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FINAL REPORT

Transforming Rescued Food into Shelf-stable Meals

ENDFOODWASTE COOPERATIVE RESEARCH CENTRE

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Author(s):

Patricia Lindeman

End Food Waste Cooperative Research Centre, University Affiliation

Philippa Harmon

End Food Waste Cooperative Research Centre, University Affiliation

Queena Wang

End Food Waste Cooperative Research Centre, University Affiliation

Philippa Lyons

End Food Waste Cooperative Research Centre, University Affiliation

Simoné Moller

End Food Waste Cooperative Research Centre, University Affiliation

Kerridyn Hooker

End Food Waste Cooperative Research Centre, University Affiliation

Jessica Morgan

End Food Waste Cooperative Research Centre, University of Queensland

Fiona Maxwell

End Food Waste Cooperative Research Centre, University Affiliation

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Level 1, Wine Innovation Central Building, Cnr Hartley Grove and Paratoo Road, URRBRAE SA 5064
enquiries@endfoodwaste.com.au +61 8 8313 3564

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Transforming rescued food into shelf-stable meals END FOOD WASTE CRC REPORT APPROVAL

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Program Leader signature and name

Molly Chapman

EFW CRC TRANSFORM Program Leader

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1. Industry Partner Foreword

For over 24 years, FareShare has been committed to rescuing surplus food and transforming it into free, nutritious meals for Australians doing it tough. Our work contributes to improved food access for Australians, particularly those experiencing financial hardship, social isolation, or the effects of natural disasters.

Frozen meals have long formed the backbone of our food relief operations. However, in times of crisis—when power outages and disruptions to supply chains occur—frozen food can become impractical or unusable, leaving vulnerable communities without essential support. Recognising this limitation led us to a pivotal opportunity: the creation of a shelf-stable meal solution using advanced retort and freeze-drying technologies.

While FareShare began the early concept development, it was clear that bringing this ambitious idea to life required collaboration. Producing safe, nutritious, and scalable shelf-stable meals from rescued ingredients involves complex processes and high standards. This project was made possible through the expertise and dedication of our partners: the Department of Primary Industries, End Food Waste CRC and FoodStream. Together, we share a commitment to developing sustainable, resilient food relief solutions.

The recent floods in Far North Queensland highlighted the urgent need for reliable, long-lasting meal options during emergencies. Likewise, many First Nations communities continue to face prolonged isolation during natural disasters. Through this project, we've gained valuable cultural insight and capability to ensure our solutions are not only effective but also inclusive.

This report captures a shared vision and effort that go beyond food—it represents our dedication to dignity, equity, and resilience in an increasingly uncertain world.

Shalini Valecha

Chief of Impact and Innovation

1 October 2025

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2. Executive Summary

This project aimed to address food insecurity in remote and disaster-affected communities by transforming rescued food into nutritious, complete meals with an extended shelf life. These meals are vital where access to fresh food or refrigeration is limited, ensuring reliable nutrition during emergencies, supply disruptions or in remote communities. The focus was on creating shelf-stable meals that preserved nutritional integrity, sensory appeal and safety while ensuring ease of distribution to vulnerable populations, particularly in areas where fresh or frozen food options are limited. The meals were developed in two formats, namely freeze-dried (lightweight and easily rehydrated with boiling water) and retort (ready-to-eat, heated in a pot or in boiling water), with both allowing for ambient storage and effective distribution. By optimising formulations and processing techniques, the project sought to rescue up to 150,000 kg of food annually, repurpose the food into formulated meals thereby reducing food waste and improving food security.

The meal development process involved collaboration between FareShare, the Queensland Department of Primary Industries (QDPI) Food Innovation Team and FoodStream. Through structured milestones, the partners jointly developed, tested and refined the freeze-dried and retort formulations and production processes to meet pre-defined quality standards. Workshops between the QDPI project team and FareShare helped define a product development brief that aligned with the nutritional, sensory, and cultural needs of remote First Nations communities, who often face isolation due to logistical challenges and limited access to nourishing, quality food. FareShare chefs and QDPI worked closely to develop meal formulations that maximised nutritional content while remaining practical for large-scale production. FoodStream's engineering expertise was key in optimising freeze-drying and retort processing to ensure high quality and extended shelf life, critical for remote communities and disaster affected areas with limited access to fresh or refrigerated food.

Through this work, a range of freeze-dried and retort meals was developed using surplus produce to create broadly appealing, family-friendly options that were nutritious, easy to prepare and suitable for diverse communities, including First Nations and disaster-affected populations. Specialised packaging solutions were employed to permit safe storage and transport without refrigeration. Ongoing microbiological and physico-chemical assessments confirmed the meals met high food safety and quality standards, with shelf life validated to six months (the maximum duration permitted by the project timeline). Extension beyond this period is expected to be achievable, pending completion of further validation studies.

To support long-term adoption, a comprehensive technical manual was produced, documenting all formulation, processing and quality control parameters for the freeze-dried and retort meals. FareShare staff were provided with hands-on training on the new processes, covering raw material handling, process control, quality assurance, and food safety. The freeze-drying and retort processes were successfully integrated into FareShare's existing HACCP (Hazard Analysis and Critical Control Point) plan, ensuring alignment with industry food safety standards.

Consumer evaluations assessed the sensory attributes, acceptability and overall appeal of the freeze-dried and retort meals. Feedback from these evaluations, along with insights from FareShare volunteers and community engagement programs, was highly positive. Most participants expressed satisfaction with the variety of meals and confidence in using them for their families. While some meals emerged as favourites, all scored favourably.

Community adoption of the shelf-stable meals was identified as essential to the project's success, given the potential challenges of cultural relevance and food preferences in remote First Nations communities, where improved nutrition is critically needed. To support this, the QDPI Consumer Intelligence team observed engagement sessions between the FareShare Indigenous

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Engagement Officers and community groups. Based on these observations, recommendations were provided to enhance session structure, encourage participation and ensure effective presentation of the shelf-stable meals. These recommendations focused on optimising the way in which the meals are introduced and discussed to foster greater community understanding and acceptance.

A Social Impact Assessment highlighted the potential of shelf-stable meals to fill critical gaps in disaster preparedness, particularly in remote areas with complex logistical challenges. These meals could play a vital role in upholding food security during prolonged isolation caused by extreme weather events. Effective distribution requires tailored distribution strategies and partnerships with disaster preparedness organisations. The research also reinforced the importance of culturally appropriate food solutions for First Nations communities. To maximise impact, pre-positioning meals in remote areas is crucial, along with follow-up assessments to determine the long-term outcomes. Further post-distribution evaluation will assess the project's effectiveness, scalability and contribution to reducing food insecurity during disasters.

This project has set a new benchmark for converting primarily rescued food into value-added, shelf-stable meals, creating a scalable model for future food security initiatives. Looking ahead, FareShare will continue expanding its impact, leveraging the project's success to expand production, develop new products and explore new funding opportunities. The lessons learned have shaped strategies for surplus food conversion, optimising food production, preservation and distribution, while driving innovation in the fight against food insecurity.

The project has demonstrated that addressing food waste and food insecurity together is not only feasible but essential for creating a sustainable and resilient food system. With continued investment and collaboration, the developed approach has the potential to enhance food security nationwide, ensuring that vulnerable populations have access to complete and nutritious meals in times of need and ultimately improving overall well-being.

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3. Introduction

Australia is facing a growing food insecurity crisis, driven by rising living costs, frequent natural disasters and the lingering effects of the COVID-19 pandemic. Nearly 2 million Australian households (19%) experienced severe food insecurity over the past year (Ipsos Public Affairs, 2024). Meanwhile, the food industry struggles with significant surpluses caused by environmental factors and oversupply, much of which goes to waste due to its perishable nature.

FareShare, a not-for-profit organisation, utilises rescued food to create nutritious fresh and frozen meals for vulnerable communities. However, logistical and infrastructure constraints including distances to remote communities, lack of continuous electricity supply, and areas frequently cut off by flooding make transporting and storing these meals particularly challenging in remote and disaster-affected regions. This project aims to address this challenge by developing a range of nutritionally balanced, long-life, shelf-stable meals from surplus food using freeze-drying and retort technologies. Retort and freeze-drying technologies are ideal for shelf-stable meals because they effectively preserve nutrition and quality while enabling long-term storage without refrigeration. These shelf-stable meals will enable FareShare to expand its reach to communities where frozen storage is unfeasible, improving food security in high-need areas.

While freeze-drying and retort technologies are well-established methods for creating shelf-stable products, they differ considerably from the processes currently used by FareShare to produce frozen meals.

3.1 Freeze-drying

3.1.1 Freeze-drying background

Freeze-dried meals are ideal for long-term storage and can be used as emergency food supplies, including in remote communities. Their low moisture content makes them lightweight, while their rapid rehydration properties enable quick preparation, typically requiring only hot water (Bui et al., 2018). The quality of freeze-dried products depends on several factors, such as the selection of raw materials, processing parameters, food safety measures and packaging.

Freeze-drying is a dehydration technique that removes water from food through sublimation, transitioning water directly from a solid (ice) to gas (vapor) state without becoming liquid. This process consists of three main phases: freezing, primary drying and secondary drying. During the freezing phase, the water content of the food solidifies. In the primary drying phase, the food is subjected to low pressure (<0.612 kPa) and low temperature (<0.01 °C) (Ratti, 2001). Heat is then applied to promote sublimation, causing frozen water to vaporise. Temperature and pressure control is crucial, as excessive heat can degrade food quality. During this phase, around 95% of the water is removed, but the food often develops a dry outer crust with a frozen inner core, necessitating further drying. A secondary drying phase is thus employed to remove residual unfrozen water; however, evaporation now occurs at a slower rate (Ratti, 2001). Initially, unbound water exits easily, resulting in a constant drying rate. As drying proceeds, the process slows due to increased product thickness and the presence of bound water. Optimisation of the secondary drying stage is therefore critical to ensure complete dehydration while preserving the food's integrity.

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3.1.2 Freeze-drying parameters

Parameters such as the initial freeze, drying temperature and drying time are crucial in determining the efficiency of the freeze-drying process and the quality of the final product. Among these, the freezing rate is particularly important. Fast freezing, achieved through methods such as blast freezing, rapidly lowers the temperature of the food, promoting the formation of small ice crystals. This minimises damage to the cell walls of fruits and vegetables, helping to preserve their texture, flavour and colour. In contrast, slow freezing gradually reduces the temperature over an extended period, leading to the formation of larger ice crystals. These larger crystals are more likely to rupture cell walls, resulting in a softer texture and greater loss of nutrients and flavour (Ratti, 2001).

Freeze-drying temperature profiles should be optimised for each food product to ensure an efficient and effective process. The collapse temperature, which defines the limit beyond which the product may lose structural integrity, is particularly important. To avoid adverse effects, the product temperature should stay at least 5 °C below the collapse temperature (Levi & Karel, 1995). For vegetables, the collapse temperatures are -12 °C for potatoes, -37 °C for carrots and -41 °C for tomatoes (Oyinloye & Yoon, 2020). For meats, beef collapses at -17 °C and chicken at -20 °C (Ratti, 2012).

3.1.3 Freeze-drying food safety

While moisture content impacts eating quality, water activity (Aw) is the most crucial factor in ensuring food safety and preserving product integrity (Igo & Schaffner, 2021). Water activity refers to the amount of free or available water in food that supports microbial growth and facilitates chemical and enzymatic reactions leading to spoilage. Microorganisms have specific minimum, maximum and optimal conditions for survival and growth. Pathogenic and spoilage bacteria do not grow in foods with a water activity below 0.85, while some yeasts and moulds can survive at water activity levels as low as 0.60 (Beuchat, 1983). Foods with a water activity below 0.60 are considered shelf-stable when stored at room temperature (20–25 °C) (Beuchat, 1983).

3.1.4 Freeze-dried product texture quality

Freeze-drying significantly alters the texture and quality of foods by removing moisture. As ice crystals sublime, the food shrinks and forms a porous structure, resulting in a lighter, more brittle texture. Optimal quality is achieved when the freeze-dried product retains the shape of the frozen food while developing a honeycomb-like texture that rehydrates easily.

Rehydration is the process of restoring freeze-dried food to its original state by soaking it in water. Several factors influence rehydration efficiency, including water temperature, soaking time and the size and structure of the food. Smaller food particles generally rehydrate more rapidly, while the food's initial composition and processing methods also play an important role. A study by Bui et al. (2018) investigated the rehydration of jasmine, basmati, brown, calrose and parboiled rice cooked using different methods. The results revealed that jasmine and basmati rice exhibit superior sensory and textural properties after freeze-drying and rehydration when prepared using the water absorption cook method.

3.1.5 Freeze-dried packaging

Freeze-dried foods are highly porous, making them susceptible to oxidation and moisture reabsorption, which can lead to product degradation over time. Although the freeze-drying process removes moisture and limits water-driven oxidation, the remaining fats

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and oils can still be affected by oxygen exposure, even in small amounts (Valentina et al., 2016). To mitigate these risks, the use of effective packaging is essential for maintaining product stability and extending shelf life.

Packaging solutions for freeze-dried foods focus on preventing oxygen and moisture ingress. High-barrier pouches with oxygen absorbers or light vacuum sealing are commonly used, while nitrogen flushing creates an inert atmosphere that further reduces lipid oxidation (Nair and Mancini, 2022). The selection of packaging materials and sealing methods is critical, as barrier properties directly influence the product's resistance to environmental factors and ultimately determine its shelf life.

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3.2 Retort

3.2.1 Retort background

Retort processing is a thermal sterilisation technique that uses pressurised steam, hot water, or cascading water to inactivate pathogenic and spoilage microorganisms in food packed in hermetically sealed packaging. Retort meals are shelf-stable and retain their safety and quality when stored at ambient temperatures. This makes them ideal for long-term, ready-to-eat applications, such as emergency food supplies or distribution to remote communities with limited refrigeration access. Since these meals are low in acid (pH above 4.6) and high in moisture, the retort process is a crucial to ensure both safety and quality (Jimenez et al., 2024). Several factors must be carefully considered when producing retort meals:

- process parameters;
- food safety,
- quality and
- packaging.

3.2.2 Retort parameters

Temperature, time and pressure are three crucial parameters for ensuring an effective and efficient retort process. Water serves as the heating medium; however, its boiling point of 100 °C (at atmospheric pressure) is insufficient for sterilising low-acid foods. Typically, retort temperatures range between 115–121 °C (Jimenez et al., 2024). To reach these higher temperatures without causing water to boil, overpressure air is applied during the come-up and sterilisation stages of retorting. This overpressure also prevents package expansion or bursting during the cooling stage.

Time management is essential throughout the three stages of the retort cycle. During the come-up stage, the come-up time (CUT) must be adequate to allow the heating medium to reach the target retort temperature. In the sterilisation stage, sufficient time is needed to ensure microbial lethality without overcooking or compromising product quality. In the cooling stage, the come-down time (CDT) is carefully controlled to ensure efficient cooling, preventing the growth of thermophilic microorganisms, which thrive above 40 °C, and avoiding overprocessing of the food (Jimenez et al., 2024).

3.2.3 Retort food safety

Food safety is a critical consideration when producing low-acid foods, as inadequate processing can allow pathogenic organisms to survive and produce toxins that may cause serious illness or death. Therefore, careful designing of the retort thermal process is essential to ensure the food receives adequate heat treatment.

A key measurement in this process is the F_0 value, which represents the 'sterilising value' of the retort process. The F_0 value measures the time needed at 121°C to kill a specific number of microbes, equivalent to the effectiveness of a given sterilisation process (Tucker & Featherstone, 2021; Holdsworth et al., 2008). This value allows for direct comparison between different heat sterilisation methods. If two processes have the same F_0 value, they achieve the same level of microbial destruction, ensuring equivalent effectiveness in sterilising the product.

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Although fatal food poisoning incidents are rare, *Clostridium botulinum* is a highly dangerous, heat-resistant, spore-forming pathogen that can thrive in low-acid foods. In such environments, where conditions are ideal for its growth, *C. botulinum* can produce botulinum toxin, a neurotoxin that may cause fatal foodborne illness if ingested. To prevent this risk, the minimum retort treatment for low-acid foods must achieve a 12-log reduction of *C. botulinum*, known as the 'botulinum cook' (Tucker & Featherstone, 2021; Holdsworth et al., 2008).

The D-value (decimal reduction time) for *C. botulinum* is ca. 0.21 minutes at 121 °C, indicating the time needed for a 1-log reduction at this temperature. Accordingly, the F_0 value for a 'botulinum cook' is around 2.5 minutes (Tucker & Featherstone, 2021). This F_0 value represents the minimum target for ensuring food safety after retort processing.

To ensure food safety, retort processes should target a higher F_0 value than that required for a 'botulinum cook'. This safety margin accounts for variations in processing and further reduces the presence of non-pathogenic, heat-resistant spoilage microbes.

3.2.4 Retort product spoilage

Microbial spoilage in retort products can result from inadequate pre-processing, under-processing, package leakage or thermophilic spoilage (Tucker & Featherstone, 2021). To minimise spoilage risks, it is crucial to carefully control retort conditions, optimise processing operations, develop appropriate formulations, ensure packaging integrity, and follow proper storage and handling procedures. Addressing each of these elements is key to maintaining the safety and quality of the final product.

Pre-process spoilage occurs when delays between pack filling and retort processing allow microorganisms to grow and potentially produce gas, leading to spoilage. Although the retort process kills microorganisms, any microbial activity before processing may cause swollen packaging and spoiled food (Tucker & Featherstone, 2021).

Spoilage due to under-processing may result from incorrect process design, faulty retort operation, operator error, overloading the batch or using raw ingredients with different heating characteristics than those specified in the validated recipes. Strict adherence to validated formulations and processes is required to prevent pre-process and under-processed spoilage (Tucker & Featherstone, 2021).

Leaked pack spoilage occurs when seals are improperly formed, allowing microbes to enter the packaging after processing. Initially, leakage may not be visible, but the packaging will swell over time as gas is produced during microbial growth (Tucker & Featherstone, 2021).

Thermophilic spoilage of retort foods is also possible, as retorting may not eliminate all thermophiles. If present, thermophilic spores can germinate within hours when food is held at temperatures between 45–60 °C, leading to quality issues (Tucker & Featherstone, 2021). The primary cause of thermophilic spoilage is an interruption in the retort cooling cycle, where packs remain in warm water for too long. This can be prevented by ensuring smooth machine operation and avoiding breakdowns. Thermophilic spoilage can also occur if products are stored at elevated temperatures, especially in hot climates, where thermophiles may produce acid or gas, resulting in a sour taste. To mitigate this, the retort process must be designed with an F_0 value that minimises thermophilic counts while maintaining acceptable organoleptic characteristics.

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3.2.5 Retort product texture quality

Preserving the organoleptic quality of food products during the retort process is essential for delivering flavourful and visually appealing meals. If the process is not carefully managed, the sensory attributes of the product can be adversely affected, leading to an undesirable appearance, texture and flavour.

