INSECTA 2025

International Conference



Book of Abstracts

14th – 15th October 2025

Magdeburg, Germany

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INSECTA 2025 – From Science to Business, From Vision to Market

Welcome to **INSECTA® 2025!**
On October 14–15, 2025, the international insect industry gathers in Magdeburg for the **10th edition** of this unique conference – hosted by ÖHMI Analytik GmbH.

What began in 2015, when PPM, an industrial research company emerged as a spin-off from ÖHMI, organized the first national INSECTA in Magdeburg, has since evolved into a leading international platform for **science, business, and investment in the insect economy**.

Over the past decade, insects have grown from a niche innovation into a fast-developing global industry. Today, they stand at the heart of new business models and investment strategies – from sustainable animal feed and human nutrition to cosmetics, biobased materials, and circular economy solutions. INSECTA has accompanied this journey from the beginning and continues to be the place **where science meets business, and vision meets market**.

This year, our focus is clear: **scaling, investing, and innovating.**
Key themes include:

- Scalable production and processing technologies for cost-efficient growth
- Regulatory frameworks shaping European and global market access
- Insects as resources for feed, food, cosmetics, and non-food applications
- Automation, digitalization, and machine learning as drivers of competitiveness

An essential part of this journey is **food analytics**. From allergen detection and food safety testing to nutritional profiling and health assessments, analytical expertise builds trust, ensures compliance, and opens new markets. At ÖHMI, together with our partners, we are proud to highlight how **science-based quality assurance** supports the success of the entire insect industry.

Our venue this year, the **Chamber of Industry and Commerce (IHK) Magdeburg**, represents more than 53,000 businesses across the region and celebrates its 200th anniversary in 2025. It is a powerful symbol of **entrepreneurship and innovation** – an ideal stage for forward-looking discussions about sustainable growth.

We warmly thank our partners, sponsors, and supporters for making INSECTA 2025 possible. And above all, we thank **you – the participants**. Your ideas, expertise, and investments continue to shape insects into a global success story.

Let us use these two days to **connect, collaborate, and create the future of the insect industry together.**

Dr Thomas Piofczyk, Dr Katharina Haupenthal Magdeburg, October 2025

Organizing Team

Dr Thomas Piofczyk

Dr Katharina Haupenthal

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The VDI is an association for technically and scientifically active people (VDI: Association of German Engineers) and is one of the largest technically oriented clubs and associations in the world.

The VDI Magdeburger Bezirksverein supports the INSECTA conference since 2015 and grants the “VDI Best Young Scientists Presentation Award” every year. It is divided into 6 district groups and many thematically different working groups and has offers for all ages. VDI Magdeburger Bezirksverein is organised by voluntary works.

The VDI Magdeburger Bezirksverein is supported in its work by numerous companies in the region and forms an important network and the VDI is also international networked.

Also VDI Magdeburger Bezirksverein has a sponsorship award for students at the universities in Magdeburg in every year and the Gruson plaque of honor for members who deserved in the technically development and the work of VDI Magdeburger Bezirksverein Magdeburg.

More information can be found at homepage:

https://www.vdi.de/ueber-uns/vor-ort/bezirksvereine/magdeburger-bezirksverein

The Magdeburg Chamber of Industry and Commerce: Your partner for the regional economy.

The Magdeburg Chamber of Industry and Commerce (IHK) is a strong partner and indispensable voice for the regional economy. It represents around 53,000 tradespeople across the entire IHK district from the Altmark to the Harz mountains. The vast majority of these members are small and medium-sized enterprises, which form the backbone of the regional economy. Membership of the IHK is a direct result of the law and includes all natural persons as well as partnerships and corporations that have registered a business - with the exception of craft businesses.

The legal mandate of the IHK Magdeburg rests on three main pillars: the representation of economic policy interests, the performance of sovereign tasks and service for the regional economy. The IHK is actively committed to promoting the commercial economy by bundling its interests and representing them in politics and administration. At the same time, it efficiently fulfills tasks assigned by the state and offers a wide range of services that benefit the entire economic area as well as directly supporting individual companies.

International Platform of Insects for Food and Feed

IPIFF, the International Platform of Insects for Food and Feed, is an EU non-profit organisation which represents the interests of the insect production sector towards EU policymakers, European stakeholders and citizens. Composed of 56 members, IPIFF promotes the use of insects for human consumption and insect-derived products as a top-tier source of nutrients for animal feed.

Beekenkamp: https://www.beekenkamp.nl/en/

INSECTA 2025
Keynotes

Mapping Insect Performance: Beyond the Reference Genome

Christine J Picard[1]
[1] *Indiana University Indianapolis, Indianapolis, Indiana USA*
[2] *NSF Center for Insect Biomanufacturing and Innovation (CIBI), USA*

Corresponding author: cpicard@iu.edu

Insects are rapidly gaining traction as sustainable sources of protein for feed and food, yet optimizing their production requires a deeper understanding of the genetic architecture underlying key traits. This presentation will highlight advanced bioinformatic approaches—particularly pangenomics, transcriptomics, and comparative genomics—that enable robust correlations between genotype and phenotype in insect species. Pangenomic frameworks allow researchers to capture the full spectrum of genetic diversity across populations, revealing structural variants and accessory genes linked to traits such as growth rate, nutrient composition, and environmental resilience. Coupled with high-throughput sequencing and functional annotation pipelines, these tools provide a scalable and reproducible foundation for trait discovery and strain improvement. Case studies from black soldier fly (*Hermetia illucens*) and yellow mealworm (*Tenebrio molitor*) will illustrate how integrative genomic analyses are driving innovation in breeding, regulatory compliance, and industrial scalability. By leveraging the power of bioinformatics, the insect biotechnology community can accelerate the development of high-performance strains tailored for diverse production systems and global markets.

Not all insects taste like nuts – sensorial properties of edible insects and products made thereof

Nils Th. Grabowski, Madeleine Plötz

Institute for Food Quality and Food Safety, University of Veterinary Medicine Hannover, Hannover, Germany

Corresponding author: Nils.Grabowski@tiho-hannover.de

The main reason to consume any given foodstuff is its palatability. Taste development is a combination of biological (genetical traits, physiological processes), social (socialization and enculturation), and individual factors over time, leading to a personal set of preferred and rejected foods. Over one's lifespan, these preferences may also change, due to multiple reasons, making food palatability a complex matter, adding to the many factors of actual food choice.

Palatability is also the main reason for traditional entomophagy worldwide. Over the millennia, recipes have been developed and adjusted to make insects tasty dishes. In non-traditional entomophagous areas such as the Western cultures, nutrition and sustainability have been used as main purchasing incentives. In Germany, complete insects have initially been offered as (freeze)dried, somewhat spiced and roasted snacks and ground insects in energy bars or insect pasta, but with limited commercial success. Dried and ground insects lose their (dreaded) shape but also a lot of rheological properties. In the last years, more complete pre-processed foods have been placed on the market, e.g. chopped insects in stews, opening the culinary potential these animals have.

When asked about the taste, "like nuts" has been repeated like a mantra in the media, but this is only part of the truth. Sensory specialists grant specific sensorial profiles to each insect species they taste, and it is to be expected that each of approx. 2,000 to 3,000 species of edible insects has its own sensorial profile, just as every type of fruit, vegetable, cheese or sausage has, due to its unique chemical composition. With that in mind, products made of them are also prone to taste different because of the interaction of chemical composition and processing. However, some traits do not seem to vary that strongly and can be traced along the range of products, e.g. a distinctive, darker colouration in bakery products containing insects.

Strategies to increase the acceptance of edible insect in areas with no entomophagous tradition like Europe should also emphasize culinary art. Taste is a strong argument to establish novel foods as was seen in the case of the many foreign cuisines that enrich the traditional ones. On one hand, foreign traditional recipes with insects can be adjusted to local taste preferences. One of those adjustments may be dissolving the insect body into a more neutral form, e.g. balls or patties. On the other hand, traditional local recipes without insects be adjusted in a way that they include them. In any way, turning edible insects into more than high-processed foods is returning to the roots of entomophagy.

