FAIRMAN KNIGHT & SONS

HACCP MANUAL

Production of Category 3 Processed Animal Protein (PAP)
and Insect Frass derived from Black Soldier Fly (*Hermetia illucens)*

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HACCP MANUAL – Document Revision History

This page records the revision history for controlled updates to the HACCP Manual.

Revision No.	Date	Description of Change	Approved By	Signature

All changes to this document must be reviewed and approved by Fairman Knight & Sons management prior to issue.

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1.Business information

Business Name: Fairman Knight and Sons UK Limited (Co. No. 15088125)

Location: 4 Washway Road, Fleet, Holbeach. PE12 8LT.

Directors: Julian Knight, William Fairman

2. Introduction

2.1. Definitions

HACCP: H.A.C.C.P. is the acronym for Hazard Analysis Critical Control Point. It is a systematic approach to identifying and assessing hazards in food operation and the risk these hazards present. Where there is a significant risk, Critical Control Points (CCP's) are identified at which hazards can be eliminated or controlled.

Pre-requisite: The good hygiene practices (GMP etc) that a food/feed business must have in place before implementing HACCP to enable the HACCP plan to concentrate on the most significant hazards. The following information is within the Pre-requisites:

- Management commitment
- Approved Suppliers and purchasing
- Pest Control
- Waste
- Personal Hygiene
- Training
- Cleaning
- Premises & Equipment
- Traceability
- Allergens
- Transport

Hazard: The potential to cause harm to the consumer or product which does not comply with specification or requirements in legislation. Hazards can be Microbial, chemical, allergens or physical.

Risk: The chance that a hazard will occur, i.e. the probability of control of failure.

Control Measures: Actions and activities that serve to eliminate hazard or reduce their occurrence to acceptable level.

Critical Control Points (CCP's): Stages in the process which if controlled will eliminate or minimise a hazard but if not controlled provide a threat to consumer safety.

Monitoring: A planned sequence of observations or measurements of critical limits designed to produce an accurate record.

Verification: Methods and procedures designed to ensure that HACCP has been correctly carried out and applied.

Target Level: A pre-determined value for a control measure which eliminates or controls a hazard at a CCP.

Tolerance: The specified degree of the control measure at a CCP values outside this tolerance indicating a deviation.

Scope: This HACCP covers all aspects of producing safe food/feed from the primary production of terrestrial invertebrates through to production of insect puree. This includes cooking, pasteurisation, pureeing and freezing of the larvae of the Black Soldier Fly (*Hermetia illucens*). It covers all new products produced on site. Currently, the puree is only available as a frozen product, which is not intended for use without further processing, for use in pet food (cats and dogs) only and not for human consumption.

2.2. Products Description

Product group: Insect puree	
Intended use	The products are delivered to pet food companies for further processing. The target groups for the product will be cats and dogs.
Ingredients, including origin (where applicable)	Various origins of ingredients UK or EU Origin
Key processes (including any treatment)	• Goods Intake - all ingredients delivered in ambient temperatures. • Stock feed and neonate feed ingredients kept in ambient storage conditions plus the option to chill the storage as the whole site is chillable. • Larvae cooked; insect puree pasteurised. • Insect puree cooled and frozen. • Insect puree sold bulk under frozen conditions
Alternative uses	No alternative uses could be identified as restricted use due to regulations.
Composition	Allergens contained in both neonate feed and feed stock ingredients which is fed to the larvae and black soldier flies. • **Note:** The insect protein from the black soldier fly is considered high in protein and possible allergenicity or cross reactivity, this is identified on the finished product label. (Technical Report Risk Profile on Edible Insects July 2022 FSA) • **Note:** The insect protein is classified as an Animal By product category 3, it is not for human consumption and does not fall under the Allergen regulations the same as food consumed by humans.
Intrinsic factors (including chemical and physical properties	Larvae cooked and insect puree pasteurized to kill vegetative microorganisms. Stock feed and Neonate feed kept under ambient conditions.

Packing systems	Aluminium racks coupled with plastic fabric tarp are used to store/grow larvae during the life cycle and feeding stages. Plastic dolav liners, shrink wrap and waxed kraft paper comes in direct contact with the product.
Storage and distribution conditions	Feedstock and neonate feed is kept under ambient conditions. Option for chilled storage available Insect puree is stored and distributed in frozen conditions
Target shelf life	Neonate feed has a maximum shelf life of 5 days and growing feed can be stored for 2 months in chilled area (4 deg C) or 3 weeks in ambient temperature. Insect puree as 1-year frozen shelf life
Instructions for use	Insect puree is a category 3 animal by product which is not for human consumption. The product is manufactured for the pet food industry and used as an ingredient in dog and cat food, after further processing by the manufacturer, it must be cooked before being consumed and cannot be fed to other animals or humans.
Considerations for potential misuse	**Pesticide levels** (*Glyphosate & Chlormequat) outside the legal permitted maximum residue level in stock feed and neonate ingredients. **Heavy metals** – Cadmium, Zinc and Arsenic **Aflatoxins B1, B2, G1 and G2, Ochratoxin A** **Microorganisms –** E. coli, Salmonella, Enterobacteriaceae, Clostridium Perfringens (if applicable) **Temperature abuse.** ***** *pesticides most used pre-harvest on UK cereals, residues are detected in virtually all surveys.*
Consumer target group	Pet food industry: cats and dogs only.

Background information on product (including scientific literature, historical and known hazards, codes of practice and guidelines for the industry, food safety legislation & customer requirements)	**Codex Alimentarius (HACCP)** **The Food Safety and Hygiene (England) Regulations 2013 and amendments** **Regulation (EU) No 1169/2011 Food Information to Consumers** **Food Safety Act 1990 & relevant codes of practice.** **Food Labelling Regulations 1996 and amendments** **Pesticide (Maximum Residue Levels in Crops, Food and Feeding Stuffs) (Amendment) Regulations 1999** **Genetically Modified Material (GMO) EEC Regs No 1830/2003 on the Traceability & Labelling of GMO & the traceability of Food and Feed products and amendments** **Plastic Materials & Articles in Contact with food (England) Regulations 2012.** **Weights & Measures (Packaged goods) Regs 2006** **Principle of General Food Law Regulation (EC) 178/2002** outlining general food law **Food Hygiene Regulation 852/2004** outlining food hygiene, operational & premises requirements (Annex II) **Food of Animal Origin Regulation 853/2004** **Official Controls Regulations Reg. 2017/625** addresses official controls and other official activities performed to ensure the application of food and feed law, rules on animal health and welfare, plant health and plant protection products. **The Novel Foods (England) Regulations 2018** **Commission Implementing Regulation (EU) 2017/2468** **Commission Implementing Regulation (EU) 2017/2469** laying down administrative and scientific requirements for applications referred to in Article 10

