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INSECTA

Innovative entomological solutions for dietary supplements

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Introduction - Context

Aging population

- Muscle loss (sarcopenia)

Health obesity programs

- Promotion of healthy sporting activity

Increase of **protein** needs

Meat supplementation, food supplements

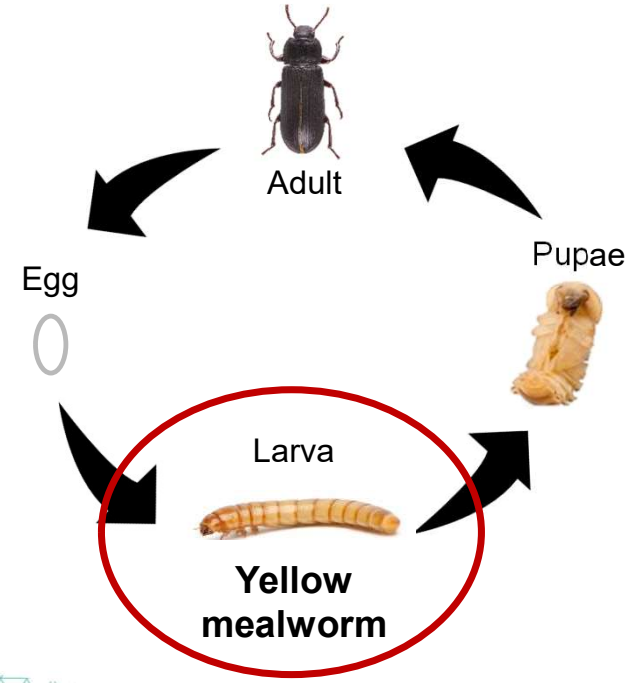
Introduction - Insects benefits

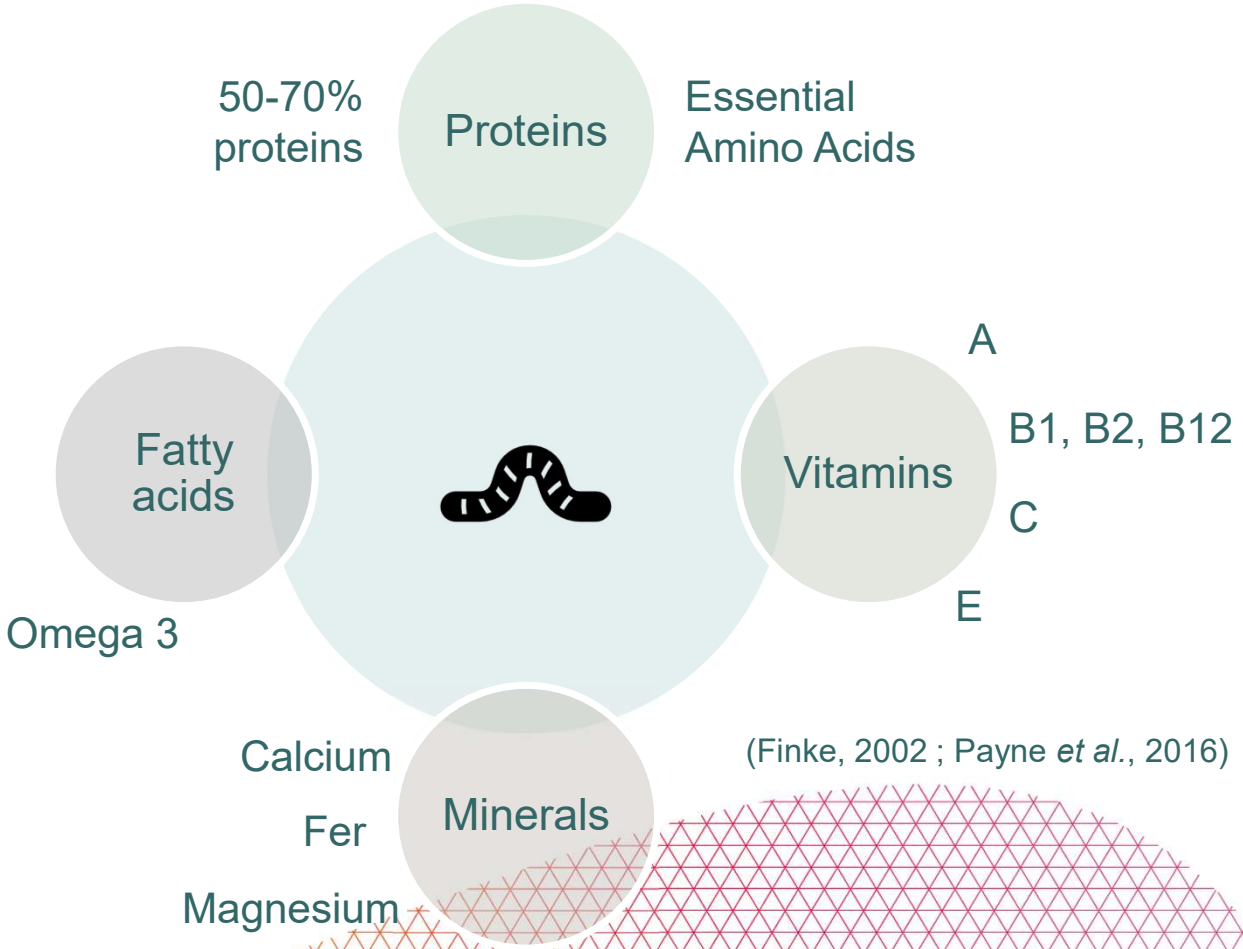
- Low GHG production
  → *direct environnemental impact reduced*
  - Require few food and water
    → *indirect environnemental impact reduced*
    - Can be fed organic waste
      → *can be beneficial for circular economy*
  - Valuable nutritional content
    → *can be used as human food*
- Fast and easy rearing (few material)
  → *can lead to affordable end-products*
  → *can be beneficial for local economy*