Edible insect farming as a circular solution to agrifood system challenges: Lessons from Africa

Chrysantus M. Tanga

International Centre of Insect Physiology and Ecology - Icipe

Corresponding author: ctanga@icipe.org

INSECTA 2025
Lectures
(Session 1-9)

Introduction to IPIFF & the EU insect sector: Main policy endevours and latest Regulatory developments

Franziska Schindler[1]

[1] *International Platform of Insects for Food and Feed (IPIFF) member Hermetia Baruth, Baruth/Mark, Germany*

Corresponding author: f.schindler@hermetia.de
steven.barbosa@ipiff.org

IN/OUT of the box: truly three-dimensional farming system for *Tenebrio molitor* (L., 1758)

Stefano Magnaghi, Emmanuel Charrois, Félicie Houbre, Quentin Nivet, Fayçal Ounnas

ENTOINNOV

Email: contact@entoinnov.com

In most current insect farming systems, the fundamental rearing unit is the plastic tray. These trays are stackable, allowing for vertical space utilization and effectively enabling three-dimensional farming. This approach increases production without expanding land use, offering a strong climate-friendly argument. However, the space between trays remains unused, and the sheer number of rearing units—often thousands or millions—leads to significant system complexity. This hampers traceability, quality control, and labor efficiency, ultimately increasing production and retail costs.

In the context of *Tenebrio molitor* farming, ENTOINNOV has developed a solution to these challenges: a bioreactor that functions as a fully automated incubator. Eggs and feed are introduced, and after two weeks, micro-larvae of approximately 5 mg (2nd–3rd instar stage) are produced with a hatching rate of 95%.

Compared to conventional tray-based systems, this bioreactor requires 10 times less surface area and 30 times less volume to produce the same quantity of micro-larvae. Automation is driven by a network of real-time sensors that monitor both population development and environmental parameters. A continuously evolving AI algorithm synthesizes these data to make dynamic, targeted adjustments to the environmental conditions, ensuring they align with the insects' developmental needs. Developmental stages are identified through visual inspection systems, enabling a responsive, stage-specific environmental management strategy.

This invention represents a technical and scientific advancement in the field of insect farming. It begins to account for the causal relationships between components within the rearing medium (e.g., substrate), the surrounding free air space, and—critically—the "*pelagos"*: the interface between these two zones. This transitional space plays a key ecological and behavioral role, often serving as a preferred zone for the insects during specific life stages.

Optimizing Rearing Substrates for Black Soldier Fly Larvae: Hydration and Macronutrient Effects

Lotte Frooninckx[1], Laurens Broeckx[1], Siebe Berrens[1], Sarah Goossens[1], Carmen ter Heide[1], Ann Wuyts[1], Marième Dallaire-Lamontagne[2] and Sabine Van Miert[1]

1Centre of Expertise Sustainable Biomass and Chemistry, Campus Geel, Thomas More University of Applied Sciences, Kleinhoefstraat 4, 2440 Geel, Belgium
[2]Département des Sciences Animales, Faculté des Sciences de L'Agriculture et de L'Alimentation, Université Laval, 2425 rue de l'Agriculture, Québec, QC G1V 0A6, Canada

Presenting author: sabine.vanmiert@thomasmore.be

As the global population continues to grow, so does the demand for sustainable protein sources. Black soldier fly (BSF) larvae present a promising solution by converting organic waste into high-quality protein suitable for animal feed. This study aims to optimize BSF larval growth by investigating the effects of hydration and feed macronutrient composition on bioconversion efficiency.

The first step involved determining the ideal dry matter (DM) content by comparing the standard 30% DM with substrates hydrated to their maximum water holding capacity (WHC). WHC represents the amount of water a substrate can retain without leaving free water. To determine this, substrates were saturated with excess water, centrifuged to separate phases, and the unbound water was removed by decanting. The remaining mass reflects the water held within the substrate matrix. Using the WHC method significantly improved larval survival rates ($p = 0.0006$) and was therefore adopted in subsequent experiments.

Artificial diets composed of chicken starter mash (CSM), sunflower oil, wheat starch, casein powder, and cellulose powder were used to evaluate the influence of macronutrients on bioconversion. Fractional factorial designs varied carbohydrate (CHC), fat, and protein levels, revealing significant main, interaction, and quadratic effects. A predictive model identified the optimal growth at 23.48% protein, 20.64% carbohydrates, and 1.91% fat (on a dry matter basis). Simulations further showed that lower fat and carbohydrate contents required higher protein levels to maintain efficiency, with optimal crude protein concentrations ranging from 15.23% to 25.50%.

Process chain development for utilisation of agricultural by-products as insect feed

Harald Wedwitschka[1], Dr. Franziska Schindler[2], Jenny Wagner[3], Dr. Alina Culetu[4], Prof. Dr.-Ing. Stefan Streif [5], Dietmar Ramhold[6]

[1] DBFZ Deutsches Biomasseforschungszentrum gemeinnützige GmbH, Torgauer Straße 116, 04347 Leipzig, Germany

[2] Hermetia Baruth GmbH, An der Birkenpfuhlheide 10, 15837 Baruth/Mark, Germany

[3] Frankenförder Forschungsgesellschaft mbH, Potsdamer Straße 18a, 14943, Luckenwalde, Germany

[4] IGV Institut für Getreideverarbeitung GmbH, Arthur-Scheunert-Allee 40-41, 14558, Nuthetal, Germany

[5] Technische Universität Chemnitz, Straße der Nationen 62, 09107, Chemnitz, Germany

[6] ISF GmbH, Wiesenweg 32, 23812, Wahlstedt, Germany

Corresponding author: harald.wedwitschka@dbfz.de

Insect protein is a successful product, marketed as an animal feed in the pet, livestock and aquaculture sectors. It is also a suitable source of protein for human nutrition. However, at present, the insect food market is still niche, with only a few long-established products on the market. Consumer acceptance of insect foods is a vital component for the growth and strengthening of this market sector. The development of innovative and sustainably produced insect protein products can be a key to this. One approach worth considering is the use of feed materials that do not compete with those used for conventional animal feed and food products, and which are sourced regionally. The utilization of inexpensive agricultural by-products as feed materials for insect production has the potential to contribute to an economically viable and environmentally friendly production process.

Sugar beet leaves and Italian ryegrass were tested on a laboratory scale as insect feed and the entire process chain was investigated, from storage and pre-treatment to feeding and post-processing. In contrast to cereal grain meal, which is currently frequently used as a feed material, the tested plant materials require feedstock conservation. An experiment was conducted to test the efficacy of ensiling with and without additives as a storage method. Further the new feedstock requires mechanical pretreatment for optimal feed uptake and product separation, due to the presence of larger particles and higher fibre content. Different chopping and grinding techniques were used to reduce the particle size. The various feed variants were then subjected to insect feeding trials, after which the product yields were determined.

Insect biorefinery: transforming Cat3 food waste into biocompounds and biogas

Franziska Schindler[1], Simon Guilbaud [1], Peter Katz[1]
[1] *Hermetia Baruth GmbH*

Corresponding author: f.schindler@hermetia.de

Despite ongoing reduction efforts, large quantities of discarded food remain underutilized. Although these waste streams still contain valuable nutrients, their use as animal feed is prohibited under EU legislation, as they are partly classified as category 3 animal by-products. As a result, they are predominantly treated via composting or biogas plants, which offer limited efficiency in resource recovery.

The InBiRa project investigated black soldier fly larvae (*Hermetia illucens*) as an alternative valorization pathway under special authorization. Various supermarket and canteen waste streams were tested in 10 kg laboratory scale trials. Canteen waste was processed by the larvae with a feed conversion ratio (FCR) of 3.56 ± 0.06 ($n = 3$). When fed various supermarket waste mixtures, the FCR ranged from 4.98 ± 0.26 to 3.73 ± 0.36 ($n = 3$), depending on the specific composition. Mixtures containing dairy products resulted in more efficient feed conversion compared to those composed of bakery products and fruits & vegetables. The highest efficiency was observed in mixtures including meat and fish. In contrast, the lowest utilization was recorded with organic household waste including green cuttings, with an FCR of 14.07 ± 2.9 ($n = 2$).

Selected mixtures were further tested on a pilot scale (1,000 kg) to evaluate for larval growth, feed conversion, and fatty acid profiles. Canteen waste, both alone and substituted with 10 % and 20 % biowaste, was processed by the larvae with an FCR ranging from 4.31 and 5.08. The supermarket returns were utilized with an FCR of 4.64. In addition, the frass generated during rearing was analyzed for its biogas potential and compared to that of the original feed mixtures, allowing an assessment of energetic valorization. The biogas potentials of canteen waste and the corresponding frass fraction were approximately 705 ml / g oTS and 599 ml / g oTS, respectively.