	of Regulation (EU) 2015/2283 of the European Parliament and of the Council on novel foods. **Commission Implementing Regulation (EU) 2017/2470** establishing the Union list of novel foods in accordance with Regulation (EU) 2015/2283 of the European Parliament and of the Council on novel foods. **Commission Implementing Regulation (EU) 2018/456** on the procedural steps of the consultation process for determination of novel food status in accordance with Regulation (EU) 2015/2283 of the European Parliament and of the Council on novel foods. **General requirements for feed hygiene and animal health Regulation 183/2005** lays down general rules governing feed hygiene, conditions and arrangements ensuring traceability of feed as well as conditions and arrangements for registration and approval of establishments. **Animal by products and Derived Products: Reg 1069/2009** lays down public health and animal health rules for animal by-products and derived products, in order to prevent and minimise risks to public and animal health arising from those products, and in particular to protect the safety of the food and feed chain. **Animal Welfare Directive 98/58/EC** protection of animals kept for farming purposes. **Placing on the Market and Use of Feed Reg. 767/2009** **Processed Animal Protein Amendments Reg. 2017/893** **Undesirable Substances in Animal Feed Directive 2002/32/EC** Directive sets maximum levels of undesirable substances and products in animal feed available on the European Union's market. It also limits the risks of contamination of animal feed by

	substances and products that are toxic or adversely affect production. **Note:** Even though the UK has exited the EU; terrestrial invertebrate legislation remains largely unchanged (in terms of hygiene, compliance, best practices) with the exception of Novel Food regulations dictating which insects can and cannot be marketed freely in the UK.
Product group : Insect Frass	
Intended use	The products are delivered to farmers for use as soil additive/enhancer. It can be essentially spread over fields, put locally within trees orchards or in potted plants / potted plants environment
Ingredients, including origin (where applicable)	Various origins of ingredients UK or EU Origin
Key processes (including any treatment)	• Goods Intake - all ingredients delivered in ambient temperatures. • Stock feed and neonate feed ingredients kept in ambient storage conditions plus the option to chill the storage as the whole site is chillable. - Larvae are separated from their frass - Frass gets heat treated and bagged
Alternative uses	No alternative uses could be identified as restricted use due to regulations.
Composition	Allergens contained in both neonate feed and feed stock ingredients which is fed to the larvae and black soldier flies. • **Note:** The insect protein from the black soldier fly is considered to be containing chitin which can present possible allergenicity or cross reactivity, this is identified on the finished product label.

	• **Note:** The insect frass is classified as an Animal By product category 3
Intrinsic factors (including chemical and physical properties	Frass heated up to 70 degrees for 1 hour to dry and reduce microbial load Stock feed and Neonate feed kept under ambient conditions.
Packing systems	Aluminium racks coupled with plastic fabric tarp are used to store/grow larvae during the life cycle and feeding stages. Plastic dolav liners, shrink wrap, 25Kg bags, bulk bags can be in contact with the product
Storage and distribution conditions	Feedstock and neonate feed is kept under ambient conditions. Option for chilled storage available Insect frass is stored and distributed in dry bulk bags
Target shelf life	Neonate feed has a maximum shelf life of 5 days and growing feed can be stored for 2 months in chilled area (4 deg C) or 3 weeks in ambient temperature. Insect frass has no theoretical shelf life as it is dry organic matter destined to be a soil amendement
Instructions for use	Insect frass is a category 3 animal by product which is not for human consumption. The product is manufactured for the farming / fertilizer industry.
Considerations for potential misuse	**Pesticide levels** (*Glyphosate & Chlormequat) outside the legal permitted maximum residue level in stock feed and neonate ingredients. **Heavy metals** – Cadmium, Zinc and Arsenic **Aflatoxins B1, B2, G1 and G2, Ochratoxin A** **Microorganisms –** E. coli, Salmonella, Enterobacteriaceae, Clostridium Perfringens (if applicable) **Temperature abuse.**

	* *pesticides most used pre-harvest on UK cereals, residues are detected in virtually all surveys.*
Consumer target group	Farming and Horticulture
Background information on product (including scientific literature, historical and known hazards, codes of practice and guidelines for the industry, food safety legislation & customer requirements)	Animal By-Products Regulations (ABPR) for Category 3 materials and PAS 100 standards for compost quality, including the Regulatory Position Statement (RPS) 281 for insect frass composting. Regulation (EU) 2021/1925 (e.g. complying with the dead insects threshold on mass and volume and the microbiological threshold). **Note:** Even though the UK has exited the EU; terrestrial invertebrate legislation remains largely unchanged (in terms of hygiene, compliance, best practices) with the exception of Novel Food regulations dictating which insects can and cannot be marketed freely in the UK.

2.3 Description

The Process Flow attached shows the steps in the manufacturing operation and identifies the CCP's.

HACCP data sheets identify the steps in the processes where hazards could be found, or occur, and list whether the hazard is of a Microbial, chemical or physical nature.

The following hazards have been identified:

- **Physical** – metal, glass, plastic, factory structure, floor, machinery e.g. nuts, screws, bolts, belts, seals, washers etc, staff e.g. hair, clothing, nails, wood, insect infestation, foreign bodies or objects, string, paper, stones, cardboard.

- **Microbial** – Escherichia Coli, Salmonella, Enterobacteriaceae, Clostridium Perfringens (as per customer requirement)
- **Chemical** – Cleaning chemicals, Lubricants, Pesticides Residues, Heavy metals, Aflatoxin and Ochratoxin.

The preventative (control) measures are listed and CCP's have been identified.

Limits and tolerances of control measures are shown against the method of monitoring them along with the corrective actions, which must be taken if a control measure is found to be outside of the stated limits.

Allergen list

Directive 2005/26/EC 21st March 05

Directive 2000/13/EC Annex llla

Directive 2003/89/EC November 03

Directive 2007/68/EC 27th November 07

Food Labelling (Declaration of Allergens) (England) Regulations 2009

The following allergens are included within the HACCP charts.

- Cereals containing gluten (i.e. wheat, rye, barley, oats, spelt, kamut, or their hybridised strains) and products there of
- Crustaceans and products there of
- Eggs and products there of
- Fish and products there of
- Peanuts and products there of
- Soybeans and products there of
- Milk and products there of (including Lactose)
- Nuts i.e. almond, hazelnut, walnut, cashew, pecan, brazil nut, pistachio, macadamia nut, Queensland nut and products there of
- Celery and products there of

- Mustard and products there of
- Sesame seeds and products there of
- Sulphur dioxide and sulphites at concentration of more than 10 mg/kg.
- Molluscs – and products there of - all species e.g. oyster, squid, cockles, mussels, periwinkle, & scallops as well as land molluscs like snails
- Lupin and product there of – e.g. lupin seeds and lupin flour.

All ingredients for the feed stock are sourced from Approved Suppliers where upon product specifications are obtained, and allergen status is known. All ingredients are stored in separate areas in the warehouse.

All employees receive allergen training on Induction and complete an allergen training module. All food that is either purchased are brought in by staff are stored and consumed in the canteen or office areas. The insect protein from the black soldier fly is considered high in protein and possible allergenicity or cross reactivity, this is identified on the finished product label, including the possible may contain cereals containing gluten, as feed may still be present in the digestive tract if recently eaten.

2.4. HACCP team

Name	**Position**	**Qualifications**	**Role**
Julian Knight	Chief Executive Officer (Team leader)	Level 2 HACCP	Quality Management system, HACCP, Primary production, harvesting, processing and finished product processes
Hatem Karboul	Entomologist and Insect farming expert	Level 2 HACCP	R&D and NPD, Quality Management system, laboratory testing and QA procedures,
William Fairman	Chief Farming Officer	Level 2 HACCP	Quality Management system, HACCP, Raw materials, procedures, product specifications, suppliers and training, Feedstock and processing, raw materials.
Thomas Barrie	Deputy Manager	Level 2 HACCP	Quality Management System, HACCP, procedures, suppliers and products.

