



SUSINCHAIN
SUSTAINABLE INSECT CHAIN

Deliverable D6.6

Guidelines for good
practices for safe insect
production



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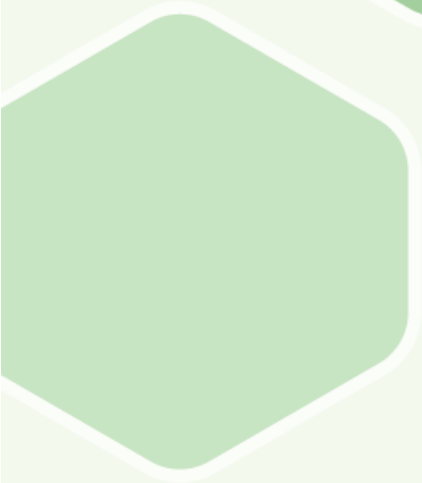
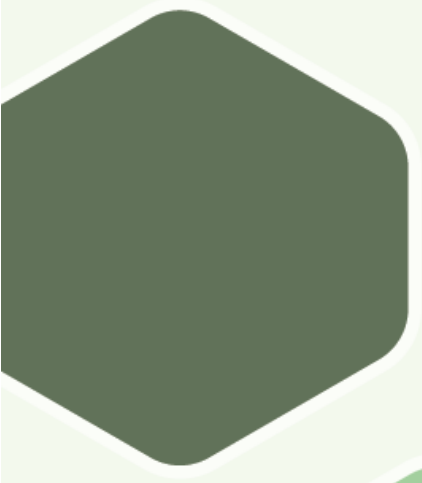
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CHAPTER 1

Introduction

Chapter 1 – Introduction

This resource is designed to help insect producers create customized handbooks, translating complex data into practical safety measures for all stages, from rearing to delivery. The guide aligns with general food laws and is relevant only for products in the EU market. It references scientific literature, primarily from the Netherlands, and will be updated as the SUSINCHAIN project and other ventures progress.

1.1 Task description

The following text concerning task 6.5 was copied from the Grant Agreement.

“This task aims to bring together all available information for a safe insect value chain and translates all data into good safety practices for rearing, storage and transport and processing of insects. To do so, information on the safe production of insects in the various insect chain stages will be collected, from scientific literature and other sources. Data becoming available over the course of SUSINCHAIN, as well as other national and international projects, will be sources as well. All available safety data will be synthesised and translated into easy to understand guidelines and practices, which will be actively communicated to the sector (as part of WP8). Hygiene codes that already were set up, at the national and international level, will be extended and fine-tuned, if needed, with the latest information available from this project and beyond.”

1.2 Background

In the rapidly evolving world of insect production, ensuring a safe and efficient value chain is paramount. This guide, an initiative by SUSINCHAIN, is meticulously crafted with the intent to serve as a comprehensive resource for insect producers. Our primary goal is to equip insect producers with a comprehensive set of instructions, enabling them to craft their own handbooks tailored to their specific needs. By amalgamating available information, this guide underscores the importance of a safe insect value chain, translating

intricate data into actionable safety practices for rearing, storage, transport, and processing of insects.

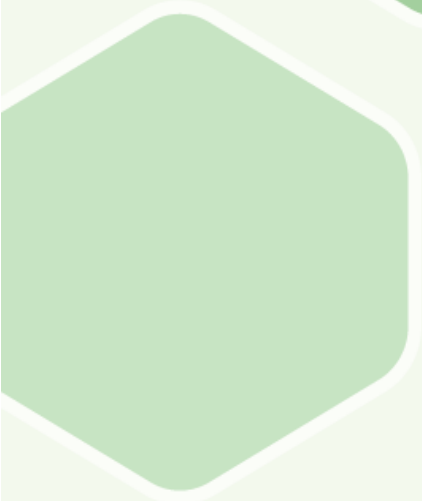
A core objective of this guide is to provide insights into practices in insect rearing that align with the general food law. It offers a holistic view, covering all production steps, from feeding to final delivery. Moreover, it's worth noting that the guidelines and practices detailed herein are applicable only to products authorized on the EU market.

Information was collected on the safe production of insects across various stages of the insect chain, referencing scientific literature and other credible sources. As the SUSINCHAIN project unfolds, along with insights from other national and international ventures, we will continually update our repository.

1.3 Creating a quality handbook at company level

Insect producers must establish a quality system based on HACCP principles to ensure food and feed safety legislation compliance. This dynamic document system helps identify and manage potential hazards in insect production, ensuring that the final products are safe for consumption. HACCP principles enable proactive risk assessment and control, safeguarding both consumers' health and regulatory compliance.

The content of each quality handbook on the level of an individual insect producer is customized to the specifications of the specific circumstances of the production facility, inputs, design, etc. This quality document is a so-called living document: when company processes, ingredients, workflows, design or introduction of new practices is changing, the quality system must be adjusted. Insect producers can use this template with the help of the information provided in this document to create their own handbook. In-depth background information can be found in the IPIFF Guide on Good Hygiene Practices.



CHAPTER 2

Understanding pre-requisite programmes



Chapter 2 – list of potential microbiological and chemical hazards in insect feed substrates

2.1 Introduction

Prior to the implementation of any food safety management system, certain essential prerequisites must be established. These prerequisites (PRPs) encompass good hygiene practices aimed at ensuring that the food establishment maintains a safe and sanitary environment. Below we present the general guidelines for these PRPs, which in the next sections we will develop specifically for the insect production industry. In essence, PRPs like GAP (Good Agricultural Practices), GMP (Good Manufacturing Practices), and GHP (Good Hygienic Practices) set the groundwork to ensure a hygienic baseline environment across different stages of the food production and distribution process. They are essential because if these foundational practices are not in place and effective, more specific food safety systems like HACCP will be difficult to implement and maintain.

2.2 GMP (Good Manufacturing Practices)

Ensures food is produced in a hygienic and safe environment within processing facilities. It is used in processing facilities, canneries, packing plants, and other places where raw agricultural products are transformed into finished goods, as well as in the facility design and maintenance, equipment design and maintenance, personal hygiene of staff, process control, storage and transportation, and waste management. To effectively implement these best practices, it's essential to take them into account:

- Begins from primary sources like farms, seas, or forests.
- Land for cultivation should be uncontaminated.
- Crop contamination and pests should be controlled.
- GAP and GHP ensure the safety of harvested foods.

2.3 Good Storage Practices (GSP)

Essential during on-farm storage and throughout the commodity system. Proper storage protocols, should be adhered to when storing agricultural products on the farm. These practices are not only addressed in the Food Hygiene Basic Texts provided by CODEX but are also encompassed by four ISO procedures specifically designed for the storage of cereals and pulses (ISO 6322 series). It is essential to maintain GSP standards consistently across the entire commodity supply chain.

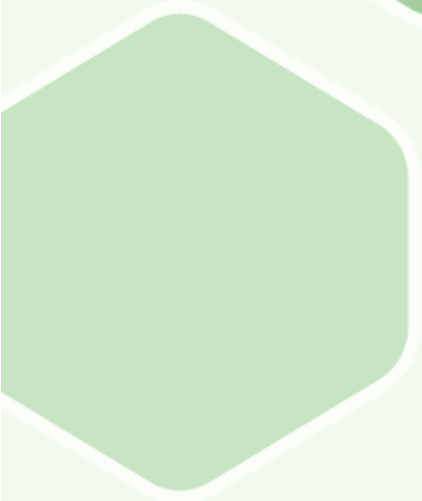
2.4 GHP (Good Hygienic Practices)

Ensures the cleanliness and hygiene of the entire food environment, including personnel. Can be applied across the food chain, from farm to fork, wherever food is handled, processed, or prepared, because it covers the guidelines of personal hygiene, facility cleanliness, equipment cleanliness, pest control, and waste management.

To successfully adopt these best practices, one must consider:

- **Establishment Design and Facilities:** The design should prevent contamination and facilitate cleaning. All food-contact surfaces should be non-toxic and easy to clean. Temperature, humidity, and pest control measures are vital.
- **Control of Operation:** Ensure reduced contamination risk via temperature, humidity controls, proper packaging, potable water, and equipment maintenance.
- **Maintenance and Sanitation:** Procedures should ensure cleanliness, waste management, and pest control.
- **Personnel Hygiene:** Food handlers should maintain cleanliness and hygiene to avoid contaminating food.
- **Transportation:**
 - Methods should prevent contamination or deterioration.
 - Appropriate environment control like chilling or freezing is crucial.

- Containers for transport should be clean and designated for food only.
- **Training:**
 - Food handlers need hygiene and operation-specific training supervised by trained supervisors.
 - Continuous training is crucial for a successful Food Safety Management System.
- **Product Information and Consumer Awareness:**
 - Adequate information should accompany the product for safe handling at every stage.
 - Consumers should be informed, especially if they're responsible for the final control measure.
 - Traceability should be ensured through identifiable batch or lot numbers.



CHAPTER 3

Understanding HACCP Principles



Chapter 3 – Understanding HACCP Principles

Prior to the implementation of any food safety management system, certain essential prerequisites must be established. These prerequisites (PRPs) encompass good hygiene practices

According to Regulation (EC) 852/2004 , every food business operator (FBO) is mandated to establish, execute, and sustain food safety management systems founded on the principles of The Codex Guideline (1997) HACCP. The Codex Alimentarius, which consists of global standards, recommendations, and codes of conduct, has been devised to safeguard consumer health and uphold equitable procedures in the food industry. The Codex Guideline (1997) outlines seven distinct actions essential for creating, executing, and sustaining a HACCP plan. These seven essential actions are commonly known as "the seven principles," and they include :

Conduct Hazard Analysis (Principle 1): To identify and evaluate potential hazards in the production process.

- Identify hazards that are likely to occur and cause injury or disease if not controlled.
- Evaluate these hazards and determine preventive measures.
- Use tools like the Ishikawa diagram, histories of non-compliances, or a list of predefined questions to sort hazards at each step.
- Use the Figure 2 as an example:

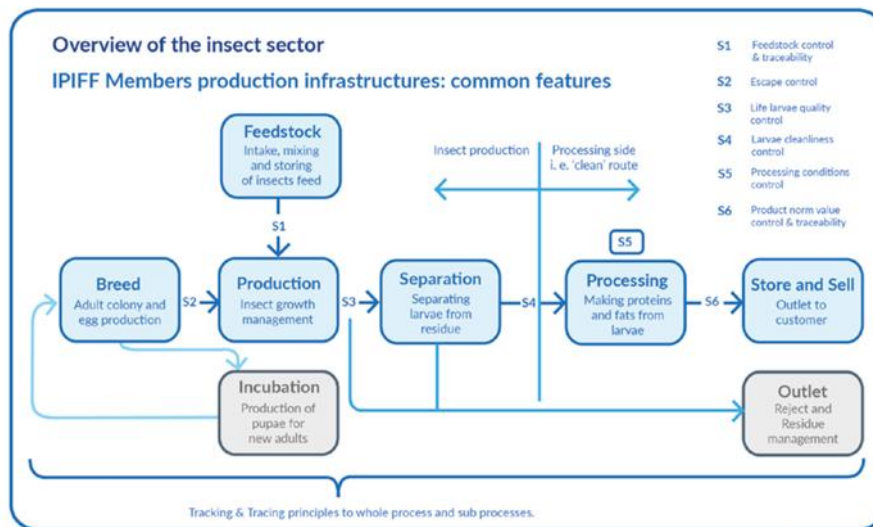


Figure 1: IPIFF overview of the insect sector.