Moreover, a chitin mass balance of by-products of larval production such as exuviae, pupal skins, dead flies was established to identify the most potential by-product stream for chitin recovery.

The results underline the potential of insect biorefineries to sustainably convert unauthorized food wastes into valuable technical compounds while offering an alternative or complementary route to conventional biogas production.

Microbial Enhancement of Manure for Black Soldier Fly Larvae (BSFL) Digestion

Branden Pierce[1], Amber E. MacInnis[2], Dimitra Papantoniou[2], Anjel M. Helms[2], Jeffery K. Tomberlin[2], and Heather R. Jordan[1]

[1] Department of Biological Sciences, Mississippi State University, Mississippi State, Mississippi, USA
[2]Department of Entomology, Texas A&M University System, College Station, Texas, USA

Corresponding author: jordan@biology.msstate.edu

Large-scale animal agriculture generates substantial waste, prompting research into sustainable mitigation strategies such as bioconversion by black soldier fly (BSF), *Hermetia illucens*, larvae. While black soldier fly larvae effectively reduce manure, there is a critical knowledge gap regarding the composition of their gut and frass microbiomes when reared on cattle manure, and how microbial amendments influence these communities, especially concerning pathogen reduction and antibiotic resistance. This study investigated microbial community dynamics and the expression of virulence and antimicrobial resistance genes in black soldier larvae reared on dairy manure. Dairy cattle manure was amended with either *Rhodococcus rhodochrous*, *Paenibacillus polymyxa*, a combination of both, or a sterile control. Following larval growth, samples of initial manure, larval guts, and frass were collected. Total DNA and RNA were isolated from these samples for next-generation sequencing. Bioinformatic analysis of raw paired reads employed a Kraken/Bracken pipeline to classify microbial taxonomy and generate Bayesian estimations of relative abundance for the microbial communities. Furthermore, an in-depth exploration of virulent genes and metabolically active antimicrobial resistance genes was conducted, specifically emphasizing their presence and expression within bacterial species identified in the frass and larval samples. This comprehensive approach characterizes potential pathogenicity and assess the safety of BSF reared on manure, evaluating the efficacy of bacterial amendments in mitigating associated risks for downstream applications.

Exploring Alternative Protein Sources: Optimizing Mealworm Cultivation with Impact of Substrate Macro-Nutrients on Larval Growth

Vinzenz Klapper[1], Chris Henze[1] and Marc Mauermann[1]
[1] *Fraunhofer Institute for Process Engineering and Packaging IV, Dresden, Sachsen*

Corresponding author: vinzenz.klapper@ivv-dd.fraunhofer.de

Mealworm larvae (*Tenebrio molitor* Linnaeus, 1758) are increasingly recognized as a sustainable protein source, yet the influence of feed composition on their growth and rearing efficiency is not fully understood. This study evaluates how macronutrient profiles of a broad range of food-industry by-products affect larval development, survival, and time to pupation. Ten substrates—ranging from poultry feed and brewer's yeast to vegetable press cakes—were offered either in their pure form or as 50 % mixtures with oat bran. Each diet was provided under controlled environmental conditions, and larval weight, mortality, and developmental stage were monitored at weekly intervals over a six-week period. Substrate carbohydrate, protein, and lipid contents were determined in duplicate by accredited laboratory procedures (measurement uncertainty 4 %, 95 % confidence level). By comparing single-component diets to nutritionally blended variants, the work seeks to identify practical feed formulations that balance waste valorization with insect performance. The findings are expected to inform both commercial mealworm production and circular-economy strategies by demonstrating how targeted use of by-products can enhance feed efficiency while reducing reliance on conventional ingredients.

High hydrostatic pressure, pulsed electric field, and microfiltration for mild processing of edible insects

Catriona M.M. Lakemond[1], Luc J.H. Sweers[1,2], Julia K. Keppler[2], M. Mishyna[1], Remco Boom[2], Vincenzo Fogliano[1]

[1]Food Quality and Design Group, P.O. Box 17, 6700 AA Wageningen, The Netherlands
[2] Food Process Engineering Group, Wageningen University, P.O. Box 17, 6700 AA Wageningen, The Netherlands

Corresponding author: Catriona.Lakemond@wur.nl

Insects need processing to produce insect food or insect semi-finished products with required qualities. Heating is a main technological process in the food industry used for reasons of preservation and safety. Thermal treatments also cause protein denaturation, with accompanying undesired changes in protein functionality, i.e. lowering protein solubility. Alternatives for thermal treatments, including high-hydrostatic pressure (HHP), pulsed electric field (PEF), and microfiltration are studied limited for insects. Therefore, insect processing using HHP, PEF, and microfiltration was investigated to inactivate micro-organisms without affecting protein techno-functional properties negatively. Lesser mealworm larvae (*Alphitobius diaperinus*) and adult house crickets (*Acheta domesticus*) were studied.

HHP treatment of soluble protein fractions at pH 3 was effective for microbial inactivation at 400 and 600 MPa. It affected protein structure less than blanching at 90°C, as linked to retaining emulsification properties for both insect species. Opposite to blanching, HHP increased protein solubility at pH 7 up to 22%. Foamability and gelation were not influenced negatively by HHP or blanching.

PEF treatment of insect slurries at pH 3 at low intensity (20 kJ/L) did not affect protein conformation, protein solubility, and endogenous protease activity. However, it was not effective for substantially lowering microbial load, while treatment at high intensity (>150kJ/kg) was. High intensity PEF went along with a temperature increase to 75°C, causing protein denaturation.

Dead end microfiltration of soluble insect fractions at pH 3 and 8 using a 0.2µm polyether-sulfone membrane led to successful microbial removal. Protein recovery in the permeate relative to protein in whole insect was 9-36% depending on pH and insect species. Proteolyses, whether induced by endogenous or added proteases, increased permeate protein recovery linearly. Foaming capacity of permeates was increased compared to that of the pre-filtrates to values surpassing those of whey protein isolates.

In conclusion, protein functionality and native protein structure is generally kept better using mild processing methods as compared to blanching. Their potential for usage needs to be aligned with the desired properties for the specific food application.

Processing of *Tenebrio molitor* larvae prior to food uses

Ondřej Pospíšil[1], Kateřina Šebelová[1], František Beneš[1], Anežka Kopecká[2], Martin Kulma[3], Lenka Kouřimská[2], Jana Hajšlová[1]

[1] *University of Chemistry and Technology Prague, Department of Food Analysis and Nutrition, Praha, Czech Republic*

[2] *Czech University of Life Sciences Prague, Department of Microbiology, Nutrition and Dietetics, Praha, Czech Republic*

[3] *Czech University of Life Sciences Prague, Department of Zoology and Fisheries, Praha, Czech Republic*

Corresponding author: kourimska@af.czu.cz

Good farming practices and suitable feed are undeniably important factors that influence the quality of the edible insects. However, it is often underestimated that the method of killing also influences the final composition and nutritional quality of the edible insects. The aim of this study was to critically evaluate the effect of alternative killing approaches (20 min in boiling water or freezing to -18 °C) on the spectrum of metabolites (molecules up to 1200 Da) in the final product. Lyophilized samples, including insect broth obtained by boiling insects, were examined by untargeted screening (fingerprinting) using ultra-high performance liquid chromatography coupled with high-resolution tandem mass spectrometry (U-HPLC-HRMS/MS). Advanced statistical methods including multivariate statistical methods were included for evaluation.

The data showed that insect samples killed by freezing contained more polar metabolites compared to those killed by boiling, because some of these compounds were transferred to the broth. These were mainly amino acids, short peptides or phenolic compounds. For example, the content of the compound tentatively identified as 2-acetamido-3-(4-methoxyphenyl) propionic acid was significantly higher in the freeze-killed insects than in the boiling-killed samples. The analyses confirmed the transfer from the insect biomass to the boiling bath. The loss of polar compounds, led to an increase in the relative abundance of triacylglycerol's and other lipophilic compounds in the boiled insects. The results of the study may contribute to optimizing the processing of edible insects for food purposes.

Acknowledgment: This output is part of the project The comprehensive laboratory strategy for identification of insect species intended for human consumption and the production of processed animal protein, authentication of insect-based foods, supported by MZe, QK23020101.

