



Final report

Kilcoy Global Foods Nutraceutical Market Evaluation

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Abstract

For many meat companies, 20% of the carcass delivers 80% of its value, with some parts of the carcass attracting little or no value. This is despite red meat organs and glands having a rich content of bioactive compounds which if harvested and further processed could change this mix significantly.

A Dietary Supplements Market Analysis was studied to identify key consumer groups and high growth opportunities within the nutraceutical sector for Australian red meat based bioactives. The global nutraceutical market is expected to grow from US\$353 billion in 2021 to \$US658 billion in 2028 at a compound annual growth rate (CAGR) of 9.3%.

This project looked to understand how underutilised red meat organs and glands can be transformed into nutraceutical ingredients, the costs and returns of doing so, and to identify hurdles to be further addressed.

Trials were conducted to harvest and freeze-dry organs to provide nutraceutical powders for assessment. The harvesting and drying process was costed, and potential yields and revenues determined.

The project determined that the process was technically feasible and commercially viable at the trial site and should be feasible across the whole red meat industry increasing the margin per head for sale of freeze-dried organ powders by 100-400 times compared with rendering, and 5-15 compared with sale as frozen organs.

Despite the current and predicted growth for freeze dried organ powders globally, the market in Australia is still limited. Stronger demand has been identified in the Middle East, Europe, and USA.

Further critical work in identifying, establishing relationships with, and understanding the nutraceutical ingredient supply chain is required and should be the focus of subsequent projects.

Executive summary

Background

Currently, 20% of the carcass delivers 80% of its value, with some parts of the carcass considered as waste, attracting little or no value.

Red meat organs and glands have a rich content of bioactive compounds including proteins, peptides, vitamins, minerals, and other compounds such as carnitine, taurine, creatine, glucosamine sulphate, albumin, collagen peptides, etc.

Organs and glands can be harvested and sold frozen but are often sent to rendering.

The global nutraceutical market is expected to grow from US\$353 billion in 2021 to \$US658 billion in 2028 at a compound annual growth rate (CAGR) of 9.3%. [note: market analysis was derived from Prof Consulting Group report - "Red Meat Based Nutraceuticals", May 2022 and Dietary Supplements – Market Analysis 2022' report].

This project looks to understand how underutilised red meat organs and glands can be transformed into nutraceutical ingredients, the costs and returns of doing so, and to identify hurdles to be further addressed.

The learnings from the project can be used by all red meat producers as a pathway to increase the value returned from each carcass for organs and glands.

Objectives

The aim of this project is to complete a full review of the Kilcoy low value red meat supply chain so that all additional value add opportunities can be identified and evaluated.

Key objectives include:

1. Identify key nutraceuticals market opportunities/barriers/consumer pain points to address for inclusion of beef organ meat and other components.
2. Identify available raw materials and yield and cost impost to harvest and prepare nutraceutical ingredients to desired specifications.
3. Complete a business case, to establish the desirability, feasibility, and viability to establish a commercially sustainable business demonstrating a significant value multiplier for further processing beef organ meat into powders.
4. Develop a network of supply chain partners to procure red meat nutraceutical ingredients necessary to support the consumer demand associated with a range of Australian red meat nutraceutical ingredients.

The first three objectives were achieved demonstrating the potential for significant added value. However, Australian supply chain partners were not identified that were motivated to develop ongoing relationships. Global demand is coming from the Middle East, EU and USA and further work is required to identify and develop relationships with these markets.

Methodology

A Grand View Research 'Dietary Supplements – Market Analysis 2022' report was purchased and studied to identify key consumer groups and high growth opportunities within the nutraceutical sector for Australian red meat based bioactives.

Potential organs and glands were identified from current producer offerings and matched against items being sought in the target nutraceutical market. Eight items were selected for further study determining potential recoveries, yields, current disposition and value, means and costs for harvesting. Freeze-drying trials were conducted to provide dry ingredient samples and determine means and costs for drying, milling, and packing.

A business model was prepared to establish the viability of producing and selling nutraceutical ingredient powders.

Products containing beef nutraceutical ingredients were identified and where possible discussions were held to identify supply chain partners and interest for utilising Australian Made beef nutraceuticals.

Results/key findings

The proteins and amino acids market is expected to grow worldwide from \$9B in 2021 to \$28.1B in 2030, with Asia Pacific alone growing by nearly \$10B.

Where glands and organs are already harvested and packed for frozen sale, no additional processing is required prior to freeze drying. For items not normally harvested additional labour and space for trimming and packing, and/ or reorganisation of the workflow may be required to avoid interruptions to the chain. Pictures of the fresh and freeze-dried organs are shown in Figure 1

Despite additional costs for harvesting, freeze-drying, milling, and packing, significantly higher returns can be achieved, compared with rendering or whole frozen sale.

Depending on the organ, The margin per head (wholesale sales price less additional processing costs) for sale of freeze-dried powders can 100-400 times the margin from rendering, and 5-15 times the margin from sale as frozen organs.

With the establishment of own freeze-drying facility and considering just three organs, with a sales volume of 800 tonnes of freeze-dried powder per annum, an annual revenue of \$34.6 million can be realised. The 10-year NPV calculated is \$9.1 million with an IRR of 20%.

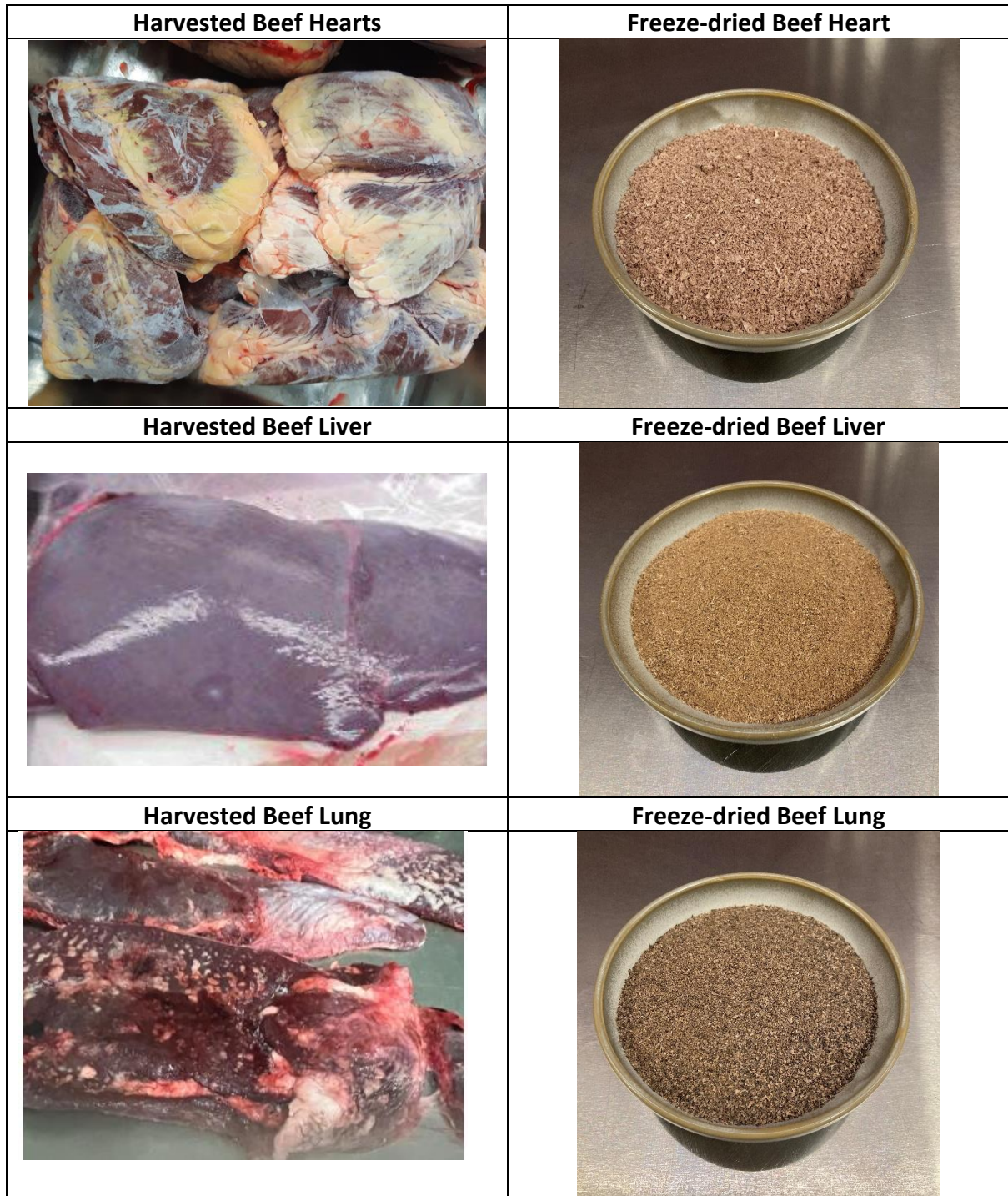


Figure 1 Fresh organs and Freeze-dried powders

Benefits to industry

With a predicted growth at near double-digit levels across each product group, region, and delivery methods for nutraceuticals that may be used to improve health, delay the process of aging, prevent chronic diseases, or support the structure and function of the body there is a growing demand for

sources of proteins and vitamins as ingredients in nutraceutical products. Red meat co-products provide a rich source of proteins, amino acids, vitamins, and bioactive compounds representing a significant opportunity for the red meat industry to provide the nutraceutical industry with valuable ingredients.

This project demonstrates the operational feasibility of harvesting organs and glands from the chain, at the viscera table or from the offal room. Preparation for freeze-drying is no more onerous than when harvesting organs and glands for frozen sale. Items can be stored frozen for freeze-drying. Freeze-drying has shown to be an effective means of converting wet materials to dry milled powders suitable as ingredients for the nutraceutical industry.