2.5 Amendments

Any changes to the HACCP charts must be discussed with the HACCP team and the Team Leaders before any changes are made.

2.6 HACCP Review

Purpose

The purpose of this system review is firstly to ensure that CCP's are being effectively monitored and secondly to ensure that any new product, processes or raw materials have been incorporated into the system by the HACCP team. A review will take place yearly or more frequently when one or more of the following occurs:

- new products
- change in processing conditions/flow or equipment.
- change in raw materials or supplier of raw materials.
- change in ingredients or recipes.
- change in packaging, storage or distribution conditions.
- change in staff or management responsibilities.
- change in consumer use.
- developments in scientific information associated with ingredients, process or product.
- emergence of a new risk e.g. adulteration of an ingredient or recall of similar product.
- following a recall

2.7 Review Procedures

HACCP team should take the following steps when conducting a review.

1. Review the process flow charts by walking the product flow.
2. Amend the flow charts if process changes have been made.
3. Review any new raw materials or products with HACCP team.
4. Amend the HACCP charts if changes are required.

HACCP reviews are recorded and kept on the share drive under the HACCP folder, this is used to ensure that the HACCP is kept up to date and any changes are identified and documented. Any changes resulting from the review are incorporated into the HACCP plan and validated by the HACCP team.

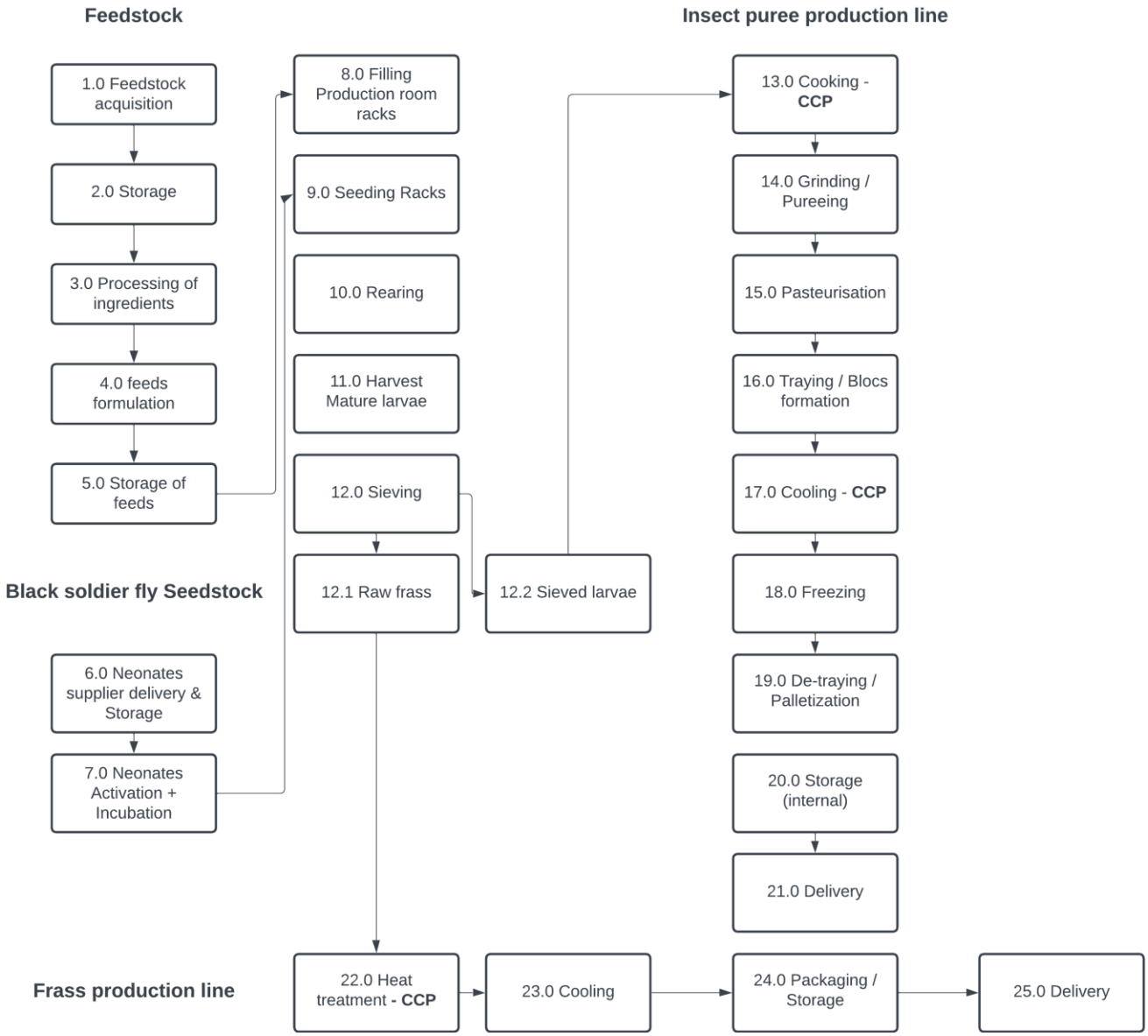


Figure 1. Flowchart describing the steps for the products manufacturing outlining the CCPs identified (both products are outlined in the same flowchart to demonstrate the divergence point within the process)

3. Process and Hazards

3.1 Process descriptions

Process Description - Feedstock:

Step 1. Feedstock acquisition– all ingredients and packaging are purchased from approved suppliers. All suppliers are approved through supplier questionnaires.

Step 2. Storage of ingredients – all ingredients stored in dedicated areas in the main ingredient reception hall. Ingredients stored in ambient conditions or chilled conditions as required.

Step 3. Process of ingredients – Shredding, mixing, dewatering, wetting processes might be applied to the ingredients received.

Step 4. Feeds formulation – ingredients mixed following specific recipes using the dedicated feedstock preparation area in the main unit. equipment is cleaned between recipes.

Step 5. Storage of feeds – Broodstock/ Seedstock feed stored in IBC's, Dolavs equipped with lids and /or mixing tanks. neonate feed on the other hand is stored in barrels. Feedstocks stored in ambient conditions or chilled conditions depending on the need.

Process Description – Black Soldier Fly Larvae – Seedstock:

Step 6. Neonate delivery & storage – Paused neonates delivered by external company to site and stored in 18°C & 60 % humidity incubators, to maintain paused state.

Step 7. Neonate activation + incubation - Neonates are moved to incubator with conditions of 30°C & 60 % humidity, where they will 'activate' from their paused state and become ready for seeding. Neonates are seeded into trays with neonate feed, excess neonates or neonates > 6 hours are frozen and disposed of. Seeded trays of neonates are left to grow into 5- 6-day old larvae.

Process Description – Black Soldier Fly Larvae – Biomass production:

Step 8. Filling of production room racks: Production room racks are filled with feedstock using the machinery dedicated. Rooms are cleaned after every production run

Step 9. Seeding racks – Seeded all filled racks with the appropriate number of seed larvae.