Natural deep eutectic solvents as green pathway to extract protein and chitin fraction from *Tenebrio molitor* beetles

Nuno Muñoz-Seijas[1,2], Helena Fernandes[1], Francisco Soto-Beltrán[1], José Manuel Domínguez[1]; José Manuel Salgado[1]

[1] *University of Vigo, Campus Auga, Industrial Biotechnology and Environmental Engineering Group "BiotecnIA", Chemical Engineering Department, 32004 Ourense, Spain*

[2] *Laboratorio Cifga, Rúa do Vidro, 117 D, Parcelas 3-6, 27003 Lugo*

Corresponding author: nuno.munoz@uvigo.gal

Tenebrio molitor beetles (TMB) cannot be directly used for food and feeding purposes since the strong bond between protein and chitin hinders digestibility. Nonetheless, both fractions can be separated resorting to eco-saving practices. Natural deep eutectic solvents (NADES) are promising mixtures of two or more biodegradable compounds that can replace harmful chemicals that are commonly used in separation of protein and chitin. In this work, different mixtures of NADES were initially studied to assess which solvents enhanced the protein extraction from TMB, studying the effect of temperature, time and water addition. The high protein extraction value was achieved using a NADES formed with choline chloride and oxalic acid (34.1%) followed by betaine and urea (32.8%). The optimization of the NADES-based extraction allows achieving a protein hydrolysis of 81.5%, using betaine and urea at 1:2 molar ratio, 30% of water, at 90 ºC, for 3 h. The protein obtained in this process showed an outstanding *in vitro* digestibility of 93.8%. After, a scale-up of extraction was carried out, achieving 91.5% of protein hydrolysis when using 50 g of TNB (dry basis). Using a NADES formed for betaine and urea at optimal conditions was highly efficient in separating protein and chitin from TNB, obtaining a protein fraction with high digestibility, foreseeing the promising applicability of this approach to improve the sustainability of food sector and of insect industry.

Production of mealworm (*Tenebrio molitor*) oil by pressing

Geert R. Verheyen, Sarah Goossens, Sabine Van Miert
Thomas More University of Applied Sciences, Center of Expertise Sustainable Biomass and Chemistry, Kleinhoefstraat 4, 2440 Geel, Belgium

Corresponding author: geert.verheyen@thomasmore.be

Mealworms (*Tenebrio molitor*) are amenable to large scale farming under sustainable conditions. When implemented for food and feed, mealworms are often processed, thereby separating the oil from the other fractions (protein and chitin). The resulting oil is a by-product which can be used in other applications.
Our previous research has focused on the extraction of mealworm oil using ethyl acetate as a solvent. This approach has the capacity to extract most of the oil, but drawbacks include the use of a solvent and the implementation of time-consuming steps (extraction, filtering, solvent recuperation). Within the PINSO-project, we performed a Life Cycle Analysis of our oil production process. Here we report results of this LCA and show that solvent extraction has a large impact on kg CO_2-equivalents produced and that alternative techniques should be explored to improve the sustainability of the process.
As an alternative to solvent extraction, we describe the production of mealworm oil by mechanical pressing and subsequent oil refining. We evaluate the effect on oil yield and quality.

Drawn to Eat: A Co-created Comic on Insects and Entomophagy

Martina Sartoni[1], Matteo Orlando[2], Giuliana Parisi[3], Carlotta Cataldi[4], Elena Tricarico[2], Giulia Secci[3], Roberta Nuvoloni[1], Francesco Riccioli[1]

[1] Department of Veterinary Science, University of Pisa, Pisa, Italy
[2] Department of Biology, University of Florence, Florence, Italy
[3] Department of Agriculture, Food, Environment and Forestry, University of Florence, Florence, Italy
[4] Freelance in International Graphic Recorder & Facilitator, Barcelona, Spain

Corresponding author: Martina Sartoni (martina.sartoni@vet.unipi.it)

By 2050, the global population is expected to reach 9 billion, increasing pressure on food systems and the environment. Edible insects offer a sustainable protein source, as they can be reared on agri-food waste and by-products, supporting circular economy principles. Their adoption could reduce reliance on conventional resources and contribute to food security. However, consumer acceptance remains a major barrier, especially in European countries like Italy, where strong cultural traditions and feelings of disgust limit willingness to approach and adopt insect-based products. Sharing scientific knowledge and promoting educational activities on sustainability, biodiversity, and healthy eating habits during childhood can be powerful tools to foster trust with new foods, such about edible insects, and their potential uses. Narrative tools such as comics and picture books enhance motivation and engagement in science education, especially on topics like evolution and biodiversity. Visual storytelling also supports behavioral change, for example by helping children accept unfamiliar foods. These practices reflect social learning principles and highlight the strategic role of visual media in promoting sustainability and addressing complex societal challenges. The Italian K-EAT (Know and Eat) project, funded under the PRIN PNRR 2022 program, aims to spread scientific knowledge through narrative approaches to reduce consumer resistance. As part of the initiative, we co-developed a comic with graphic recorder Carlotta Cataldi to introduce insects as food and feed sources, highlighting their ecological role and their contribution to sustainable food systems and environmental health. The development process followed a structured four-step workflow: (i) Development of the conceptual foundation with the research team and the graphic recorder. In this phase, the recorder conducted an in-depth conversation with the researchers to understand the core concept and project's scope, define the core message we wanted to communicate to young readers, and gather the key content to be included in the comic; (ii) One-on-one discussion with a researcher, this step served to refine the concept further and identify creative solutions to potential narrative challenges; (iii) Co-creation of the storyboard, the visual recorder presented an initial version of the storyboard, which was then revised and expanded by the research team in a collaborative process, leading to the final version; (iv) Development and revision of the visual draft, a preliminary visual version of the comic was shared and iteratively revised until the final format and narrative was completed. The concept behind the comic was carefully developed to introduce children (ages 8–10) to edible insects, their

ecological roles, and potential as sustainable food sources; designed as a black-and-white, single-page A4 comic, it invites children to engage creatively by coloring, while gently introducing unfamiliar concepts. We intentionally avoided emphasizing the negative aspects of traditional protein production; instead, we focused on the value of insects in ecosystems and food systems. The storyboard underwent several iterations to balance scientific accuracy with narrative appeal, steering away from overly didactic formats, and its final version is presented in **Figure 1**. The comic concludes with open-ended questions to stimulate reflection at school and at home, encouraging family discussions. The co-creative process highlighted the importance of interdisciplinary collaboration in creating accessible educational tools. The classroom distribution of the comic sparked children's curiosity and shifted their perception of edible insects, with families engaged through take-home materials to encourage broader discussions on sustainable food. Alongside the comic, the K-EAT project organized workshops and other activities to deepen knowledge of insects and entomophagy. Using storytelling and narratological practices, the project fostered empathy, critical thinking, and meaningful learning, while promoting sustainable nutrition and sharing results with diverse audiences.