F.A.O. recommandation

Introduction - Yellow mealworm

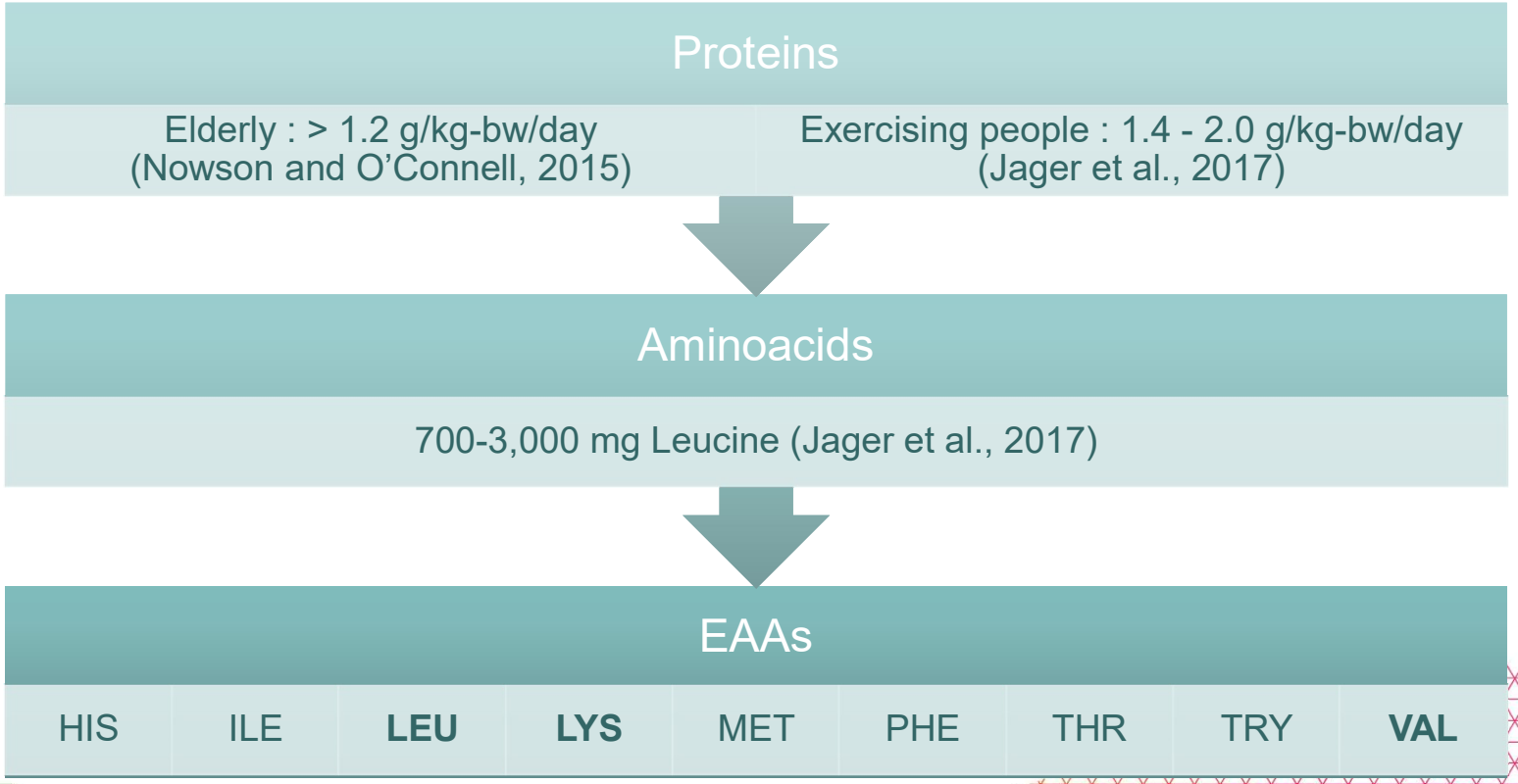
Tenebrio molitor





(Finke, 2002 ; Payne *et al.*, 2016)

Introduction - Nutrients in food suppl.



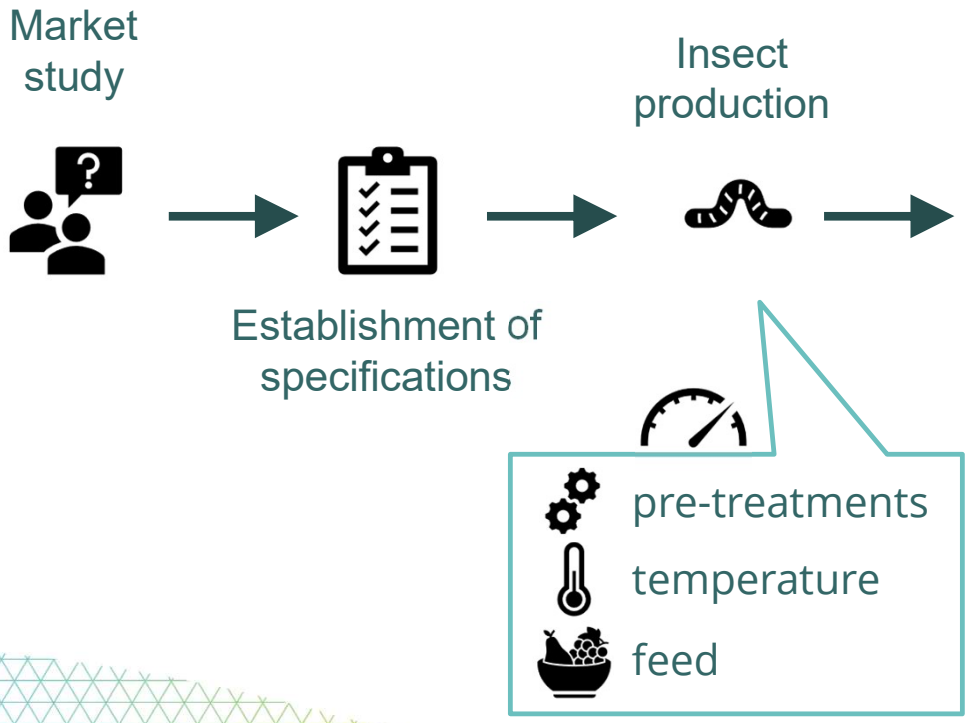
(Janssen 2017 ; Finke 2002)