To minimise these effects, precise control over cooking methods and ingredient sequencing before retorting is crucial. Heat-sensitive ingredients should be carefully managed during the cooking stage to prevent overprocessing. Additionally, maintaining an optimal F_0 value is critical for balancing food safety and product quality. The selected F_0 range must achieve sufficient microbial reduction while avoiding excessive thermal exposure. Implementing these measures ensures the production of safe, high-quality and shelf-stable meals that meet both regulatory standards and consumer expectations.

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3.2.6 Retort packaging

Retort packaging is specifically designed to withstand intense heat processing and preservation demands. The materials must be heat-resistant to prevent deterioration during thermal processing, ensuring the integrity, quality and safety of the finished product. The packaging is also hermetically sealed, providing strong barrier properties against microbial contamination throughout shelf life. This seal helps block external elements like moisture, oxygen, gas and light, preserving the product's freshness, nutritional value and overall quality (Walsh & Kerry, 2012).

Historically, manufacturers used cans and glass jars to package retort foods, but these options were costly to manufacture and distribute. Retort pouches have become a cost-effective and efficient alternative, offering a lightweight, durable and flexible structure while maintaining the necessary protection during the retort process. Retort pouches are composed of four layers, each serving a specific function. The exterior layer, made of durable polyester (PET), offers a clean surface for printing. The second layer, comprising aluminium foil (AL), provides an effective barrier against light, gas, moisture and microorganisms. The third layer, polyamide (PA), enhances abrasion resistance and structural strength. Lastly, the interior layer is a heat-resistant polypropylene-based sealant film (RCPP), designed to withstand retort applications (Primepac, 2020). This multi-layer construction provides optimal protection throughout the processing and shelf life of the product.

3.3 Management of glut products

Due to the short shelf life of fresh produce, excess fruit and vegetables often go to waste when they cannot be used immediately. FareShare frequently receives large quantities of fruit and vegetables due to oversupply, overproduction or cancelled orders. In most cases, such produce is frozen or incorporated into frozen meals within a few days. However, freezing is not always practical, as certain produce does not freeze well, and the volumes may sometimes be too large to process. Converting surplus produce into a shelf-stable format helps prevent waste, diverts food from landfill and allows for future utilisation.

3.4 Culturally appropriate sensory training

Culturally appropriate training is essential for fostering effective communication and building trust with diverse communities, particularly those with unique cultural backgrounds and traditions (Wong.J et al 2025). This approach recognises that each community has its own values, practices and communication styles, which can significantly impact the success of engagement efforts. By equipping FareShare community engagement officers with adaptable sensory evaluation skills and techniques, they can engage in more appropriate and meaningful interactions. The approach emphasises inclusivity, helps address power imbalances and creates an environment where all voices are heard, thereby fostering stronger and more effective relationships.

3.5 Creation of the technical manual

A comprehensive technical manual is crucial for ensuring the efficient and consistent production of high-quality products. A well-developed manual equips teams with the necessary tools and knowledge to navigate the complexities of formulating, processing and packaging food items, such as freeze-dried and retort meals. It serves as a technical framework, outlining the essential specifications and procedures required to maintain food safety, product consistency and quality standards. By addressing key areas like raw material selection, process parameters, critical control points and packaging requirements, such manuals help

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streamline operations and ensure compliance with safety and quality regulations, thus supporting successful production of shelf-stable meals.

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3.6 Training of FareShare staff

Training is critical to ensure that staff have the necessary knowledge and skills to carry out their roles effectively, especially in complex food production processes. By offering targeted training alongside clear documentation, organisations can ensure consistency, efficiency and adherence to established specifications in their production processes.

3.7 Incorporation of new products and process into FareShare's existing HACCP plan

HACCP (Hazard Analysis and Critical Control Point) is a systematic approach for identifying, evaluating and managing food safety hazards throughout the production process. It ensures that all stages of food processing, from raw material handling to final product distribution, are monitored for potential risks. Maintaining an up-to-date HACCP plan is essential for standardising food safety protocols across various production methods, ensuring consistent compliance with industry regulations. Integrating new processes, such as freeze-drying and retort methods, into an existing HACCP plan helps maintain a unified framework for safeguarding safety and quality across all production operations.

3.8 Consumer and sensory assessment of final products

Consumer evaluation is a powerful step in the product development process, providing valuable insights into how products resonate with the target audience. By understanding consumer preferences and behaviours, businesses can make informed decisions to enhance product appeal. This process also highlights areas for improvement, enabling ongoing product refinement to meet consumer expectations.

3.9 Qualitative evaluation of social impact

A Social Impact Assessment (SIA) is a vital tool for understanding the broader implications of a project, particularly in addressing the needs of vulnerable communities. It helps evaluate how initiatives, such as the implementation of shelf-stable meals in disaster-affected regions, can effectively address critical issues like food security and disaster preparedness. This type of assessment ensures that the project is culturally relevant and sensitive, particularly for First Nations communities, while identifying any potential challenges or unintended consequences. It also provides a framework for refining strategies and measuring the long-term impact and scalability of the project, ensuring its overall effectiveness and sustainability.

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4. Methodology

The project was divided into key milestones:

- Define the product brief;
- Develop and optimise the formulation and process for two freeze-dried meals and two retort meals;
- Develop and optimise the formulation and process the additional three freeze-dried and retort meals;
- Complete scale-up trials confirming process and packaging of all meals;
- Validate the shelf life of the meals to six months;
- Apply knowledge learned from meal optimisation trials to convert glut products into a shelf-stable format;
- Facilitate culturally appropriate sensory training;
- Create the technical manual covering all aspects of formulation and process for freeze-dried and retort meals;
- Train FareShare staff on the new processes;
- Incorporate the new products and processes into the FareShare HACCP plan;
- Conduct consumer and sensory assessments of the meals and
- Define the qualitative evaluation for future social impact.

4.1 Freeze-drying methodology

4.1.1 Define the freeze-dried meal parameters

The product development brief outlined key operational, processing, nutritional, sensory and quality parameters for freeze-dried meals. QDPI facilitated workshops with FareShare and FoodStream to gather insights into processing requirements, nutritional composition, sensory attributes and quality standards. These parameters were informed by FareShare's community research and experience in producing nutritionally dense frozen meals, as well as FoodStream's technical expertise. Five family-friendly meal concepts were scoped to appeal to a broad consumer base, with a focus on optimising taste, texture and appearance. The product parameters were carefully aligned with FareShare's operational capacity to ensure efficient production and distribution within their existing framework. Consideration was given to raw material availability and packaging specifications to maintain product integrity and extend shelf life.

4.1.2 Preliminary freeze-dried formulation and process development

Initial formulations were developed in collaboration with FareShare chef, James Fein, following the guidelines established in the product development brief. Meals were cooked at FareShare using a Bratt pan (FlexiChef MKN, Wolfenbüttel, Germany). The

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sauce, which included protein and vegetables, was cooked separately from the carbohydrate component (e.g., pasta or rice) and later combined after blast chilling. Preliminary process development was conducted using FareShare's Dynavac 10 kg freeze-dryer (DHF40, Brisbane, Australia) to assess the suitability of raw materials, flavour profile and rehydration properties of the meals. The formulations were refined in accordance with the feedback from group tasting sessions, which involved a cross-section of project participants. Prior to tasting, all samples were rehydrated with hot water (90 °C) for 15 minutes to ensure consistency.

Initial bench-scale trials focused on Beef Bolognese with Pasta and Savoury Chicken with Vegetables and Rice, with full details included in Appendix B1. Two process profiles were tested: a 10-stage standard process recommended by Dynavac and a 4-stage simplified process designed to improve efficiency. Process optimisation was guided by a literature review and consultations with FoodStream, particularly regarding the secondary drying stage. Following freeze-drying, the product was packed into 160 x 270 mm pouches (Appendix 7), with a fill weight of 100 g, and sealed using a heat sealer.

The initial trials were conducted using FareShare's Dynavac freeze-dryer, with the findings forming the basis for further trials at Rehydraid, AGTECH, QDPI and Sustainable Farming and Development (SFD).

4.1.3 Scale-up trials for freeze-dried meals

Several freeze-drying contract manufacturers were explored for scale-up purposes, with SFD in Newcastle selected due to its equipment capability, capacity and trial costs. Details of the trials conducted at AgTech, Rehydraid and QDPI are included in Appendix B1. The SFD trials were conducted in four stages to refine the formulation and ensure the product could be consistently dried to a safe standard. The goal was to develop a process that would allow the product to be freeze-dried within 24 hours, while maintaining both quality and food safety. Various contract manufacturers advised that this process timeframe was the most cost-effective option. The scale-up trials were designed to evaluate and optimise the freeze-drying processes for the five meals. Conducted in multiple stages, each phase focused on refining specific aspects of the freezing and drying parameters. Table 1 provides an overview of each trial stage.

Table 1 Freeze-dried product scale-up trial summary

Stage	Formula	Chilling	Portioning	Blast freezing	Freeze drying
1	Beef Bolognese with Pasta and Savoury Chicken with Vegetables and Rice (100 kg batches).	Transferred to QDPI facilities. Cooled from 60 °C to 21 °C in 2 hours, then further cooled from 21 °C to 5 °C in 4 hours.	Divided into 1 kg and 1.5 kg portions and placed in 28 cm × 42 cm trays with blue plastic liners.	Custom CSK blast freezer (QDPI) at -30 °C for 30 minutes.	SFD (Cuddon HL50 Freeze Dryer, Dehlia). See Appendix B1 for additional information.
2	Tuna Mornay, Asian Chicken Noodle, and Chickpea Tagine (100 kg batches).	Chilled at FareShare from 60 °C to 21 °C in 2 hours/ Transferred to QDPI and further	1.5 kg per tray (28 cm × 42 cm with blue plastic liners).	Custom CSK blast freezer (QDPI) at -30 °C for 60 minutes.	

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		cooled from 21 °C to 5 °C in 4 hours.			
3	Beef Bolognese with Pasta and Savoury Chicken with Vegetables and Rice (100 kg batches).	Chilled at FareShare from 60 °C to 21 °C in 2 hours. Transferred to QDPI and further cooled from 21 °C to 5 °C in 4 hours.	1.5 kg per tray (28 cm × 42 cm with blue plastic liners).	Custom CSK blast freezer (QDPI) at -30 °C for 60 minutes.	
4	All formulas (100 kg batches).	Chilled at FareShare from 60 °C to 21 °C in 2 hours.	1.5 kg per tray (28 cm × 42 cm with blue plastic liners).	FareShare blast freezer at ca. -15 °C for 120 minutes.	

4.1.4 Freeze-dried product packing trials

The product from the Stage 4 trials conducted at SFD was returned to FareShare in 1 kg packs, packaged in heavy-gauge plastic bags. These meals were then repacked into 100 g portions in sample pouches. The pouches were sealed using a vacuum packer (***Promax*** (Sealed Air) Model No# DC650 FB-C-H, S/No# FM15092403). with a vacuum setting of 35%, a seal setting 1 of 18 seconds, seal setting 2 of 18 seconds, cool setting of 15 seconds, and a 2-second nitrogen flush. To verify the effectiveness of the nitrogen flush, a multigas detector (ALTAIR® $XR) was used. First, the detector was placed inside a clear bag and sealed using the vacuum packer with the nitrogen flush turned off, providing a baseline reading. The process was then repeated with the nitrogen flush activated. The low oxygen levels detected in the second test confirmed the effective removal of oxygen from the bag and the successful operation of the nitrogen flush.

4.1.5 Shelf-life validation of freeze-dried meals

Beef Bolognese with Pasta (batch 170724f), Savoury Chicken with Vegetables and Rice (batch 160724f), Tuna Mornay (batch 12082024), Chickpea Tagine (batch 250924) and Asian Chicken with Noodle (batch 120924a) were packed into freeze-drying pouches at QDPI, sealed with a light vacuum and stored at ambient temperature (24 °C). The physico-chemical and microbiological properties of samples from Stage 1 and 2 scale-up trials were evaluated each month over the six-month shelf life. The testing methodology is detailed in Appendix B2.

4.2 Retort methodology

4.2.1 Define the retort meal parameters

Similar to the freeze-dried products, the product development brief for the retort process outlined key operational, processing, nutritional, sensory and quality parameters for these meals. The retort meals were developed to offer five distinct, family-friendly

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options with broad consumer appeal. Each meal was formulated to optimise taste, texture and appearance, while ensuring nutritional balance through high protein content, abundant vegetables and whole food ingredients. A key focus during development was maintaining microbiological safety throughout the shelf life. Additionally, the meal design was carefully aligned with FareShare's operational capacity, ensuring efficient production within their existing framework. The meals were tailored to meet the dietary and cultural needs of the communities FareShare serves, ensuring accessibility and relevance while maintaining consistency with their current frozen meal offerings.

4.2.2 Retort meal formulation and process development

Five retort meals were selected during an industry partner workshop, namely Spiced Chicken with Vegetables and Rice, Beef Bolognese with Pasta, Chilli Con Carne, Chickpea Tagine and Beef Stroganoff. The meal formulations were developed in collaboration with FareShare chef, James Fein, following the creation of the product brief.

Meals were partially cooked using a kettle (Dieta Soupper M14, Helsinki, Finland) or Bratt pan (FlexiChef MKN, Wolfenbüttel, Germany). Once cooked, they were blast chilled, packed into 160 x 270 mm stand-up retort foil pouches (400 g nominal weight) and sealed. The sealed products were refrigerated for a maximum of 24 hours before retort processing.

Meals were retorted at FareShare in a static water cascade retort machine (Steriflow Barriquand 911R, Steriflow®, Roanne, France) with a maximum capacity of 12 pouches per tray across seven trays. Seven test packs were probed with Ecklund-Harrison T-type 70 mm needle thermocouples (TechniCAL, Metairie, USA) positioned in the slowest-heating area of the chamber. Larger vegetable, meat or carbohydrate pieces were selected for measurement and placed on the probe tips. To simulate the worst case scenario, test packs were overfilled to 420 g and placed in the bottom two trays. Temperature data were collected using a Picotech TC-08 logger (Pico Technology, Cambridgeshire, UK), with probes calibrated to within 0.3 °C. F_0 values were calculated from probe data, with the lowest value confirming food safety.

The minimum F_0 value for the finalised formulation and process was recalculated using Gillespy's Method, which estimates the effective F_0 value under the worst-case scenario by accounting for the lowest initial product temperature and shortest come-up time. In this study, the recalculated F_0 value was based on an initial product temperature of 4 °C (immediately after cold storage) and a 20-minute come-up time.

For sensory evaluation, the products were removed from their pouches and microwaved for 2 minutes prior to tasting. The meals were assessed by a representative participant group in line with the product development brief, guiding formulation refinements.

4.2.3 Validation trials for retort meals

The finalised retort processes for all five products, including formulations, cooking and retort procedures, were replicated to ensure consistent quality and safety (F_0 value). Standardised formulations, cook and pack processes were established based on the findings from the development trials. The pouches were vacuum-sealed at 60% vacuum with a 7.5-second sealing time and 15-second cooling. A second seal was applied with a band sealer to prevent water from catching in the seam during retort processing. The products were refrigerated for a maximum of 24 hours before retort processing.

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The retort machine was fully loaded with pouches in seven 595 x 400 mm trays, each holding twelve packs. Pouches were arranged in two evenly spaced rows, with thick ends facing the tray edges. Seven 420 g pouches were probed with Ecklund-Harrison T-type 70 mm needle thermocouples (TechniCAL, Metairie, USA), placed in the slowest-heating areas to validate the worst-case scenario of the retort process. To simulate 'extreme' variations, a pouch was probed containing product from the top of a tray that had been held overnight in the cold room without mixing, resulting in a drier product that heated more slowly. Probing, placement and calibration followed the same procedures as previously outlined. A process flowchart was created (Appendix B13), outlining each step from the receipt of raw materials to the dispatch of the frozen product to the contract manufacturer.

4.2.4 Shelf-life validation of retort meals

Chilli Con Carne, Chickpea Tagine and Beef Stroganoff were prepared using approved validated formulations and retort programs, then stored for shelf-life assessment. These samples underwent organoleptic, physico-chemical and microbiological assessments over a six-month period. One set of samples was stored at ambient temperature (20–25 °C) and a second set was stored at an elevated temperature (45 °C), with monthly evaluations to assess organoleptic and microbiological stability throughout the shelf life.

For Beef Bolognese with Pasta and Spiced Chicken with Vegetables and Rice, microbiological shelf-life samples were taken from batches subjected to a 50-minute sterilisation process, which was 5 minutes shorter than the finalised retort program. Despite the shorter sterilisation time, this represented a worst-case scenario for microbial elimination, reinforcing confidence in the microbial stability anticipated with the longer retort program. Additionally, samples of Beef Bolognese with Pasta were taken from the shorter retort batch for future organoleptic assessment. An additional batch, prepared using the approved retort program, was later evaluated, and compared to the shelf-life assessment batch to confirm that no quality degradation occurred with the extended processing time. The testing methodology is detailed in Appendix B2.

4.3 Management of glut products

A review of historic surplus produce was conducted using FareShare's data from the past five years to identify high-volume glut products, produce that exceeds demand and may go to waste and determine the most effective methods for converting them into a shelf-stable format. Several factors were considered, including end use, product consistency, quality after processing and cost-effectiveness. Priority was given to products that could not easily be frozen, based on the needs of the end users and the challenges faced by food insecure communities. The review revealed that in some regions, protein sources like fish, livestock and wild game meat were readily available, while fruits and vegetables were scarce or expensive.

For the retort trials, three flavour profiles were tested: Tomato and Vegetables, Curry Sauce and Vegetables and Asian Sauce and Vegetables. Multi-wall, heavy-gauge foil bags were used, each sized to fit two bags per tray (350 x 400 mm), with a fill weight of 3.0 kg per bag. The bags were sealed using a band sealer, with no vacuum applied, following the same processes used for meal development.

For the freeze-drying trials, sweetcorn, which was abundant at the time, was chosen as the glut product. Corn is highly nutritious, readily available and typically received in a frozen format by FareShare, making it an ideal candidate for freeze-drying. In addition, freeze-dried corn offers a more practical long-term storage solution and can be readily incorporated into a range of family-friendly freeze-dried meals. Frozen corn was sent to SFD for freeze-drying, which entailed initial freezing at -20 °C for 1 hour, followed by freeze-drying at 70 °C for 6 hours and 50 °C for 15 hours.

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4.4 Culturally appropriate sensory training

The QDPI Consumer Intelligence team liaised with the FareShare Indigenous Engagement Officer to engage with diverse consumer groups from First Nations communities. Community members, particularly elders and mothers with children, were involved, ensuring that cultural relevance and age-appropriate methods were prioritised. Workshops with FareShare Indigenous Engagement Officers helped to ensure the use of culturally appropriate language, and sensory sessions were designed to maximise participation and comfort with the products.

To support FareShare in conducting culturally sensitive focus groups, QDPI staff attended three focus groups in person:

- Burringilly (16 May 2024);
- Cherbourg (15 August 2024) and
- Hymba Yumba (27 August 2024).