The project also determined that the process was feasible at other KGF works and should be feasible across the whole red meat industry increasing the margin per head for sale of freeze-dried organ powders by 100-400 times compared with rendering, and 5-15 compared with sale as frozen organs.

Future research and recommendations

Despite the current and predicted growth for freeze dried organ powders globally, the market in Australia is still limited, with minimal presence on retail shelves. Stronger demand has been identified, in conjunction with a local freeze-drying company, in the Middle East, Europe and USA.

Establishing and developing an ongoing supply relationship with nutraceutical product manufacturers or ingredient suppliers is the greatest hurdle to realising the benefits of this project for KGF and for the Australian red meat industry.

The benefits and nutritional value of red meat organs as a nutraceutical ingredient have been well studied and documented. The technical and operational requirements for harvesting and production of freeze-dried powders have been established.

However, further critical work in identifying, establishing relationships with and understanding the nutraceutical ingredient supply chain is required and should be the focus of subsequent projects. Identifying any local players would determine if local freeze-dried powder sales are possible or if sales must be to overseas markets in the Middle East, Europe and USA.

The marketing and sales processes for dry ingredients is different from sales of red meat and fresh/frozen co products and also from meat and bone meal and tallow. A new understanding and skill set is required to realise the potential value increase to the red meat industry.

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1. Background

According to the MLA 2025 strategic plan, “Currently, 20% of the carcass delivers 80% of its value, with some parts of the carcass considered as waste, attracting little or no value. A focus on market and product diversification could start to shift this mix. Changes in consumer behaviour and lifestyle choices are affecting how, when and why consumers eat certain foods. Current and emerging global trends around convenience, snacking, personalised nutrition and wellness offer new usages and occasions for red meat beyond the traditional centre of plate protein.”

Nutraceuticals is a broad umbrella term that is used to describe any product derived from food sources with extra health benefits in addition to the basic nutritional value found in foods. Nutraceutical products can be considered non-specific biological therapies used to promote general well-being, control symptoms, and prevent malignant processes.

As of 2020, the global nutraceutical market was valued at US\$320 billion. The COVID-19 pandemic has presented an opportunity for significant growth for industries such as pharmaceuticals and nutraceuticals, as consumers increasingly seek health-boosting products. As a result, the global nutraceutical market is expected to grow from US\$353 billion in 2021 to \$US658 billion in 2028 at a compound annual growth rate (CAGR) of 9.3%.

Kilcoy Global Foods (KGF) are in the process of establishing a dedicated innovation team with the intent to fully understand the commercial opportunities that can be achieved through the harvesting of the traditional low value red meat carcass value chain. Recently completed proof of concept projects identified a significant opportunity for Australian producers and processors to generate far greater value from this low value or waste stream. Low value red meat glandules and offal can attract up to 4–10 times the incremental value when diverted into the nutraceutical channel.

The aim of this project is to complete a full review of the Kilcoy low value red meat supply chain so that all additional value add opportunities can be identified and evaluated. These findings will be captured and documented in a business model canvas so that potential next steps can be easily identified and articulated.

2. Objectives

1. Identify key nutraceuticals market opportunities/barriers/consumer pain points to address for inclusion of beef organ meat and other components.
2. Identify available raw materials and yield and cost impost to harvest to desired specifications.
3. Identify key resources and partners required to ideate and develop proof of concepts.
4. Complete Business case, to establish the desirability (product-market fit value proposition), feasibility (technically possible) and viability to scale up (commercially sustainable business model and cost benefit analysis CBA demonstrating value multiplier by further processing beef organ meat into powders/capsules)
5. Develop a network of supply chain partners that are interested in and motivated to procure the required volumes of red meat nutraceutical ingredients necessary to support the consumer demand associated with a range of Australian red meat nutraceutical ingredients.

3. Methodology

3.1 Market Analysis

3.1.1 Nutraceutical Market Analysis

A Grand View Research 'Dietary Supplements – Market Analysis 2022' report was purchased to identify key consumer groups and high growth opportunities within the nutraceutical sector for Australian red meat based bioactives. The insights were interpreted to identify potential increased value opportunities vs the current market value of cuts, co-products, or blood.

Market insights were reviewed by geography, ingredient segmentation, delivery method, and application segmentation.

3.1.2 Capacity Modelling

Key dry ingredient supply companies identified in the research report were contacted for further insights and understanding into establishing strategic raw material supply chains.

Interviews with other companies in the region were also held exploring short term opportunities for supplying unprocessed co-products.

3.1.3 Ingredient Value

The pricing of the retail product offerings identified were used to determine a business-to-business ingredient value to assess profitability of harvesting red meat co-products for supply to the markets identified.

3.2 Supply Analysis

3.2.1 Selection of priority co-product items

Potential organs and glands were identified from current producer offerings and matched against items being sought in the target nutraceutical market. Eight items were selected to study further giving a cross section of larger organs and smaller glands and currently sold products and those habitually rendered.

3.2.2 Weight of harvested items

For co-products currently, or previously, harvested and sold the average item weight was determined from company production data. For items not previously packed trials were conducted to determine weights. Weights were determined for an average 355 kg carcass weight.

3.2.3 Current disposition and value of co-products

The current disposition of items was determined as currently packed and sold wet or rendered. The market value for items sold was determined from current sales or previous enquiries. A render value was determined for all items based on protein and fat content. Values used were for last week of April 2022.

3.2.4 Specifications and requirements for sale

Organ purchase specifications were obtained from an existing Nutraceutical Freeze Drying Company and compared with existing company Beef Offal supply specifications. Where neither specification was available, requirements were extrapolated from existing specifications.

Requirements for materials presented to freeze drying were determined in discussions with an existing freeze dry operator with experience handling beef offal.

3.2.5 Means of Harvesting

Existing methods of harvesting and packing for sale were reviewed and applied to materials for freeze drying. Where materials had not previously been harvested trials were conducted on head chain and viscera table.

3.2.6 Means of converting to dry powder

Existing industry solutions were sought for the most appropriate means of converting frozen organs and glands into a dry milled product for sale as an ingredient to nutraceutical ingredient supply companies.

3.2.7 Harvesting and processing costs

Actual harvesting and packing costs for currently sold materials were applied to materials to be freeze dried. For materials never sold, harvesting trials were used to determine costs, comparing with similar materials. For items that were too large to fit freeze-drying trays additional labour was estimated for slicing and/or dicing before packing. Costs for mincing at freeze drying facility were also obtained, as an alternative.

Costs for freeze drying, milling, and packing were obtained from an existing freeze-drying facility on a toll processing basis.

3.2.8 Margin comparison

For each of the identified items the margins were compared for rendering, selling whole packed and frozen, and selling as a freeze-dried powder.

3.3 Production of Freeze-dried powders

3.3.1 Harvesting for Freeze Drying

Organs and glands of interest identified in milestone 2 were harvested using techniques developed. For the larger organs, around 10 kg of wet product was harvested and around 2 kg for the smaller glands.

Items were packed in plastic lined cartons and frozen upon harvesting, following the method used for preparation for sale of frozen organs.

Any issues with harvesting and preparation were noted.

3.3.2 Freeze Drying Trials

Cartons of frozen items were delivered to Freeze Dry Industries for contract freeze drying.

Frozen items were thawed and dried whole or, for larger items, cut into smaller pieces. Following drying, items were milled, screened, and packed in 1 kg bags.

3.3.3 Freeze-dried powder assessment

The ease of drying was noted, minimum screen size determined, and product yields calculated for each item.

3.4 Customer Discoveries

3.4.1 Ingredient purchasing

After initial discussions with potential value chain partners by Prof Consulting, in depth discussions were held with a customer who manufacture custom nutritional powder blends and source nutritional powders for inclusion in their formulations. The key values and requirements for an ingredient supplier to businesses formulating and preparing nutraceutical products for retail sale were determined.

3.4.2 Specifications and requirements for sale

Based on the customer discussions Freeze-dried ingredient specifications and ingredient attributes were prepared for the freeze-dried organs and glands.

3.4.3 Intended Market

Based on the market research applications and product types were identified where the freeze-dried powders would be sought.

3.5 Regulatory requirements

The freeze-dried offerings were assessed against the requirements of the following codes.

3.5.1 Petfood

The relevant requirements of AS 5812, Australian Standard for Manufacturing and Marketing of Pet Food, for a pet food ingredient were determined.

3.5.2 Food

Requirements in the Food Standards Code for Formulated meal Replacements, Formulated Supplementary Foods and Formulated Supplementary Sports Foods were determined.

3.5.3 Capsules

An assessment of ingredient type for freeze dried organs was made and requirements for encapsulation of powders were determined.

3.6 Value chain design

Key resources and potential partners required to realise recovery of materials and supply of red meat nutraceutical ingredients was determined.

3.7 Cost benefit analysis

3.7.1 Availability of organs and glands for freeze drying

Based on the yields determined in milestone 2 the total availability of each of the target organs, suitable for freeze-drying, was determined based on actual kill figures. The loss due to organs being condemned was determined and deducted from total availability.

Using the freeze-dried powder yields determined in milestone 3 potential availability of freeze-dried powders was determined.

3.7.2 Cost to harvest and freeze-dry.

The costs to harvest and freeze, determined in milestone 2 were used for the CBA. Costs for freeze drying were determined in consultation with FDI. These were compared with other market process costs. Estimates to freeze-dry in own equipment were also determined.

The capacity of FDI to dry organs was also determined.

3.7.3 Market sector / product form

The market sectors were assessed in terms of pricing and ease of product preparation. This included food, pet food, and complimentary medicines. Various delivery forms were considered including powders, sachets, gummies, and capsules.