INSECTA project timeline

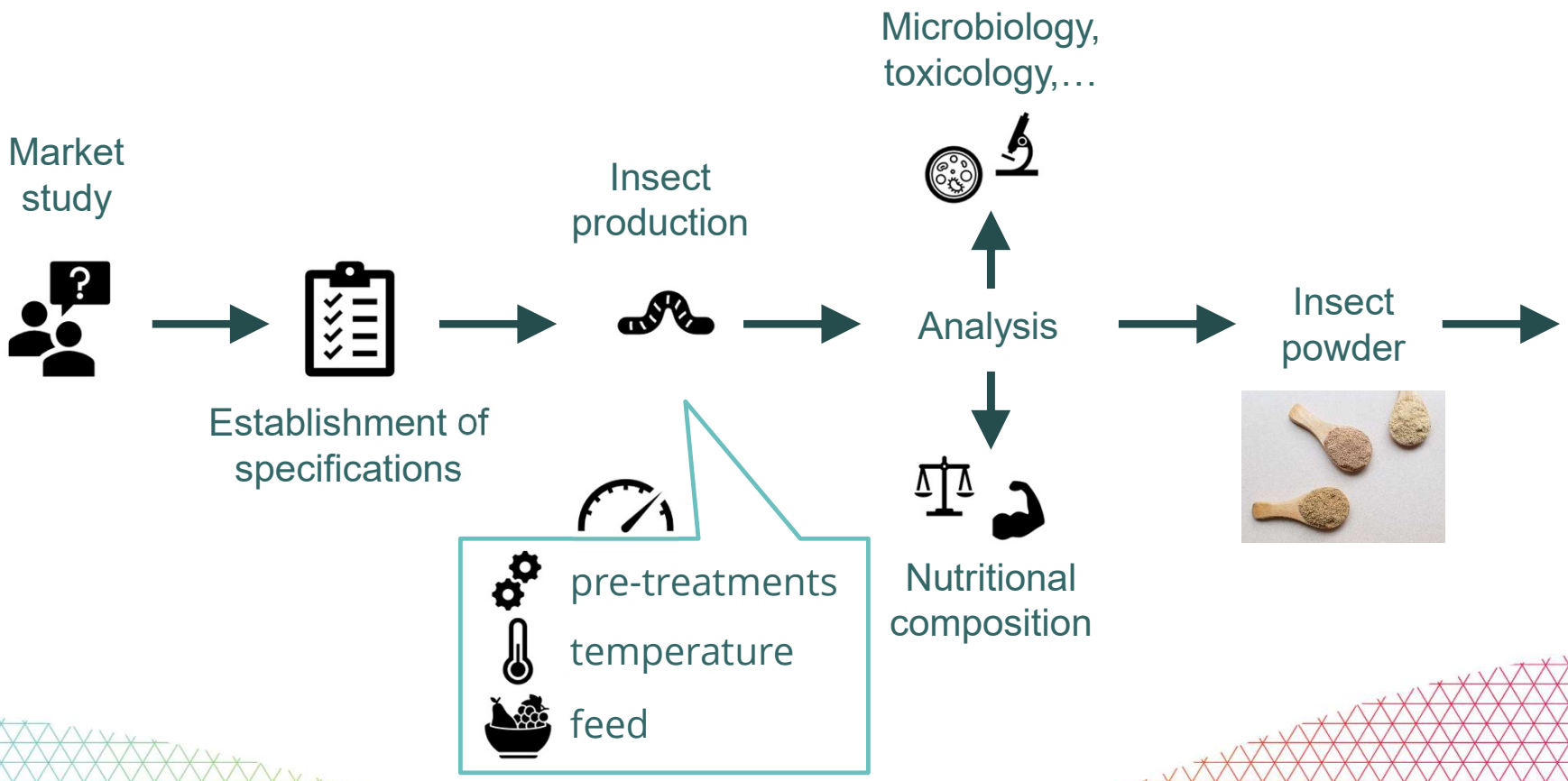
Market study

Establishment of specifications

INSECTA project timeline



INSECTA project timeline



INSECTA project timeline

Market study

Establishment of specifications

Insect production

pre-treatments

temperature

feed

Microbiology, toxicology,…

Analysis

Nutritional composition

Insect powder

Packaging

Galenic

Flavouring

Supplement formulation

Commercialization

Aims of the research

Make an ingredient for food supplement

- High-protein content
- Controlled nutritional value
- Environmental friendly

Clarify the impact of breeding parameters and treatments on

- Nutritional value
- Microbiological quality
- Galenic

Develop protocols for insect matrix

- Protein dosage
- Microbial analysis
- …

Material - Rearing environment

- Temperature 27°C
- Relative humidity 65%
- Cycle (egg → harvest) : 3 months
- Control feed : wheat bran
- Water source : agar (25 g/L)