Determine Critical Control Points (CCPs) (Principle 2): To identify points in the process where control can be applied to prevent or eliminate hazards.

- Identify and document CCPs in the production process where control is critical for safety.

Establish Critical Limits (Principle 3): To set acceptable limits for preventing hazards at CCPs.

- Define and document the acceptable limits for each CCP.

Establish Monitoring Procedures (Principle 4): To track and document the performance of the process at CCPs.

- Set up procedures to monitor CCPs and ensure they remain within the critical limits.

Establish Corrective Actions (Principle 5): To take necessary actions when monitoring indicates a deviation from established critical limits.

- Define and document corrective actions to be taken when deviations occur.

Establish Verification Procedures (Principle 6): To confirm that the HACCP system is working effectively.

- Set up procedures for verification.
- Ensure verifications are conducted by individuals with appropriate expertise.
- Use methods like random sampling and analysis to verify the system's effectiveness.

Establish Record-Keeping and Documentation Procedures (Principle 7):

To maintain a record of all HACCP activities and ensure traceability.

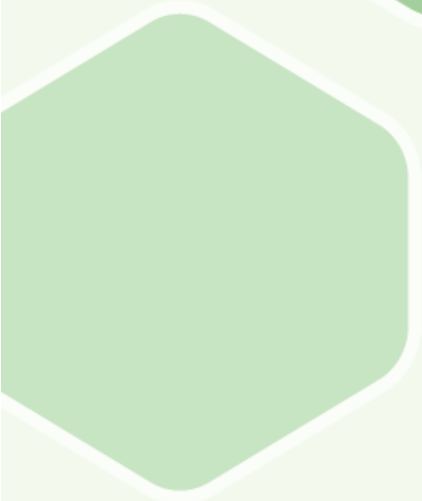
- Keep records generated during the operation of the HACCP system.
- Document the hazard analysis, HACCP plan, and all related procedures and records.

Note that you can use these 7 principles to create your own HACCP plan. In addition to this, other actions to take into account are:

- **Assemble the HACCP Team:** *To have a dedicated group responsible for applying the HACCP method.*
 - Identify and train individuals within the company to implement, review, and maintain the HACCP plan.
 - The team should respond to any crisis related to the product(s).
 - Include multidisciplinary specialists from different levels, both field staff and management, related to the insect sector.
- **Describe the Product and Its Distribution:** *To have a clear understanding of the product's characteristics and distribution chain.*
 - Provide detailed descriptions of the insect product, its ingredients, and its distribution methods.
- **Identify the Intended Use and Consumers:** To understand the target audience and the intended use of the product.
 - Clearly define the target consumers and the intended use of the insect product.

- **Develop a Flow Diagram Describing the Process:** To visually represent the entire production process.
 - Create a comprehensive flow diagram that outlines each step of the insect production process.
- **Verify the Flow Diagram:** To ensure the accuracy of the flow diagram.
 - Conduct an on-site review to confirm the accuracy of the diagram.
 - Investigate all process routes, including interactions between personnel, wastes, and the product.
 - Document and record evidence of the verification.

Conducting a HACCP study serves to channel the attention of all stakeholders toward a meticulous examination of the production process, fostering heightened vigilance regarding safety concerns. It's important to recognize that implementing a HACCP system isn't a final goal in itself; rather, the true advantages emerge through continuous upkeep and maintenance of the HACCP plan, ensuring ongoing safety and quality standards are upheld.



CHAPTER 4

**Understanding the Food and Feed Safety
legislation**



Chapter 4 – Understanding the Food and Feed Safety legislation

4.1 Introduction

The European Union (EU) has established a detailed regulatory framework to ensure the safety and quality of food and feed products, among which are also the production and marketing of insects. These requirements aim to protect consumers, guarantee fair trade practices within the EU, and facilitate traceability in the event of food safety issues. Insect producers must adhere to the same general rules that apply to other sectors. EU law regulates the conditions for food and feed business operators, such as insect producers, to produce and commercialize their products in the European Union. Key legislative texts include the 'General Food Law' (Regulation No 178/2002) and the 'Hygiene Package' (e.g., Regulation No 853/2004 on the hygiene of foodstuffs and Regulation No 1831/2003 on feed hygiene). These texts ensure that insect producers, like any other food or feed business operator, are responsible for the safety of the products they market. The subsequent section aims to explain this legislation, offering clarity on its interpretation and practical guidance on how insect producers can seamlessly integrate and comply with these mandates.

4.2 Regulation (EC) No 178/2002: General Food Law

Establishes the foundational principles and requirements of food law within the European Union.

- **Safety First:** The primary objective is to ensure a high level of protection of human health and consumers' interests concerning food.
- **Risk Analysis:** Decisions related to food safety should be based on a comprehensive risk analysis. This includes risk assessment, risk management, and risk communication.

- **Precautionary Principle:** If there is uncertainty about the safety of a food product, measures can be taken to ensure consumer protection, even if all the scientific evidence is not available yet.
- **Transparency:** Authorities should maintain transparency in their operations and decisions, especially concerning public health, consumers, and the food industry.
- **Responsibility:** Food and feed businesses have the primary responsibility for ensuring the safety of their products.
- **Traceability:** Food and feed products should be traceable at all stages of production, processing, and distribution.
- **Rapid Alert System:** A system for quickly notifying risks to human health deriving from food or feed.
- **European Food Safety Authority (EFSA):** The establishment of an independent agency responsible for risk assessment and providing scientific advice on food safety matters.
- **Crisis Management:** Procedures to manage potential food safety crises are outlined.
- **Import and Export Rules:** Specific provisions for foods and feeds imported into or exported from the EU.

4.3 Regulation (EC) No 852/2004 on the hygiene of foodstuffs and Regulation (EC) No 1831/2003 on the safety of feed

Facilities producing insect-based food or insect-based feed must maintain high hygiene standards to prevent contamination. Insect producers must ensure that their insects are kept in good health to prevent the spread of diseases. The responsibilities of animal breeders in health and biosecurity are established in the 'EU Animal Health Law' (Regulation (EU) No 2016/429).

- **Facility Cleanliness:** All production and storage areas must be kept clean, free from pests, and regularly sanitized. This includes walls, floors, ceilings, and all equipment.

- **Personal Hygiene:** Staff must practice good personal hygiene, including regular handwashing, wearing clean uniforms, and using protective gear such as gloves, masks, and hairnets where necessary. Staff should also be medically fit to handle food.
- **Equipment and Utensil Sterilization:** All tools, machinery, and utensils used in the food and feed production process should be cleaned and sterilized regularly to prevent microbial growth and cross-contamination.
- **Waste Management:** Proper disposal procedures must be in place for both organic and non-organic waste. Regular waste removal should be practiced to prevent accumulation, which can attract pests.
- **Temperature Control:** Refrigeration and freezer units must be regularly monitored to ensure they operate at safe temperatures. This is especially crucial for perishable items to prevent bacterial growth.
- **Pest Control:** Regular pest control measures should be in place. This includes periodic checks, using sealed storage containers, and ensuring facility entry points are secured against pests.
- **Water Quality:** Only potable water should be used in the production process. Regular checks should be in place to ensure water purity.
- **Raw Material Storage:** Ingredients and raw materials should be stored in designated areas with appropriate temperature controls, away from chemicals or other contaminants.
- **Separation of Operations:** Raw and finished products should be strictly separated to avoid cross-contamination. This also applies to the handling of allergens.
- **Regular Inspections and Audits:** Facilities should undergo periodic inspections and audits to ensure that hygiene and safety standards are consistently met.
- **Hazard Analysis and Critical Control Point (HACCP):** Businesses involved in the (insect) food chain must implement and maintain a HACCP system. This system identifies potential food safety hazards and establishes control points to prevent or reduce those hazards to acceptable levels. HACCP is elaborated in section 3.

- **Transportation:** Food or feed must be transported in hygienic conditions to prevent contamination.
- **Traceability:** Companies must be able to trace their products at all stages of production, processing, and distribution. This ensures that in the event of a contamination or product recall, affected products can be quickly identified and removed from the market. Insect producers must adhere to the following key traceability requirements:
 - **Provider Information:** Record the name, address, and relevant details of:
 - Substrate providers (e.g., feed materials, batch number, delivery date).
 - Insect breeding flock providers, including flock characteristics and delivery date.
 - **Product Details:** Document the nature, formulation, quantity, manufacturing date, and batch number of products. Retain samples and records as per EU hygiene regulations.
 - **Allergen Information:** Note any food allergens in the substrate, especially when insects are for human consumption.
 - **Buyer/supplier Information:** Record the name and address of the buyer and the delivery site for finished products.

Different techniques can be used to ensure **traceability**:

- **Barcode and Scanning Systems:** Each product or batch of products is assigned a unique barcode. As the product moves through various stages, it's scanned, automatically updating its status and location in a central system.
- **Batch identification and Lot Coding:** Products are assigned batch or lot numbers, enabling companies to identify when and where they were produced. If an issue arises with a particular batch, it can be swiftly recalled or addressed.

Documentation and Record Keeping: Maintaining comprehensive records of procurement, production, quality checks, shipments, and sales is essential.

These records serve as an audit trail, confirming the product's path through the supply chain. EU regulations recommend retaining traceability documents for at least two years. Producers should have systems to share information with safety authorities when necessary. Insect producers may also keep records of:

- Loading and unloading points.
- Transport and storage details, including companies and equipment used.
- Product-specific details like temperature levels, processing control points, equipment, and staff involved.
- Labeling of finished products for batch traceability.
- Procedures for handling products rejected for safety reasons.

Testing and Quality Checks: By regularly testing products at different stages and maintaining records, anomalies can be traced back to their source, ensuring corrective actions can be taken swiftly.

Expiration Date: The shelf life or 'use by' date should be mentioned to ensure the food or feed product is used when still of good quality.

Regular Monitoring and Reporting: The EU requires regular checks and inspections at various stages of the food and feed production process.

Businesses are also obligated to report any safety or quality concerns they encounter.

- **Monitoring:** In the EU, businesses involved in the insect industry, whether for food or feed, are subject to regular checks and inspections by national competent authorities. These inspections ensure that the businesses adhere to the EU's safety and quality standards. This could involve checking breeding and rearing facilities, the health and safety of the insects, and ensuring that the production process is hygienic and free from contaminants.
- **Reporting:** Businesses in the insect industry are obligated to report any safety or quality concerns they encounter. This reporting is typically done through official channels set up by the respective national competent authorities. Businesses would need to submit detailed reports on any

issues they come across, the measures they've taken to address these issues, and any potential risks to consumers or animals.

