Use of *Hermetia illucens* to waste processing: exploring chemical safety of larvae focusing on heavy metals

Mgr. Tomáš Persaň
Supervisors: Mgr. Jana Vašíčková, Ph.D. and doc. RNDr. Jakub Hofman, Ph.D

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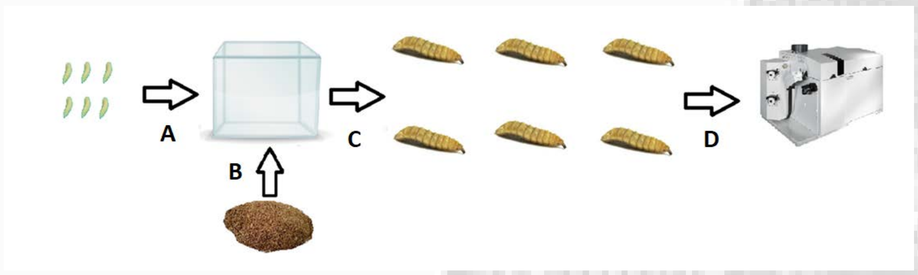
INTRODUCTION

As the human population is growing and sources in our world are limited, there is a constant need to explore new sources and improve the efficiency of current technologies. The demand for food of animal origin is expected to be doubled by 2050 in comparison to the year 2019 [1]. Proposed work explores the usage of *Hermetia illucens larvae* (HI) as an efficient converter of low-quality biomass (for example food waste) into nutritionally valuable proteins. This process is viable due to dispositions of HI larvae, which are able to process a wide range of organic materials into biomass - a source of proteins and fats, that can be used for various applications: food for poultry, fish, and others. However, if the HI larvae should be used as feed for farmed animals on a large scale, there are still questions and problems that need to be addressed.
In this project, which is part of my Ph.D. work, I am focusing on risk linked to bioaccumulation of heavy metals in HI larvae when used for livestock and human consumption in the future.

METHODOLOGY

To study the bioaccumulation factors (BAFs) of metals in HI we use different (feeding-model) matrices (rice, oat flakes, spent grain, etc.) to simulate different levels of concentration of the metals which can be regularly found in biowaste. This was the central part of my master thesis. Based on this work, our research will continue to obtain comprehensive results and reproducibility of the obtained data in time .



Scheme of the experiment
200 of 7-days old larvae are counted (A) and grew under monitored conditions (B+C). Finally, the measurement is conducted on LC-MS (D).

EXPECTATIONS

There are two topics which needed to be explored:
1) The time dependence of BAFs (dependence of BAFs on the age of larvae), this is explored by sampling HI larvae on each day and subsequent analysis.
2) The possibility to control BAFs: this will be tested out by changing parameters in the range, which is favorable for HI development according to literature review (mainly pH in test box) and followed by metal analysis.

The series of experiments were performed to provide complete evidence on how BAF factors (concentrations) variate in time and how we control BAFs. The samples were collected, and the metal analysis will be performed soon.

PRELIMINARY RESULTS

If HI larvae should be used as feed for livestock, they need to fulfill European legislation. Since 2017, according to EU regulation 2017/893, it is possible to use insect protein to feed fish. And, it is expected that it will be allowed to use insect protein as fodder for chicken too [2]. Simultaneously there is EU direction 2002/32 dealing with limits of contaminants in animals feed. EU 2002/32 is containing limits for 27 groups of pollutants, for example, Cadmium, Lead, Arsenic, Aflatoxin B1, Hydrocyanic acid, Theobromine, Aldrin, Dioxins (sum of PCDD and PCDF), or DDT. All these limits need to be fulfilled and checked.
Our research on toxic metals showed that limits were achieved for larvae feed by spent grain. Cadmium turned out as the most problematic metal (but its concentration in larvae fed by spent grain still fulfilled legislative requirements).