3.7.4 Forecast sales / Market penetration

For the chosen market sectors, sales estimates were determined over a five-year period. Sales prices were determined from current retail pricing, an estimation of manufacturing costs and manufacturer, retailer mark-ups, and available information on nutraceutical ingredient pricing.

3.7.5 Market and investment readiness

The presence of freeze-dried products on retail shelves was assessed and wholesale channels investigated.

3.7.6 Cost Benefit analysis

The information obtained above was consolidated in a business case model and diversion of organs to nutraceutical powders compared against current sales of frozen organs and rendering.

3.8 Supply chain partners

3.8.1 Potential manufacturers

Products containing beef nutraceutical ingredients were identified and where possible discussions were held to identify supply chain partners and interest for utilising Australian Made beef nutraceuticals.

3.8.2 Potential contract manufacturers

Manufacturers capable of freeze-drying red meat organs were discovered as well as options for encapsulation.

3.8.3 Intended market

Manufacturers of products containing beef nutraceutical ingredients were identified. Global ingredient supply companies were also identified. An assessment was made on the best entry route to the ingredient market and for sale of produced freeze-dried powders.

3.9 Business Model Canvas

In light of new learnings and further review of the market the Business Model Canvas was updated.

4. Results

4.1 Market Analysis

4.1.1 Nutraceutical market analysis

The market analysis report, “Red Meat Based Nutraceuticals”, May 2022, produced by Prof Consulting Group, is included as appendix 1.

Nutraceuticals are classified as substances that have physiological benefits, with the potential to provide protection against chronic diseases. Nutraceuticals may be used to improve health, delay the process of aging, prevent chronic diseases, or support the structure and function of the body.

Globally the market is reported to be over \$151B USD, with strong growth projections to exceed \$327B USD by 2030 as the macro trend towards natural and healthier living continues to outperform traditional food growth.

Nutraceuticals growth is predicted at near double-digit levels across each product group, region, and delivery methods. The Asian market has the highest growth outlook, across almost all product groups. Vitamins and minerals have strong growth forecasts, with protein and amino acids representing a significant opportunity and further align with the beef industry's raw material supply. Retail remains the major channel for OTC supplements.

The proteins and amino acids market is expected to grow worldwide from \$9B in 2021 to \$28.1B in 2030, with Asia Pacific alone growing by nearly \$10B.

More widely, Australian sourced raw material is demanding a premium although not regularly differentiating by breed, feed regime, or husbandry at a retail level in the same way consumers are experiencing the fresh meat experience. There is however growing differentiated ranges by breed, sex, or feed regimes online.

Whilst the regulatory frameworks are mature, providing clarity, the supply chains are fragmented or transactional with the risk to growth being access to consistent quality, volume, harvesting capability and price stability.

Initially targeting the freeze dried B2B market, predictions on increased profitability had been made based on retail prices less margin assumptions. This has highlighted considerable opportunities to increase the dollar returned per carcass processed, the key measure used by the Kilcoy team.

Whilst the process has identified the key global players and the increased demand for raw material, it was not within the scope to introduce suppliers to Kilcoy seeking strategic supply partnerships, or high-volume quality raw material. The report should be used to validate the market opportunity and ability to increase profitability as such warranting further investment in commercial samples and new business support to further engage suitable partners.

4.1.2 Supply chain interviews

Whilst interviews with key supply chain ingredient suppliers did not identify any immediate requirements for red meat co-product supply, useful insights into the way business is done, and hurdles for entry were obtained.

Strategic supply chain opportunities are an important area of focus. Trading relationships are built on key purchase criteria rather than purely priced focus. Recognising the complexity of supplier approval, once gained, business opportunities are longer term. There is an opportunity to better understand the value chain across nutraceutical sourcing. Australian produced / sourced raw materials can demand a premium versus other countries. In these initial discussions it was identified that market is not generally differentiating on production systems such as grass fed or grain fed. However, in later discussions it was found that nutraceutical customers were favouring grassfed over grain, while pet food customers had no such preference.

Not all companies contacted responded within the project timeframe. The project was introduced as an MLA project in conjunction with an Australian meat producer.

4.1.3 Nutraceutical products of interest

Red meat co-products are sought for their rich content of bioactive compounds including proteins, peptides, vitamins, minerals, and other compounds such as carnitine, taurine, creatine, glucosamine sulphate, albumin, collagen peptides, etc. Examples of products are included in the market analysis report.

Retail product forms include freeze dried powders, encapsulated powders, tablets, and liquid shots.

Raw materials sold containing these bioactives include kidneys, liver, heart, spleen, pancreas, thymus, lung, thyroid, and adrenal glands.

The form of bioactive ingredient sold into the manufacturers of these products is as a dried, generally freeze-dried, powder. As a dry powder the ingredients are shelf stable and easily handled. If KGF were to enter the supply chain, the raw organs and glands would need to be dried.

4.1.4 Ingredient value

As no comprehensive pricing for dried nutraceutical ingredients was able to be obtained from ingredient suppliers, retail pricing for the products of interest were obtained. As a forecast of retailer and brand owner margin the retail price was deducted by 70% to give an ingredient sale price.

For the products of interest, the following B2B prices have been determined, Table 1. Calculations are included in Supply Analysis workbook, appendix 2.

Table 1 Nutraceutical ingredient pricing

Freeze Dried Ingredient Powder	B2B pricing (A\$/kg dry powder)
Liver	\$132
Lung	\$484
Spleen	\$284
Pancreas	\$297
Thymus	\$627
Heart	\$124
Thyroid gland	\$654
Adrenal gland	\$268

4.2 Supply Analysis

4.2.1 Selection of priority co-product items

Information on a wide variety of co-products was compiled with known information on yields, value to pack and sell, and current disposition of items, i.e., packed and sold, or rendered.

The following eight items were chosen for closer analysis, being those identified in the market analysis as retail products of interest, as well as giving a range of different materials to harvest. Some being large and already harvested, those not currently harvested with low packing value, to those more difficult and more time consuming to harvest. The items chosen are shown in Table 2.

Table 2 Priority co-product items

Material	Current disposition
Adrenal Gland	Rendered
Thyroid Gland	Rendered
Thymus	Rendered
Pancreas	Rendered
Spleen	Rendered
Liver	Packed
Lung	Packed
Heart	Packed

4.2.2 Weight of harvested items

The carcass weight for animals slaughtered at Kilcoy is reasonably consistent and only one weight range, with an average carcass weight of 355 kg is required. Weight of harvested items is based on this body weight.

For several items currently packed, the average item weight could be obtained from production data. Some other items had previously been assessed to determine the value of packing. New trials were conducted to determine weights for Adrenal glands, thyroid glands, and pancreas.

Material yields, kg per head, and recovery per day, are shown in Table 3.

Table 3 Weight of harvested items

Material	Yield, kg/head	Recovery, kg/day
Adrenal Gland	0.028	39
Thyroid Gland	0.060	84
Thymus	0.178	249
Pancreas	0.450	630
Spleen	1.380	1932
Liver	6.920	9688
Lung	2.300	3220
Heart	2.410	3374

4.2.3 Current disposition and value of co-products

Rendered values were calculated based on the protein and fat content of items. The MBM and Tallow values used were as at 28/04/2022. Changes to these values will affect the value to rendering. The impact of pricing is therefore periodically monitored and preferred disposition reviewed. Details of the value calculations are included in the Supply Analysis Workbook, appendix 2. A comparison of margins for rendering, packing and freeze drying is included in Table 5.

4.2.4 Specifications and requirements for sale

Specifications for raw materials purchased by one manufacturer for freeze drying into nutraceutical products were obtained for Heart, kidney, liver, pancreas, and spleen. Copies are included in appendix 3.

The key requirements common to all materials is that the item is trimmed free of fat and extraneous tissues. Fat remains unchanged during the freeze-drying process and can cause problems when milling and sieving. Excess fat on the raw material will likely cause the dry powder to exceed limits for fat in the powder specification.

The specifications for freeze drying were compared with KGF specifications for packing and sale. As for the freeze-drying specifications, the same common requirements, for the item are to be trimmed free of fat and extraneous tissues, are also included in the KGF specifications. Therefore, if the material is suitable for packing it will be suitable for freeze drying. KGF Specifications are included as appendix 4.

Customer specifications for freeze dried powders were not obtainable in this stage of the project but will be required when assessing customer acceptance in milestone 3.

4.2.5 Means of harvesting

Liver, lung, and heart are already currently being harvested and packed for sale. Additional labour is stationed at the viscera table to separate and trim the organs which are then sent via chute to the offal room below. In the offal room further labour collect the organs from a conveyor and pack into cartons. Cartons are closed and sent for freezing and sale.

The thymus and spleen are sometimes harvested for sale, when returns are favourable, in the same manner as the organs above.

Adrenal and thyroid glands have been studied previously to determine value for packing. Further trials were conducted to confirm requirements for harvesting. Adrenal glands can be separated on the viscera table and sent to the offal room for packing.

The thyroid currently travels with the tongue root which is separated from the head on the head chain and sent via a chute to the offal room for packing. The thyroid could be separated from the tongue root while on the chain or when root arrives in offal room.

The pancreas has never been harvested. Trials were conducted to identify and separate the pancreas. Again, this can be achieved on the viscera table and sent to the offal room for packing.

The requirements for removal, trimming and packing for freeze drying are similar to those for packing and the same processes can be used. However, as more items are harvested and packed for sale or freeze-drying, space on the viscera table and offal room becomes limiting. There is no dedicated location for trimming, and this must be done on viscera or offal lines without interrupting or slowing the chain. If harvesting becomes a greater part of operations the whole workflow and space will need to be reviewed.