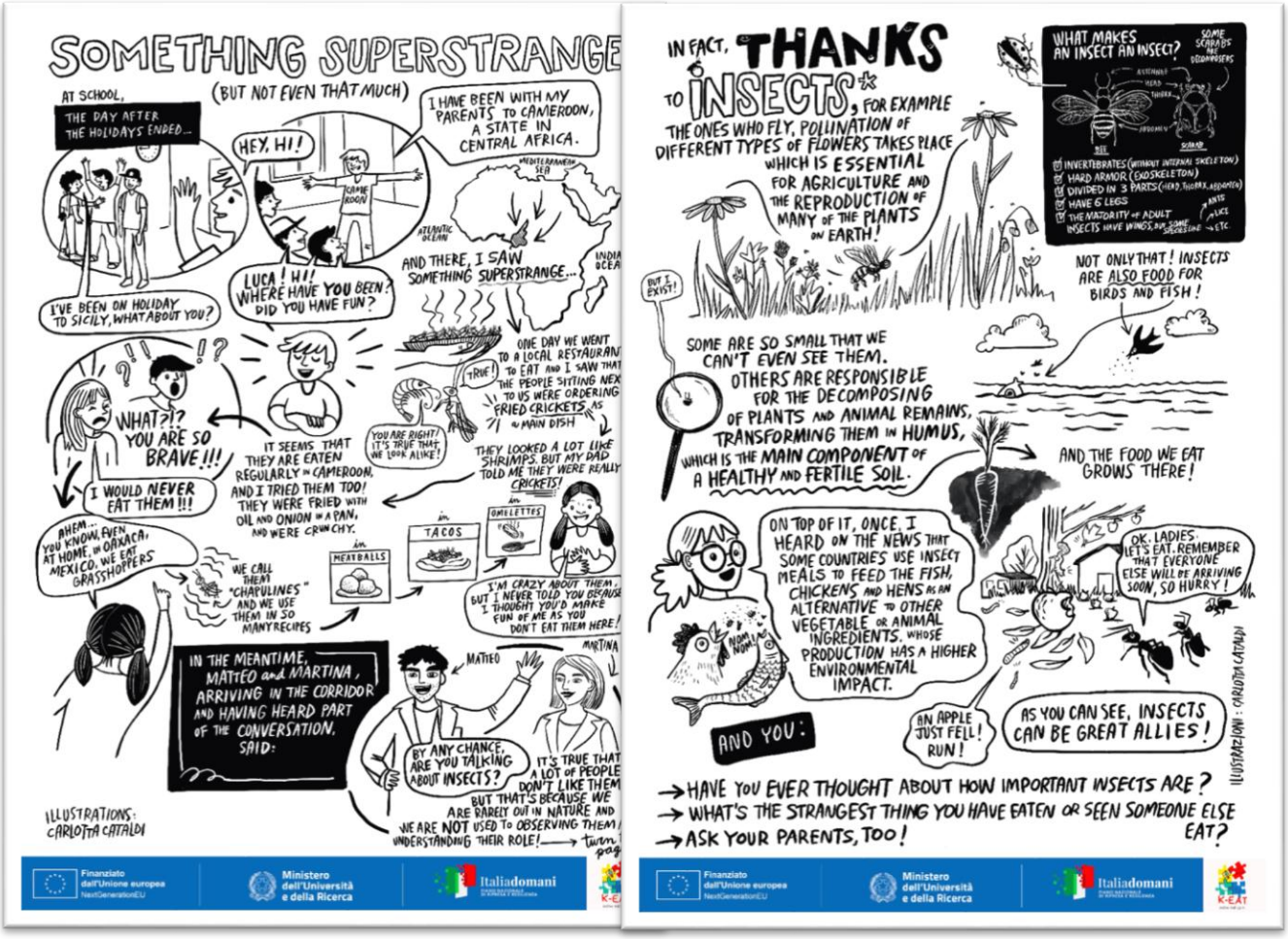

Figure 1. The co-created comic on insects and entomophagy (*source, KEAT project)*

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Beyond Western noses – farming arthropods with local importance

Nils Th. Grabowski, Madeleine Plötz

Institute for Food Quality and Food Safety, University of Veterinary Medicine Hannover, Hannover, Germany

Corresponding author: Nils.Grabowski@tiho-hannover.de

There are approx. 1,180,000 species of recent arthropods. Of those, some 2,000 to 3,000 insect, several hundred crustacean, approx. 40 arachnid, and ten myriapod species are known to be edible. Of those, only a minor percentage is reared commercially for food, e.g. approx. 20 to 30 insect, 60 crustacean, and five to ten arachnid species, meaning that most edible arthropods are still harvested from the wild, just as with edible vertebrates. This is due to many factors, e.g. the feasibility to satisfy a given species' life requirements, its life cycle and ethology, its relevance as a food, the socio-cultural background of farmers, a market that justified the implementation costs etc.

From a global view, commercial insect farming for food and feed is centred on two fly (*Hermetia illucens*, *Musca domestica*), several cricket (*Acheta domesticus*, *Gryllodes sigillatus, Gryllus assimilis*, *G. bimaculatus*), grasshopper (*Locusta migratoria*, *Schistocerca gregaria*), and darkling beetle (*Tenebrio molitor*, *Alphitobius diaperinus*, *Zophobas atratus*) species, along with *Apis mellifera* and *Bombyx mori*. However, there are many other species that meet general farming requirements (i.e. fully controllable life cycle, ecological and ethological flexibility to deal with captivity, and a stable market to cope with initial high implementation costs). Some of them are already reared commercially.

While there is a tradition of rearing some species like stingles bees (Meliponini spp.), non-*Bombyx* silk moths, cochineal (*Dactylopius coccus*) or cheese mites (*Tyrophagus casei*), some other taxa with local relevance have been tested successfully regarding their farming potential, e.g. giant water bugs (Belostomatidae spp.), termites (e.g. *Macrotermes* spp.), palm weevils (*Rhynchophorus* spp.), scarab (Scarabaeidae spp.) and huhu beetles (*Prionoplus reticularis*), ants (e.g. *Oecophylla* spp.) or scorpions (e.g. *Heterometrus* spp.). Just as with any other reared species, farming them must adapt to their particular needs. In some cases, rearing is basically possible, but discouraged because of biosecurity issues in a given region, e.g. palm weevils and termites in Europe. Other taxa are popular food insects, but rearing would be much more labour and cost-intensive than harvesting them from the wild, e.g. dragonflies (Odonata spp.), shield bugs (Pentatomidae spp.), territorial crickets living in subterranean burrows (e.g. *Brachytrupes* spp.) or shore flies (*Ephydra* pp.).

Establishing this kind of farm is a particular challenge, as many aspects, from biology and veterinary aspects to processing, food safety, legal framework, consumer acceptance, biosecurity etc. must be taken into consideration before starting it. However, this is how any farming resp. aquaculture activity started eventually, from the beginnings of domestication 15,000 years until today.

How safe are edible insects? Pesticides residue analysis as a key to safe and sustainable insect production

Anna Büttner[1,2], Björn Hardebusch[1], Karl Speer[2]

[1] *European Union Reference Laboratory for Pesticides in Food of Animal Origin and Commodities with High Fat Content (EURL-AO) Freiburg, Bissierstr. 5, D-79114 Freiburg, Germany*
[2] *Technical University Dresden, Food Chemistry, Bergstraße 66, D-01069 Dresden, Germany*

Corresponding author: anna.buettner@cvuafr.bwl.de

Edible insects are increasingly recognized as a sustainable protein source of the future – rich in nutrients, resource-efficient in production, and versatile in application. But how safe are they for human consumption? Since insects are generally consumed whole, contamination with pesticides or other residues from feed or the environment become a critical issue. These analyses are therefore essential to identify potential risks at an early stage and to ensure the safe integration of insects into the food chain.

This study combines two analytical approaches for comprehensive pesticide residue assessment in insect samples:
For lipophilic substances such as pesticides and polychlorinated biphenyls (PCBs), a fully automated method was developed that integrates extraction, fat determination, clean-up via gel permeation chromatography (GPC) and solid-phase extraction (SPE) on the LCTech FREESTYLE system, followed by GC-MS/MS analysis. For polar pesticide residues, a modified QuEChERS approach with subsequent LC-MS/MS analysis was applied.

Both methods were successfully validated for the quantitative determination of 93 pesticide analytes in insect matrices and are suitable for extended screening of over 400 analytes, enabling broad-spectrum pesticide detection.

This study presents analytical approaches, validation results, and initial routine testing experiences, including challenges encountered during implementation. These findings contribute significantly to the safety assessment and standardisation of insects as food. The aim is to raise awareness of potential risks along the production chain – particularly with regard to feed quality – and to highlight critical points for further monitoring and regulation.

The dietary properties of Black-Soldier-Fly-Larvae used as the sole source of dietary protein for mice are attenuated by meal processing

Roee Gutman[1,2]

[1] *MIGAL-Galilee Research Institute, Laboratory of Integrative Physiology, Kiryat Shmona, Israel.*
[2] *Tel-Hai College, Faculty of Sciences and Technology, Department of Animal Sciences, Upper Galilee, Israel.*

Corresponding author: roeegu@telhai.ac.il.