Before these sessions, the QDPI team developed product feedback forms (Figure 1) and tailored methods and materials to guide FareShare staff in facilitating focus groups effectively. Key considerations included cultural sensitivity, resource limitations and group dynamics. During the sessions, interactions between the FareShare Indigenous Engagement Officer and participants were observed by QDPI Consumer Intelligence staff, with insights documented. QDPI Product Development staff prepared meals for the participants. Observations focused on participant engagement, group dynamics and the effectiveness of the methods and materials used.

After each session, debrief meetings between QDPI and FareShare staff offered an opportunity to reflect on the focus group process. Successful aspects were noted, areas for improvement were identified and strategies were discussed to address complex issues in future focus groups. This iterative approach ensured continuous refinement of the methodology.

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Image 1 Food prepared for Burringilly focus group

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Product feedback form

Purpose: To collect structured feedback on products being tested.

Name of Product: _____

Taste:

☐ Excellent

☐ Good

☐ Average

☐ Poor

Texture:

☐ Excellent

☐ Good

☐ Average

☐ Poor

Appearance:

☐ Excellent

☐ Good

☐ Average

☐ Poor

Packaging (if applicable):

☐ Excellent

☐ Good

☐ Average

☐ Poor

Overall Satisfaction:

☐ Excellent

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☐ Good

☐ Average

☐ Poor

What did you like most about this product?

_____

__

What could be improved?

_____

__

Would you use or purchase this product?

☐ Yes

☐ No

☐ Maybe (please explain why): _____

Figure 1 Product Feedback form

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Throughout the project, the data collected from the focus groups were regularly reviewed, key insights were summarised and strategies for future sessions were developed. As part of this final report, recommendations and supplementary materials were compiled by QDPI to support FareShare in achieving ongoing success in their focus group initiatives.

4.5 Creation of the technical manual

All necessary data for the technical manual were gathered, including best practices for freeze-dried and retort meals in light of FareShare's needs and capabilities. Industry standards and food safety guidelines were reviewed to ensure regulatory compliance. Process parameters, including temperature, time and equipment specifications, were outlined for product consistency and safety. Instructions were developed to address raw material handling, critical control points during production and packaging guidelines to preserve quality and extend shelf life.

4.6 Training of FareShare staff

FoodStream provided comprehensive training for FareShare staff, covering raw material handling, process parameter maintenance and quality control measures for freeze-dried and retort meals. Emphasis was placed on food safety protocols, including hygiene standards, monitoring critical control points and following packaging guidelines. Operational procedures were clarified to ensure efficient and safe meal production, with staff also receiving instruction on troubleshooting potential issues.

4.7 Incorporation of new products and process into FareShare's existing HACCP plan

FareShare's consultant, Food Safety Systems, conducted a comprehensive review of the organisation's existing processes, procedures and packaging methods. This review aimed to identify necessary updates to the HACCP plan and food safety protocols to accommodate the introduction of the new meal products. The evaluation focused on assessing potential risks in the production of freeze-dried and retort meals, providing a basis for the implementation of additional safety measures where required.

4.8 Consumer and sensory assessment of final products

Consumer evaluation was conducted on five freeze-dried products (Table 2) and five retort products (Table 3). Tasting sessions took place from 19–21 December 2024 in QDPI's purpose-built sensory booths (Image 2) at the Health and Food Sciences Precinct (HFSP) in Coopers Plains, Brisbane. A total of 42 participants evaluated the freeze-dried products, while 34 assessed the retort meals. Participants were recruited from QDPI staff and FareShare volunteers. All participants received information about the study and products being tasted before providing their consent to take part.

The consumer survey was designed collaboratively by QDPI and FareShare to ensure it met the research criteria. EyeQuestion® (version 5.7.4 (build 2883)) sensory software was used to design consumer questionnaires. Consumer

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evaluation data were analysed using EyeOpenR® (version 5.7.4) Developer; Qi Statistics Ltd. Two-way ANOVA with Tukey's posthoc analysis was carried out to indicate any statistically significant differences in the data at a 95% confidence level.

Samples were freshly prepared for each session, following the instructions in Appendix B21. Products were presented to consumers one at a time in a small white pot labelled with a 3-digit blinding code. Samples were presented in a randomised, controlled order to prevent any bias from sample serving order.

Image 2 Sensory booths, Health and Food Sciences Precinct (HFSP) in Coopers Plains, Brisbane

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Table 2 Freeze-dried product names and images (as displayed in consumer questionnaire)

Product name and blinding code	Image
Savoury Chicken with Vegetables and Rice(509)	
Beef Bolognese with Pasta (381)	
Chicken Noodle (927)	
Chickpea Tagine (476)	

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Tuna Mornay (117)	

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Table 3 Retort product names and images (as displayed in consumer questionnaire)

Product name and blinding code	Image
Spiced Chicken with Vegetables and Rice (197)	
Beef Bolognese with Pasta (923)	
Chilli Con Carne (348)	
Chickpea Tagine (571)	
Beef Stroganoff (237)	

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4.9 Qualitative evaluation of social impact

The SIA was developed using structured frameworks and qualitative research methods to evaluate the anticipated social and environmental impact.

4.9.1 Development of the logic model and theory of change

The logic model and theory of change (Appendix B20) were created using the Social Impact Toolbox (2024). The theory of change posits that: *Through the provision of shelf-stable meals made from rescued food, we can help to address food insecurity issues for vulnerable communities in disaster impacted areas, improving physical and emotional health outcomes for recipients of the meals, as well as having positive community and environmental impacts.*

To assess this, a logic model was developed which included:

1. Issue Addressed: Disaster-impacted and remote communities struggle to access fresh and frozen food. FareShare's shelf-stable meals offer a nutritionally complete alternative.
2. Inputs: Resources include rescued and purchased ingredients, funding, manufacturing costs, volunteers and FareShare's facilities.
3. Activities: Research & development (R&D), sensory training, ingredient preparation, meal manufacturing, business development and delivery coordination.
4. Outputs: Distribution of freeze-dried or retorted meals through disaster relief organisations.
5. Outcomes: Increased food security, resilience and well-being in disadvantaged communities.
6. Impact: Enhanced disaster preparedness, reduced food waste and emissions and improved community resilience.

This framework links project resources, activities and outputs to intended impacts, creating a roadmap for meaningful social and environmental change.

4.9.2 Development of the Evaluation Model

The evaluation model (Appendix B20) aligned with the logic model, incorporating both quantitative and qualitative measures to assess outcomes.

Note: given that the SIA coincided with the meal's development phase, evaluation focused on anticipated outcomes, with further assessments required post-distribution. This evaluation model was designed to be used both during the design phase as well as once the meals are being distributed.

Key components of the evaluation model include:

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1. Outputs:
    - Quantitative Metrics: Number of meals distributed, proportion of rescued food used and volunteer participation rates.
    - Qualitative Observations: Usability feedback from organisations and community responses on taste, cultural appropriateness and ease of use.

2. Outcomes:
    - Food Security: Surveys and interviews measuring reductions in food insecurity and accessibility during emergencies.
    - Community Resilience: Case studies and testimonials on preparedness and recovery.
    - Health and Well-being: Nutritional tracking and health impact analysis.
3. Long-Term Impacts:
    - Environmental Benefits: Food waste reduction and greenhouse gas emission estimates.
    - Community Value: Social Return on Investment (SROI) analysis and resilience improvements.
    - Operational Impacts: Evaluation of efficiency gains in disaster relief and new stakeholder partnerships.
4. Data Collection Tools:
    - Research review on food insecurity and health impacts.
    - Surveys and interviews with disaster relief organisations and community representatives.
    - Community case studies, such as in Wujal Wujal, to document real-world impacts.

This iterative model ensures the project is monitored and improved, supporting broader efforts to address food insecurity in remote disaster-prone regions.

Stakeholder Engagement

Semi-structured interviews were conducted with representatives from Red Cross, Foodbank, Salvation Army and Uniting Vic.Tas to understand their roles in disaster response. Key questions included:

- What is your role in disaster preparedness and response?
- How do you currently source and distribute food?
- What are your warehousing strategies for disaster preparedness?
- Would FareShare's shelf-stable meals be best stored centrally or pre-positioned?
- What are the community impacts of food shortages during emergencies?

Insights from Remote First Nations Communities

Further discussions were held by FareShare's First Nations Officer with First Nations Elders, Councils and community service providers in Wujal Wujal and Mornington Island to understand food security challenges during disasters. Key questions explored:

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- What support systems exist to address food insecurity in disasters;
- What are the main barriers to food access in emergencies and
- How would access to shelf-stable meals impact community resilience?

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5. Results

5.1 Freeze-dried meal results

5.1.1 Define the freeze-dried meal parameters

The product development brief defined key parameters for the freeze-dried meals. It outlined the common attributes for all five meals, specifying both desirable and undesirable attributes as outlined in Table 4.

Table 4 Freeze-dried meals product development brief

Product Description	Five 'homestyle' complete freeze-dried meals. Ingredient piece size of 20 mm maximum to align with contract manufacturer limitations. Meals must be formulated robustly to allow flexibility of ingredients depending on FareShare donations and seasonality. Five finalised freeze-dried meal concepts: 1. Beef Bolognese with Pasta 2. Savoury Chicken with Vegetables and Rice 3. Tuna Mornay 4. Asian Chicken Noodle 5. Chickpea Tagine
Desirable sensory attributes	The final product will maintain comparable sensory attributes (aroma, flavour, texture and appearance) of current frozen FareShare meals when ready to eat. After hydration, the meal will present as a 'homestyle' meal, true to product descriptor, including warmth and variety of colour with identifiable ingredients. Required product attributes when heated: • Vibrant colour; • Multitextured and depth of flavour; • Variety of visible vegetables; • Appealing aroma true to product descriptor; • Good meat texture, not mushy requires some mastication; • Medium heat/spice to suit target consumers and • Good balance of visible protein, vegetables, carbohydrates and sauce

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	Negative attributes to be avoided: • Fatty mouthfeel; • Dry/ bland meat; • Phase separation and • Raw spices
Desired end use	Ready to hydrate and consume. Aim for all meals in the range to have consistent preparation parameters (time, temperature, cooking instructions), with full hydration of all ingredients.
Desired product claims	Meals must be formulated robustly to allow flexibility of ingredients depending on FareShare donations and seasonality/availability. • Nutrition criteria (value per 400 g meal): o Protein 20–30 g o Vegetables > 2 serves (2 x 75 g) o Sugar < 15 g o Sodium < 800 mg o Saturated fat < 5 g • Additives: natural colour and modified starch/stabilisers acceptable when needed; • Allergen status: no restriction and • At least 1 vegetarian option (Chickpea Tagine).
Product format	Shelf-stable meals.
Microbiological considerations	Absence of spoilage organisms and food pathogens over shelf life prior to rehydration.
Packaging	Primary packaging must be stand-up foil pouches with a 5 cm gusset nitrogen flushed with a double seal opening. Each pouch should contain a 400 g single serving after rehydration.
Required shelf life	6 months at ambient storage, consume upon opening.
Target market	Remote communities and areas affected by natural disasters.

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5.1.2 Freeze-dried formulation and process development

Formulation development

Savoury Chicken with Vegetables and Rice

Appendix B1 provides details of the freeze-drying trials for the Savoury Chicken with Vegetables and Rice variant. A total of 34 trials were conducted before reaching the final formula (Appendix B4). Below is a summary of the trials.

Stage 1 trials revealed that meals should be fully cooked before freeze-drying, as the residual heat from boiling water during rehydration is insufficient to further cook the product. Furthermore, various rice types were evaluated, including jasmine and long-grain, as well as different cooking methods, such as par-cooking compared to fully cooking. Fully cooked long-grain rice was selected for its structural integrity after the freeze-drying process.

Two agents were investigated for thickening the sauce: a modified waxy maize (Purity W®, Ingredion) and citrus fiber (Citri-Fi 100, Fibrestar). Batches 250124a–250124d evaluated various ratios of these ingredients. The most favourable mouthfeel and viscosity was achieved when using Purity W® at 2%.

The initial formulations of Savoury Chicken with Vegetables and Rice contained potato; however, evaluations revealed incomplete rehydration of both the potato and chicken, regardless of piece size, water temperature or rehydration time. As a result, potato was removed, and various chicken cooking methods were evaluated (batch 301024). To improve the texture of the chicken component, different processing methods were explored, including variations in cooking methods and water inclusion rates. Pressure cooking was found to enhance the internal structure of the chicken, improving water penetration during rehydration. Consequently, pressure cooked chicken was used in subsequent trials. Pressure cooking resulted in a cook loss of approximately 40%, which was accounted for in the formulation to ensure the meal met protein content guidelines.

Beef Bolognese with Pasta

Appendix B1 provides details of the freeze-drying trials for the Beef Bolognese with Pasta formulation. Five trials were completed before finalising the formula (Appendix B4). Below is a summary of the trials conducted.

Various pasta shapes (macaroni, shell and elbow) and cooking levels (e.g., al dente vs. well-cooked) were assessed. Small macaroni, cooked for 12 minutes, was selected due to its optimal texture and rehydration performance. The formulations were modified to meet both flavour and nutritional requirements. Pasta content was reduced, while tomato and beef proportions were increased. Starch and herb levels were fine-tuned to enhance flavour and texture. To achieve low saturated fat targets, only lean beef (>90% lean) was used, given its substantial inclusion in the recipe (18.5%). Fattier meats were avoided due to their potential for lipid oxidation, which accelerates at water activities below 0.4 (Gumus & Decker, 2021). The salt content was gradually reduced from 0.33% to 0.20%. Additionally, Purity W® was added at to help suspend the pasta pieces and create a more uniform product mix.

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Tuna Mornay

Appendix B1 provides details of the freeze-drying trials for the Tuna Mornay formulation. Six trials were conducted before finalising the formula (Appendix B4). Below is a summary of the trials.

Initial trials focused on refining the nutritional profile and sensory qualities to align with the product development brief. Similar to Beef Bolognese with Pasta, 20% pasta was preferred in the product. However, adjustments to water, milk and spice levels were necessary to improve the flavour balance. Early small-scale batches exhibited watery textures and bland flavours after rehydration, prompting formulation adjustments. Purity W® was added to increase the sauce thickness, while spice levels were fine tuned to create a more well-rounded flavour.

Notably, Tuna Mornay was the only meal formulated with prepacked frozen vegetables, which consistently rehydrated well and retained their colour throughout processing. Several adjustments were made to meet the nutritional brief: sweet potato was removed, the vegetable mix was increased, salt and milk were reduced, and water content was increased. Adjustments were made to the total sugar and salt inclusion, with the final formulation including 20% pasta, 14% tuna and 12% broccoli. While the flavour remained slightly bland, it was considered acceptable. A grey appearance was observed in one batch of Tuna Mornay (batch 12082024), but this did not occur in subsequent batches. The colour change did not affect the flavour profile of the meal, and its precise cause remains undetermined. This will require monitoring in future production runs.

Chickpea Tagine

Appendix B1 provides details of the freeze-drying trials for the Chickpea Tagine formulation. Five trials were carried out before finalising the formula (Appendix B4). Below is a summary of the trials.

The formulation was developed based on insights gained during the Chickpea Tagine retort product development. As with other formulations, the meal needed to be fully cooked before freeze-drying to ensure product quality. Undercooked vegetables and inconsistent bean sizes led to poor rehydration outcomes. Initially, both faba beans and chickpeas were included to meet protein content targets in the product development brief. However, the high bean levels resulted in an unbalanced meal. The large faba beans were visually unappealing and negatively affected the overall eating experience. In consultation with FareShare, the initial nutritional targets were adjusted and the formulation modified to prioritise the organoleptic quality of the meal. Faba beans were removed, pepper was reduced, and the raisins and tomato purée were increased to enhance both flavour and overall appeal.

Asian Chicken noodle

Appendix B1 provides details of the freeze-drying trials for the Asian Chicken Noodle formulation. Six trials were conducted before finalising the formula (Appendix B4). Below is a summary of the trials.

The initial trials focused on evaluating different types of noodles (think and flat/thick) and cooking methods. Thin noodles were preferred for their taste and appearance, while flat noodles, though more authentic, were less desirable overall. Poaching the chicken resulted in a bland flavour profile, whereas cooking it with garlic, onion, chilli and ginger created a more authentic and flavourful profile. The chicken hydrated well, due to the meal's relatively high water content (15.4%). This moisture content helped create an open texture during freeze-drying, allowing the meat to rehydrate effectively due to its porous structure.

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To meet nutritional requirements, the formulation was adjusted to include 25% noodles, 18% chicken and a vegetable mix including broccoli florets and stems, carrots, capsicum and cabbage. Flavour was enhanced with soy sauce, sesame oil and Conimex Ketjap Manis, while a small amount of Purity W® improved the overall texture. In later trials, salt was removed, as the sodium levels from the soy sauce and Ketjap Manis were sufficient to reach the sodium limit outlined in the product development brief.

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Stage 1 trials

The Stage 1 freeze-drying trials (30 July to 2 August 2024) demonstrated that the proposed process (freeze-drying for 24 hours with maximum secondary drying temperature of 35 °C) did not sufficiently dehydrate the meals to less than 0.6 Aw. In trials 1 and 2, the water activity of the product ranged from 0.61–0.74 across multiple product trays (Figure 2), which is insufficient to inhibit yeast and mould growth over time.

The drying process for the Savoury Chicken with Vegetables and Rice (batch160724a–160724f) and Beef Bolognese with Pasta (batch 170724a–170724f) revealed some notable differences. Beef Bolognese with Pasta dried more rapidly than Savoury Chicken with Vegetables and Rice, losing about 80% of its weight compared to 75% for the Savoury Chicken with Vegetables and Rice. The thickness of the slabs played a key role in drying time, with 1 kg slabs drying more rapidly than 1.5 kg ones. Although drying 1.5 kg slabs in under 24 hours was not achieved, the data collected offered a clearer understanding of process requirements and limitations.