Step 10. Rearing – Seeded racks are left to grow for 7-9 days. Mortalities might occur and need to be disposed of if they happen.

Step 11. Harvesting – Once larvae have been reared to 11-16 days old, they will be harvested for the production line. tarps are removed from the racks and the content (larvae + raw frass) is conveyed out / transported to the sieving area.

Step 12. Sieving – Harvested biomass end up in emptied onto the sieve and separated from their frass.

Process Description – Production Line:

Step 12.1. Sieved Larvae – Sieved larvae are loaded onto the production line via conveyor.

Step 13. Cooking – Once larvae have entered hot water bath they are cooked. This step is used to kill the larvae and prevent melanisation of the puree.

Step 14. Pureeing: Whole cooked larvae - Cooked larvae are passed through the bone/meat grinder this will blend them into a puree

Step 15. Pasteurisation – Puree is pumped from a holding tank through the pasteuriser continuously allowing the operators to fill the trays with hot product

Step 16. Traying – Clean trays are sanitised, labelled with the Batch ID and then pasteurised puree is pumped into the tray.

Step 17. Cooling/Blast freezing – Trays are wheeled to the blast freezer located on the processing line.

Step 18. Freezing – Trays remain in the freezer until frozen.

Step 19. De-Traying – Blocks of frozen puree removed from trays and loaded onto pallets/ dolavs.

Step 20. Storage (internal) - Loaded pallets/ dolavs moved to freezer for longer term storage. Dolav liners and cardboard corner posts, and shrink wrap, final securing with black plastic ties.

Step 21. Delivery - To customers.

Process Description – Frass Production Line:

Step 22. Heat treatment - post inspection, frass is loaded into the hot bed dryers and put on a timer i for 1 hour at 70 Deg C. temperature data will be logged.

Step 23. Cooling - Offload the frass batch, let it cool down in ambient temperature

Step 24. Packaging and storage – Weigh, and fill the batch in 25Kg bags, label, palletize and store

Step 25. Delivery – To customers or external storage

3.2. Hazard identification for insect puree production

Hazards associated with Primary production, harvesting, processing of insect protein through to delivery. Identification of the point of the process where food hazards may occur. From this, the hazards at each step were identified:

Process step	Description	Hazard
1	Feedstock acquisition	Physical contamination of the delivered goods either through distribution or storage at the supplier (i.e. foreign bodies – plastic, wood, glass, personnel, pest infestation, allergens) Chemical contamination of the delivered goods either through pesticide, heavy metals, aflatoxins used by the supplier on growing or through cleaning chemicals used by supplier on their site. Microbial contamination of the delivered goods or during transport i.e. damage to sealed product or inadequate temperature control during transit leading to microbial growth (where applicable).
2	Storage (of ingredients and Feedstock)	Microbial contamination due to inadequate storage conditions or packaging. Physical contamination of the goods due to foreign bodies, pests, or allergens within storage areas. Chemical contamination due to cleaning chemicals or lubricants used in the storage area.
3	Processing of ingredients	Physical contamination of goods with packaging materials on decanting/dewatering or allergens within the area. Microbial contamination due to poor personal hygiene or insufficient cleaning of equipment

		Chemical contamination due to cleaning chemicals or lubricants used within the area.
4	Feeds formulation	Physical contamination of product due to allergens or foreign bodies (e.g. from staff or equipment) within the production area. Microbial contamination due to poor personal hygiene or insufficient cleaning of equipment Chemical contamination due to cleaning chemicals within the area.
5	Storage of feeds	Physical contamination of product due to allergens or foreign bodies (e.g. from staff or equipment) within the production area. Microbial contamination due to poor personal hygiene or insufficient cleaning of equipment Chemical contamination due to cleaning chemicals within the area.
6	Neonate delivery & storage	Physical contamination of product due to allergens or foreign bodies within area. Chemical contamination due to cleaning chemicals or lubricants within the area. Microbial contamination due to poor personal hygiene or insufficient cleaning of equipment.
7	Neonate activation + Incubation	Physical contamination of product due to allergens or foreign bodies within area. Chemical contamination due to cleaning chemicals or lubricants within the area. Microbial contamination due to poor personal hygiene or insufficient cleaning of equipment.
8	Filling production room racks	Physical contamination of product due to allergens or foreign bodies within area. Chemical contamination due to cleaning chemicals or lubricants within the area. Microbial contamination due to poor personal hygiene or insufficient cleaning of equipment.
9	Seeding racks	Physical contamination of product due to allergens or foreign bodies within area.

		Chemical contamination due to cleaning chemicals or lubricants within the area. Microbial contamination due to poor personal hygiene or insufficient cleaning of equipment.
10	Rearing	Physical contamination of product due to allergens or foreign bodies within area. Chemical contamination due to cleaning chemicals or lubricants within the area. Microbial contamination due to poor personal hygiene or insufficient cleaning of equipment.
11	Harvest Mature Larvae	Physical contamination of product due to allergens or foreign bodies within area. Chemical contamination due to cleaning chemicals or lubricants within the area. Microbial contamination due to poor personal hygiene or insufficient cleaning of equipment.
12	Sieving	Physical contamination of product due to allergens or foreign bodies within area. Chemical contamination due to cleaning chemicals or lubricants within the area. Microbial contamination due to poor personal hygiene or insufficient cleaning of equipment.
12.1	Sieved larvae	Physical contamination of product due to allergens or foreign bodies within area. Chemical contamination due to cleaning chemicals or lubricants within the area. Microbial contamination due to poor personal hygiene or insufficient cleaning of equipment.
13	Cooking	Physical contamination of product due to frass and/ or foreign bodies within area. Chemical contamination due to cleaning chemicals or lubricants within the area.

		Microbial contamination due to poor personal hygiene, insufficient cooking or cleaning of equipment.
14	Grinding / Pureeing	Physical contamination of product due to foreign bodies within area. Chemical contamination due to cleaning chemicals or lubricants within the area. Microbial contamination due to poor personal hygiene, insufficient cooking or cleaning of equipment.
15	Pasteurisation	Physical contamination of product due to foreign bodies within area. Chemical contamination due to cleaning chemicals or lubricants within the area. Microbial contamination due to poor personal hygiene, insufficient cooking or cleaning of equipment.
16	Traying / Blocs formation	Physical contamination of product due to foreign bodies within area. Chemical contamination due to cleaning chemicals or lubricants within the area. Microbial contamination due to poor personal hygiene or cleaning of equipment.
17	Cooling / Blast freezing	Physical contamination of product due to foreign bodies within area. Chemical contamination due to cleaning chemicals or lubricants within the area. Microbial contamination due to inadequate cooling, poor personal hygiene or cleaning of equipment.
18	Freezing	Physical contamination of product due to foreign bodies within area. Chemical contamination due to cleaning chemicals or lubricants within the area. Microbial contamination due to poor personal hygiene or cleaning of equipment.

19	De-Traying	Physical contamination of product due to foreign bodies within area. Chemical contamination due to cleaning chemicals or lubricants within the area. Microbial contamination due to poor personal hygiene or cleaning of equipment and area.
20	Storage (internal)	Physical contamination of product due to foreign bodies within area. Chemical contamination due to cleaning chemicals or lubricants within the area. Microbial contamination due to poor personal hygiene or cleaning of equipment and area.
21	Delivery	Physical contamination of product due to foreign bodies within area. Chemical contamination due to cleaning chemicals or lubricants within the area. Microbial contamination due to poor personal hygiene or insufficient cleaning of equipment.