The black soldier fly (*Hermetia illucens*) instar five larvae (BSFL5) are known to contain complete protein and have been approved for use as a dietary protein for animal feed. However, the protein-chitin (fiber) ratio in BSFL5 meal is higher than recommended for human nutrition, and little is known about its ability to support muscle growth in laboratory mice, which are considered animal models for human nutrition. Hence, we aimed to produce defatted BSFL5 meals with regular vs. low cuticle level (*i.e.*, whole meal, WM, vs. LCM), and *in vivo* examine their nutritional properties as a protein source for laboratory mice, compared to the casein-based regular diet (RD). At first, we compared two ways to generate a low-fiber BSFL5-based meal: using a roller grinder, followed by filtration, vs. an oscillating granulator (OG); we chose the OG due to its simplicity. Following defatting, the WM and the LCM showed an amino acid score that enables their use for humans, even for children's nutrition from 6 months of age, as found for casein. Compared to WM, LCM showed a lower fiber level with a higher protein-fiber ratio, and both meals were used as the sole protein source in a mouse study. *In vivo* results showed that, compared to the RD, WM showed similar body weight gain, yet lower lean mass gain, overcompensated by fat mass gain. LCM, however, resulted in a lower weight gain than the other diets, due to attenuation in lean and fat mass gain. Food, energy, and protein intake were higher in WM-fed mice, compared to RD-fed mice, while LCM resulted in lower RD-matching intakes. These results showed that compared to RD, WM resulted in lower conversion efficiencies of food, energy, and protein intake to total and lean mass gain. Reducing the cuticle level did not rescue these lower weight-gain efficacies. These results indicate that, even due to their high cuticle levels, low-fat cuticle-rich BSFL5 meals can serve as the sole source of dietary protein, resulting in an RD-matching weight gain. WM, however, resulted in an altered body composition, with attenuated lean mass gain, and lower weight gain efficiency; hence suggesting an attenuation in protein digestion-absorption-assimilation processes. Reducing the meal's cuticle (fiber) level did not rescue these lower efficiencies. These results highlight the potential of BSFL5 meal as the sole protein source for human nutrition, even without cuticle reduction, and show that meal processing can affect its nutritional properties. Furthermore, they highlight the need for careful evaluation of the digestibility and protein retention efficacy of BSFL5-based meals and the effect of meal processing on these properties.

Challenges and Opportunities of Automation and Artificial Intelligence in Insect Farming

Andreas Herzog[1], Thomas Piofczyk[2], Nils Th. Grabowski[3]
[1] *Fraunhofer-Institut für Fabrikbetrieb und -automatisierung IFF, Gruppe Kognitive Prozesse und Systeme, Magdeburg, Germany*
[2] *ÖHMI Analytik GmbH, Magdeburg, Germany*
[3] *Institute for Food Quality and Food Safety, University of Veterinary Medicine Hannover, Hannover, Germany*

Corresponding author: Andreas.herzog@iff.fraunhofer.de

Insect farming is emerging as a sustainable and resource-efficient solution for alternative protein production, addressing global challenges related to food security, climate change, and circular resource use. Compared to conventional livestock, insects offer high feed conversion efficiency, low greenhouse gas emissions, and the potential to valorise organic by-products. However, large-scale implementation requires reliable, scalable, and controllable production processes. Automation and Artificial Intelligence (AI) are key technologies to meet these requirements and transform insect farming from manual pilot operations into standardized industrial systems.

Future insect farming will rely on automatization to enhance process efficiency, reproducibility, and biosecurity. Camera-based monitoring combined with AI-driven image analysis enables automated counting, growth assessment, and health monitoring. Spectroscopic and hyperspectral systems provide non-invasive insights into feed composition, moisture, and contamination, while acoustic sensors can reveal stress or behavioural changes. Electronic nose technologies detect volatile organic compounds (VOCs) such as ammonia or organic acids, indicating hygiene conditions, overcrowding, or microbial activity. Fusing these multimodal data streams delivers a comprehensive view of biological and environmental dynamics but also poses challenges in calibration, synchronization, and interpretation.

Building on these sensing technologies, AI-supported control systems can dynamically adapt environmental and feeding parameters—such as temperature, humidity, aeration, and illumination—to the insects' developmental stage and physiological state. Predictive models can forecast growth and mortality risks, while reinforcement learning shows potential for adaptive control strategies optimizing energy use, yield, and product quality. Integrating such models with automated actuators enables closed-loop control and self-optimizing production environments.

Despite these advances, challenges remain. Biological heterogeneity and environmental variability demand robust sensor integration and model generalization. The quality and labelling of training data, explainability of AI decisions, and cost–benefit considerations are further barriers to adoption. Moreover, user acceptance and operator training are critical for implementation in existing facilities.

Future developments will focus on self-learning, modular, and scalable systems adaptable to different insect species and rearing conditions. The convergence of automation, AI, and digital agriculture will ultimately enable intelligent, data-driven bio-production systems—positioning insect farming as a vital component of sustainable food systems and smart farming concepts.

Automated Image-Based Quality Assessment of Black Soldier Fly Larvae for Industrial Production

Sai Dheeraj Reddy Tippani[1], Helmut Tödtmann[1], Dominik Ewald[1], Bastian Kubsch[1]
[1] Fraunhofer Institute for Graphical Data Processing, Department of Bioeconomy, Rostock, Germany

Corresponding author: bastian.kubsch@igd-r.fraunhofer.de

The larvae of the black soldier fly (*Hermetia illucens*) are emerging as a promising bio-logical resource for sustainable protein and lipid production across multiple industrial sec-tors. As insect-based bioconversion scales up, there is an increasing demand for robust, objective, and reproducible methods to assess larval quality. This work presents a novel, fully automated, image-based analysis approach designed to contribute towards an industry-wide quality standard for Black Soldier Fly larvae.

The method applies advanced computer vision and machine learning techniques to ac-quire and process visual data, enabling the objective characterization of larval appear-ance and behaviour at batch level. Key quality parameters include colour information, size distribution, and activity levels. These features are extracted and aggregated into interpretable indicators that allow consistent and comparable quality assessments. Preliminary evaluations in controlled and pilot-scale industrial settings show promising performance during production, supporting both the optimization of rearing conditions and the potential for cost reduction and ecological efficiency gains across the sector.

The system is intended for flexible deployment along the production chain, including stages beyond rearing such as transport and storage, and supports integration with existing quality management frameworks, regulatory compliance processes, and Industry 4.0 environments. By providing a standardized, data-driven metric, it facilitates transparency, traceability, and alignment between producers and processors. The present contribution outlines the conceptual design and application scope of the analysis module, with ongoing work focusing on refinement, large-scale integration, and comprehensive industrial validation.

This work introduces a scalable, non-invasive quality assessment tool for Black Soldier Fly larvae, enabling consistent standards and data-driven decision-making across the in-sect production industry.

We thank FarmInsect GmbH for providing access to production facilities for data acquisition and for valuable feedback from an end-user perspective

Bugs in the System: Have the economic and environmental benefits of insect farming been overstated?

Corentin Biteau [1]

[1] Observatoire national de l'élevage d'insectes (National Observatory on Insect Farming), Paris, France

Corresponding author: corentin.biteau@onei-insectes.org

Insect farming has been heralded as a sustainable solution for the food industry, yet recent developments raise questions about its viability. This presentation will examine the significant challenges facing the industry, drawing on recent peer-reviewed studies. Notably, major insect farming companies, such as Ynsect, Agronutris, and Enorm Biofactory, which collectively received over €900 million in investment, are either bankrupt or nearing bankruptcy. Investment in the sector has dropped by two-thirds between 2022 and 2024, and insect meal remains significantly more expensive than alternative protein sources like fishmeal and soymeal.

Furthermore, evidence increasingly challenges the sustainability claims of insect farming. Despite initial promises, the use of food waste as insect feed has proven difficult in large-scale operations, and many Life Cycle Analyses indicate that insect meal may have higher greenhouse gas emissions than fishmeal or soybean meal, even when insects are fed waste. Additionally, insect-based foods tend to replace plant-based foods, which already have relatively low environmental impacts, rather than meat.

This presentation will provide insights into the economic and environmental limitations of insect farming, offering a realistic perspective on the sector's future.

Effect of ultrasound processing on physico-chemical properties of edible insects: a preliminary investigation

Giacomo Rossi[1], Annalisa Altavilla[1], Luma Rossi Ribeiro[1], Marina Höhne[1], Majhar Babor[1], Oliver K. Schlüter[1]

[1] Leibniz-Institut für Agrartechnik und Bioökonomie e.V. (ATB), Max-Eyth-Allee 100, 14469 Potsdam, Germany

Corresponding author: grossi@atb-potsdam.de

Edible insects are recognized as an important source of proteins. Processing has been identified as crucial for improving consumers' acceptability, while keeping high quality. The aim of this study was to investigate the effect of ultrasound processing (US) on the quality of three different edible insect species (*Acheta domesticus* adults, *Hermetia illucens* larvae, *Tenebrio molitor* larvae). Initial material was obtained by milling fresh insects with water (insect:water ratio = 1:1 for *T. molitor* and *H. illucens*; 1:2 for *A. domesticus*). Three products (environments), consisting in fresh insects mixed with tap water (A), blanched insects (70°C, 5 min) mixed with tap water (B) and fresh insects mixed with plasma-activated water (C), were prepared and subjected to US treatment (700 W, 100% amplitude, 30 min, on/off = 10s/50s). An unprocessed control was prepared for each environment. Effect of insect species, US processing, and environment were evaluated using a linear model with interactions. Particle size distribution (PSD), texture, protein solubility (Lowry), total phenolic content and oxidative status (TBARs) were used as response variables.