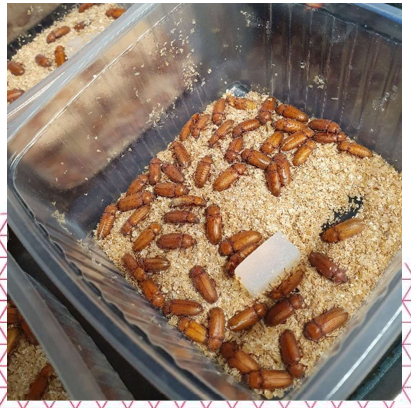
Material - Breeding

Pupae sieving

Pupae sieve
3D printed
3.5 mm spaces

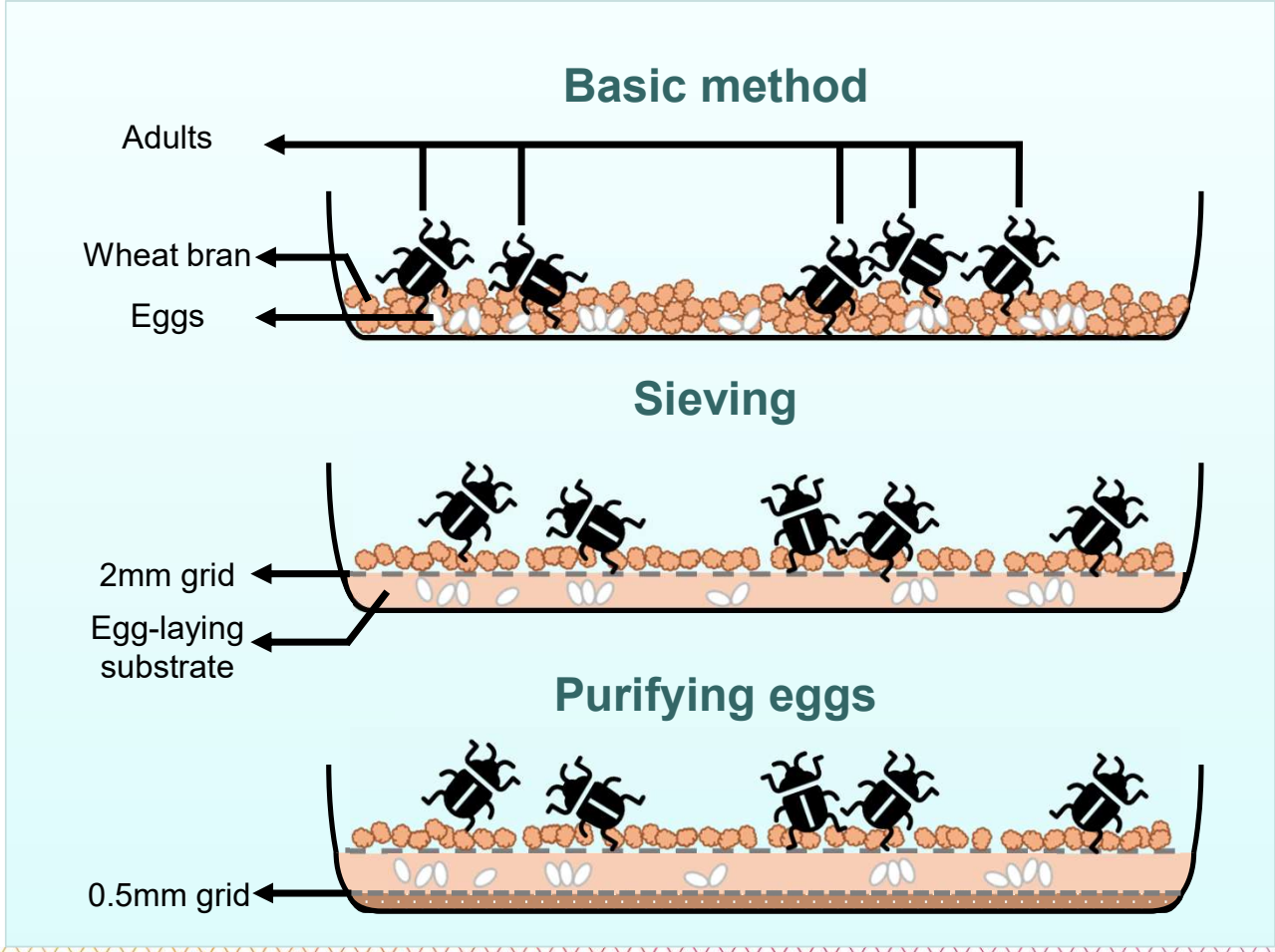
Fasting and maturation

(Leclerc, 1948)



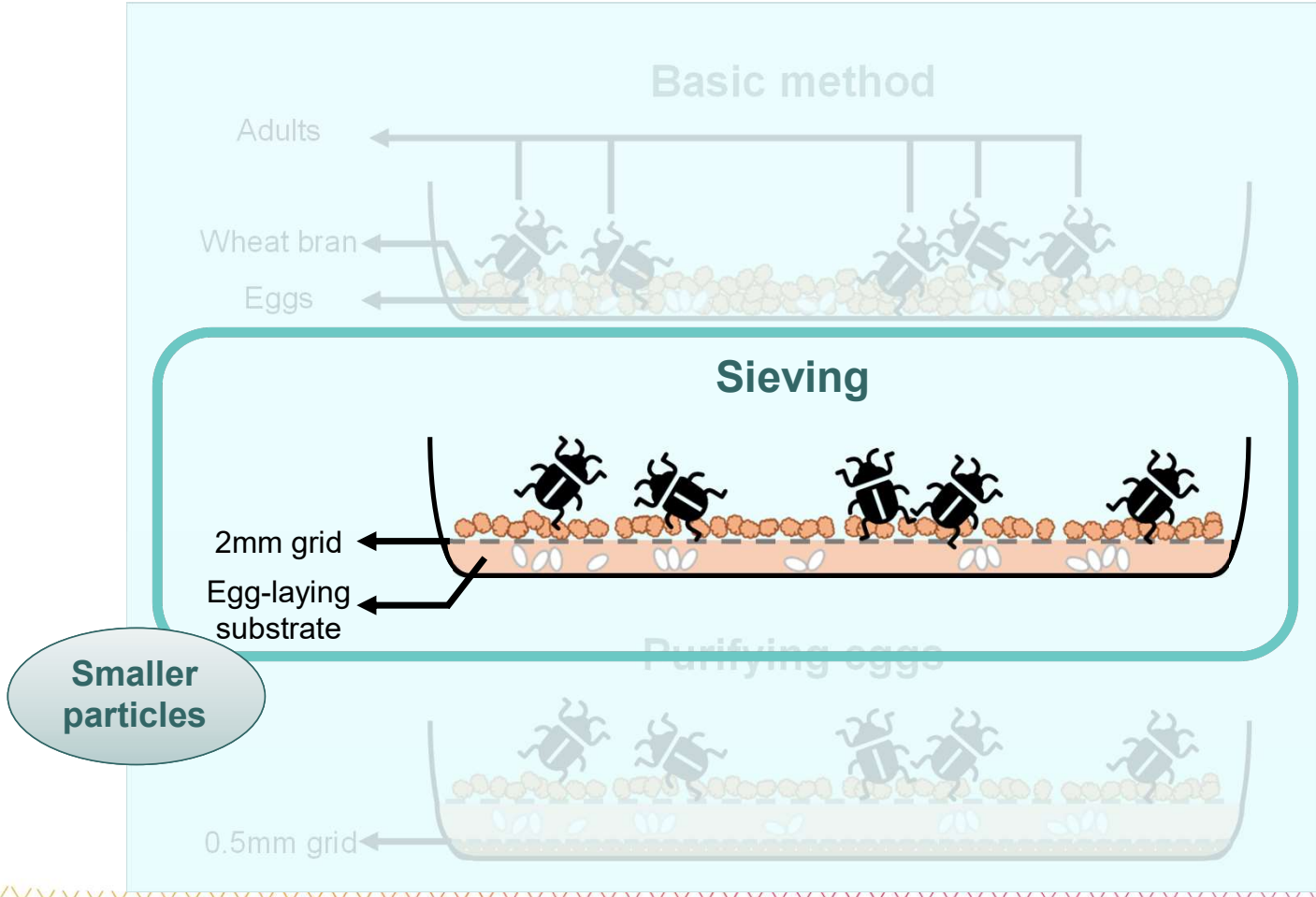
Material – Egg laying

(Dossey *et al.*, 2016)