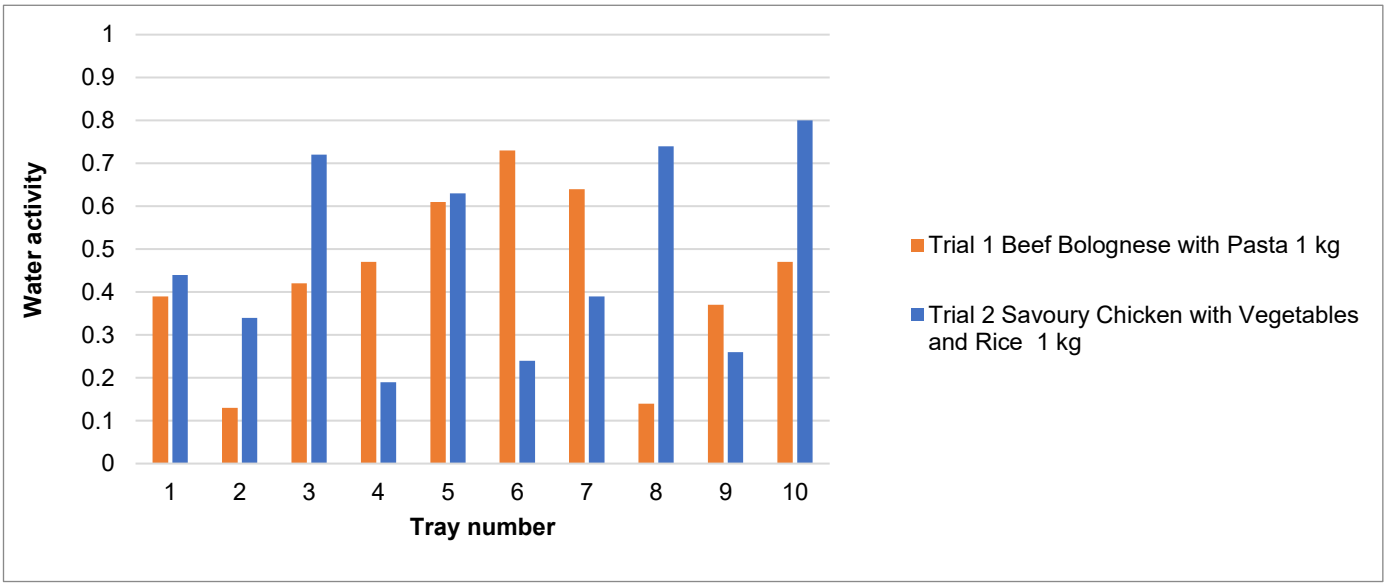

Figure 2 Stage 1 – water activity (Aw) of Trial 1 and 2 products, following freeze-drying.

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Stage 2 trials

During Stage 2 freeze-drying trials (8 October 2024 to 15 October 2024), batches of Chickpea Tagine (batch 250924), Tuna Mornay (batch 2B00824) and Asian Chicken Noodle (batch 120924) were freeze-dried with maximum secondary drying temperature of 50 °C. Both thick and thin noodles were assessed in the Asian Chicken Noodle meal (batches 120924a and 120924b). The drying process resulted in moisture loss ranging from 77–82%, with water activity ranging from 0.05–0.19 (Figure 3). Appendix B5 details the water activity and moisture results achieved.

During the Chickpea Tagine trial, the operator noted that tray 18 had a section of wet product after removal. This section was separated and discarded to prevent the wet section encroaching on the rest of the tray. The water activity of the dry sections of the tray was 0.15. While the trial produced a safe product, the processing time exceeded 24 hours, prompting further investigation in Stage 3 trials.

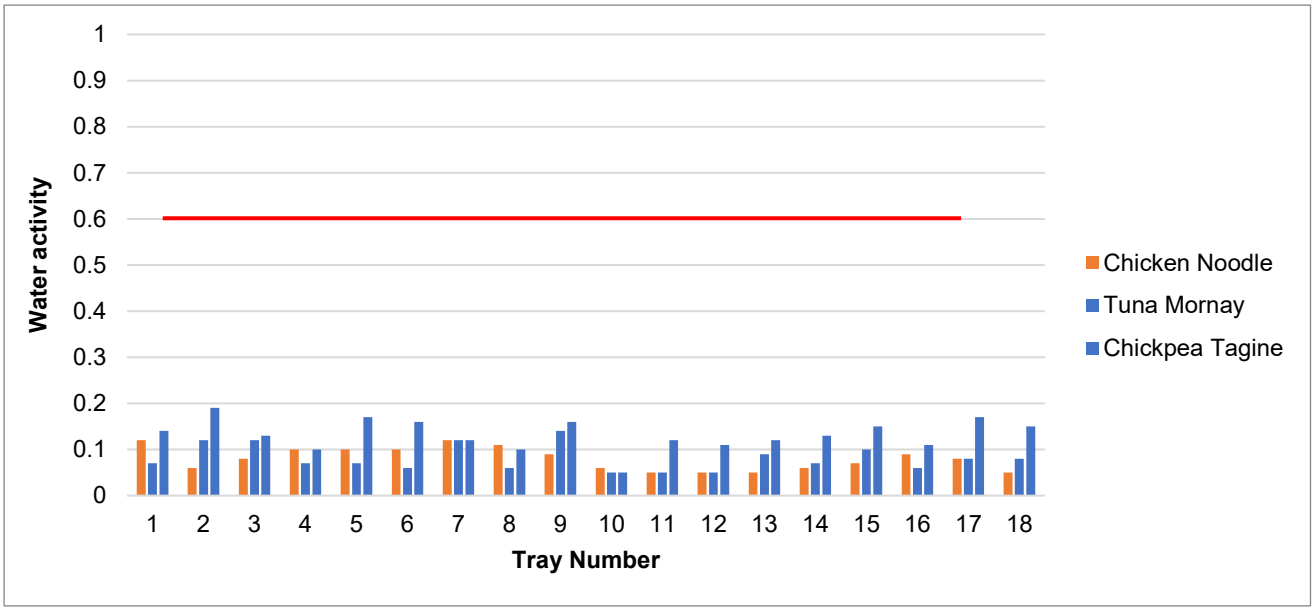

Figure 3 Stage 2 – water activity (Aw) achieved following freeze-drying.

The red line at 0.6 Aw represents the microbiological safety threshold, below which microbial growth is inhibited.

Stage 3 trials

During Stage 3 freeze-drying trials (11–12 November 2024), batches of Savoury Chicken with Vegetables and Rice (batch 041124a–041124b) and Beef Bolognese with Pasta (batch 041124a–041124b) were freeze-dried at a maximum temperature of either 50 °C or 60 °C. The trials assessed the impact of temperature on flavour and drying times.

Although the goal was to complete drying within 24 hours, this was not achieved. Despite setting the maximum temperature at 60 °C, temperature probe readings showed that the product temperature never exceeded 50 °C. Instead, a prolonged ‘flat’ period of 9 to 18 hours occurred, during which the product temperature remained relatively stable below 50 °C.

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No notable difference in water activity were observed with the two temperatures, which ranged from 0.10–0.23. Additionally, sensory evaluation detected no flavour taints. Based on these findings, a maximum temperature of 60 °C was selected for further processing in Stage 4 trials.

Stage 4 trials

Stage 4 freeze-drying trials (30 Dec 2024 to 4 Jan 2025) aimed to reduce the drying time to under 24 hours by applying higher temperature settings.. Overall, the process worked well, with most batches drying in approximately 23 hours. However, operational issues, such as uneven slab thickness and insufficient hard freezing before loading, caused minor problems.

During Stage 4 trials, approximately 84 kg of each of the five meals was processed. The team analysed each tray in every trial for water activity and moisture loss. The parameters and results of the Stage 2–5 trials are included in Table 5.

Table 5 Freeze-dried validation trial results

Stage	Meal type	Batch	FD parameters ° C/hours	Aw	Standard deviation Aw
2	Tuna Mornay	1208224	50 /25	0.08	0.03
2	Chickpea Tagine	250924	50 /25	0.13	0.03
2	Asian Chicken with Noodle – thin	120924a	50 /25	0.08	0.03
3	Beef Bolognese with Pasta	041124a	50 /25	0.18	0.04
3	Beef Bolognese with Pasta	041124b	60/23	0.23	0.04
3	Savoury Chicken with Vegetables and Rice	041124a	50/23	0.11	0.03
3	Savoury Chicken with Vegetables and Rice	041124b	60/23	0.15	0.04
4	Beef Bolognese with Pasta	4122024	60/23	0.18	0.08
4	Savoury Chicken with Vegetables and Rice	061224/091224	60/23	0.09	0.02
4	Tuna Mornay	051224	60/23	0.07	0.03

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4	Chickpea Tagine	051224	60/23	0.14	0.03
4	Asian Chicken Noodle	061224	60/23	0.23	0.15

5.1.3 Freeze-dried meals development summary

The critical control points (CCPs) identified for the process include:

- Formulation and preparation of the product according to the defined procedure (including maximum piece size).
- Controlling the fill weight and freezing on freezer trays and ensuring the slabs are flat when placed in the carton.
- Maintaining temperature control during storage and transportation to the contract manufacturer.
- Ensuring that the product is thoroughly dried, with no cold spots remaining after the freeze-drying process.
- Ensuring freeze-dried pouches are securely sealed to prevent air from entering and compromising the product's quality throughout its shelf life.

Optimisation of the formulations and processes ensured the predefined nutritional criteria were met, apart from the Chickpea Tagine. The theoretical nutritional profiles of the meals were validated with product analysis (Appendix B6). The rehydration process was validated by adding 300 mL of boiling water, mixing and allowing to stand for 15 minutes.

FareShare collaborated with external agencies to design the pack, label and rehydration instructions. QDPI provided draft labelling information, in accordance with Food Standards Australia New Zealand (FZANZ) Food Standards Code requirements and the approved product formulas.

5.1.4 Shelf-life validation of trial freeze-dried meals

Stage 4 trial samples were retained for shelf-life assessment. Over the shelf-life period, the water activity in all retention samples remained below 0.60, thus preventing the growth of foodborne pathogens. Microbiological assessments were conducted by a commercial laboratory (BVAQ, Brisbane), with the Standard Plate Count (SPC), mesophilic aerobic spore count and selected pathogens tested at both the beginning and end of the shelf life. SPC and mesophilic aerobic spores were also tested monthly to monitor microbial growth conditions. All results were within acceptable limits according to the Compendium of Microbiological Criteria for Food (FSANZ, 2022).

All five meals met the defined quality and safety requirements at six months when stored at ambient temperature. Further details on the shelf-life assessment are included in Appendix B5, with the full assessment report provided in the supplementary appendices.

5.1.5 Freeze-dried product packing trials

Packaging was conducted in FareShare's temperature-controlled room to maintain low humidity levels. To ensure uniformity and consistency, the bulk freeze-dried product was stirred before portioning 100 g into each pouch. To prevent atmospheric moisture absorption, only small quantities of product (2 kg) were opened at a time. Images 2 and 3 show the multigas detector readings with

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and without nitrogen flushing. The oxygen level dropped from 20.8% (without nitrogen flush) to 3.6% (with nitrogen flush), confirming the effectiveness of the nitrogen flush in expelling oxygen.

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Image 2 Mulitgas reading without nitrogen flush

Image 3 Multigas reading with nitrogen flush

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5.2 Retort meal results

5.2.1 Define the retort meal parameters

The product development brief defined key parameters for the retort meals. It outlined the common attributes for all five meals, specifying both desirable and undesirable elements as outlined in Table 6.

Table 6 Retort meals product development brief

Product Description	Five 'homestyle' retort, complete meals. Meals will be a homogeneous consistency with rice, pasta or potato chunks. Two separate phases of food (e.g., layer of mashed potato) is not feasible. Five finalised retort meal concepts: 1. Beef Bolognese with Pasta 2. Spiced Chicken with Vegetable and Rice 3. Chilli Con Carne 4. Beef Stroganoff 5. Chickpea Tagine
Desirable sensory attributes	The final product will maintain comparable sensory attributes (aroma, flavour, texture and appearance) to current frozen FareShare meals when ready to eat. After heating, the meal will present as a 'homestyle', true to product descriptor, including warmth and variety of colour with identifiable ingredients. Consider acceptability if eaten at room temperature. Required product attributes when heated: • Vibrant colour; • Multitextured and depth of flavour; • Variety of visible vegetables; • Appealing aroma true to product descriptor; • Good meat texture, not mushy requires some mastication; • Medium heat/spice to suit target consumers; and • Good balance of visible protein, vegetables, carbohydrates and sauce.

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	Negative attributes to be avoided: • Fatty mouthfeel; • Dry/ bland meat; • Phase separation; and • Raw spices.
Desired end use	Ready to heat and consume. Aim for all meals in the range to have consistent preparation parameters (time, temperature, cooking instructions) for consistent heat for all ingredients.

Desired product claims	Meals must be formulated robustly to allow flexibility of ingredients depending on FareShare donations and seasonality/availability.
	
	• Nutrition criteria (values per 400 g meal):
	  ○ Protein 20–30 g
	  ○ Vegetables > 2 serves (2 x 75 g)
	  ○ Sugar < 15 g
	  ○ Sodium < 800 mg
	  ○ Saturated fat < 5 g
	• Additives: natural colour and modified starch/stabilisers acceptable when needed.
	• Allergen status: no restriction.
	• Include at least one vegetarian option (Chickpea Tagine).

Product format	Shelf-stable meals. Ready to heat.
Microbiological considerations	Absence of pathogens over shelf life prior to reheat. The presence of thermophiles will not cause food spoilage when stored at elevated temperature.
Packaging	Primary packaging must be stand-up foil pouches with a 5 cm gusset and a single-seal opening, designed for retort processing and reheating in-pack. Each pouch should contain a 400 g single serving.
Required shelf life	6 months at ambient storage, consume upon opening.
Target market	Remote communities and regions affected by natural disasters.

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5.2.2 Retort formulation and process development

Spiced Chicken with Vegetables and Rice

The Spiced Chicken with Vegetables and Rice retort trials focused on optimising the processing parameters and formulations. Appendix B8 outlines the trial details.

Formulation development

Nine formulations of Spiced Chicken with Vegetables and Rice were initially evaluated, with Formulation 9 approved as the final version. Two chicken formats (5 cm and 10 cm sliced chicken breast) were tested. The 5 cm slices distributed more evenly throughout the meal, enhancing the visual appeal of the final product. Various ratios of spices were assessed in the meal.

The use of either sweet potato and carrot was found to be interchangeable, as both displayed comparable heating characteristics through retorting and resulted in a product with similar organoleptic properties. Since sweet potato/carrot and potato maintained a firmer texture than other vegetables post-retort, they were added in higher quantities. Zucchini added a contrasting dull green colour to the meal's overall yellow and orange hues. Purity W® starch was added to thicken the sauce, ensuring even distribution of ingredients within the sauce and final product.

The format, cooking method and addition rate of rice impacted the final product texture and quality after retort processing. Among long-grain, jasmine and basmati rice, basmati provided the firmest texture. Trials comparing raw, par-cooked and fully cooked rice mixed with sauce indicated that fully cooked long-grain rice offered the best structural integrity post-retort.

Pre-washing the rice effectively removed surface starch and enhanced its integrity after retorting, while coating par-cooked rice with 2% vegetable oil created a protective layer that mitigated overhydration.

Retort program development

Six retort programs were evaluated, with program 6 selected as the final program,. Additionally, a top band seal was applied to the pouch after vacuum sealing to prevent leakage and food entrapment in the sealing line, which could lead to spoilage. This improved sealing method was applied in subsequent trials.

Beef Bolognese with Pasta

Appendix B9 provides details of the retort trials for the Beef Bolognese with Pasta. These trials focused on optimising the formulation and retort program, including ingredient selections and ratios, cooking methods and refining the processing parameters.

Formulation Development

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Eleven versions of the Beef Bolognese with Pasta formulation were evaluated to optimise product safety and quality. The results indicated that the beef mince needed to contain more than 90% lean meat to ensure the final product met the predetermined saturated fat target. Trials showed that dried mixed herbs provided a more well-rounded, authentic flavour compared to fresh rosemary. Furthermore, the addition of Purity W® starch effectively thickened the base and ensured even ingredient distribution during packing.

Onion, tomato puree, zucchini, carrot and celery were selected as the vegetable components due to their availability, flavour contribution and vibrant colour. The ratio and size of each vegetable was systematically adjusted to achieve the desired organoleptic results. Trials on the pasta shape (macaroni and large spiral) and preparation (raw, oil-coated; raw, par-cooked and fully cooked) demonstrated that raw, large spiral pasta coated with 1% vegetable oil provided the best texture, remaining firm after retort processing. Several sauce-to-pasta ratios were trialed.. Nutritional analysis of the final Beef Bolognese with Pasta formulation indicated a sodium content of 884 mg per 400 g, which slightly exceeded the target of 800 mg per 400 g. However, considering the favourable organoleptic properties of the meal and the result falling within the acceptable error range of nutrient testing, no modifications were made to the formulation. This result may also be due to slight variations in the raw materials, batch and consistency of the sample analysed. It should be noted that the theoretical sodium content of the formulation is below the target of 800 mg per 400 g.

Retort program development

Seven retort programs were trialled before the final program (Program 7) was established

Chilli Con Carne

Appendix B10 details the Chilli Con Carne retort trials to optimise the ingredient selection and ratios, cooking methods and processing parameters.

Formulation development

Four Chilli Con Carne formulations were evaluated, with Formulation 4 approved as the final version due to its superior overall quality. Theoretical nutritional analysis showed that mince with at least 90% lean beef was required to meet the predetermined saturated fat target in the final product. Onion, tomato puree, carrot and sweet potato were selected as the vegetable components to create a balanced flavour profile, variety of inclusions and favourable visual presentation. Small carrot dices (1–2 cm) were preferred for their even distribution and visual appeal.

Both red beans and red kidney beans were assessed in the meal, with red kidney beans performing better due to their larger size and lighter colour, which helped maintain the meal's appearance after retort. The beans were fully hydrated using either the soaking method (stored in water in the chiller overnight, minimum 16 hours) or by par-cooking for 13 minutes in boiling water. Both methods produced fully hydrated beans with the same texture post-retort and had no impact on the F_0 value when using the same retort program. However, the soaking method is preferred by FareShare for its easier management. The optimal bean-to-sauce ratio was 17% fully hydrated red kidney beans to 83% sauce, providing the desired balance of beans and sauce in the final product.

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Retort program development

Two retort programs were evaluated, with program 2 selected as the final program, achieving a minimum F_0 value of 9.9 minutes, calibrated using Gillespy's method. The F_0 values remained consistent across all trials. Adjustments from Program 1 to Program 2 shortened the cooling period, improving overall program efficiency.

Chickpea Tagine

Appendix B11 details the Chickpea Tagine retort trials to optimise the ingredient selection and ratios, cooking methods and processing parameters.

Formulation development

Five formulations of Chickpea Tagine were evaluated. Achieving the target protein content defined in the product development brief required a substantial portion of beans, which negatively impacted the meal quality. For this meal, it was decided to prioritise quality over nutritional targets, with Formulation 5 approved as the final formulation due to its favourable organoleptic properties.

The vegetable combination for the final meal included onion, carrot, sweet potato, mushroom, broccoli stem, tomato purée and green peas. This blend provided a balanced sweet and sour flavour, helped mask bitterness from the spices and contributed vibrant colour to the final meal. Vegetables were cut into 1–2 cm pieces to ensure even distribution throughout the meal. Various spice proportions were trialed to provide an authentic, flavourful product without undesirable bitterness.

Various ratios of chickpeas and faba beans were also evaluated. Faba beans contributed a deep brown colour and large, unappealing pieces. In contrast, chickpeas maintained their texture and structure after retorting, providing a light yellowish colour and smaller pieces that enhanced the meal's appeal. Consequently, 23.39% of soaked chickpeas were incorporated into the final product. Two methods of preparing the beans were compared: soaking in the fridge overnight for a minimum of 16 hours, or the same soaking process, followed by boiling for 5 minutes. Both methods resulted in similar finished product textures and F_0 values, therefore the soaking method without the additional boiling for 5 minutes was chosen for its operational simplicity.

Retort program development

Three retort programs were evaluated, with Program 3 selected as the final program, achieving a minimum F_0 value of 13.0 minutes, calibrated using Gillespy's method.

