# Alternative Proteins

INTERNATIONAL MAGAZINE FOR ALTERNATIVE PROTEINS TO ANIMAL FEED by Feed Additive Magazine

April 2024 - Issue 3

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A step from plastics to proteins – Larvaes that eat plastic

Insect meal as a tool for reducing the environmental impact of livestock production



Alex Diana, Innovafeed Innovafeed creates a new aspect to the insect industry with its investments



Andrea Lopez, Selko From waste stream to alternative protein – Preserving food by-products for animal feed



Aubin Bernard, Flylab Maximizing performance, a necessary transition to BSF ingredients

## EDITOR Derya YILDIZ

## The rise of alternative proteins in animal nutrition

Due to the world's increasing need for food and climatic and environmental issues, the food sector in general, and the animal production industry in particular, is undergoing a significant change in terms of sustainability and efficiency. In this period, it is of great importance to reduce the dependence on traditional protein sources and to search for alternative food sources. In this context, different alternative protein sources stand out as a new approach for animal nutrition as well as human nutrition.

Because animals also need proteins in their diet and these proteins have important effects on their growth, development, performance and health. However, traditional protein sources have high carbon emissions, water and land requirements. This is a serious concern for environmental impact and sustainable production. At this point, alternative protein sources that stand out with less carbon emissions, less water and land requirements come into play. However, this field is still in its infancy and needs a serious source of information.

Alternative Proteins Magazine, which started its publishing life for this information need, continues to shed light on sustainable alternative protein sources that can

### be utilised in animal nutrition with its first issue of 2024. In this new and innovative sector, there are remarkable developments in many areas from insect-based proteins to plant-based proteins, from cell and fermentation-based proteins to algae-based proteins. We have shared some of the important developments in the last 6 months with you in the news section.

In this issue, we have focused on insects, which is a prominent topic among alternative protein sources. We are aware of the fact that the most needed subject in this sector, which is rapidly taking steps towards industrialisation, is more technical information and research. We hope that the articles and interviews, which shed light on the results of the latest researches and different production models in the insect industry, which we have created with the contribution of important players of the sector, will be a highly efficient resource for those interested in this sector.

We will continue to explore the future of alternative protein sources and follow the developments in this innovative field.

Enjoy your reading... Hope to meet you in the next issue!

## Alternative Proteins

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## Entobel and Vinh Hoan partnership accelerates adoption of insect protein in aquaculture

Progressing closer towards the goal of building a more sustainable and resilient aquaculture supply chain, Entobel and Vinh Hoan announced the signing of an expanded strategic partnership. The partnership includes an offtake agreement by Feed One, a subsidiary of Vinh Hoan, to purchase a substantial volume of insect protein produced at Entobel's Vung Tau factory in 2024.

According to the companies, this landmark partnership builds upon the global leadership of both companies in developing a more sustainable food system with a lower environmental impact and accelerating the adoption of insect protein in aquaculture.

In addition to the offtake for 2024, through this agreement, Vinh Hoan will purchase a minimum of 15,000 metric tons of insect protein from Entobel over the next three years, from 2025 to 2027, inclusive.

"Today, in collaboration with Entobel, we are cre-



ating a more sustainable and resilient aquaculture value chain with the added benefit of incorporating nutritious aquaculture feed ingredients with demonstrated health and immunity benefits," said Nguyen Ngo Vi Tam, the CEO of Vinh Hoan. "Accelerating the adoption of Entobel's insect protein in pangasius production will make it possible for Vinh Hoan to source aquaculture feed ingredients in a more sustainable way and use feed ingredients that are not in direct competition with human nutrition, facilitating a more responsible aquaculture industry."

<u>Read more>></u>

## MARA approves FeedKind protein for aquafeed

China's Ministry of Agriculture and Rural Affairs (MARA) has formally given Calysta's single cell protein full approval for use in fish and shrimp feeds after an extensive evaluation process. It means that protein produced by Calysseo – Calysta and Adisseo's joint venture to produce FeedKind for the Asian aquaculture market – can now be sold and used in Chinese aquaculture feeds.

Calysseo's first production plant is in Chongqing, already producing sustainable FeedKind protein for the aquaculture industry, giving producers access to an alternative to plant or animal sources for aquafeed diets. The protein is produced by harnessing the power of a naturally-occurring microbe that converts methane into a healthy, nutritious feed ingredient, FeedKind.

Sun Bin, Calysseo's Chairman, commented: "This is an important step forward not just in helping make food production systems more sustainable, but in improving global food security, by providing feed producers with a domestically-produced, reliable feed ingredient that isn't susceptible to weather or climate-driven fluctuations in supply."

According to the company's statement, FeedKind is a natural, sustainable and traceable feed ingredient produced by fermentation for aquaculture feeds and pet foods producing using no plant or ani-



mal ingredients. FeedKind has been validated via extensive trials across popular aquaculture species, including shrimp, seabass, and salmon. Research previously demonstrated distinct benefits for shrimp, concluding that FeedKind promotes strong, healthy growth, while also helping activate shrimp's immune response to Vibrio, the causative agent of Early Mortality Syndrome.

## Fermentation-based animal protein being tested in pet food

**B**ond Pet Foods shipped its first two metric tonnes of animal protein created through fermentation to Hill's Pet Nutrition, which will begin to formulate test products using the innovative, more sustainable ingredient for regulatory review and market evaluation.

Separately, the companies announced a second joint development agreement to create an additional animal protein for potential use in Hill's products. The collaboration between Bond and Hill's, announced in late 2021, aims to develop a source of more sustainable animal protein to fulfil the dietary needs of dogs and cats.

The two metric tonnes produced by Bond represent a major milestone towards commercialising its fermentation technology for pet food applications. The scale of the delivery will allow Hill's to formulate a variety of products at its Pet Nutrition Centre in Topeka, KS, for evaluation. That data will be used for the ingredient's eventual review by the U.S. Food and Drug Administration's Centre for Veterinary Medicine, as well as to prepare prototypes for market evaluation.

"Hill's is known for its leadership in precise, complete, and



balanced, science-based nutrition. We are excited to continue our relationship with Bond and support their truly novel approach to producing animal proteins in a more sustainable way that meets our high-quality standards," said Dave Baloga, Executive Vice President of Science & Technology for Hill's Pet Nutrition.

<u>Read more>></u>

## Siemens, Nasekomo collaborate on digitalization of insect production

Nasekomo, a biotech scale-up, and Siemens Bulgaria, a part of the global digital leader Siemens AG, forged an agreement to collaborate on the digitalization of insect biotransformation—an emerging industry with significant potential for sustainable development.

The partnership between Siemens and Nasekomo, unveiled during the UN Climate Change Conference (COP 28), will serve as the foundation for establishing an intelligent insect industry 4.0. with built-in industrial cyber security to fulfil the growing demand for protein in both quality and quantity. The collaboration aims to expedite the expansion of the insect industry by leveraging digitalization to enhance capacity.

The official signing took place in the presence of the Bulgarian Minister of Innovation and Growth, Milena Stoicheva, and the Minister of Environment and Water in Bulgaria, Julian Popov. The strategic cooperation document was signed by Virak Chhuor, Vice President of Engineering and Production at Nasekomo, and Dr. Eng. Boryana Manolova, CEO of Siemens for Bulgaria, North Macedonia, and Ukraine.

The partnership will bolster Nasekomo's development concept, which envisions a data-driven franchising business model. This involves initially creating a connected network of factories within European countries and eventually expanding globally. The initial phase of the collaboration will focus on establishing a state-of-the-art breeding centre to provide a sustainable supply of young insects for the network of bioconversion factories.

Read more>>

## Leading innovators collaborate on alternative protein production solutions

International technology group Andritz and Netzsch-Feinmahltechnik GmbH, one of the leading companies in grinding and classifying technologies, entered a strategic partnership to collaborate on serving the alternative protein market with future-oriented technologies and processes.

The collaboration will bring together Netzsch's expertise in fine grinding and subsequent classifying to extract a protein-rich fraction with Andritz's extensive know-how in key processes such as conditioning, extraction, dewatering, drying, extrusion, and pelleting complemented by advanced process automation and a first-class global service offering. Tailor-made process solutions include conceptual design, process engineering, implementation, automation, and maintenance of turn-key plants, as well as trials in the laboratories.

One key aspect of this partnership is the commitment to energy efficiency. The companies state that they provide innovative technologies and processes that enable a significant reduction in energy consumption and thus create both ecological and economic added value.

Christian Kling, Director Business Development for Alternative Protein Solutions at Andritz, says: "We are very pleased to have found a partner in Netzsch that shares and strengthens our vision for the alternative protein market. It is an excit-



ing market but moving from lab to industrial scale can be challenging. Andritz – as a trusted partner on the side of its customers – not only has the production technology but also helps customers speed up commercialization and bridge the gap to full-scale production. With a history of 170 years, we have been engineering and implementing solutions for many industries including food and feed for decades."

<u>Read more>></u>

## Globe Buddy introduces new dog food with insect protein

Danish pet food company Globe Buddy introduced a super-premium dog food based on a novel and sustainable source of protein: insects. The brand wants to inspire a positive change and help dog owners live greener pet lives.

"We have made it easy to feed your furry friend a healthy and tasty diet while doing some good for the planet, simply by reducing the climate impact of dog food," said Bjarne Gravesen Jensen, CEO and co-founder of Globe Buddy.

According to the company's statement, the insect-based dog food Globe Buddy Brown features protein from the black soldier fly larvae, which is good for all dogs, especially those with sensitive digestion or intolerances to traditional meats.

It is also a win for the climate. Using insect protein in pet food reduces carbon emissions. The carbon footprint of the ingredients in Globe Buddy's new product is just over half that of the ingredients



used in the market's average dog food, according to calculations performed by the consultancy firm Viegand Maagøe on behalf of Globe Buddy.

The insect-based product comes with a third-party-verified carbon footprint, something that is still rarely seen in the pet food industry.

"While many companies have brought what are claimed to be green pet foods to market, we saw a need among pet parents for increased transparency in the environmental sustainability of their dog's food. Our brand aims to address this unmet need," said Bjarne Gravesen Jensen.

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## KAUST scientists develop new techniques for industrial microalgae production

Scientists at King Abdullah University of Science and Technology (KAUST) announced that they have devised new techniques that can produce nutritious microalgae in industrial volumes, which could interest countries looking to diversify themselves off imported feed products and promote domestic food security.

Algae is recognized as a superfood that can be grown cheaply with just sunshine, carbon dioxide and water. However, cultivation at scale is difficult, meaning its potential has yet to be realized. Scientists working at KAUST's new Saudi Center for Algal Biotechnology Development and Aquaculture, have developed their own Spirulina and Chlorella strains of algae which is uniquely adapted to seawater. Scientists state that the innovation dispenses with the need for freshwater and make the production of livestock feed cultivated from algae sustainable and economically viable.

Saudi Arabia currently imports most of the raw materials it needs for livestock feed – protein, lipids, and carbohydrates – from countries like Brazil and USA. KAUST's groundbreaking research means locally produced microalgae could ultimately become a substitute for the 13 million



tons of imported feed materials that it is predicted the Kingdom will require annually by 2030.

According to KAUST's statement, the Kingdom's plan for algal cultivation on an industrial scale aligns with its Vision 2030 goals. These include increasing its domestic food security and decreasing its dependency on imported feed and raw food materials.

Read more>>

## Protix to construct new production plant in Poland

The European Investment Bank (EIB) has committed to supporting Protix in the expansion of its sustainable protein production. The signing of the loan agreement marks a significant milestone, providing Protix, a producer of sustainable protein used for animal feed and pet food, with up to  $\notin$ 37 million in additional funds for its international rollout. This agreement is in line with the InvestEU objective of a Sustainable Bioeconomy and Circular Economy and was made possible with the support of the InvestEU programme, which aims to trigger more than  $\notin$ 372 billion in additional investment in the European Union over the period 2021-27.

EIB Vice President Teresa Czerwińska said: "Supporting innovative solutions is one of the priorities of the European Investment Bank, and we are pleased to start collaborating with Protix. This financing is supported by the InvestEU programme and will enable the company to expand its activities and to apply its technologies, which contribute to



the sustainable development of solutions within the bioeconomy sector."

Protix CFO Lynn De Proft said: "We are thrilled about this agreement with the EIB, not only for the opportunities it brings for further expansion but also as a resounding affirmation. This support reinforces the fact that our industry is not just here to stay but is poised for significant growth. Following our expansion to the United States and now our ability to do the same in Poland, we are excited to accelerate our mission to bring the food system back in balance with nature."

Read more>>

## Hungarian insect producer chooses Bühler for industrial insect plant

Tungarian insect producer Agroloop chosen Bühler's sophisticated insect growth system for its industrial black soldier fly plant. The facility will produce up to 4,000 metric tonnes of animal feed ingredients per year and will be built in Üllő, Hungary. Swiss technology group Bühler will deliver its proven crate-based nursery and rearing technology, which will enable a quick ramp-up of the plant for commercial production. By the end of 2024, Agroloop plans to launch its first products, contributing to a more sustainable animal feed value chain.

Following its foundation in 2017 and the successful operation of a pilot facility, Agroloop got the green light for the implementation of an industrial insect plant in Hungary in 2022. Now they have selected all execution partners and are working at full speed to construct the plant and get it operational. The insect facility will be realised in an existing building of the Aerozone Park in Üllő, which is located next to the Budapest Ferenc Liszt International Airport. The new plant, Agroloop, supported by Bühler insect technology expertise, will produce more than 25,000 metric tonnes of black soldier fly larvae that will be turned into sustainable feed ingredients for the pet food, aquaculture, and livestock sectors.

The plant is only the first step in Agroloop's strategy to make insect feed ingredients available for Central and Eastern European (CEE) agribusiness. "The abundance of food processing by-products pres-



ents a unique opportunity for Agroloop's multi-plant rollout strategy in the CEE region. Leveraging our strategic partnership with the leading regional feed producer, UBM Group, we improve feed quality and sustainability by creating future-proof feed formulas. This enables Agroloop to focus on rapid expansion and solidifies our position as a key player in the region," said István Nagy, co-founder and CEO of Agroloop.

<u>Read more>></u>

## Nasekomo appoints Stefka Mavrodieva as CDO

N asekomo, one of the leading biotech companies in the insect bioconversion industry, announced the appointment of Stefka Mavrodieva as its new Chief Digital Officer. Mavrodieva brings over 20 years of experience in the IT industry, with a focus on strategic programs involving digitalization, cloud solutions and overall business development.

In her new role, Mavrodieva will be responsible for the development and execution of Nasekomo's digital strategy, including big data management, artificial intelligence driven automation, technology integration and cyber security. She will also play a role in the company's efforts to scale its operations and expand into new markets through its innovative franchise model.

The appointment comes a few months after the company attracted an investment of 8 million euros to develop a new generation of bio-based technologies with zero waste and after late last year Nasekomo and Siemens Bulgaria announced a strategic partnership to digitise the cultivation of Hermetia Illuces for industrial purposes.

"I am inspired to join Nasekomo at this pivotal time in the



Stefka Mavrodieva

company's growth," said Mavrodieva. "The company presents the unique opportunity to revolutionise the insect bio-engineering industry and I am confident that my experience and expertise will help achieve these goals."

## Enifer builds first-of-its-kind mycoprotein ingredient factory

**B** usiness Finland has conditionally approved a recycling and reuse investment grant of more than  $\notin 12$  million for biotech startup Enifer to build its first commercial-scale PEKILO<sup>®</sup> mycoprotein ingredient factory. The funding comes from the European Union NextGenerationEU recovery instrument. It will support building first-of-its-kind industrial facilities promoting the reuse and recycling of industrial by-products and waste streams, hence aligning with the EU's circular economy action plan and the Sustainable Growth Programme for Finland.

The commercial-scale factory will produce Enifer's unique PEKILO<sup>®</sup> mycoprotein ingredients, which are made using fungal fermentation. The PE-KILO<sup>®</sup> fermentation process has a long legacy; it was originally developed by Finnish forest industry engineers in the 1970s. As the world's first commercial mycoprotein production process from 1975 to 1991, it converted forest industry by-products into



sustainable feed protein for the domestic market.

The new facility will have a production capacity of 3 million kilograms a year of sustainable, locally sourced protein -roughly equivalent to the protein content of meat from 30,000 cows- but with at least 20 times lower carbon emissions and considerably lower water and land use. The factory is currently projected to cost  $\in$ 30 million to build and is expected to be completed by the end of 2025, with production ramp-up occurring in 2026.

Read more>>

## MicroHarvest launches pilot plant to produce single-cell protein samples

MicroHarvest, one of the leading industrial biotechnology companies dedicated to advancing sustainable protein production, launched its cutting-edge pilot plant in Lisbon, Portugal – enabling the company to produce single-cell protein samples.

The official launch of the pilot, marked by an event held on November 16th in Lisbon, attended by investors FoodLabs and Faber to name but a few, marks a significant milestone in MicroHarvest's mission to reshape the landscape of sustainable food production.

With the ability to operate beyond labscale inhouse, the pilot plant will accelerate MicroHarvest's journey toward commercialization and market availability. The plant will produce protein samples for customers, allowing the company to further hone its technology and test production runs before bringing them to commercial scale.

The pilot plant is located at their Factory Lisbon site. In a remarkable span of six months, MicroHarvest transformed a portion of its office space into a fully equipped laboratory and pilot plant.

