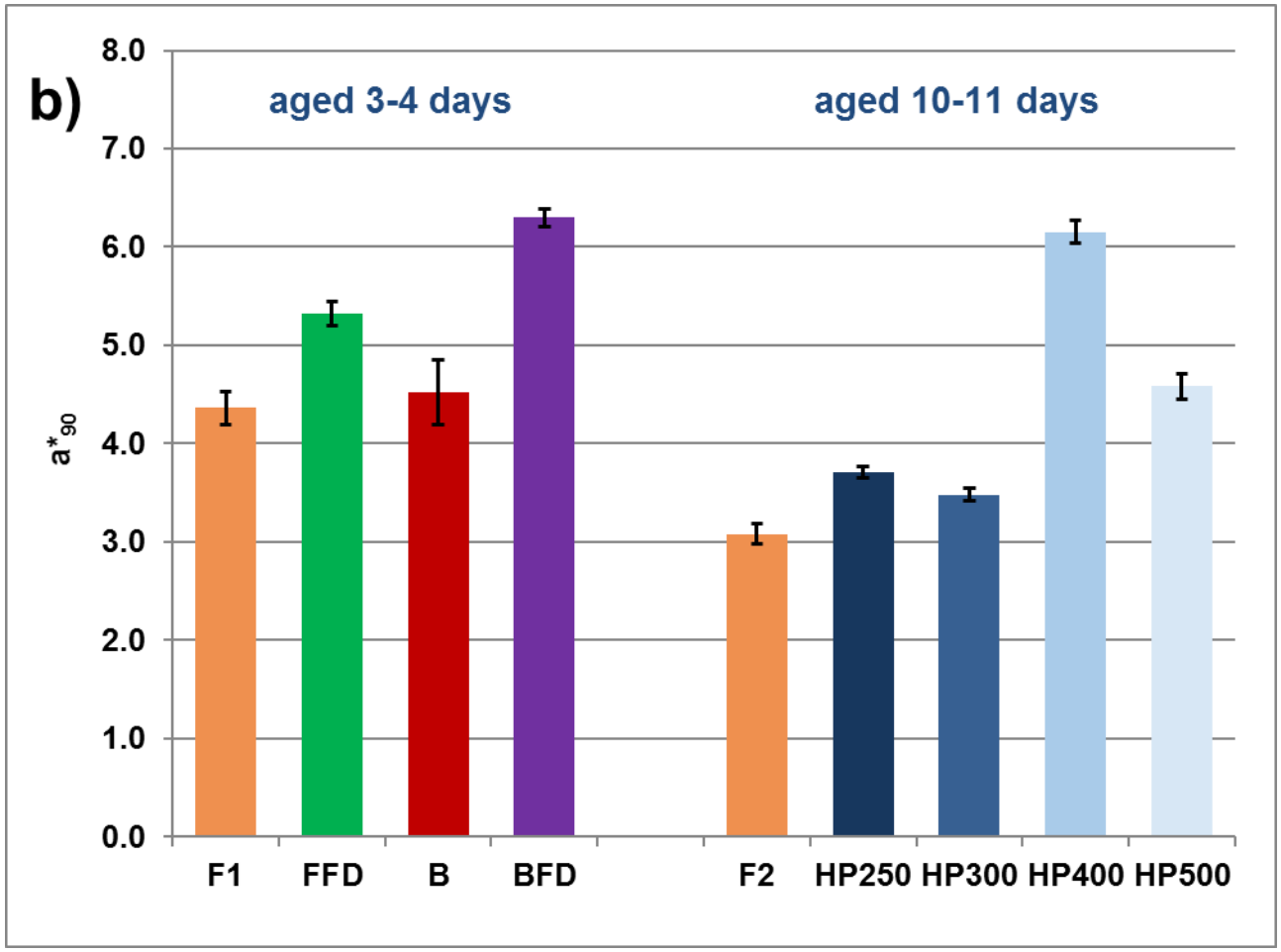
Effect of different treatments on the colour of ±10% paste after drying at 105ºC: a) freeze dried (FFD), b) blanched + freeze dried (BFD) and c) HP400.