3.3 Hazards identification for frass production

Hazards associated with steps from the point Raw frass production at step 12. till delivery of frass to customers. The prior hazards that may occur before Raw frass appearance are shared between All products (insect puree). The list goes :

Process step	Description	Hazard
12.2	Raw Frass	Physical contamination of goods with packaging materials on loading / offloading of product or allergens within the area.

		Microbial contamination due to poor personal hygiene or insufficient cleaning of equipment Chemical contamination due to cleaning chemicals or lubricants used within the area.
22.0	Heat treatment	Physical contamination of goods with packaging materials on loading / offloading of product or allergens within the area. Microbial contamination due to poor personal hygiene or insufficient cleaning of equipment Chemical contamination due to cleaning chemicals or lubricants used within the area.
23.0	Cooling	Microbial contamination due to inadequate storage conditions. Physical contamination of the goods due to foreign bodies, pests, or allergens within cooling areas. Chemical contamination due to cleaning chemicals or lubricants used in the cooling area.
24.0	Packaging / Storage	Physical contamination of product due to allergens or foreign bodies (e.g. from staff or equipment) within the production area. Microbial contamination due to poor personal hygiene or insufficient cleaning of equipment Chemical contamination due to cleaning chemicals within the area.
25.0	Delivery	Physical contamination of product due to foreign bodies within area. Chemical contamination due to cleaning chemicals or lubricants within the area. Microbial contamination due to poor personal hygiene or insufficient cleaning of equipment.

3.4. Risk Assessment methodology

Apart from the Prerequisite Programmes for managing general hazards, the Hazard Analysis further considers specific hazards associated with the products at individual stages during production.

A Risk Assessment is conducted to establish the significance of each specific hazard identified, based on:

1. The likelihood of the hazard occurring, taking account of existing control measures already in place (Prerequisites)
2. Its severity or harmful effect, if any.

The Risk Factor is a measure of the likelihood and severity associated with a hazard. It is used to draw attention to those stages in the production where control is essential to ensure product safety and consistency with HACCP principles:

Hazards with a risk factor of 10 or more will be considered for control through HACCP, i.e. when there is a possibility of the hazard occurring would cause minor upset, injury or discomfort. However, when the severity of the hazard is life threatening it will still be considered even with the most unlikely occurrence.

Hazards with Risk Factors ≥ 10 are highlighted in subsequent tables with orange background.

Risk Factor (RF = L x S)				
Likelihood (L)	Severity (S)			
	No ill effects/ revulsion only	Minor upset/ injury/ discomfort	Serious injury/ food poisoning/ potentially life-threatening	Life- threatening
	0	2	5	10
No hazard recognized = 0	0	0	0	0
Unlikely = 1	0	2	5	10
Possible = 5	0	10	25	50
Probable = 10	0	20	50	100

Where such hazards arise, a Decision Tree is used to determine whether the relevant process stage is the CCP for the hazard.

Hazards with a Risk Factor less than 10 are controlled through Prerequisite Programmes/GMP.

Significant hazards that threaten the safety of products at specific stages in the process are controlled by a HACCP system based on the *Codex Alimentarius* Principles. In determining Critical

Control Points, we look for parameters that are measurable and require no judgment on the part of the operative monitoring them.

3.5 Hazard Analysis for insect puree production

Process Step	Description	Potential Hazards introduced or enhanced at this process step	L	S	RF =L x S	Significant (RF ≥ 10, then Yes)	Preventative/ Control Methods Pre-requisite programmes (PRP)
1	**Feedstock acquisition**	Microbial, chemical or physical contamination of the delivered goods, either through growing, harvesting, manufacturing, processing, distribution or storage at the supplier's site.	1	2	2	NO	PRP: Approved Suppliers, Traceability, Management commitment.
2	**Storage (of ingredient)**	Microbial, chemical or physical contamination of ingredients due to poor handling and storage practices on site.	1	2	2	NO	PRP: Traceability, Cleaning, Premises & equipment, Allergens, Personal hygiene, Pest control and Training. Segregated storage on site
3	**Processing of**	Microbial, chemical or physical contamination of ingredients due to poor handling, storage and	1	2	2	NO	PRP: Cleaning, Premises & equipment, Allergens,

	ingredients	practices on site, and inadequate cleaning on site.					Personal hygiene, Traceability, Pest control, Waste and Training. Feed stock prepared in a dedicated low risk area and segregated storage.
4	**Feeds formulation**	Microbial, chemical or physical contamination of feed stocks during preparation due to poor hygiene, cleaning and handling practices on site.	1	2	2	NO	PRP: Cleaning, Premises & equipment, Pest control, Allergens, Traceability, Personal hygiene, and Training. Fully packaged/ segregated storage/ enclosed product/dedicated area.
5	**Storage of feeds**	Microbial, chemical or physical contamination of feed stocks in storage due to poor hygiene, cleaning and handling practices on site.	1	2	2	NO	PRP: Cleaning, Premises & equipment, Allergens, Pest control, Traceability, Personal hygiene and Training. Segregated storage and

							product labelled with shelf-life duration.
6	**Neonate delivery & storage**	Microbial, chemical or physical contamination of eggs during incubation/storage due to poor hygiene, cleaning and handling practices on site.	1	2	2	NO	PRP: Cleaning, Premises & equipment, Allergens, Pest control, Personal hygiene and Training. Segregated storage/enclosed process
7	**Neonate activation + incubation**	Microbial, chemical or physical contamination of the neonates due to poor hygiene, handling, storage and cleaning practices on site.	1	2	2	NO	PRP: Cleaning, Premises & equipment, Allergens, Pest control, Personal hygiene and Training Segregated storage/ enclosed products
8	**Filling production room racks**	Microbial, chemical or physical contamination during seeding of containers due to poor hygiene, handling, storage and cleaning practices on site.	1	2	2	NO	PRP: Cleaning, Premises & equipment, Allergens, Pest control, Personal hygiene and Training.
9	**Seeding racks**	Microbial, chemical or physical contamination					PRP: Cleaning, Premises &

		during rearing due to poor hygiene, handling, storage and cleaning practices on site.					equipment, Allergens, Pest control, Personal hygiene, Waste and Training.
10	**Rearing**	Microbial, chemical or physical contamination during rearing due to poor hygiene, handling, storage and cleaning practices on site.	1	2	2	NO	PRP: Cleaning, Premises & equipment, Allergens, Pest control, Personal hygiene, Waste and Training.
11	**Harvest Mature Larvae**	Microbial, chemical or physical contamination during harvesting due to poor hygiene, handling, storage and cleaning practices on site.	1	2	2	NO	PRP: Cleaning, Premises & equipment, Allergens, Personal hygiene, Waste and Training
12	**Sieving**	Microbial, chemical or physical contamination during sieving due to poor hygiene, handling, storage and cleaning practices on site.	1	2	2	NO	PRP: Cleaning, Premises & equipment, Allergens, Personal hygiene, Pest control, Waste and Training.
12.1	**Sieved Larvae**	Microbial, chemical or physical contamination during processing due to poor hygiene, handling, storage and cleaning practices on site.	1	2	2	NO	PRP: Cleaning, Premises & equipment, Allergens, Pest control, Personal hygiene, Waste and Training.