Luísa Cruz, CTO of MicroHarvest, notes, "This pilot plant serves as tangible evidence of the scalability of our process. With a lower investment when compared to alternative technologies, and within a mere 200 square meters, we can achieve a daily production of 25 kg." Simultaneously, after successfully transferring the technology and scaling up production to reach daily outputs in tons, the team engaged a commercial production partner.

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## New study: Diet based on BSF improves oral health and reduces bad breath in dogs

A recent study published in the Journal of Insects as Food and Feed into the impact of insect ingredients in dog food reported positive effects on dental health. Volatile sulphur compound (VSC)-producing bacteria in the dental plaque were reduced and beneficial bacteria such as Moraxella were increased in saliva microbiota. The study, conducted with a diet based on the black soldier fly (BSF), shows a drop in the dreaded bad breath that afflicts many of our canine companions. The results open up exciting opportunities

for pet food manufacturers to develop new applications, from treats and kibble to wet food, that capitalise on the positive oral health message.

Researchers at the Federal University of Paraiba (UFBP) in Brazil reported a 7% reduction in the bacteria that cause VSC and trigger bad breath. This outcome is particularly notable since VSC-producing bacteria would generally be expected to increase with the consumption of regular food with no dental prophylaxis. In addition, based on a metagenomic analysis, the black soldier



fly diet seems to modulate saliva microbiota. The abundance of Moraxella in saliva was increased. The Moraxella group of bacteria is considered a marker of oral health and beneficial for the oral microbiome.

Read more>>

## Northern Europe's largest insect farm opens in Denmark

E norm Biofactory inaugurated the largest insect farm in Northern Europe in Hvirring, Denmark. Enorm aims to produce 100 tonnes of larvae per day on its new farm.

On the new 22,000-square-meter farm, black soldier fly larvae (BSFL) will be bred and processed into insect protein and insect oil. Much of the technology installed at Enorm Biofactory was supplied by Better Insect Solutions, a subsidiary of the Big Dutchman Group that specialises in complete solutions for insect farming. Better Insect Solutions provided the climate systems for the breeding and growing sections, air cleaning and heat recovery equipment, the liquid feeding system, and the crates for the larvae. Overall, around EUR 70 million was invested in the project.

"Enorm Biofactory is a milestone for insect farming in Europe, and we are delighted that our equipment has made such an important contribution to the success of this lighthouse project," said Dr. Frank Hiller, CEO of Big Dutchman. "We value this cooperation very highly because the larvae of the black soldier fly have enormous potential. We



believe that this alternative protein source can permanently replace a large part of the soy that is currently being imported to Europe." Accordingly, Big Dutchman has bundled the group's insect farming know-how into the subsidiary Better Insect Solutions, which was founded in 2020.

Enorm Biofactory breeds black soldier flies that mate and lay eggs, from which the larvae hatch. The larvae's main food source is residue from the regional food industry. After around 12 days, they are processed into insect oil and insect meal, products that have already shown promising results in connection with the management and health of pigs and poultry. The goal to produce 100 metric tonnes of larvae per day.

## Manna Insect sells insect farming technology to more than 20 countries

anna Insect announced that it became one of the world's leading insect farming solution providers and has sold its insect farming technology to well over 20 countries across 6 continents since it started selling about 18 months ago. The company states that especially the Manna MIND climatization technology has been raising interest across the globe since its 2nd generation version was launched in September 2023. "Counting the number of climatization units that have already been sold and shipped or that will be shipped in the next few weeks, in May 2024 we will surpass 50 MIND unit milestone,"

Manna Insect officials say.

According to the company, the milestone is significant, in practice it means that Manna Insect's technology is the centre piece and enabler of professional level insect production in over 50 insect farming facilities around the world. Manna Insect notes that compared to other insect farming technology providers, no other company has helped set up more than a handful of insect farms anywhere in the world.

Manna Insect aims to solve biowaste and animal feed problems with a set of solutions that are specialized in the utilization of black soldier fly (BSF) to upcycle organic waste into cost-effi-



cient and nutritious animal feed and organic fertilizer. Some of the solutions are technical – the climatization technology, readymade BSF production units, and an insect farming mobile app – whereas some are services, such as the new insect business accelerator program and insect farming trainings, according to the company's statement.

<u>Read more>></u>

## Entobel opens largest insect protein production plant

Entobel, one of the global leaders in the production of functional insect protein for animal and plant nutrition, celebrated the opening of its new black soldier fly (BSF) production plant, the largest of its kind in Asia.

Entobel's state-of-the-art facility was constructed in an industry record time of 12 months and is currently the world's most CAPEX-efficient BSF production facility. The facility features 50 levels of vertical rearing, incorporating automation via robotics, cutting-edge sensors, and data analytics that enhance productivity. Leveraging a US\$33 million Series B funding round raised in 2022 and backed by Mekong Capital, Dragon Capital, and The International Finance Corporation (IFC), the Vung Tau facility marks Entobel's second industrial-scale production facility in Vietnam and will have an annual production capacity of 10,000 MT of insect protein. The facility will serve as an economic and



community anchor, creating 150 jobs in manufacturing and operations.

"Today marks a major milestone in our journey to transform the insect protein landscape and supply sustainable feed ingredients to the rapidly growing aquaculture and pet food industries," said Alexandre de Caters and Gaëtan Crielaard, co-founders and co-CEOs of Entobel.

## EntoGreen to produce 25 tons of larvae per day with WEDA feeding system

The German feeding technology specialist WEDA Dammann & Westerkamp supplied a liquid feeding system for the black soldier fly (BSF) to the Portuguese breeder EntoGreen. Founded in 2014 by Daniel Murta, EntoGreen produces high-quality animal protein and organic fertilizer from by-products of the agricultural and food industries at its headquarters in Santarém.

In the system, the larvae of the BSF are fed with the by-products until they reach their final weight. The WEDA system, including control and process visualization, is a container system with mixing tanks that were specially developed and built for EntoGreen. "We worked closely with our partner WEDA on the design and construction," emphasizes Daniel Murta, founder and CEO of EntoGreen.

According to WEDA's statement, the feed substrate can be mixed in parallel in the liquid feeding



system. The integrated Intrix dosing system ensures an individual combination and precise portioning of the feed substrate in the rearing units. In numerous test runs, even viscous substrates could be dosed and conveyed without any problems. At EntoGreen, the vegetable materials on which the larvae of the black soldier fly thrive consist of regional vegetable by-products that otherwise could not be used as nutritional sources and were lost.

<u>Read more>></u>

## Benson Hill introduces five 2024 soybean varieties

enson Hill, Inc., self-de-**D**scribed as an ag tech company unlocking the natural genetic diversity of plants, announced that recent advances in its soybean breeding programme will drive the doubling of its seed portfolio by 2025. The latest field evaluations on Benson Hill's third generation of Ultra High Protein Low Oligosaccharides, non-GMO soybean varieties, showed protein gains of 2% over the previous generation and achieved a yield gap of only 3 to 5 bushels per acre, compared with commodity GMO soybeans.

"We've successfully demonstrated that CropOS<sup>®</sup>, our AI-based prediction and data insights platform, can drive our predictive



breeding efforts and give us a stepchange forward on multiple traits like protein and yield," said Jason Bull, Chief Technology Officer of Benson Hill. "We are now seeing massive gains in the field that minimise the tradeoff between yield and protein, surpassing expectations from when we began building on the high-protein soybean genetics we acquired in 2019." "What this means for the industry is that we're accelerating our speed to market with de-risked, outcome-based products in record time," Bull added. "We expect to expand our portfolio of seed innovations again in 2025 to offer two dozen varieties that encompass protein, lower-indigestible sugars, and quality oil."

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## Argenta combines legacy brands to further advance animal health

F ollowing several acquisitions, including Klifovet, Pen & Tec Consulting, and Ondax Scientific, Argenta rings in the new year by bringing its businesses together under one, energised brand. The combined identity reflects the company's enhanced offering to customers, providing them with unparalleled, comprehensive support right across the animal health product development cycle from 'molecule to market.'

According to the company's statement, Argenta already held a unique position as the world's only combined CRO and CDMO dedicated to animal health, partnering with clients big and small for more than 17 years on the pathway from concept to market. The acquisition of Klifovet, Pen & Tec Consulting, and Ondax Scientific has strengthened this offering, and joining together under one brand reflects a determination to maximise the group's collective capabilities and global footprint to help more clients improve the health of pets and livestock, and achieve their commercial goals.

Argenta stated that the good news for customers is that there will be no changes to legal entities and who they do business with, and they'll continue to work with the same experienced contacts at Argenta but will now have easier access to a greater range of expertise and capabilities as their requirements evolve.

"As we've grown in recent years, we've brought some great companies into the group, expanding our offering to customers and strengthening Argenta's position as the world's only combined CRO and CDMO dedicated to animal health," said Will Downie, CEO of Argenta. "Now, bringing our businesses together under the Argenta brand reflects our collective expertise and truly specialised role as a leading global partner in our industry, supporting clients right across the product development cycle, from molecule to market."

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## Meatly creates world's first lab-grown cultivated chicken for cats

Meatly, one of the leading cultivated meat companies in the world, announced that it created the world's first cans of pet food that use cultivated chicken as the protein source. The product was created in collaboration with its first brand partner, Omni, a fast-growing novel protein pet food company in the UK, founded by veterinarian Dr. Guy Sandelowsky.

This is also a significant step in Meatly's B2B route to market, as it looks to become both the first company in the world to sell cultivated meat for pets, and the first to gain regulatory approval and sell cultivated meat-based products in the UK and Europe.

For Omni, which has achieved

more than £2 million in sales to date selling dog food crafted from pulse, algae, and yeast protein diets, this first venture into the cultivated meat market comes in the form of canned wet food for cats. By utilising Meatly's cruelty-free chicken ingredient, this step represents a much-anticipated evolution of the pet food market as pet food brands, like Omni, look to offer ethical and more environmentally friendly products that are healthier for pets, Meatly stated.

It also marks a huge moment for the wider pet food industry, which is growing 7% per annum globally and is expected to be worth £120bn by 2026. However, with this growth, the industry's envi-



ronmental impact is increasing rapidly. 22% of the meat currently consumed in the UK is consumed by pets, representing a significant amount of GHG emissions. Meatly said that it addresses this by producing sustainable, tasty and nutritious meat, whilst reducing our reliance on industrial agriculture.

<u>Read more>></u>

## AlgaEurope 2023 highlights future of algae industry

Jointly organized by EABA and DLG Benelux, AlgaEurope 2023, the annual conference highlighting breakthroughs and trends in the algae biomass sector, saw an extraordinary gathering of 407 delegates from 40 countries and 221 organizations. Hosted in Prague, Czech Republic, from December 12-15, the event unfolded over four days, featuring a curated programme delivered by 112 expert speakers. The content spanned scientific, technological, and business dimensions within the global algae biomass sector.

Exploring an array of subjects, AlgaEurope is one of the most comprehensive conferences in its field. More than 20 plenary sessions covered Physiology, Biorefinery, Food, Feed, Biostimulant, Bioremediation, and Biomaterial among others. The conference featured distinguished keynote speakers, including Sónia Ventura (Portugal), Susana Coelho (Germany), Angela Wulf (Sweden), and Robert Henrikson



(USA), offering profound insights and expertise.

One of the highlights of the conference was the poster presentation area, which provided researchers with a platform to present their work. Some 136 scientific authors presented their work. The introduction of the Poster Presentation Award this year recognised outstanding contributions.

The next AlgaEurope conference will be held in Athens on December 10-12, 2024.

## Ÿnsect receives approval to commercialize mealworms in US

Ynsect, one of the strongest players in the production of insect-based proteins, has been granted authorization by the AAFCO (Association of American Feed Control Officials) to use defatted mealworm proteins in dog nutrition. It is the first time that mealworm-based ingredients for pet foods have been approved in the USA.

The authorization follows two years of evaluation by AAFCO, the organisation responsible for the safety of animal food in the USA. Approval was granted to Ÿnsect based on a comprehensive scientific dossier that included a 6-month trial introducing mealworm-derived ingredients into the diet of dogs. The results demonstrated the safety of the product and its nutritional benefits.

A further study commissioned by Ÿnsect with Professor Kelly Swanson from the Animal Sciences Laboratory at the University of Illinois' Urbana-Champaign, proved that the protein quality of defatted mealworm flour from Tenebrio molitor was comparable to



high-quality animal proteins traditionally used in pet food manufacturing, such as beef, pork, and salmon.

"We are very proud to have obtained the very first authorization for the commercialization of mealworm-based ingredients for pet food in the United States. It is the recognition of over 10 years of research for the benefit of animal health. This authorization opens the doors to the immense American market just as we are preparing to deliver our first pet food customers from our Amiens farm," said Shankar Krishnamoorthy, CEO of Ÿnsect.

Read more>>

## Future Green Solutions rebrands as Arvela

Future Green Solutions announced that it rebranded to Arvela. Since its inception in 2012, Arvela has been at the forefront of sustainable agri-business, supplying industry-leading black soldier fly eggs and converting organic waste into high-value products like antibacterial oils, animal protein substitutes, and biofertilizers. "This is a significant move that symbolises our ongoing commitment to sustainable development and marks a new chapter in our business journey," said Luke Wheat, Arvela founder.

According to the company's statement, the rebranding coincides with the addition of new leadership talent to the company's board and management team. These seasoned professionals bring a wealth of experience, invigorating Arvela's strategic vision and heralding an era of heightened innovation, operational excellence, and business growth.

Arvela, a creative reimagining of the word 'larvae', encapsulates the company's ethos of transforming waste into valuable, eco-friendly products. From industry-leading black soldier fly eggs to a diverse range of agri-products, Arvela continues to redefine sustainable agricultural practices, contributing significantly to a circular economy – living its mission statement to 'give waste a purpose'.



The company stated, "We embraced this change to better reflect who we are today and to symbolise our dynamic future. In a world that never stands still, it's crucial that our brand mirrors our ability to adapt and thrive. The new brand is a clear representation of our values and our promise to tackle environmental challenges while ensuring commercial success."

## Ittinsect secures €600,000 in funding for sustainable protein production

Ittinsect secured over €600,000 in non-dilutive funding from Invitalia, Italy's Development Agency. This funding will facilitate the construction of a pilot plant capable of producing 2,300 metric tons of sustainable proteins annually.

This marks a key step toward the biotech company's goal of scaling up to an industrial-scale production of proteins derived from 100% circular economy processes by 2025. This initiative highlights the importance of scaling up sustainable aquafeed for safeguarding our oceans, according to the company.

Ittinsect will deploy €602,500 to build a section of its inaugural production facility. The facility will prove both the technical and economic advantages of Ittinsect's products at scale, laying the groundwork for the company's first industrial plant. This scale-up will also bolster the recruitment of specialized personnel and the pursuit of new patents, solidifying Ittinsect's position as the preeminent innovator in the market.

Ittinsect's CEO, Alessandro Romano, underscored



the significance of national support from Italy's National Development Agency, stating, "We are honored to secure this funding, building upon the trust already received from the Lazio Region during the project's pre-seed phase. The backing from Invitalia confirms the regional interest has transcended into a national one. Our goal is now to extend public support to an international level."

Read more>>

## Deep Branch appoints Kaspar Kristiansen as new CEO

eep Branch, one of the creators of high-value ingredients for a more sustainable food system, announced the appointment of Kaspar Kristiansen as its new Chief Executive Officer (CEO), taking over from co-founder Peter Rowe. With Kristiansen's arrival, Rowe will dedicate his focus to commercial development activities, with both working closely together to redefine the company's long-term strategy and lay the foundations for growth. The company unveiled that this management team evolution is combined with an injection of additional funding

from existing investors.

Kaspar Kristiansen joins Deep Branch following six years serving as Managing Partner and Managing Director of Waterland, where he was responsible for the global private equity firm's Nordic business. Having also previously headed up Danish engineering firm FLSmidth's M&A and business improvement activities, Kaspar is seasoned in dealing with the challenges of scaling and commercialising novel process technologies. He brings extensive experience in enabling high-potential businesses to realise their true value; experience



Kaspar Kristiansen

he will apply to Deep Branch as he oversees the successful completion of the company's ongoing pilot project and prepares the organisation for future growth through the establishment of stronger internal structures, planning and processes.

Read more>>

## Innovafeed launches its new brand Hilucia for monogastrics and aqua

In order to support the acceleration of its production and sales growth, which more than doubled in 2023, Innovafeed unveiled its new brand Hilucia<sup>TM</sup>. With Hilucia<sup>TM</sup>, the company redesigned its offer around a complete range of high-quality ingredients for animal and plant nutrition, with minimal environmental impact.

Hilucia<sup>™</sup> embodies the combination of the exceptional upcycling capabilities of the Hermetia illucens larvae with the cutting-edge technology developed by Innovafeed's teams, according to the company's statement.

"Enhanced and expanded with two new products - protein for monogastrics and oil for aqua the Hilucia<sup>™</sup> range reaffirms Innovafeed's anchoring and leadership in its four main markets: pets (Hilucia<sup>™</sup> for pets), livestock (Hilucia<sup>™</sup> for monogastrics), aquaculture (Hilucia<sup>™</sup> for aqua), and agriculture (Hilucia<sup>™</sup> for plants)," said Elizaveta Le Floch, Chief Business Officer of Innovafeed.

The company states that the Hilucia<sup>™</sup> range is the result of an extensive effort made in recent years by Innovafeed's teams.

Innovafeed emphasizes that it has created a unique model of "industrial symbiosis" that maximizes the natural productivity of Hermetia illucens larvae. This model is based on the clustering of facilities with suppliers of the two main inputs required for insect rearing: agricultural co-products for lar-



val feed and energy. The facilities are directly connected by pipelines, which significantly reduces environmental impact, transport needs, and production costs.