After blast chilling, the sauce became thin and settled at the bottom of the tray, potentially causing inconsistencies between pouches due to inadequate mixing during packing. The heating process slowed in pouches with less liquid, resulting in a lower F_0 value. The retort program-maintained safety even under extreme conditions, such as when less liquid was incorporated into the pouch. To prevent inconsistencies in product composition, an additional step to ensure uniform meal blending was added to the instructions in the technical manual.

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Beef Stroganoff

Appendix B12 details the various formulations and processes trialed to develop retorted Beef Stroganoff.

Formulation development

Four formulations of Beef Stroganoff were developed, with Formulation 4 selected as the final version for its superior overall quality. Trimmed bolar blade beef was selected as a low-saturated fat beef option, providing a good texture after the retort process. A combination of onion, mushroom, sweet potato, dill cucumber and green beans added variety, depth of flavour and vibrant colours. Full cream milk created a creamy, opaque sauce without introducing excessive saturated fat compared to cream

Retort program development

Three retort programs were evaluated, with Program 3 selected as the final program, achieving a minimum F_0 value of 12.0 minutes, calibrated using Gillespy's method.

5.2.3 Validation trials for retort meals

Spiced Chicken with Vegetables and Rice

As shown in Figures 4 and 5, the pack that accumulated the lowest F_0 value was pack 6, with a final F_0 of 7.3 minutes. However, it exhibited an unusual heating pattern, starting very slowly and then suddenly increasing toward the end, after cooling had begun. This anomaly may have resulted from product movement within the pouch, potentially influenced by pressure changes during cooling, although this is uncommon. Despite this irregularity, an F_0 value of 7.3 minutes remains conservatively safe for pathogen destruction, but it may allow survival of excessive thermophiles. Excluding this outlier, the next lowest F_0 was 9.3 minutes, which was adjusted to 8.8 minutes after calibrating with Gillespy's method. This result aligned with data from the previous trial.

When comparing the two slowest heating probed packs with normal, unprobed packs, the probed packs appeared visibly drier, suggesting that low moisture content contributed to slower heating. To avoid over-processing the rice, increasing the holding (sterilisation) time further to raise the F_0 value is not recommended. Instead, thoroughly mixing the meals before packing ensures the ideal F_0 value is achieved. The defined retort program is shown in Table 7.

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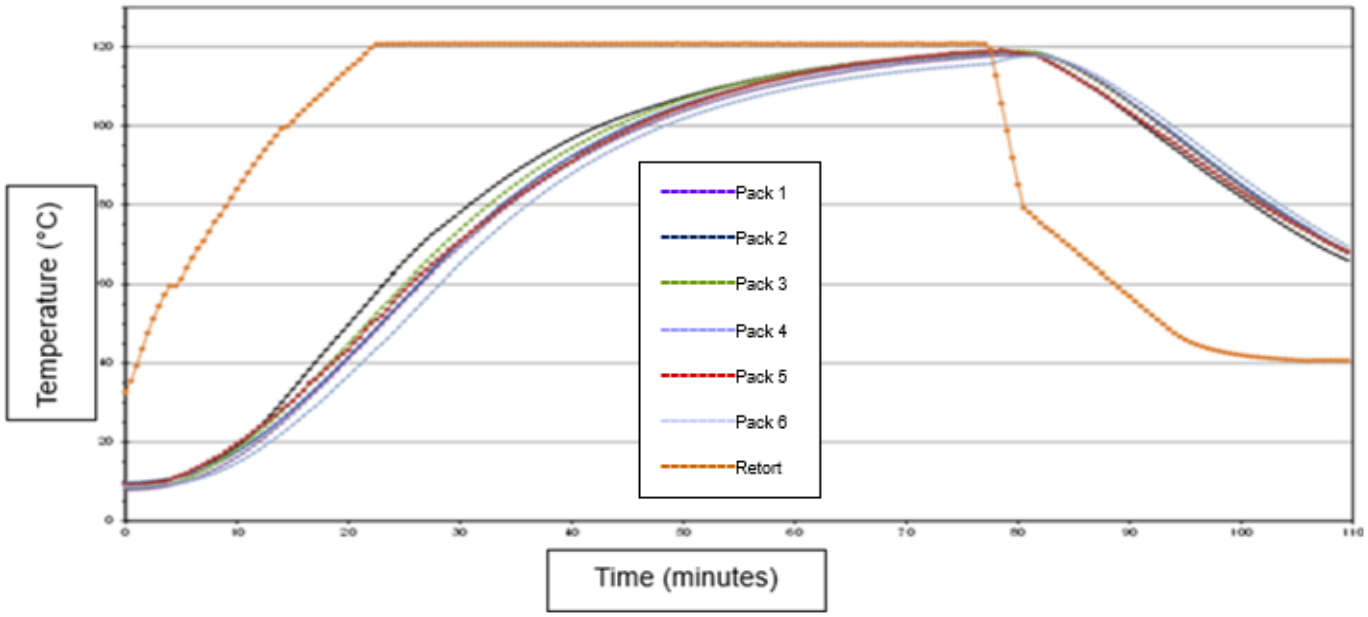

Figure 4 Spiced Chicken with Vegetables and Rice retort temperature profile during the validation trial

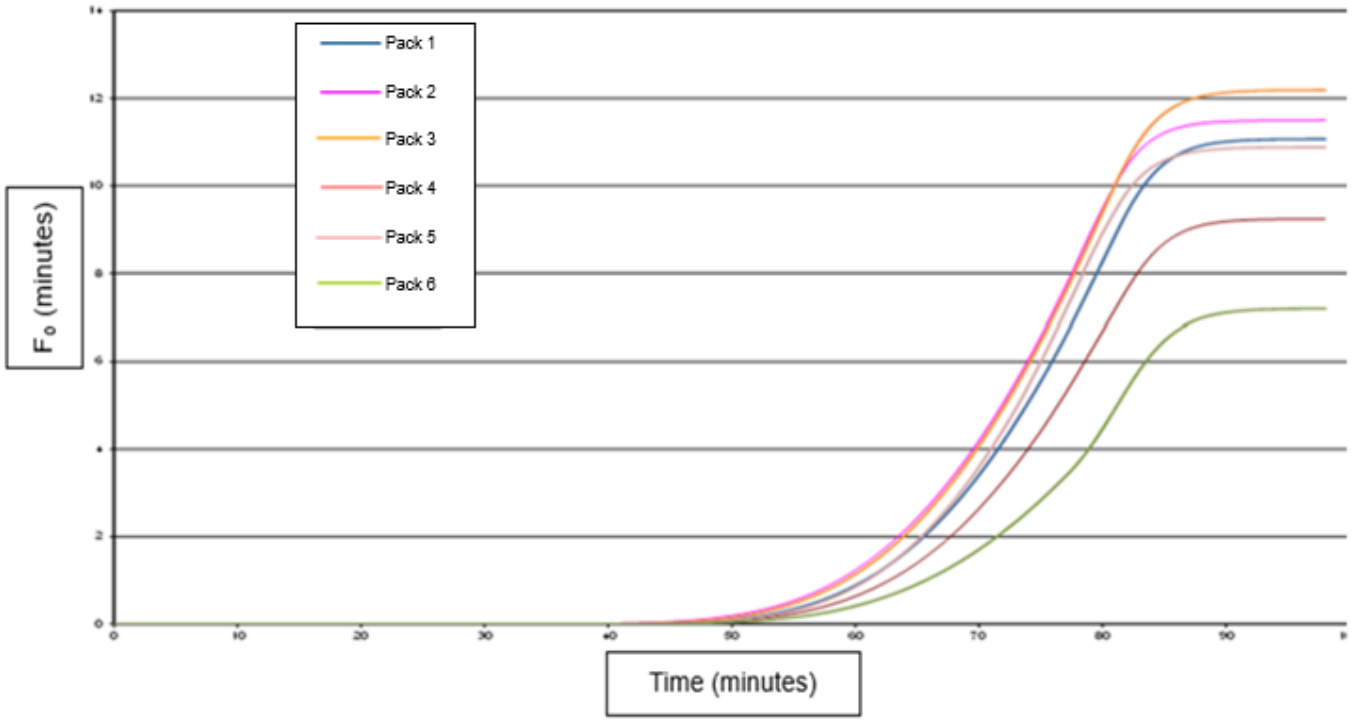

Figure 5 Spiced Chicken with Vegetables and Rice accumulated F_0 values during the validation trial

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Table 7 Defined Spiced Chicken with Vegetables and Rice retort process

Step	Temperature (°C)	Pressure (bar)	Time (minutes)
1	60	0.4	3
2	100	1.2	9
3	121	2.0	8
4	121	2.2	55
5	80	2.0	3
6	45	0.6	15
7	Forced cooling	0.2	20

Beef Bolognese with Pasta

During the validation trial, F_0 accumulation was slower than in the previous trials due to the drier consistency in the probed pouches. As a result, the holding (sterilisation) time was extended to a target of 55 minutes (54 minutes actual). As shown in Figures 6 and 7, pack 4 had the lowest F_0 accumulation, with a final F_0 of 9.8 minutes. After calibration using Gillespy's method, the minimum F_0 value was adjusted to 9.1 minutes. This indicates that the F_0 will exceed 9 minutes even if the product is not properly mixed during packaging. Organoleptic assessment later confirmed no compromise in meal quality, leading to the approval of an increased process time of 55 minutes. The defined retort process is detailed in Table 8.

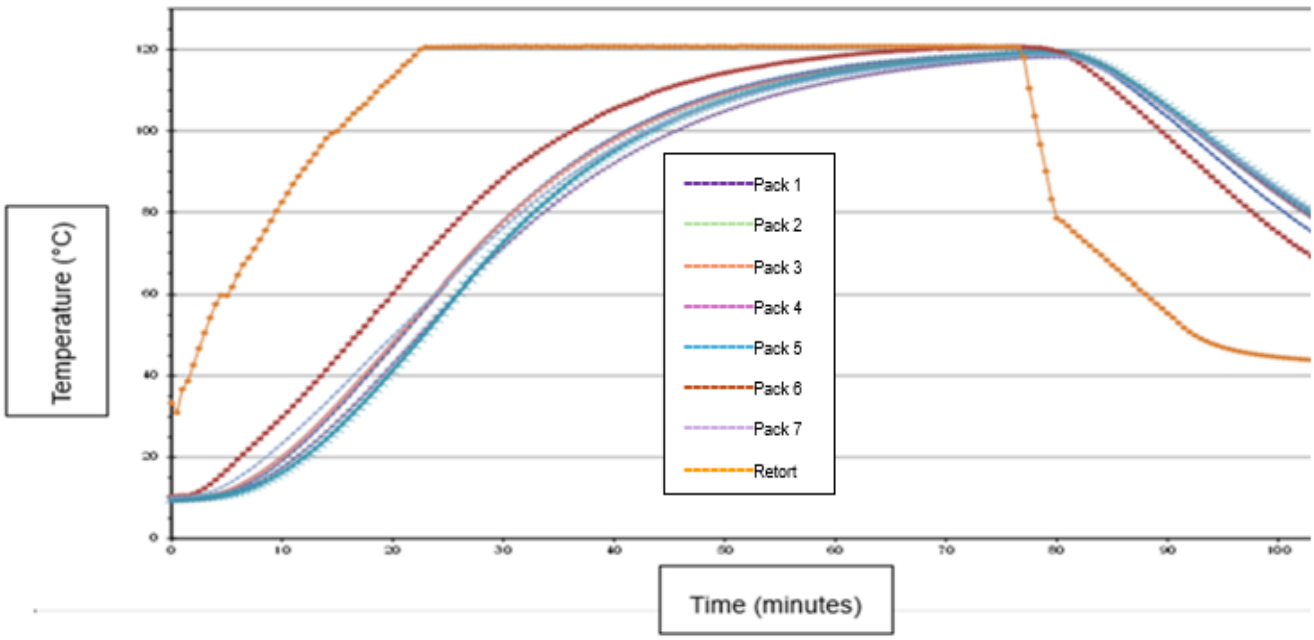

Figure 6 Beef Bolognese and Pasta retort temperature profile during the validation trial

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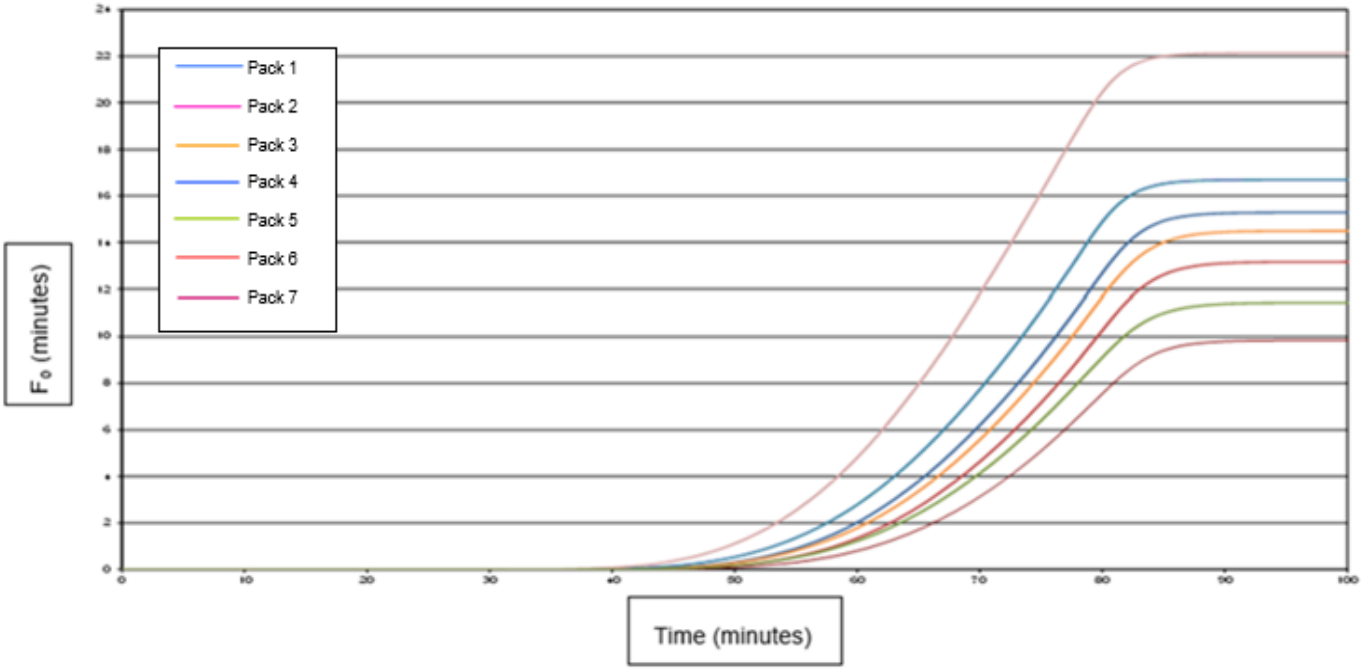

Figure 7 Beef Bolognese and Pasta accumulated F_0 values during validation trial

Table 8 Defined Beef Bolognese and Pasta retort process

Step	Temperature (°C)	Pressure (bar)	Time (minutes)
1	60	0.4	3
2	100	1.2	9
3	121	2.0	8
4	121	2.2	55
5	80	2.0	3
6	45	0.6	15
7	Forced cooling	0.2	20

Chilli Con Carne

As shown in Figures 8 and 9, pack 2 accumulated the lowest F_0, with a final F_0 of 16.5 minutes. After calibrating with Gillespy's method, the minimum F_0 value was adjusted to 12.5 minutes, which was higher than the value observed in the previous trial. The defined retort program is included in Table 9.

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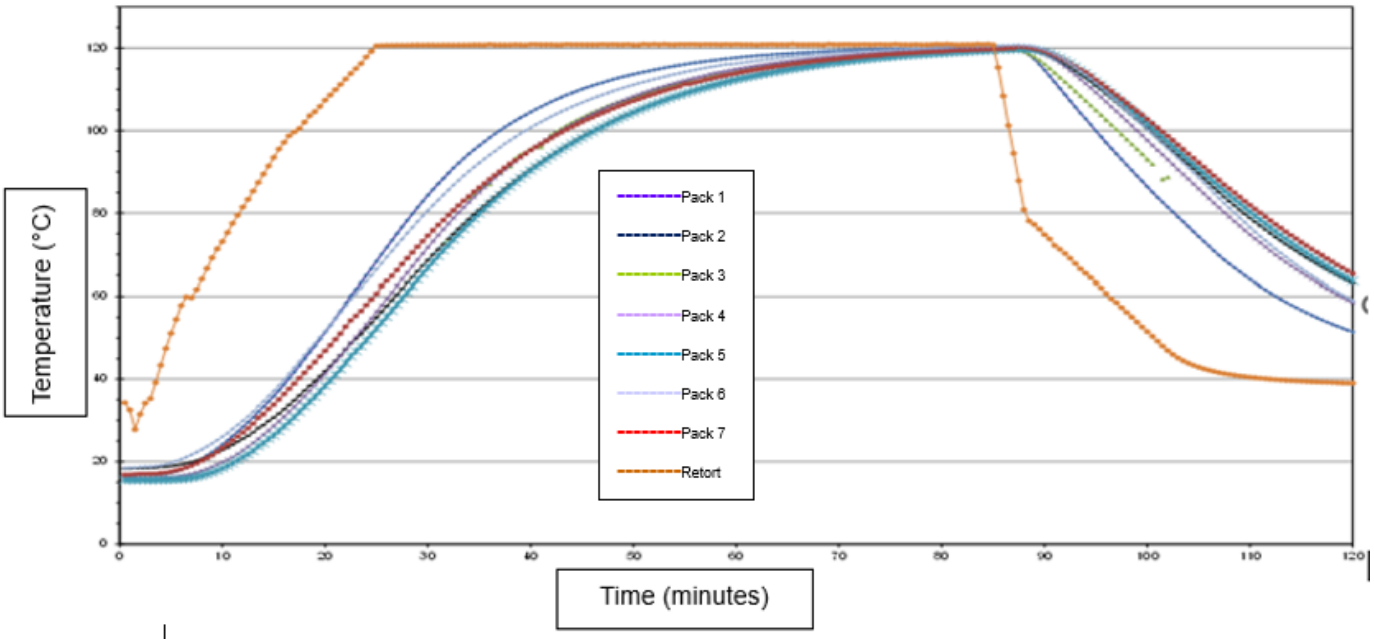

Figure 8 Chilli Con Carne retort temperature profile during the validation trial

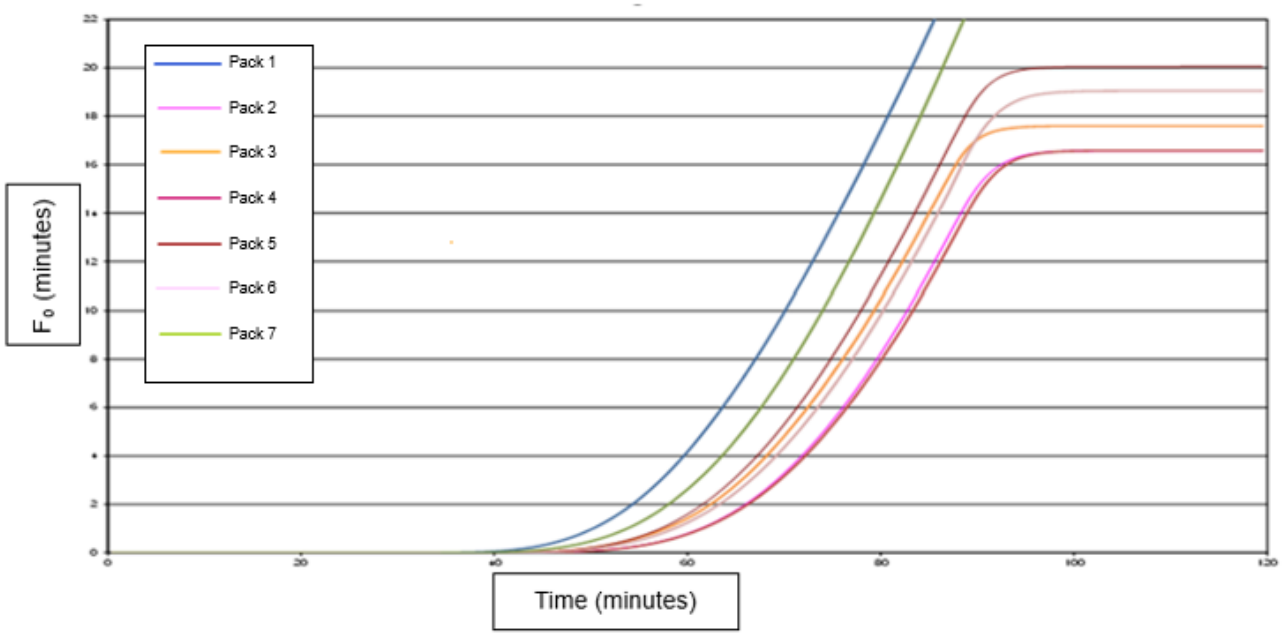

Figure 9 Chilli Con Carne accumulated F_0 values during the validation trial

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Table 9 Defined Chilli Con Carne retort program

Step	Temperature (°C)	Pressure (bar)	Time (minutes)
1	60	0.4	3
2	100	1.2	9
3	121	2.0	8
4	121	2.2	60
5	80	2.0	3
6	45	0.6	15
7	Forced cooling	0.2	20

Note: Some minor changes have been made to the heating and cooling profiles, but critical factors are unchanged.

