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Invaluable WP4

Processing and nutrient availability of mealworms

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Agenda

- What is DTI and who am I?
- Impact of drying method on Crude Protein Digestibility Corrected Amino Acid Score (PDCAAS)
- Defattening of mealworms – experienses and obstacles
- Fatty acid composition of different extraction methods
- Optimization of two-phase extraction methods

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About me

- Simon Hvid
- Consultant at DTI – center for Food Technology
- Chemisty and biochemistry engineer – Cand.Polyt
- Working with insects as food ingredient for 3 years

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About DTI Food Technology

Product development
New food concepts, applications, novel technologies

Physical and chemical characterisation
Characterisation & analysis

Process development
Microencapsulation, drying and stabilisation of ingredients

Food safety
Legislation and labelling
HACCP, prevention of food fraud

Sensory & consumer tests
Consumer and market tests
Sensory of food and non-food

Pilot production
Extrusion of food and feed, milling,

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How DTI Food Technology can help your business

- Product development of insect food products
- Functionality of insect ingredients
  - Emulsion capacity, water-absorption, foam-stabilising ability
- Insect meal processing
  - Lipid extraction (pilot scale)
  - Protein extraction (pilot scale)
  - Extrusion (pilot scale)

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7 methods of meal preparation

Overview of product abbreviations, insect and process.		
Abbreviation		Explanation
TM freeze-dried		Tenebrio molitor, freeze-dried
AD freeze-dried		Alphitobius diaperinus, freeze-dried
AD defatted		Alphitobius diaperinus, freeze-dried, defatted with diethyl ether, filtered and dried
AD enzymes		Alphitobius diaperinus, freeze-dried. Enzymes added to the diet.
AD extruded		Alphitobius diaperinus, extruded and dried (120 °C)
AD hydrolysed		Alphitobius diaperinus, grounded, mixed with water (2:1), hydrolysed with formic acid (pH 3.7) and freeze-dried
AD industrial-dried		Alphitobius diaperinus, dried at two temperature zones (160 °C and 120 °)
AD vacuum-dried		Alphitobius diaperinus, vacuum-dried (40 °C and 10 mbar)

Collaboration with J. V Nørgaard @AU

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Drying methods

- Freeze drying: Until water content was constant
- Defattening: Stirring flour with diethyl ether, settle, decant, repeat x 3 before drying flour
- Enzymes added to feed: Freeze dried flour, different enzymes added in attempt to achieve chitinase side effects, increasing solubility and availability of proteins
- Extruded and dried: Twin-screw extrudor, dried at 120°C

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Drying methods

- Hydrolyzation: Mixed with water, hydrolyzed with formic acid before freeze drying
- Industrial drying: Two zones at 160°C and 120°C
- Vacuum drying: Dried at 40°C and 10 mbar

- All products ground to 1 mm prior to use them in rat studies

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Results

- Drying methods or the addition of an enzyme mix had no larger effect on PDCAAS
- Freeze drying had the best protein quality (AD: 0.82, TM;0.76)
- Extrusion and defattening reduced protein quality slightly
- Vacuum drying and hydrolysis had even less quality

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Defattening of Tenebrio Molitor

- Fat content → problems when grinding
  - Tends to create a greasy mass that clock up the grinder
- Possible solutions
  - Freezing to -80°C prior to grinding improve performance
    - Friction in grinder is still a problem
    - Dry ice as method – working, but expensive
  - Slowly decrease pore size in grinder and freeze between each step
    - Time consuming and still not efficient below 2 mm pore size