The ingredients of the Hilucia<sup>TM</sup> range aim to meet the growing demand for high-quality food products - it is estimated that global protein demand will increase by 40% by 2030 – while meeting sustainability requirements, both in resource use and  $CO_2$  emissions.

Read more>>

## FreezeM raises \$14.2 million in Series A funding

FreezeM, one of the Agri-tech pioneering biotechnology companies, announced the closure of \$14.2 million in Series A funding. The funding round was led by a group of seasoned industrial investors and the prestigious European Innovation Council Fund (EIC Fund), along with FreezeM's existing investors and partners. The funding will be used to accelerate the growth of the company's breeding hubs network and commercialize its novel solutions at scale, accommodating the rapidly increasing market demand.

"The current funding round will enable FreezeM to embed our technology globally at scale and accelerate the growth of our breeding hubs in Europe and Israel, thereby driving successful commercial expansion. Our technology unleashes the insect market from its shackles and will propel the insect protein market to fulfill its true potential," said Dr. Yuval Gilad, Co-founder and CEO of FreezeM.



FreezeM aims to simplify BSF reproduction and increase protein yield through the supply of its PauseM<sup>®</sup> product to BSF protein producers, tapping an estimated \$3.96 billion market by 2033 according to Meticulous Research forecast. This innovation plays a vital role in boosting insect protein production capacity for livestock and pet food while implementing a circular economy, conserving precious global farmland, and reducing ocean depletion, according to the company.

## Mosa Meat secures €40M in funding for cultivated meat

Mosa Meat, one of the leaders in cultivated beef production, announced that it is welcoming new and existing partners to help bring cultivated beef to consumers, as part of €40M in new capital raised to finance the next phase for the company. The funds will be used to further scale up production processes and prepare for market entry.

The oversubscribed round was led by Lowercarbon Capital and M Ventures. Investors include new government-backed partners like Invest-NL, the Dutch state-owned impact investor, partly with coverage InvestEU, the European Commission program supporting initiatives that align with EU policy priorities, LIOF, the regional development agency for the Limburg province and the Limburg Energy Fund (LEF), the regional fund supporting greenhouse gas emissions reduction. New partners with a background in the conventional meat sector were also added, including the PHW Group, one of Europe's largest poultry producers. Furthermore, XO Ventures, Doux Investments and other new investors joined existing investors to create a more diverse and resilient food system together.

"The overall macroeconomic landscape has been rough in the last two years, which has culled the herd of companies and forced us to be even more strategic and focused on achieving our mission. As such, we are humbled and honoured to welcome both public parties and conventional meat producers to join this critical journey. In an en-



vironment that is increasingly polarised, we choose to connect and collaborate, working towards a future where cultivated beef is a real choice for consumers and a complementary solution in the toolbox to combat the climate crisis, biodiversity loss, and food insecurity. Rethinking how we produce great food for a growing planet without destroying it is quite a daunting task and will take many people and organisations to pull in the same direction," said Maarten Bosch, CEO of Mosa Meat.

Read more>>

## Bioflytech produces flour and fat from dried BSF larvae

**B** ioflytech has started the production of flour and fat from dried black soldier fly larvae in its new facilities located in Palas de Rei, Galicia. The company has started the activity after becoming the first Spanish company in this innovative sector to obtain the authorisation to produce, transform and commercialise this type of product. The dried black soldier fly larvae, with which the rendering lines are being set up and the first batches of flours and fats produced, come from the company's other plant in Fuente Álamo, Murcia.

These new facilities in Palas de Rei are now up and running after obtaining authorisation for the production – by means of a drying process – of the products that make up the company's portfolio and which are mainly aimed at animal feed, especially pet food and for the aquaculture sector. The com-



pany notes that obtaining this authorisation was possible thanks to the hard work of the technicians involved in the project at all levels, from those who work at Bioflytech to those who are part of the national, regional and local administration.

## Arla Foods Ingredients harnesses upcycling power of insects

Arla Foods Ingredients teamed up with ENORM, Northern Europe's largest insect farm, in a partnership that will significantly reduce food waste.

Delactosed permeate (DLP) is a residual dairy stream generated in large volumes during lactose production. Most DLP is currently used as material for biogas production, which is a less preferable option than reusing it for animal feed according to the food waste hierarchy set out in the EU's Waste Framework Directive.

Arla Foods Ingredients has long been investigating ways to address this challenge, but DLP's composition has previously made it difficult to use in traditional animal feed. This is about to change thanks to the larvae of the black soldier fly. Currently used by ENORM for animal feed, they also offer huge potential as a healthy and sustainable source of protein for humans.

Having developed the capacity to turn DLP into



nutritious feed for larvae, Arla Foods Ingredients has been supplying ENORM with DLP for trial production for several years. However, ENORM opened a major new facility on December 6 in Flemming, Denmark, and is gearing up for full-scale production.

As a result, the amount of DLP that Arla Foods Ingredients supplies to ENORM will increase substantially – to 15 truckloads a week in early 2024. When the new facility is up and running, it will be able to produce 100 tonnes of larvae daily – enough for more than 10,000 tonnes of insect meal.

Read more>>

## Agronutris becomes a B Corp company

Agronutris, a biotech company that focuses on Aattaining sustainability in the world through bioconversion, has been awarded with B  $Corp^{TM}$ , a certification that proves the company meets high standards in terms of environmental, social and societal impact.

Argonutris joining the exclusive community of 8,000 companies worldwide that are B Corp certified is the result of a several month-long in-depth audit carried out by the independent international NGO B Lab.

Augustin Boulot, CEO of B Lab France commented, "We are delighted to welcome Agronutris to the B Corp movement. The development of a fairer and more sustainable food supply chain is a key issue for the future of the sector. Agronutris' experience of shared governance is a model that we find particularly interesting: transparency, collaboration and interdependence are key values of the B Corp movement. By choosing to put people at the heart of its business, Agronutris is shaking things up!"

This certification confirms Agronutris' strong com-



mitment to the five 'pillars' of environment, customers, employees, governance and communities.

Mehdi Berrada, co-founder of Agronutris, explained, "At Agronutris, we are trying to create a collective adventure that offers an environmentally virtuous circular economy solution. Together, we are building a collaborative culture based on shared governance and freedom, and aim to create relationships of transparency and trust with stakeholders. We believe that these are the ingredients for sustainable performance."

## Selective breeding increases omega-3 content of microalgae

S cientists shown that selective breeding can significantly increase the omega-3 content of microalgae. Marie Lillehammer is behind the research.

"We wanted to know whether breeding can contribute to faster growth and increased omega-3 content. The initial trials we carried out yielded very promising results," said Nofima Senior Scientist Lillehammer.

To grow, algae require light, temperature, and nutrients. However, growth is also affected by algae genes. Therefore, scientists tested whether it is possible to breed microalgae as one does with farmed fish: when crossing individuals or genera that produce high yields, the next generation produces higher yields than the previous one, and so on.

Many microalgae reproduce vegetatively. Therefore, the scientists chose the species Seminavis robusta, a well-studied alga that has sexual reproduction. Eight lines of the species were crossed with each other in one generation and tested in the breeding trial. Although the species is not very relevant as a feed resource, the trial showed that 18% of omega-3 production in the



algae is determined by the genes (heritability). Breeding gives an 8.8% increase in omega-3 in one generation.

Growth percentages were even higher. With a 50% heritability, the microalgae grow 25% faster per generation -in theory, a ninefold increase per year, given ten generations in one year.

"It may be that inbreeding and physiological limitations would halt growth over generations, or growth would have side effects. However, the trial shows that breeding should be explored further if microalgae is to become an important feed ingredient for European aquaculture," says Lillehammer. **Read more>>** 

## Protix unveils new LCA results for BSF

Protix, one of the global leaders in insect ingredients for feed and food, unveiled the results of a new Life Cycle Assessment (LCA) conducted by the German Institute of Food Technologies (Deutsches Institut für Lebensmitteltechnik, DIL e.V.). The figures follow on from numbers published in an earlier assessment conducted in 2022, and demonstrate that Protix's black soldier fly ingredients have positive effects in terms of environmental footprint.

Driven by its mission to help feed the growing global world population while taking good care of our planet, Protix works to further reduce the footprint of its ingredients for pet food, animal feed and fertilisers. The improved results are driven by continuous improvement across operations, genetics and nutritional science, the company states.

Kees Aarts, CEO of Protix, comments: "We take pride in leading innovations within our industry on a pathway to low-footprint-nofootprint proteins. With our previous LCA, we shared the vision that the environmental footprint of our black soldier fly ingredients could be reduced and we have lived up to that promise: the latest DIL figures once again demonstrate an improvement in the footprint of our Protix ingredients. We look forward to translating these LCA numbers into new commercial opportunities to help our customers produce better and greener."

LCA RESULTS:

- ProteinX<sup>\*</sup> insect meal reduces  $CO_2$  emissions by 78% compared with poultry meal (ProteinX: 0.832 kg  $CO_2$  eq; poultry meal: 3.8 kg  $CO_2$  eq). Poultry meal is often used in pet food and livestock feed. Compared to soy protein concentrate, an ingredient often used in aquaculture, ProteinX lowers  $CO_2$  emissions by as much as 89% (ProteinX: 0.832 kg  $CO_2$  eq; soy pro-

tein concentrate: 7.5 kg  $CO_2$  eq).

- LipidX<sup>®</sup> insect fat dramatically reduces land use, using 99.9% less than coconut oil (LipidX: 0.0102 m2 land use and coconut oil: 12.98 m2 land use). Coconut oil is commonly used as a fat source in livestock and aquaculture feed as well as in pet food.

- PureeX<sup>®</sup> insect meat uses a staggering 99.8% less water than poultry meat (PureeX at 0.098 m3 and poultry meat at 61.13 kg m3). Poultry meat is commonly used in pet food as a high moisture protein source.

- Protix's insect frass shows only 0.01 kg  $CO_2$  eq. per kilogram of product.

- Larvae, used as feed for live-



stock, show 0.198 kg CO<sub>2</sub> eq. per kilogram of product.

Protix underlines that it understands the importance of a robust scientific foundation for its products. The company is heavily invested in substantiating its findings and sharing data that manufacturers can translate into compelling claims.

This latest LCA was conducted by DIL, the German Institute of Food Technologies. This is a private, non-profit research provider with around 150 member companies from the food industry and related fields. As in the previous LCA, the results are based on the established and proven IMPACT 2002+ methodology. To further support the robustness of the findings, the results were compared against benchmark results from literature and relevant databases.

<u>Read more>></u>

## Foodvalley NL announces Protein Transition Map NL

In the Netherlands, more than 500 organizations are actively involved in the Protein Transition. Together, they generate a combined annual production value of at least 881 million euros and employ at least 3,500 people. Foodvalley NL and the provinces made this visible through the Protein Transition Map NL, demonstrating the Dutch commitment to innovation and protein transition.

The Protein Transition Map NL is an online, interactive tool that provides insights into the Dutch protein transition. Accompanying an economic analysis, which illustrates the added value in euros and the number of employees per province. It shows that the economic value of producers and knowledge suppliers in the field of unconventional animal proteins has doubled since 2015. This has turned the sector in the Netherlands into a serious industry with international growth potential.

The international launch took place on April 23, 2024, during the Plant FWD event in Amsterdam.



On main stage, Jeroen Willemsen (Foodvalley NL), together with the representatives from the Dutch provinces, launched the interactive map to an international audience.

The companies and organisations featured on the map focus entirely or partially on the industrial production, processing, and marketing of alternatives to conventional animal protein sources. These alternatives include plant proteins such as legumes, animal protein alternatives like insects, and industrially produced proteins such as algae.

## Feed & Food Show 2024 to shine light on insects as sustainable feed ingredients



an the industrial breeding of insects as ani-I mal feed contribute to feeding the growing world population? The "Inhouse Farming - Feed & Food Show", which will take place from 12 to 15 November 2024 at the trade fairgrounds in Hanover, is dedicated to answering this question. The B2B platform, organised by the DLG (German Agricultural Society), focuses on technologies and solutions that show that insects can now be used economically as an alternative source of protein for sustainable animal feed. "Inhouse Farming" optimally complements one of the world's leading trade fairs, EuroTier, and EnergyDecentral, one of the leading international platforms for decentralised energy supply, which will take place at the same time, offering new perspectives and business models for the entire value chain.

For Prof. Nils Borchard, Head of DLG Research and Development, insects are the missing link in the circular economy. "They could be the animal feed of the future, as they provide valuable proteins, fats and other nutrients. Their production is also very resource-efficient." But what makes them the raw material for the feed production of the future? Answers to this question will be provided at the "Inhouse Farming - Feed & Food Show" in Hanover in mid-November, according to a press release from DLG.

#### FOCUS ON THE BLACK SOLDIER FLY

Seven insect species are now authorised in the EU for use as processed animal protein in livestock feed. The larvae of the black soldier fly (Hermetia illucens) have proven to be ideal for the production of animal feed. Their protein content is comparable to that of soya bean meal - 40 to 47 per cent in dry matter. "The potential of larvae is huge," confirms Dr. Frank Hiller, CEO of Big Dutchman. This is because they produce high-quality protein from otherwise hardly usable residues, which is ideal as animal feed. Hiller assumes that the alternative protein source can permanently replace a significant proportion of the soya imported to Europe. For this reason, Big Dutchman has pooled its existing expertise in the field of insect farming and production in Better Insect Solutions, which was founded in 2020. The company, which specialises in complete solutions for insect farming, will be presenting its systems at the "Inhouse Farming - Feed & Food Show".

What these look like in practice could be seen in Hvirring (Denmark) in November 2023 - when the Enorm Biofactory, currently the largest insect farm in Northern Europe, was opened. Larvae of the black soldier fly are bred on site on an area of 22,000 square metres and processed into insect protein and oil. According to a statement from DLG, large parts of the technology, including the climate control systems for the breeding and fattening area, the exhaust air purification and heat recovery, the liquid feeding system and the boxes for fattening, were supplied by Better Insect Solutions. The experts plan and build complete high-tech insect farms for investors, including breeding, fattening and processing. The highly automated, modular fattening systems in the product range are aimed more at farmers who want to add another mainstay as insect fatteners.

### OPPORTUNITIES FOR LIVESTOCK FEEDING

The black soldier flies bred in the Enorm Biofactory are given food consisting mainly of waste from the

### SPECIAL NEWS

regional food industry. After around twelve days, the larvae are processed into insect oil and meal, which have already shown promising results in trials on farms in terms of production and animal health in poultry and pigs. The aim is to produce 100 tonnes of larvae on a daily basis. Europe's farmers want to avoid importing some of their soya from overseas in future by using insect-based protein feed. Even though beneficial insects have been authorised as an ingredient in fish feed since 2017, such animal feed has so far been a niche product in Europe, DLG stated. Only since September 2021 has it been possible to feed processed animal protein from farmed insects to pigs and poultry in the EU under a special regulation. This opens up new growth areas for producers of insect proteins such as Livin Farms AgriFood, Illucens and Viscon.

However, experts like Prof. Nils Borchard see even more potential applications. In addition to being used as animal feed, the farmed insects or their constituents could also be used in the production of meat substitutes and other foods as well as in the manufacture of cosmetics. Until now, the production of insect protein has often been difficult from an economic point of view, as the production

and processing methods are not yet able to compete with conventional animal feed. "Utilising agricultural by-products and by-products from the food industry as feed for insect breeding can help reduce production costs," says Borchard. How the potential of organic residues and waste can be exploited is therefore one of the questions that will be discussed at the "Expert Stage: Inhouse Farming" on 12 November as part of the Insects theme day. The IPIFF (International Platform of Insects for Food and Feed), a non-profit EU organisation representing the interests of the insect production sector, is an expert partner in the development of the content.

#### **INSECTS AS UPCYCLING PROFESSIONALS**

The answer to this question has long since attracted the attention of research institutions and start-ups. There are more than enough residual materials, because "in the European Union, around 58 million tonnes of unused food are produced every year," explains Prof. Jörg Woidasky from the Pforzheim University of Applied Sciences. The university has been cooperating with Alpha-Protein, a start-up from Bruchsal, Germany, for several years. "In addition to selecting suitable by-products from the food industry, we were also able to optimise the handling of the sensitive animals," explains the expert in sustainable product development. Alpha-Protein uses these by-products as food for the mealworm (Tenebrio molitor) and upcycles them into a protein-rich raw material with vitamins, unsaturated fatty acids and minerals.

"In addition, we obtain a nutrient-rich plant fertiliser when rearing the mealworms, which has many

> other positive effects such as soil activation and long-term fertilisation," says company founder Gia Tien Ngo. Industrial production is currently being planned in Ludwigshafen, Germany on an area of two hectares. The plan is to produce 1,000 tonnes of dried insects and over 5,000 tonnes of fertiliser annually. The plan is to feed used bread from bakeries in the region as a primary source of animal feed.

#### CHALLENGES OF AUTOMATED BREEDING

The control of environmental factors such as temperature and humidity, the precise handling of sensitive fly eggs and the uniform portioning of freshly hatched larvae are complex tasks that need to be solved when automating breeding - a topic that the exhibiting companies at the "Inhouse Farming - Feed & Food Show" are also addressing. WEDA Dammann & Westerkamp, a specialist in feeding technologies, will also be present in Hanover. The company from Lutten recently supplied a corresponding system, including control and process visualisation, to the Portuguese company EntoGreen. The larvae of the black soldier fly are fed with the residues in the system of containers and mixing tanks until they reach their final weight.