Chickpea Tagine

Figure 10 shows that the temperature profile data from six packs experienced a delay in starting the logger, with initial data not being recorded. However, this delay did not impact the collection of critical data. As shown in Figure 11, pack 1 accumulated the lowest F_0 value, achieving a final F_0 of 11.3 minutes. After calibrating with Gillespy's method, the minimum F_0 was value adjusted to 8.3 minutes. While this value was slightly lower than that observed in the previous trial, it still represented a conservatively safe level for pathogen elimination. This demonstrates that the defined process remains safe, even under extreme conditions such as poor mixing during packing and low liquid content in the product. The defined retort program is shown in Table 10.

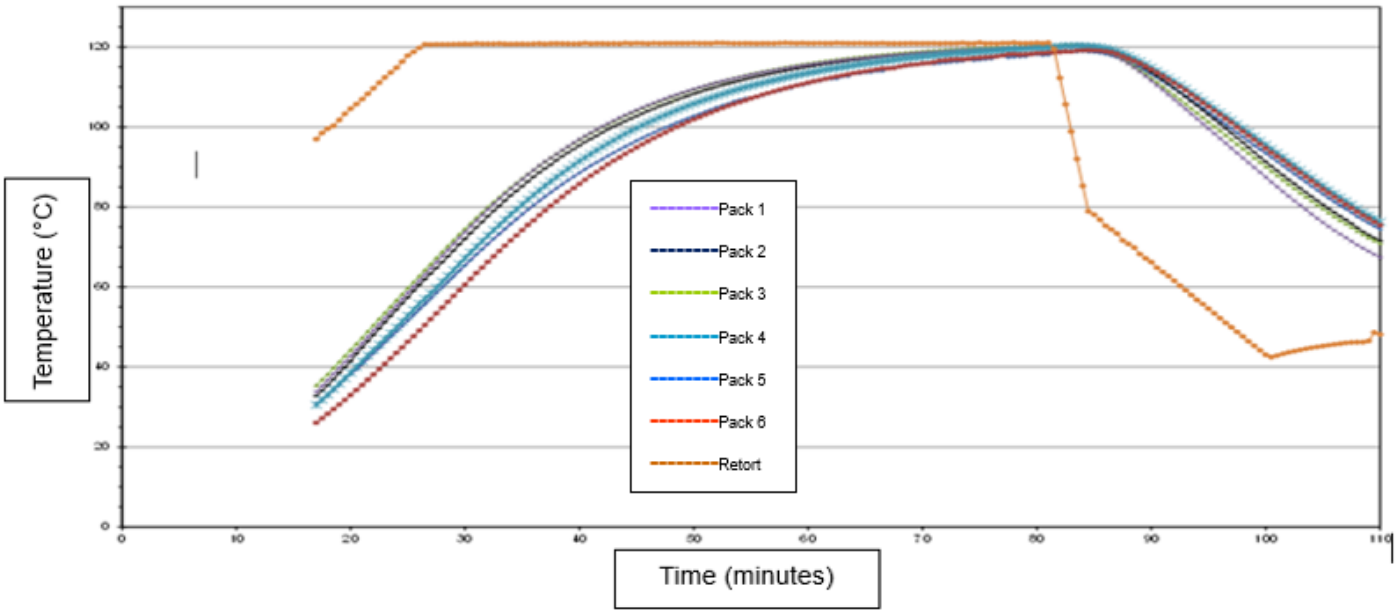

Figure 10 Chickpea Tagine retort temperature profile during the validation trial

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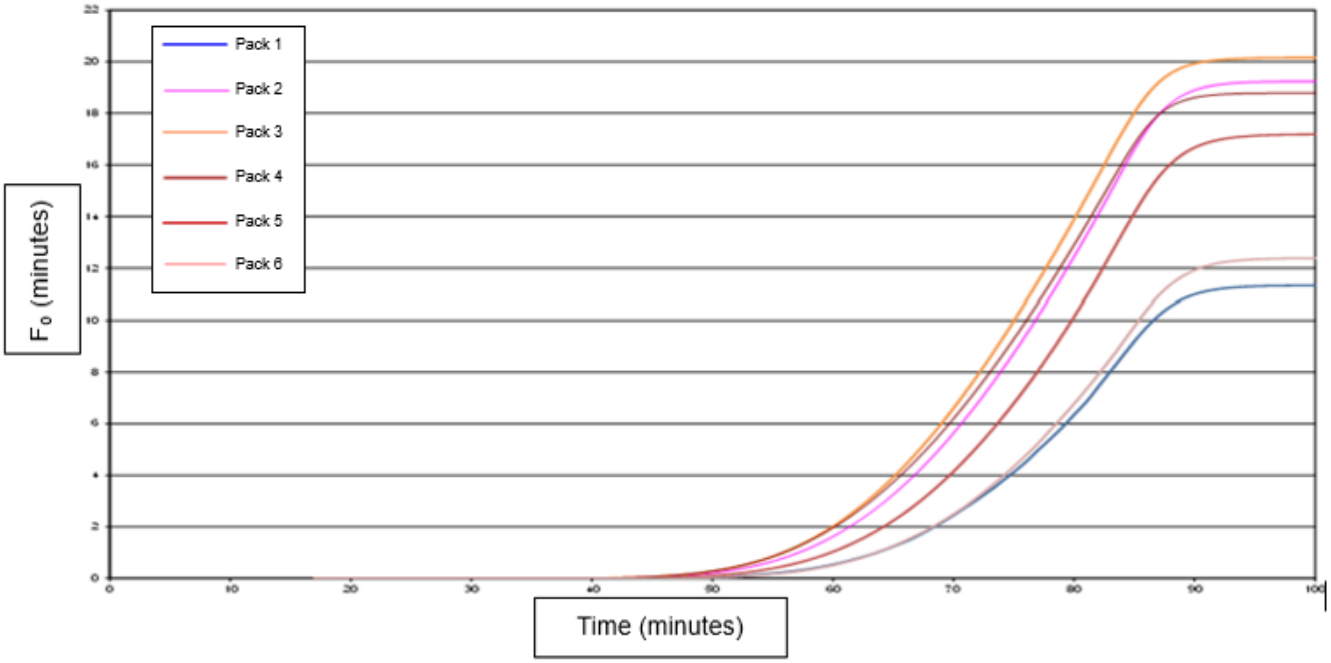

Figure 11 Chickpea Tagine accumulated F_0 values during the validation trial

Table 10 Defined Chickpea Tagine retort program

Step	Temperature (°C)	Pressure (bar)	Time (minutes)
1	60	0.4	3
2	100	1.2	9
3	121	2.0	8
4	121	2.2	55
5	80	2.0	3
6	45	0.6	15
7	Forced cooling	0.2	20

Note: Some minor changes have been made to the heating and cooling profiles, but critical factors are unchanged.

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Beef Stroganoff

Figures 12 and 13 show that pack 2 accumulated the lowest F_0 value, with a final F_0 of 12.0 minutes. After calibrating with Gillespy's method, the minimum F_0 value was adjusted to 9.2 minutes. While this value was slightly lower than that observed in the previous trial, it still represented a conservatively safe level for pathogen elimination. This demonstrates that the defined process remains safe, even under extreme conditions such as poor mixing during packing and low liquid content in the product. The defined retort program appears in Table 11.

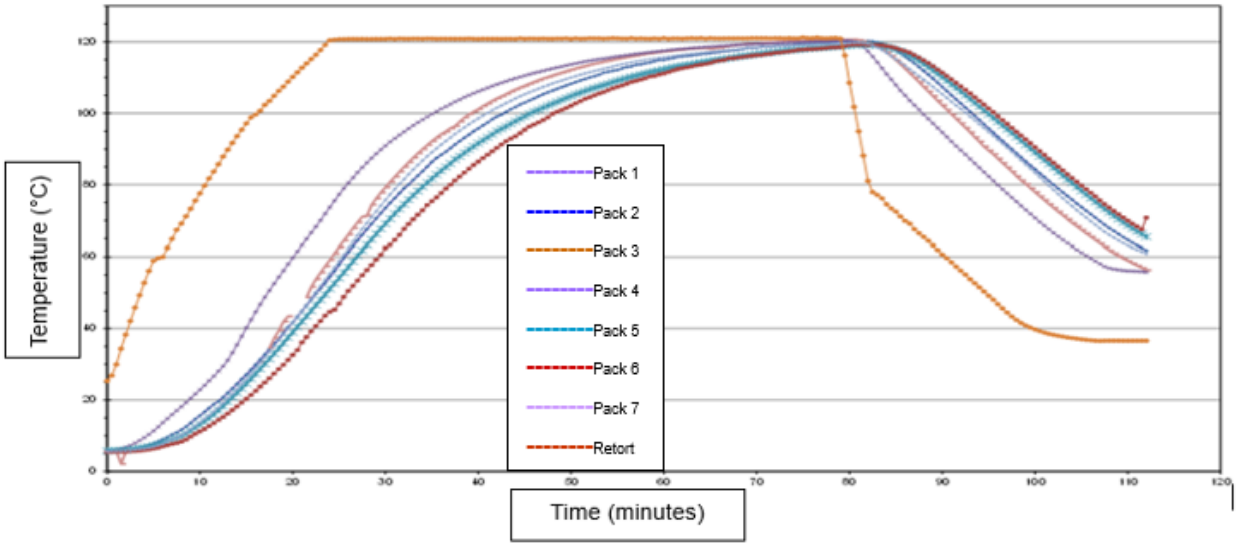

Figure 12 Beef Stroganoff retort temperature profile during the validation trial

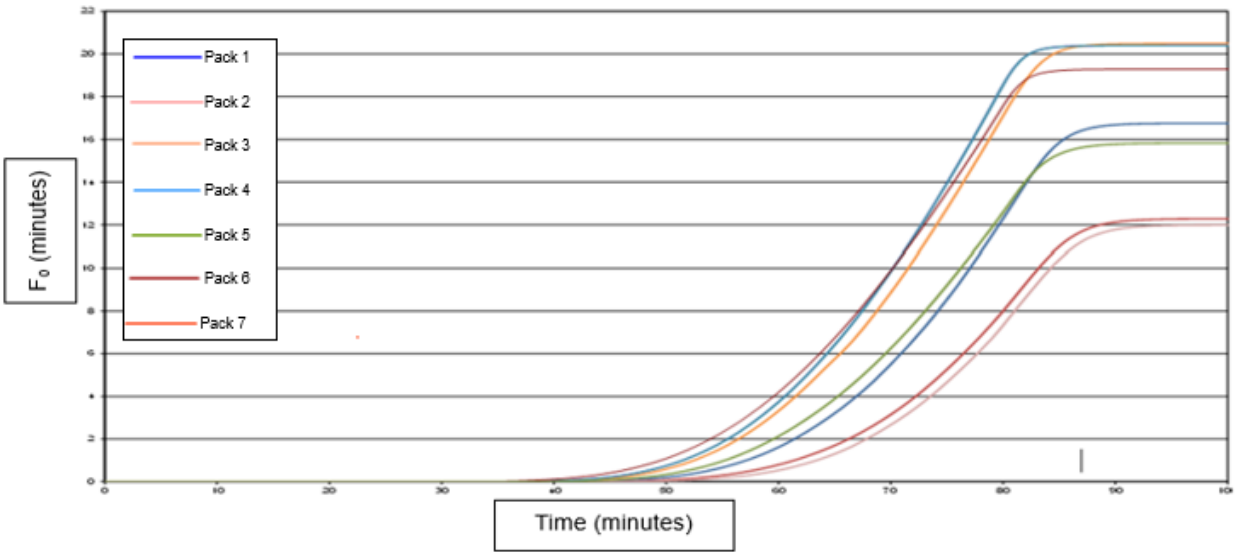

Figure 13 Beef Stroganoff accumulated F_0 values during the validation trial

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Table 11 Defined Beef Stroganoff retort program

Step	Temperature (°C)	Pressure (bar)	Time (minutes)
1	60	0.4	3
2	100	1.2	9
3	121	2.0	8
4	121	2.2	55
5	80	2.0	3
6	45	0.6	15
7	Forced cooling	0.2	20

5.2.4 Retort meals development summary

The critical control points for the retort process include:

- Formulation and preparation of the product according to the defined procedure (including maximum piece size).
- Controlling the maximum fill weight for each pouch and ensuring a secure seal is applied to all pouches.
- Loading retort trays in accordance with the approved pattern. Ensuring the product's temperature is not below the minimum Initial Temperature (IT) at the start of retorting.
- Applying the process according to the approved program, specifically:
    1. The Come-Up-Time (CUT) must meet or exceed the approved minimum.
    2. The hold time at the process temperature must be at least the approved process time.
    3. The process temperature during the hold time must be maintained at or above the approved process temperature.

Optimisation of the formulations and processes ensured the desired nutritional criteria defined in the product development brief were met, except for the Chickpea Tagine. As noted earlier, it was not possible to produce Chickpea Tagine with satisfactory organoleptic properties within the pre-determined nutritional criteria. Appendix B16 details the nutritional profile of the retorted meals. Reheat options include heating the sealed pouch in boiling water for 15 minutes or transferring the contents to a dish and heating in the microwave (1000 watt) for 2 minutes. The products are also safe to eat cold. The final formulations and cook process are provided in Appendix B14. FareShare collaborated with external agencies to design the pack, label and rehydration instructions. QDPI provided draft labelling information, in accordance with Food Standards Australia New Zealand (FZANZ) Food Standards Code requirements and the approved product formulas.

5.2.5 Shelf-life validation for retort meals

A summary of the shelf-life validation results for the retort meals is provided in Appendix B15, while the full report is available in the supplementary appendices. The Standard Plate Count (SPC), mesophilic spore count and selected pathogens were evaluated at both the beginning and end of the shelf life. SPC and mesophilic aerobic spores were also assessed on a monthly basis. The

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results for all five products remained within the acceptable limits in accordance with the Compendium of Microbiological Criteria for Food (FSANZ, 2022).

The organoleptic assessment results for all products are included in Appendix B15. Evaluators assessed the aroma, flavour, colour, texture and appearance of each product. When stored at ambient temperature, product quality remained stable throughout shelf life, with only minor degradation observed, which is typical for long shelf-life foods stored at ambient temperatures. Meat components stored at elevated temperatures (45 °C storage) became drier over shelf life, but the overall quality of all five products remained acceptable under this condition.

5.3 Management of glut products

Appendix B18 outlines the retort freeze-drying trials for the glut products, including refining processing parameters and ingredient ratios.

5.3.1 Freeze-dried process development for glut products

FareShare received a donation of individual quick frozen (IQF) corn kernels, which were processed at the SFD facility. The final product reached a water activity of 0.08 and a moisture content of 0.49%, ensuring stability and an extended shelf life. During rehydration, the corn absorbed water quickly and fully, demonstrating its suitability for integration into meals. These insights can be applied to a variety of glut fruits and vegetables.

5.3.2 Retort formulation and process development for glut products

Three vegetable-based sauce formulations were developed: Tomato-Based Pasta Sauce, Asian-Style Sauce and Curry Sauce. The vegetable piece size, herbs, spices and cooking parameters for each ingredient were based on insights gained from developing the five meals. The sauces were packaged in 3 kg heavy-duty foil bags, air was manually removed and pouches were sealed without vacuum. The retort program followed validated procedures for the meals, with an extended sterilisation phase to ensure sufficient heat transfer to the thermal centre of the 3 kg packs. The holding time at 121 °C and F_0 for each sauce is included in Table 12.

Table 12 Defined glut sauce retort program

Sauce type	Holding time at 121 °C (minutes)	F_0 (minutes)
Tomato and Vegetables Sauce	90	4.9
Asian-Style Sauce and Vegetables	80	11.3
Curry Sauce and Vegetables	94	8.4

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Variations in processing times and F_0 values stemmed from differences in sauce thickness. The thicker consistency of the tomato sauce led to a lower F_0, despite the 90-minute hold at 121 °C. Since large pack sizes restricted water flow through the trays, measurements were taken from the bottom of the pack, yielding more conservative readings than if measured from the top. Despite the long process times, sauce quality remained acceptable. While a framework for retorted, glut sauces has been established, the formulations, processes and pack sizes require optimisation. Insights from the trials will be applicable to a variety of glut products.

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5.4 Culturally appropriate sensory training

The insights gained from attending the focus groups shown in Table 13.

