



Final report

Using HPP to improve the quality of texture modified foods for dysphagia sufferers and ageing consumers.

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Abstract

Specialist dysphagia foods are not widely available in the community, outside of Aged Care facilities, hospitals, and specific providers such as Meals on Wheels. There is some availability from on-line players such as Textured Concept Foods, Home Chef or pharmacies. Providers of texture modified foods rely on a frozen thaw back / heat approach for food delivery and wastage minimization. Meals on Wheels provide a fresh portion size approach for in home food delivery, but this supply is not commercially financially viable as currently labour input is from volunteers. Providers of Dysphagia foods must comply to international standards which were adopted in Australia in 2019. Some older Australians are even consuming baby food as a substitute for unavailable dysphagia compliant in-home food solutions.

Care Food Co currently manufacture and sell a range of fresh meal components suitable for consumers suffering dysphagia, with extended chilled shelf life living at home as well as hospital patients and people in aged care. The incorporation of red meat protein into dysphagia products is important as red meat Lean red meat is an excellent source of high value nutrients; protein, vitamin B12, niacin, vitamin B6, iron, zinc and phosphorus and an excellent source of long-chain omega-3 polyunsaturated fats, riboflavin, pantothenic acid, selenium and vitamin D. Important nutrients for older consumers and those who have nutritional challenges.

This project found that high pressure processed texture modified products containing red meat proteins meeting International Dysphagia Diet Standardisation Initiative (IDDSI) standards can deliver key nutrients to consumers better than non-HPP or frozen-thawed red meat-based dysphagia products. Products tested included Beef Bolognese, Beef Chilli Con Carne and Lamb Tagine pouched / tub products across various grades (e.g., pureed IDDSI 4; minced & moist IDDSI 5; and soft & bite sized IDDSI 6).

The project also designed new packaging suitable for elderly consumers and those suffering dysphagia or arthritis with reduced dexterity and strength abilities still at home or in Institutional Care that is suitable for HPP processing.

Executive Summary

This project provided outcomes that enabled Care Food Co to refine its manufacturing processes to produce high-quality fresh, minimally processed meals incorporating red meat. The project also gained consumer insights into packaging format design that would be easier for older consumers to access which will eliminate any barrier to purchase caused by product packaging.

Care Food Co products will ensure older consumers in Aged Care and Health Care facilities and those still living independently at home are delivered a nutritionally balanced, quality meal that is appealing and enjoyable, readily accessible and at a reasonable cost. The findings from this project also enable Care Food Co to compete in-market with products manufactured overseas, by offering consumers high quality, tasty Australian made products that incorporate Australian red meat as a core component. Red meat is a natural source of protein, zinc and iron that is well absorbed by the body for muscle health, which is especially helpful in maintaining independence in later years. The outcomes from the project underpin that market penetration strategy for Care Food Co's range of red meat-based meals for those ageing Australians that are either living independently, are in hospital or residential aged care facilities. This will become an increasingly significant focus as Australia's population continues to age with the +65 Cohort expected to represent 23% of the general population by 2060.

The project showed that the application of high-pressure processing disrupts the food matrix allowing nutrients to be readily bioaccessible to consumers. Demand for Care Food's products will increase the demand for low value red meat such as trim by transforming it into high-value fresh, enjoyable, and nutritious meals for elderly consumers and dysphagia sufferers still living at home, or in Institutional care, which will ultimately result in increasing returns to producers.

Care Food Co is now using approximately 5% more beef in its current recipe formulations and is also using approximately 3 % more lamb in the corresponding dysphagia meal formulations, thus making the product more nutrient dense. This project found that a higher red meat content has resulted in better binding qualities in the finished product, with HPP appearing to reduce product hardness and viscosity. That is, this project found that addition of HPP has unlocked higher protein contents foods from the inclusion of beef and lamb that could now be more easily swallowed which can only be beneficial in increasing the nutrient uptake of elderly consumers and those suffering from dysphagia.

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1. Background

In 2019 Care Food Co began manufacturing a range of high-quality, flavoursome, nutritious, minimally processed foods with extended chilled shelf life for consumers suffering dysphagia at home, in residential and institutional care. Swallowing difficulty (dysphagia) is any problem with sucking, swallowing, drinking, chewing, eating, controlling saliva, taking medication, or protecting the lungs from food and drink 'going the wrong way'. It can be a problem with keeping the lips closed so that food, liquid or saliva doesn't dribble out. There are numerous causes, including stroke, head and neck cancer, dementia, Parkinson's disease or simply ageing. Swallowing is a complex process that relies on many nerves and muscles of the mouth, throat, and oesophagus. Older adults with swallowing difficulties are at increased risk of pain, dehydration, and malnutrition. Swallowing problems can mean that food and fluids entering the airway (laryngeal penetration) or the lungs (aspiration) can cause chest infections (aspiration pneumonia), choking or even death.

The Australian and New Zealand Society for Geriatric Medicine has estimated that the prevalence of people in the community suffering dysphagia is between 7 and 22% and its incidence is as much as 40 to 50% among older people in long-term care facilities [1]. Dietary modification by adapting the texture, consistency, and viscosity of food and drinks guided by a speech therapist is a common approach for patients with dysphagia. Although it is not considered a normal part of ageing, dysphagia can occur due to the physiological ageing process, especially in people over 80. However, it is often a symptom of an underlying disease or condition.

Dysphagia is also common in people with developmental disability. It has been estimated that its prevalence in adults with multiple disabilities is as high as 76%. A large proportion of people with development disabilities have difficulties in relation to both feeding and nutrition. For many infants with development disabilities, problems with sucking and swallowing in the first 12 months of life are common. Some studies have noted rates as high as 56% of infants having sucking problems and 28% experiencing swallowing difficulties. For children who have dysphagia, silent aspiration, the accidental inhalation of food or liquid into the trachea (windpipe or airway) without knowing, occurs at a high frequency (estimated in some studies to be as much as 97%) making detection more difficult and increasing the likelihood of respiratory problems in this population. Gastro-intestinal impairments (reflux and constipation) are common for children and adults with development disabilities, and it is thought to affect an estimated 70% of this population. According to the Australian Institute of Health & Welfare more than 4 million Australians have a disability and 32% (1.3 million people) of those have severe or profound disability, which Care Food Co can contribute to improve their health through improved nutrition.

Specialist dysphagia foods are not widely available in the community, outside of Aged Care facilities, hospitals and specific providers such as Meals on Wheels. There is some availability from on-line players such as Textured Concept Foods, Home Chef or pharmacies. Providers of texture modified foods rely on a frozen thaw back / heat approach for food delivery and wastage minimization. Meals on Wheels provide a fresh portion size approach for in home food delivery, but this supply is not financially viable even though labour input is from volunteers. Providers of Dysphagia foods must comply to international standards which were adopted in Australia on 1 May 2019. Some older Australians are even consuming baby food as a substitute for unavailable dysphagia compliant in-home food solutions.

The 2020 Royal Commission into the state of Australian Aged Care, determined that approximately 50% of Aged Care Residents are either malnourished, or at risk of malnutrition [2]. It has been shown that an intake of 25-30g of protein at meals times through high protein menu planning will support elderly residents and assist with reducing the impact of sarcopenia (loss of muscle mass). Red meat is an excellent source of high bioavailable protein. Malnutrition is caused from an inability to eat enough food, and often the elderly have reduced intake, small meals, difficulties swallowing or cannot eat enough volume to maintain body weight.

The current Australian dysphagia food market is supplied by thickened liquid foods, manufactured locally by Flavour Creations, Steggall Nutrition and Trisco Foods or from overseas owned multinationals such as Nestle', Hormel and Unilever. Very few of these products are Australian manufactured or contain Australian ingredients. The products are typically liquid or powder thickeners, purees, thickened liquid powders or pre-thickened liquids that are bland; odorless and flavorless. Consuming thickened fluids is not a particularly pleasant experience and therefore consumer compliance is low, resulting in dehydration and malnutrition. These products also usually lack the ideal flavour and textural properties and fall short of energy and nutrition requirements.