Read more>>





Prof. Nils Borchard

### INTERVIEW

Nathalie Berezina, CEO of Norbite: "Let's be positive and dream about the future. We are not so far away from long-distance space trips. When we are talking about circularity on earth, it is nice to have, but when we are talking about long-distance space trips then circularity is a must have. Then it is mandatory to build a type of circular system where waste from one process becomes a resource or materials for another one and re-enter the system. In this connection, I assume that it is interesting to mention that Norbite's first project was related to space."



## A STEP FROM PLASTICS TO PROTEINS LARVAES THAT EAT PLASTIC

S weden-based Norbite, which recently joined the insect industry, contributes to the solution of two important world problems at the same time with its field of activity. The first of these problems is plastic pollution, with the second being supplying sustainable food. Although it may be a bit difficult for us to think that these problems have a single solution, Norbite CEO Nathalie Berezina explains this in a very clear way for us.

"Norbite has created, controlled and protected a process using a specific insect, *Galleria mellonella*, whose digestive activities enable it to convert plastic waste into proteins and lipids," says Berezina. And adds: "Norbite's disruptive approach offers a new economic reality for the end-of-life polymeric materials for which there are no viable re-use or recycling solutions to-date." In this recycling method, insects grown with polymeric materials are also utilized in industrial applications such as feed and food.

Norbite CEO Berezina shared an intriguing detail about the company's first project, which was related to space, and answered our questions about Norbite's promising recycling methods for the future.

### Miss Berezina, firstly could you tell us a bit about Norbite? What could you tell us about your company's field of activity and practices?

Norbite was established in July 2020. Based on a novel insect - based biorefinery technology, we tackle the problems of plastic waste pollution and transfer plastic waste into valuable bioproducts as proteins and lipids. Thus, Norbite focuses on two prominent global issues as plastic pollution and sustainable food supply for the growing human population. We use scientific and technological innovations to address these real-world problems. Norbite has created, controlled and protected a process using a specific insect, *Galleria mellonella*, whose digestive activities enable it to convert plastic waste into proteins and lipids. Norbite's disruptive approach offers a new economic reality for the endof-life polymeric materials for which there are no viable re-use or recycling solutions to-date. Proteins and lipids are to be used in feed/food industry or for industrial applications.

It is probably worth reminding that mass production of plastics started in the first half of the last century. Plastics are synthetic molecules mostly derived from fossil fuels and highly resistant to degradation. The production of these new materials has burst over the past 70 years. They entered compellingly into our daily life, bringing a revolution to our society and a new way of living. Plastic and polymeric materials became essential materials in many fields, such as packaging, textile, and furniture. In the past 40 years the production of those materials has increased exponentially. However, this revolution came with a price. This massive usage of synthetic polymers generates the accumulation of millions of tons of plastic waste. Breaking down plastic is not easy as it has long, difficult-to-break hydrocarbon chains. The same property that makes plastic such a widely used material, ironically, also turns against it, when talking about sustainable handling of its end-of-life.

On the global scale, only 9% of plastic is recycled. Around 12% goes to incineration, 22% is mismanaged and the rest ends in landfills and in our oceans. In Sweden 1,2 million tons of plastic burn every year. During incineration for each and every kilogram of plastic 2,5 kg of  $CO_2$  equivalent is released in our atmosphere, while our proprietary process reduces  $CO_2$  emission by 67%.

On the other hand, the world's population is growing and food requirements are growing with it. According to the United Nation, 690 million people are suffering hunger, that is 8.9 percent of the world's population. The total is expected to increase by 10 million people in one year and 60 million in five years. If nothing changes, the world will fall far short of the United Nations's goal to reach zero hunger by 2030.

We know that plastic waste is a big problem for the environment. But you say that it can be converted via insects. This is a noteworthy idea but how can we convert plastic waste via insects? Could you explain it to us?

Yes, a step from plastics to proteins might look too long, unrealistic, or even too good be true but it is real. Plastic structure is similar to the chemical structure of beeswax and yet the only living species that are able to digest it are Greater Wax moths, *Galleria mellonella*, the insects we are working with.



### INTERVIEW

To tell more about this specific insect, a Greater Wax Moth lives exclusively on beeswax. A female moth lay 300 to 600 eggs in clusters on combs or in small cracks in hive material. The eggs hatch within 3 to 5 days when temperatures range from 29°C to 35°C. After hatching, the small very active larvae dig tunnels in comb. During millions and millions of years of its evolution, this insect has adopted itself to digest beeswax, that is extremely resistant to degradation and if not for Greater Wax Moths we would probably have a huge amount of accumulated beeswax on our planet.

### Could all plastic waste be converted through this way? What are the types of plastic waste that insects can consume and which insect species can digest these plastic wastes?

Until now, everything we have tested, i.e. more than 90% of commonly used plastic and polymeric materials have worked perfectly well. I would mention some plastic materials such as Polyethylene, Polypropylene, Polystyrene, Polyamide, Polyacrylate, Polyester, Polyurethane and their mixtures and co-polymers, including natural fibres and biopolymers as well. Thus, we are tackling one of the biggest issues within the waste treating industry, i.e. working with dirty lasting waste streams where everything that can be recycled has already been sorted out, and the only destination of those lasting waste streams would have been the incineration.

### Can the insects you use for this conversion be used for human or animal nutrition? What can you tell us about the products that can be obtained from these insects, as well as their fields of use?

The nutritional composition of the thus obtained larvae makes it very suitable for human and animal food, yet we need to comply with the specific regulations. And here, in Europe there are three main stages, feed for the animals that do not enter in the human value chain i.e. pets and fur animals – our products can be directly used there. Feed for animals that do enter the human food value chain – several tests need to be made for the validation by EFSA; for human food, there is a need to pass through the so called "novel food" regulation. For these reasons, our primary target is pet food and food for fur animals.

### Are we sure that this is a healthy conversion? Would the usage of these insects in animal feed pose a threat to human and animal health, as well as food safety? Are there any studies regarding this topic?

We have been conducting several studies in this field, and until now we have never found any undesirable compounds, such as heavy metals or flame-retardant agents, in the final products. Moreover, some other insects, for instance *Hermetia illucens*, a black soldier fly, that eager to convert manure, are currently to be shown to detoxify the substrates they are growing on. That is the insects, may actually contribute to transform substrates unlikely to be consumed to actually safe food for humans and animals.

#### What is the cost and efficiency of this conversion? For example, how many insects can be raised with how many tons of waste?

Approximately 100 pieces of larvae consume an ordinary shopping plastic bag within 24 hours. If plastics are grinded or broken into small pieces the process goes even faster.

For our first demonstration prototype, we are aiming to convert 5 000 tons of plastic waste per year that allows us to produce about 1,7 tons of larvae. Larvae grow between five or seven weeks to become wax moths that in their turn lay new eggs and create a circular process of reproduction. Then larvae are ready to become new moths, we harvest about ninety percent of them and leave the rest for the next step of reproduction.

What would such a conversion bring to the world? First and foremost, we are offering solutions to the urgent problems such as plastic waste pollution and hunger. Obviously, traditional ways to solve these problems are not efficient enough. Time is crucial to find alternatives ways and allow innovations to enter. There is no silver bullet, everything counts! We simply do not have time to wait for some miraculous breakthroughs. We need commitment from



multiple actors and collaborative efforts to move forward. By identifying gaps and opportunities in the recycling system, creating small and big loops to upscale plastic waste stream, including decentralized recycling and industrial symbiosis simultaneously producing valuable bioproducts, could help to move in solving the problems of plastic waste pollution and hunger.

On the other hand, let's be positive and dream about the future. We are not so far away from long-distance space trips. When we are talking about circularity on earth, it is nice to have, but when we are talking about long-distance space trips then circularity is a must have. Then it is mandatory to build a type of circular system where waste from one process becomes a resource or materials for another one and re-enter the system. In this connection, I assume that it is interesting to mention that Norbite's first project was related to space. To feed astronauts and handling their waste by using insects is a very promising way to secure circularity in space.

## Finally, is there anything else you would like to add?

Norbite's solutions go beyond just technical and technological development. Innovations are required to deal with plastic waste at different stages. We are fully aware that challenges are too big to be solved by one actor and transforming the industry requires a system-level change with collaboration and commitment to innovate from multiply actors together with public sector and civil society. So, we offer and invite committed, forward- thinking individuals and companies to join us and follow this journey together.

#### About Nathalie Berezina

Nathalie Berezina is educated as chemist (MSc) and chemical engineer (MSc), education completed by a PhD in biotechnology. She has more than 15 years of international experience in the field and is a recognized expert with more than 30 peer-reviewed scientific papers and 20 filed patent applications. Berezina worked as Senior scientist and Project leader with Materia Nova (Belgium) for more than 9 years and as CSO and IP representative with Ynsect (France) for 5 years. In 2020 Nathalie successfully launched Norbite, the company focusing on the upcycling of un-recyclable plastic waste by an insect-based biorefinery. The company has won numerous prestigious awards, has participated in international incubation and acceleration programs, consolidated several collaborations, partnerships, and earn grants at national and international levels.

### INTERVIEW

Alex Diana, Product Manager at Innovafeed: "Downstream, our main clients are leaders in the animal nutrition sector such as Cargill and ADM. We position ourselves as suppliers of high-quality and sustainable ingredients that are complementary to existing traditional ingredients. Securing long-term contracts with such tier 1 players was key for us to finance our growth. Our ambition is to create a whole new industry and we aim to deliver largescale impact."



## INNOVAFEED CREATES A NEW ASPECT TO THE INSECT INDUSTRY WITH ITS INVESTMENTS

Founded in 2016, France-based agtech company, Innovafeed, has quickly become one of the biggest companies in the insect industry. Thanks to its collaborations with major global companies in the food value chain and the funding it has received, the company, which first commissioned its industrial-scale production facility in Nesle, France, and recently in Decatur, USA, is strengthening its presence as one of the leading suppliers of insect-based ingredients to the animal nutrition industry. We asked Alex Diana, Product Manager, about all these remarkable growth and developments at Innovafeed. Mr. Diana details everything that our readers are curious about:

#### As Innovafeed, you made rapid progress despite having been established in 2016. Can you tell us the key to your success?

From the creation of the company in 2016, Innovafeed has followed three rules that were key to its success: • Give a solution to future scarcity of proteins: Insects, as a sustainable, high-quality source of proteins, are a valid alternative to traditional ingredients for animal nutrition.

• Build an ecosystem of public and private partners to accelerate the growth of the company: Eg., strong relationships enabled us to quickly identify a production site for our first farm in France back in 2017

• Prove quickly that insects can be farmed at an industrial scale: To achieve this, we put a lot of effort into demonstrating our ability to deliver in record time a pilot-scale production site in Gouzeaucourt, France. From there and with our first concrete volumes of insect-based ingredients, we were able to convince our partners Cargill to secure a first long term commitment and Tereos to deploy our first industrial-scale site in Nesle which started to operate in 2020.

### You have strategic partnerships with some of the leading companies such as Cargill and ADM. Could you give us some details about the scope and goals of these partnerships?

As suppliers of feed ingredients, we are a new brick in the food value chain and we try to collaborate with all the stakeholders in the chain, up to the end consumer.

Upstream, our industrial strategy is to co-locate our production sites with our suppliers of feedstock, as is the case with Tereos in Nesle, France and with ADM in Decatur, Illinois. This co-location model enables us to save transportation and drying costs which are key to our economic and impact balance. We call this production model "industrial symbiosis".

Downstream, our main clients are leaders in the animal nutrition sector such as Cargill and ADM. We position ourselves as suppliers of high-quality and sustainable ingredients that are complementary to existing traditional ingredients. Securing longterm contracts with such tier 1 players was key for us to finance our growth. Our ambition is to create a whole new industry and we aim to deliver large-scale impact. In addition, one key aspect of our commercial strategy is to build consumer-facing projects to generate value for all the stakeholders of the value chain by promoting insect ingredients as premium and sustainable sources of nutrients. In 2018, we successfully launched a partnership with Auchan, a major retailer in France, to commercialize trout fed with insect proteins.

You have other facilities in operation and projects in progress since your first pilot production facility in France. Could you give us information about your completed facilities so far and your planned facility investments?

We currently have three sites, two in France and one in the United States:

• Based in Gouzeaucourt (France), our first pilot site is currently being converted into a centre for innovation and technological development to conduct R&D at various scales which will be inaugurated in the second semester of 2024.

• Our industrial-scale production site is based in Nesle (France) and is being progressively extended to reach its maximum capacity of 100,000 T of insect ingredients (of which 15,000 T of proteins).

• Our first site in the US is based in Decatur (Illinois) thanks to our strategic partnership with ADM: a pilot facility was inaugurated on April 18th, 2024 in the presence of local officials, our ecosystem, partners, and media.

Innovafeed has the ambition to expand its model on multiple sites and regions. Our industrial deployment team is screening potential locations globally.



### INTERVIEW

You talk about the largest insect production capacity in the world. Is this what you are capable of with your current size, or a size that will be achieved with the projects you have planned? What is the average production capacity you will reach with the completion of your facility in the US?

As mentioned in the previous question, Innovafeed currently operates 2 production facilities in France for a total capacity of 15kT of insect proteins when all extensions are deployed. We inaugurated April 18th our First Insect Research Center in Decatur, Illinois, which will become one of the world's largest facility of insect rearing with a potential production capacity of up to 60kT of insect proteins. Especially your facility in Nesle has a very modern and technological infrastructure. What can you tell us about the equipment and infrastructure at this facility?

Nesle is the combination of unique in-house expertise and advanced technologies that have been developed over the last years and can be summarized over the three following expertise:

• Insect Science: Genetics, zootechnical performance, and R&D to address the specific needs of Black Soldier Fly.

• Data Science:

- Advanced AI Analytics to identify key performance drivers and predict future production,

## Innovafeed opens its Insect Innovation Center in US

Innovafeed, a global leader in the production of insect ingredients for high-quality animal feed, pet food and plant nutrition, inaugurated its North American Insect Innovation Center (NAIIC) in Decatur, Illinois on the 18th of April. This pilot plant is the first step of the rising French agtech's industrial expansion to North America and aims to scale up production and commercialization of insect protein in the USA.

Innovafeed breeds *Hermetia illucens*, also known as black soldier flies, in state-of-the-art indoor farms, while efficiently repurposing agricultural by-products from its strategic partner, ADM, in a pioneering zero-waste framework. This innovative process yields insect meal, oil, and soil amendment, which Innovafeed markets under the brand Hilucia<sup>™</sup>.

According to ADM, the inauguration of NAIIC will be a milestone in Innovafeed's expansion



in North America. The choice of Decatur, Illinois, is not coincidental: located in the heart of the corn belt adjacent to ADM's North American headquarters and the world's largest corn mill operations, with hundreds of processing plants across multiple States, the region offers high potential for multiple sites to be deployed in the future. The broader area is also a historical innovation hub for the agro-industry, making it a strategic location for Innovafeed to serve its core markets. Since 2023, the company in partnership with

ADM, already has commercialized Hilucia<sup>™</sup> insect ingredients for the pet food market in North America. As part of this effort, ADM has invested in a comprehensive R&D study at the University of Illinois at Urbana-Champaign, with results to be released later this year demonstrating the nutritional and health benefits of its ingredients. Future opportunities with other types of animal feed are also being explored as part of the comprehensive partnership between the two companies.

Read more>>

- World's largest database on industrial rearing of insects to leverage AI capabilities,

- Powerful data management and BI system to structure and articulate data flows.

• **Industrial Automation:** Fully integrated automated system leveraging data and automation to optimize operations on a real-time basis 24/7,

- Advanced vertical breeding system,

- In-house HVAC model to optimize zootechnical performance and energy consumption,

- World-class rendering process designed to reach the highest product quality.

Innovafeed's technology allows the company to have superior products while enabling scalability and continuous innovation.

### We notice that you are working on the *Hermetia Illucens* species. Why did you pick these species? Are there any other species that you are currently farming or plan on farming?

Today, EU regulation authorizes 8 insect species to be farmed for animal nutrition and *Hermetia Illucens* is one of them. Like ~70% of players in the insect industry, we decided to select this species for several reasons:

• *Hermetia illucens* larvae are rich in high-quality nutrients - including protein, fats, and minerals.

• With the same amount of food, they gain body mass more rapidly than other insect species (it multiplies its weight by 10,000 in 2 weeks!) and have shorter life cycles, enabling them to improve the economy while lowering our environmental impact.

• This species thrives on a large variety of plantbased feedstocks, allowing us to consider a multitude of possible locations for our farms in the world.

Each insect species requires very specific breeding conditions, so we prioritize our efforts in scaling up our activities with *Hermetia illucens*. We however consider other species: for example, we have supported the World Mosquito Program in improving their industrial model to farm mosquitos used to reduce the prevalence of diseases like dengue.

### Do you rely entirely on by-products for insect farming? Which by-products do you feed the insects with the most?

Innovafeed's mission is to build more sustainable food systems and we put circularity at the core of our model. We leverage insects as upcyclers to convert low-grade feedstocks into high-quality nutrients. That's why we have focused on plant-based by-products to feed our larvae.

In addition, our industrial strategy is based on the by-products location: We build our farms where by-products are available in large quantities and where our symbiosis model can be implemented: for example, wheat in Europe, corn in the USA, and palm in South East Asia. Our R&D team dedicates significant efforts to screening feedstocks and optimizing the nutrition of larvae at the best cost.

Lastly, let's talk a little bit about your insect-based products. We see that you are carrying out innovative works in this field as well. Could you tell us about Innovafeed's product range, starting with Hilucia<sup>™</sup>, which you recently launched?