Table 13 Focus group details and insights

Location	Staff in attendance	Session details	Insights
Burringilly	Philippa Lyons (QDPI) Trish Lindeman (QDPI) Jason Mollenhauer (FareShare) Fiona Maxwell (FareShare)	Jason led the focus group. He began by introducing the concept to the participants, providing pre-prepared and prepared products as examples. During the session, Jason prompted discussion with questions, encouraging people to express their thoughts and opinions.	• The retort Beef Bolognese and Pasta and the freeze-dried Chicken Curry (the original name given to the Savoury Chicken with Vegetables and Rice) meals were well received with positive comments about the taste and appearance. • The naming convention of the chicken meal was discussed at length; the consensus was that the flavour and appearance did not match the descriptor. Chicken and Vegetable with Savoury Rice was one of the suggested names. • The comments highlighted the need to ensure the product name matches the meal flavour. This learning was incorporated into the consumer and sensory analysis.
Cherbourg	Trish Lindeman (QDPI) Philippa Lyons (QDPI) Kerridyn Hooker (QDPI) Jason Mollenhauer (FareShare) Ev Mollenhauer (FareShare)	There were two tasting sessions, the first at the Mayors' chambers with council staff and the second at the community centre with family groups. Freeze-dried strawberry was used as an ice breaker. The use of laminated pictures that described the products and the reheating instructions helped to set the scene. Jason led the groups, prompting participants to express their thoughts and opinions.	• The council staff were pleased with the product concept, envisaging several opportunities to support the community. They also praised the products' flavours and textures, especially the retort Beef Bolognese and Pasta. Capturing individual feedback in this session was difficult due to the short time frame. • There were limited participants at the community centre, those who did attend expressed a preference for the Beef Bolognese. They explained that they do not eat much tinned tuna in their community and the flavour profile was not something they enjoyed.

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Table 13 Focus group details and insights continued

Location	Staff in attendance	Session details	Insights
Hymba Yumba	Philippa Lyons (QDPI) Jason Mollenhauer (FareShare) Fiona Maxwell (FareShare)	Supported by schoolteachers, Fiona and Jason introduced the products to the students, sharing freeze-dried fruit as an icebreaker. Students were asked to taste the products and use the printed smiley-face scale to indicate their liking. Students were then asked what they would score the products out of 10, and if they had a preference. When the students had finished their tasting, community Elders were also invited to participate.	• The students all engaged with the exercise. Feedback from all eight students was overwhelmingly positive, more so than any other focus group completed. All flavours and textures were accepted by the students, with requests for second and third servings. • It was difficult for Jason and Fiona to capture all feedback provided by the students as students spoke over one another, all excited by the opportunity. • The Elders also commended on the products, praising their flavour and potential versatility for use in school and at home for many families.

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5.5 Creation of the technical manual

FoodStream, QDPI and FareShare collaborated to refine and update the technical manual. The draft manual was used for the initial training of the FareShare team. Revisions were made to ensure the manual was practical, easy to follow and included all the necessary information for ongoing meal production. The complete technical manual is included in a supplementary appendix.

5.6 Training of FareShare staff

FareShare held an eight-hour training session on 23 January 2025 at their Morningside facility. The course was attended by six chefs and covered the complete process for producing retort meals and the preparation of freeze-dried meals for the contract manufacturer. Gordon Young and Chris Bourne led the training, providing an overview of the processes, with a strong emphasis on critical control points and the importance of maintaining quality and safety during each production stage. The group was introduced to the process and operation of the retort. Two FareShare chefs later attended retort supervisors training, provided by FoodStream.

5.7 Incorporation of new products and process into FareShare's existing HACCP plan

The team integrated the new processes for freeze-drying and retort into FareShare's existing HACCP plan. The original plan covered the critical control points for cooking, chilling and managing raw materials. The updated plan added new critical control points for the retort process and for handling and storing products sent to the contract manufacturer for freeze-drying.

5.8 Consumer and sensory assessment of final products

Full details of the consumer and sensory assessment are available in Appendix B21. A summary and highlights are detailed below.

5.8.1 Freeze-dried

Consumer demographics, purchase and consumption habits

Forty-two consumers took part in the freeze-dried product tasting. Table 14 summarises consumer demographics, purchase and consumption habits.

Chilled and frozen meals are the most consumed ready-to-eat meals (RTEM), which are purchased primarily from supermarkets. This cohort are unfamiliar with freeze-dried meals, with only one quarter of consumers having previously purchased a freeze-died meal.

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Those that rarely or never purchase RTEM (43%) said that they prefer to cook fresh food and eat lots of fresh vegetables. In addition, the cost of RTEM was also a prohibiting factor.

Consumers who had previously purchased freeze-dried meals felt that they are convenient for outdoor activities such as camping and hiking. Many consumers find freeze-dried meals expensive relative to their size or value and some report strong or imbalanced flavours (e.g. too salty or sour). Limited availability in some grocery stores was cited as a prohibitive factor in the purchase of freeze-dried meals.

Key reasons that consumers had not previously purchased a freeze-dried meal included lack of need or interest, preference for fresh food, limited awareness or availability, lack of appeal, cost and uncertainty about what the meals would be like. Many consumers felt that freeze-dried meals are suited to specific outdoor activities such as camping and they would not use them on other occasions.

Table 14 Summary of demographics, purchase and consumption habits – freeze-dried

General demographics	Age	26–65 years
	Gender	29% males 71% females
	Ethnicity	55% Australian
	Household status	48% live with a partner 31% two-parent family with children (as parent)
	Care for children	31% regularly care for children
	Household income	76% $100,000–<$200,000 per annum
	Dietary preferences	71% no preferences
	Shopper status	88% main sopper or shared responsibility
	Supermarkets	70% Coles 70% Woolworths 64% Aldi

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RTEM purchase and consumption	Frequency	55% consume RTEM at least monthly
	Type of RTEM	69% chilled 54% frozen
	Purchase point	87% supermarkets 15% online meal delivery service
	Freeze-dried purchase	26% have previously purchased

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Concept liking and emotions

Consumers were shown a video introducing them to the FareShare freeze-dried products. The mean liking score for the freeze-dried product concept provided in the video was 7.83. This score shows that the product concept was well received by consumers. Interested, inspired, empathy, enthusiastic and caring were the top emotions felt when watching the concept video.

Food access

Ten percent of consumers had experienced a time when they were unable to access enough food due to a natural disaster or issues with food access in a remote area. Many consumers stated that they did not make any provisions for such occasions, stating reasons such as feeling 'privileged' or 'lucky' not to have experienced a need. Some individuals indicated that they actively stockpile food, including keeping cupboards, fridges and freezers well-stocked, storing shelf-stable foods such as instant noodles and canned goods.

Consumer evaluation of samples

Figure 14 shows the mean liking scores for the freeze-dried meals. All samples were liked with overall liking scores above 6.1. The Beef Bolognese with Pasta (7.1) and Asian Chicken Noodle (7.0) scored 7 or above on the 9-point hedonic scale indicating highly acceptable sensory quality (Barbosa-Canovas et al (2009)).

When a score less than 5 (neither like nor dislike) was provided, consumers were asked to provide reasons for this. Appendix B21 summarises the comments provided for each of the freeze-dried samples.

A total of 71% of consumers felt that the 400 g portion size for the freeze-dried meals was just-right, whilst 24% felt that the portion size was somewhat too small or much too small (Figure 15).

The majority of consumers felt that the product names were fit for purpose. However, 29% of consumers said that they did not find the name Tuna Mornay suitable for the product. Consumers said that Tuna Mornay makes them expect a creamy sauce which was not evident in this product. Additionally, 24% of consumers felt that the name Asian Chicken Noodle was unsuitable for the Chicken Noodle product. Some consumers commented that Asian Chicken Noodle made them expect the flavour of a cup noodle product or a soup. Alternative name suggestions are provided in Table 15.

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Table 15 Alternative meal name suggestions

Product	Alternative name suggestions
Tuna Mornay	Tuna Bake/Tuna Pasta Tuna Surprise Tuna and Vege Bake Tuna Pasta Bake
Asian Chicken Noodle	Thai Chicken Vermicelli Chicken Vegetable Stir-fry/Stir-fry Chicken Noodle Chicken Vermicelli Asian Style Chicken Noodles Stir-fry Chicken Noodles

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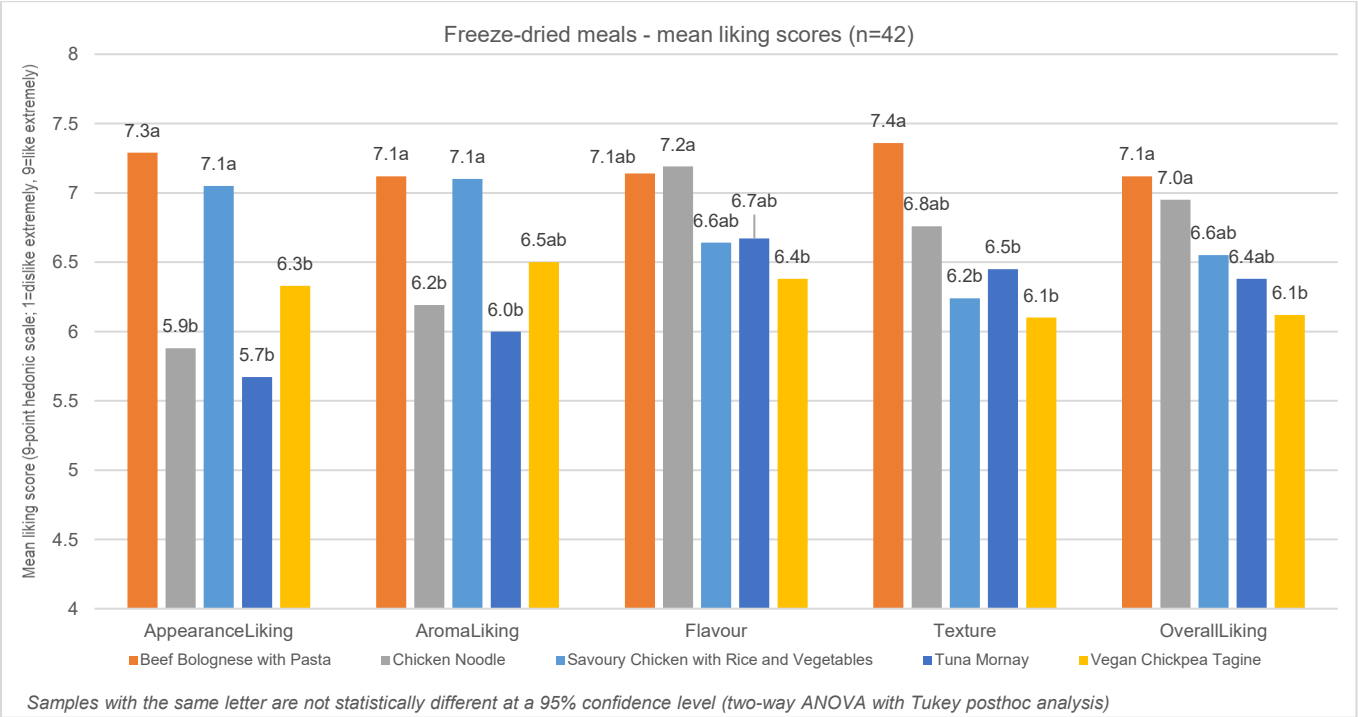

Figure 14 Freeze-dried meals – mean liking scores for appearance, aroma, flavour, texture and overall

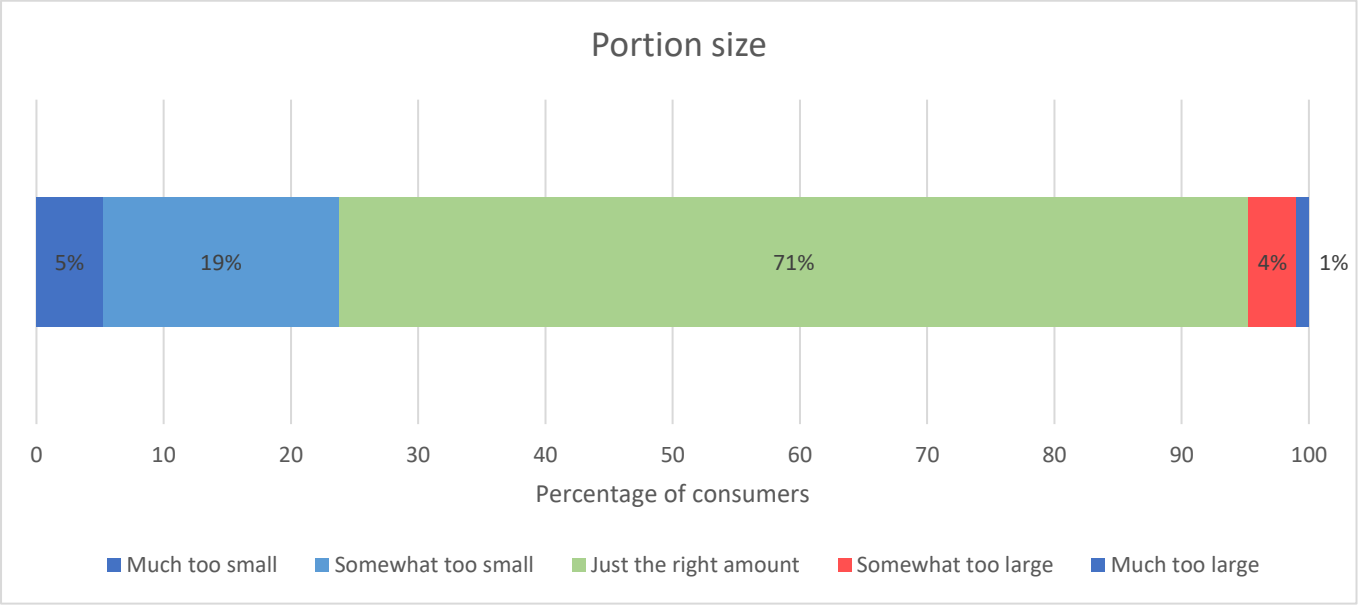

Figure 15 Freeze-dried meals – portion size (400 g)

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Family suitability

More than 80% of consumers felt that all of the freeze-dried products were suitable for the whole family. About a quarter of consumers felt that the Asian Chicken Noodle and Chickpea Tagine were not suitable for the whole family. It was assumed that the Asian Chicken Noodle would be too spicy for young children. Panelists also assumed that the spices, level of vegetables and texture of the Chickpea Tagine would be unsuitable for young children.

Product criteria

The majority of consumers felt that the product criteria was met for all freeze-dried products.

Emotional response

The freeze-dried products generally evoked positive emotions for consumers. Table 16 shows the top emotions selected for each product.

Table 16 Top emotions evoked by retort samples (selected by >25% of consumers)

Product	Criteria for improvement
Savoury Chicken with Vegetables and Rice	Healthy, comforted, satisfied and content
Beef Bolognese with Pasta	Satisfied, content, comforted, happy and healthy
Asian Chicken Noodle	Satisfied, content, comforted and healthy
Chickpea Tagine	Healthy, comforted and content
Tuna Mornay	Satisfied, healthy, comforted and content

Retail opportunity

A total of 64% of consumers would be somewhat or very likely to purchase the freeze-dried products. The majority of consumers who said they would be unlikely to purchase the freeze-dried products said that they prefer cooking fresh food (90%). Freeze-dried products are popular for all usage occasions with camping and outdoor adventures being selected the most. The majority of consumers would like to see these products sold in supermarkets (91%), camping stores (63%) and through online retailers (41%). Only 31% of consumers would like to purchase these products directly from the FareShare website. Almost half (41%) of consumers would pay less than $15 and 41% would pay $15–20 for a 400 g serving freeze-dried meal. The multi-pack with five different flavours (34%) and single serving packs (31%) are popular choices. Discounts or promotions (50%), supporting a charity or cause (50%) and recommendations from friends or family (40%) are the top factors increasing likelihood of purchase.

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5.8.2 Retort

Consumer demographics, purchase and consumption habits

Thirty-four consumers took part in the retort sensory evaluation trial. Table 17 summarises consumer demographics, purchase and consumption habits.

Chilled and frozen meals are most consumed RTEM formats among this cohort. This cohort are familiar with retort meals and provided varied feedback, reflecting both positive and negative sentiments. Many consumers appreciated the convenience, portability and ease of preparation of retort meals. Whilst other consumers mentioned that retort meals are inferior in quality when compared to fresh or frozen alternatives.

Those who do not currently consume RTEM state their reasons being that they prefer to use fresh products and know what ingredients are included in their food to avoid chemicals and preservatives.

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Table 17 Summary of demographics, purchase and consumption habits – retort

General demographics	Age	26–65 years
	Gender	26% males 74% females
	Ethnicity	62% Australian
	Household status	50% two-parent family with children (as parent) 21% live with a partner
	Care for children	44% regularly care for children
	Household income	85% $100,000-<$200,000 per annum
	Dietary preferences	65% no preferences
	Shopper status	88% main shopper or shared responsibility
	Supermarkets	71% Coles 56% Woolworths 50% Aldi
RTEM purchase and consumption	Frequency	64% consume RTEM at least monthly
	Type of RTEM	70% chilled 61% frozen
	Purchase point	94% supermarkets 9% online meal delivery service
	Retort purchase	74% have previously purchased

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Concept liking and emotions

Consumers were shown a video introducing them to the FareShare retort products. The mean liking score for the retort product concept provided in the video was 7.56. This score shows that the product concept was well received by consumers. Interested, caring, inspired, empathy and enthusiastic were the top emotions felt when watching the concept video.

Food access

One fifth of consumers mentioned being in a situation where they have not had access to food due to a natural disaster such as flooding or hurricanes, due to being in a remote location or due to lack of availability during the COVID-19 pandemic because of disruption to supply chains and lock downs. There are varied levels of preparedness for emergencies/disasters within this consumer cohort, from proactive stocking of emergency supplies to a complete lack of provisions. One consumer said that during a flood all they had was 'tinned food and noodles' which they found 'limited and boring'.

Consumer evaluation of samples

Figure 16 shows the mean liking scores for the retort meals. All samples were liked with overall liking scores above 6.5. The Beef Bolognese with Pasta (7.2) and Chilli Con Carne (7.1) scored above 7 on the 9-point hedonic scale. 'A mean liking score of 7 or higher on a nine-point scale is usually indicative of highly acceptable sensory quality; hence, a product achieving this score could be used confidently as a good illustration of 'target' quality' (Barbosa-Canovas et al (2009)).

When a score less than 5 (neither like nor dislike) was provided, consumers were asked to provide reasons for this. Appendix 21 summarises the comments provided for each of the retort samples.

A total of 53% of consumers felt that the portion size for the retort meals was just the right amount, whilst 43% felt that the portion size was somewhat too small or much too small (Figure 17).

The majority of consumers felt that the retort product names were fit for purpose. However, 32% of consumers said that they did not find the name Beef Stroganoff suitable for this meal. Alternative names that were suggested for this product included; Beef Stew, Classic Beef Stew and Beef and Vegetable Stew.