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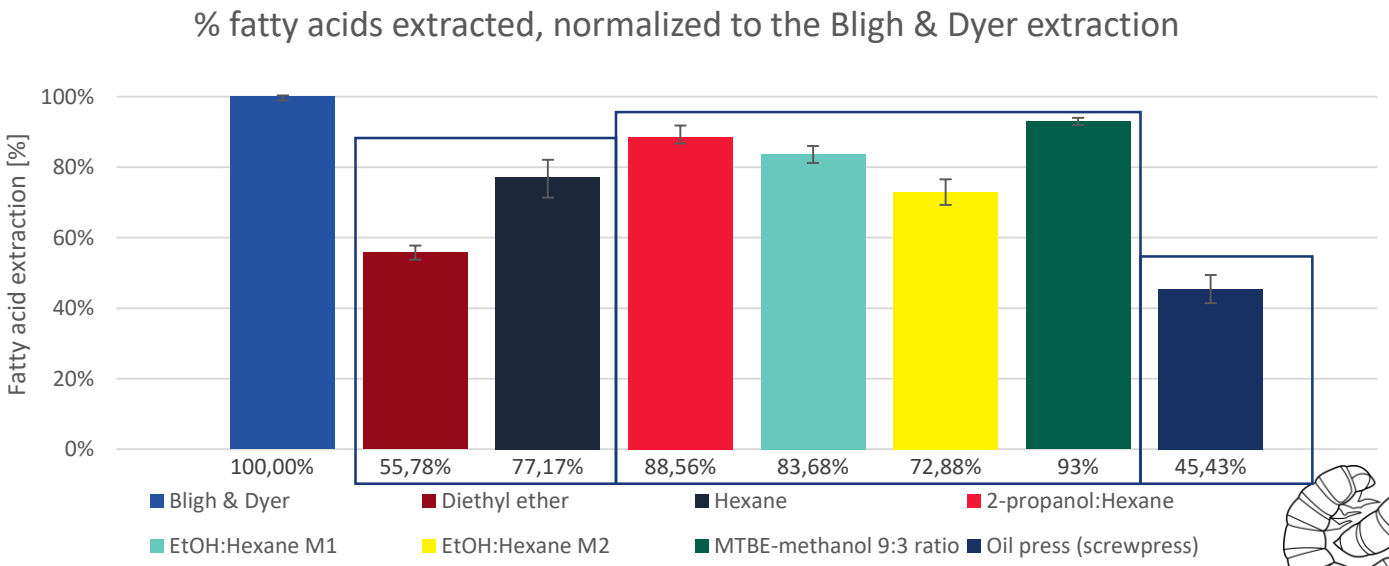
Different lipid extraction methods

- Single phase extraction
  - Diethyl ether
  - Hexane
- 2-phase extraction
  - 2-propanol – hexane
  - Ethanol – hexane
  - Bligh & Dyer
  - MTBE - methanol
- Mechanical extraction
  - Screw press with no temperature control



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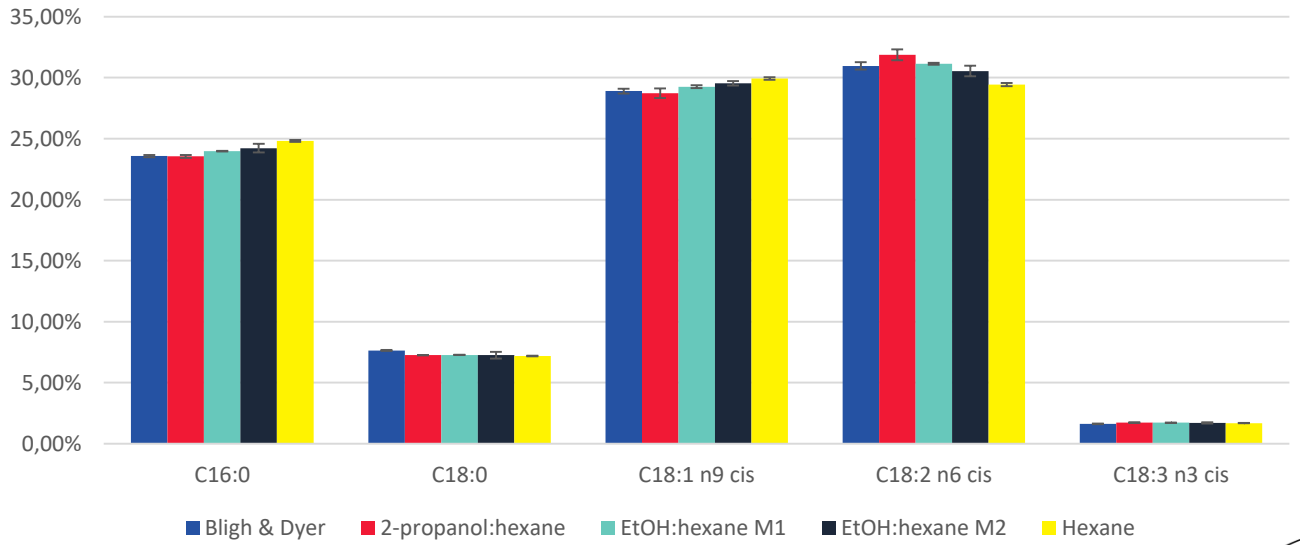
Fatty acid composition in extracts

