

Position Paper – 10/2019



InDIRECT Consortium views on Insect value chain related aspects

Within the H2020-BBI-InDIRECT project, a consortium of 9 partners investigated the conversion of plant-based side-streams to marketable products using insects (Black soldier fly & Lesser mealworm) as intermediates. This document summarizes the views of the InDIRECT consortium on a number of questions related to the establishment of insect-based value chains.

Can side-streams be used as feed ingredients for insect rearing?

Plant based side-streams that are feed-grade and are free of animal by-products and contaminants (like agrochemicals, plastic waste) can be used as feed to rear insects within the current legal framework. Within InDIRECT different types of side-streams from the agri-food sector were evaluated as feed ingredient for Black soldier fly larvae and the Lesser mealworm, comprising green leaves, fruits, vegetables, grain derivatives and press cakes.



- Insect rearing trials within InDIRECT revealed that growth on multiple side-streams is possible, where side-stream mixtures perform generally better than single side-streams. The larvae are able to concentrate the proteins and lipids, and as such to upgrade these compounds.
 - Recommendation 1: Besides nutritional values, also insect specific requirements related to texture and moisture content of the side-streams are to be taken into account.
 - Recommendation 2: As some side-streams were associated with negative impacts on the insect larvae growth, a careful selection of side-streams is recommended.
- With respect to the impact of varying feed ingredients (side-streams), only a slight effect on the larval nutrient concentrations was observed within the tests performed. Cost estimations (based on lesser mealworm) indicated that side-stream inclusions in feed can be economically favorable in terms of cost per fresh larvae reared as well as cost per dry amount of protein.
 - Recommendation 3: As the larval nutrient profiles proved to be relatively stable in case of good growth, changes in the diets due to seasonality should not be considered as a barrier for year-round generation of reproducible insect biomass product year-round.
 - Recommendation 4: As the cost-price of side-streams is market driven, it needs to be taken into account that all side-streams suitable for insect-rearing will have a cost-price at a certain point.
- To improve larval yield and minimize CO₂ emissions, first steps were taken within InDIRECT to co-balance side-stream based feeds for insects using a



concentrate (combination of premix and oil). A mathematical tool MiXinsect was developed as beta-version within InDIRECT.

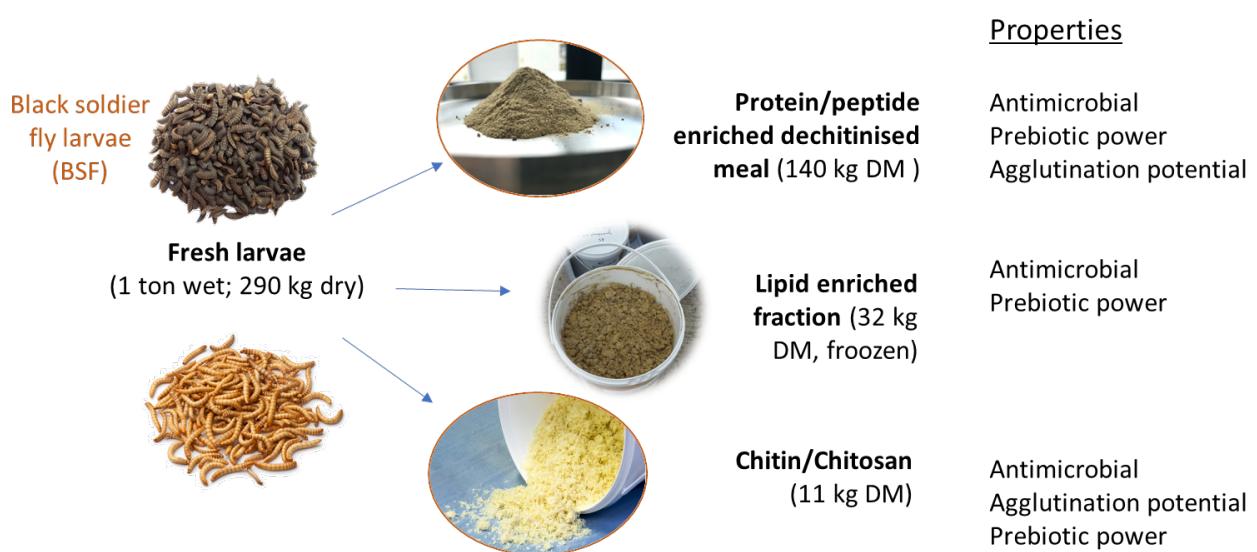
- **Recommendation 5:** To further elaborate the MiXinsect-tool and come to accurate calculations to predict co-balanced insect feed, an depth knowledge on digestibility indices and metabolic losses for raw materials for insects needs to be gained. Investments in this type of research will enable the insect farming sector to increase in efficiency and sustainability.
- **Recommendation 6:** In respect to logistics, when envisioning the use of side-streams in feed, especially fresh side-streams, storage and preservation of the side-streams is a point of attention.