In January 2024, we announced <u>the launch of</u> <u>our Hilucia<sup>TM</sup> brand</u>. This product range combines the cutting-edge technology of Innovafeed with the natural upcycling power of an exceptional insect, *Hermetia illucens*, to produce the highest quality ingredients at the lowest environmental cost.

Hilucia<sup>™</sup> is our functional product range for animal and plant nutrition. We are also developing new products from our insects which will be progressively released into the market.

#### About Alex Diana

Alex Diana is a dedicated Product Manager specialized in functional feed ingredients derived from Black Soldier Fly (Hermetia illucens). With a focus on protein ingredient applications for aquaculture, particularly for the salmonids and shrimp, Alex Diana brings a wealth of expertise to the table. Currently situated in Brussels, Belgium, he holds a degree in Marine Biology, with a specialization in aquaculture.

### INTERVIEW

Insects are attracting more and more interest and investment as a new and exciting way in the circular food chain. Wageningen University & Research supports this interest with knowledge through its Summer School Insects as Food and Feed. In this summer school, anyone interested in the topic can discover the challenges and opportunities of rearing insects for sustainable consumption and animal feed, and learn about the optimal production design and facilities needed to farm and process insect protein.



## WAGENINGEN UNIVERSITY SUPPORTS THE INSECT INDUSTRY WITH EDUCATION

ore resources are needed to feed the grow- ${f M}$  ing world population, but the world's resources are limited. Moreover, the negative environmental impacts of our current methods of both plant and animal food production increase the pressure on these limited resources. This problem has led people to turn to sustainable alternative sources and to look a little closer at insects. Prof. Dr. Ir. Arnold van Huis from Wageningen University & Research comments on this situation as follows: "The realization that insects can be used either for human consumption or for animal feed in the Western world is very recent. Insects in the tropics have been harvested from nature and consumed already for a very long time. This was erroneously considered by westerners as a primitive habit. It is now recognized that insects are very nutritious, safe to eat and can be produced with much lower environmental impact than our common meat products."

However, for insects to be a truly sustainable alternative, industrial-scale production and the training of people who will do it are needed. The opening of a summer school on insects at Wageningen University addresses this need. Prof. van Huis, who spearheaded the Summer School on Insects as Food and Feed, explains the need for education and the driving force behind the idea to organize a summer school as follows: "To exploit this food source, we need to rear them in large quantities. It was in 2014 that we published the FAO report 'Edible insects, future prospects for food and feed security'. The book was downloaded millions of times and triggered interest worldwide. Being the main author of this publication, I thought about how to spread the message about this new food and feed source. Ten years ago, the knowledge of how to rear and process insects was rudimentary as well as the knowledge about environmental impact, nutrition, food safety, consumer attitudes, marketing, etc.

These gaps have been and are filled by the academic world. The last ten years the number of scientific publications on these issues increased exponentially. So, the idea of organizing this summer school was to provide the newest developments to participants by inviting the best experts from around the world."

**Prof. Arnold van Huis** also emphasizes, "After publishing the FAO book, we never expected that the issue would be embraced by so many around the world."

#### THE GROWTH OF THE MARKET MAY REACH 100 BILLION USD IN A DECADE

One of the key reasons why insects are seen as a good alternative is their environmental impact, as Prof. van Huis points out. This issue, which is extremely important in today's world, combined with the other important aspects of insects, has led to an increase in the number of investors in this field and continues to do so. "Insects in comparison to livestock, can be produced with less emissions of greenhouse gas and ammonia, while much less water and land is required. Besides, several insect species can be reared on organic side streams, important if you consider that one third of our agricultural produce and food is wasted," says van Huis. "In this way insect production for food and feed can contribute to a circular economy. Only in Europe more than 1.5 billion euros have been invested in the sector and the growth of the market may reach 100 billion US\$ in a decade."

#### WHAT TOPICS DOES THE TRAINING COVER?

Wageningen University & Research also supports this rapidly growing market with education through a summer school led by **Prof. Dr. van Huis**. In this summer school, anyone interested in the topic can discover the challenges and opportunities of rearing insects for sustainable consumption and animal feed, and learn about the optimal production design and facilities needed to farm and process insect protein. **Prof. Dr. Ir. Arnold van Huis** shares the following details about the scope of the training: "All issues from producing to consuming edible insects will be treated: automation of rearing, processing, environmental impact, nutrition, food safety, legislation, marketing, and consumer attitudes. We organize one day a trip to Belgium where participants will visit an insect facility and they will see and hear firsthand about insect production and processing. We expect the participants after the course to have a general knowledge of the whole field of insects as food and feed."

#### WHO CAN PARTICIPATE

In principle, everybody can participate in the training. "What we see is that attending people are from the edible insect industry, academics, but also people from governmental bodies such as food safety agencies, and people who are just interested and may engage in edible insects in the future," adds **van Huis**.

The training, which was also organized once online only during COVID, is now in person. This year's training will be organized between July 1-5, 2024. People, who want to participate in the one week training, must register through Wageningen Academy. If there is enough interest, these trainings are planned to continue as the summer school each year.

**Prof. van Huis** invites those who want to learn more about insects for feed and food to this training: "We welcome everybody to this exciting and fast-developing field."

#### About Prof. Dr. Ir. Arnold van Huis

Prof. Dr. Ir. Arnold van Huis worked from 1974 to 1979 in Nicaragua. He got his PhD from Wageningen University, the Netherlands. From 1982 to 1985 he coordinated a crop protection training project for eight Sahelian countries. From 1985 to 2015 he worked as tropical entomologist at Wageningen University. Since 2015 he is emeritus professor and concentrates on insects as food and feed. In 2013 he published with FAO the book Edible insects: future prospects for food and feed security which has been downloaded millions of times. In 2014 he organised with FAO the conference Insects to feed the world, attended by 450 participants from 45 countries. He is chief editor of the Journal of Insects as Food and Feed. He published more than 300 papers of which 170 refereed. On edible insects, he (co)authored several books, 15 book chapters, and 35 refereed and 40 non-refereed publications. Each year he gives presentations in and outside the Netherlands on insects as food and feed.



## **MEALWORMS:** LOW ASH CONTENT WITH AN INTERESTING MINERAL PROFILE FOR PET FOOD RECIPES

**Dr. Lorena Sanchez** Scientific Project Manager Sprÿng Powered by Ynsect

"Added to pet food recipes, mealworm-based products help pet food product meet the nutritional recommendations set by the AAFCO and the FEDIAF, with a balanced, rich, high-quality ingredient. Mealworms could be the one-size-fit-all solution to premium, high-protein pet food diets, full of interesting minerals."

More than ever, consumers expect transparency and quality around the food they feed their animals. Pet diets remain under scrutiny as recipes boast premium ingredients and reduced unwanted additives. Many look to the ash content in a meal as a marker of protein-quality as it provides a measure of the inorganic matter of a feed material, that comes from bone, cartilage, tendons. The lower the ash level, the better quality of food. Ash levels are often a limiting factor of high-protein inclusion in pet food recipes. Full of a valuable mix of minerals that fit nutritional needs, Sprÿng's mealworm-based ingredients are particularly attractive because they combine high protein levels with a low ash content.

#### ASH, A LIMITING FACTOR OF HIGH-PROTEIN INCLUSION IN PET FOOD RECIPES

Crude ash provides a measure of the inorganic matter or total mineral content of a feed material, such as phosphorous, calcium, zinc and iron<sup>1</sup>. It depicts a rough estimate of the amount of mineral present in a diet while being less complex and expensive to measure than individual minerals. Indeed, the ash content is calculated based on the remaining percentage of food left after combustion.

Ash can originate from mineral additives added to the product, but oftentimes, it comes from animal and fish bones, cartilage, tendons and the like that have been ground into the meat meal. As such, high ash contents are often perceived as a measure of these low-value materials with low digestibility. Many look to ash as the key to understanding if a higher quality protein is being used in the making of a dog or cat food.

Pet food producers take great consideration in the ash content of their ingredients and end-products. While official recommendations advocate diets with less than 10% of ash, the average ash content of most commercial dog foods appears to be about 5-8 percent, with higher meat recipes averaging ash levels closer to 10%<sup>2</sup>. Dry pet foods, especially those that contain higher protein concentrations and more meat meals in the ingredient list, are usually higher in ash than canned foods<sup>3</sup>. The ash content is often a limiting factor of high-protein inclusion in pet food recipes but also tends to be used as a marker of protein-quality. Sprÿng ingredients are

particularly attractive because of their high protein content associated with low ash levels, less than 5%.

### PET FOOD NEEDS TO INCLUDE MINIMAL ASH AS MINERALS ARE NECESSARY FOR PET HEALTH

Despite its link to low-value materials, don't write off ash just yet. Essential minerals play an important role in pet health. Dogs and cats actually require roughly about 2% ash in their diet to meet their mineral needs.

Essential minerals are found in all food ingredients. In commercial pet food, they can be supplemented via specialized ingredients to provide a complete and balanced nutritional profile. For dogs and cats, these essential minerals can be divided into two separate categories: macrominerals needed in large amounts and trace minerals in very small quantities<sup>4</sup>. Both support a range of body functions that help pets remain healthy, active and strong. For instance, they promote bone development, nerve and muscle function, balancing of fluid in cells, thyroid function, skin and coat maintenance and red blood cell production.

Pet food products should contain a healthy amount of minerals to avoid medical concerns. It is important to have a balanced intake of minerals. Minerals need to be included in the right quantities - specified by the nutrient profiles and intake guidelines from public pet food organizations like the AAFCO or the FEDIAF - in the diet of cats and dogs to promote health and wellbeing of animals. The AAFCO specifications indirectly restrict ash by setting limits on calcium and phosphorus levels and their ratio.

## THE INTERESTING MINERAL PROFILE OF MEALWORMS

Sprÿng mealworm products are particularly attractive because they have a high protein concentration, combined with the sought-after low in ash content that meets the nutritional needs of both dogs and cats. Compared to equivalently qualitative animal

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protein sources, like fish or poultry, mealworms contain 3 to 5 times less ash. Our dry protein concentrate made of ground up mealworms, Protein70 only contains 3.6% ash for a protein concentration of 72.6%. This makes mealworm proteins similar to vegetal protein sources and far more interesting that animal proteins. Indeed, mealworms are a significant source of essential minerals.

Sprÿng products don't contain a lot of ash, but the ash they do contain has an interesting mineral profile that contributes to good health and nutrition. For instance, a 20% inclusion of Protein70, supplies more than a third of the required mineral for phosphorus (P), potassium (K), and sodium (Na). More importantly Protein70 will provide 90% of magnesium (Mg) intake, 72.2% copper (Cu) intake, 50.8% iron (Fe) intake, 57.6% manganese (Mn) intake and 64.2% zinc (Zn) intake recommended for an adult dog. Similarly, it will provide 157.5% of Mg intake, 104% Cu intake, 66.8% Mn intake and 61.6% Zn intake recommended for an adult cat. For information, magnesium is involved in hundreds of reactions in the body and supports electrolyte balance inside cells, bone structure integrity and heart cell function. Iron is important in energy metabolism, supporting notably the synthesis of red blood cells and muscle cells. Zinc is linked to skin integrity. Manganese is essential to energy metabolism and healthy bones. And finally, copper helps with coat quality.

As for minerals in which there is a maximum level of inclusion, not a single macromineral or trace-element is added in excess when including 10 to 30% of our Protein70 in kibble recipes.

Added to pet food recipes, our mealworm-based products help pet food product meet the nutritional recommendations set by the AAFCO and the FED-IAF, with a balanced, rich, high-quality ingredient. Ash is an important part of pet food formulation. With our Sprÿng products, the pressure of including a premium protein source, without adding too much ash to the final product is vastly alleviated. Mealworms could be the one-size-fit-all solution to premium, high-protein pet food diets, full of interesting minerals.

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<sup>2</sup><u>What is Crude Ash and why is it in my dogs dinner?</u> <u>– Bone Idol</u>

<sup>3</sup><u>All About Ash – Clinical Nutrition Service at Cum-</u> mings School (tufts.edu)

<sup>4</sup>Brown S., Taylor B., "See Spot Live Longer", 2007 Creekobear Press, Eugene, OR USA, p 55

#### About Dr Lorena Sanchez

Lorena Sanchez is Scientific Project Manager at Ynsect with more than 8 years of experience in agroindustry. Her main topics of interest are on the development of novel ingredients that are nutritious, healthy and sustainable. She has worked on process and product development of insect based ingredients and is currently responsible for building strategic scientific evidence, to support nutritional and health claims for human and animal applications. Sanchez has a bachelor degree in Biology and a Master and PhD in Biotechnology from the National Autonomous University of Mexico.



## From Waste Stream to Alternative Protein PRESERVING FOOD BY-PRODUCTS FOR ANIMAL FEED

Andrea Lopez Global Product Manager Selko

"High-moisture by-products generated by the food industry are abundant and rich in nutrients. However, these perishable ingredients present challenges when it comes to storage, transport, handling, and utilization on the farm. Implementing a multistep process that spans every phase of the by-product lifecycle can help mitigate these challenges."

From snack foods made with insects to cultured meat grown in a laboratory, alternative proteins are emerging as viable sources for meeting dietary demands while preserving the planet's limited food production resources. A promising approach to solving the protein production dilemma focuses on repurposing by-products from human food for use in animal feed production. Around the globe, stakeholders in the food chain ranging from breweries and bakeries to food traders and farms are discovering ways to convert food by-products from the waste stream into nutritious protein sources for use in livestock feeds.

While the concept of using food by-products is not new, stakeholders' knowledge about how to practically implement this process has been limited. Most food by-products start to deteriorate quickly, reducing nutrient value, palatability, and, most importantly, the safety of the foodstuffs.

However, like many aspects of food production, science is introducing innovations to help manage these challenges and make preservation of by-products practical. Multiple studies conducted by Selko, the feed additive brand of Nutreco, have shown that highly potent buffered and non-buffered organic acid blends can preserve valuable nutrients in high-moisture by-products.

Selko has a long legacy of researching the mode of action that underlies organic acids' efficacy in animal nutrition. Multiple studies have provided insights to help develop products with demonstrated efficacy in inhibiting microorganisms, such as yeast, bacteria and moulds, and extending the shelf life of by-products and finished feeds. Below, we look at the scientific and practical aspects of collecting and reusing by-products for use as alternative protein sources.

### MANAGING MICROBIAL RISK IN HIGH-MOISTURE PRODUCTS

High-moisture by-products generated by the food industry are abundant and rich in nutrients. However, these perishable ingredients present challenges when it comes to storage, transport, handling, and utilization on the farm. Implementing a multi-step

process that spans every phase of the by-product lifecycle can help mitigate these challenges. A holistic approach to preserving by-products for use in animal feed should include recollection, treatment, transport to feed producers' facilities, and eventual storage and handling on the livestock farm. Adequate management measures are essential to achieve feed quality and safety objectives. Factors that must be considered include microbial diversity, spoilage mechanisms, and the application of validated preservation techniques using specific organic acids. A proactive and carefully considered approach to logistics can help preserve by-products for use as alternative protein sources.

The food industry produces significant quantities of high-moisture by-products, including, but not limited to, fruit and vegetable pulps, dairy whey, and brewery spent grains and yeasts. Sadly, much of this food goes to waste. In fact, the U.N. Food and Agriculture Organisation has reported that one-third of food produced – about 1.3 billion tons – is lost in the food chain. While some of that waste can be recollected and used for animal feed, by-products are highly susceptible to microbial spoilage and must be properly treated to protect ingredient safety. There are also logistical challenges that must be managed across every phase of the lifecycle, starting with the production facility.

#### By-product lifecycle assessment #1: Production Facility

A producer of high-moisture food by-products – typically a brewery/distiller, dairy processor, fruits and vegetable processing plant, or some other production facility – is the first point of contact for introducing preservation efforts. Treatment starts with the application of preservation products, like Revalet. The goal is to inhibit microbial proliferation and preserve nutrient quality. In developing the Revalet preservation product, Selko scientists relied on potent blends of buffered and non-buffered acids known to exhibit antimicrobial properties against a broad spectrum of microorganisms, including bacteria, yeasts, and moulds.

Measurement is essential for management, so the status of by-products must be assessed prior to treatment. Some assessment metrics include the by-products' pH, moisture content, nutrient composition, and microbial load. The assessment helps to determine the appropriate product and inclusion rate required for an effective treatment on a given by-product.



At the production facility, Revalet is generally applied to by-products through dedicated dosing systems that mix the product directly onto the by-product process lines before the final storage tank. Treatment at food production facilities may include inactivation of microorganisms used on biotechnology processes (i.e. fermentation). Revalet is commonly used for inactivation and microbial growth inhibition on the by-product. The treatment time may vary depending on factors such as the microbial count, temperature and pH of the by-product. Monitoring and quality control measures should be continued throughout the treatment to assess the efficacy of treatment and ensure the safety and quality of the treated by-products.

#### Lifecycle Assessment #2: Trader companies

Trader companies source high-moisture by-products, not always treated previously, at food production facilities. During the by-product recollection process, attention must be paid to factors such as freshness, hygiene, and initial microbial contamination levels to ensure the quality of the incoming by-products. The high-moisture by-products are transported from the producer to trader company facilities using specialised vehicles equipped with refrigeration or temperature control systems to maintain freshness and prevent spoilage. Upon arrival at the trader company's facilities, these products undergo a precise treatment protocol to control microbial growth and enhance shelf life. Selko's quality assurance and preservation experts can provide tailored guidance to adjust treatments.

