Production of insect protein hydrolysates: a multifactorial study

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Introduction

The food economy is challenged by social and demographic change, a steady loss in the amount of arable land, and other factors. In addition, creating food security plans based on sustainable agriculture production and the hunt for other protein sources must take into account the rising need for various types of foods. From an ecological standpoint, it is predicted that by 2050, some 150 million people might be at risk of not getting enough protein in their diets owing to rising levels of atmospheric CO2 (Żuk-Gołaszewska, et al. 2022). The protein gap may be filled by introducing insect protein, a rich source of nutrients, to modern food chains. Insects are a key biological resource that is currently underutilized, particularly in Europe. Numerous bug species have the potential to be useful and secure food ingredients. Protein, amino acids, lipids, carbohydrates, a variety of vitamins, and trace elements are all abundant in edible insects. In recent years, Western nations have supplied a considerably wider range of insect-based products. Entrepreneurs are becoming more interested in using this novel food component in crisps, energy bars, and other functional foods (Skotnicka et al. 2021). More specifically, it has been suggested that one way to improve customer acceptance is to extract nutritional components (such as proteins and lipids) from edible insects and utilize them as food ingredients (Borges et al. 2023). Several peptides and amino acid sequences have been identified within a wide range of dietary proteins, which have been associated with bioactive properties. These have been identified, for example, for their antihypertensive, antioxidant, antidiabetic, immunomodulatory and mineral-binding properties (Nongonierma and FitzGerald 2017, Sousa et al. 2020).

Therefore, the aim of this study was to establish the optimal conditions to obtain bioactive peptides from *Tenebrio molitor* and *Hermetia illucens*, by enzymatic hydrolysis using alcalase.

Methods

Tenebrio molitor

Hermetia illucens

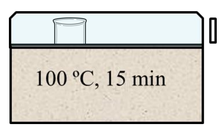
Milling

Enzymatic hydrolysis

Alcalase
pH 8, 50 ° C

Experimental design

Run	E/S %	Time min
1	1.5	240
2	1.5	240
3	1.5	30
4	0,5	30
5	1.5	450
6	0.5	450
7	2.5	240
8	2.5	450
9	0.5	240
10	2.5	30



Enzyme inactivation

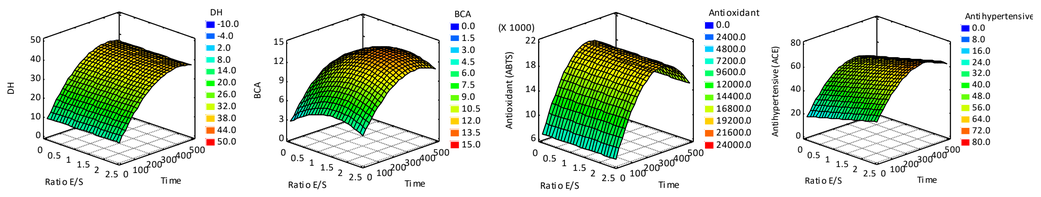
Centrifugation

Insect protein hydrolysate

Response
- Degree of hydrolysis
- Protein content
- Antioxidant activity
- Anti-hypertensive activity

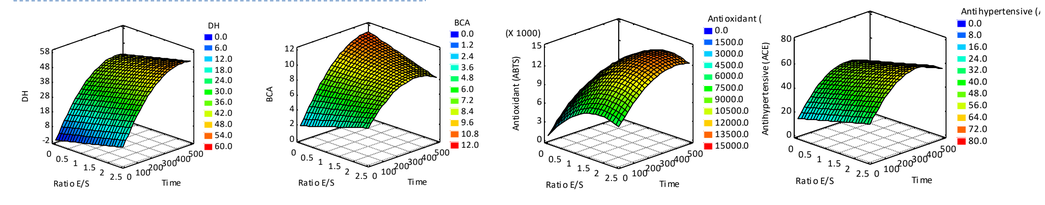
Results

***Tenebrio molitor* protein hydrolysates**



Degree of hydrolysis | Protein content | Antioxidant activity | Anti-hypertensive activity

***Hermetia illucens* protein hydrolysates**



Degree of hydrolysis | Protein content | Antioxidant activity | Anti-hypertensive activity

Figure 1 – Response surface graphs corresponding to the combined effect of % enzyme and hydrolysis time on degree of hydrolysis, protein content, antioxidant activity and anti-hypertensive activity responses obtained with enzymatic hydrolysis using alcalase

Table 1 – Results obtained in a validation of enzymatic hydrolysis performed with the optimal conditions achieved

***Tenebrio molitor* hydrolysates**				
Optimal condition		Degree of hydrolysis (%)	Protein amount (mg/mL)	Antioxidant activity (µmol/L)
E/S	1.9%	38.4 ± 6.2	11.0 ± 0.1	24573 ± 891
Time	6 h			
***Hermitia illucens* hydrolysates**				
Optimal condition		Degree of hydrolysis (%)	Protein amount (mg/mL)	Antioxidant activity (µmol/L)
E/S	2.1%	48.2 ± 2.4	8.5 ± 0.1	21337 ± 1785
Time	6h20			

Discussion/Conclusions

The aim objective of this study was to establish the optimal production conditions to obtain *Tenebrio molitor* and *Hermetia illucens* hydrolysates, by enzymatic hydrolysis using alcalase. The factorial design allowed for the evaluation of the effects of two factors (enzyme/substrate ratio and hydrolysis time) on protein/peptides release, degree of hydrolysis (DH), antioxidant and anti-hypertensive properties of the insect hydrolysates.

Tenebrio molitor hydrolysates produced using the optimized conditions (1.9% E/S, 6 h) showed 11.0 ± 0.1 mg/mL of protein, antioxidant activity via ABTS method of 24573 ± 891 µmol TE/L, and a DH of 38.4 ± 6.2%. *Hermetia illucens* hydrolysates produced using the optimized conditions (2.1% E/S, 6h20) showed 8.5 ± 0.1 mg/mL of protein, antioxidant activity of 21337 ± 1785 µmol TE/L and a DH of 48.2 ± 2.4%.

Insects can be used as a source of hydrolysates rich in peptides with relevant bioactive properties, and showing potential for use as ingredients in food and feed industries. Future insect-based food solutions should rely on further investigation, which is enable putting innovative and sustainable solutions on clearer grounds.

References

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