For the larger items it will be necessary to reduce the size of the organs to fit on the trays in the freeze dryer. The maximum height on the tray is 27 mm. Often this is done by mincing, and this can be done by the freeze-drying company. Alternatively, the organs can be sliced or diced prior to being packed, although current space for this is limited.

The current means of harvesting for packing and sale can be used for harvesting for freeze drying, with additional slicing for larger items. Depending on the total number of items harvested, additional space or reorganisation of the workflow will be required to avoid interruptions to the chain.

A process map is included as appendix 5.

4.2.6 Means of converting to dry powder

The most common method utilised for drying organs and glands, while preserving the nutritional and bioactive attributes, is freeze drying.

The market analysis revealed that whole animal co-product powder ingredients were obtained by freeze drying.

One company in New Zealand advised that they use freeze drying exclusively for preparation of freeze-dried animal and plant products for supply to the nutraceutical industry. Another freeze-

drying company in Queensland advised that more and more of their business is in freeze drying animal co-products.

On this basis, freeze drying was chosen as the preferred means of preparing wet organs and glands for supply to the nutraceutical industry.

Requirements for the preparation of materials for freeze drying were obtained from a local Queensland company. The only additional requirements beyond those for currently packed products is reducing the size to meet the height restriction (27mm) when product is placed on trays for drying.

Eliminating extraneous fat from the materials is critical in obtaining a free-flowing product meeting nutraceutical ingredient specifications.

4.2.7 Harvesting and processing costs

As the requirements for harvesting and packing for sale are equivalent to those for harvesting for freeze drying, costs for packing can be used for both options.

Costs for harvesting items not currently packed were calculated on the same basis using existing models for assessing viability of packing for sale.

Costs for additional size reduction, by slicing or dicing, were determined based on one additional labour unit. As it is not yet decided for which items freeze drying will be used the additional labour is applied individually for each item. The additional labour may be able to slice more than one item or the item maybe able to be sliced at the time of trimming by the same labour unit. That is, the most costly scenario has been used.

Costs for offsite mincing, freeze-drying, milling, and packing were obtained on a toll processing basis from a local Queensland freeze-drying company familiar with drying animal organs. Charges for freeze drying are for a 1000 kg batch. A breakdown of costs is included in the Supply Analysis Workbook, appendix 2.

The costs for harvesting and packing alone and costs for harvesting, packing, and freeze-drying are summarised in Table 4.

Table 4 Comparison of costs for packing and freeze drying, \$/kg RM

Material	Additional cost to	
	Harvest and pack	Harvest and freeze-dry
Thyroid Gland	8.17	14.12
Thymus	11.51	17.46
Pancreas	1.09	7.04
Adrenal Gland	17.50	23.45
Spleen	0.36	6.66
Liver	0.18	6.20
Lung	0.53	6.69
Heart	0.23	6.38
All costs are A\$ per kg of raw material		

4.2.8 Margin comparison

For each item considered three options were compared. 1) The value if item is rendered, providing a contribution to the tallow and MBM yield based on fat and protein content. 2) the value as an item packed and sold raw frozen. 3) the value of an item sold as a freeze-dried powder.

The margin, sales price less additional processing cost, is compared in Table 5 as A\$ per kg of raw material and as A\$ per head. Livers, lungs, and hearts are currently packed and sold while the other items are currently rendered.

Table 5 Comparison of Margins, \$/kg RM & \$/head

Material	Margin, \$ per kg raw material		
	Render	Pack	Freeze-dry
Thyroid Gland	0.50	18.83	227.01
Thymus	0.56	-3.01	193.76
Pancreas	0.22	-1.09	102.23
Adrenal Gland	1.07	-6.50	75.16
Spleen	0.25	0.64	62.14
Liver	0.31	2.32	35.38
Lung	0.21	4.72	23.70
Heart	0.42	3.27	23.70

4.2.9 Business model canvas

A business model canvas is included as appendix 6.

4.3 Production of freeze-dried powders

4.3.1 Harvesting for freeze drying

The organs and glands harvested for freeze-drying trials are listed in Table 6 below. The table also shows the amount collected and carcass numbers required to achieve harvested weight.

Table 6 Items harvested for freeze-drying

Material	Current disposition	Harvested weight, kg	No. of carcasses
Adrenal Gland	Rendered	2.730	98
Thyroid Gland	Rendered	2.710	45
Thymus	Rendered	9.990	56
Pancreas	Rendered	5.890	13
Spleen	Rendered	11.500	8
Liver	Packed	11.980	2
Lung	Packed	12.79	6
Heart	Packed	9.950	4

The liver, lung, and heart are normally harvested and packed for sale and no issues were encountered. Few organs were required to achieve target weight. The spleen is sometimes harvested and packed for sale and again no issues were encountered. No problems were encountered trimming these larger organs of excess fat and connective tissue.

While the pancreas is not difficult to harvest, even the small number harvested required extra labour to keep pace with the viscera table. KGF currently has no dedicated station for trimming and packing the pancreas. Ongoing recovery would require additional labour and establishment of a packing area in the offal room.

The thymus gland, or sweetbread, is sometimes harvested and packed for sale. Its small size (170 g) and lobulated form make the thymus difficult to trim of excess fat. And with around 20% fat this gland may not be suitable for freeze drying.

The thyroid gland is around 60 g per head requiring 45 bodies to recover 2.7 kg for freeze drying. The thyroid is attached to the tongue root which is sent to the offal room for packing. The lack of a dedicated space and room for harvesting the thyroid was the main issue encountered.

Similarly, the adrenal glands weigh around 30 g per head requiring 98 bodies to recover 2.7 kg for freeze drying. Adrenal glands need to be harvested from the viscera table. Again, extra labour is required to harvest and there is no chute or facility to send to and pack in offal room. Ongoing recovery would require additional labour and establishment of a packing area in the offal room.

Once packed, the harvested glands and organs can be frozen and stored as per raw organs normally sold packed and frozen.

4.3.2 Freeze-drying trials

Based on initial discussions with Freeze dry Industries it was anticipated that the whole organs would be minced frozen at the freeze-drying site. This is the practice at a New Zealand freeze-drying facility also. However, for the trial the organs were thawed and separated and dried whole, except for the larger items which were cut into smaller pieces to fit the trays.

The dried organs maintained a similar size and shape of the original wet organ. Photos of the wet and dried organs can be found in the report attached as Appendix 7

After drying the organs were then milled and screened. Photos of the milled powders and screen used are also shown in Appendix 7.

Freeze dry Industries reported that all products dried as expected and all were milled successfully, except for the thymus due to the higher fat content. The product outcomes were comparable to other red meat organs dried on site.

Where possible the dried organs were milled to pass through a 2 mm screen. However, some of the products were more difficult to mill and coarser screens were required.

4.3.3 Freeze-dried powder assessment

Organs with a higher fat content are more pliable, do not fracture to such fine particles, and hence do not pass through a 2 mm screen. Lungs and liver went through the 2 mm screen without issue. Adrenal glands, thyroid glands and hearts were passed through a 5 mm screen. These organs and glands have less than 5% fat. The pancreas and spleen went through a 10 mm screen. The pancreas will have around 18% fat. The spleen will normally average around 3% fat so should have been easier to mill. Additional trimming of the spleen may be required before freeze drying.

The higher fat content (20%) of the thymus meant that it was not possible to mill the dried organs to a powder, a thick fatty paste was generated in the mill and blocking the screen. This can be seen on page 7 of the report included as Appendix 1

In milestone 2 the expected moisture content of each organ was established from industry data and used to determine a freeze-dried powder yield per kg of wet material.

In the freeze-drying trials actual yields were determined from the weight of powder packed after drying, and wet organ weight received. On average, the actual yield was 20% less than the calculated yield. The difference is likely to be a difference in actual raw moisture of organs harvested and some losses during milling and screening. For heart the actual yield was 30% higher than calculated. As no dry powder was recovered a yield for the thymus could not be determined.

A summary of the freeze-drying data is shown below in Table 7.

Table 7 Freeze Drying Data

Material	Wet weight, kg	Dried weight, kg	Actual Yield kg FD/kg RM	Expected Yield kg FD/kg RM	Screen size, mm
Adrenal Gland	2.730	0.480	0.176	0.368	5
Thyroid Gland	2.710	0.650	0.240	0.368	5
Thymus	9.990	-	-	0.337	-
Pancreas	5.890	1.770	0.301	0.368	10
Spleen	11.500	2.250	0.196	0.242	10
Liver	11.980	2.760	0.230	0.316	2
Lung	12.79	2.290	0.179	0.211	2
Heart	9.950	3.100	0.312	0.242	5

The supply analysis workbook, prepared in milestone 2, was updated with the actual yields from the freeze-drying trials.

4.4 Customer discoveries

4.4.1 Ingredient purchasing

Steggall Nutrition Formulate premixes to a specific nutritional profile, manufacturing custom nutritional powder blends, Sports Nutrition blends, Formulated Meal Replacements, Nutritional Drinks, Multivitamin Supplement blends, Formulated Supplementary Foods, Formulated Supplementary Sports Foods. Product health benefits include improving heart health and immunity.

Products are usually powders intended for mixing with hot or cold water to make a beverage, 30 g in 200 mL of water. The 30g serve includes 1-2 g of active ingredients. The bulk could be a protein powder (whey) and high fibre ingredient.

Suppliers can provide bulk products like whey protein concentrate, source of protein, or high fibre ingredients. Other suppliers provide active ingredients bringing particular health benefits. KGF freeze-dried powders would fit into this latter category.

Demand is for high protein or high fibre ingredients. No demand for carbohydrate sources. Formulators strive to minimise carbohydrate content.

Suppliers of active ingredients supply their products in 1 to 5 kg pouches, boxes etc depending on the dosage and value.