13	**Cooking**	Survival of pathogens due to inadequate cooking temperature achieved. Chemical or physical contamination during processing due to poor hygiene, handling, storage and cleaning practices on site.	10	5	50	YES	Cooking and pasteurisation procedure PRP: Cleaning, Premises & equipment, Allergens, Pest control, Personal hygiene and Training.
14	**Grinding / Pureeing**	Microbial, chemical or physical contamination during pureeing due to poor hygiene, handling, storage and cleaning practices on site.	1	2	2	NO	PRP: Cleaning, Premises & equipment, Allergens, Personal hygiene, Pest control and Training
15	**Pasteurisation**	Microbial survival due to inadequate pasteurisation temperature leading to pathogens in the product. Chemical or physical contamination during pasteurising due to poor hygiene, handling, storage and cleaning practices on site.	10	5	50	YES	Cooking and pasteurisation procedure PRP: Cleaning, Premises & equipment, Allergens, Personal hygiene, Pest control and Training.
16	**Traying**	Microbial contamination of the product due to poor personal hygiene, storage and cleaning. Chemical or physical contamination during	10	5	50	YES	PRP: Cleaning, Premises & equipment, Allergens, Personal hygiene, Pest

		pasteurising due to poor hygiene, handling, storage and cleaning practices on site.					control and Training.
17	**Cooling**	Inadequate/slow cooling process leading to growth of pathogens in the product. Chemical or physical contamination during cooling due to poor hygiene, handling, storage and cleaning practices on site.	10	5	50	YES	Documented Cooling validation. PRP: Cleaning, Premises & equipment, Allergens, Personal hygiene, Pest control and Training.
18	**Freezing**	Inadequate/slow freezing process which leads to growth of pathogens in the product. Chemical or physical contamination during freezing due to poor hygiene, handling, storage and cleaning practices on site.	1	2	2	NO	PRP: Cleaning, Premises & equipment, Allergens, Personal hygiene, Pest control and Training. Product fully packed and segregated in storage. Fridge/freezers temperature checked and recorded.
19	**De-Traying**	Microbial, chemical or physical contamination during de-traying due to poor hygiene, handling,	1	2	2	NO	PRP: Cleaning, Premises & equipment, Allergens, Personal hygiene, Pest

		storage and cleaning practices on site.					control, Waste and Training.
20	**Storage (internal)**	Microbial, chemical or physical contamination during storage due to poor hygiene, handling, storage and cleaning practices on site.	1	2	2	NO	PRP: Cleaning, Premises & equipment, Allergens, Personal hygiene, Pest control and Training.
21	**Delivery**	Microbial, chemical or physical contamination during delivery due to poor hygiene, handling, storage and cleaning practices on site or at third party transport company site.	1	2	2	NO	Third party transport company/ contract/BRC Standard PRP: Approved suppliers, Cleaning, Premises & equipment, Allergens, Personal hygiene, Pest control and Training.

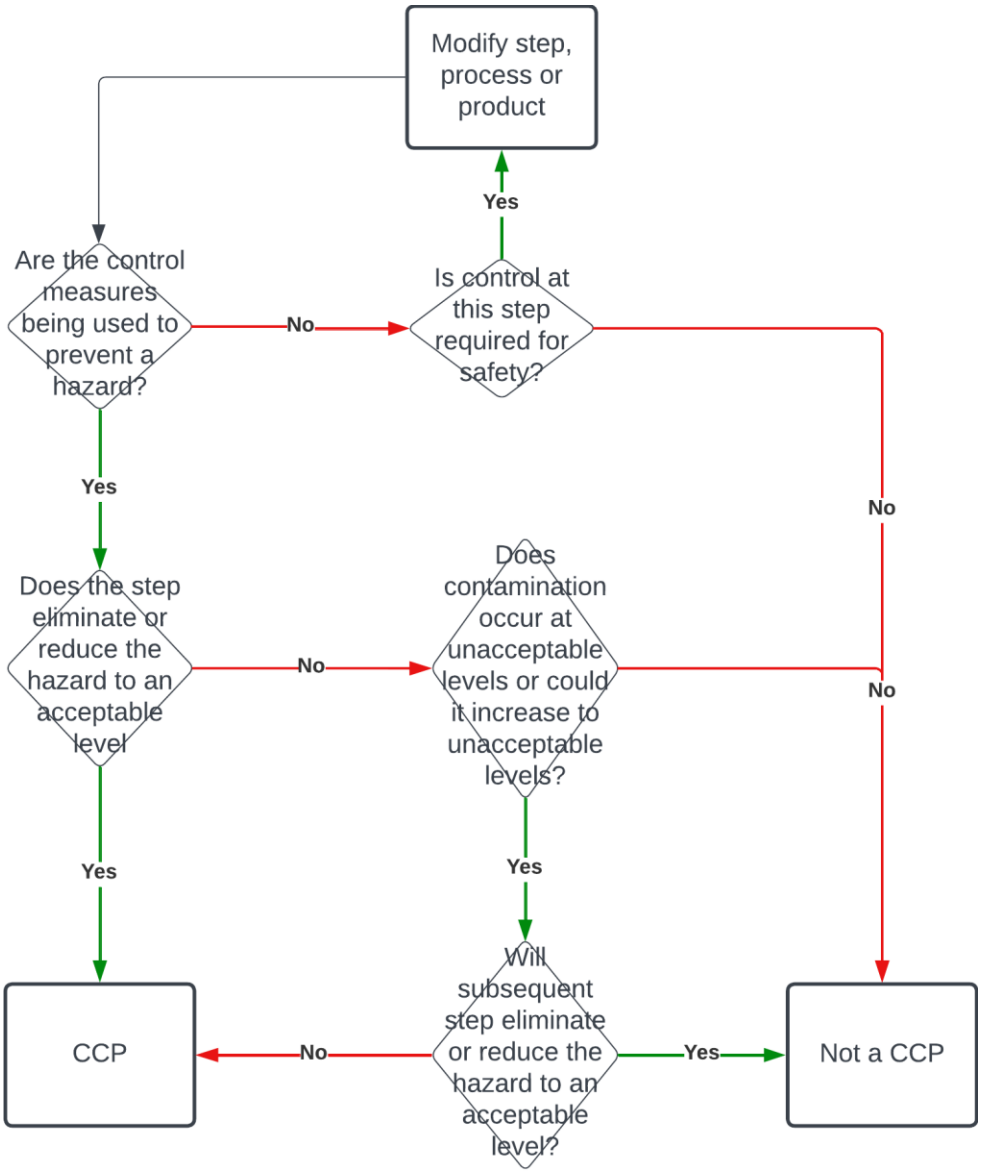


Figure 2. Decision tree used to establish CCPs

3.6. Identification of CCPs for insect puree (Using Decision Tree)

The decision tree has been used to identify which of the control points are critical, see Figure 2.