A study published in 2022 by Rajati, F. et al. estimated the global prevalence rate of dysphagia was 43.8% or 3.4 billion people [3]. The market is estimated to be valued at about US\$3.7 billion per year in the US alone. It affects 18% to 22% of all people in long-term care facilities and many people being cared for at home. For people suffering from stroke, heart disease, multiple sclerosis, AIDS, and many other illnesses, the effects can be devastating, emotionally and nutritionally. In 2015, the International Dysphagia Diet Standardisation Initiative (IDDSI) released the IDDSI Framework to provide safety through a global standardised way of naming and describing food texture and drink thickness for people with swallowing difficulties across their lifespan <https://iddsi.org/framework/>.

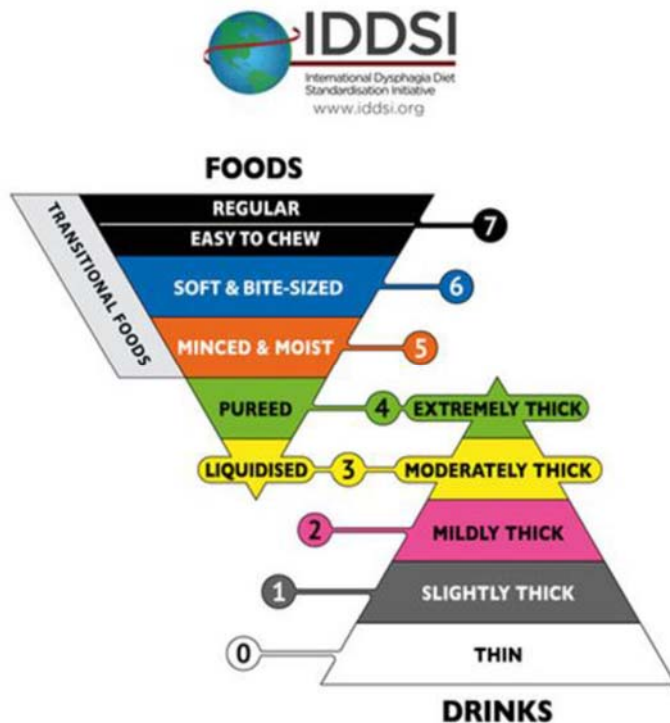


Figure 1. International Dysphagia Diet Standardisation Initiative (IDDSI)

A Global Market Insights report has estimated that the Silver Food (elderly nutrition) Market was estimated at over \$US13.4 billion in 2018 and will exceed \$US18 billion by 2025 [4]. The chewing difficulty food market is projected to expand at an annual growth rate of around 7 to 8%. Demand for nutritionally balanced diets for preventing residents of long-term care facilities from undernutrition is increasing. Supply of meals into home-care elderly patients and the preventive care market is projected to increase at 3% growth.

The MLA report 'Concept Development of a Meat Pie for Dysphagia Sufferers' (V.RMH.0085) noted that food and fluids are required to be modified for a person to achieve their nutritional requirements. Not all foods can be modified and are often removed from the available menu. Many red meat items are avoided even when braised or slow-cooked as they form a fibrous bolus when chewing. Typically, the foods are pureed using a blender. It is common for texture modified meals to look unappealing, be repetitive, unrecognisable, served as scoops on the plate, or blended and often have the same colour combination.

Care Food Co currently manufacture and sell a range of fresh texture modified meal components suitable for consumers suffering dysphagia, with extended chilled shelf life living at home as well as hospital patients and people in aged care. The incorporation of red meat protein into dysphagia products is important as Lean red meat is an excellent source of high value nutrients; protein, vitamin B12, niacin, vitamin B6, iron, zinc and phosphorus and an excellent source of long-chain omega-3 polyunsaturated fats, riboflavin, pantothenic acid, selenium and also vitamin D. Important nutrients for older consumers and those who have nutritional challenges.

In 2018–19, Australia produced approximately 2.4 million tonnes carcass weight (cwt) of beef and veal (ABS) and in 2019, Australia exported 76% of its total beef and veal production with an export value of A\$10.8 billion. Australian red meat producers sell their animals to processors who process the animals and sell whole carcasses, boxed beef as well as all the other parts of the animal. Cattle carcasses will typically be 48-56% of live weight depending on age sex, fat score and time off pasture. The yield of meat from a carcass is typically in the range of 67-77%. This means meat forms between and 32 and 43% of the live animal. The meat component of a carcass is divided into prime cuts and trim with the prime cuts having a higher value than the trim. Good quality prime cuts of beef are in high demand and can be sold at high prices.

Generating value out of the trim is one of the key challenges for the Australian red meat industry. Traditionally trim can be used for sausages, burgers and other processed meat products. Obtaining the market premiums from the trim is especially a challenge with premium products such as certified grass-fed and organic command a premium. The use of red meat trim in Care Food Co products offers an opportunity to increase returns to producers. While prime cuts such as steak are seen as the highest value and most sought-after cuts of beef, they are not the most highly consumed. More than twice as much ground beef is consumed than steak in the USA.

Arthritis Australia estimates that up to one billion, one in seven or 14% of the world's population have arthritis. They have estimated that 4 million Australians currently live with arthritis and will increase to 5.4 million by 2030. Packaging can have an adverse impact on quality of life, with 65% of consumers having to wait for someone to come and open packaging for them (Catalyst Research, 2013) and 89% of consumers feeling frustrated or furious with packaging. 53% of consumers have also suffered an injury while trying to open packaging. These negative experiences with packaging can impact a consumer's life, particularly if they live alone or have a functional limitation. It is critical to ensure that packaging is easy to open for older consumers and those suffering dysphagia or arthritis or reduced dexterity. Care Food Co undertook a process to re-design and develop packaging that can meet the dexterity and

strength abilities of elderly consumers and those suffering dysphagia or arthritis still at home. Care Food Co reviewed the Arthritis Australia report 'Food Packaging Design Accessibility Guidelines' [6].

Meat and meat products are rich sources of protein. However, constriction of collagen and coagulation of myofibrillar protein (MP), which occurs during heating, generally result in the hard texture of meat and meat products, which can then lead to difficulty in consuming such products by dysphagic patients.

High Pressure Processing (HPP) is a technology that delivers hydraulic pressures in excess of 6,000 atmospheres to food products immersed in a liquid medium (see: <https://www.mla.com.au/research-and-development/reports/2015/high-pressure-processing/>).

Nonthermal technologies such as high-pressure processing (HPP) not only extend chilled shelf life, but also improve the textural properties of meat and meat products while preserving nutritional characteristics of the modified products [5]. This is because nonthermal technologies are generally known to exhibit less effects on small molecules such as amino acids, vitamins, and flavour compounds; proteins, enzymes, and nucleic acids, which are of larger molecules may be altered. HPP has been shown to be capable of improving the gelatinisation of protein by changing its conformational structure; depending on the applied pressure.

The range of dysphagia foods must meet the IDDSI standards, with the application of high-pressure processing (HPP) technology to deliver a fresher, more flavoursome and nutritious products, with extended chilled shelf life, for in-home and residential sufferers of Dysphagia. HPP is superior to traditional pasteurisation methodologies as it locks in the goodness of food and does not "cook" out nutrition. The IDDS framework has been adopted by Aged Care facilities as well as Queensland and NSW Health to ensure food supplied to dysphagia consumers is safe to eat. Care Food Co is currently delivering their products direct to homes, to help older Australians remain in their homes longer.