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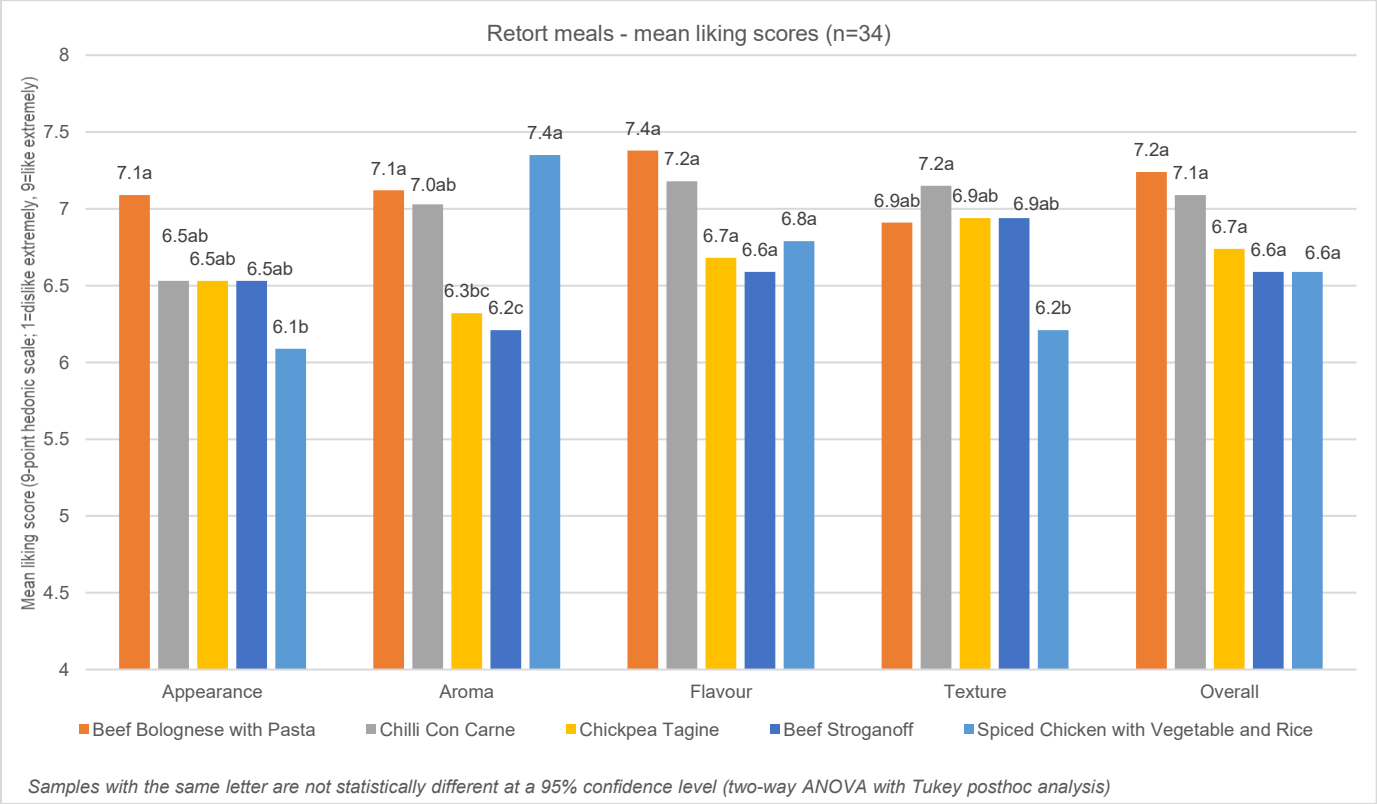

Figure 16 Retort meals – mean liking scores for appearance, aroma, flavour, texture and overall

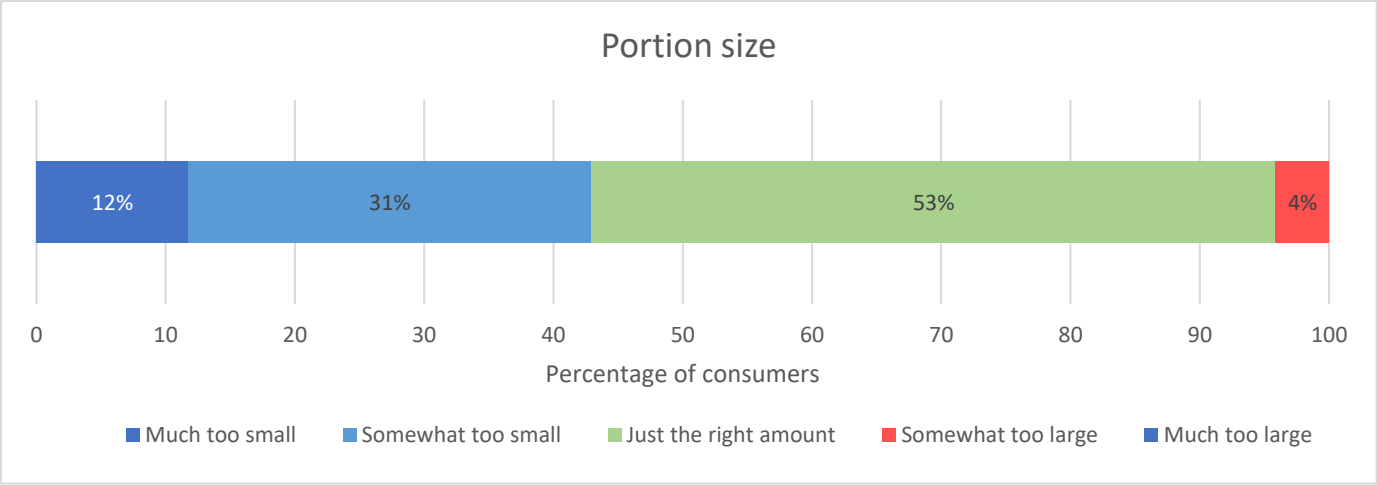

Figure 17 Retort meals – portion size (400 g)

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Family suitability

Beef Bolognese with Pasta and Beef Stroganoff were deemed suitable for the whole family by 97% and 94% of consumers, respectively. Approximately 50% felt that the Chilli Con Carne was not suitable for the whole family due to the spice level and richness of the sauce. About a quarter of consumers felt that the Spiced Chicken with Vegetables and Rice and Chickpea Tagine were not suitable for the whole family. The Spiced Chicken with Vegetables and Rice was thought to be unsuitable for the whole family, due to its spice level and visible vegetables. Texture was cited as a common reason for the Chickpea Tagine being unsuitable for young children as well as dried fruit being something that children may not like.

Product criteria

The majority of consumers felt that the product development criteria was met for all retort products.

Emotional response

The retort products generally evoked positive emotions for consumers. Table 18 shows the top emotions selected for each product, with comforted being selected most.

Table 18 Top emotions evoked by retort samples (selected by >25% of consumers)

Product	Emotions evoked
Spiced Chicken with Vegetables and Rice	Comforted, content, healthy and satisfied
Beef Bolognese with Pasta	Comforted, satisfied and content
Chilli Con Carne	Comforted, content, satisfied and healthy
Chickpea Tagine	Healthy, comforted, content, satisfied and indifferent
Beef Stroganoff	Comforted, healthy, content and satisfied

Retail opportunity

More than 80% of consumers said that they would be somewhat or very likely to purchase the retort products. For those that were unlikely to purchase the product, the main reason was a preference for cooking fresh food. The retort products are popular for all usage occasions with camping and outdoor adventures and backup meals for busy days being selected the most. Consumers would like to see these products sold in supermarkets (97%), convenience stores (57%) and camping stores (47%). Only 20% would purchase the retort products directly from the FareShare website. The majority (77%) of consumers are willing to pay $5-10 for a 400 g serving retort meal. Single serving packs (37%) and multi-pack of five different flavours (30%) are popular choices.

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Discounts or promotions (50%), supporting a charity or cause (44%) and recommendations from friends or family (44%) are the top factors increasing likelihood of purchase.

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5.9 Qualitative evaluation of social impact

Research Review

Natural disasters disrupt agriculture and supply chains, leading to an adverse impact on food security. The UNFCCC (2021) found that droughts cause 34% of global crop and livestock losses, with agriculture bearing 82% of all drought impacts. Floods and storms further exacerbate food scarcity by damaging infrastructure and displacing populations. Vulnerable communities face heightened hunger and malnutrition due to reduced availability and increased prices (Ainehvand et al., 2019).

Nutritional access is vital for disadvantaged populations. Yin et al. (2019) found dietary diversity boosts psychological resilience in older adults, while Whatnall et al. (2019) linked nutritious diets to reduced distress in university students. Slavin and Lloyd (2012) emphasised the health benefits of fruit and vegetable intake, which help prevent chronic diseases. Rio-Celestina and Font (2020) further underscored the role of fruit and vegetables in promoting general well-being. Hosseini et al. (2017) found increased fruit and vegetable consumption reduces asthma and wheezing risks. Ensuring access to balanced meals can improve health outcomes and foster resilience in vulnerable groups.

Findings from Interviews

Interviews with Red Cross, Foodbank, Salvation Army and Uniting Vic.Tas revealed key insights:

- Geographic Needs: Remote communities have a stronger need for shelf-stable meals than regional areas, where resources are more accessible.
- Current Practices: Red Cross and Salvation Army provide fresh meals or bulk food packs, while Foodbank is expanding disaster preparedness efforts.
- Cultural and Health Considerations: Uniting Vic.Tas stressed the importance of culturally appropriate, health-conscious meals, particularly for people with dietary or physical constraints.
- Challenges: Limited safe water access in disaster-impacted areas may affect freeze-dried meal usability.

Insights from Remote First Nations Communities

Following the initial interviews, additional insights were gathered from remote First Nations communities in Wujal Wujal and Mornington Island. FareShare's First Nations Officer engaged with Elders, Councils and community service providers to understand the unique challenges these communities face during natural disasters. The interviews highlighted the urgent need for improved food security in remote communities, particularly during the wet season.

In Wujal Wujal, formal food relief outside of FareShare's *Meals for the Mob* program (FareShare, 2025) is very limited. The *Meals for the Mob* program has become essential, particularly as food security has only recently been prioritised in disaster planning. Food stores in Mornington Island and Wujal Wujal stock basic supplies, but excessive costs and logistical barriers, such as season road closures and reliance on barge deliveries, limit access. FareShare has previously sent frozen meals, which are stored in generator-powered containers. However, frequent power outages threaten this supply, and the volume of meals is typically only sufficient to sustain the community for one or two days. Community members living rough due to housing shortages face additional challenges accessing food, and families often remain in refuges for extended periods due to a lack of housing options. In response to Cyclone Jasper (December 2023), Wujal Wujal has prioritised food in disaster planning, identifying five high-ground locations to store emergency food supplies.

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Beyond physical sustenance, the interviews emphasised the mental health and social benefits of food relief, with shared meals fostering connection and resilience. Feedback on the shelf-stable meals was overwhelmingly positive, particularly for their nutritional quality and soft texture, which suited Elders with dental issues. First Nations Officer, Jason Mollenhauer noted, that pre-positioning 2,000 to 3,000 shelf-stable meals in Wujal Wujal would be transformative, ensuring access to nutritious food for up to five days in emergency situations. Unlike the existing wet season planning boxes, which contain uninspiring canned vegetables, the freeze-dried and retort meals are complete and hearty. The meals developed would not only enhance food security and community well-being but would represent a transformative shift in disaster relief planning.

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6. Conclusions & Recommendations

The objectives of the project were successfully met, in accordance with the parameters outlined in the product development briefs. All five retort meals, as well as the freeze-dried Savoury Chicken with Vegetable and Rice and Beef Bolognese with Pasta, were validated with a minimum shelf life of six months, showing only minor, yet acceptable, changes in flavour and appearance. At the completion of the project, the three remaining freeze-dried meals were validated to five months shelf life. The six-month results will be communicated with FareShare, when available. A shelf life of six months was chosen to align with the project timeline, although there is an opportunity to continue to monitor and validate the shelf life of the products, until a point of organoleptic impact.

The first stage of scale-up trials was successfully completed, enabling FareShare to launch the products on a small scale. In the future, engaging contract manufacturers with larger production capacities will be necessary. It will be essential to revalidate the shelf life of the products if any deviations are made to the formulations, processes or contract manufacturers. The framework for processing glut products into an extended shelf-life format has been defined, allowing for utilisation across various surplus produce.

Feedback from the sensory analysis, and FareShare volunteers, along with input from community engagement programs, was consistently positive. The variety of meals was well received. While there were standout favourite meals, all meals scored highly. Once the meals are distributed, it may become evident that some are more popular than others. It is recommended that consumer feedback is continuously monitored, with less popular meals being replaced with alternative options.

Due to the necessary, informal nature of the community engagement sessions, limitations in the feedback collection process were experienced. Such limitations included the use of unstructured methods, time constraints and low attendance, all of which reduced the diversity of insights. Additionally, overlapping conversations, particularly with community Elders, impeded the accurate recording of feedback, thereby affecting the overall quality of data collected. To address these challenges, a structured approach with clear objectives, breakout groups and multi-method data collection is recommended. Involving local Elders in facilitation, also recording sessions (with consent) will improve engagement and data quality. Additionally, allocating sufficient time, providing pre-session materials and ensuring follow-ups will strengthen the process. Importantly, the concept and products were very well received by the community, with overwhelmingly positive feedback.

The findings from the SIA study suggest that shelf-stable meals have significant potential to address critical gaps in disaster preparedness and response, particularly in remote areas facing unique logistical challenges. These meals could play a vital role in maintaining food security during prolonged isolation caused by extreme weather events. The need for tailored distribution strategies was highlighted, such as partnering with organisations already involved in disaster preparedness. Insights from First Nations communities reinforced the importance of offering culturally appropriate food solutions that respect local needs and preferences. To ensure success, it is crucial to pre-position meals in remote communities to enhance preparedness. Further post-distribution evaluation is essential to assess the outcomes, long-term social impact and scalability of the project in addressing food insecurity during disasters.

The initial training on meal production has been completed by the core FareShare staff, equipping them with a strong understanding of the processes. In the future, it will be essential to train and monitor volunteers to ensure they grasp the importance of each step and understand how it contributes to the creation of the final meals.

The technical manual contains all process and formulation information for the freeze-dried and retort meals. It will serve as both a training guide and reference for all operations. It is recommended that the manual be continually updated, with revisions made promptly with any changes to processes or formulations.

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The following is a summary of the proposed recommendations:

- Engage with additional contract manufacturers to explore options for scaling up production of both freeze-drying and retort processes.
- Continue to assess and validate the shelf life of the meals, in real time. If possible, extend the shelf life of the meals beyond six months.
- Gather ongoing feedback to ensure the meals are well-received and enjoyed by consumers.
- Extend the product range by introducing new meal options as required. Similarly, continue to review the uptake and volume of the meals provided, modifying the range, as necessary.
- Implement a structured approach to community engagement sessions with clear objectives, breakout groups, multi-method data collection, involvement of local Elders in facilitation, session recordings (with consent), sufficient time allocation, pre-session materials, and follow-ups to enhance engagement and data quality.
- Ensure training is provided to new staff or volunteers assisting with preparing the meals.
- Revise the technical manual if processes or formulas are updated.
- Review the sodium content of the retort Beef Bolognese and Pasta to confirm whether it meets the target level or if the salt in the formulation needs to be reduced.
- Develop strategic partnerships with disaster relief organisations for effective distribution.
- Conduct follow-up assessments to measure long-term social impact.

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7. Impact and Ongoing Monitoring

The project is poised to deliver substantial benefits across multiple areas, particularly in reducing food waste and improving societal outcomes related to food security and sustainability. Below is a breakdown of anticipated impacts across the seven CRC impact areas:

Food Waste Reduced

The project will significantly reduce Australia's food waste by utilising an anticipated **150,000 kg of food waste per year**. This food waste will be redirected and processed into nutritious, ready-to-eat meals, offering a sustainable solution to food surplus issues. During peak seasons and fresh produce gluts, the project could repurpose this produce, ensuring that large quantities of potentially wasted food are utilised.

Industry Profitability Gained

The FareShare model is based on the receipt of donated or rescued food, which is provided at no cost to the organisation. In addition, FareShare predominantly works with volunteer labour, ensuring low or no labour costs. At present, FareShare meals are distributed at no cost to vulnerable population groups, so there is no direct profitability expected from this project. However, by developing nutritious, shelf-stable meals, FareShare has the option to create a revenue stream for the business by selling meals to a wider audience.

Rescued Food Distributed

The project predicts it will repurpose up to **150,000 kg of food waste per year**, by transforming it into extended shelf-life meals. These meals will be delivered to individuals and communities experiencing food insecurity in remote or disaster affected areas, making a direct societal impact by providing nourishment to those in need. This distribution supports both social equity and sustainability goals by addressing food insecurity in a scalable manner.

Greenhouse Gas Emission Savings

Repurposing food waste, rather than sending it to landfill, will lead to a direct reduction in greenhouse gas emissions. By diverting a significant amount of produce into long shelf-life meals, the project is expected to mitigate methane emissions from decomposing food waste, thereby reducing overall greenhouse gas emissions. This contribution is in line with the broader environmental goals of lowering emissions and minimising the ecological footprint of food production and waste management.

Circular Economy Jobs Created

While the FareShare model primarily relies on volunteer labour, it does not directly foster the development of circular economy jobs. However, the project will support the creation of roles in the collection, processing and distribution of rescued food. These positions will play a pivotal part in reducing food waste, driving economic activity and sustainable practices.

Future Leaders Graduated

The project provides a significant opportunity for the education and training of future industry leaders. By engaging with professionals in formulation development, product development methodologies, HACCP (Hazard Analysis Critical Control Point)

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enquiries@endfoodwaste.com.au

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protocols, food safety and sensory evaluation techniques, the project helps to develop a workforce skilled in innovative food production techniques, ensuring the future sustainability of food systems.

Industry People Trained

Through direct training efforts, **seven FareShare personnel** have been trained in key skills related to food formulation, HACCP, alternative processing methodologies, product development processes and equipment use, enhancing their capability to produce long shelf-life meals. Furthermore, the **FareShare volunteer network** (approximately 780 volunteers) will be exposed to the specific skills and requirements needed for manufacturing shelf-stable meals. This extensive training network will help build capacity within the food rescue and redistribution sector.

Ongoing Monitoring Measures

To ensure the continued impact of the project, the following ongoing monitoring measures are recommended:

- **Tracking Food Waste Utilisation**: Once fully operational, regular monitoring will ensure that the target of utilising up to 150,000 kg of food waste annually (plus additional kgs during glut seasons) is met, providing a clear measure of food waste reduction.
- **Meal Distribution Monitoring**: Develop systems to monitor and track meal distribution to communities, ensuring consistent progress toward the goal of providing meals to those facing food insecurity.
- **Greenhouse Gas Emissions**: Emission reductions tracked through lifecycle assessments of the food waste-to-meal process, including the reduction in landfill waste and associated methane emissions.
- **Training Impact**: Implement ongoing monitoring to track the successful completion of targeted training for seven FareShare personnel and the exposure of 780 volunteers to essential food safety and production skills. Regular feedback and assessments should be used to evaluate the effectiveness of the training programs and their real-world application.

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