In conclusion, plant-based side-streams do have potential for insect rearing. Even more, also **other side-streams that comprise animal by-products** (such as manure, catering waste) have potential for rearing insects. However, the use of such feedstocks for rearing insects is currently not allowed, under the feed ban Regulation, irrespective of the downstream use of the insect products. Technical applications of products from insects reared on such feedstocks, would be technically and economically feasible, and compose no risk for the food chain.

Recommendation 7: To fully explore the potential of insects towards side-streams, and vice versa, a link between insect feedstock and final application of the insect-derived products is recommended to be taken into account when elaborating/adapting the legal framework. This will open opportunities for the insect value chain in the circular economy, without causing safety issues.

Do insect-based products have potential as marketable compounds?

Within InDIRECT different cascading biorefinery approaches were elaborated and evaluated on lab and pilot scale. A first approach was applied on wet larvae (no drying process required) and included a mechanical separation step to dechitinize the majority of the insect biomass. This biomass was further fractionated into a **lipid enriched** and **protein enriched** fraction. The proteins in the chitin rich fraction that was generated, were recovered and the chitin was purified and converted to **chitosan** and **chitosan (oligomers)**. Via another fractionation approach, involving enzymes, **peptides** was generated.



As such, insect-based products rich in proteins, lipids and chitin were produced with potential interesting properties towards feed and food application, as well as for other applications like chemicals, textiles and cosmetics. Based on feed/food related in vitro tests, interesting bioactive properties were identified.

- **Recommendation 8:** In view of an **economic viable insect-based value chain** it is necessary to 1) aim for maximum valorization of all generated biomass (fractions), comprising all insect fractions (including sheddings) as also the frass, and 2) to address higher value end markets for at least part of the fractions obtained.
- **Recommendation 9:** Further optimization of the cascading biorefinery approach is required to ensure reproducibility and to decrease the environmental impact, i.e. solvent recycling and lower energy use. InDIRECT experience learned that these optimization should be performed at pilot scale level.
- **Recommendation 10:** A good understanding of the exact functionalities and characteristics of the insect fractions should be further elaborated. Customizing the compounds to specific needs of end-users to create a higher value is key. Further research in this field is required.
- **Recommendation 11:** Towards feed and food application, besides nutritional value, techno-functional and bioactive properties, palatability (impact of taste & odor) is an aspects that requires attention. Impact of the side-stream on this aspect of the insect biomass is unexplored.
- **Recommendation 12:** Multidisciplinary research is required to further explore the potential of insect based value chains.

What about safety issues of insect-derived food and feed ingredients?

The potential risks related to the use of insects as food and feed has already been reviewed by EFSA in 2015 ("Risk profile related to production and consumption of insects as food and feed", <https://doi.org/10.2903/j.efsa.2015.4257>). EFSA at that time already concluded that microbiological risks are expected to be comparable with other food or feed ingredients, if insects are fed with permitted feed materials. The documents concluded that, due to the lack of data, also further studies were needed about the fate of the chemical contaminants and allergen in insect-derived processed products (such as protein fractions or oils). Within InDIRECT, the presence of mycotoxins, agrochemicals, heavy metals, allergens and pathogens were considered, both on full insects and on ingredients derived from them.