1. Objectives

Meat and meat products are rich sources of protein. However, constriction of collagen and coagulation of myofibrillar protein (MP), which occur during heating, generally result in the hard texture of meat and meat products, causing subsequent difficulty in consuming such products by dysphagic patients. Nonthermal technologies such as high-pressure processing can serve as an alternative to the modification of the texture of meat and meat products. It is important to note that such technologies not only improve the textural properties of meat and meat products but are also able to preserve nutritional characteristics of the modified products. This is because nonthermal technologies are generally known to exhibit less effects on amino acids, vitamins, and flavour compounds, proteins, enzymes, and nucleic acids. High Pressure Processing (HPP) is known to alter the rheology of dysphagia foods.

This project undertook the following objectives.

1. Undertake Results Chain Analysis to develop a model to estimate business viability and potential impact on Australia's red meat industry.
2. Development of an understanding of the effect of high-pressure processing on the rheology and structure of texture modified foods for aged care and those suffering dysphagia that incorporated red meat. This research investigated the relationship between HPP processing conditions (pressure, dwell time, moisture content) and final product hardness, adhesiveness, and cohesiveness.

3. Investigation of the effect of High-Pressure Processing on the bioaccessibility of micro-nutrients of red meat based textured modified foods. Levels of Vitamin A, Total carotenoids, omega 3 fatty acids and iron were measured before and after high pressure processing.
4. Refine the product range recipes and optimise manufacture process to ensure viability and feasibility of Care Food Co's fresh textured modified foods incorporating red meat with extended chilled shelf life.
5. Confirm desirability and useability of redesigned packaging format that meets the dexterity and strength abilities of elderly consumers and those suffering dysphagia or arthritis, using consumer ethnography provider, Watch me Think.

2. Methodology

This project involved the following methodology.

2.1 Results Chain Analysis.

The project undertook a Results Chain Analysis (RCA) to estimate the potential benefits for the Australian red meat industry. ProAnd & Associates have extensive experience in developing RCA models. A working model was developed that could be continually refined and reviewed as the project progressed to ensure financial viability of Care Food Co's business model and to measure returns to Australia's red meat industry.

The RCA analyse and evaluates 1) Impacts - Positive and negative, primary, and secondary long-term effects produced by the project directly or indirectly, intended or unintended, 2) Outcomes - The likely or achieved short term and medium-term effects of the projects output, 3) Outputs - The products, capital goods and services which result from the project; may also include changes resulting from the project which are relevant to the outcomes 4) Activities - Actions taken or work performed through which inputs such as funds, technical assistance and other resources are mobilised to produce specific outputs and 5) Inputs - The financial human and other resources used for the project.

Once the Results Chain had been constructed a Prediction Model was prepared based on 'best guess' assumptions to indicate the most likely metrics for the project. The Prediction Model has also been structured to conduct some high-level Sensitivity Analysis associated with changes in the prediction assumptions.

2.2 HPP effect on rheology and structure.

The project objective investigated the effect of high-pressure processing on the rheology and structure of texture modified red meat food products to develop a relationship between HPP processing conditions (pressure, dwell time, moisture content) and final product hardness, adhesiveness, and cohesiveness. Dr Simon Little of Quality Food Systems undertook the investigation by measuring and assessing the effect of HPP on finished product hardness, adhesiveness, and viscosity.

Hardness is a textural characteristic estimated during the first mastication; strength is applied on the food product in an approximately linear way and can be satisfactorily reproduced instrumentally through a uniaxial compression test. A uniaxial compression test to determine Hardness values was applied to all samples using the TA-TX2 Texture Analyzer. The instrument was set to a Pre-Speed of 1 mm/s, Test-Speed of 1 mm/s, and post-Speed of 10 mm/s. The distance was set to 50% strain, the trigger box at .049 N, and the acquisition rate to 50 points per second (pps). A 75mm diameter

compression plate performed the compression onto the samples and was calibrated by the TA-TX2 Analyzer before testing began. The compression test was run twice per sample and experiments were run with samples at room temperature.

Adhesiveness is the work/force necessary to overcome the attractive forces between the surface of the product and the surface of the material with which the product comes in contact such as the inside of the mouth, the tongue and utensils. The Koehler K95200 was used to determine adhesiveness values of all samples. 5 mL of the sample was placed on the bottom plate, then after pressing start, the top plate comes down and presses against the sample allowing it to bond to both plates. After this step, the top plate retracts at a constant speed and measures the force needed to pull the sample apart.

Viscosity is a measure of a foodstuffs resistance to flow and is a contributing factor towards the level of adhesiveness. Viscosity ('thickness') of textured modified foods directly impacts swallowing. A Brookfield Viscometer model 4535 was used to determine viscosity values of all samples. Spindle number LV1 was chosen, and the speed was set to 30rpm.

Care Food Co process their product range using a UDHE 350L High Pressure Processing Unit manufactured by Thyssenkrupp. <https://www.thyssenkrupp-industrial-solutions.com/high-pressure-processing/en/products/uhde-350-60.html>

Product is conveyed in special baskets into the high-pressure vessel. It then moves into the machine and is filled with water. Pumps increase the pressure in the vessel, which is applied both immediately and evenly spread leaving no evident crushing effect on the products. HPP processed product has a much longer chilled shelf life and maximum product safety.





Care Food Co UDHE 350L HPP



2.3 HPP effect on micronutrient bioaccessibility.

This project objective involved investigating the effect of High-Pressure Processing on the bioaccessibility of micro-nutrients of red meat textured modified foods was also undertaken. Levels of Vitamin A, Total carotenoids, omega 3 fatty acids and iron were measured before and after high pressure processing and the effects of high-pressure processing on the cellular matrix was investigated.

Samples of red meat-based Care Food Co. products (with and without HPP processing) were studied on a NanoSEM 450 Scanning Electron Microscope to investigate cellular and food matrix disruption which would indicate the potential for improved bioaccessibility of key nutrients. The NanoSEM 450 is a field-emission scanning electron microscope (FE-SEM), which attains ultra-high imaging resolution.

2.4 Refine Manufacturing Process and Product Range.

Care Food Co undertook a review of their manufacturing process to improve yield and efficiency as well as adjusting the product range recipes to maximise the nutritional profile while optimising costs.

2.5 Redesign of Packaging.

Currently older consumers and those who have dexterity challenges caused by arthritis or simply ageing, have difficulty opening Care Food Co current packaging format. Care Food Co conducted a packaging design review using Arthritis Australia's Packaging Design Guidelines to determine the specifications for a new packaging format that would provide better accessibility for consumers with dexterity and strength challenges.

2.6 Desirability and Useability of Care Food Co Packaging

Care Food Co engaged the Watch me Think team to garner consumer insights into Care Food Co's existing pouch packaging <https://www.carefoodco.com.au/collections/main-dish/products/beef-bolognese-200g-iddsi-level-4> and a proposed new pot packaging format with large peel seal tab. This activity is a design led thinking process with users in designing an acceptable packaging format.

Watch me Think, a global consumer insights company was engaged to confirm desirability and useability of the new packaging format by institutional catering and in-home consumers. <https://watchmethink.com/>

Watch Me Think call their consumer insight cohort 'Thinkers'. The consumer group used was ten Australian 'Thinkers', a mix of current Care Food Co customers (carers or those with swallowing difficulties) and older arthritis sufferers as well as a mix of gender.

3. Results

3.1 Results Chain Analysis of benefits to the Australian industry.

ProAnd & Associates have developed a tool for measuring potential industry outcomes from MLA investments like Care Food Company's product range. The Results Chain Analysis (RCA) helps determine the likely outcomes for industry from such an investment. The RCA process analyses the project according to inputs, activities, outputs, outcomes and subsequent impacts.

Once the Results Chain is constructed, a Prediction Model is prepared to indicate the most likely metrics for the project. The Prediction Model is used as the basis to conduct top-level Sensitivity Analysis associated with changes in the prediction assumptions. Information about the product, process, perceived market demand and prevailing values was provided by Care Food Co. The RCA details the industry benefits of this project and identifies markets where texture modified meals would likely be adopted.