- **Registration:** Producers of insects intended for animal feed use must be registered as 'feed business operators' before their national competent authorities. It's likely that a similar registration process exists for insects intended for human consumption, given the categorization of insects as "Novel Foods" in the EU.
- **Training and Competence:** Staff working in sectors that handle food or feed must be adequately trained in hygiene and safety procedures.

4.4 Regulation (EC) 853/2004

This regulation outlines specific hygiene rules for food of animal origin. It covers various aspects of food safety in the production and distribution of animal-derived foods such as meat, milk, fish, and eggs. Some key provisions of this regulation include requirements for the hygiene of premises, transportation, and equipment, as well as the establishment of Hazard Analysis and Critical Control Points (HACCP) principles in food processing facilities. It also sets down rules for the handling and labeling of these products.

4.5 Regulation (EC) 854/2004

This regulation complements Regulation (EC) 853/2004 by specifying the specific rules for official controls on products of animal origin intended for human consumption. It establishes the procedures and criteria for inspections, sampling, and testing of such products to ensure compliance with food safety standards. It also outlines the role of competent authorities in conducting these controls and details the requirements for the training and certification of personnel involved in food safety inspections

4.6 Feed restrictions

The specific rules concerning the sourcing, processing, and labelling of animal feed in the European Union (EU) are detailed under the EU's regulatory

framework, ensuring the safety and quality of animal feed to protect both animal and human health. Feed businesses must ensure that the produce, use, or distribution of feed does not harm animal or human health. There are specific rules regarding the sourcing, processing, and labelling of animal or insect feed. EU decision-makers have established restrictions on the feed given to 'farmed animals', which includes animals kept for food, feed, or other derived products. These restrictions also apply to insects intended for human consumption or animal feed use.

Origin of Ingredients: Only approved and listed feed materials can be used in animal feed. Certain feed materials derived from animals have restrictions or bans due to potential risks:

Insects can only be fed with materials of vegetal origin.

- Exceptions are made for materials of animal origin such as milk, eggs, honey, rendered fat, or blood products from non-ruminant animals.
- Feeding farmed animals with slaughterhouses or rendering derived products, manure, or catering waste is prohibited.
- The same ban applies to the use of unsold products from supermarkets or food industries if they contain meat or fish.

4.7 EU Animal Health Law' – Regulation (EU) No 2016/429

Obligations are placed on insect producers to ensure that their animals are kept in good health to prevent the spreading of diseases among their production flock. This is governed by the 'EU Animal Health Law' – Regulation (EU) No 2016/429 on transmissible animal diseases. It's essential for insect producers to be proactive in their approach to insect health and disease management. By implementing rigorous health and biosecurity measures, producers can ensure the well-being of their insect colonies and the quality of their products. Based on the general principles of the EU Animal Health Law and common practices in animal husbandry, a generalized checklist that insect producers might consider:

- **Biosecurity Measures:** Implement strict biosecurity measures to prevent the introduction and spread of pathogens. This includes controlling access to production areas and ensuring cleanliness.
- **Regular Health Monitoring:** Regularly monitor the health of the insect colonies. Any signs of disease or unusual behaviour should be promptly addressed.
- **Feed Quality:** Ensure that the feed provided to insects is of high quality, free from contaminants, and meets the nutritional needs of the specific insect species.
- **Hygiene and Sanitation:** Maintain cleanliness in the production areas. Regularly clean and disinfect equipment, containers, and other tools used in insect rearing.
- **Pest Control:** Implement measures to control potential pests that could introduce diseases or compete with the insect colonies for resources.
- **Disease Management:** Have a plan in place for managing outbreaks of diseases. This includes identifying the disease, isolating affected colonies, and implementing treatment or control measures.
- **Isolation of New Colonies:** Any new insect colonies or batches introduced should be isolated and monitored for a specific period to ensure they are disease-free before integrating them with the main production.
- **Training:** Ensure that staff and workers are trained in best practices for insect rearing, disease identification, and biosecurity measures.
- **Documentation:** Maintain detailed records of insect health, feed sources, biosecurity measures, and any incidents of disease outbreaks. This documentation can be crucial for traceability and addressing any issues that arise.
- **Regular Consultation:** Engage with experts or consultants in the field of insect rearing and health to stay updated on best practices and emerging threats.
- **Compliance with Regulations:** Stay informed about any changes or updates to regulations related to insect rearing and ensure compliance with all requirements.

4.8 Regulation (EU) No 1143/2014

European insect producers must also adhere to EU environmental legislation. Notably, Regulation (EU) No 1143/2014 restricts the insect species that are eligible for farming purposes by establishing a list of 'invasive alien species'. The objective is to prevent the introduction of species that may threaten biodiversity or ecosystems. Since September 2021, the possibilities to feed insect proteins to certain animal species have expanded, thanks to the lifting of the EU 'feed ban' rules. In April 2021, the EU Member States approved the use of insect processed animal proteins (PAPs) in poultry and pig feed. An eight species (silkworm) was added by way of Regulation (EU) 2021/1925. Additional national legislation may apply.

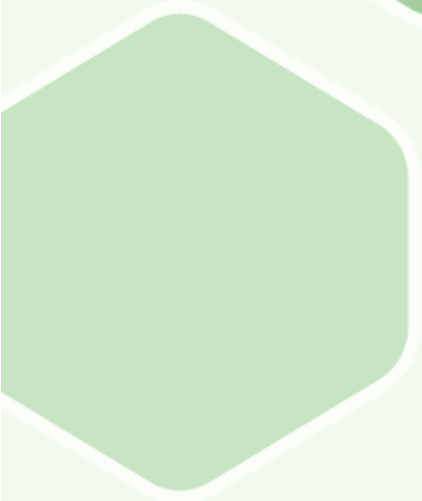
4.9 Animal Welfare

Invertebrate animals, including insects, are excluded from the scope of the EU animal welfare legislation. This means insect producers are exempted from EU legal obligations in the area of animal welfare. IPIFF encourages insect producers to embrace animal welfare standards by applying Brambell's 5 degrees of freedom which provide good welfare practices for insects :

- Freedom from hunger and thirst: provide sufficient food and water adequate temperature and ventilation conditions.
- Freedom from discomfort: respect the physiological needs of the insects, providing them with adequate environment.
- Freedom from pain, injury, or disease: refrain from using materials that are likely to injure the insects. limit cannibalism by managing optimal density and adequate space. Only use killing methods that ensure the rapid death of the insect so as to reduce the potential pain risk.
- Freedom to express normal behaviour: only use housing or husbandry practices that allow for a normal behavioural pattern.
- Freedom from fear and distress: Stay updated on recent scientific findings about the possible sensations of fear or distress in insects.

Some extra advice

- **Stay Updated with Changes:** Regulations can evolve, and staying updated ensures continued compliance.
 - Regularly check official EU publications and updates on food and feed hygiene.
 - Engage with industry associations like IPIFF for the latest guidance and best practices.
- **Seek Expert Advice:** Interpretation of regulations can be complex, and expert advice ensures accurate understanding.
 - Consult with legal experts specializing in EU food and feed regulations.
 - Attend workshops, seminars, or training sessions focused on EU hygiene requirements.
- **Implement Good Hygiene Practices (GHP):** GHP is a cornerstone of ensuring food and feed safety.
 - Develop and maintain an insect operation level food and feed safety management system.
 - Train employees in GHP and ensure they understand their roles and responsibilities.
 - Regularly review and update the safety management system based on internal and external audits.
- **Engage in Continuous Learning:** The field of food and feed safety is dynamic, and continuous learning ensures that producers stay ahead of the curve.
 - Participate in industry forums, workshops, and seminars.
 - Collaborate with other producers to share knowledge and best practices.



CHAPTER 5

Safeguarding Responsible Management



Chapter 5 – list of potential microbiological and chemical hazards in insect feed substrates

5.1 Introduction

In the world of insect production, the meticulous management of responsibilities and the structured organization of operations play a pivotal role in ensuring the safety and quality of products. As the industry evolves, it becomes imperative to have a clear framework that delineates the roles and expectations of all stakeholders involved, from the management to the employees on the ground. Personnel performing work should be competent, based on appropriate education, training, skills and experience. There should be sufficient personnel with the skills and qualifications required to produce safe feeds. Management and supervisory personnel of feed businesses should have the necessary knowledge of feed safety and soundness principles and practices to be able to assess potential risks and take necessary actions to eliminate deviations. The following sections delve a tailored guide that aims to streamline management practices and ensure the highest standards are maintained throughout the production process.

5.2 Appoint a Qualified Person

To supervise the quality control of the production and/or process lines and ensure product safety parameters. Designate a responsible person with the necessary qualifications. This person should have the authority to develop and maintain Good Hygiene Practices (GHP) within the company as well as be able to report about issues and suggest appropriate measures to remediate or control problems when they occur. The production department should be supervised by a person who has the necessary qualifications. Where relevant, a person possessing the necessary qualifications should be in charge of quality control.

5.3 Train the Health, Safety, Environment, and Quality (HSEQ) Team

To ensure the team is equipped to develop and maintain the HACCP system and implement GHP. The responsible person should prepare for and train the HSEQ team. This training should cover the development and maintenance of the HACCP system and the implementation of GHP.

5.4 Employee Training

To ensure all employees are aware of their duties and responsibilities. Train company employees in GHP. Ensure that employees, including temporary, recently hired staff, maintenance and transport staff, as well as suppliers, are informed about and trained in their duties and areas of responsibilities. Make them aware of hygiene requirements.

5.5 Establish Communication Channels

To keep the responsible person informed about significant changes in products or processes. The Management should ensure that adequate communication channels are in place. This will allow the responsible person to be informed of any significant changes in products or processes.

5.6 Review and Update the Safety Management System

To ensure the system is up-to-date and effective. The safety management system in place should be reviewed and updated when necessary. This can be based on the outcomes of internal and external audits. Employees should be kept informed accordingly. Periodic assessment of the effectiveness of training and instruction should be conducted. Regular monitoring and reviews should be conducted to ensure that procedures are effectively implemented.

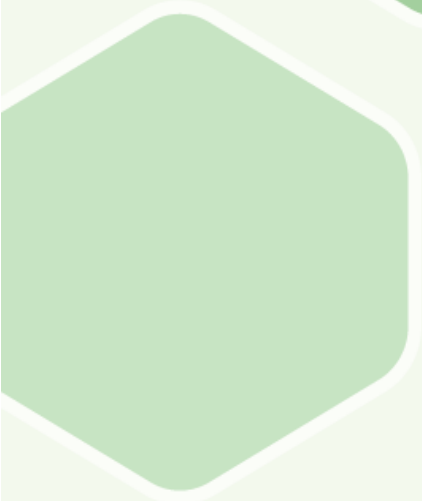
5.7 Set Objectives for Operating Staff

To provide clear guidelines and expectations for the staff. The Management should set the objectives related to GHP and HACCP principles for the operating staff, rearing, killing, processing, storage, and transport operations, as well as for visitors and subcontractors.