Results showed that US treatment improved the protein solubility, although the high variability observed between the studied environments did not lead to any overall significant effect. Significant differences were however observed between species within the same environment with *H. illucens* showing lower protein solubility than the other two species (p-value = 0.04). Similarly, significant differences were detected between different environments within the same species, with environment C leading to lower protein solubility than environments A and B in *A. domesticus* (p-values = 0.0184 and 0.0173, respectively) and then environment B in *H. illucens* (p-value = 0.0257). TPC resembled Lowry, increasing after US process, regardless by the species and the environment. No significant effects attributable to the processing were detected by the general linear model with interactions, although significant differences were computed between species, with *H. illucens* always showing lower TPC than the other two species. Absence of differences were computed in terms of TBARs, albeit *T. molitor* showed higher oxidation than *A. domesticus* when environments B (p-value = 0.0060) and C (p-value = 0.0422) were considered. US processing was responsible for reducing particle size dimension in all the species and regardless by the environment. Singular behavior was however observed for *H. illucens*, which displayed an increase of particle aggregation after US process. Significant differences were indeed only observed among species (p-value = 0.0223), while no differences in PSD were attributable to processing and environment.

In conclusion the study suggested that US processing can strongly affect the physico-chemical properties of edible insects, with variable effects, which appear to be strictly due to the considered insect species.

Options for extracting and processing insect oils

Thomas Piofczyk. Katharina Haupenthal
ÖHMI Analytik GmbH, Magdeburg, Germany

Corresponding author: info@oehmi-analytik.de

Insect Oils and Fats: Sustainable Extraction and Refining for Future Applications

As the global demand for sustainable resources grows, oils and fats derived from insects are emerging as a promising alternative to conventional plant-based and animal-based lipids. This presentation offers an accessible overview of how these insect oils can be extracted and refined for future use in various sectors.

Two main extraction methods are currently in use: mechanical pressing and solvent extraction. Solvent-based methods are particularly effective in achieving high oil yields and efficient use of raw materials. The talk will explain these processes in simplified terms, along with the key considerations for choosing appropriate methods from a sustainability perspective.

In their raw form, insect oils often require further processing—known as refining—to improve shelf life, taste, smell, and overall quality. Traditional refining techniques used for vegetable oils can be adapted, but insect oils may present unique challenges. For example, they can contain residues from insect feed or the farming environment, including beneficial micronutrients but also possible contaminants such as antibiotic traces. Addressing these issues may require customized solutions to ensure safety and quality.

Although still in early stages of development, insect oils hold great potential for sustainable applications—not only in technical products like lubricants and cosmetics, but possibly also in the food industry. This presentation invites discussion on the future role of insect-based oils in a circular economy and highlights their potential contribution to more resilient and resource-efficient food systems.

Testing bio-based lubricants based on the soldier fly for sheet metal forming

Kai Weigel[1], Hoang Viet Le[1]
[1] *Fraunhofer Institut für Schicht- und Oberflächentechnik, Braunschweig, Germany*

Corresponding author: kai.weigel@ist.fraunhofer.de

Environmentally friendly lubricants are essential for sustainable sheet metal forming. Their effectiveness depends on physical and chemical interactions between lubricant, tool and workpiece surface. The aim of this study is to investigate the eligibility of bio-based base lubricants from *Hermetia illucens* for sheet metal forming. Different processing stages, conventional and bio-based additives and plasma vacuum deposited coatings are considered.
The *Hermetia* based lubricant was prepared to be tested in some different stages ranging from additive-free raw base material to fully processed with EP-additives.
All variations were inspected in a pin-on-disk test with a 1.2379 tool steel pin sliding versus steel and aluminum sheet metal materials, namely 1.4401 fine steel, EN AW-5083 aluminum alloy and 1.0917 DX51D zinc plated steel. Five different surface preparations were applied to the 1.2379 pin.
Depending on friction and wear characteristics of the pin-on-disk tests the best performing candidates were afterwards tested in strip and cup drawing tests and punching in an industrial environment.
The results show that bio-based lubricants from *Hermetia illucens* have good applicability for sheet metal forming. Depending on the combination of tool surface and workpiece material it was found that the lubricating effect was comparable to reference lubricants such as KTL N16 and in some cases even better. Regarding the dependencies on the applied additives there are many interesting aspects for further investigations.

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The impact of lignocellulosic agricultural residues on growth performance parameters of *Zophobas atratus* larvae

Nazanin Fazel Dekhordi[1], Amr Abd El-Wahab[1], Alexandra Rath[1], Jan-Berend Lingens[1], Madeleine Plötz[2], Nils Th. Grabowski[2], Kashif ur Rehman[3], Christian Visscher[1], Cornelia Schwennen[1]

[1]Institute for Animal Nutrition, [2]Institute of Food Quality and Food Safety, University of Veterinary Medicine Hannover, Foundation, Hanover; [3]German Institute of Food Technologies, Quakenbrück,

Germany e-Mail: Nazanin.Fazel.Dehkordi@tiho-hannover.de

Introduction: The growing demand for sustainable protein sources has increased interest in *Zophobas* larvae as a feed ingredient for animals [1]. Large-scale production requires cost-effective and nutritionally balanced diets to ensure feed efficiency, optimal growth, and sustainability. One potential approach is the utilization of lignocellulosic materials [2], particularly lignocellulose-rich products from grassland- and rewetted peatlands (LPRP), which could contribute to the sustainable management of environmentally harmful by-products and support circular economy principles. This study aims to assess the impact of different levels of LPRP on the growth performance parameters and survival rate of *Z. atratus larvae*.

Animals, materials, and methods: A total of 1,250 young larvae (age 90 days; weight = 0.022 g/larva) were reared under controlled conditions (24°C, 40% humidity, 12 h light/dark cycle) over 10 weeks. Larvae were randomly assigned to six groups with four replicates per treatment. The control group received wheat bran only, while the other five groups were fed 10%–50% LPRP with varying wheat bran and brewers' dried grains to equalize protein (17.7%). All diets were offered ad libitum, and 4 g of carrots were added twice weekly as a water source. Feed intake, larval weight, and survival rate were recorded weekly. Data normality was assessed using the Shapiro–Wilk test. For normally distributed data, group differences were tested using the Ryan-Einot-Gabriel-Welsch test (ANOVA). Non-normal data were analyzed via Kruskal–Wallis followed by the Wilcoxon two-sample test. Statistical significance was set at $p < 0.05$.

Results and discussion: The final larval body weight gain was significantly influenced by the level of LPRP inclusion. The highest gains were observed in the control group and the 10–20% LPRP groups, with values of 0.377 g, 0.382 g, and 0.380 g, respectively. In contrast, the lowest gains occurred at 40% and 50% LPRP, measuring 0.327 g and 0.295 g. Feed conversion ratio (FCR) decreased progressively with higher LPRP levels, from 3.51 in the control to 2.32 at 50% LPRP, reflecting improved feed efficiency. Similarly, the efficiency of conversion of ingested food (ECI) increased with increasing LPRP inclusion, reaching 45.9% at 50% compared to 34.9% in the control, indicating enhanced biomass conversion. Survival rates remained consistently high (>98%) across all treatments, suggesting that dietary LPRP had no adverse effects on larval viability.

Conclusion: These findings demonstrate the potential of LPRP as a sustainable feed ingredient in insect farming. While moderate inclusion levels (up to 30%) supported optimal growth and feed efficiency without affecting survival, higher inclusion levels (40 50%) improved feed utilization but resulted in reduced larval body weight gain

References: [1] Dragojlović, D et al. 2022 ,12 (10), 1277. [2] Szentner et al. 2019;485,107811.