Process step	Description	Potential hazards introduced or enhance at the process step	Q1. Are the control measures being used to prevent an hazard?		Q2. Does the step eliminate or reduce the hazard to an acceptable level?		Q3. Does contamination occur at unacceptable levels or could it increase to unacceptable levels?		Q4. Will subsequent step eliminate or reduce the hazard to an acceptable level?		CCP YES/NO
			Y/N	JUSTIFICATION FOR DECISION	Y/N	JUSTIFICATION FOR DECISION	Y/N	JUSTIFICATION FOR DECISION	Y/N	JUSTIFICATION FOR DECISION	
13	Cooking	Survival of microbes (vegetative pathogens) due to inadequate cooking.	Y	This step is designed to kill larvae and cook to a microbiologically compliant level	Y	This step is designed to kill larvae and cook to a microbiologically compliant level, there is no further processing step.	--	--	--	--	YES

15	Pasteurisation	Microbial survival due to inadequate pasteurisation temperature leading to pathogens in the product.	Y	This step is designed to kill all vegetative pathogens in the product.	---	----------	---	----------	---	----------	YES
16	Traying /Bloc formation	Microbial contamination of the product due to poor personal hygiene, storage and cleaning.	Y	Contamination could occur in the product if procedures not followed.	N	Product handled in the High care area. Cleaning schedules Personal hygiene standards	N	Product handled in the High care area. Cleaning schedules Personal hygiene standards Laboratory schedule	---		NO
17	Cooling	Inadequate or slow cooling process leading to growth of pathogens in the product.	Y	Slow cooling process could lead to growth of pathogens in the product	---	----------	---	----------	---	----------	YES

Process step	Description	Hazard	L	S	LxS	Significant (RF ≥ 10, then Yes)	Preventative/ Control Methods Pre-requisite programmes (PRP)
12.2	Raw Frass	Physical contamination of goods with packaging materials on loading / offloading of product or allergens within the area. Microbial contamination due to poor personal hygiene or insufficient cleaning of equipment Chemical contamination due to cleaning chemicals or lubricants used within the area.	10	2	20	YES	PRP: Cleaning, Premises & equipment, Allergens, Personal hygiene, Pest control and Training.
22.0	Heat treatment	Physical contamination of goods with packaging materials on loading / offloading of product or allergens within the area. Microbial contamination due to poor personal hygiene or insufficient cleaning of equipment Chemical contamination due to cleaning chemicals or lubricants used within the area.	10	2	20	YES	Heat treatment procedure documented, Heat sensors / probes data collection and validation PRP: Cleaning, Premises & equipment,

							Allergens, Personal hygiene, Pest control and Training.
23.0	Cooling	Microbial contamination due to inadequate storage conditions. Physical contamination of the goods due to foreign bodies, pests, or allergens within cooling areas. Chemical contamination due to cleaning chemicals or lubricants used in the cooling area.	1	5	5	NO	PRP: Cleaning, Premises & equipment, Allergens, Personal hygiene, Pest control and Training.
24.0	Packaging / Storage	Physical contamination of product due to allergens or foreign bodies (e.g. from staff or equipment) within the production area. Microbial contamination due to poor personal hygiene or insufficient cleaning of equipment Chemical contamination due to cleaning chemicals within the area.	1	5	5	NO	PRP: Cleaning, Premises & equipment, Allergens, Personal hygiene, Pest control and Training.
25.0	Delivery	Physical contamination of product due to foreign bodies within area. Chemical contamination due to cleaning chemicals or lubricants within the area.					

		Microbial contamination due to poor personal hygiene or insufficient cleaning of equipment.					

3.7. identification of CCPs for insect Frass production

Process step	Description	Potential hazards introduced or enhance at the process step	Q1. Are the control measures being used to prevent a hazard?		Q2. Does the step eliminate or reduce the hazard to an acceptable level?		Q3. Does contamination occur at unacceptable levels, or could it increase to unacceptable levels?		Q4. Will subsequent step eliminate or reduce the hazard to an acceptable level?		CCP YES/ NO
			Y/ N	JUSTIFICATION FOR DECISION	Y/ N	JUSTIFICATION FOR DECISION	Y/ N	JUSTIFICATION FOR DECISION	Y/ N	JUSTIFICATION FOR DECISION	
12.2	**Raw frass reception**	Microbial load is high due to the nature of the product (wet by product of rearing insects)	Y	The reception bay is zoned away from other products	N	It's the point of generation of the product	N	--	Y	Heat treatment is the step where the hazard is going to be controlled	NO

22.0	**Heat Treatment**	Inadequate temperature and time prescribed by legislation to reduce the microbial load	Y	The step is designed to reduce the microbial load of the product to enable farmers to use it safely	Y	Heat treatment at 70degrees for 1 hour has been proven to reduce the microbial load of frass to an acceptable level	N		N		YES

3.8 Prerequisite Programmes for the entire business operation (PRP)

PRP	Hazard (M) Micro (P) Physical (C) Chemical	Preventative (control) Measures	Monitoring		Critical Limits	Corrective Action	Document Required	Responsibility
			Procedure	Frequency				
Approved suppliers and Purchasing	Ingredients may contain agriculture residue (pesticides), heavy metals, aflatoxins, allergens or foreign bodies or high levels of pathogens.	Procedures covered in the QA Manual section 1 Supplier Approval Procedure	Check approval status. Product specifications	Every 3 years Every 3 years	Approval status 'current' Product specifications	Reject ingredients. Contact supplier Review supplier approval status and de-list and seek alternative supplier	Approved Supplier list. Supplier Questionnaires Product specifications	CFO

	(P) (C) (M)	Raw Material & Packaging Inspection procedure					Goods In checks	
Cleaning	Introduction of foreign bodies, chemicals and pathogens into the product due insufficient cleaning of equipment & environment or poor personal hygiene **(P) (C) (M)**	Cleaning schedules Tray wash procedure COSHH data sheets	Cleaning schedules	Continuous	All areas & equipment visibly clean All cleaning operations completed and signed off according to schedule	Re-clean, inform staff. Review Cleaning Schedules Staff Training	Cleaning schedules Chemical dosing checks Cleaning records Environmental swabbing	CFO
Premises and equipment	Introduction of foreign bodies to product due to poorly maintained environment, equipment, vehicles and lack of GMP controls on site. **(P) (C)**	Procedures covered in the QA Manual section 1.	Planned maintenance schedule in place	Continuous	Building and equipment all maintained as per schedule	Isolate the equipment, report to a manager, discard product, repair, clean before use. Look at future orders	Site audits QA code Contractor induction Contractor supervision	Deputy Manager