Staff Hygiene Practices: To ensure everyone is on the same page regarding hygiene standards. The Management should inform the operating staff about the hygiene practices and protocols being followed in the company. They should also be committed to ensuring the implementation of these practices within the company. Personnel working with feed shall take good care of themselves with a view to feed safety and shall wear suitable clothing and footwear. Protective clothing should be worn if it is apparent that contamination of feed may occur. There should be clear rules regarding eating, drinking or smoking in the production areas.

5.8 Visitors

Visitors to areas where insects are produced, processed or handled should wear protective clothing, where necessary, and adhere to the applicable rules for personal hygiene.



CHAPTER 5

Safeguarding Responsible Management



Chapter 6 – list of potential microbiological and chemical hazards in insect feed substrates

6.1 Introduction

Buildings, workspaces, associated facilities, process equipment, support services

Establishing a robust infrastructure and optimizing production conditions are critical components in the insect production sector. A well-structured facility is paramount for ensuring both the safety and efficiency of the production process, as well as maintaining the quality of the end product. This section provides a comprehensive guide, detailing essential infrastructure components and best practices. From foundational aspects like building design and location to intricate details of ventilation and water supply, each element plays a vital role in achieving operational excellence. As a reference, this checklist offers insights into creating an environment that aligns with regulatory standards and fosters optimal production outcomes.

6.2 Ensure proper building and premises design, including ventilation and water supply

To ensure the safety and efficiency of the production process

Insect production should be carried out in an environment where the presence of potentially hazardous substances cannot lead to unacceptable levels of those substances in animal feed and human food. Company buildings may not be located on or near sites such as contaminated sites, waste disposal sites, etc. If the environment presents risks to feed safety, it must be demonstrated by means of a risk assessment that the risks are adequately controlled. It is essential to:

- Provide a suitable location for the production site.
- Ensure availability of essential services: electricity, gas, potable water, drainage, and waste collection.

- Protect the site from potential contamination sources like farms, chemical industries, areas with waste accumulation, waterways, flood-prone areas, pest-infested areas, areas with high airborne bacteria, and loud external noises.
- There should be a strict and absolute physical and organizational separation between products intended for use in the animal feed sector on the one hand and non-animal feed products such as manure, fuel, detergents and waste on the other.

6.3 Designing the Building and Premises

To maintain hygiene and ensure smooth operations.

- Design should allow for adequate cleaning and disinfection.
- Minimize risks of contamination and cross-contamination.
- Ensure machinery used is dried after any wet cleaning process.
- The premises and equipment must be such that good hygienic production is possible and that maintenance and cleaning, and/or disinfection can be carried out in an adequate manner.
- Premises and equipment shall be in good technical condition, suitable for their intended use, and shall function in accordance with their intended use.
- The premises and equipment shall be such that production can be carried out in a neat and orderly manner.
- Spaces or storage units of animal feed products should be clearly identifiable and/or marked. These rooms or storage units must be lockable.
- Floors must be constructed in such a way that proper drainage and cleaning is possible.
- Surfaces, which come into direct contact with feed, should be in good condition, and of durable material that is easy to clean and maintain. Surfaces should be made of smooth, impermeable material that is inert to

feed and can withstand repeated cleaning and disinfection under normal conditions.

- Ceilings and ceiling fixtures shall be designed, constructed, and finished, where necessary, to prevent the accumulation of dirt and to reduce condensation, undesirable mold growth, and particle loosening.
- The premises, and the premises surrounding them, should be accessible only to persons authorized by the participant. There should be an access arrangement for visitors.
- Proper containment or protection from pests and other animals that may contaminate the feed should be present:
 - Windows and other openings shall, where necessary, be constructed to be impermeable to harmful organisms. Where necessary, windows should be fitted with insect screens.
 - Doors must close tightly and be impermeable to harmful organisms when closed. They should be closed as much as possible when production activities permit.
 - Where closure is not permanently possible (e.g., fans, chute) measures should be in place to prevent the entry of pests.

6.4 Ensuring Proper Ventilation

To maintain air quality and prevent contamination.

- Mechanical or natural ventilation should:
 - Provide suitable means of natural or mechanical ventilation.
 - Avoid airflow from contaminated areas to clean areas.
 - Be designed for easy maintenance and cleaning.
 - Ensure that contamination of feedstuffs from the air (or condensation droplets) is minimized.
 - Ensure that ambient temperatures and humidity are controlled.

6.5 Maintaining Water and Light Supply

To meet the needs of the production process.

- The water used for production should be safe for animals. Water pipes should be of inert material.
- Ensure a sufficient supply of potable water.
- Protect potable water from contamination.
- Ensure water meets local and national regulatory requirements.
- Monitor water quality and microbiological requirements based on its intended use.
- Sewage, wastewater, and rainwater shall be disposed of in a manner that does not adversely affect the quality of the animal feed.
- Sufficient daylight and/or artificial light should be present. The intensity and colour of the lighting should be sufficient to ensure the production of a safe feed.
- Where necessary, lighting should be shielded to prevent contamination of animal feed if broken.
- Drainage facilities shall be suitable for their intended purpose and shall be designed and constructed to prevent any risk of contamination of the feed.

6.6 Maintaining Installations

To meet the needs of the production process.

- Sewage, wastewater, and rainwater shall be disposed of in a manner that does not adversely affect the quality of the animal feed.
- Containers and equipment used for transportation, storage, internal transport, handling, and weighing must be clean.
- All weighing and measuring equipment should be matched to the weights or volumes to be determined. The accuracy should be checked regularly. The dosing capacity must be adapted to the quantity of product to be measured. The minimum and maximum permissible weighing loads or

dosing capacities and accuracy of the weighing and dosing equipment must be recorded.

- Weighing and dosing equipment should be fitted with a safety device in such a way that there is certainty that the weighed and/or dosed amount of ingredient has indeed ended up in the intended animal feed. If dosing silos are used in production, an adequate locking system should be applied when filling these silos.
- All mixing equipment must be appropriate to the weights or volumes to be mixed and suitable to obtain homogeneous mixtures and dilutions. The effectiveness of the mixing equipment with respect to homogeneity must be proven.
- In the case of direct drying, it must be proven that the drying process results in animal feed that meets the standards. Special attention is required here for the choice of fuel. It must be prevented that undesirable substances can contaminate the animal feed (such as dioxins and PAHs).
- Facilities for heat treatment, refrigeration, freezer storage and freezing shall be designed to achieve the required product temperatures and to maintain the temperature for a sufficient period of time to preserve the safety and soundness of the feed.
- It must be possible to record time and temperature. When necessary, facilities must be equipped with effective means to control and record humidity, air currents and any other process parameter that may have a harmful effect on the safety and soundness of feed.
- The implementation of the monitoring plan requires determination of the monitoring and measuring facilities needed to provide evidence of feed safety. The monitoring and measuring installations must be registered.
- Processes must be established to ensure that monitoring and measurement can be performed and that they are performed according to the monitoring and measurement requirements.
- The measurement systems shall:
 - have been calibrated or verified at specified intervals or prior to use according to measurement standards traceable to international or

- national measurement standards; where no such standards exist, the base used for calibration or verification must be recorded and inspected according to standardized checklists;
 - be adjusted or re-adjusted as necessary;
 - be identified so that the calibration status can be determined;
 - be protected against adjustment if that would invalidate the measurement result;
 - be protected from damage and deterioration during handling, maintenance and storage.
- The validity of previous measurement results must be assessed and recorded, if it has been found that measurement equipment is not functioning according to the requirements. Appropriate measures must be taken regarding the equipment and any product that has been affected. Records of the results of calibration and verification must be kept.
 - The performance of the software used for monitoring and measuring must meet the intended application and be reconfirmed before the first use and as needed.
 - Installations used for weighing/dosing premixes, additives and veterinary drugs must be calibrated at least twice a year.
 - All installations, which are used for the dosage of feed materials for example, must be calibrated at least once a year.

6.7 Maintaining Storage Facilities

To meet the needs of the production process.

- Appropriate facilities for storage of feed ingredients and non-food/feed materials (such as cleaning agents, lubricants, and fuels) should be available.
- Facilities for the storage of feed shall be designed and constructed to:
 - enable adequate maintenance and cleaning;
 - prevent hiding places and accumulation of pests;
 - effectively shield animal feed from contamination / infection;
 - loss of product is prevented.

- Animal feeds should be stored and transported in suitable containers. They should be stored in rooms designed, furnished and maintained to provide good storage conditions. Feedstuffs should be stored and transported in such a way as to be easily identified and to avoid cross-contamination and prevent spoilage.
- Storage of raw materials and ingredients should be effectively managed (rotation, first-in/first-out).
- Where necessary, the temperature should be kept as low as possible to avoid condensation and spoilage.
- A separate part of the storage area should be designated for the storage of premixes and additives. Veterinary medicines should be stored in a separate area.
- Processed insects should be kept separate from unprocessed feed materials and additives to avoid cross-contamination of the processed feed. If several products are stored in one storage area, measures must be taken to prevent unwanted mixing. To prevent cross-contamination, untreated and treated products are separated where necessary.

6.8 Maintaining the Work Environment

- Premises and equipment intended to be used for mixing and/or production shall be adequately and regularly inspected in accordance with written procedures established by the feed manufacturer. The activities and findings shall be recorded.
- Cleaning programs should be introduced that include areas and parts of facilities and utensils, responsibilities and methods, and frequency and times of cleaning. Provisions for monitoring should also be included. Cleaning agents and disinfectants should be suitable for the purpose for which they are used and should not pose a risk to feed safety. The residues of cleaning agents and disinfectants should be kept as small as possible. Machinery that comes into contact with dry feed should be dried after wet cleaning or be dry when used again.

- The execution of the cleaning programs should be recorded in such a way that it is clear to everyone that the cleaning program has been executed correctly.
 - To prevent penetration of harmful organisms:
 - spillage of feed shall be limited as much as possible;
 - accumulation of dust, dirt and feed residues shall be prevented.
 - Where necessary, the temperature should be kept as low as possible to avoid condensation and spoilage.

6.9 Setting Up Sanitary Facilities, Staff Rooms, and Laboratories

To ensure the health and safety of staff and prevent contamination.

