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Development and Optimization of Sustainable Protein-Source-Based Food

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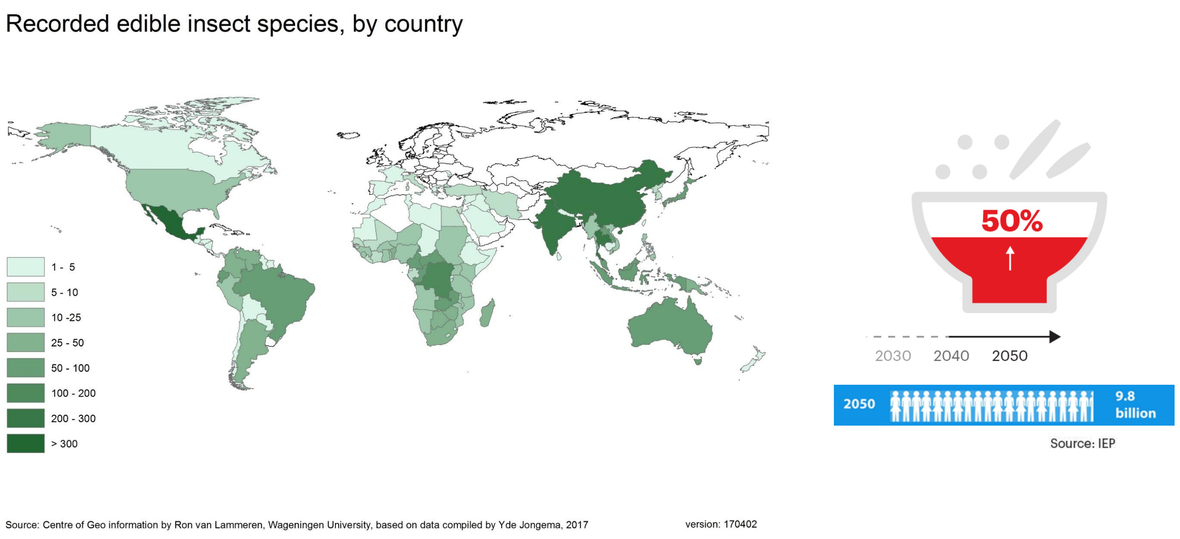
Introduction

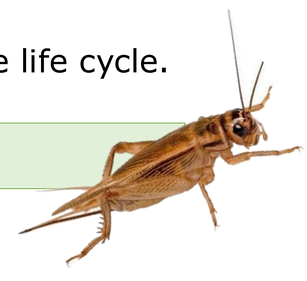
Insects have been part of human diets since ancient times and are currently consumed in over 112 countries worldwide, 11 of which European, while Mexico, China, Thailand, and India are the leading consumers.



They offer high-quality proteins, reduced environmental impact, and provide a sustainable solution to **food security** challenges. If the demand for livestock products is expected to double in the next 30 years, insects:

- ✓ Grow rapidly;
- ✓ Are farmed vertically;
- ✓ Have high feed-to-meat conversion rate;
- ✓ Their environmental impact is very low over the entire life cycle.

Acheta domesticus (house cricket)



- ❖ **57–77% protein**
- ❖ 4–22% unsaturated fatty acid
- ❖ 7–12% fiber

State of the art

Insect flour is already used to enrich existing foods as supplementary source of protein for **beverages**, **egg or dairy replacements meat analogues** (Shoeckley et al., 2018).

Insect	**Texturization**
-	**Soybean** protein and **wheat** gluten are texturized through twin extruder at specific **moisture** conditions between **40%** and **60%**. (Wu et al., 2019)
Alphitobius diaperinus *(up to **40%** w/w)*	In combination with soy protein concentrate, produced an extruded with more **layered** texture and meat-like highly anisotropic **fibrous structures**. (Smetana et al., 2018)
Acheta domesticus *(up to **45%** w/w)*	In combination with SPI, improves meat analogues texture, allowing the formation of meat-like anisotropic **fibrous structures**, a **homogeneous, dense fiber network** and **tensile properties/tenderness**. (Kiiru et al, 2023)

Allergen risks: Chitin (Belluco et al., 2013)
- ✓ Long-chain polymer of N-acetylglucosamine;
- ✓ Primary component of the exoskeleton;
- ✓ Has *anti-nutrient* properties due to its potential negative effects on protein digestibility.

To date, overall, there is still very limited research on the production of insect protein-based meat alternatives, not only made with **extracted insects' protein** but with their use as the **main protein source**.

Aim

This PhD project **aims** at the development and optimization of **meat analogues** using textured **insect proteins** in partial or total substitution of the more commonly used plant proteins. The **optimization** of protein extraction methods and extrusion parameters will aim to obtain fibrous structures with **meat-like properties**, simultaneously reducing the risks connected to the presence of known allergen, such as chitin.

PhD Objectives

A1) **Source selection and protein extraction**
Insect selection (A1.1) and extraction pre-treatment and protocols will be identified (A1.2) and optimized (A.1.3).

A2) **Protein characterization**
Technological and functional properties of extracted protein (Water and Oil holding capacity, Solubility, Foaming capacity and stability, Emulsifying capacity and stability, gelling capacity, rheological and thermal properties) will be identified (A2.1) and optimized (A.2.2).

A3) **Protein Texturization**
Identification (A3.1). and optimization (A3.2) of High Moisture Extrusion parameters to optimize the mechanical and chemical-physical property of the extruded.

A4) **Meat analogues development**
Formulation and production (A4.1); chemical-physical, microbiological characterization of the optimized food products, sensory analysis and allergen risks evaluation (A4.2) and shelf-life (A4.3).

A5) **Writing and Editing** of the PhD thesis, scientific papers and oral and/or poster dissemination of the results.

PhD GANTT

Activity	Months 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
A1)	***Protein extraction***																							
	1) Source identification																							
	2) Technique identification																							
	3) Technique optimization																							
A2)	***Protein characterization***																							
	1) Technique identification																							
	2) Technique optimization																							
A3)	***Protein texturization***																							
	1) Key parameters identification																							
	2) Key parameters optimization																							
A4)	***Meat analogues***																							
	1) Formulation and production																							
	2) Characterization																							
	3) Shelf-life analysis																							
A5)	***Thesis and Paper Preparation***																							

References

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