A Results Chain Diagram was constructed that indicates the Inputs, Activities, Outputs, Outcomes and Impacts necessary for the successful development of a dysphagia meal business (Appendix 1. Figure 8). The RCA model captures the inputs and assumptions made so that the model can be updated and re-run as the project progresses, and knowledge improves. The RCA Model has been constructed on the assumption that production of marketable quantities of dysphagia meals occurs in Year 1.

Domestic Market Volume Projection

A Care Food Co main meal comprises of protein, beef or lamb, plus vegetables, stock and seasonings. The respective meat used is a specific percentage of the meal ingredients. There is also a separate side dish range which includes vegetables and starches.

The Table below provides an estimate of domestic market volumes based on the number of dysphasia-affected consumers. Care Food Co intends to market dysphagia meal products initially into the Australian domestic market. (However, the potential for export of dysphagia meals is significant once the Australian market has been developed. It would be expected that Care Food would enter export markets once the domestic market is soundly established.)

In order to generate data around domestic market volumes, the following assumptions were adopted:

- The size of the dysphagia-affected population in Australia was determined from The Australian and New Zealand Society for Geriatric Medicine who estimated that the prevalence of people in the Australian community suffering dysphagia to be 7 to 22% and its incidence is 40 to 50% among older people in long-term care facilities.
- It is assumed that each diagnosed person consumes two Care Food meals per day (lunch and dinner).
- Care Food Co advised that each meal is 120gms in weight and the average protein per meal is 24gms (20% of total weight).

Sensitivity analysis

A series of sensitivity projections were conducted using the RCA projection model. The analysis demonstrated that with a 10% decrease in sales price, EBITA remains positive, indicating the business would continue to be viable. With a 20% increase in red meat cost there is little impact on business viability. A 20% decrease in yield (more red meat in the protein sachets) results in an increased requirement of around 860 carcasses/annum in year 6. Processor benefits were calculated to increase to around \$1,200,000/annum in year 6.

It can be concluded from the outcomes of the sensitivity analysis that the viability of the business is not significantly impacted by a 10% decrease in sales price, or a 20% increase in red meat cost.

The sensitivity analysis also indicates the quantum of benefit that flows to the red meat industry if the amount of red meat is increased in the total protein sachet offer from 23% to 28%. A summary of the Impacts resulting from the Results Chain Analysis are detailed below.

IMPACTS	Year 2	Year 5	Years 6-10
Carcasses Required (Number)	48	385	687
Beef Processor Benefit (\$A million)	\$0.06	\$0.5	\$1.0
Cumulative Beef Processor Benefit (\$A million)	\$0.1	\$1	\$5
Market Share of Global Market %	0	0	0
Market Share of Domestic Market %	0%	0.3%	1%
Operating employment generated (Number)	4	30	54
Environmental benefits (\$A thousand)	\$1	\$7	\$13

Table 2. RCA Impact Summary

Based on the assumptions used in the RCA the Care Food Co business model is viable and not significantly impacted by the sensitivity analysis that has been conducted.

While the red meat benefits may appear limited, the Care Food Co production projections only address about 1% of the total domestic dysphagia market by year 6-10. This indicates that there is significant upside for the red meat industry associated with improved access to red meat-based dysphagia protein produced using Care Food Co's technology IP.

Six months into the project ProAnd & Associates undertook a review of the Results Chain Analysis with updated inputs and project deliverables. Discussions were held with Care Food Co and identified the following new information:

- Care Food Co is using approximately 5 % more beef in its current recipe formulations. This is making the product more nutrient-dense.
- Approximately 3 % more lamb is used in the corresponding dysphagia meal formulations.
- Higher red meat content has resulted in better binding qualities in the finished product.
- However, in the case of lamb it is less apparent, possibly due to fat content of lamb meat.
- During the intervening period since the initial analysis there has been a significant increase in red meat costs. However, this has started to abate in the first fortnight of December 2022 and overall price changes have been marginal.
- Concomitantly, Care Food Co conducted a separate study on the rheology of its texture modified red meat and vegetable-based meals produced using high pressure processing (HPP).
 - HPP appears to improve the hardness and viscosity of its red meat and vegetable meals.
 - HPP seems to have little impact on adhesiveness.
 - All three criteria can have a major bearing on the meals being easier for dysphagia patients to consume.

The Table below (Table 3) below provides an updated summary of the Impacts resulting from the Results Chain Analysis. The main variations in impacts are set out in the rows.

Main Variations in Impacts (Dec 2022)	Year 2	Year 5	Years 6-10
Carcases Required (Number) Increase	1	8	14
Cumulative Beef Processor Benefit	\$1,838	\$20,419	\$119,535
Environmental benefits (\$A thousand)	\$17	\$150	\$276

Table 3 – Summary of Variation in RCA Impacts from initial Results September 2022

The main variations are due to increased use of red meat in recipe formulations. This is projected to result in greater number of carcasses used, higher cumulative benefits to beef processors but also a decline in the enterprise's EBITDA stemming from raw material costs.

3.2 HPP effects on rheology and structure.

Investigate the effect of high-pressure processing on the rheology and structure of texture modified red meat food products to develop a relationship between HPP processing conditions (pressure, dwell time, moisture content) and final product hardness, adhesiveness, and cohesiveness. Care Food Co processed samples of their product range using a UDHE 350L High Pressure Processing Unit manufactured by Thyssenkrupp. <https://www.thyssenkrupp-industrial-solutions.com/high-pressure-processing/en/products/uhde-350-60.html>.

Hardness is a textural characteristic estimated during the first mastication; strength is applied on the food product in an approximately linear way and can be satisfactorily reproduced instrumentally through a uniaxial compression test. A uniaxial compression test to determine Hardness values was applied to all samples using the TA-TX2 Texture Analyzer. The compression test was run twice per sample and experiments were run with samples at room temperature. Table 9 in the Appendix 2 displays the Hardness Rating in MPa for all samples tested.

Adhesiveness is the work/force necessary to overcome the attractive forces between the surface of the product and the surface of the material with which the product comes in contact such as the inside of

the mouth, the tongue and utensils. The Koehler K95200 was used to determine adhesiveness values of all samples. This testing method has excellent repeatability with a gauge equipment variance of only .097.

Viscosity is a measure of a foodstuffs resistance to flow and is a contributing factor towards the level of adhesiveness. Viscosity ('thickness') of textured modified foods directly impacts swallowing. A Brookfield Viscometer model 4535 was used to determine viscosity values of all samples. Spindle number LV1 was chosen, and the speed was set to 30rpm. Results were given in Pascal seconds.

Research undertaken by JW Park, et al found that adhesiveness was the most important property of the semi-solid foods, requiring most effort in pharyngeal swallowing in the older adults. Providing foods having low adhesiveness value in the same viscosity category, may make it easier to swallow in older adults [8].

Results indicate that High Pressure Processing (HPP) reduces the hardness of the food likely related to cellular disruption. A reduction in hardness translates to less force being required for chewing when compared to non-HPP processed variants, which means Care Food Co products are easier to chew than other dysphagia foods of the same IDDSI level and can lead to more food being consumed.

High Pressure Processing also reduces the viscosity of textured modified foods by approximately 10%, making the food easier for consumers suffering from dysphagia or other swallowing difficulties to consume. This will lead to improved nutritional outcomes for consumers eating Care Food Co's product range.

3.3 HPP effects on micronutrient bioaccessibility.

Investigation into the effect of High-Pressure Processing on the bioaccessibility of micro-nutrients of red meat textured modified foods was also undertaken. Levels of Vitamin A, Total carotenoids, omega 3 fatty acids and iron were measured before and after high pressure processing.