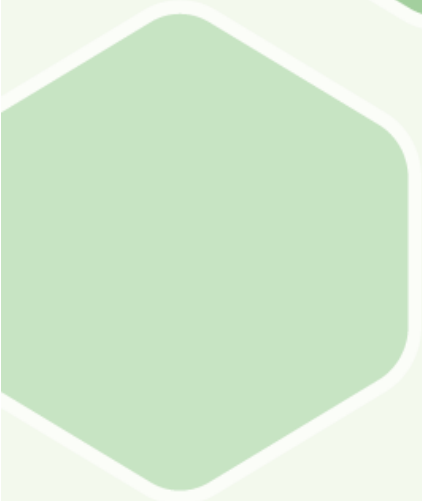
- Provide an adequate number of flush lavatories, ensuring they don't open directly into food handling rooms.
- Set up washbasins for hand cleaning with hot and cold running water, cleaning materials, and hygienic drying facilities.
- Separate facilities for washing food from hand-washing facilities.
- Ensure sanitary areas are equipped with sinks, toilets, soap, and running water.
- Provide well-lit, ventilated, and clean staff facilities.
- Offer cloakrooms for staff to change clothes.
- Ensure working clothes and regular clothes are stored separately.
- Set up facilities to wash and disinfect hands and shoes at the entry to processing areas.
- Design microbiology laboratories to prevent contamination and ensure they don't open directly onto production areas.

6.10 Managing Waste

- Waste and material not suitable for use as animal feed should be isolated and identified. If dangerous concentrations of veterinary drugs,

contaminants, or other hazards are present in such material, it should be disposed of appropriately and not used as animal feed.

- Waste should be collected and stored in clearly distinguishable bins or containers. The places where waste is stored should be included in the cleaning and pest control program.
- It must be made clear how waste and its disposal are controlled, and it must be demonstrated that the waste has not or cannot enter the animal feed chain.



CHAPTER 7

Management of Insects Substrates



Chapter 7 – Management of Insects Substrates

7.1 Introduction

The potential risk for the presence of food safety hazards in insects primarily originates from chemical and biological contaminants present in the feed substrate. The most efficient way to minimize these risks is by testing incoming feed ingredients for potential food safety hazards, especially those contaminants and pathogens known to accumulate from the substrate to insects.

7.2 Substrate Sourcing

To ensure the quality and safety of the substrate used for insect rearing.

- Ensure that substrates are sourced from registered or approved Feed Business Operators.
- Maintain up-to-date information listing the prerequisites for substrates to be safely used as feed for insects intended for food or feed purposes (the so-called 'specifications').
- Regularly check incoming materials through sampling measures to verify compliance with parameters defined in the specifications.
 - Test incoming feed (ingredients) for the possible presence of food safety hazards, such as contaminant, pathogens and heavy metals. For a guide on what to test please consult [Best practices analysis of incoming feeds substrates](#). The potential danger of encountering food safety hazards in insects typically arises from the presence of chemical and biological contaminants within their food source. To effectively mitigate these risks, it is advisable to examine the incoming feed, particularly its ingredients, for potential food safety hazards. The focus should be on identifying contaminants and pathogens known to transfer from the substrate to insects. In particular, it is crucial to avoid using feed that is contaminated with heavy metals during the rearing of insects

7.3 Storage of Substrates

To maintain the quality of the substrate and prevent contamination.

Effective storage and transport methods are vital for maintaining the quality and viability of insects larvae. Producers should regularly review and update their practices based on the latest research and technological advancements to ensure optimal outcomes.

- Store incoming materials in dry conditions, at appropriate temperatures, and in hygienic conditions.
- Ensure storage facilities are free from vermin, birds, and pests. They should have roofs, walls, or other protection systems and be regularly checked to avoid leaks or rodent infestation.
- Damaged or corrupted substrates must be contained and evaluated for potential reuse or disposal.
- Appropriate facilities for storage of feed ingredients and non-food/feed materials (such as cleaning agents, lubricants, and fuels) should be available.
- Facilities for the storage of feed shall be designed and constructed to:
 - enable adequate maintenance and cleaning;
 - prevent hiding places and accumulation of pests;
 - effectively shield animal feed from contamination / infection; loss of product is prevented.
- Animal feeds should be stored and transported in suitable containers. They should be stored in rooms designed, furnished and maintained to provide good storage conditions. Feedstuffs should be stored and transported in such a way as to be easily identified and to avoid cross-contamination and prevent spoilage.
- Storage of raw materials and ingredients should be effectively managed (rotation, first-in/first-out).

- Where necessary, the temperature should be kept as low as possible to avoid condensation and spoilage.
- A separate part of the storage area should be designated for the storage of premixes and additives. Veterinary medicines should be stored in a separate area.
- Processed feeds should be kept separate from unprocessed feed materials and additives to avoid cross-contamination of the processed feed. If several products are stored in one storage area, measures must be taken to prevent unwanted mixing. To prevent cross-contamination, untreated and treated products are separated where necessary.

7.4 Administration of Substrates

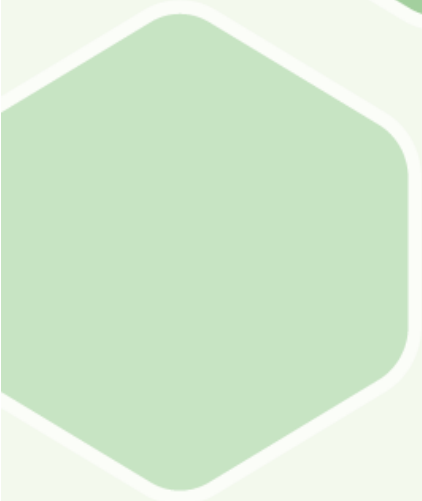
To provide insects with the necessary nutrients for their growth.

- Heavy metal contaminated feed should not be used in the rearing of insects.
- Select the substrate based on the chosen insect species, considering its resistance to mycotic, bacterial, and viral diseases.
- Ensure each batch of substrate delivered to the animals is traceable.
- Use equipment certified as 'food contact' material to provide the nutrients/substrates to the animals, ensuring it's thoroughly cleaned.
- Clean boxes/cages containing insects and equipment used to provide the substrate and/or water between each batch of production.
- It is not allowed to mix ingredients with levels of contamination above the respective legal limits with other feedstock to achieve a lower level of the contaminant in the resulting compound feed.
- An example of an optimal feeding strategies for mealworm larvae is when cultivated in a feed substrate with a depth of 10 cm, accommodating 1 larva per cm³. The ideal feed particle size is under 2 mm. For optimal growth, it's essential to provide moist feed, ensuring that the distance between wet feed areas is no greater than 10 cm, especially when the larvae are young .

7.5 Pre-treatment of Substrates

To ensure the safety and quality of the substrate before feeding it to insects.

- Pre-treat substrates, when necessary, through methods like shredding, grinding, milling, mixing, or acidification.
- Ensure that feeding substrates left overs are disposed of or, if reused, are treated appropriately to prevent the multiplication of micro-organisms.
- Prevent actively cross contamination.



CHAPTER 8

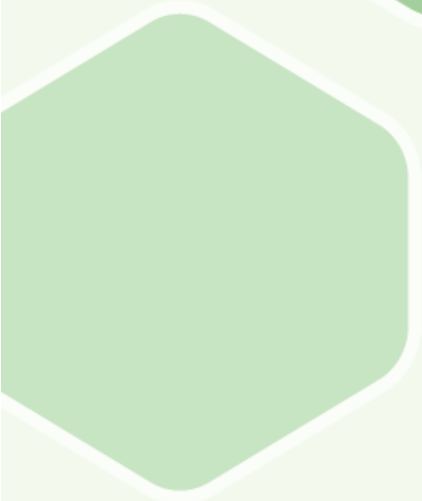
Regular Checks and Analysis



Chapter 8 – Regular Checks and Analysis

To monitor and ensure the quality of the substrate.

- Veterinary drugs, especially antibiotics, can have negative impacts on the health of insects. Residues of these drugs can also be transferred to the insects, which can then enter the food chain when these insects are consumed. Regular monitoring and testing are essential to ensure the safety of the insects and the products derived from them.
- Microbiological contaminants can pose a significant risk to human health if consumed. The presence of these contaminants in the substrate can lead to their transfer to the insects. The survival and proliferation of these pathogens depend on various factors, including the rearing conditions and the specific insect species. Ensuring proper hygiene and monitoring is crucial to mitigate these risks.
- Test against the presence of unauthorized substances and applicable limits for contaminants present in the substrate.
- Make samples and results of the analysis available to national competent authorities upon request.
- For a guide on what to test please consult Best practices analysis of incoming feeds substracts.



CHAPTER 9

Managing Insect Rearing Activities



Chapter 9 – Managing Insect Rearing Activities

9.1 Introduction

The potential risk for the presence of food safety hazards in insects primarily originates from chemical and biological

As the demand for insect-based foods rises, it becomes imperative to ensure the highest quality in rearing practices. From the diet provided to the insects to the conditions they are raised in, every aspect plays a crucial role in determining the final quality of the product. This comprehensive section delves into insect rearing activities, focusing on essential aspects such as diet, sanitation, monitoring, disease management, and more. By adhering to these best practices, insect producers can ensure the health, well-being, and optimal yield of species like Black Soldier Fly, mealworms, locusts, and crickets.

9.2 Insect Diet

Black Soldier Fly larvae, are recognized for their ability to bio-convert a variety of organic substrates, including fruit and vegetable waste, into valuable proteins and other nutrient. Yellow mealworms, when reared under optimal conditions, can thrive on diets comprising vegetable waste, garden waste, and even manure supplemented with chicken feed. Fresh vegetables, such as carrots, can serve as a moisture source. Locusts, which are closely related to grasshoppers, can be nourished with a combination of fresh grass, vegetables, and grains as part of a sustainable animal production system. Crickets, on the other hand can be provided with a balanced diet of grains, vegetables, and specialized cricket feed to ensure optimal growth and nutrient composition.

Furthermore, the following activities should be considered:

- Provide a nutritionally balanced diet that meets the needs of the specific insect species.
- Regularly evaluate the diet's quality and make necessary adjustments.
- Store ingredients in a cool, dry place and check for mold or contamination.

9.3 Sanitation and Hygiene

- Regularly clean and disinfect rearing containers and equipment.
- Implement a waste management system to dispose of old food and waste products.
- Ensure that workers follow strict hygiene protocols, including hand washing and wearing protective clothing.

9.4 Monitoring and Record Keeping

- Monitor insect populations for signs of disease, stress, or poor health.
- Keep detailed records of rearing conditions, diet formulations, and any observed anomalies.
- Use records to identify patterns and make informed decisions.

9.5 Disease Management

- Quarantine new insect colonies to prevent the introduction of diseases.
- Regularly inspect colonies for signs of disease and take prompt action if detected
- Implement biosecurity measures to prevent the spread of diseases.
- Avoid using chemical pesticides unless absolutely necessary.

9.6 Genetic Diversity

- Maintain genetic diversity by introducing new breeding stock periodically.
- Avoid inbreeding, which can lead to reduced vigor and increased susceptibility to diseases.
- Use genetic markers, if available, to monitor genetic diversity.

9.7 Handling

- Handle insects gently to avoid causing them stress or injury.
- Use appropriate tools and techniques for handling specific insect species.