Evaluation of Black Soldier Fly Meal as a Sustainable Protein Source in Larval Diets for Gilthead Seabream (*Sparus aurata*)

Aviel Melchior[1], Shlomo Pleban[1], Adi Jonas-Levi[1,2]

[1] *Feed Beter group, Zemach Extrufeed, R&D department, Jordan Valley, Israel*
[2] *Tel Hai College, Food Science department, Qiryat Shemona, Israel*

Corresponding author: jonasleviadi@telhai.ac.il

The development of sustainable aquafeeds is crucial for reducing reliance on fishmeal and krill meal in marine aquaculture. In this study, we evaluated the performance of *Sparus aurata* larvae fed with five diets: a well-known commercial reference and four in-house formulated diets. In three of the experimental diets, 50% of the fishmeal, krill meal, or both were replaced with *Hermetia illucens* (Black Soldier Fly, BSF) meal. This was a preliminary observational study conducted without replication. Each diet was tested in a single 100-liter tank, initially stocked with 3,000 larvae. The trial took place at an experimental facility within a commercial hatchery (Dagon, Israel), under standard commercial farming conditions (e.g., larval density, water temperature, and co-feeding protocol). The feeding experiment began at 17 days post-hatch (DPH). At 53 and 64 DPH, individual fish were randomly sampled from each treatment group and weighed to determine average body weight.

At 53 DPH, no significant differences in fish weight were observed between groups ($F_{4,45} = 0.415$, $p = 0.797$), and no differences in survival were visually detected. However, by 64 DPH, the homemade Zemach formulation without any fishmeal or krill meal replacement yielded significantly higher average weights than all other groups ($F_{4,51} = 9.390$, $p < 0.001$). The other three Zemach microdiets, with 50% replacement of fishmeal, krill meal, or both, resulted in growth performance comparable to the commercial control.

These findings suggest that BSF meal can serve as an effective and sustainable alternative protein source in early larval diets of gilthead seabream. Partial replacement of fishmeal and krill meal with BSF meal supports larval development and may significantly reduce the ecological footprint of marine aquaculture feeds. However, given the lack of replication in the present trial, further studies with replicated tanks and broader evaluation of performance parameters are needed to confirm these preliminary results.

The chemical valorisation of insects and microalgae as a sustainable alternative feedstock

Joost Matthijssen [1], Thomas Quanten [1], Mik Van Der Borght [2], Sander Van den Bosch [2], Bert F. Sels [2], and Sabine Van Miert [1]

[1] *Centre of Expertise Sustainable Biomass and Chemistry, Campus Geel, Thomas More University of Applied Sciences, Kleinhoefstraat 4, 2440 Geel, Belgium*

[2] *Centre of Sustainable Catalysis and Engineering (CSCE), KULeuven, Celestijnenlaan 200F, 3001, Leuven (Heverlee)*

Corresponding author: joost.matthijssen@thomasmore.be

The chemical industry is looking into biomass as a more sustainable and alternative feedstock to produce industrial building blocks which we use in our everyday lives. Recently, the chemical valorisation of insects and (micro)algae have gained increased interest in this field, as they have proven to be a more sustainable feedstock that yield different interesting substrates. For example, the Black Soldier Fly (*Hermetia illucens*) and mealworm (*Tenebrio molitor)* are two species with a high fat content (~ 30 wt.%) that can be reared at a low environmental impact.

This makes them a more sustainable alternative for the extraction of fats or fatty acid methyl esters (FAMEs) compared to the current sources of seed or palm oils, which is a driving factor in deforestation. These FAMEs mixtures are used as biodiesel or to extract interesting fatty acids (*e.g. lauric* acid). The fatty acid composition of microalgae makes them less interesting for biodiesel production but compose of polyunsaturated fatty acids (such as EPA and DHA), making them interesting an interesting feedstock for the feed or pharmaceutical industry. However, research is yet to show its industrial applicability by a lack of upscaling and optimisation to make these processes economically viable.

This work will present the process plan for the upscaling and optimisation of these procedures. It will discuss the extraction of FAMEs from Black Soldier Fly Larvae (BSFL) and mealworms, with the focus on 1 – 3L scale reactions. These reactions will be optimised for both a high production and low economical cost. The FAMEs mixture will be tested for its application as biodiesel according to EN14214. Alternatively, the FAMEs mixture will be fractionated into specific methyl esters of interest (*e.g.* methyl laurate) and hydrolysed towards lauric acid, an industrially interesting fatty acid. Finally, the chemical derivatisation of lauric acid to different amines will be investigated (both on lab and pilot scale), as they are also used in the chemical industry as corrosion inhibitors or intermediates for the synthesis of surfactants. Similarly, the fat content of different microalgae species will be investigated and extracted as FAMEs, with the focus on isolating the long chain, polyunsaturated fatty acids for the feed or pharmaceutical industry.

Scalable Transgenic Black Soldier Flies for the Production of Recombinant Insulin

Paul Mozdziak[1], Zara Vermast [1], Dries Willems[1], Xike Chen[1], and Tannaz Norizadeh Abbariki[1]

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Corresponding author: paul@flyblast.bio

The Black Soldier Fly (BSF, *Hermetia illucens*) is an attractive platform to produce recombinant proteins offering several advantages over classical recombinant production platforms, such as *E. coli*. Specifically, BSF can produce complex glycosylation patterns similar to other insect recombinant protein production platforms, such as SF9 cells. The BSF is an economically efficient upstream platform due to low inputs, and it is readily scalable. Freshly laid BSF eggs were injected with a PiggyBac transposase plasmid, and a PiggyBac plasmid carrying the human proinsulin gene. 2500 BSF eggs were injected with the PiggyBac vectors, resulting in a hatchability of approximately 50% viable offspring. Subsequently, insulin positive larvae were identified via PCR based upon DNA from the exuviae, and visually using the Green Fluorescence Protein (eGFP) marker gene that was encoded in the injected vector. G0 founders were mated with wildtype stock. Subsequently, insulin positive clutches were identified using PCR and visually confirmed by eGFP fluorescence. The insertion sites were mapped using the Splinkerette PCR procedure, followed by Sanger sequencing. The G1 flies were intermated to produce G2 progeny that were a mixture of homozygous, heterozygous and wildtype individuals. Homozygous individuals were identified via PCR on the exuviae and propagated as homozygous lines. A total of 15 lines were chosen for propagation, and 6 lines have been maintained through at least the 10^{th} generation. All propagated lines were confirmed to express insulin via Reverse Transcriptase PCR. Furthermore, semi-quantitative Western Blotting revealed proinsulin at approximately 2.6 mg per gram of fresh larvae. Overall, it appears that the Black Soldier Fly is an attractive platform to produce recombinant insulin, and its utility as a biomanufacturing platform may be translated to other more complicated proteins.

Revealing the nutritional and functional of adult insects up grading the sustainability of food systems

Nuno Muñoz-Seijas[1,2], Helena Fernandes[1], Borja Fernández[1], Francisco Soto-Bel tran[1], José Manuel Domínguez[1], José Manuel Salgado[1]

[1] University of Vigo, Campus Auga, Industrial Biotechnology and Environmental Engineering Group “BiotecnIA”, Chemical Engineering Department, 32004 Ourense, Spain

[2] Laboratorio Cifga, Rúa do Vidro, 117D, Parcelas 3-6, 27003 Lugo

Corresponding author: jmsalgado@uvigo.es

The use of edible insects as ideal protein sources is increasing in Western societies but is mainly restricted to larvae meals. To meet the increasing global demand for quality food and aiming to reduce the by-products disposal of the insect industry, such are the adult insects, this work focuses on the characterization and valorisation of adult insects of three species, named Locusta migratoria (LM), Acheta domesticus (AD) and Hermetia illucens (HI). Among all species, AD stands out with 70% protein content (dry weight, DW), while HI and LM reached 55.5% DW and 45.3, respectively. Inversely, LM showed up to 30% DW of lipids, followed by HI with 20.1% DW and AD with 7.95% DW. Chitin of the three species ranged between 9.25-10.70%, unveiling the potential valorisation of these bio masses without resorting to harmful procedures. Additionally, LM and AD showed high antioxidant activity (256.2 µmol TE/g and 250.6 µmol TE/g, respectively) while lower ac tivity was found in HI (37.0 µmol TE/g). Soluble protein was higher in AD (530.3 mg/g), while HI showed the lowest value (78.0 mg/g). Contrarily, HI achieved higher amino acids content (168 mg/g), while AD (77.9 mg/g) and AD (71.8 mg/g) showed similar results. The three species entail a highly promising nutritional and functional value that may be explored resorting to eco-saving methods, reducing the disposal of this biomass while also improving the sustainability of food production systems.

Credits

Bibliography of cover photos

(from left to right)

(1) Nils Th. Grabowski
(2) Nils Th. Grabowski
(3) Thomas Piofczyk

ÖHMI Analytik GmbH

Berliner Chaussee 66

39114 Magdeburg

Tel.: +49 391 8507-181

E-Mail: info@oehmi-analytik.de