When offering a new nutraceutical ingredient to a prospective customer a product sample needs to be offered. For active ingredients 50-100g is normal, depending on the value. For KGF freeze dried organs 100 g would be suitable and for the glands 50 g.

An ingredient brochure should describe the particular functionality of the ingredient and the benefits the ingredient brings to the consumer. For example, that Beef Heart is the richest source of naturally occurring co enzyme Q10 in nature. CoQ10 plays an important role in the body's metabolism. Can also lower blood pressure and can slow Alzheimer's disease.

Sourcing and provenance etc. should also be promoted.

Together with the sample and brochure, an ingredient specification and commercial information on pricing and supply is sought.

4.4.2 Specifications and requirements for sale

Steggall Nutrition also advised that, for compatibility in the blended formulation, powdered ingredients should ideally pass through a 16 mesh (1200 microns) screen. Some ingredients can be up to 4 mesh (5 mm). The main concern is that powders are free flowing. Particle size range should be included on specification. This may need further assessment for the higher fat ingredients which would not pass through a 5 mm screen.

Dissolvability of ingredient important. If too fine, powder can clump on surface and be difficult to stir into solution. This is not so important for minor ingredients which are dispersed through the bulk ingredients.

For active ingredients there is not much expectation on tasting good or having nice flavour. These flavours can be masked in the mix formulation.

Model Freeze-dried powder specifications are included in Appendix 8. As well as required information for completion of final product Nutrition Information Panel (NIP) the specification indicates the key measurable minor nutrients. Microbiological parameters are also listed. Values are indicative and will need to be confirmed with additional testing of further dried samples.

A collection of claimed benefits for freeze-dried beef organs has been compiled for use in product brochures and is attached as Appendix 9.

As well as being high in protein (>50%), Beef organs are good sources of highly absorbable fat-soluble vitamins, B group vitamins, Co enzyme Q10, choline, and minerals such as selenium, improving health and immunity.

4.4.3 Intended market

While the intended market is for human consumption, freeze-dried beef organs are also included in many pet food products and could be considered as a potential market.

For human consumption powders may be utilised as ingredients in Nutritional powder blends such as Formulated Meal Replacements, Nutritional Drinks, Multivitamin Supplement blends, Formulated Supplementary Foods, Formulated Supplementary Sports Foods.

Dried organ powders are also sold encapsulated, either alone or mixed with liver powder.

4.5 Regulatory requirements

4.5.1 Petfood

The requirements for the manufacturing and marketing of pet food in Australia is specified in the Australian Standard (Standards Australia, 2017).

A pet food ingredient is a nutritive component part or constituent of any combination or mixture making up a pet food.

The prescribed name of an ingredient is defined in the provisions of the FSANZ Australia Food Standards Code.

All raw materials used in the manufacture of pet food shall comply with the relevant Australian regulations.

Specifications of the ingredients should be provided to manufacturers.

Freeze-dried powders meeting the requirements of the Food Standards Code will be suitable for inclusion in pet food formulations.

4.5.2 Food

Foods for the intended market of supplementary foods are covered in the (Food Standards Australia New Zealand)

- Standard 2.9.3 Formulated meal replacements and formulated supplementary foods
 - 2.9.3—3 Compositional requirements for formulated meal replacements
 - 2.9.3—5 Compositional requirements for formulated supplementary foods
- Standard 2.9.4 Formulated supplementary sports foods
 - 2.9.4—3 Composition of formulated supplementary sports foods

The general requirement is that a serving of such foods contributes a minimum amount of protein and 20% RDI of at least one vitamin or mineral listed in schedule 29 of the code.

Freeze-dried beef organs would meet the requirements of the Food Standards Code and provide useful ingredients to manufacturers formulating and manufacturing such products.

4.5.3 Capsules

In Australia, a sports supplement, or supplementary food, can be classified as either a food or medicine. How it is classified depends on factors including the products ingredients and how it is presented, including the dosage form, e.g., capsule, tablet, food bar, powder etc.

Supplements that contain ingredients that have stimulant or other drug-like effects, such as changes to hormone levels, or are in a medicinal dosage form (e.g., tablets, pills and capsules) can present a higher risk to the consumer and it is therefore inappropriate to have them available for purchase as foods.

Sports supplements will be regulated by the TGA as therapeutic goods if:

- they are presented in the medicinal dosage form of a pill, tablet or capsule, or
- their ingredients are higher risk to consumers

Therefore, the same freeze-dried beef organs, when presented in a tablet or capsule are regulated by the TGA as a medicine and must be manufactured and marketed under the requirements of the TGA under the Therapeutic Goods Act (TGA, 1989).

A complementary medicine is defined in the Therapeutic Goods Regulations 1990 (TGA, 1990) as a therapeutic good consisting of one or more designated active ingredients. Schedule 14 of the regulations lists the designated active ingredients.

Freeze dried beef organs come under item 10

10. non-human animal material (or a synthetically produced substitute for material of that kind) including dried material, bone and cartilage, fats and oils and other extracts or concentrates

These low-risk ingredients can be used in complimentary medicines. The complimentary medicines must be listed on the Australian Register of Therapeutic Goods (ARTG) and must be manufactured in accordance with the principals of GMP in a TGA licenced facility.

To utilise the animal derived ingredient, the supplier must provide supporting documents to allow the manufacturer to gain a pre-clearance certificate. These documents must include a veterinary certificate indicating animals have been subjected to ante- and post-mortem examination and satisfy health requirements for human consumption. · Evidence that the tissues have been procured in Government approved facilities.

4.6 Value chain design

Table 8 Value Chain Design

Product Development	Determination of nutritional properties and benefits Determination of product variability, establishment of limits, product functionality, customer requirements				
Harvesting	Freeze-drying	Packing	Testing Analysis	Outbound Logistics	Marketing Sales
Capacity Planning Infrastructure Labour Storage	Production Control Scheduling	Packaging requirements Pack sizes Artwork	Control of fat, protein level. Nutritional monitoring	Storage Dispatch Delivery	Specifications Brochures Customer identification Order taking Sales analysis

4.6.1 Harvesting

KGF have the existing capability to harvest, trim pack and freeze beef organs and glands. Where an identical item is currently harvested for sale, the item can be redirected for freeze drying without change. For items not currently harvested, additional space and handling facilities are required around the viscera table and in the offal room to allow continual recovery without affecting existing operations or chain speed.

4.6.2 Freeze-drying

Freeze Dry Industries currently freeze-dry meat products and have the capability to mince, dry, mill and pack KGF organs and glands. Depending on customer packing requirements additional packing capability may be required at FDI, KGF or another location. Individual packs may be packed in cartons for shipment.

Packaging requirements and design will need to be determined.

4.6.3 Sale for food and pet food

Once packed, the red meat nutraceutical ingredients are ready for distribution to customer locations. A dry powder storage and dispatch facility would be required at KGF or 3rd party.

Marketing and sales resources, conversant with the benefits and requirements of the red meat nutraceutical ingredients, would need to be established within KGF.

More extensive testing and analysis of each the offerings will need to be conducted to establish key benefits for inclusion in customers' formulations.

Sales, technical, and promotional materials will need to be developed to promote key messages and benefits of offerings.

4.6.4 Sale for capsules

If sold as a bulk ingredient, requirements for the sale of red meat nutraceutical ingredients for encapsulation would be no different than for sale as a food ingredient. Animal product documentation requirements may differ.

If KGF decide to market their own encapsulated ingredient brand then KGF would need to contract a TGA licenced manufacturing facility to prepare, blend, encapsulate, pack, and distribute the capsules.

It is still to be determined who can register the complimentary medicines on the Australian Register of Therapeutic Goods (ARTG), KGF or the contract facility.

4.7 Cost Benefit Analysis

4.7.1 Availability of organs and glands for freeze drying

In milestone 3, eight glands and organs were selected for freeze-drying trials being:

Liver, lung, heart, thyroid gland, pancreas, spleen, adrenal gland, and thymus. The higher fat content of the thymus meant it was not possible to mill the dried thymus to a powder and thymus was eliminated from the potential organs for sale.

The low recovery per head and difficulty in harvesting from the viscera table eliminated Adrenal glands. Additional labour and infrastructure would be required. Adrenal glands have been eliminated at this time.

Spleen, packed frozen, is sold out for 2023 and was also eliminated.

The thyroid and pancreas were later removed from the business case as there was no evident shelf presence or market data for these items and additional infrastructure required for their harvest.

Liver lungs and hearts are currently harvested for frozen sales and were selected for the business case analysis.

Not all organs harvested are available for conversion to nutraceutical products with varying percentages condemned. Based on 338 days worked the potential annual availability of frozen organs and freeze-dried powder is shown in Table 9

Table 9 Potential annual freeze-dried volumes

Material	Recovery per year, tonne	Condemn rate %	Packable tonnes p.a	Freeze dried Yield %	Freeze dried powder, tonne p.a.
Adrenal Gland	13	0	13	18	2.3
Thyroid Gland	27	0	27	18	4.9
Pancreas	208	0	208	30	62
Spleen	630	6.5	589	19	112
Liver	3158	24	2400	23	552
Lung	1049	37	661	17.9	118
Heart	1100	1.43	1084	31.2	338
Sum Liver, lung, heart			4145	24	1008

4.7.2 Cost to harvest and freeze-dry

In milestone 2, the costs to harvest individual items was determined based on actual costs to harvest organs for frozen sale or through trials to determine required labour and packaging.

In milestone 4 a cost benefit analysis needs to compare the alternative of freeze-drying organs for sale as a dry powder against the current supply of whole frozen organs. Therefore, for the three selected organs, liver, lung, and heart, a comparison can be made by “selling” the frozen organs to the freeze-drying operation, instead of to external customers. The following values, or material costs, have been applied to the organs based on the 2023 budget sales value, and shown in Table 3.