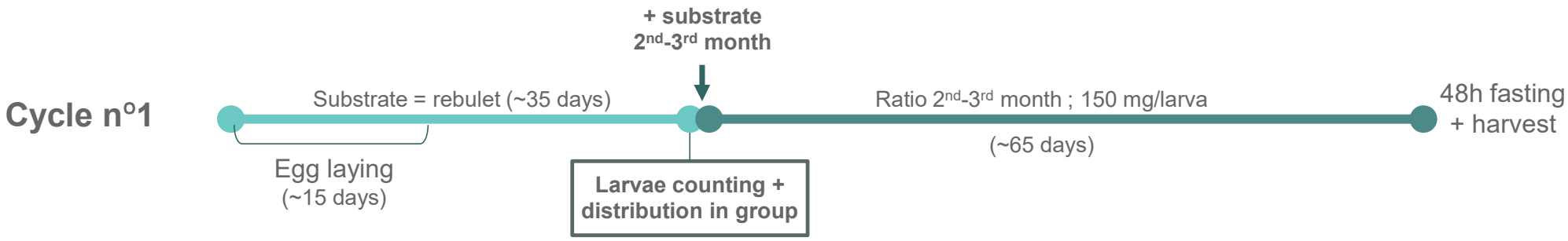


Material – Egg laying

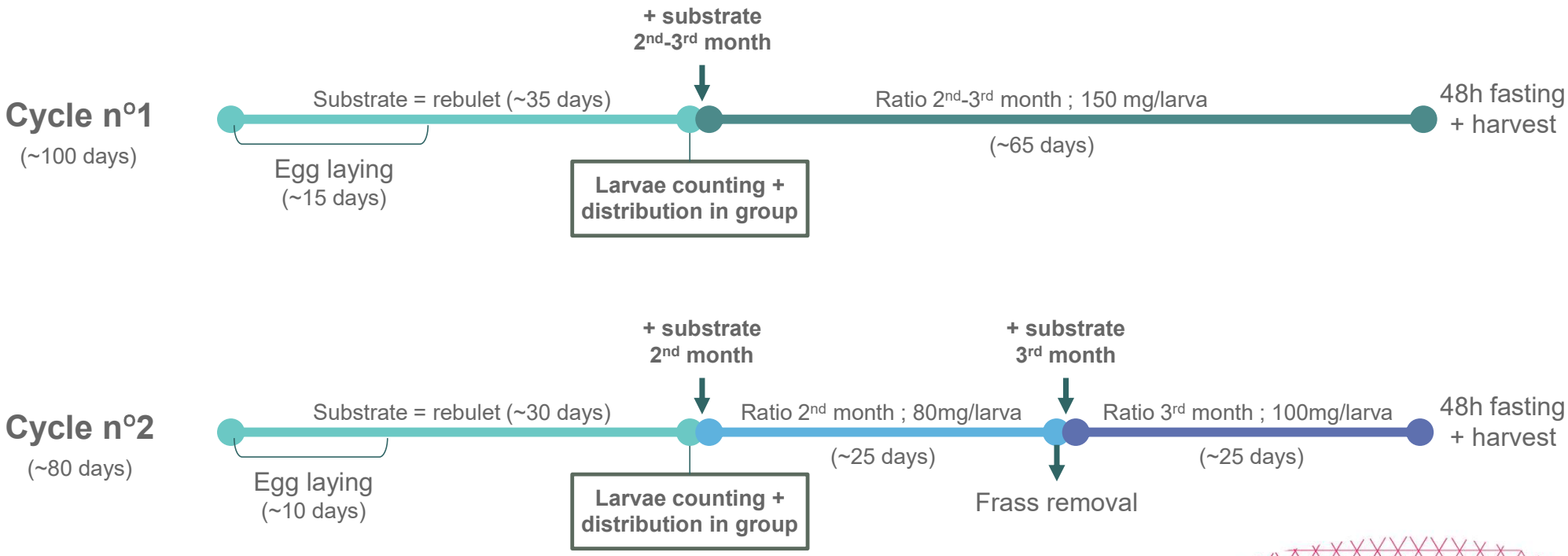
(Dossey *et al.*, 2016)



Method - Rearing cycles



Method - Rearing cycles



Ingredients

Hydrolysate of pea proteins

- Proteins 80%
- Carbohydrates 5%
- Fats 8%
- Ash 4%

Supplier : Cosucra

Buttermilk powder

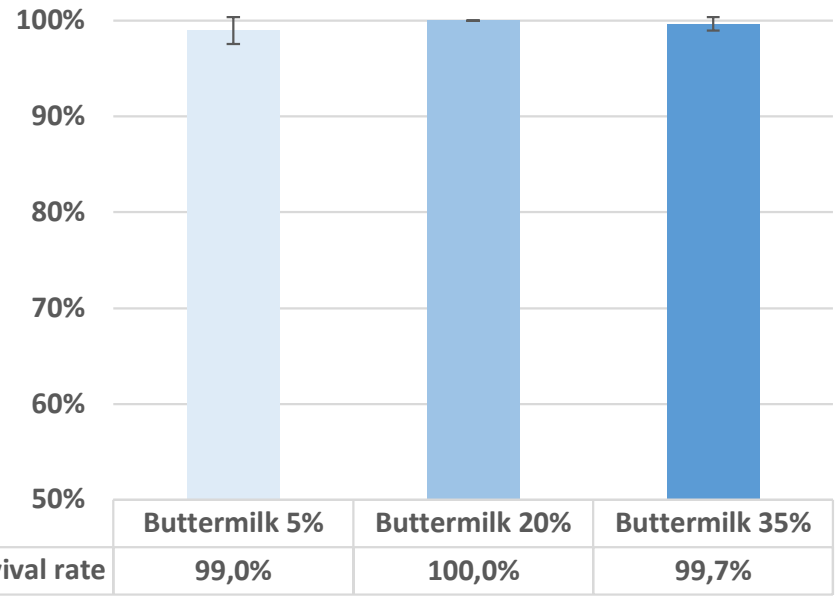
- Proteins 30%
- Carbohydrates 47%
- Fats 14%
- Ash 7%