High Pressure Processing (HPP) is a method of food preservation that has rapidly gained attention over the last decade as an alternative to the more traditional methods of food preservation such as heat pasteurisation. High pressure processing typically involves exposing the food product to elevated pressures, between 4500 – 6000 bar, for a short period of time that can vary from 1- 10 minutes depending on the type of food, the packaging used, and various physical factors associated with the food including pH, fat level and sugar level. No heat is involved in this process. High pressure processing has been found to be effective in substantially reducing the microbial load on food products which translates into longer shelf life. The effect of HPP on microorganisms has been extensively studied over the last decade.

It has been found to induce many changes in the bacterial cell, including inhibition of key enzymes, inhibition of protein synthesis, alterations in cell morphology and the cell membrane, as well as affecting the genetic mechanisms of the microorganism such as disruption of transcription and translation and cellular functions responsible for survival and reproduction [9].

HPP can disrupt large molecules or microbial cell structures, such as enzymes, proteins, lipids, and cell membranes, and leave small molecules such as vitamins and flavour components unaffected [10]. The result is that High Pressure Processed food products exhibit organoleptic qualities, such as flavour, texture and aroma, that are very often indistinguishable from the equivalent fresh product.

Bioaccessability and bioavailability are terms applied to explain the ingestion and absorption of certain micronutrients by the human body. More recent research on HPP has focused on the ability of this technique to provide foods that are nutritionally enhanced compared to their thermally processed counterparts. This enhancement is discussed in terms of increased nutrient bioaccessability and bioavailability and has been linked to cellular changes in the tissue matrix due to the high pressures encountered in HPP.

There has been considerable research into this area that is related to fruits, vegetables and legumes. HPP processing of green beans at 600 MPa was found to provide a significant increase in lutein availability compared to untreated samples and this positive effect was due to facilitated release of lutein within the plant tissue matrix during the *in vitro* digestion process by the disruption of cellular structures in the beans by exposure to high pressures [11].

The bioaccessability and bioavailability of polyphenols, carotenoids, and glucosinolates were found to be enhanced by HPP due to the process increasing their extractability [12]. The same authors concluded that the impact of HPP on bioaccessability and bioavailability of nutrients, in general, is dependent on the type of nutrient, the structure and composition of the food matrix. They also stated that micronutrients and phytochemicals in vegetables such as carrots and green beans may be made more bioavailable by high pressure processing.

With respect to muscle foods, the limited research available supports the cellular disruption model in providing increased bioavailability of macro and micronutrients in meat and meat-based food products [13].

In General, there is much research to suggest that High Pressure Processing (HPP) can increase the bioavailability and bio-accessibility of a number of important nutritional elements such as vitamins, minerals, phenols, antioxidants and other micronutrients when compared to traditional methods of food processing that involve heat such as pasteurisation and retorting.

The mechanism by which this occurs is not fully understood, but researchers tend to agree that the action of HPP is such that the tissue matrix of the food is altered or disrupted which allows for increased extraction of these compounds which thus enables them to be more readily available for digestion and other biological processes.

Further to this, HPP has been found to alter the physical, and the chemical, state of macromolecules such as proteins and starches making them more digestible. This has positive implications for members of the community who have certain dietary sensitivities. Whilst much of the research to date has concentrated on the effects of High-Pressure Processing on the bioavailability of nutrients in single or stand-alone food items such as carrots or apples, there is no evidence to suggest that multi-component food products such as ready meals would not exhibit similar results.

Based on the available information it was considered useful to determine if High Pressure Processing would alter the cellular matrix of Care Food Co meals. Any cellular matrix disruption could enhance the bioavailability of the nutrients contained within these meals.

Samples of Care Food Co. product range (with and without HPP processing) were studied using a Nano SEM 450 Scanning Electron Microscope to investigate how HPP disrupts the food matrix and cell structure to make micronutrients more bioaccessible. The Nano SEM 450 is fitted with a retractable annular backscattered electron detector as well as a Bruker SDD-EDS detector for the convenient visualisation of compositional differences across the specimen surface.

Due to project timing constraints only, the following products were studied using the scanning electron microscope. Meat based products examined were Lamb Shank IDDSI Level 6, Beef Bolognese IDDSI Level 4. Vegetable products examined were Mushy Pea IDDSI Level 4, Sweet Corn Mash IDDSI Level 4, and Carrot Puree IDDSI Level 4.

The SEM images showed tissue matrices for samples with and without high pressure processing. With respect to the meat-based meals, due to time constraints the Lamb Shank IDDSI Level 6 and Beef Bolognese IDDSI Level 4 were the only meat samples analysed. These were chosen to determine if the higher level of mincing in IDDSI Level 4 affected the cellular matrix of the product to a higher degree than the less processed IDDSI Level 6. The images below clearly show a level of cellular disruption in the samples that were treated with high pressure processing, and this was regardless of IDDSI level.

The results of the scanning electron microscope clearly showed that high pressure processing breaks open the cellular matrix of textured modified red meat-based food products. The literature supports Care Food Co's hypothesis that the cellular disruption associated with the high pressure processed textured modified foods could enable macro and micronutrients to be more bioavailable to consumers than those that have not been high pressure processed. This initial research demonstrates a compelling case for HPP as a platform that can be pursued for the development and delivery of IDDSI compliant red meat meals. IDDSI red meat based ready meals and meal components that have been high pressure processed are easier for those suffering dysphagia to consume and potentially will achieve improved health outcomes. As the populations in Australia and southeast Asia continue to age, the rising consumption of HPP dysphagia meals will contribute an increased demand for Australian red meat.

Analysis of product nutrients in Care Food Co product was undertaken pre high pressure processing and compared with post high pressure processing to ensure amino acids were unaffected by the HPP process.

Whilst on initial review of the measurements indicated that HPP processing has increased amino acid (proteins) levels this is not possible. What is likely is that there is a distribution issue of the protein within the samples being tested and if we took enough statistical samples, we would find that all samples approximate the mean with a fairly large standard deviation which would indicate that there was a large variance in protein distribution within the product. There is no feasible mechanism that would increase the level of amino acids as far as the total protein content in the products during HPP and their molar ratios are almost identical with in around +/- 0.2% so this indicates product protein content distribution rather than an increase in protein.

The sample that was selected post HPP for testing had a slightly higher amount of protein (and therefore amino acids) than the one in pre HPP as they are discrete samples and statistical sampling wasn't required.

Care Food Co is now using approximately 5 % more beef in its current recipe formulations and is also using approximately 3 % more lamb in the corresponding dysphagia meal formulations, thus making the product more nutrient dense. A higher red meat content has resulted in better binding qualities in the finished product, however in the case of lamb it is less apparent possibly due to lamb meat containing higher levels of fat. Higher protein content in dysphagia meals can only be beneficial in increasing the nutrient uptake, in particular protein of elderly consumers and those suffering from dysphagia.

During the intervening period since the previous report there has been a significant increase in red meat costs. However, this has started to abate in the first fortnight of December 2022 and overall price changes have been marginal.

Concomitantly, Care Food Co conducted a separate study on the rheology of its texture modified product range that is processed using high pressure processing (HPP). The findings showed that HPP appears to improve the hardness and viscosity of its red meat-based meals that HPP seems to have little impact on adhesiveness, and that hardness, viscosity and adhesiveness can all have a major bearing on the ease of swallowing for the elderly and dysphagia patients.

The changes in market assessment were made due to Care Food Co noting a growth in the total number of gastric banding procedures being performed in Australia each year (estimated at approximately 30,000). Patients recovering from gastric banding surgery are restricted for approximately six weeks to consuming only a protein-dense diet in a pulverised form such as produced by Care Food Co, due to the constriction of the intestinal system. This represents a new market channel for Care Food Co distinct from the elderly and dysphagia market channel initially identified.

3.4 Refine Care Food Manufacturing Process & Product Range.

Care Food Co undertook further development and refinement of the manufacturing of their dysphagia product range, they found the need to fine tune the product recipes, optimise the manufacturing process, and account for changes in raw material costs.