In the first two years of the business case the lower volumes allow for the use of a contract freeze-dryer in Queensland. The cost to mince, dry, mill and pack is \$6.45 per kg of raw material. In year 1 12 tonnes of wet material will be processed and in year 2 20 tonnes.

In years three onwards the volumes to dry exceed the capacity of a toll processor and the business case assumes the installation and operation of a dedicated freeze-drying facility. In year 3 50 tonnes and in year 4 on, 70 tonnes of wet material will be processed.

A 1 tonne freeze drying unit can dry 5 tonnes of raw material per 5-day week. For year 3, 13 by 1 tonne units are required. In year 4 on, 18 units are required. At full capacity 5 operators are required to run the drying units, over 5 days per week, plus 2 packing operators.

The associated operating costs for own freeze-drying, at full capacity drying 70 tonne of raw material per week, are shown in table 10.

Table 10 Own Freeze-drying Costs

Activity	\$ per kg of wet material
Freeze-dryer running cost	0.20
Product packaging cost	0.18
Freeze-dryer labour	0.15
Packing labour	0.06
Freeze drying supervisor	0.04
Total Operation costs	0.64

Costs, per kg of raw material, to harvest and freeze dry each of the three raw materials is summarised in Table 11.

Table 11 Manufacturing costs FD powders

Material	Material Costs \$/kg	Toll drying, \$/kg	Own drying, \$/kg
Liver	2.03	6.45	0.64
Lung	4.64	6.45	0.64
Heart	3.40	6.45	0.64

4.7.3 Market sector / product form

Opportunity exists for KGF to enter the growing dietary supplements market through the sale of freeze-dried organs for the nutraceutical market. The predominant product form is encapsulated organ powders, singularly or mixed, or in tub packs for home use. KGF has the option to supply to a wholesale ingredient distributor or to capsule manufacturing of a nutraceutical product as a white label product into wholesale or a private brand into the retail market.

The global dietary supplements market is expected to grow from \$152B in 2021 to \$327B in 2030. The CAGR% (2021-2030) for Asia Pacific is 12.5%. Within the global dietary supplements market the proteins and amino acids market is expected to grow worldwide from \$9B in 2021 to \$28B in 2030, with Asia Pacific alone growing by nearly \$10B.

4.7.4 Forecast sales / market penetration

For thyroid and pancreas there was no evident shelf presence or market data for these items.

Selected sales items, which currently have a market presence are freeze dried powders of grain fed beef liver, heart, and lung.

For the cost benefit analysis sales have been based on the available volumes of organs from The Kilcoy plant. It is assumed that this volume can be absorbed into the global market. First year sales have been estimated at 12% of potential volumes for the three identified sales items. Growth is based on freeze-drying capacity and growth in market share, reaching full capacity in year 4. Forecast weekly and annual sales of freeze-dried powders are shown in tables 12 and 13.

Table 12 Forecast Weekly Sales Freeze-Dried Powders

Material	Year 1 kg p.w.	Year 2 kg p.w.	Year 3 kg p.w.	Year 4 on kg p.w
Liver	920	1533	4169	7738
Lung	716	1193	2466	2466
Heart	1248	2080	5647	7046
Total	2884	4807	12,282	17,249

Table 13 Forecast Annual Sales Freeze-Dried Powders

Material	Year 1 tonne p.a.	Year 2 tonne p.a.	Year 3 tonne p.a.	Year 4 on tonne p.a
Liver	44.160	73.604	200.100	371.419
Lung	34.368	57.283	118.351	118.351
Heart	59.904	99.845	271.066	338.195
Total	138.432	230.732	589.517	827.964

Additional volumes could be sourced from other KGF works with additional dryer capacity to match. There is potential to expand this further with organ material from other producers.

4.7.5 Market and investment readiness

Despite the current and predicted growth for freeze dried organ powders globally, the market in Australia is still limited, with minimal presence on retail shelves. Most local availability of even locally produced brands is via internet sales. This is in contrast to overseas locations identified in Milestone 2. Stronger demand has been identified, in conjunction with a local freeze-drying company, in the Middle East, Europe and USA.

KGF has therefore determined the best sales channels is through global wholesale ingredient suppliers for export sale.

4.8 Supply Chain Partners

4.8.1 Potential manufacturers

A potential Australian manufacturer of encapsulated nutraceutical products has been identified as a target customer or for toll encapsulating. However, given the low presence of encapsulated product on local retail shelves the timing is considered too early. Further discussions will be held later in the year.

Globally, manufacturers such as Amway, Abbott, GSX and Pfizer have been identified as utilising beef organ powders for European and USA markets.

4.8.2 Intended market

While the intended market is for human consumption, freeze-dried beef organs are also included in many pet food products and could be considered as a potential market.

For human consumption powders may be utilised as ingredients in Nutritional powder blends such as Formulated Meal Replacements, Nutritional Drinks, Multivitamin Supplement blends, Formulated Supplementary Foods, Formulated Supplementary Sports Foods.

Dried organ powders are also sold encapsulated, either alone or mixed with liver powder.

For the business case, the anticipated market is to wholesale supply to ingredient suppliers such as ADM, Bayer, and Pharmavit for export sale as ingredients to more established markets in Europe,

USA and Middle East. Locally these suppliers sell onto end product manufacturers such as Natural Vitality and Vitex Pharmaceuticals. And sold through chains like Chemist Warehouse and Woolworths. As the market matures it is anticipated that greater volumes can be supplied locally.

4.9 Business model canvas

The Business Model Canvas, initially developed in Milestone 2, has been updated and included as Appendix 10

5. Conclusion

5.1 Key findings

- Nutraceuticals are classified as substances that have physiological benefits. Globally the market is reported to be over \$151B USD, with strong growth projections to exceed \$327B USD by 2030 as the macro trend towards natural and healthier living continues to outperform traditional food growth.
- The proteins and amino acids market is expected to grow worldwide from \$9B in 2021 to \$28.1B in 2030, with Asia Pacific alone growing by nearly \$10B, representing a significant opportunity for the beef industry's raw material supply. Australian sourced raw material is demanding a premium.
- Red meat co-products are sought for their rich content of bioactive compounds including proteins, peptides, vitamins, minerals, and other compounds such as co-enzyme Q10, choline, carnitine, taurine, creatine, glucosamine sulphate, albumin, collagen peptides, etc.
- Nutraceutical ingredient supply chains are fragmented or transactional with the risk to nutraceutical product growth being access to consistent quality, volume, harvesting capability and price stability. While this may present challenges to establish robust supply chains, opportunity exists to provide consistent supply of quality raw materials. Trading relationships are built on longer term partnerships.
- Where glands and organs are already harvested and packed for frozen sale, no additional processing is required prior to freeze drying. For items not normally harvested additional labour and space for trimming and packing, and/ or reorganisation of the workflow may be required to avoid interruptions to the chain.
- Organs can be stored frozen until ready for freeze-drying from the frozen state. Partial thawing and mincing is required immediately prior to loading drying trays.
- The suitability of organs for freeze-drying and grinding to a fine powder (<2mm) is dependent on the organ fat content. Organs such as the thymus, with 20% fat, are unsuitable for drying and milling. Organs with lower fat content, <10%, are readily dried and milled.
- There are no regulatory hurdles preventing sale of red meat nutraceutical ingredients to the food, pet food and complimentary medicines markets.

- Freeze-drying can be conducted by third party freeze-drying companies. However, there is limited capacity in Australia for higher volumes requiring the installation of own, or JV, facilities.
- Despite additional costs for harvesting, freeze-drying, milling, and packing, significantly higher returns can be achieved, compared with rendering or whole frozen sale.
- Depending on the organ, The margin per head (wholesale sales price less additional processing costs) for sale of freeze-dried powders can 100-400 times the margin from rendering, and 5-15 times the margin from sale as frozen organs.
- With the establishment of own freeze-drying facility and considering just three organs, with a sales volume of 800 tonnes of freeze-dried powder per annum, realises an annual revenue of \$34.6 million. The 10-year NPV calculated is \$9.1 million with an IRR of 20%.

5.2 Benefits to industry

With a predicted growth at near double-digit levels across each product group, region, and delivery methods for nutraceuticals that may be used to improve health, delay the process of aging, prevent chronic diseases, or support the structure and function of the body there is a growing demand for sources of proteins and vitamins as ingredients in nutraceutical products. Red meat co-products provide a rich source of proteins, amino acids, vitamins, and bioactive compounds representing a significant opportunity for the red meat industry to provide the nutraceutical industry with valuable ingredients.

This project demonstrates the operational feasibility of harvesting organs and glands from the chain, at the viscera table or from the offal room. Preparation for freeze-drying is no more onerous than when harvesting organs and glands for frozen sale. Items can be stored frozen for freeze-drying. Freeze-drying has shown to be an effective means of converting wet materials to dry milled powders suitable as ingredients for the nutraceutical industry.

The project also determined that the process was feasible at other KGF works and should be feasible across the whole red meat industry.

The value multiplier for wholesale sales to the nutraceutical industry of at least 100 times compared with rendering, and 5-15 times compared with whole frozen sale, should also be applicable across the red meat industry.

6. Future research and recommendations

Whilst collection of organs already harvested for frozen sale did not present any challenges, harvesting of new items and an increasing number of organs would require a reorganisation of, and possible increase in size of, offal collection rooms. This includes access to collect and separate organs on the viscera table, delivery to the offal room, and stations to trim and pack items for freezing.

Despite the current and predicted growth for freeze dried organ powders globally, the market in Australia is still limited, with minimal presence on retail shelves. The only evidence of products on retail shelves was for encapsulated liver, lung, and heart. Most local availability of even locally produced brands is via internet sales. Stronger demand has been identified, in conjunction with a local freeze-drying company, in the Middle East, Europe and USA.