Supplier : Corman

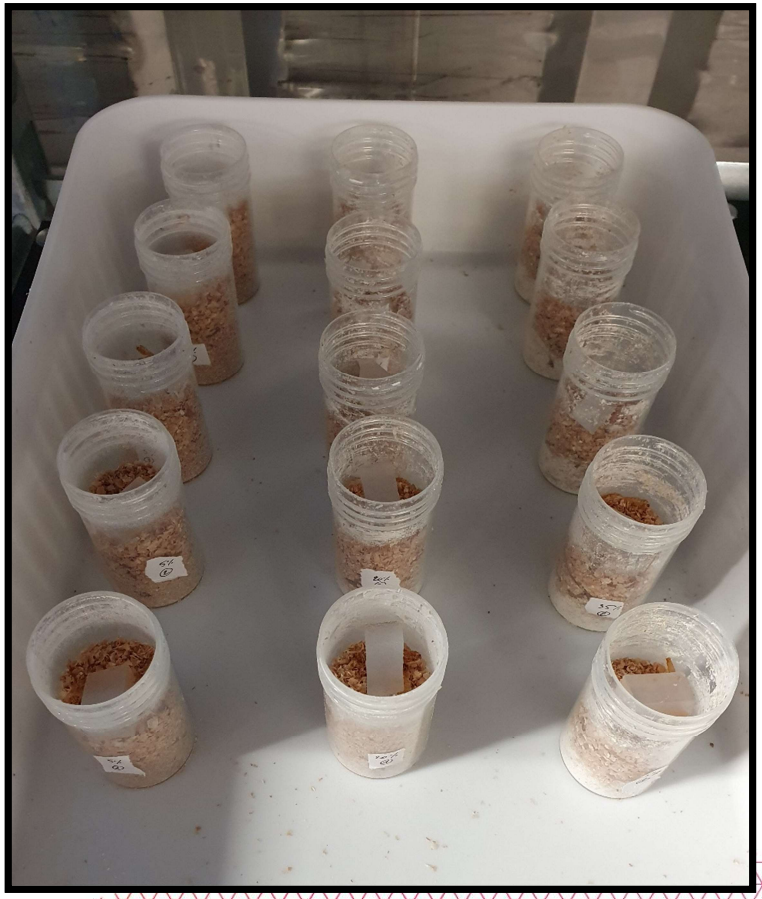
Survival test

In Rumbos *et al.* (2020) Milk powder =

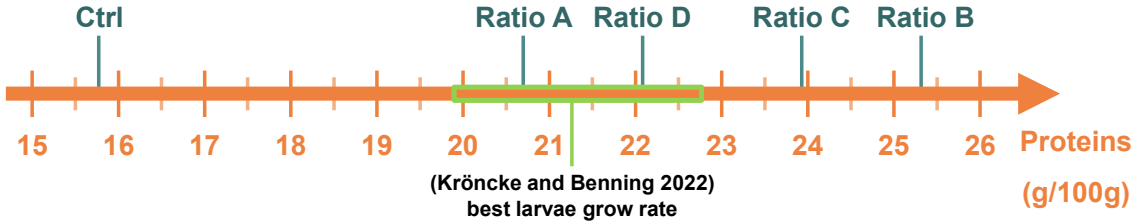
Good protein content in T.M. but high mortality



	Buttermilk 5%	Buttermilk 20%	Buttermilk 35%
Survival rate	99,0%	100,0%	99,7%



Feed recipes



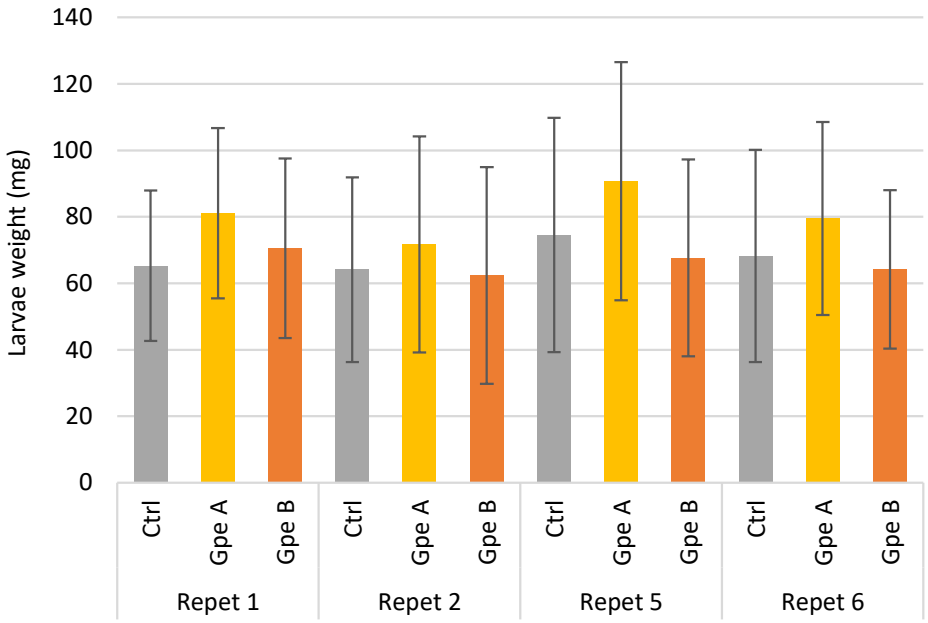
	Rebulet	Wheat bran	Pea proteins	Buttermilk powder	Proteins	Carbohydrates	Fats
Nutritional needs 2nd month					15,4%	63,9%	5,5%
Nutritional needs 3rd month					30,4%	43,7%	8,3%
Average nutritional needs					**22,9%**	**53,8%**	**6,9%**
Rebulet (1st month)	**100%**				**14,3%**	**60,2%**	**2,4%**
Wheat bran (2nd-3rd month)		100%			14,0%	57,3%	2,0%
Control (wet) tot	33%	67%			14,1%	58,3%	2,1%
Control (dry) tot	**33%**	**67%**			**15,8%**	**65,5%**	**2,4%**
Ratio A (2nd-3rd month)		90%	10%		20,5%	52,0%	2,6%
Ratio A (wet)tot	33%	60%	7%		18,4%	54,7%	2,5%
Ratio A (dry) tot	**33%**	**60%**	**7%**		**20,6%**	**61,3%**	**2,8%**
Ratio B (2nd-3rd month)		80%	20%		26,9%	46,7%	3,2%
Ratio B (wet) tot	33%	53%	13%		22,7%	51,2%	2,9%
Ratio B (dry) tot	**33%**	**53%**	**13%**		**25,3%**	**57,0%**	**3,2%**
Ratio C 2nd month		96%	4%		16,6%	55,2%	2,2%
Ratio C 3rd month		70%	30%		33,4%	41,5%	3,8%
Ratio C (wet) tot	33%	55%	11%		21,4%	52,3%	2,8%
Ratio C (dry) tot	**33%**	**55%**	**11%**		**23,9%**	**58,3%**	**3,1%**
Ratio D 2nd month		84%		16%	16,5%	55,6%	3,9%
Ratio D 3rd month		50%	15%	35%	29,1%	45,5%	7,0%
Ratio D (wet) tot	33%	45%	5%	17%	20,0%	53,8%	4,4%
Ratio D (dry) tot	**33%**	**45%**	**5%**	**17%**	**22,1%**	**59,3%**	**4,9%**