3.5 Developing packaging for consumers with arthritis or reduced dexterity and strength.

3.5.1 Packaging review and redesign

The target demographic for Care Food Co's product range is consumers that are suffering dysphagia (swallowing difficulties) which could be associated with cerebral palsy, stroke or even aging, as well as seniors living in residential or institutional care or simply living at home. The bulk packaging format is suitable for supply to hospitals, institutions and aged care where there are staff who can dispense individual meals. The small pouch packaging format is for in-home care and not suitable where consumers don't have assistance readily available.

As a result, Care Food Co reviewed literature from Arthritis Australia to better understand the needs of consumers with strength and dexterity challenges and have found that accessibility was a major concern.

The target demographic has declining abilities due to old age, increased diseases, vision degradation, declining strength/dexterity, etc. This coupled with the fact that more food items are getting increasingly difficult to open. Having increased child, tamper, and theft resistance; along with mandatory requirements such as structural integrity and increased portion control places extra barriers to consumption.

According to the 2014 'Packaging Accessibility' report by Fergal Barry, Strategic Partnerships Manager of Arthritis Australia, packaging opening difficulty significantly increases by age, with 91% of consumers experiencing frustration opening packaging, and 65% of consumers having to wait for someone to open packaging for them. This led to 36% of consumers switching products due to negative experiences, and as a result accessible packaging has been identified as a major opportunity for food manufacturers and suppliers.

As seen in Figure 2 below, 26% of consumers in developed markets have bought a product again due to packaging and 24% switched brands due to a change in packaging.

Packaging influences purchasing behavior even more in developing markets

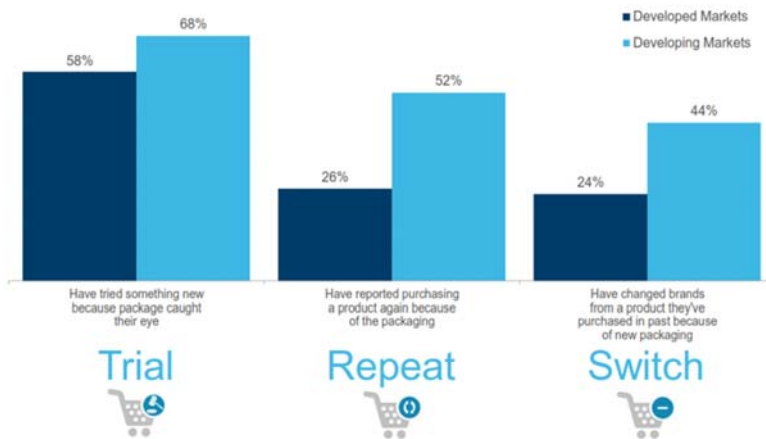


Figure 2. Packaging and purchase behavior.

Care Food Co supply their product range direct to consumers in individual spouted pouches or gusseted stand up pouches and to Institutional and aged care facilities in bulk piping pouches.

Individual Serve Pouch Packaging



Figure 3. Care Food Co individual packs

Bulk Serve Packaging



Figure 4. Care Food Co bulk packs

Individual Serve Tub Packaging

Care Food Co reviewed the current packaging for single use applications and decided that the pouch format was a barrier to easy of use and ultimately repeat purchases. Care Food Co reviewed their packaging design based on Arthritis Australia's Food Packaging Design Accessibility Guidelines [6] of 2018.

Guideline 04

- Reduce the requirement for fine motor control.
- Offer redundant modes of operation utilizing the next larger set of motor movements (finger to hand, hand to arm).
- Allow for alternatives to a standard grip. Size the gripping area and clearances to allow alternatives to the standard grip, including knuckles, the side, back and heels of the hand, and two-handed "pinch" grips.

Good Example is shown in Figure 4 where the film consists of a large tab that can easily be grasped with the tips of the fingers or the whole hand.



Figure 5. Large tab allows alternative grips.



Figure 6. Semi-ridged Pot



Figure 7. Lamb Tagine & Beef Chilli Con Carne

4.5.2 Desirability and Useability of Packaging

Care Food Co products meet the IDDSI standards and are processed with high-pressure processing (HPP) technology to deliver a fresher, more flavoursome and nutritious products, with extended chilled shelf life, for in-home and aged-care residents.

Watch Me Think is an international company that undertakes consumer qualitative ethnography research, that helps many of the World's largest FMCG companies improve innovation success rates by understanding the consumer experience at the point of use and consumption. Care Food Co engaged the Watch me Think team to gather consumer insights into the existing pouch packaging format <https://www.carefoodco.com.au/collections/main-dish/products/beef-bolognese-200g-iddsi-level-4> along with feedback on a proposed new pot packaging format with large peel seal tab, in a design led thinking process with users (consumers).

Watch Me Think call their consumer insight cohort 'Thinkers'. The consumer group used was ten Australian 'Thinkers', a mix of current Care Food Co customers (carers or those with swallowing difficulties) and older arthritis sufferers as well as a mix of gender.

Care Food Co can now undertake additional packaging design refinement and additional testing of the pot sealing to ensure a consistent and even seal that can be opened by consumers with restricted or limited hand mobility or low strength.

4. Conclusion

4.1 Analysis of foresight trends and industry/economic/market forces effecting the value proposition.

In conclusion this project involved i) validation of stakeholder and customer development discoveries and ii) analysis of foresight trends and industry/economic/market forces that will affect the value proposition for range of texture modified meals.

4.1.1 Customer Archetypes

Care Food Co has three core consumer¹ groups. These consumer groups have one commonality; they are all impacted by a medical condition of varying severity that effects their ability to swallow.

1. **Disabled consumers** living with the long-term consequences of their medical condition. These individuals are best represented as stroke survivors. These consumers are typically older and require long term support. Circa 1+ years
2. **Able-bodied or Disabled consumers** living with medium term medical conditions and recovering from medical events such as throat cancer, hernia type operations or troubling dental/denture issues. These consumers require medium term support (typically 6 months).
3. **Able bodied consumers** living with short term medical conditions such as broken jaw or gastric banding surgery. These consumers require short term support (typically 1 month).

Care Food Co has two customer² groups.

1. Able bodied consumers **who can** manage their condition themselves.
2. Carers of consumers **who cannot** manage their condition themselves.

¹ Care Food Co define Consumers as those individuals who consumer their products.

² Care Food Co categorize Customers as those people who make a purchase decision.

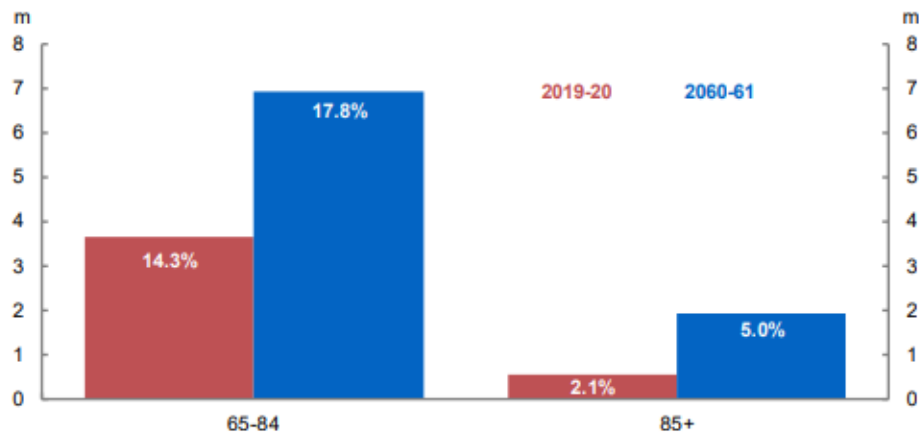
4.1.2 Industry, Economic and Market forces

Today “Around one million Australians have a swallowing difficulty. Swallowing problems can occur at any stage of life. However, the knowledge of dysphagia and its implications remain largely unknown for most Australians [14].”