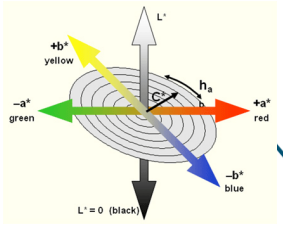
Darkness L^*_{90} of ±10% mealworm pastes after 90 minutes at RT

F1, F2 – fresh with different aging, FFD – fresh freeze dried, B – blanched, BFD – blanched freeze dried, HP250 to HP500 – HP treated with pressures from 250 to 500MPa

Browning: Redness

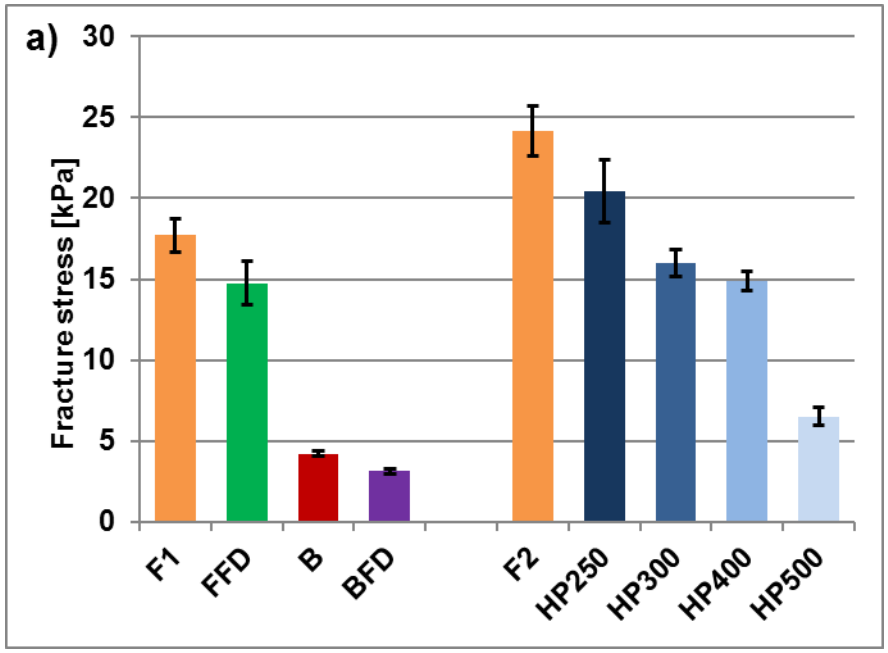


Redness a^*_{90} of ±10% mealworm pastes after 90 minutes at RT



F1, F2 – fresh with different aging (3 versus 10 days), FFD – fresh freeze dried, B – blanched, BFD – blanched freeze dried, HP250 to HP500 – HP treated with pressures from 250 to 500MPa

Texture of heat set gels from pastes



- Fracture stress and Youngs modules simil
- Gel strength and stiffness was best for fre
  worst for blanched
- Weak texture for blanched and HP500
- Coarse texture, chitin?, serum loss

F1, F2 – fresh with different aging (3 versus 10 days), FFD – fresh freeze dried, B – blanched, BFD – blanched freeze dried, HP250 to HP500 – HP treated with pressures from 250 to 500MPa

Product Application

- Tailor texture by combining the results of blanching and high pressure treatments allows us to tailor the texture of the mealworm product.

- Spread (light colour & soft texture): blanching
- Burger (brown, crumbly): fresh, freeze dried
- Pâté type of texture: HP400

How the researchers perceived the paste

- HP treated mealworms showed an appealing orange / light brown colour
- Aroma of (fresh) mealworm paste was savoury, with a mushroom and nut note
- Upon baking, the aroma even intensified.

Conclusions

- Blanching and freeze drying of insects is current industrial method
- Needed to prevent spoilage
- Blanching decreased browning
- Loss of texturizing properties
- High pressure could be an alternative: better texture, no browning, spoilage?
- Future work
    - Test for microbial activity: now only checked via pH
    - Combine P&T

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Thank you

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ADDING VALUE TO CAMELINA AND CRAMBE OIL