Mycotoxins and agrochemicals (and potentially also **heavy metals**), are transferred from the substrates used to feed insects to the insects themselves, but no indications have been found from the collected data suggesting that insect concentrate obnoxious compounds inside their body. Rather, the concentration has always been found lower in insects than in the feed substrates, when using naturally contaminated (into the legal limits) substrates.

- **Recommendation 13:** Always use to feed insects substrates which are feed grade as far as chemical contaminants are concerned, i.e. with agrochemicals, mycotoxins and heavy metals under the legal limits for feed. This will likely ensure that also insects and insect preparations will be inside the legal limits for feed. Anyway, always check for toxic compounds contamination in insect-derived ingredients, also considering possible biotransformation products.
- **Recommendation 14:** No extension of the current legislation to not yet regulated mycotoxins is suggested, since no evidence of presence of not regulated mycotoxins has been found in insects. However, current legislation can be extended considering species-specific sensitivity towards chemical contaminants before defining the destination of use of insects intended for feed.

Pathogens can be a risk if the rearing conditions are not carefully checked, yielding microbiologically contaminated insects. This finding confirms the ruling out, as feeding substrates for insects meant for food and feed applications, naturally microbiologically contaminated materials, such as for example manure.

- **Recommendation 15:** always ensure the absence of pathogens in the rearing environment for insects, and always check insect and insect-derived ingredients for the absence of pathogens.

- Recommendation 16: For insects meant as food and feed ingredients, the current ban on naturally contaminated substrates as growing substrate (such as manure) seems fully justified, and should be maintained. For other applications, it can be considered.

Allergen risk has been confirmed to be present in insects and insect-derived preparation, both indirectly (proteins with high similarity with known allergens) and directly (IgG reactivity with tropomyosin 1 polyclonal antibody isolated from rabbit and reactive against mammals and IgE reactivity of insect preparations with sera of patients allergic to crustaceans)

- Recommendation 17: in food preparations containing insect-derived ingredients, a warning on the label is to be implemented, alerting consumers which are allergic to insects and/or to crustaceans. For example “This preparation contains insects. Might be harmful for persons having allergy to insects or to crustaceans”.
- Recommendation 18: Strictly monitor the appearance and the prevalence of allergic reactions following the introduction of insect-based novel foods in the market.

Overall:

- Recommendation 19: Promote more research related to 1) possible mycotoxins (and agrochemicals) metabolites produced by insects grown on contaminated substrate, in order to assess the presence of “undetectable” metabolized forms, and their possible toxicity, as also 2) to possible ways to produce hypoallergenic insect ingredients, such as using proteolytic enzymes to degrade allergic proteins

INDIRECT context: The InDIRECT project targets biorefinery of under-spent side-streams as feedstock, aiming at ‘closing loops’ and ‘producing more with less’. One of the studied approaches, the Indirect biorefinery approach, converts side-streams into crude extracts via a two-step process consisting of (1) conversion of biomass by insects and subsequent (2) biorefinery of the insect biomass. The aim of the first step is to convert heterogenic feedstock into a homogenous biomass via insects. Insects are able to convert a variety of feedstock into a more homogenous biomass, being their own biomass. The indirect approach is expected to have potential for a year-round relatively stable production of mainly chitin, proteins, lipids and an N-light remaining fraction (frass).

The diagram illustrates the InDIRECT biorefinery process. It starts with 'Side-streams' including Grass, Green leaves, Fruits, Vegetables, Press cakes, and Manure. These feed into 'Homogenisation by insects Step 1', which leads to 'Proteins', 'Lipids', and 'Carbohydrates & fibers'. These are then processed into 'MARKETABLE PRODUCTS' such as Cosmetics, Food, Feed, Chemistry, and Agro. The process is divided into 'DIRECT BIOPROCESSING' (using insects to convert biomass) and 'INDIRECT BIOPROCESSING' (using insects to produce biomass, which is then refined). Various compounds like Carotenoids, polyphenols, vitamins, and minor compounds are also identified along the flow.

Project partners:



Website: www.bbi-indirect.eu



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