							Site risk assessment Glass & Hard plastic audits	
Pest control	Contamination of the product during storage or processing due to pest infestation with the building or on the vehicles. **(P) (M)**	Procedures covered in the Quality Manual section 1. Use reputable Pest contractor	Visual inspection of building perimeter inside & outside by the pest contractor	12 technical visits annually 1 biologist visit annually. 12 EFK service and inspection	All areas adequately proofed to prevent pest ingress. Inspections carried out according to service agreement. All areas free from pest activity All contractor's recommendations followed up and signed off	Repair/ replace any defective proofing. Follow up with Contractor. Contractor to follow up until site pest-free. Discard any contaminated product.	Pest control records	Deputy Manager
Training	Introduction of allergens, pathogens, foreign objects and chemicals due to poor handling practices. **(P) (C) (M)**	Procedures covered in the Quality Manual section 1. All staff trained.	Training procedures All staff supervised & monitored during production.	Continuous As per procedure	All employees signed off for Induction Training. Refresher training signed off as scheduled	Schedule training/ additional refresher training, as required. Discipline staff if instructions ignored.	Training matrix All procedures trained to staff including allergen awaren	CFO

							ess, food hygiene, HACCP.	
Personal hygiene	Introduction of foreign bodies and pathogens from inadequate processing or poor handling and storage of ingredients and finished products. **(P) (C) (M)**	Procedures covered in the Quality Manual section 1. Personal hygiene training	Personal hygiene procedures	Continuous As per procedure	All employees supervised on site	Report to manager, retrain staff, monitor staff. Discipline staff if instructions ignored.	Personal hygiene procedure: staff induction, personal and hand hygiene, hand swabbing	CFO / Deputy Manager
Transport	Ingredients are contaminated or damaged during loading the vehicle or during transit to the customer. **(P) (C) (M)**	Service Provider Contract	Review the third-party transport contract and procedures.	Continuous	Vehicle inspections, recording of temperature when 3rd party transport company arrive on site	Contact supplier Review supplier approval status and de-list and seek alternative supplier	Service provider contract. BRC certificate or equivalent Goods Out log.	Entomologist
Allergen Controls	Contamination with undeclared allergens or product not labelled correctly.	Procedures covered in the Quality Manual	Specifications, allergen risk assessment,	Continuous	All products labelled correctly. Product specifications	Inform manager, dispose, clean, retrain. Review Allergen	QA Manual Allergen risk assessment	Entomologist

	(P)	section 1. All products fully packed and labelled				risk assessment	Allergen training	
Waste	Introduction of foreign bodies and pathogens due to poorly handled waste. **(P) (M)**	Waste Contractors Designated storage bins	Waste procedure Staff Training	Continuous	All waste removed by contractor from site. Bins emptied regularly during production	Report to manager, retrain staff	Waste licences Cleaning schedules Cleaning records	Deputy manager
` Traceability	Failure to recall products effectively from the customer or third-party transport company due to inadequate traceability system. **(P) (M) (C)**	Procedures covered in the Quality Manual section 3. Traceability procedures	Traceability test Recall Trial	6 monthly Yearly	All products can be traced onsite including all raw materials and packaging	Retrain staff, regular audits on staff, relabel products	Traceability test Recall Trial	Entomologist / Deputy manager
Management Commitment	Failure to control food safety due to lack of resources and managemen	Approved Suppliers HACCP	Quality Management System	Continuous	TBD		Quality Management System HACCP	CEO/CFO

	t commitment. **(P) (M) (C)**	Quality Management System Training					QA records.	

3.9. Monitoring, critical limits, corrective actions and documents required for insect puree production

Process step	Description	Hazard (M) Micro (P) Physical (C) Chemical	Preventative (control) Measures	Monitoring		Critical Limits	Corrective Action	Document Required	Responsibility
				Procedure	Frequency				
13	Cooking	Survival of microbes (vegetative pathogens) due to inadequate cooking. **(M)**	Every batch	Cooking & Pasteurisation procedure	Every batch	Target: 75°C Limit: 72°C	Cook larvae for longer to achieve temperature. Report equipment failure. Inform manager. Dispose product	Cooking & pasteurisation records Laboratory Schedule	Entomologist/ deputy Manager
15	Pasteurisation	Microbial survival due to inadequate pasteuris	Validation of cooking and pasteurisation	Cooking & Pasteurisation procedure	Every batch	Target: 75°C	Cook puree for longer to achieve temperature.	Cooking & pasteurisation records	Entomologist / Deputy manager

		ation temperature leading to pathogens in the product. **(M)**	equipment			Limit : 72°C	Report equipment failure. Inform manager. Dispose product	Laboratory Schedule	
17	Cooling	Inadequate or slow cooling process leading to growth of pathogens in the product. **(M)**	Validation of cooling process	Cooling procedure	Every batch	Product must be < 5°C within 24 hours	Report to a manager. Investigate the cause, dispose of product	Cooling records Laboratory Schedule	Entomologist and Deputy Manager

3.10. Monitoring, critical limits, corrective actions and documents required for frass production

Process step	Description	Hazard (M) Micro (P) Physical (C) Chemical	Preventative (control) Measures	Monitoring		Critical Limits	Corrective Action	Document Required	R
				Procedure	Frequency				

22.0	Heat treatment	Microbial survival due to inadequate heat treatment temperature or time journey leading to pathogens in the product. **(M)**	Validation of heat treatment procedure Sensor testing and calibration schedules (both in-house and using third parties)	Heat treatment procedure (machine startup and heat up time)	Every batch	Target: 75°C Limit: 72°C	Redo the procedure Report equipment failure. Inform manager. Dispose product	Frass production batch records, including heat sensor data and start/stop timings Laboratory Schedule	E D m

3.11. Verification Procedures

All breaches of critical limits are reported to the Chief Farming Officer, action taken and recorded. The HACCP must be reviewed with the team immediately to identify if any changes are required, this must be documented, relevant procedures and QA records must be amended to reflect the changes.

3.12. Documentation and Record-Keeping

• Records are kept for each aspect of the HACCP plan Validation: and for operations in-conjunction

Records	**Document description**	**References**
Cooking & pasteurisation records	Cooking and pasteurization records will be collected from production in the form of a datasheet (paper or digital). Data will be then processed into a batch tracking spreadsheet with the information necessary about production, CCP conformity and eventually laboratory analysis for positive release procedures.	DS001, DS002

Cooling records	Same as above	DS001
Laboratory Schedule	A schedule for the routine analysis of products (Puree, Frass) for product specs and microbial load	
Supplier questionnaire	Basic questionnaire shared with the suppliers or carried out by FKS staff to gather information, credentials, assess risks and take a decision on supplier approval/rejection	DOC001
Approved supplier list	A database of the different supplier of inputs to the business that keeps track of the information gathered from inputs suppliers	DOC002
Product specifications	Technical datasheets of catalogued products with the technical information about production and use cases	
Goods In check	Operational checklist for data collection upon waste receiving	DS004
Cleaning schedules	Identifies routine and process- related cleaning	
Chemical dosing checks	SOP on chemical dosing for cleaning purposes Record of Chemical dosing for process related equipment and surfaces	
Cleaning records	Routine sign-on/ off for cleaning crews	
Environmental swabbing	Schedule and record of environmental swabbing for bacteria (E.coli, Enterobacteriaceae, Legionnaires (for water), Clostridium...	
Site Audits	Record of internal site audits with reports and actions tracking	
QA code	A piece of policy code for quality assurance	

Contractor induction	Process of onboarding /accepting contractors to be working in production environment	
Glass and hard plastic audits	Document outlining a schedule, process and recordkeeping	
Training matrix	Training matrix combining all aspects of QHSE and production tasks	
Pest control records	In-house records of Pest control contractor visits, reports and routine inspections	
Sensors and measurement systems calibration certificates	Schedule and record of all asset sensor or measurement tool calibrations. Primarily, the sensors used for CCP monitoring and goods volume tracking	