- GC-FID analysis
- No major difference in FA-composition
- <1% of total FA is not displayed
  - 31 identified from C14:0 to C21:5 n3 cis by ECL-values



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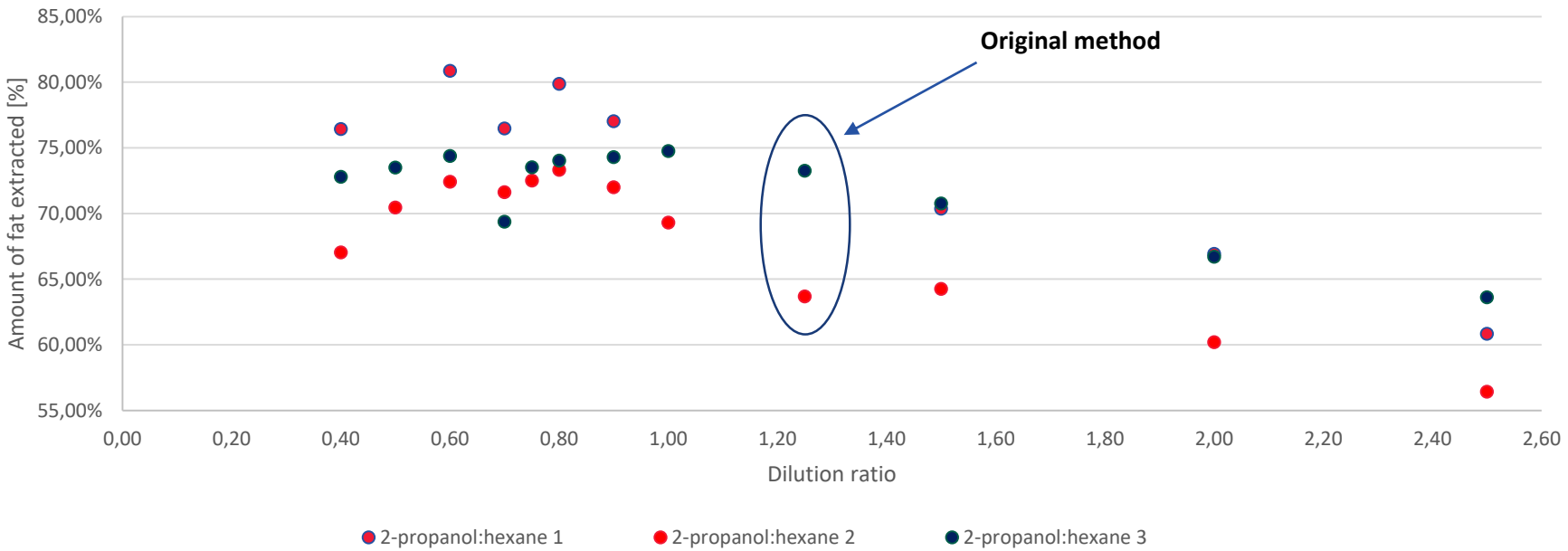
Different tissue – different solvent ratio

- 2-propanol-hexane – an example



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Advantages/disadvantages

	Screw press			1-phase extractions			2-phase extractions		
Pros	No use of solvents	Easy to scale		No drying required	Simpler thant 2-phase extraction	Fewer chemicals used	Highest extraction levels	Less chemicals to evaporate	
Cons	High pressure and temperature may impact proteins	Lower outoput	Require drying prior to lipid extraction	Lower output	Solvents may denature proteins	More chemicals to evaporate	Higher workload to extract phases	Require optimization for each use	Solvents may denature proteins

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Conclusion

- Drying techniques did not alter digestibility of proteins in rat studies, even though furosine damage was observed
- Several lipid extraction methods have been applied to *tenebrio molitor*
  - Total amount of lipids extracted vary from method to method
  - Fatty acid composition does not change
  - Most methods are developed for specific tissue and may be optimized

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Future works

- Polishing of the oil
- Investigating protein digestibility after different lipid extraction methods
- Optimize mechanical extraction to give higher output

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Questions

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