#### Lifecycle Assessment #3: Animal feed producers

Upon arrival at the animal feed production facility, by-products are again inspected for quality. Food by-products quality checks usually include visual appearance, odour, dry matter and microbial load. At this stage, depending on the by-product's source, whether it be traders or directly from the food producers, by-products undergo further treatment with Selko products to help maintain their nutritional value and palatability. Additives such as vitamins, minerals, and enzymes may be incorporated into the by-products to meet specific nutritional requirements and support animal health and performance.



The treated by-products are then mixed and blended with other feed ingredients to create feed premix formulations. Collectively, these processes contribute to the sustainability and efficiency of animal agriculture by utilising valuable by-products from the food industry and applying them to feed production.

#### Lifecycle Assessment #4: On the farm

Managing and utilising feed premixes derived from high-moisture by-products directly on the farm involves careful handling, storage, and application to ensure the diet delivers optimal nutrition and supports animal health. Incorporating specially selected organic acid blends in feed premix formulations plays a crucial role in conserving quality, reducing nutritional spoilage, and enhancing microbial control.

## Below is a playbook of on-farm processes that support by-product treatment:

**a.** Storage and handling: Upon delivery, feed premixes should be stored in designated areas under controlled conditions to prevent exposure to moisture, sunlight, and contaminants.

**b.** Feed premixes can be incorporated into moist feed systems used to feed livestock, such as swine or ruminants. Conditions are different on every farm, so it is important to apply proper treatments for a given situation. Appropriate additives are added to moist feed formulations to inhibit microbial growth,

preserve nutritional integrity, and extend shelf life. Feed premixes are then carefully mixed with other feed ingredients, such as crushed grains, molasses, other by-products, and supplements, to achieve the desired nutrient composition and consistency.

c. Including preservative products in animals' feed premix and final feed helps to lower the pH levels in feed, creating an environment unfavourable for harmful microbial growth and reducing the risk of feed spoilage. Selko additives are designed to act as potent preservatives, extending the shelf life of feed formulations.

Preserving food by-products for use in animal feed can reduce use of landfill. This practice can also open up new feed ingredient options for regions of the globe where traditional protein ingredients may be in short supply. As an overlooked "alternative protein," properly treated food by-products can help optimise the allocation of resources used in food production and play a role in feeding the future.

## An integrated strategy support to a more circular approach

Given the multiple phases involved in the food by-products life cycle, Feed & Additive magazine wanted to know about how an integrated strategy can support ingredient quality and stakeholders' efforts to create a more circular approach to protein utilisation. Below are excerpts from a conversation with author Andrea Lopez, Global Product Manager at Selko.

### What opportunities and challenges do food producers face when it comes to managing high-moisture by-products like dairy whey, fruit and vegetable pulps, and brewery spent grains and yeast?

High-moisture products are utilised every day in various production processes and in food and beverage businesses. A perpetual stream of high-moisture ingredients is available in by-products and can be put to good use in animal feed, as opposed to ending up in a landfill or as biogas. However, the high level of moisture in these by-products can make it quite difficult to preserve the nutritional value so that the feed maintains its shelf life and nutritional value.

## How can stakeholders across the food chain manage these challenges?

It's essential to create a wise logistics strategy. A plan needs to consider the best time to pick the by-products up, the best means to transport them to the trader company, feed premix facility, or farm, in the proper conditions. Preservation products applied to by-products at any stage of the process can help reduce microbial proliferation, inhibit the deterioration of by-products, and preserve nutritional quality.

## How is ingredient quality managed across the by-products journey?

I'll share an example from the Netherlands, where we pay close attention to the life cycle of by-products as they travel from the producer to the food traders to the feed mill or premix facility and eventually to the farm. As perishable ingredients age and conditions change, monitoring must be consistently carried out. By assessing ingredients at each point, we can determine the proper Revalet or Selko products to introduce the specific inclusion level. For example, we can see how much of the treatment product is needed to inactivate yeast development at a producer's location. When ingredients arrive at the food-or, by-products traders or feed producers, it may be necessary to add other Selko solutions to maintain the nutritional value and decrease the microbial load. Additional treatment depends on whether ingredients were previously treated at the food producer's facilities or if they come directly from food processing. More adjustments may be needed to deal with challenges at the farm, like biofilm levels in the pipes of liquid feeding systems.

## How does preserving by-products benefit participants across the distribution chain?

Workers at trading companies, feed premix facilities, and on the farm are all very busy. While it's



true that you can't buy time, proper treatment of ingredients can allow more time for a product to be kept in transit or storage and still maintain its nutritional value and other attributes like palatability and dry matter levels.

We also should be mindful of production regions that may not have ready access to ingredients. Again, treating by-products with preservatives provides a workable way to get animals the high-protein ingredients necessary to achieve production goals.

And, finally, if we can put materials that would otherwise end up as landfill or biogas, to use in animal feeds, we can reduce the amount of natural resources required to produce protein ingredients for livestock production.

#### Do different phases of the ingredient life cycle present more challenges when it comes to preservation?

The conditions on a farm are typically different than the conditions in a production facility or during transit. For example, varying levels of heat, humidity, or ventilation in the environment should be considered to ensure that products maintain quality and nutritional standards until they are consumed by the animal.

At Selko, we've done studies to understand which specific organic acids and inclusion rates are most effective at treating different by-products in different conditions and life cycle stages. Data from these studies can help by-products traders, feed premix producers, and farmers evaluate the best approach to achieve a good return on investment.

## What species can consume feeds made with by-products?

Brewer's yeast by-products are particularly well suited for liquid swine feeds. Similarly, molasses is a good ingredient for liquid feeds used in ruminant nutrition. As a research-driven organisation, Selko is investing in studies to understand how the preservation of by-products can lead to more innovation in animal feed for a range of aquaculture. Some industries – like aquaculture – are more challenging than others, but there is an opportunity to build on the successes we've seen with by-product use in swine and ruminant nutrition.

#### About Andrea Lopez

Andrea Lopez is Selko's Global Product Manager for Yeast Control and Food2Feed program. She is a dynamic professional with a background in biotechnology and a wealth of experience in sustainable practices within the food and feed industry. Her work experience has been dedicated to implementing sustainable solutions that optimize the utilization of by-products as alternative protein and nutrients sources, replacing common raw materials used in animal feed. Currently, Lopez serves in a pivotal role focusing on the application of organic acids for nutritional preservation and microbial control in high moist by-products. As an integral member of the team, she spearheads initiatives aimed at harnessing the potential of organic acids to enhance the nutritional quality and safety of these by-products when used on animals. Her dedication to addressing environmental concerns while promoting nutritional preservation underscores her commitment to shaping a more sustainable future for the feed and food industry.



## INSECT MEAL AS A TOOL FOR REDUCING THE ENVIRONMENTAL IMPACT OF LIVESTOCK PRODUCTION

Nick Piggott Co-Founder and Co-CEO Nutrition Technologies

"Similar to livestock production, the top two impact hotspots in BSF production are energy and feed, indicating that using a clean energy mix, and making efficiencies and optimising feed formulae for the BSF will make the biggest saving in emissions, which can then be passed on to feed manufacturers and animal producers."

t is well reported that livestock production, Lespecially ruminants, has a significant negative impact on the environment, both locally and globally. It is also well noted that as the forecasted population and demographic changes materialise, the global population will consume more, not less meat. The implications this has for both local environments around livestock farms (through land usage change, water eutrophication, etc) and the global environment (Global Warming Potential, water acidification, etc) are massive. 80% of global land use is attributed to livestock (mostly through the production of feedstock), which in turn causes land degradation, biodiversity loss, and air quality deterioration, making the search for less impactful sources of feed increasingly urgent.

In parallel to the growth of the livestock industry, the science behind measuring environmental impact through Life Cycle Assessments (LCAs) has become more reliable, and the ability to report on environmental impact is fast approaching the demand for increased transparency in the food supply chain. Global databases like The Environmental Footprint (EF) database from SimaPro, and standardised methodologies such as the Product Environmental Footprint (PEF) developed by the European Commission over the last decade have made it infinitely easier to compare and contrast products. This in turn, has enabled businesses around the world to identify both their key categories of concern (GHG emissions, land usage change, water usage, etc), as well as their 'hotspots' - where the bulk of their own impact is coming from. These two data points facilitate a clearer understanding of the impact being made, and the prioritisation of the inputs or processes to make the biggest reductions therein.

At a very high level, academic studies into livestock production conclude two things; that feed is one of the major contributors to climate impact, and that the protein source is the biggest contributor within the feed.

With this in mind, livestock feed producers can make a number of simple adjustments to reduce their own environmental impact by focusing on the key impact areas of; energy, and protein in feed. Solar power is already becoming commonplace in industrial and agricultural production systems, reducing the energy input requirement, thus reducing the use of grid energy. This is particularly significant in parts of the world where little of the energy mix is renewable, and so can make an outsized difference by replacing grid with solar.

The other major opportunity is to use feeds with low-impact protein ingredients, such as insect meal. Insect meal, and particularly BSF meal, has been identified as a high potential replacement for fishmeal to reduce ocean impacts, and soybean meal to reduce deforestation and biodiversity loss, but little has been discussed around the GHG-reduction opportunity presented by insect meal (and oil). In 2023 Nutrition Technologies conducted a LifeCycle Assessment (LCA) following the European Commission's cradle-to-gate Product Environmental Footprint (PEF) methodology, to identify the various impacts that result from farming BSF for animal feed in Malaysia. Similar to livestock production, the top two impact hotspots in BSF production are energy and feed, indicating that using a clean energy mix, and making efficiencies and optimising feed formulae for the BSF will make the biggest saving in emissions, which can then be passed on to feed manufacturers and animal producers.

Looking more closely at our own production hotspots and comparing them to publicly available information from other BSF producers around the world, we can see that the lower environmental impact of our BSF meal is possible for three major reasons; the use of a low-energy tropical production system, the use of low-grade raw materials used to feed the BSF larvae, and implementing a fermentation step to release more nutrition from the raw materials.

One of the major implications of comparing LCAs from different producers, is to understand



that different production systems can have vastly different environmental impacts, and that different insect meals aren't necessarily interchangeable when it comes to sustainability metrics. A BSF producer operating in cold winter climates must heat, light and humidify huge volumes of warehouse air, demanding significant energy inputs, which can have a massive impact on Green House Gas (GHG) emissions. Similarly, feeding insects with corn, wheat and barley byproducts (which themselves could otherwise be used as a direct animal feed) have massive environmental footprints, which impacts the 'real' sustainability of the resulting insect meal.

While sustainability is a growing issue around the world and climate-aware consumers are asking more demanding questions about supply-chain transparency, reducing environmental impacts is still not a priority for many producers, particularly during periods of market volatility, outbreaks of disease (eg ASF), and other more immediately pressing issues exist. However, there is a vast and rapidly growing body of evidence that proves that not only does a tropically-produced insect-based feed reduce the environmental impact associated with livestock production, it also improves the feed uptake & feed efficiency, can increase resistance to common pathogens thereby reducing the usage of antibiotics, and reduce the overall costs of livestock production. Insect meal is a complex ingredient with multiple value propositions spanning nutritional, environmental and functional, and it is for these reasons that formulators and farm operators should look at the ingredient through a multifaceted, holistic lens.



#### About Nick Piggott

Nick Piggott is a co-founder and Co-CEO of Nutrition Technologies, an industrial insect manufacturer based in South East Asia. With a background in Life Sciences, Piggott was exposed to the challenges of food security whilst working for the UN in West Africa, and the company has since developed insect-based feed-ingredients for the livestock and aquaculture industries to address this issue. Piggott is the industry-side face of Nutrition Technologies, overseeing the product, regulatory, & client side of the business, ensuring that the organization maintains constant awareness of the competitive & regulatory landscape, market trends, technology developments and industry standards. Expand your knowledge and make a positive impact to global transitions

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## INSECT MEALS AS A SOURCE OF FUNCTIONAL AND BIOACTIVE COMPOUNDS

"Today, insects from order Orthoptera, Coleoptera and Diptera represent the most prevalent groups of insects which are used as an alternative feedstuff, either as a full fat insect meal, defatted insect meal, or insect derived oil. Their inclusion is in many cases considered as a good quality protein or fat addition in feed mixtures, but edible insects pose as much more when it comes to their physiological and biological activity."

With the world population projected to reach 9.8 billion people by 2050, both accessibility and affordability of alternative proteins are to be taken into account if they are to play a substantial role in addressing these challenges. Showing great potential for future food systems, edible insects are considered an environmentally friendly choice as alternative sources of proteins. Their primary benefit is reflected in a good nutritional profile — high percentage of protein with high-quality amino acids, fatty acids (e.g. omega-3), fibers, vitamins (e.g. vitamin B12), and minerals such as calcium and iron, as well as highly efficient conversion of ingested matter into biomass. Many insects possess the potential for recycling

agricultural waste products, which they can use as feeding substrates and transform them into nutritious food and feedstuff, which is then returned to the production cycle.

Today, insects from order Orthoptera, Coleoptera and Diptera represent the most prevalent groups of insects which are used as an alternative feedstuff, either as a full fat insect meal, defatted insect meal, or insect derived oil. Their inclusion is in many cases considered as a good quality protein or fat addition in feed mixtures, but edible insects pose as much more when it comes to their physiological and biological activity. The bioactivities of various edible insect species have been tested using in vitro assays and in vivo models, either as extracts from the whole insect or as isolated compounds.

#### ANTIOXIDATIVE ACTIVITY

Oxidative stress is a physiological imbalance between the production of reactive oxygen species (ROS) and the ability of the body to detoxify them or repair the resulting damage. Essentially, it occurs when there's an overabundance of these harmful molecules compared to the body's antioxidant defenses. ROS are highly reactive molecules containing oxygen, such as superoxide radicals, hydrogen peroxide, and hydroxyl radicals, which can damage cells, proteins, and DNA if not neutralized. It is considered that the eating habits of insects have a significant influence on antioxidative activity of their meals. Luckily, the commercially available edible insects which have vegetarian dietary habits endowed the highest antioxidant capacity in vivo test which were aiming on activity of radical scavenging and ferric reducing antioxidant power (FRAP). Both approved species from the family Tenebrionidae, yellow mealworm Tenebrio molitor and buffalo mealworm Alphitobius diaperinus can play an important role in the prevention of oxidative stress-related diseases. Inclusion of T. molitor insect meal in the pig diet containing suitable levels of antioxidants, like vitamin E and selenium. In vitro tests

showed increased activity of important antioxidant enzymes (CAT, GPX and SOD) in liver and *gastroc-nemius* muscles of growing pigs.

#### ANTI INFLAMMATORY ACTIVITY

The anti-inflammatory activity of insect meals refers to their ability to reduce inflammation within the body. Inflammation is a natural response by the immune system to injury or infection, but chronic inflammation can contribute to various diseases such as arthritis, cardiovascular diseases, and certain cancers. Insects, particularly from the order Orthoptera (*Grylloides genus*) have bioactive compounds, which have been studied for their potential to mitigate inflammation. These bioactive compounds belong to the group of peptides and various fatty acids. Research suggests that certain edible insects, when consumed as part of the diet, may exhibit anti-inflammatory effects. Anti-inflammatory mechanisms within the animal body are divided into several groups:

• Modulation of immune cells: Certain compounds in insect meals may modulate the activity of immune cells, such as macrophages and lymphocytes, involved in the inflammatory response. By regulating immune cell function, insect meals can help maintain immune homeostasis and reduce excessive inflammation.



• Inhibition of inflammatory enzymes: Some insect-derived bioactive compounds may inhibit the activity of enzymes involved in the production of inflammatory mediators, such as *cyclooxygenase* (COX) and *lipoxygenase* (LOX). By blocking these enzymes, insect meals can suppress the synthesis of pro-inflammatory prostaglandins and leukotrienes.

• Gut microbiota modulation: Insect meals may influence the composition and activity of the gut microbiota, which plays a crucial role in immune regulation and inflammation. By promoting the growth of beneficial bacteria and inhibiting pathogenic microbes, insect meals can help maintain intestinal barrier integrity and reduce inflammation in the gut.

• Modulation of cytokines: Insect meals may contain bioactive compounds that regulate the production and activity of pro-inflammatory cytokines, such as tumor necrosis factor-alpha (TNF- $\alpha$ ), interleukin-6 (IL-6), and interleukin-1 beta (IL-1 $\beta$ ). By inhibiting the expression of these cytokines, insect meals can attenuate the inflammatory response.

*T. molitor* and *Z. morio* full-fat meals, as functional feed additives, increased the growth performance of broiler chickens and changed traits of their immune system (Benzertiha et al. 2020), while defatted *Z. morio* larvae meals can lead to immunomodulation in the gilthead seabream *Sparus aurata* (Henry et al. 2022).

#### ANTI CANCEROGENIC ACTIVITY

Wide range of research aims to prove that different types of edible insects, their exoskeleton, hemolymph, have a negative impact on cancer cell growth. Although the research dealt with human lines of cancer cells it is worth mentioning that insects will have a significant role in the future as a potential novel pharmaceutical. Last 40 years of research mostly shined light on the Hymenoptera species as a source of anti-cancer pharmaceutical, thus testing *Apis mellifera*, *Chalicodoma siculum*, and *Xylocopa pubescens* hemolymph on human liver cancer (HepG2) and human cervical cancer (HeLa) cells, where all hemolymph extracts resulted in inhibition of cell viability against the tested cancer cell lines in a dose-dependent manner. Experiments related to the approved edible insect species like house cricket showed that its Chitin and its degraded products such as chitosan have been shown to exert anticancer and antimicrobial properties.