The 2021 Intergenerational Report [15] commissioned by the Australian Government provides an outlook for the economy and the Australian Government’s budget over the next 40 years. The report identified Australia’s population continues to age with the +65 Cohort expected to represent 23% of the general population by 2060. People are living longer.

2021 Intergenerational Report

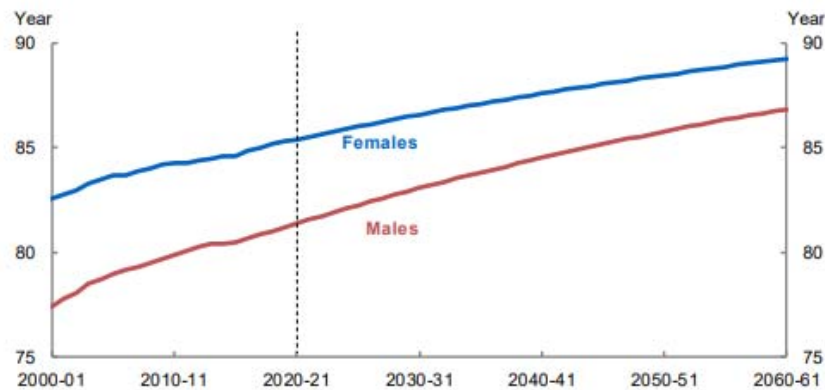
Chart 2.15 Older Australians by level and share of population



Source: ABS National, state and territory population, September 2020, and Treasury.

2021 Intergenerational Report

Chart 2.13 Life expectancy at birth



Source: ABS Australian Historical Population Statistics; ABS Life Tables: States, Territories and Australia, 2016-18; ABS Life Tables, 2017-2019; and Treasury.

Dysphagia is not considered a normal part of ageing; however, it can occur due to the physiological ageing process, especially in people over 80. Older people may have difficulty swallowing (mild) or may not be able to swallow at all (severe) [16].

The ability to swallow can be affected by:

- loss of muscle mass and strength
- fatigue or exhaustion
- loss of dentition
- a decrease in mouth and tongue movements
- changes in eating habits and taste buds (often due to loss of senses of taste and smell)
- extended time in eating and drinking.
- difficulty managing oral secretions.
- food taking longer to travel down the oesophagus to the stomach.

For older people in hospital, swallowing difficulties can prolong recovery time and contribute to functional decline, frailty, and loss of independence. Severe dysphagia is often indicative a person is in the end stage of their disease.

The Safe Swallowing organisation, a Dysphagia Education & International Dysphagia Diet Standardisation (IDDSI) Management resource stated that a significant proportion (16-22%) of Australians over the age of 50 years' experience dysphagia (difficulty swallowing, either solids and/or liquids) [17]. Dysphagia can be caused by a number of age-related health conditions including stroke, Parkinson's disease, dementia as well as a consequence of ageing.

Royal Commission into Aged Care

The Royal Commission into Aged Care defines aged care is not a single service. It is provided over a range of programs and services. The care ranges from low-level support to more intensive services. Aged care includes:

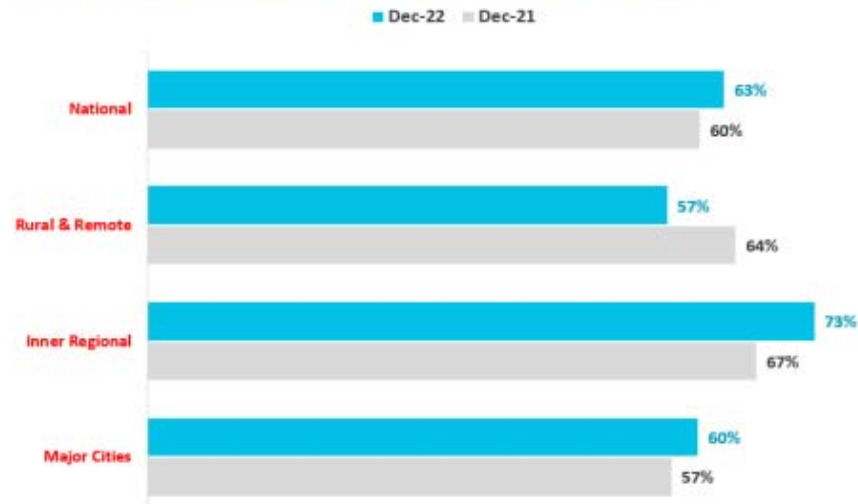
- assistance with everyday living activities, such as cleaning, laundry, shopping, meals and social participation
- respite
- equipment and home modifications, such as handrails
- personal care, such as help getting dressed, eating and going to the toilet.
- health care, including nursing and allied health care.
- accommodation.

Aged care is provided in people's homes, in the community and in residential aged care settings. People commonly think of nursing homes, or residential care, when they think about aged care. However, while most of the aged care budget is spent on residential aged care, more than two-thirds of people using aged care services do so from home.

A December 2022 report on Aged Care Institutional Financial position produced chartered accountancy firm StewartBrown, identified through its industry survey that 63% of Aged Care Institutions in Australia are operating at a loss [18].

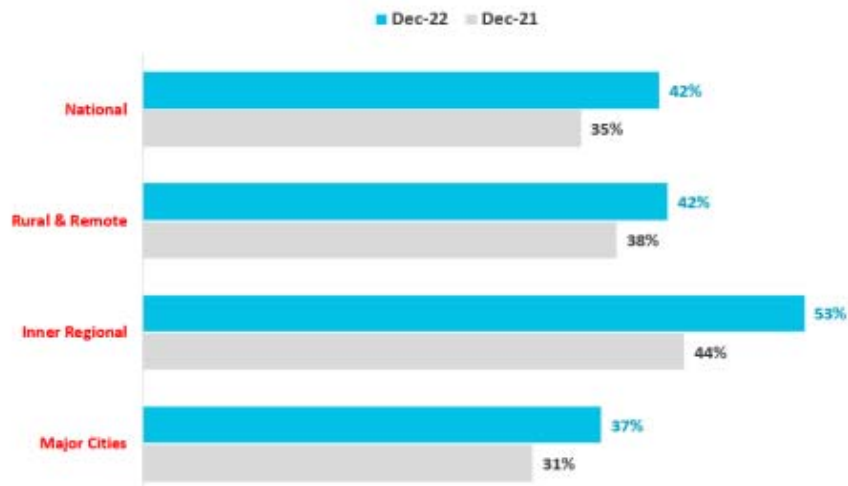
Number of Aged Care Homes making an Operating Loss

Figure 5: Aged care homes making an operating loss by remoteness



Number of Aged Care Homes making an EBITDA loss

Figure 6: Aged care homes making an EBITDA (cash) loss by remoteness

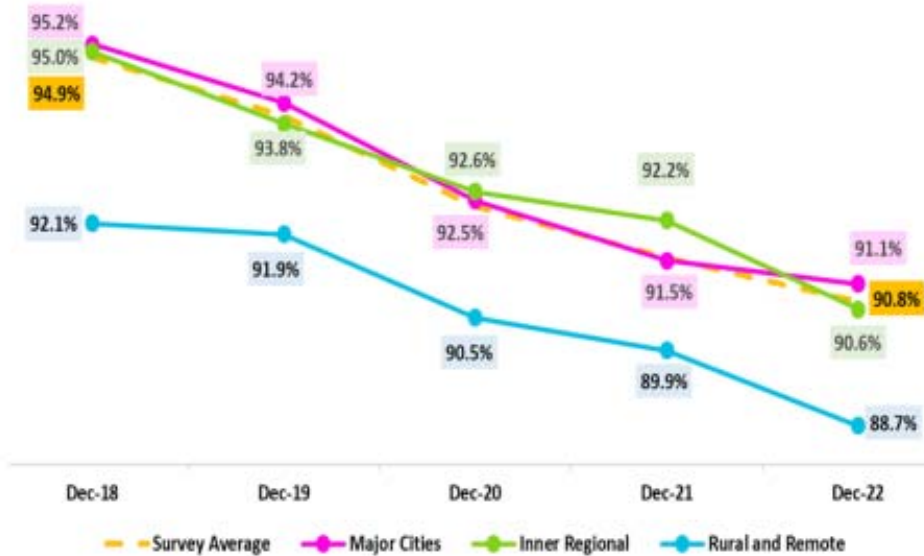


Aged Care Financial Performance Survey Sector Report (December 2022)
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They also found that Residential Aged Care Institution Bed occupancy continues to decline.