CONCLUSION

- ✓**There is enormous potential to use HI as efficient protein producer.**
- ✓**HI converts low-quality biomass (for example food waste) into valuable proteins.**
- ✓**Accumulation of heavy metals is studied to make sure produced protein is safe.**
- ✓**Cadmium is the most problematic element.**
- ✓**Currently, we are studying accumulation as a function of time, nowadays, samples are homogenized, and analysis will be conducted soon.**

REARING

The HI are reared in test boxes in standardized conditions (T = 28 °C, humidity 70-80 %), and they are feed by the exact amount of feeding stuff (we exactly know parameters of these feed, e.g., water content, the content of metals). Then after 15 days, larvae are removed, they are being allowed to empty their gut for 24 h, and then they are stored at - 80°C until the next step of the analysis.

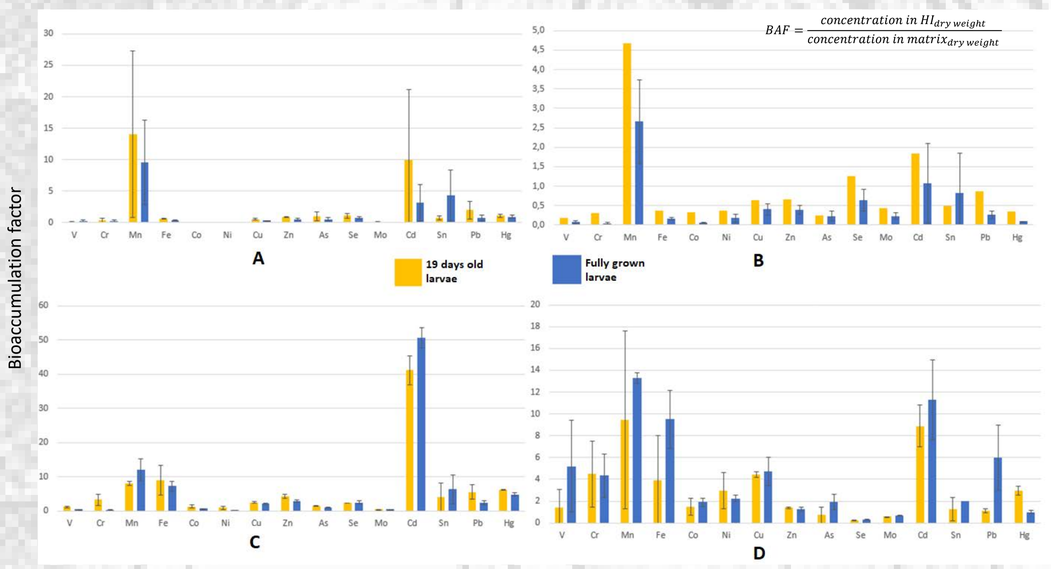
Rearing of *Hermetia illucens*

ANALYSIS

In the analysis, larvae will be lyophilized, ground, and 100 mg of the sample will be dissolved in 2 ml of HNO_3 and 1 ml of H_2O_2. Samples will be analyzed by mass spectrometry and by atomic absorption spectroscopy. This experiment will clarify the occurrence of metals and their levels in different matrices. The results will be used in the next step.

Analyzed elements		
Hg	Sn	Se
Cd	V	Mo
As	Ni	Zn
Pb	Co	Mn
Cr	Cu	Fe

Bioaccumulation factors



Bioaccumulation factors in larvae fed by peas (A), spent grain (B), rice (C), and curd (D).

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[1] FAO, "Meat & Meat Products," *Animal Production and Health*, 2019. [Online]. Available: http://www.fao.org/ag/againfo/themes/en/meat/home.html. [Accessed: 20-Sep-2019]
[2] T. McDougal, "Insects as food and feed – the legal perspective," *Poultry world*, 2018. [Online]. Available: https://www.poultryworld.net/Health/Articles/2018/5/Insects-as-food-and-feed--the-legal-perspective-289064E/. [Accessed: 24-Nov-2018]

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