#### ANTI MICROBIAL ACTIVITY

Research in this area is ongoing, specifically focusing on the antimicrobial activity of edible insects, some studies have shown promising results.

#### Several factors may contribute to the antimicrobial potential of edible insects:

• **Chitin:** Insects are rich in chitin, a polysaccharide that forms their exoskeleton. Chitin and its derivatives have been studied for their antimicrobial properties, particularly against bacteria and fungi.

• **Peptides and proteins:** Insects produce various peptides and proteins as part of their immune response to pathogens. Some of these peptides have demonstrated antimicrobial activity against a wide range of microorganisms.

• Secondary metabolites: Edible insects, like other organisms, produce secondary metabolites that may possess antimicrobial properties. These compounds could be present in various tissues, such as the gut, fat body, or hemolymph.

• Microbial composition: The gut microbiota of insects might produce antimicrobial substances that could influence the overall antimicrobial activity of the insect.

Research has shown that extracts from certain edible insects exhibit antimicrobial effects against common foodborne pathogens such as Escherichia coli, Salmonella spp., and Staphylococcus aureus. For example, extracts from mealworms (*Tenebrio molitor*) and crickets (*Acheta domesticus*) have shown inhibitory effects against these bacteria in laboratory studies.

However, it's important to note that the antimicrobial activity of edible insects can vary depending on factors such as species, life stage, diet, and processing methods. Additionally, while laboratory

studies provide valuable insights, more research is needed to understand how these findings translate to real-world applications, such as food preservation or medical uses.

Overall, while there is evidence to suggest that edible insects may possess antimicrobial properties, further research is necessary to fully understand the mechanisms involved and to explore their potential applications in various fields, including food science, medicine, and agriculture.

Hermetia llucens is a species which is often highlighted as a species whose body and feces are rich in antimicrobial peptides, new molecules with great potential in pharmaceutical and biomedical fields. This species is especially standing out in this field as the progressive misuse of antibiotics has unfortunately favored the selection and spread of resistant populations of bacterial agents. The development of antibiotic-resistant bacterial strains and the reduced availability of effective antibiotics, a need to identify new molecules in which insect species have their spotlight, to be used for the development of alternative therapies. Recent studies have also highlighted the potential antimicrobial activity of some H. illucens AMPs against Staphylococcus aureus, methicillin-resistant S. aureus and Pseudomonas aeruginosa.

#### CONCLUSION

The exploration of the medicinal properties of edible insects reveals a promising avenue for both food science and healthcare. Delving deep into their potential as sources of anti-cancer, anti-inflammatory, antioxidant, and antimicrobial compounds unveils a wealth of bioactive molecules within these often looked as an exclusive, alternative protein food source. However, while the initial findings are promising, further research is necessary to fully elucidate the mechanisms of action, optimize extraction methods, and assess the safety and efficacy of these compounds for animal and human use. Additionally, considerations such as species variability, life stage, diet, and processing methods must be taken into account to harness the full therapeutic potential of edible insects.



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## WHY EDUCATION IS KEY TO PROMOTING INSECTS AS FOOD AND FEED

**Rodrigo Llauradó Casares** Co-Founder and Marketing Specialist Insect Academy

"Insect education creates a sense of empowerment and resilience among communities worldwide. As people gain the knowledge and skills to rear, process, and utilize insects, they become less reliant on traditional food systems that can be inefficient and unsustainable. This self-sufficiency not only enhances food security but also promotes economic development and social equity."

As the demand for insect ingredients for food, feed, and non-food applications grows, there is a corresponding need for qualified personnel within the insect production industry. This includes professionals from a wide variety of fields e.g. entomology, engineering, veterinary science, food science, and agronomy, among others.

It is necessary to create an appropriate educational offer for the actors within this industry, meaning quality materials, qualified instructors, and collaborations with insect producers.

#### CHALLENGES IN ACCESSING QUALITY EDUCATION ON INSECTS AS FOOD AND FEED

For those intrigued by the possibility of exploring insects as a source of food and feed, the learning curve presents many challenges. The field is still in its infancy, with no university programmes dedicated exclusively to insect breeding and production for food and feed. Instead, these subjects are often integrated into broader curricula. Those seeking specialized knowledge must rely on courses, seminars, or workshops offered by universities, private entities, or start-ups linked to insect production. With the exception of a few offerings, these resources are often costly, can be restricted by language, usually follow a traditional face-to-face format, or lack solid scientific support.

If we are to meet the needs of the growing human population, there is no way to maintain conventional livestock production from an environmental point of view. The use of insects as a viable alternative for food and feed is essential to meet this challenge. Improved education in this field is therefore essential.

Renowned entomologist Arnold van Huis, whose pioneering work has boosted the insect-based food and feed industry, advocates for the integration of this field into formal education. This is in line with Sustainable Development Goals 4 and 12, which emphasize quality education and responsible consumption and production, respectively. Recognizing its potential role in securing our future food supply, van Huis stresses the importance of fostering expertise in this burgeoning field (Rumpold and van Huis, 2021).

#### ADDRESSING EDUCATIONAL GAPS WITH ONLINE COURSES

Insect Academy is a pioneering web platform dedicated to promoting the potential of insects as food, feed, and various other applications. Our values include a commitment to educating people about this innovative topic with the utmost passion and rigour. At Insect Academy we strive to develop high-quality, research-based courses with passion and, most importantly, a constant drive to promote insects as sustainable food and feed alternatives.

Recognizing the importance of accessibility, we offer courses entirely online, available on demand and at minimal cost. By removing barriers to access, we aim to reach a wider audience and enable people from all over the world to enter this field.

Looking ahead, at Insect Academy we want to forge partnerships with key stakeholders in the insect production sector. These collaborations will not only reinforce the credibility of our courses, but also ensure alignment with industry standards and best practices. Together, we want to create a community dedicated to advancing the use of insects for sustainable food and feed solutions.

## CAREER OPPORTUNITIES IN THE INSECT PRODUCTION INDUSTRY

The insect production industry offers a wide variety of career opportunities in fields as diverse as life sciences, engineering, agriculture and livestock management (Table 1).

Imagine learning about the insect production industry not just as a niche topic, but as a fundamental component of our sustainable future. By adopting this education, individuals gain the knowledge and skills needed to contribute to a global shift towards more environmentally friendly and nutritious food and feed sources, as well as alternative nonfood ingredients.

Students become pioneers in the field, leading the way toward a future in which insects play a vital role in addressing food security challenges and promoting responsible consumption and production practices. As they learn, they move closer to a future in which insect farming is not just a novel concept, but a cornerstone of agricultural sustainability.

Table 1. Disciplines involved in the insect production industry	
Life Sciences	Animal Behavior, Biochemistry, Biology, Dermatology, Entomology, Medicine, Microbiology, Neuroscience, Nutrition, Pharmacology, Veterinary Medicine
Engineering	Chemical, Civil, Electrical, Electronic, Environmental, Industrial, Mechanical, Software
Agriculture and Livestock	Agronomy, Animal Nutrition, Aquaculture, Farm Management, Insect Farming, Livestock, Poultry, Zootechnics
Environment	Conservation Science, Ecology, Environmental Consulting, Renewable Energy, Waste Management
Data and Technology	Biotechnology, Data analysis, Data Science, IT Project Management, R&D
Social Sciences and Humanities	Anthropology, Communication, Pedagogy, Psychology, Sociology, Writing
Food	Food Quality, Food Science, Food Supply, Gastronomy
Others	Academic Research, Architecture, Cosmetology, Education, Industrial Design, Marketing



### BUILDING A SUSTAINABLE FUTURE THROUGH EDUCATION ON INSECTS AS FOOD AND FEED

Moreover, insect education creates a sense of empowerment and resilience among communities worldwide. As people gain the knowledge and skills to rear, process, and utilize insects, they become less reliant on traditional food systems that can be inefficient and unsustainable. This self-sufficiency not only enhances food security but also promotes economic development and social equity.

In essence, the transformation brought about by insect education extends beyond academia. It represents a paradigm shift in how we perceive and interact with the natural world, ushering in a new era of sustainability.

At Insect Academy, we support appropriate education about insects as food and feed, ensuring it is accessible to as many people as possible. For us it is not simply about believing in insects as the future; it is about knowing they are the real deal right now. That is why we urge people to take advantage of the wealth of opportunities that are already available within this thriving industry.

If you aspire to be part of the insect production industry today, the first step is to immerse yourself in learning about it. Whether you are a student eager to explore new horizons, a professional looking to diversify your career, or an enthusiast intrigued by the possibilities, we extend an open invitation to join us. It's your time to leverage the current potential of this dynamic field.

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1. Rumpold, B.A.and van Huis, A. Education as a key to promoting insects as food. Journal of Insects as Food and Feed, 2021; 7 (6): 949-95. <u>http://dx.doi.</u> org/10.3920/JIFF2021.x007

#### About Rodrigo Llauradó Casares

After 9 years of experience in research on the use of insects as food and feed, Llauradó Casares is committed to promoting the nutritional, environmental, and culinary potential of insects. With a background in Social Sciences and Marketing, Llauradó Casares is currently driving edible insect education through virtual courses at Insect Academy. He co-founded the Edtech company with Alexandre Chatelier, an insect industry marketing specialist holding a double MSc in Entrepreneurship and Innovation.



## MAXIMIZING PERFORMANCE, A NECESSARY TRANSITION TO BSF INGREDIENTS

Aubin Bernard Entomologist Flylab

"The transition from fishmeal to insect-based ingredients in aquaculture nutrition represent a huge shift in the industry. The availability of fishmeal has reached its limit and cannot support this rate of overfishing, positively leading to much more sustainable solutions such as BSF meal."

B lack Soldier Flies (BSF), a fast-growing industry, has caught the attention of all major aquaculture producers globally, and for a good reason, including BSF meal in many species of fish seems to increase performance and is becoming more available with companies producing at larger scales.

#### NUTRITIONAL PROFILE

BSF or *Hermetia illucens* are bio-accumulators, this means they will absorb and store substances such as amino acids, fatty acids and micronutrients from their feed source. This also implies that they will accumulate pollutants or toxins if present in their feed. The quality and nutritional profile of BSF meal is thus largely based on the rearing substrate. This underlines that the feed intake for the insects will directly affect the nutritional profile of the products fed to fish. At Flylab, we have chosen a naturally complete diet in order to maintain our clients' quality standards, and have a nutritional profile to fit the needs of the aquaculture industry.

#### **CASE STUDIES**

The performance of BSF meal directly compared

to fishmeal has been studied in a number of animal species. We have chosen to analyse 4 species in this article; Pacific White Shrimp (*Litopenaeus vannamei*), Koi Carp (*Cyprinus carpio var. koi*), Siberian Sturgeon (*Acipenser baerii*) and Atlantic Salmon (*Salmo salar*). For further information, these studies are available at the end.

#### Performance on Pacific White Shrimp (1):

Kasetsart University in Thailand made an experiment designed to assess the effects of partial replacement of fishmeal in Pacific White Shrimp diets. The insects were sourced from Flylab in Thailand. A total of 5 treatments were analysed, gradually replacing fishmeal by BSF meal by up to 60%.

Over the course of 8 weeks, the Pacific White Shrimp showed distinct differences in weight, survival rate, feed conversion ratio and even colour.

• Average weight gain went from 6.55 to 7.98g, underlining a 22% gain.

• Survival rate went from 75.56 to 91.11%, another gain of more than 20%.

• Feed conversion ratio went from 1.12 to 1.67, a staggering 49% difference.

This unpublished study shows that BSF meal is not only a potential replacement for fishmeal in Pacific White Shrimp diets, but it also completely outperforms it.

#### Performance on Siberian Sturgeon (2):

Poznań University of Life Sciences in Poland made an experiment designed to compare the sustainability, economy and GIT development of BSF ingredients in comparison with fishmeal and oil. The insects were produced at HiProMine in Poland. A total of 7 treatments were analysed, also gradually replacing fishmeal by BSF meal to include a total of 30% in the end recipe.

Over the course of this experiment, many factors were considered, the key numbers to extract from the performance on Siberian Sturgeon were the following:

• The fish-in fish-out ratio decreased from 1.04 to 0.26. This decrease of 75% in potential feed usage is not necessarily the best economic choice when further analysing the results, however it is best in sustainability.

• The feed conversion efficiency went from 1.13 to 1.47, thus potentially needing less feed for the same output.

• The profit per kg of live fish was increased from  $6.48 \in$  to  $6.70 \in$  in the best treatments, a potential increase of  $0.22 \in$  per kg of fish.

This study does show that, at current prices, all treatments containing insect ingredients are favoured

considering environmental sustainability and economic profitability in Siberian Sturgeon production.

#### Performance on Atlantic Salmon (3):

Institute of Marine Research in Norway made an experiment designed to assess the potential of insect-based diets in fresh-water Atlantic salmon. The insect ingredients were produced by Protix in the Netherlands. A total of 6 treatments were analysed testing different formulations with inclusions of BSF meal and BSF Oil.

The results of this experiment show very similar results between diets and underline that it is possible to add insect meal in combination with insect oil in the diets of fresh-water Atlantic Salmon up to 600g/kg without any adverse effects on growth performances, feed utilization, apparent digestibility and whole-body composition.

#### Performance on Koi Carp (4):

Chiang Mai University in Thailand made an experiment designed to gradually totally replace fishmeal by BSF meal in Koi Carp diets. The black soldier flies were produced locally by Chiang Mai University's Faculty of Agriculture. A total of 5 treatments were analysed over the course of 8 weeks.

The results of this experiment show benefits in immune-related gene expression after incorporating higher amounts of BSFLM (Black soldier fly larvae meal) into the diet. This could also explain the sig-





nificant trends in growth parameters, resulting in bigger and healthier Koi Carp.

## KEY TAKE-AWAYS FROM ACADEMIC RESEARCH

These studies demonstrate that incorporating black soldier fly larvae into different fish diets can lead to improved overall performance, or at worst, no significant changes. These findings, and many more, are supported by quantitative data and statistical analysis that is available online should anyone want to read more about the different experimental protocols and results.

The transition from fishmeal to insect-based ingredients in aquaculture nutrition represent a huge shift in the industry. The availability of fishmeal has reached its limit and cannot support this rate of overfishing, positively leading to much more sustainable solutions such as BSF meal. Insects additionally offer enhanced performance leaving them as one of the top choices to meet consumer demand for sustainable protein sources.

#### UNDERSTANDING DIFFERENCES IN MARKET OFFERINGS

As mentioned above, the nutritional profile and quality of BSF meal will vary depending on feed source and supplier, and can even be tailored for specific markets and individual species' needs. For example, BSF meal can range in crude protein content from 37 to over 60%, each of which will have different amino-acid composition depending on the initial diet of the insects. The performance of insect-based ingredients will need to be further tested and compared between different key industry stakeholders in order to offer consistent products over time.

At Flylab, we see premium insect-based ingredients in aquaculture nutrition being a key factor in improving performance in the coming years, while also bringing more sustainable products to impact our future. Usually, nature comes at a cost, we believe that we can achieve both increasing performance in aquaculture and reducing overfishing, offering a win-win solution for all parties, including our planet.

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#### About Aubin Bernard

With more than 5 years of insect rearing experience in laboratories and industrial set-ups, Aubin is passionate about insects and nature conservation. Having kept over 200 total different species, Aubin Bernard now focuses solely on black soldier flies. Currently based in Bangkok, Aubin is a French self-taught entomologist who chose hands-on experience over academia.



## NEW STUDY: FUNGI-DERIVED MYCOPROTEIN DELIVERS OPTIMAL PROTEIN AND FIBER

Elisa Arte Ingredient Development Manager Enifer

Published in Food Research International, the study reveals that fungi-derived mycoprotein has high protein digestibility and gut fermentability of dietary fibres. Notably, certain strains studied outperformed the protein digestibility of Quorn mycoprotein.

While fungi have always been a natural part of the human diet, they have often been regarded more as a curiosity than a dietary staple – we might go foraging in the forest to pick a few to add to a sauce or buy some to add a bit of flavor to a dish. However, they present untapped potential as a major sustainable protein source alongside plants and meats.

With the global population projected to reach 10 billion by 2050, <u>estimates suggest</u> that it's impossible to increase the supply of conventional protein sources without the world boiling over. The development of alternative protein production methods is crucial to address this challenge. However, transitioning to non-animal protein sources has been hindered by the perception that plant-based/vegetarian diets may lack sufficient protein and essential nutrients.

A <u>new study</u> conducted by researchers at VTT Technical Research Centre of Finland examined the nutritional quality of microbial biomass samples, including mycoprotein, a bacterial strain, and yeast. The study assessed the protein contents and digestibility, the dietary fibre content, and carbohydrate fermentability in the colon using in vitro methods, with Quorn mycoprotein serving as a reference. The study presents a promising avenue for addressing the nutritional concerns of alternative proteins.

### MYCOPROTEINS SHOW STRONG DIGESTIBILITY

The study reaffirmed what we already understand about mycoproteins' high protein content, ranging from 20 % in Myco-Rhizopus to 46 % in the mycoprotein PEKILO<sup>®</sup> sample, with Quorn at 39 %.

However, beyond protein content lies the importance of protein digestibility and nutrient absorption, which are indicators of overall nutritional quality. Protein digestibility refers to the body's ability to utilize dietary protein and absorb amino acids after digestion, influenced by factors such as bioavailability and protein structure.