Cycle n°1

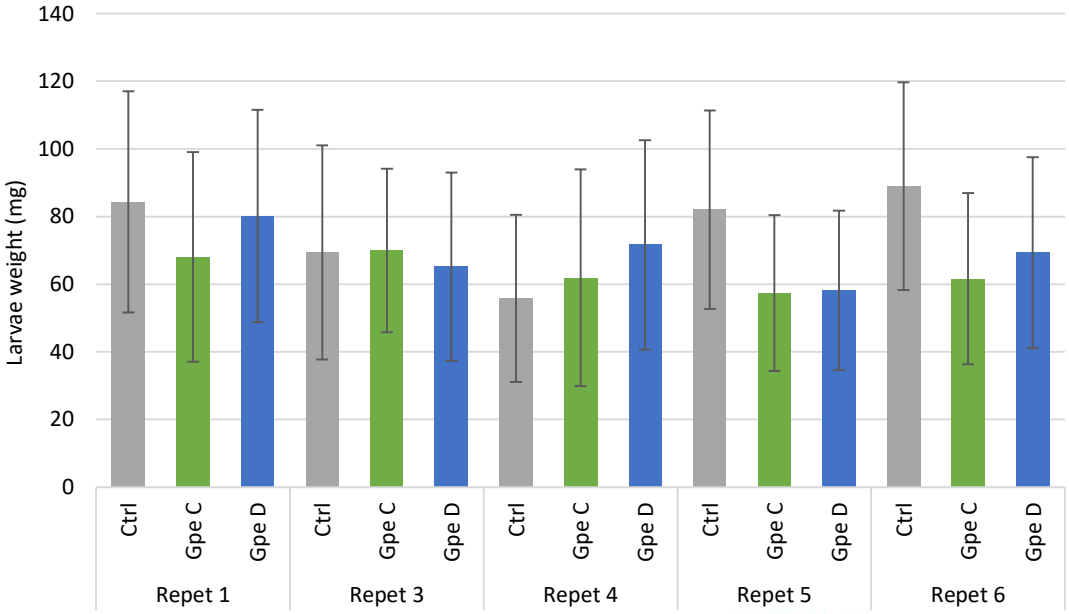
Cycle n°2

Larvae weight

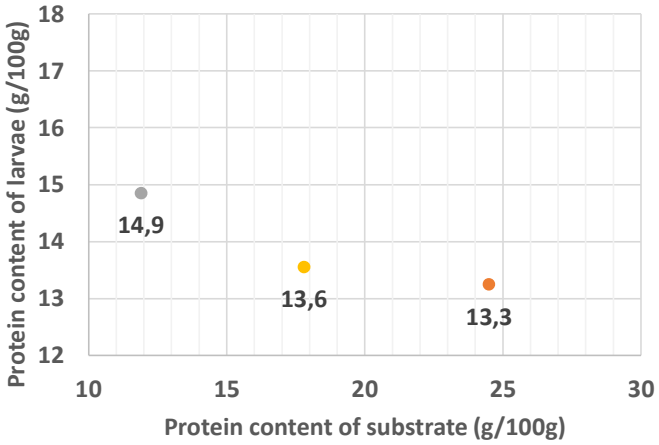
Cycle n°1

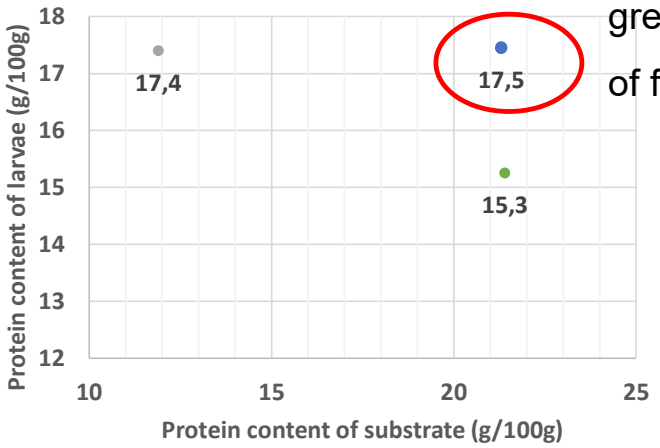


Cycle n°2



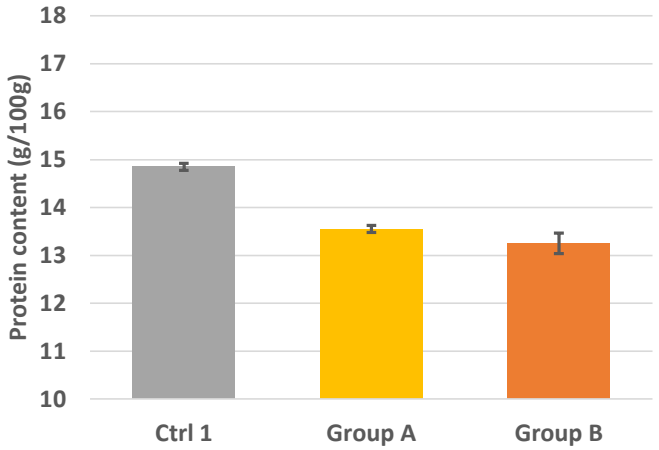
Protein content – preliminary results

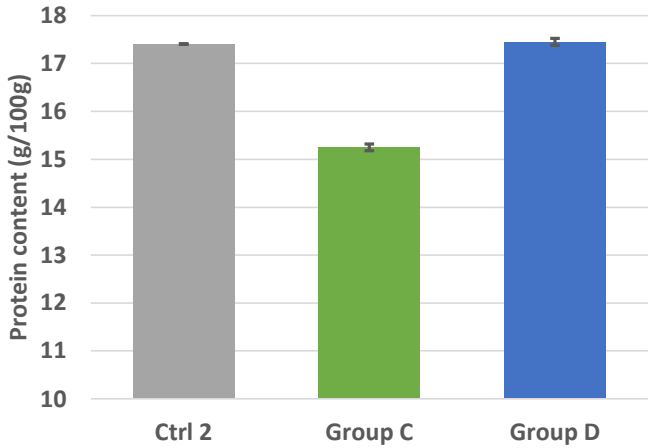




great influence

of fatty acids





Kjeldahl

certified analysis

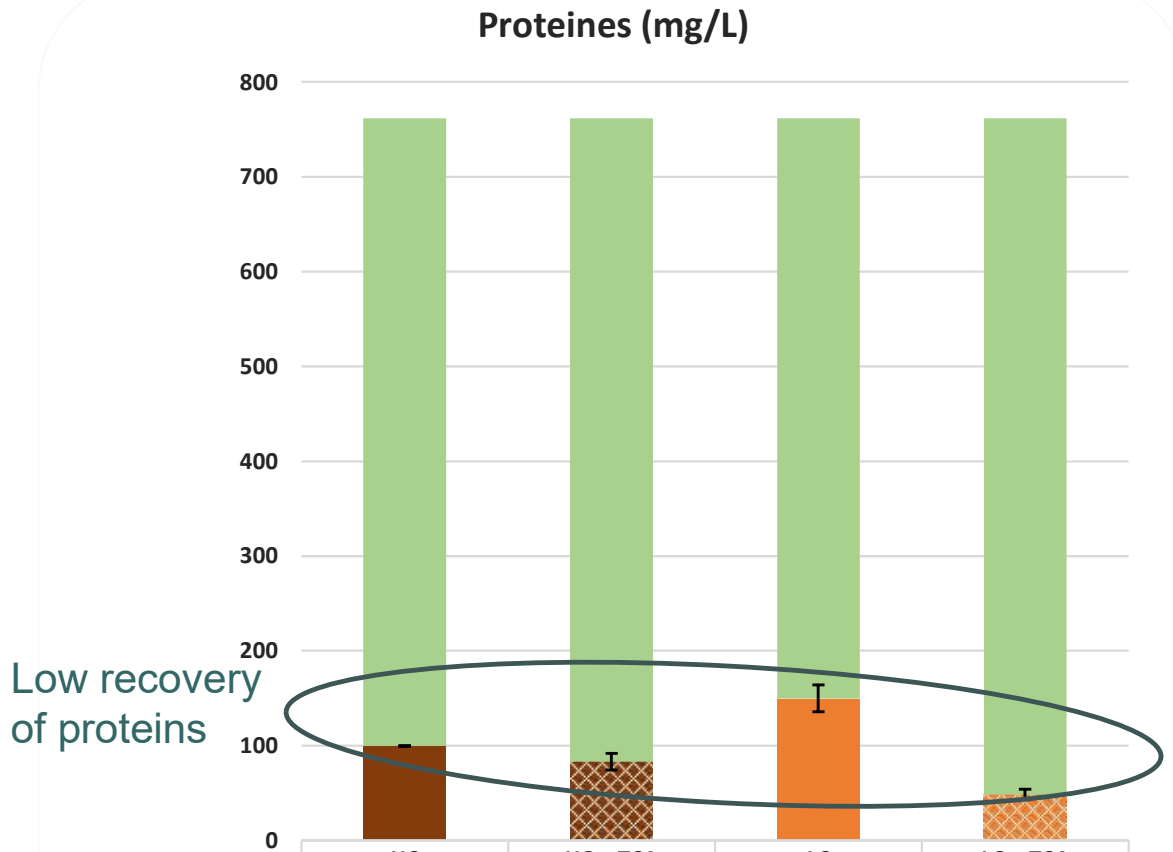
Kp = 4.76

RCDC protein assay

Principle : proteins react with Folin-Ciocalteu reagent, which changes color based on the protein content. Determine the amount of protein by measuring the color change.

Challenges :

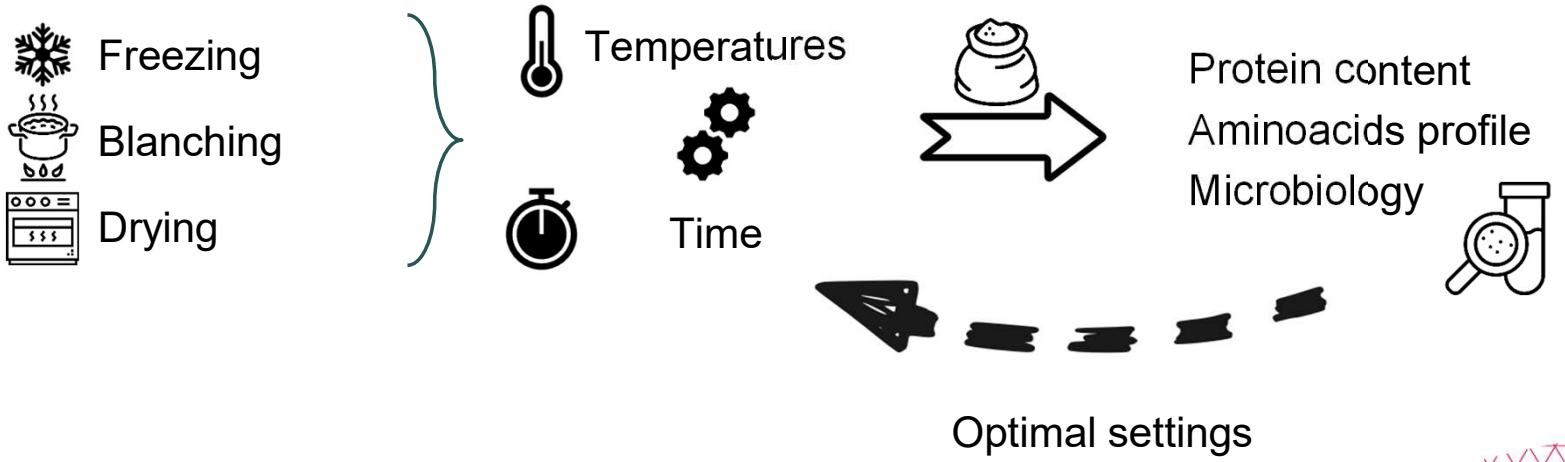
- Heterogeneous
- Poor solubility in water
- Potential interferences of other compounds of the mixture



	HC	HC + TCA	LC	LC + TCA
Target value	662	678	612	713
Protéines (mg/L)	100	83	150	49

Next steps

Optimization of the pre-treatments



Discussion

Method optimization

- Material : 3.5 mm mesh sieve to harvest pupae
- Breeding : smaller particles substrate = more eggs
- Rearing : Density = 7.7 → 6.7 larvae/cm²

Yellow mealworm development

- Similar to other studies
- High variability

Perspectives

Next cycle of production

- increase fats (buttermilk)
- stable CO_2 & temperature
- investigate earlier development stages (60-70 days ?)

Pre-processing

Determine the best settings (blanching, drying) to preserve nutritional value and ensure the food safety

Nutritional analysis

Develop sample pre- treatments to increase solubilization and homogeneization

Conclusion

Yellow mealworm

- ✓ environmental-friendly
- ✓ economy-friendly
- ✓ high nutritional value
- ✓ add value to local by-products

Current challenge :

Clarify impact of rearing parameters on nutritional content & optimize the rearing process

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Haute Ecole Libre Mosane

Thank you

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