9.8 Reproduction and Breeding

- Provide suitable conditions for mating and reproduction.
- Separate different life stages if necessary to ensure proper care and feeding.
- Collect and store eggs or larvae in optimal conditions to ensure high hatch rates.

9.9 Environmental Control

- Maintain optimal temperature, humidity, and light conditions for the specific insect species.
- Regularly calibrate and check environmental control equipment.
- Monitor for sudden changes in environmental conditions and adjust accordingly.

9.10 Staff Training

- Provide regular training for staff on insect biology, rearing techniques, and quality management.
- Encourage staff to stay updated with the latest research and best practices in insect rearing.
- Foster a culture of continuous improvement and encourage feedback.

9.11 Regular Review and Improvement

- Periodically review rearing protocols and make necessary adjustments based on feedback and observations.
- Stay updated with the latest research and technological advancements in insect rearing.
- Collaborate with experts and other rearing facilities to share knowledge and best practices.

9.12 Observing in Insect Farming

To accumulate facts, incidents, and circumstances.

Observing the physical, behavioral and patherns characteristics of insects is crucial for effective rearing practices and ensuring their quality. The texture of an insect, whether glossy or rough, can indicate its health and adaptability. Likewise, Non-interactive behaviors, such as feeding patterns or irritability, can provide insights into their individual well-being. Environmental factors like temperature and humidity directly impact their development, while by-products like molts and frass offer insights into their well-being. interactions with other biotic and abiotic elements, like nutrition choices or oviposition preferences, are key indicators of their environmental adaptability and reproductive health. In essence, these observations are foundational for fostering healthy insect populations. Some advice is:

- Pay attention, be patient, and practice to research the facts.
- Avoid letting emotions or personal biases influence the observation.
- Potential Pitfalls in Observation:
- Apply knowledge from books to real problems.
- Avoid biases about how the situation "should" be.
- Avoid relying solely on suggestions from others.

9.12.1 Types of Observations

- **Physical Characteristic:**
 - Size, number, color, morphology, and density.
 - Texture: glossy, matte, rough.
 - Environmental factors: temperature, humidity, airflow rate and direction, light intensity.
 - By-products: molts/skins, webbing, features of frass.
- **Behavioral Characteristics:**
 - Non-interactive behaviors: irritability, attractiveness, repulsion, feeding.
 - Interaction with conspecifics: crowding, cannibalism, mating.

- Interaction with other biotic and abiotic elements: nutrition, oviposition preference.
- **Patterns or Trends**
 - Look for patterns in performance, behavior, and location.
 - Understand daily, weekly, and annual patterns.
 - Observe if certain employees influence insect behavior.
- **Changes Over Time**
 - Understand the insect species through its entire life cycle.
 - Distinguish between temporary and permanent changes.
 - Look for subtle changes that could indicate future problems.
 - Understand that biologically based systems will change over time.

9.12.2 Recording Observations

- Use tools like batch labels, notebooks, computers, cameras, charts, and drawings.
- Record results shortly after observations are made.
- Be precise, concise, and clear.
- Always include dates and initials.
- Reference other recorded information accurately.

9.13 Managing the quality

- Regularly inspect insects for quality and health.
- Implement quality control measures to ensure the production of high-quality insects.
- Use standardized protocols and procedures to maintain consistency in rearing practices.
- Measure insect characteristics over time to gauge the consistency of the growing environment and insect quality.
- Monitor consistently.:
 - Disease occurrence.
 - Changes in behavior.

- Reproduction capacity.
- Fertility.
- Colony development.

9.14 Control of Overall Growing Environment

To provide a conducive environment for insect growth and prevent contamination.

- Keep insects in a closed environment, such as vessels, containers, boxes, or cages.
- Ensure the supply of air and substrate is well controlled.
- Implement appropriate cleaning and sanitary measures to avoid contamination or spread of diseases among the breeding flocks.
- Set up a pest control plan in the growing rooms, such as checking for the absence of pests like external insects or rodents.

9.15 Insect Breeding Flock Management

To ensure the quality and traceability of the breeding flocks.

- Use breeding flocks of a known and traceable origin, traceable for at least 3 generations.
- Maintain consistent population density at each developmental stage.
- Keep records of all breeding flocks, possibly through a traceability report.

9.16 Equipment and Tools

To ensure safety and prevent contamination.

- Use equipment, vehicles, boxes, and tools dedicated solely to insect rearing activities.
- Clean them thoroughly between batches and ensure they do not circulate outside of the insect rearing perimeter.

9.17 Control Access to Facilities

To prevent contamination and ensure the safety of the rearing environment.

- Strictly control the admission of people to the facilities.
- Ensure workers involved with different animals do not enter the rearing perimeter without clean and dedicated clothing, shoes, gloves, and other necessary protective gear.

9.18 Administration of Substrates

To provide essential nutrients to the insects.

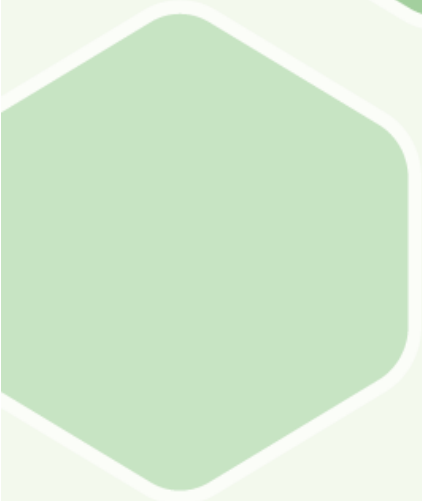
- Ensure the traceability of the substrates given to the animals.
- Use certified food contact equipment to provide the nutrients/substrates to the animals.
- Comply with feed preparation formulas and visually control the truck before unloading and accepting the delivery.

9.19 Optimize Rearing Conditions

To ensure the best growth rate and health of the insects.

- Control key parameters like temperature and humidity. For instance, temperatures between 25°C to 45°C are beneficial for most insects, and humidity levels should be adjusted based on the insect species (See Table 1 for more details).

INSECT SPECIES	HABITAT	DIET	BREEDING	HARVESTING
BLACK SOLDIER FLY (BSF)	Warm and humid conditions (27-30°C, 70-80% humidity)	Organic waste (fruit, vegetable scraps, grains)	mate and lay eggs (use corrugated cardboard)	Harvest mature larvae (~2 weeks)
MEALWORMS	Dark, dry conditions (20-25°C)	Grains, bran, oats, and fresh vegetables (e.g., carrots).	Separate pupae from larvae. Beetles lay eggs that hatch into larvae.	Harvest mature larvae before pupation
LOCUSTS	Spacious cages with ventilation (30-35°C, 50-60% humidity).	Fresh grass, vegetables, and grains.	Sandy substrate for egg-laying. Eggs hatch in 10-14 days	Harvest young and tender locusts
CRICKETS	Warm conditions (26-28°C).	Grains, vegetables, commercial cricket feed.	Moist substrate for egg-laying. Eggs hatch in ~14 days.	Harvest mature crickets (~6 weeks).



CHAPTER 10

Potential Risks



Chapter 10 – Potential Risks

10.1 Introduction

Insect rearing facilities, especially those intended for producing insects for food and feed, face various potential risks which can compromise the safety and quality of the final products.

10.2 Pests

- Birds: can be attracted to insect rearing facilities due to the abundance of food (insects). They can introduce diseases and contaminants.
- Insects and spiders: Other unwanted insects and spiders can compete for resources, introduce diseases, or prey on the insects being reared. They can also contaminate the products.
 - Dermestid beetles (*Dermestes* spp.): These beetles are known to infest mealworm cultures. They can be a nuisance as they can consume the mealworms and their feed, and their presence can lead to the rejection of entire batches of mealworms by customers.
 - Mites: Mites can be problematic in insect cultures. They can compete with mealworms for food and can also cause direct harm to the mealworms.
 - Fungus gnats (*Bradysia* spp.): These small flies can be found in insect cultures where they lay their eggs. Their larvae can then feed on the mealworms, causing harm to the culture.
 - Grain moths and mealmoths: These moths can infest the feed used for mealworms, leading to contamination and potential harm to the mealworms.
 - Grain beetles: Like grain moths, grain beetles can also infest the feed used for mealworms.
 - Ants: They can be attracted to the food sources in the facility and can become a nuisance.

- House Flies and Blow Flies: These flies can be attracted to the organic waste that is often used as feed for BSF larvae. They can compete with BSF for resources and can also introduce diseases.
- Rodents, and other small mammals can pose a hazard to the safety of food and feed derived from insects. In addition, Rodents such as rats and mice can be attracted to the food sources in the facility. They can damage equipment and introduce contaminants into the production facility, compromising the quality and safety of the products.
- Pathogenic Organisms : These include bacteria, fungi, and viruses that can infect and kill the insect in the rearing. They can be introduced by other pests or through contaminated food and water sources. A list of potential microbiological and chemical hazards in insect feed substrates is present at the delivery D6.1. In this publication is listed bacterial foodborne pathogens associated with insect rearing substrate ingredients as well as bio-accumulation of heavy metals.
- Parasites: Edible insects can carry parasites that may pose risks to humans. possible transmission of foodborne intestinal flukes to humans have been suggested through edible insects by trematodes belong to the Lecithodendridae and Plagiorchiidae families. Protozoa like *Entamoeba histolytica*, *Balantidium* spp., *Isospora* spp., *Giardia lamblia*, *Toxoplasma* spp., and *Sarcocystis* spp. have been found in edible insects. There have been documented cases of people getting intestinal infections from insects on unwashed fruits .
- Edible insects may also carry *Cryptosporidium* spp. and *Trypanosoma cruzi* (Chagas disease). If insects are raised on chicken manure, there's a risk of coccidia parasites. Proper processing is crucial to reduce these health risks when using insects as animal feed.
- The presence of foodstuffs and water, even as mere trails, unprotected from contact with ambient air, can attract pests.

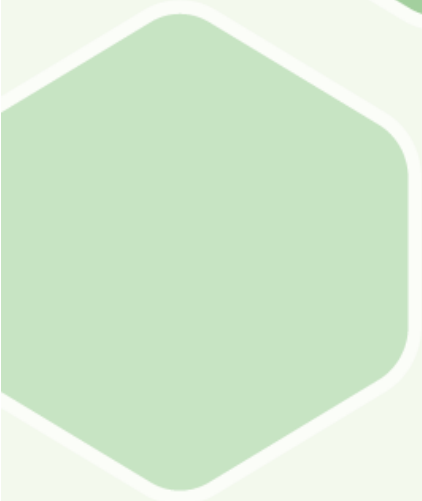
10.3 Pest Control Measures

- Documented Pest Control Program: To systematically prevent pest activity inside the facility and within the boundaries of the outer grounds.
- Create a comprehensive plan detailing the types of pests, their potential breeding sites, and the measures to control them.
- Remove Breeding Sites: To prevent the multiplication of pests within the facility.
- Regularly inspect the facility for potential breeding sites and remove them. Ensure all orifices are sealed off or hermetically blocked.
- Install Protective Devices: To prevent pests from entering the facility.
- Fit windows, doors, and air vents with appropriate devices like nets, grids, or other barriers.
- Maintain Good Housekeeping: A clean environment is less attractive to pests.
- Control the accumulation of food and paper debris, keep gangways and passages clear, remove redundant equipment and materials from production areas, ensure good stock rotation, and keep organic and soiled waste containers covered.
- Avoid Food and Water Trails: Trails can attract pests.
- Ensure there are no food and water trails left unprotected from contact with ambient air.
- Regular Monitoring: To detect and address pest infestations early.
- Check for the presence of infestation regularly and review the monitoring plan based on the results of the inspections.
- Use of Bait Stations: To control rodent activity.
- If rodent baits are used, they should be based on fatty and waxy substrates and placed in a solid box. Use poison baits for rodents along the external walls of the facility (unsecured bait stations). Ensure no bait spillage occurs to prevent food safety risks.
- Electric Flying Insect Killers: To control flying insects.