Globally, manufacturers such as Amway, Abbott, GSX and Pfizer have been identified as utilising beef organ powders for European and USA markets.

Establishing and developing an ongoing supply relationship with nutraceutical product manufacturers or ingredient suppliers is the greatest hurdle to realising the benefits of this project for KGF and for the Australian red meat industry.

The benefits and nutritional value of red meat organs as a nutraceutical ingredient have been well studied and documented. The technical and operational requirements for harvesting and production of freeze-dried powders have been established.

However, further critical work in identifying, establishing relationships with and understanding the nutraceutical ingredient supply chain is required and should be the focus of subsequent projects. Identifying any local players would determine if local freeze-dried powder sales are possible or if sales must be to overseas markets in the Middle East, Europe and USA.

Strategic supply chain opportunities are an important area of focus. Trading relationships are built on key purchase criteria rather than purely priced focus. Recognising the complexity of supplier approval, once gained, business opportunities are longer term. It is vital to better research and understand the value chain across nutraceutical sourcing.

The marketing and sales processes for dry ingredients is different from sales of red meat and fresh/frozen co products and also from meat and bone meal and tallow. A new understanding and skill set is required to realise the potential value increase to the red meat industry.

7. References

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Appendix 3

Material Specifications for Freeze Drying

Specifications for

[Bovine Heart](#)

[Bovine Kidney](#)


[Bovine Liver](#)


[Bovine Pancreas](#)


[Bovine Scapula Cartilage](#)


[Bovine Spleen](#)


[Bovine Tracheal Cartilage](#)


Material		Bovine Heart
Description	Bovine Heart – Edible Grade, Human Consumption	
Species	Bovine only. All grades and classes of bovine cattle excluding bobby calf and culled dairy cows.	
Market	Standard Export – USA, Japan, Korea, Australia, New Zealand, EU	
Status	Edible Grade Human Consumption	
State	Frozen – Bulk Packed. Poly liners should be of a suitable thickness so as not to tear when frozen blocks are unwrapped. Poly liner should be pulled frequently during packing to prevent liner folds becoming entrapped upon blast freezing.	
Processing Details	The hearts are to be well drained of blood and washed. All non - heart tissues are to be removed. Hearts incised for inspection purposes are acceptable. Butchers cut heart to be included	
Maximum Fat	All non- heart and other extraneous tissues to be removed	
Packaging	Solid bulk pack into standard meat export carton, poly-lined (or leak proof type) to standard 15.0 – 20.0kg net. NZMPI or relevant Australian Government seals to be applied	
Branding	Carton main panel: Beef Heart Carton End Panel: B/Heart	
Photo		


Material		Bovine Kidney
Description	Bovine Kidney – Edible Grade, Human Consumption	
Species	Bovine only. All grades and classes of bovine cattle excluding bobby calf and culled dairy cows.	
Market	Standard Export – USA, Japan, Korea, Australia, New Zealand, EU	
Status	Edible Grade Human Consumption	
State	Frozen – Bulk Packed. Poly liners should be of a suitable thickness so as not to tear when frozen blocks are unwrapped. Poly liner should be pulled frequently during packing to prevent liner folds becoming entrapped upon blast freezing.	
Processing Details	The kidneys are to have all the external fat and blood vessel ends removed. Cut kidneys are acceptable.	
Maximum Fat	All external non-kidney tissue and fat to be trimmed	
Packaging	Solid bulk pack into standard meat export carton, poly-lined (or leak proof type) to standard 15.0 – 20.0kg net. NZMPI or relevant Australian Government seals to be applied	
Branding	Carton main panel: Beef Kidney Carton End Panel: B/Kidney	
Photo		

Material		Bovine Liver
Description	Bovine Liver – Edible Grade, Human Consumption	
Species	Bovine only. All grades and classes of bovine cattle excluding bobby calf and culled dairy cows.	
Market	Standard Export – USA, Japan, Korea, Australia, New Zealand, EU	
Status	Edible Grade Human Consumption	
State	Frozen – Bulk Packed. Poly liners should be of a suitable thickness so as not to tear when frozen blocks are unwrapped. Poly liner should be pulled frequently during packing to prevent liner folds becoming entrapped upon blast freezing.	
Processing Details	The livers are to have the gall bladder removed. Milk spots and other blemishes to be removed in accordance with inspection directives.	
Maximum Fat	All non-liver and other extraneous tissues to be removed	
Packaging	Solid bulk pack into standard meat export carton, poly-lined (or leak proof type) to standard 15.0 – 20.0kg net. NZMPI or relevant Australian Government seals to be applied	
Branding	Carton main panel: Beef Liver Carton End Panel: B/Liver	
Photo		

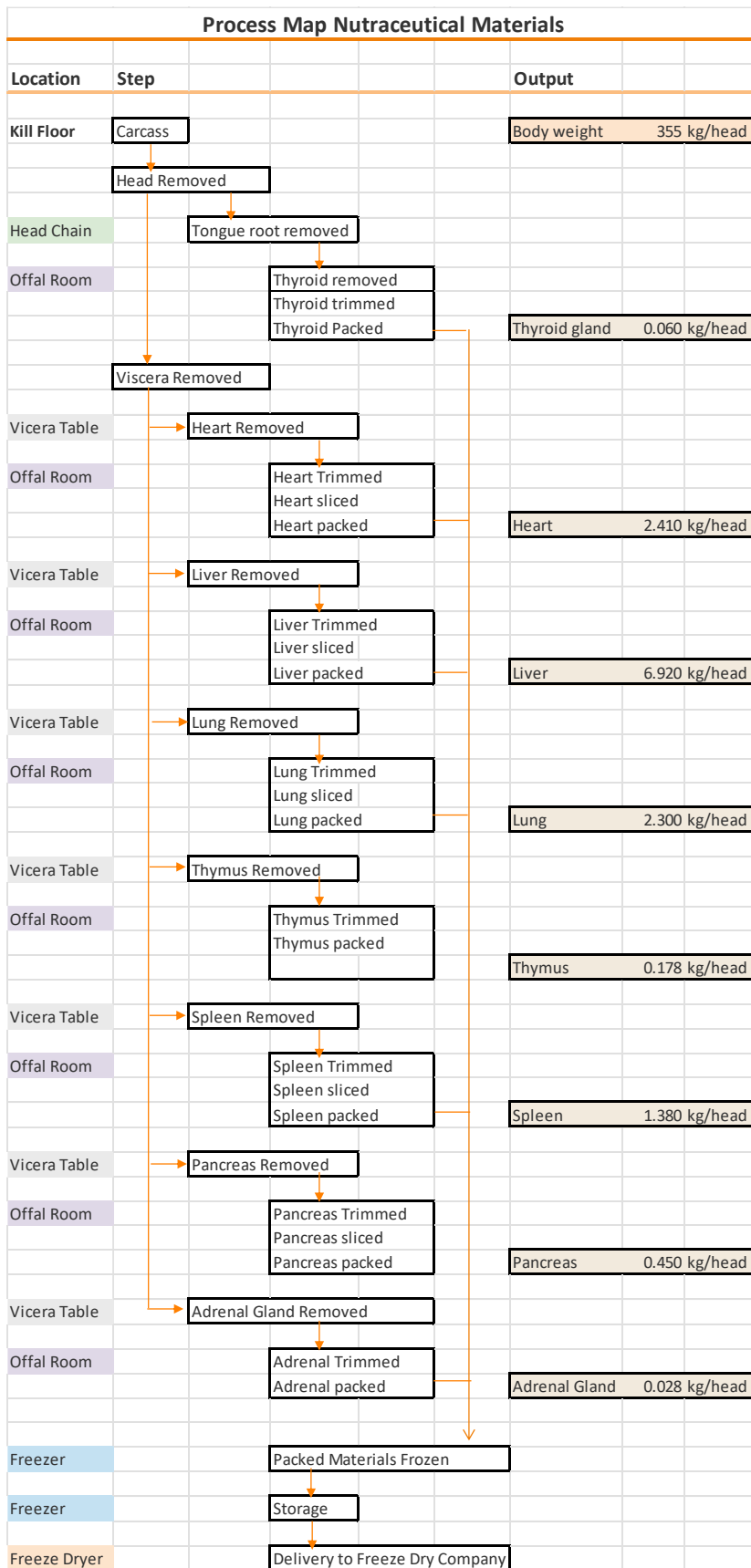
Material		Bovine Pancreas
Description	Bovine Pancreas – Edible Grade, Human Consumption	
Species	Bovine only. All grades and classes of bovine cattle excluding bobby calf and culled dairy cows.	
Market	Standard Export – USA, Japan, Korea, Australia, New Zealand, EU	
Status	Edible Grade Human Consumption	
State	Frozen – Bulk Packed. Poly liners should be of a suitable thickness so as not to tear when frozen blocks are unwrapped. Poly liner should be pulled frequently during packing to prevent liner folds becoming entrapped upon blast freezing.	
Processing Details	The entire pancreas is to be separated from the colon ensuring that the “tail” at the spleen end is retained. The pancreas should be trimmed of all non-pancreas tissue, extraneous fat, and vessels. Lymph glands are to be removed.	
Maximum Fat	All external non-pancreas fat to be removed	
Packaging	Solid bulk pack into standard meat export carton, poly-lined (or leak proof type) to standard 15.0 – 20.0kg net. NZMPI or relevant Australian Government seals to be applied	
Branding	Carton main panel: Beef Pancreas Carton End Panel: B/Pancreas	
Photo		