Mycoproteins exhibited high digestibility rates in the study, and have superior protein digestion compared to plant sources. The highest digestibility came from the mycoprotein PEKILO<sup>®</sup>, with its digestibility ranging from 56% to 77% – even better than Quorn (45%). Furthermore, mycoproteins exhibited superior protein digestibility compared to plant proteins due to differences in the cell wall composition and the absence of anti-nutritional compounds, which are typically produced by plants in self-defense.

Given these findings and the favorable amino acids profile of mycoprotein, especially the highest-ranking PEKILO<sup>®</sup>, it emerges as a highly nutritious ingredient.

#### MYCOPROTEINS OFFER SIGNIFICANT BENEFITS FOR GUT HEALTH

Mycoproteins are not just replacing meat – it has other attributes, such as dietary fibre content, that make them a highly valued ingredient. It's well known that high dietary fibre intake <u>leads to reduc-</u> tions in the risks for type two diabetes, heart diseases, and colorectal cancer, for example.

The study by VTT revealed that the dietary fibre content of the biomass does not affect protein digestibility, a common issue in plant-based ingredients where protein is surrounded and covered by dietary fibre, rendering it inaccessible to digestive enzymes. This finding suggests that mycoprotein offers a dual advantage by delivering both proteins and dietary fibres effectively.

In fact, the fermentability of mycoproteins' dietary fibre was found to be comparable to that of wheat bran, indicating the potential benefits of its dietary fiber as nourishment for the gut microbiota.

#### WHAT ELSE IS MYCOPROTEIN GOOD FOR?

Research published in the Journal of Nutrition indicates that fungi-derived mycoprotein is as effective as animal protein at supporting muscle building during resistance training.

Furthermore, a <u>2023 study</u> by researchers at the University of Exeter concluded that fungi-derived pro-



tein is equally effective in supporting muscle building during resistance training compared to animal protein.

Additionally, a study published in <u>Clinical Nutri-</u> <u>tion</u> compared the effects of consuming mycoprotein or fungal protein products with those of fish and meat over four weeks. The results demonstrated that the group consuming mycoprotein experienced a reduction of up to 10% in certain cholesterol levels.

#### CONCLUSION

A significant challenge in exploring alternative protein sources to meat and dairy lies in delivering health benefits, particularly high-quality protein, to consumers. Nevertheless, recent studies consistently prove the health and environmental advantages of consuming fungi-based proteins.

Additionally, mycoprotein production requires no additional agricultural land and minimal water, resulting in negligible nutrient runoff and an exceptionally low environmental footprint compared to both plantbased and animal-based proteins. Overall, the health benefits and low environmental footprint of mycoprotein make it a highly impactful ingredient.

#### About Elisa Arte

Elisa Arte is the Ingredient Development Manager at Enifer. She holds a PhD in Food Sciences from the University of Helsinki, and has previously worked at Raisio as a Research and Development Specialist





**Azwa Aasdik** Quality Assurance Manager Veolia Bioconversion Malaysia Sdn Bhd

**Tze Min Teo** Chief R&D Officer Entofood Sdn Bhd

## ENSURING QUALITY, FEED SAFETY AND HYGIENE: A COMMITMENT TO EXCELLENCE

"The production of insects and the use of insect-based products in animal feed is growing worldwide and safety issues related to insect farming and processing remain a major concern for the feed industry such as pet food, aquafeed, livestock feed. Insect producers are becoming more professional by establishing and adhering to the rules."

Insect farming has become increasingly popular in Asia and there are challenges involved in the scaling of insect protein particularly related to quality control measures, risk assessments due to the absence of an international regulatory framework.

A recent study conducted by the Asian Food and Feed Insects Association (AFFIA) in 2022<sup>1</sup> found that nearly most of the Southeast Asian surveyed producers refer to global standards such as the Good Manufacturing Practices (GMP/GMP+), HACCP, and to IPIFF Good Hygiene Practice guidelines<sup>2</sup>. These guidelines emphasise good hygiene practices and incorporate HACCP principles for insect production, addressing specific concerns outlined by the European Food Safety Authority (EFSA)<sup>3</sup>. While sector-specific hygiene guides are encouraged, compliance remains voluntary for insect producers, with the guide serving as a reference rather than a substitute for regulation. It also applies to third country operators wishing to sell insect products in the EU, indicating compliance with EU standards. The guidelines outline the details of importing insect products, and emphasises compliance with specific regulations and certification requirements. It covers subsequent activities within the EU, including packaging, transport, and retailing<sup>4</sup>.

#### **HEALTH & SAFETY STANDARDS**

Veolia Bioconversion Malaysia Sdn Bhd, one of the largest producers of Black Soldier Fly in Asia Pacific, has its facility located in the north of Kuala Lumpur, Malaysia with a production capacity of 3 000 tons of insect-based products per year.

Ensuring feed safety is crucial for Veolia Bioconversion Malaysia to meet regulatory requirements, maintain the confidence of feed customers and uphold industry standards for insects. Although there is no international standard for insects set by the World Organisation for Animal Health (WOAH), our approach has been to apply appropriate quality management principles demonstrating that we are operating in a feed safety environment.

We are ISO 22000:2018 certified, a globally recognised food safety management system, with a strong emphasis on risk assessments.

We follow strict quality control, provide ongoing staff training/education and adapt the best practices from the food industry. As such, we implement the Hazard Analysis Critical Control Point (HACCP) principles by identifying hazards and critical control points (CCP) in our production process.

Our production line is equipped with sensors that monitor the process and parameters impacting on critical control points during the drying and packing steps. Additionally, our plant is GMP+ certified, ensuring consistent adherence to international quality standards.

We are committed to IPIFF Good Hygiene Practices on biosecurity by protecting our building and premises from external environmental risks, such as flooding, pollution, pests and diseases. We have designed and built our plant with specific measures to prevent the escape of insects.

By applying all these stringent standards and complying with EU and FDA regulations<sup>5</sup>, we are able to export our high quality, consistent products to the regulated markets.

#### CHALLENGES IN INSECT PRODUCTION

The quality of our insect products is determined not only by the nutritional value but also by the controls implemented during the manufacturing process. Insect-based ingredients production consists of three steps: farming, harvesting and processing. It is crucial to monitor them and be compliant with feed regulations. Our integrated model guarantees complete traceability at every step of our production.

On site, we handle all three steps and we ensure that Black Soldier Fly are farmed under controlled hygienic conditions. We implement sanitary processing techniques to limit safety risks.

We focus on the quality of the substrate used to feed the Black Soldier Fly larvae. We are regularly testing it to guarantee that they don't contain any physical, chemical and microbiological contaminants (e.g foreign materials, heavy metals, dioxins, pesticides residues, mycotoxins...)<sup>6</sup>. We have also established a strong relationship with our substrate suppliers and share the best practices through production, transportation and storage.

We continuously monitor the moisture content and systematically perform toxicological tests on all batches of feeding substrate.

In addition, our process includes effective treatments such as high-temperature blanching and drying, which are critical steps in controlling microbial pathogens. Each batch of our products is marked at every stage of the production process to ensure full traceability and to comply with microbiological safety standards and required residue limits stipulated in the relevant regulations<sup>7</sup>.

As an establishment registered in the TRACES system, which is required to export animal products to the European market, Veolia Bioconversion Malaysia undergoes regular veterinary and sanitary inspections by the local Malaysian authorities through the Disease Control and Veterinary Biosecurity Division of the Department of Veterinary Services.

### OPERATIONAL EXCELLENCE AND INNOVATION

Beyond compliance, it is important to actively seek for innovative solutions to improve quality and safety. We have improved our breeding and production through

the use of data analytics where all data is collected, analysed and leveraged. Our data-driven approach allows us to monitor the production, to identify patterns, detect anomalies and eventually predict safety or quality issues. This enables us to promptly adjust and maintain optimal and high-quality insect farming conditions.

#### CONCLUSION

The production of insects and the use of insect-based products in animal feed is growing worldwide and safety issues related to insect farming and processing remain a major concern for the feed industry such as pet food, aquafeed, livestock feed. Insect producers are becoming more professional by establishing and adhering to the rules.

At Veolia Bioconversion Malaysia, we have gained deep knowledge on the hazards associated with farming and processing of Black Soldier Fly larvae by analysing all the data collected. We comply with the feed hygiene standards, good breeding and manufacturing practices, which is supporting us to continuously optimise and improve the quality and safety of our insect-based products.

In Southeast Asia, AFFIA (Asian Food & Feed Insects Association) brings together the industry players and researchers during the 5th International Insect to Feed the World Conference (IFW 2024) which will be held in Singapore from June 19th-22nd. This international platform is a good opportunity to share experience on hygiene, quality and safety.

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<sup>2</sup>IPIFF Guide on Good Hygiene Practices.

<sup>3</sup>Risk profile related to production and consumption of insects as food and feed. (2015) EFSA Scientific Committee

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<sup>5</sup>A. Lähteenmäki-Uutela, S.B Marimuthu and N. Meijer, 2021. Regulations on insects as food and feed: a global comparison. Journal of Insects as Food and Feed 7(5): 849-856

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<sup>7</sup>Method 7 in Regulation Chapter III of Annex IV to Commission Regulation EU 142/2011 on health rules as regards animal by-products and derived products not intended for human consumption

#### About Azwa Aasdik

Azwa Aasdik has over eleven years of quality experience in the agro-industry and joined Veolia Bioconversion Malaysia Sdn Bhd as Quality Assurance Manager. She manages the quality team and works closely with the technical and production teams to maintain consistent quality of the insect-based ingredients. She also ensures compliance with the local & international regulations.

Aasdik obtained a BSc degree in Chemistry from The National University of Malaysia & she is certified Environmental Professional in Scheduled Waste Management from the Environmental Institute of Malaysia.

#### About Tze Min Teo

Tze Min Teo is an entomologist and molecular biologist with over thirteen years of experience in research activities. She is currently the Chief R&D Officer at Entofood Sdn Bhd and involved in improving black soldier fly farming. She also provides technical support to Entofood's partner Veolia Bioconversion Malaysia.

Tze Min holds a Doctor of Philosophy in Zoology from the University of Oxford. She is an active member of various organisations in Malaysia such as the Entomological Society of Malaysia (ENTOMA), the Malaysian Plant Protection Society (MAPPS) and the Genetic Modification Advisory Committee (GMAC) to the Malaysian Department of Biosafety. Teo is passionate about environmental conservation and serves as a volunteer survey diver for Reef check Malaysia, an NGO dedicated to reef protection.



## HOW BSF IS 'CLOSING THE LOOP' BY BUILDING A ZERO-WASTE FOOD SYSTEM

**Nicola Gardner** Creative Marketing and Media Manager Beta Bugs Ltd

"The global climate crisis and the growing human population present an existential threat never encountered before. Harnessing nature's solutions like the BSF's unique traits to mimic nature and create a circular bioeconomy with proper waste management systems is essential in addressing these challenges."

Now more than ever, it is important for the insect-farming industry to step up and scaleup – a feat which is largely possible through new market entrants such as farmers and entrepreneurs setting up their own insect farming operations.

#### HOW THE BLACK SOLDIER FLY IS TACKLING ENVIRONMENTAL ISSUES HEAD ON

The UN's Food and Agriculture Organization (FAO) estimates around £31.5M per year of food, or 14% of global food production, is wasted from harvest to shelves. Consumers waste another 17% of food after retail purchase, according to UN-EP's food waste report. In a world where 40% of the food, on average, goes to landfills or into other waste streams, BSF provides an attractive solution to the problem. BSF can be fed onsite waste from other food processes, recycling organic waste into high-value end-products used by the same industries to produce other products, minimising the use of new raw materials.

BSF has applications in aquaculture, terrestrial protein, pet food, human supplements, biopesti-

cides, and pharmaceuticals. These sectors, which need to reduce unsustainable inputs, have well-established, high-volume demand end markets with attractive margins for top-quality proteins.

### HOW FARMERS CAN LEVERAGE INSECT FARMING INTO CURRENT PROCESSES

As a result of the industry's efforts to date, insect farming has become increasingly accessible, with multiple turnkey solutions now available, removing the need for spending time in extensive R&D and planning phases. As a result, a new generation of operators and insect farmers will enter the market to compete in supplying current and future demand for insect protein.

Farmers are seriously considering farming insects as a means of generating revenue, reducing their use of soya in animal feed, and localizing their protein production. There are a range of production options, from small, on-farm units to units that are as large as a farm in its entirety. By producing protein locally using locally derived materials, insect farming provides perfect opportunities for farmers who want to use insect protein directly in their feed, or to sell it on to feed manufacturers.



Now is an exceptionally good time to farm insects as there is more off-the-shelf insect farming equipment and know-how available from well-known suppliers, making it easier to farm insects. By joining in at this moment, farmers are able to leverage a local, yet global, opportunity and be part of one of the world's fastest growing industries.

## THE BENEFITS OF INSECT FARMING DIVERSIFICATION

When it comes to diversification, insect farming equipment providers give existing farmers the means to produce their own protein on-farm using on-farm surplus heat, space, and energy they have available. Insects such as Black Soldier Fly Larvae can be reared at high densities, meaning tonnes of protein can be produced from a relatively small footprint, reducing feed ration costs at small-scale. As a result, the best way for farmers to leverage insect farming is to become an insect farmer themselves. By working with established technology and BSF egg and/or juvenile BSF larvae suppliers such as Beta Bugs, farmers can now produce Black Soldier Fly larvae at a range of scales be it small-scale systems (12 tonne of live larvae/year) that produce larvae for on-farm usage or by supplying neighboring farms, or large-scale facilities (1000+ tonne of insect meal/year) that will supply animal feed manufacturers. Both these routes allow farmers to diversify their operations in a low-carbon manner.

For those who want to establish large-scale production, the diversification opportunity is similar to setting up large-scale animal production where farmers target a scale of production in the thousands of tonnes/year, with the resulting insect protein and fat being supplied to feed manufacturers in the livestock, aqua and pet sectors to generate revenue. Alternatively, the protein is used directly within large-scale animal production operations, especially if a feed mill is available on site. If on-farm production is not possible or desired, farmers can still use insects within their feeding regime by working with local suppliers of insect protein.

Furthermore, farmers can use agricultural product that has not been taken up by the supply chain as a feed for growing black soldier fly larvae on, turning a potential waste stream into a circular protein source. Lastly, the frass (insect excreta) is rich in Nitrogen, Phosphorus and Potassium, meaning it can be used as an on-farm fertiliser to reduce fertilizer costs or sold on to create a further revenue stream.

#### HOW BETA BUGS ARE CONTRIBUTING TO THE INSECT FARMING INDUSTRY

At Beta Bugs, we have created Just-Fly<sup>™</sup>, which is available in the form of BSF eggs through our dedicated multiplication and BSF egg production centre – The Multiplier<sup>™</sup>. Multiplication is a key part of all genetics sectors and ensures we can supply our industry with the scale it requires. Just-Fly<sup>™</sup> is our first product, reared to the same high zootechnical standards as our elite BSF egg product, HiPer-Fly®, but not put through our breeding programme. It provides market entrants with the opportunity to fast track towards creating profitable and scalable impact whilst developing an understanding of Black Soldier Fly husbandry and stockmanship, establishing key processes to rear it. It also caters to operators who are simply looking to up-scale production rapidly or avoid running a fly rearing operation whilst becoming familiar with working with a genetics partner that is dedicated to enabling their operation. Our flexible batch sizes and pricing enables operators to conduct the R&D, piloting and production that they need and when they need it, so that they can then bring larger facilities online. This also streamlines operations as focussing on larval rearing simplifies the rearing operation significantly. It means that the entire facility footprint can be dedicated to the step that generates revenue - protein production and processing.



#### THE IMPORTANCE OF INSECT GENETICS

The global climate crisis and the growing human population present an existential threat never encountered before. Harnessing nature's solutions like the BSF's unique traits to mimic nature and create a circular bioeconomy with proper waste management systems is essential in addressing these challenges. Insect farming and BSF as the leading species in it, is evolving a new industry that should be named InsecTech. InsecTech refers to the utilization of insects in the industrial production for food and feed, novel applications (like biofuel), and waste valorisation. All of which are resulting in novel biomanufacturing processes and more resilient feed and food supply chains, and sustainable biomass to biofuel.

The BSF industry is currently focused on improving technologies for waste handling, cheaper and more efficient rearing processes, optimization of diets, product extraction methods and more. Implementing genetic programs in BSF facilities, including selective breeding and genetic engineering, offer a repertoire of solutions to optimise the bioreactor itself – the BSF. The importance of managing genetic diversity for the long-term viability and produc"Harnessing nature's solutions like the BSF unique traits to mimic nature and create a circular bioeconomy with proper waste management systems is essential."

tivity of BSF colonies is becoming more and more prevalent in the scientific community.

By applying tried and tested breeding techniques, utilising high-throughput technologies and leveraging Black Soldier Fly biology, Beta Bugs is achieving improved genetic performance and bringing it to market with their genetics-based development of the HIPER-FLY\* selective breeding programme, taking into account key principles which play a major role in expanding the value proposition of InsecTech and the BSF market. Innovative opportunities armed with high-throughput sequencing technologies and powerful tools for genome editing are primed to yield promising results that will give substantial contributions to fighting climate crisis and food shortage, and position the BSF-based InsecTech at the forefront of bioeconomy and biomanufacturing.

#### About Nicola Gardner

Nicola Gardner is the Creative Marketing and Media Manager at Beta Bugs Ltd, with responsibility for all marketing programs, brand/design management, and media management. She is also the editor of Beta Bugs own insect farming publication - Beta Buzz.

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