Occupancy

Figure 9: Residential Occupancy by region (mature homes)

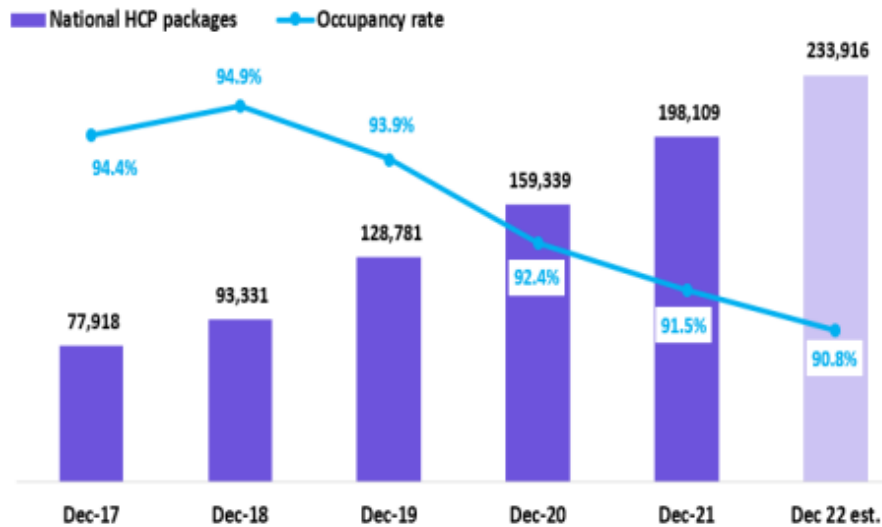


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Home Care Packages continue to grow in line with people’s desire to age at home.

Figure 10: Residential Occupancy comparison to Home Care Packages



These metrics are all indicators that the market for Care Food Co’s product range is going to continue to rapidly increase. With further refinement of the findings from this project, Care Food Co have identified 500,000 units as a sales target within three years. Representing additional \$3,000,000 of red meat sales to an otherwise unreachable market.

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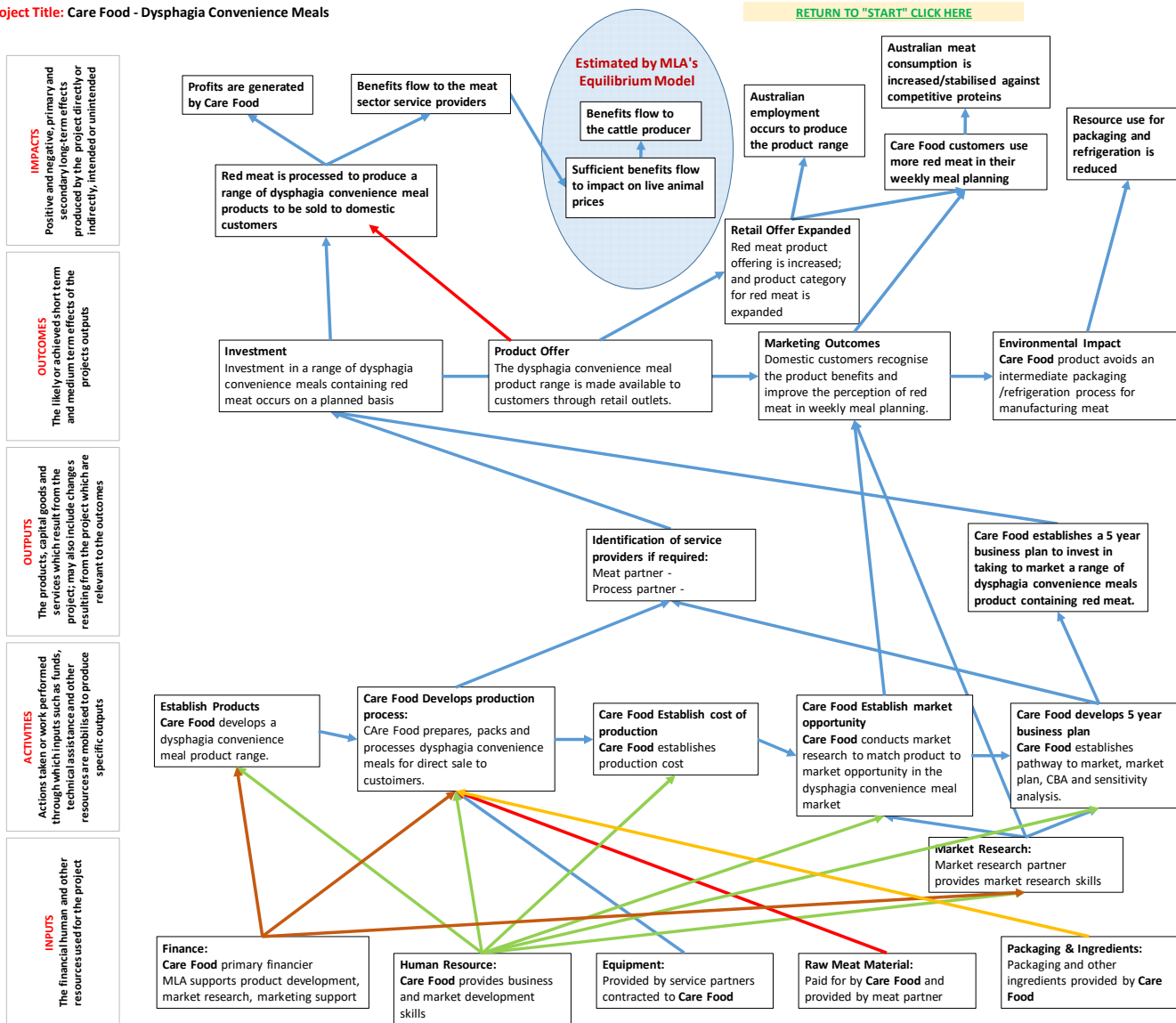
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Appendix 1 Results Chain Analysis

Figure 8. Results Chain Analysis Diagram

Project Title: Care Food - Dysphagia Convenience Meals



The Table below provides a summary of the Impacts resulting from the Results Chain Analysis Model Projection. It needs to be noted that this table is based on a series of ‘best guess’ assumptions. Results alter somewhat when different sensitivities in yield and raw material price are tested, and these are discussed in the report.

Some observations from the Impact table and sensitivity analysis include:

1. Based on the assumptions used in the RCA, the Care Food Co business model is viable and not significantly impacted by the sensitivity analysis that has been conducted.
2. While the red meat benefits may appear limited, the Care Food Co production projections only address about 1% of the entire domestic dysphagia market by year 6-10. This market is actually expected to expand as more cases of dysphagia are diagnosed in the future among the elderly and also among younger people living with major disabilities. This therefore suggests that there is considerable upside for the red meat industry associated with improved access to red meat-based dysphagia protein sachets produced using the technology IP being developed and adopted by Care Food Co.

IMPACTS	Year 2	Year 5	Years 6-10
Carcasses Required (Number)	48	385	687
Beef Processor Benefit (\$A million)	\$0.06	\$0.5	\$1.0
Cumulative Beef Processor Benefit (\$A million)	\$0.1	\$1	\$5
Market Share of Global Market %	0	0	0
Market Share of Domestic Market %	0%	0.3%	1%
Environmental benefits (\$A thousand)	\$1	\$7	\$13

Summary of RCA Impacts