- Install electric flying insect killers that do not attract outside insects. Place them more than three meters away from unprotected products.
- Restrict Domestic Animals: Domestic animals can introduce pests and contaminants.
- Ensure no domestic animals are allowed to enter production or storage areas.

10.4 Implementing pest control measures and waste management:

- In general, try to get rid of infected crates and to maintain a healthy colony. In case of an infestation that takes over the full breederly it would be wise to clear the breederly, professionally clean everything and start over.
- A level of cleanliness and neatness should be achieved at all stages of production such that no pests are attracted.
- Effective pest control programs shall be implemented. For mealmoths pheromone traps can be used, electrical insect lamps, ventilators to shred them and sticky traps. As they are not native they enter through the feedstock, this can be prevented by freezing or heating the feed before it enters the breeder.
- To control mite populations make sure the relative humidity stays under 70%.
- From the point of view of employee and feed safety, acceptable and permitted pest control methods and agents are used.
- Pest control shall be performed by qualified people.
- The implementation of the pest control program should be recorded in such a way that it is clear to all that the program is being implemented correctly.



CHAPTER 11

Processing Methods for Insects



Chapter 11 – Processing Methods for Insects

11.1 Killing Step

To humanely and efficiently prepare insects for processing.

Ensure the method used is appropriate for the specific insect species and desired end product:

- Chilling: Use cold temperatures specific to the insect species:
 - Black Soldier larvae and mealworms: 0°C-5°C.
 - Crickets: 5°C-10°C.
 - Ensure the temperature remains consistent throughout the process.
 - Store/transport chilled insects in containers, forming a layer of a certain thickness.

- Killing by Hot Water Plunge insects in hot water.

The killing temperatures vary based on the insect species and their growth status:

- Black Soldier Fly: Typically around 80°C for about 4-6 minutes.
- Mealworms: Above 90°C for about 5-7 minutes.
- Ensure the chosen time-temperature combination effectively reduces potential microbiological pathogens.

Monitor for appropriate pathogen levels.

- Freezing: Kill insects at temperatures below 5°C (most freezers operate at -20°C).
 - Set appropriate freezing times based on the insect species.
 - Use industrial tunnel freezing methods such as cryogenic, fluidization, and impingement, utilizing liquid nitrogen/CO₂ or cooled air.
 - Store frozen insects in sealed boxes or bags at -20°C.

11.2 High-moisture extrudates (HMEs)

Are used to create fibrous meat substitutes. Using standard recipes with soy and pea proteins, up to 30% of these proteins can be substituted with whole

insects (like HC, BSFL, MW, or HF) to enhance the protein and amino acid content.

The HME production process involves:

- Pretreatment: Insects, either fresh or frozen, are ground and mixed to ensure even distribution in the HMEs.
- Thermal Processing: This step, which uses equipment like the twin screw extruder, serves for pasteurization and texturization. Key parameters include a peak barrel temperature (160°C for soy and 150°C for pea-based HMEs) and a screw speed of 400 rpm. The process lasts about 3-4 minutes. The water content of the insects determines the additional water needed during this phase.
- Cooling Phase: The mixtures are moved to a cooling die, ensuring core temperatures remain below 100°C.

Incorporating insects affects the HME's final characteristics. Their high water content reduces the need for added moisture during processing, while their fat content results in a softer, juicier product. Using frozen insects can affect the extrusion temperature, potentially softening the HMEs, but adjustments to the barrel temperature or screw speed can counteract this. Insects introduce more microorganisms, but the high processing temperatures significantly reduce these, including bacterial endospores. The insect exoskeleton might slightly alter the HME's sensory attributes, but adequate grinding and mixing can minimize these effects. Please check Best practices: High moisture extrusion of mealworms, black soldier fly larvae, house flies and house crickets to have detailed information.

11.3 Extracting lipids

To produce insect meal is crucial in the insect industry. While traditional methods include dry rendering, solvent extraction, and wet rendering, this guideline focuses on the advantages of wet rendering, especially when combined with enzymatic pre-treatment obtained from the Susinchain results . For detailed information consult this publication.

- Traditional Extraction Methods Overview:
 - Dry Rendering: Involves heating, drying, screw press, and decanter. However, it has downsides such as:
 - Lower product quality.
 - High energy consumption.
 - Complex washing operations.
 - Extended processing times.
 - Solvent Extraction: Requires pre-dried insect biomass and often uses environmentally unfriendly organic solvents.
- Wet Rendering with tricanter Centrifugation: An alternative to dry rendering and solvent extraction which uses heating and a three-phase decanter. Advantages include:
 - Simultaneous separation of fats, liquid phase, and solids.
 - Faster and more controllable than pressing.
 - Can handle materials with high solid content and very fluid materials.
 - Allows for an enzymatic pre-treatment phase, which requires water.
- Enzymatic Pre-treatment:
 - An added step to the conventional process.
 - Enhances the insect meal by:
 - Improving protein digestibility.
 - Reducing allergenicity.
 - Although it incurs additional costs due to enzyme usage, the enhanced quality of the insect meal can offset these costs.



CHAPTER 12

Thermal Processing

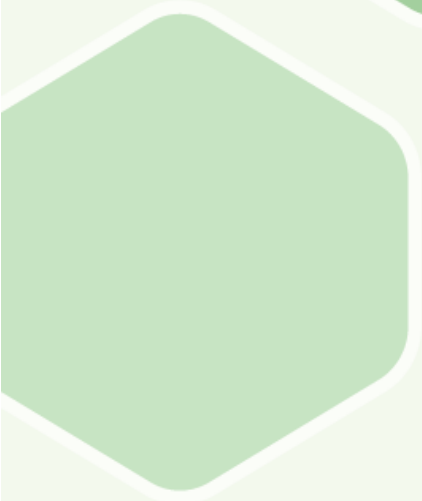


Chapter 12 – Thermal Processing

To preserve the quality of the insects and prepare them for further processing.

- **Heat-Based Dehydration:**
 - Use an oven to maintain high temperatures, allowing moisture to evaporate.
 - Ensure drying temperatures are consistent throughout the process.
 - The specific temperature levels and time required may vary based on the insect species, pre-treatment steps (e.g., blanching time), and equipment used. (e.g., oven, microwave). For instance, for certain insects:
 - Black Soldier Fly: Typically, the temperature applied is usually around 80°C for about 4-6 minutes.
 - Mealworms: The temperature goes above 90°C for about 5-7 minutes.
 - Clean the oven thoroughly between batches and dispose of insect residues appropriately.
- **Cooling After Heat Treatment:** After hot water or boiling water treatments, strictly monitor residual water post-treatment in cooling tanks or cooling chambers.
 - Ensure that water used to cool the container after heat treatment is not a source of contamination for the insects.
- **Mechanical Separation/Crushing:** *To separate the insect parts and prepare them for further processing or as end products.*
 - Use mechanical methods like sieving machines for larvae or sorters for adult insects.
 - Ensure the separation process effectively removes unwanted parts like frass, dead individuals, and substrate residues.
- **Heat-Based Dehydration Methods:** *To remove moisture from the insects, preventing microbiological contamination.*
 - Use ovens or other heat sources to maintain high temperatures, allowing moisture to evaporate.

- Ensure consistent drying temperatures are maintained throughout the process.
 - Clean the oven thoroughly between batches and dispose of insect residues appropriately.
- **Storage and Handling:** To maintain the quality of the processed insects until they are used or sold.
 - Store processed insects in hygienic conditions, ensuring they are protected from contamination.
 - Handle with care to prevent damage or contamination.
- **Regular Checks and Quality Control:** *To ensure the quality and safety of the processed insects.*
 - Conduct regular checks on the processed insects for quality and safety parameters.
 - Implement quality control measures to ensure consistency in the processed products.
- **Packaging:** To protect the processed insects from external contaminants and maintain their quality.
 - Use appropriate packaging materials that are safe for food or feed use.
 - Ensure packaging is sealed properly to prevent contamination.
 - Visitors to areas where insects are produced, processed or handled should wear protective clothing, where necessary, and adhere to the applicable rules for personal hygiene.



CHAPTER 13

Storage and transportation



Chapter 13 – Storage and transportation

The effective storage and transportation of insects are crucial components in the insect production value chain. This guide provides an overview of the best practices based on recent research findings on BSF of Susinchain

13.1 Understanding Storage Environments

Different storage environments can impact the survival and quality of BSF larvae. It's essential to choose the right method based on the intended use and duration of storage.

- **Vacuum Storage:** While it might seem beneficial due to the absence of gases, especially oxygen, vacuum storage doesn't offer significant advantages for both living and killed larvae compared to regular air storage. However, a slightly reduced storage temperature can enhance the survival of living larvae and the microbial quality of killed ones.
- **Controlled Atmosphere:** Using a 100% N₂ atmosphere for microwave-dried BSF larvae can effectively control lipid oxidation. This method is as efficient as freezing and can be a cost-effective solution for transporting oxidation-sensitive dried BSF larvae products.
- **Water Storage:** Storing BSF larvae in water for short durations is feasible. Preliminary findings suggest better survival rates at cooler temperatures (15 °C) than at room or refrigerated temperatures. This method can offer additional benefits like simultaneous insect washing and cooling.

13.2 Importance of Killing Methods (during storage):

- The method used to kill the insects, especially those with a decontamination effect like blanching, can significantly influence their microbial quality during storage. Producers should consider methods that improve the initial microbial quality, thereby slowing down microbial activity during storage.

13.3 Transport Considerations:

For dried and stabilized killed insects, the challenges associated with storage and transport differ from those of living or fresh insects. Producers should:

- Prioritize chemical stability, ensuring processes like lipid oxidation are minimized.
- Consider using 100% N₂ atmosphere packaging for oxidation-sensitive dried BSF larvae products to avoid the costs and challenges of frozen transport.
- For BSF transport recommendations are :
 - Eggs:
 - Use 500 ml plastic boxes with a mesh at the bottom.
 - Store up to 3 grams of 24-hour-old eggs per box to avoid clustering.
 - Maintain a temperature above 25°C and 60% RH.
 - Neonates:
 - Use 500 ml plastic boxes with filter paper, placed inside a larger cork box.
 - Store 1 gram of 2-day-old neonates, 20 grams of feed (70% hen feed, 30% wheat bran), and 18 grams of water per box.
 - Keep the temperature at 25°C and 60% RH. Use a datalogger for monitoring and a heat pack in cold conditions.
- Transporting mealworms is most efficient during their egg stage, as they can't escape and require minimal space and oxygen. For successful transport, maintain a temperature range of 15 °C to 30 °C and a humidity level between 40% and 80%. Temperatures above 30 °C can reduce hatching rates. While temperatures below 15 °C are feasible, they should be limited to 2 days at 10 °C or a single day at 5 °C
- House cricket eggs have a gel-like consistency and adhere to the surface they're laid on. If this surface remains uncontaminated, it's ideal for the eggs. When moving these eggs, it's advised to:
 - Separate the egg-filled container from the one with adult crickets.
 - Ensure no adult crickets are in or on the egg container.

- Check the humidity of the egg container; if it's dry, moisten with clean water.
- For transportation, place the container in a box, minimizing movement.
- Regardless of the season, maintain a temperature between 15°C and 35°C for optimal hatching. However, note that in cold conditions, eggs might be viable for up to 23 days post a six-day transit, but it's uncertain if they'll hatch after this period.
- Aim for a quick transit to prevent temperature fluctuations, mold growth, or physical disturbances.
- Studies on transporting live eggs mainly looked at temperature impacts over six days. Eggs were then incubated at 33°C. Transporting at 30°C yielded the best outcomes. Still, temperatures above 15°C might delay hatching without affecting the hatch rate

Another recommendations for storage are6:

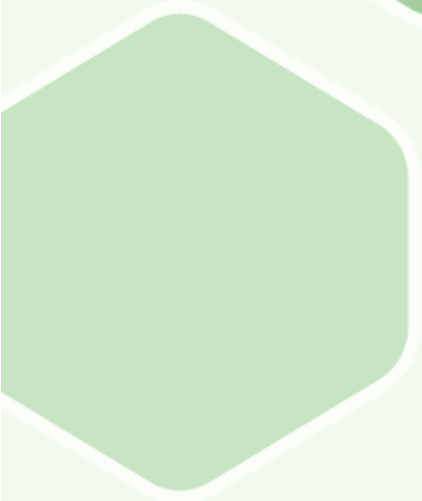
- **Determine Storage Conditions Based on Product Type:**
 - Dry, Cool, and Closed for Insect Powders: These products are typically incorporated into food or feed formulations. Given their characteristics and potential use, such storage parameters are essential.
 - Store in a dry, cool, and closed environment to maintain product quality and prevent contamination.
- **Frozen Storage for Whole Insects:** These products are typically used as feed or food. Freezing allows for a longer shelf life, especially given the higher water activity compared to powdered insects.
 - Store in a freezer at very low temperatures (typically -20°C or lower).
- **Ensure Proper Premises Layout:** *To ensure a safe environment, prevent contamination, and allow for maintenance.*
 - Design premises to avoid any release of live insects into the environment.

- Maintain separate storage areas for treated and untreated live insects to avoid cross-contamination.
- Ensure storage areas are designed to minimize the risk of product contamination.
- **Control of Storage Conditions:** *To maintain product quality and safety.*
 - Store raw materials and ingredients at specified temperatures. For instance, materials requiring cold storage should be placed under chilled conditions (i.e., temperature between 0°C and 8°C) without delay.
 - Manage placement of finished products in the warehouse according to the principle of First In – First Out (FIFO).
 - Monitor and control temperature and humidity as required by product or storage specifications.

Additionally, for transportation it recommended6:

- **Maintain Hygiene Standards:** *To ensure the safety and quality of insect products during transport.*
 - Adhere to hygiene standards as outlined in Regulation (EC) No 852/2004 on the hygiene of foodstuffs and Regulation (EC) No 1831/2003 on feedstuff requirements.
 - Comply with specific requirements for insect Processed Animal Proteins (PAPs) intended as feed for non-ruminant farmed animals as per Regulation (EC) No 999/2001.
- **Vendor/Supplier Approval System:** *To ensure that transport providers adhere to good hygiene practices.*
 - Monitor the selection of transports and their activities through an appropriate vendor/supplier approval system.
 - Ensure transport providers demonstrate their commitment to good hygiene practices, especially concerning their transportation units and workers.
- **Transport Units Design and Maintenance:** *To prevent cross-contamination during transport.*

- Use transport units designed to avoid cross-contamination due to simultaneous or consecutive transport.
- Ensure transport units are cleanable and made of appropriate material or are appropriately coated.
- The design should facilitate inspection, cleaning, disinfection, and, when necessary, temperature and cooling control.
- **Sanitary Requirements:** *To maintain the safety and quality of insect products during transport.*
 - Adhere to sanitary requirements as they are as crucial in transport operations as in manufacturing activities.
 - Comply with specific obligations for transport and storage of insect PAPs and compound feed containing such products intended for non-ruminant farmed animals.
- **Temperature Control (if applicable):** *To maintain the desired product quality and prevent spoilage.*
 - Use transport units equipped with temperature control mechanisms.
 - Monitor and maintain the required temperature throughout the transport duration.
- **Documentation and Traceability:** *To ensure product safety and facilitate traceability in case of any issues.*
 - Maintain proper documentation related to transport conditions, product specifications, and any other relevant information.
 - Ensure traceability of the product from the production site to the destination.
- **Regular Checks and Monitoring:** *To ensure the consistent quality and safety of transported products.*
 - Conduct regular checks on the transported products for quality and safety parameters.
 - Implement monitoring measures to ensure consistency in the transported products.



CHAPTER 14



**Storage and Transportation Record-
Keeping**

Chapter 14 – Storage and Transportation Record-Keeping

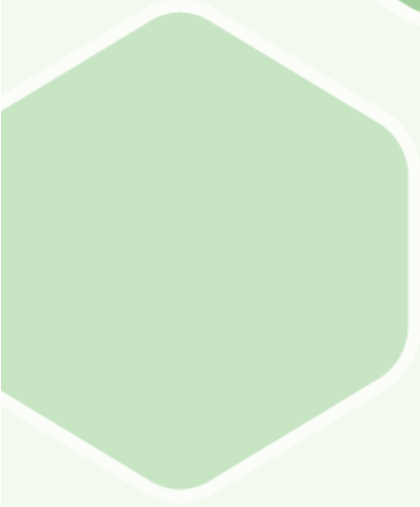
To ensure compliance with food and feed safety regulations, insect producers should maintain records of the following information for effective storage and transportation

- **Point of Loading and Unloading:**
 - Document the locations where insect products are loaded onto and unloaded from transport vehicles or vessels.
- **Transport Details:**
 - Record information about the transport company responsible for moving the products.
 - Specify the means of transport used, including boats (mentioning whether they are in the hold or tank) and vehicles (with reference to the trailer or container type).
- **Storage Information (if applicable):**
 - Note the storage company involved, if any.
 - Specify the means of storage used, such as warehouses, silos, or tanks.
 - Include the number or distinguishing mark of the storage facility or silo, if applicable.
- **Batch Information:**

Maintain detailed records for each product batch, including:

 - Temperature levels during storage and transportation.
 - Information on processing control points.
 - Product origin.
 - Details about processing equipment used.
 - Records of heat and freezing treatments applied.
 - Information about the substrates used in production.
 - Results of any quality or safety samples taken.
 - Record the staff members involved in each product batch's handling.

- **Batch Labelling:**
 - Ensure that all finished products are labelled with batch numbers.
 - Implement a "first in, first out" strategy to manage product rotation effectively.
 - Handling Rejected Products:
 - Establish a system for dealing with products rejected by customers for food or feed safety reasons.
 - Document the reasons for rejection and any corrective actions taken.
- **Document Retention:**
 - Comply with EU regulations and national legislations by retaining these records for traceability purposes.
 - Generally, retain documents for a recommended period of two years or until it is reasonable to assume that the food has been consumed.
- **Information Sharing:**
 - Have systems and procedures in place to facilitate the sharing of information with national food and feed safety authorities when deemed necessary.
 - By following these record-keeping instructions, insect producers can maintain transparency, traceability, and compliance with food and feed safety regulations throughout the storage and transportation of their products.
- Visitors to areas where insects are produced, processed or handled should wear protective clothing, where necessary, and adhere to the applicable rules for personal hygiene.



CHAPTER 14

Packaging and Labelling



Chapter 15 - Packaging and Labelling

Labelling Specifications for Edible Insect Products

- Once an edible insect species is authorized and included in the UL, specific product specifications will be laid out, including labelling.
- Two main labelling concerns identified by IPIFF are the 'Name of the food' and 'Allergen Labelling'.

Name of the Food:

- Currently, there's no 'legal name' for insects as food under the FIC Regulation.
- Due to the lack of regulated terminology, operators use descriptive names. However, this has led to varied descriptions, with terms like 'cricket flour' potentially misleading consumers.
- IPIFF Recommendation: Define product names based on the insect's characteristics, e.g., 'name of insect' powder, 'name of insect' oil, or whole 'name of insect'. For instance, "Mealworms (*Tenebrio molitor*) powder" for ground insects.

Allergen Labelling:

- Food Business Operators (FBOs) must label ingredients that can cause allergies or intolerances. Edible insects aren't currently listed as allergens, but they have allergenic properties similar to crustaceans and molluscs.

Situations Covered Under FIC Regulation:

- Situation 1: Allergies from the substrate consumed by the insects, e.g., if insects ate cereals with gluten.
- Situation 2: Allergies from other ingredients in insect-based products, e.g., if a product contains nuts.
- Situation Not Covered:
- Situation 3: Allergies caused by the insect itself, as they aren't listed in Annex II to the FIC Regulation.

- IPIFF Recommendation: For Situation 3, IPIFF suggests mandatory allergen labelling. Products should carry a warning about the allergenic properties of edible insects, indicating similarities to crustaceans, molluscs, and dust mites. The label might read: "People who are allergic to molluscs, crustaceans, and/or dust mites may have an allergic reaction to insect consumption."

Maintain Hygiene and Security

To prevent contamination and ensure product safety.

- Implement cleaning and disinfection procedures.
- Prevent the accumulation of organic material.
- Conduct visual checks for foreign objects in the product.
- Implement a First In First Out (FIFO) strategy for product rotation.
- Ensure adequate storage conditions align with product specifications.
- Maintain proper documentation for all storage operations.

Monitor and Document:

To ensure consistent quality and safety of stored products.

- Periodically check the stability of the product during its shelf-life. Document any deviations and take appropriate actions if needed.
- Maintain documentation related to storage conditions, product specifications, and any other relevant information.



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