Material	
Bovine Scapula Cartilage	
Description	Bovine Scapula Cartilage – Edible Grade, Human Consumption
Species	Bovine only. All grades and classes of bovine cattle excluding bobby calf and culled dairy cows.
Market	Standard Export – USA, Japan, Korea, Australia, New Zealand, EU
Status	Edible Grade Human Consumption
State	Frozen – Bulk Packed. Poly liners should be of a suitable thickness so as not to tear when frozen blocks are unwrapped. Poly liner should be pulled frequently during packing to prevent liner folds becoming entrapped upon blast freezing.
Processing Details	The scapula cartilage is to be removed from the end of the shoulder blade bone. The scapula cartilage should be trimmed of excess meat prior to removal. Care must be taken to ensure that when the scapula is removed from the shoulder blade bone that there is no shoulder bone tissue attached to the collected scapula cartilage.
Maximum Fat	All external fat and meat tissue to be trimmed
Packaging	Solid bulk pack into standard meat export carton, poly-lined (or leak proof type) to standard 15.0 – 20.0kg net. NZMPI or relevant Australian Government seals to be applied
Branding	Carton main panel: Beef Scapula cartilage Carton End Panel: B/Scapula Cartilage
Photo	

Material		Bovine Spleen
Description	Bovine Spleen – Edible Grade, Human Consumption	
Species	Bovine only. All grades and classes of bovine cattle excluding bobby calf and culled dairy cows.	
Market	Standard Export – USA, Japan, Korea, Australia, New Zealand, EU	
Status	Edible Grade Human Consumption	
State	Frozen – Bulk Packed. Poly liners should be of a suitable thickness so as not to tear when frozen blocks are unwrapped. Poly liner should be pulled frequently during packing to prevent liner folds becoming entrapped upon blast freezing.	
Processing Details	The spleens are to be trimmed free of any fat and extraneous tissues. Dark coloured spleens are suitable. Cut spleens are acceptable.	
Maximum Fat	All external non-spleen material and fat to be trimmed	
Packaging	Solid bulk pack into standard meat export carton, poly-lined (or leak proof type) to standard 15.0 – 20.0kg net. NZMPI or relevant Australian Government seals to be applied	
Branding	Carton main panel: Beef Spleen Carton End Panel: B/Spleen	
Photo		

Material	
Description	Bovine Trachea – Edible Grade, Human Consumption
Species	Bovine only. All grades and classes of bovine cattle excluding bobby calf.
Market	Standard Export – USA, Japan, Korea, Australia, New Zealand, EU
Status	Edible Grade Human Consumption. No TB or TB reactor cattle.
State	Frozen – Bulk Packed. Poly liners should be of a suitable thickness so as not to tear when frozen blocks are unwrapped. Poly liner should be pulled frequently during packing to prevent liner folds becoming entrapped upon blast freezing.
Processing Details	Whole Trachea. Lung Lobes and neck trimmings removed. Trimmed of all fat, meat & lungs, leaving only the “pipe” part of the Trachea with minimal membrane attached. Collect as much trachea as possible. Trim to remove any excess fat or meat. Special attention needs to be given to the removal of hair contamination, ensuring the membrane is removed and the product is well washed and drained before packing. Trachea may be cut open or in half longitudinally to allow more to be packed per carton.
Maximum Fat	6% w/w
Packaging	Solid bulk pack into standard meat export carton, poly-lined (or leak proof type) to standard 15.0 – 20.0kg net. NZMPI or relevant Australian Government seals to be applied
Branding	Carton main panel: Beef Trachea Carton End Panel: B/Trachea
Photo	

Appendix 5



Appendix 7

Product Specification Beef <Organ>- Dried

1. Product

Edible Beef <organ> - Freeze dried, Raw

2. Description

Freeze Dried raw beef <organ> powder from 100 % Australian beef. Edible grade <organ> from Bovine cattle, with extraneous tissues removed, freeze dried and milled. (If applicable can claim hormone, pesticide, or GMO free)

3. Ingredients

100% edible beef <organ>

4. Specifications

Nutritional Information	UOM	Per 100 g
Energy	kJ	Spleen, heart, lung 1350
		Pancreas, liver 3000
Protein	g	52-65
Fat, total	g	Pancreas 50
		Others 50
saturated	g	tbd
Carbohydrate, total	g	tbd
sugars	g	tbd
Sodium	mg	Lung 625
		Others 300
Vitamin B1	mg	0.1-0.8
Vitamin B2	mg	1-3
Vitamin B3	mg	12-28
Vitamin B5	mg	3-12
Vitamin B9	µg	10-30
Vitamin B12	mg	12-40
Calcium	mg	15-30
Choline	mg	Liver 500,
		Heart 270
Iron	mg	Spleen 140
		Others 7-25
Zinc	mg	5-12
Copper	mg	Liver 30
		others 0.1-1.0
Potassium	mg	800-1300
Selenium	µg	60-200
CoQ10	mg	tbd

Phosphorous	mg	600-1200
Magnesium	mg	40-70
Moisture	g	<8%
Ash	g	tbd
Heavy Metals (as Lead)	mg/kg	<1.5
Physical Information		
Mesh Size	max retained on 5 mm	<2%
	max through 1 mm	<5%
Microbiological	UOM	Limit
Aerobic Plate Count	cfu/g	10,000
Total coliforms	/g	Absent
Escherichia coli	/g	Absent
Staphylococcus aureus	cfu/g	10
Salmonella sp.	/25g	Absent
Yeasts and moulds	/g	100

5. General

This product complies with the current Australian and New Zealand Food Standards Code

6. Product Information and Packaging

Individual bags are labelled with product name and lot number. Bags are X kg nett.

Other formats are possible including ...

7. Storage

Bags should be stored in a cool, dry area. When so stored there should be no major changes in product properties for a period of 24 months.

8. Manufacturing Site

Appendix 8

Associated Benefits of Beef Organ Supplements

Beef Liver

- ✓ A naturally abundant source of bioavailable nutrients.
- ✓ Most abundant source of Preformed Vitamin A (Retinol) found in nature, for healthy immune function, vision & skin health.
- ✓ Vitamin A to assist with iron metabolism
- ✓ Vitamins B12, B2, B3 & B5 to help reduce fatigue, promote energy production, support neurological performance & normal blood formation.
- ✓ B12 to improve exercise performance, mind clarity
- ✓ A highly useable form of iron.
- ✓ Rich amounts of trace-minerals, including copper, zinc and chromium.
- ✓ CoQ10, a nutrient of particular importance to the cardiovascular system, and a renowned energy booster.
- ✓ Eye health: The vitamin A (retinol) and B vitamins in liver play a crucial role in vision, helping to maintain a clear cornea (which is the outside covering of your eye).
- ✓ Energy and mood: Liver is an excellent source of vitamin B12, copper, heme-iron, coenzyme Q10 (CoQ10) and niacin, all of which are crucial for energy, optimal exercise performance, metabolism, red blood cell production and mood.
- ✓ Immune system: Selenium is a cofactor for the body's antioxidant defence (glutathione peroxidase, thioredoxin reductase) and (together with copper) supports optimal immune function.
- ✓ Skin health: The hyaluronic acid, copper, zinc and selenium in liver are crucial for maintaining healthy skin and connective tissue.
- ✓ Brain health and cognition: The highly absorbable B vitamins (riboflavin, folate and B12), amino acids (anserine, carnosine, taurine and l-carnitine), choline and zinc in liver are vital for brain health and cognition, as well as for neurotransmitter formation.
- ✓ Teeth and bones: The vitamin K2 in liver is crucial for bone and tooth health because it supports the remineralization and absorption of calcium.

Beef Heart

Heart is the richest source of naturally occurring coenzyme Q10 (CoQ10) in nature

Beef heart is also rich in six micronutrients that also support health and immunity and are listed below;

- ✓ Vitamin B1 [Thiamine] – essential in boosting functions of the heart, mental health, and also the production of energy
- ✓ Vitamin B2 [Riboflavin]- helps in energy production, blood health, improved vision, protects cells from pathogen and reduces fatigue

- ✓ Vitamin B3 [Niacin] – involved in energy creation, nervous system operations, mental health, and also prevention of chronic diseases
- ✓ Vitamin B5 [Pantothenic Acid] – takes part in the production of energy, enhances mental health, and reduces tiredness and fatigue
- ✓ Vitamin B12 – enhances immune function, healthy cell division, supports mental health, and reduces fatigue
- ✓ Choline – a chemical nutrient that assists in brain membrane formation, memory, muscle control, and mood.
- ✓ CoenzymeQ10 is a fat-soluble vitamin compound and can be found in beef heart
- ✓ Rich in collagen and elastin

Beef Lung

The lung features a unique, remarkable density of widely differentiated blood vessels. The lung contains arteries, capillaries and veins in the approximate proportions that they exist throughout the body. Moreover, these tissues encompass the widely varied anatomy and physiology of the systemic circulatory system, including thickness, elasticity, muscularity and functions. Lung appears to be nature's all-natural lung, respiratory and arteriovascular supplement.

Beef Thyroid

Thyroid is a good source of preformed vitamin A, B12, choline, folate (as opposed to the synthetic version called folic acid), heme iron and other micronutrients commonly found in thyroid tissue.

The thyroid secretes thyroid hormones T3 and T4, (thyroxine and triiodothyronine) which affect metabolic rate and are important for energy metabolism.

Thyroid powder may be used in supplements for hypothyroidism

Beef Pancreas

Main source of digestive enzymes for breaking down protein, fat and carbohydrate. Responsible for production of insulin for blood glucose control

Pancreas powder may be used in formulations for digestive support (pancreatic enzyme deficiency), and glucose metabolism.

beef spleen is known to be one of the best sources of heme-iron. It also provides highly bioavailable nutrients like vitamin B12, vitamin C, riboflavin, niacin, selenium, iron, copper, phosphorus, selenium and zinc.

Proteins exclusively found and expressed in pancreatic tissue

Pancreatic enzymes required to break down fats (lipase), proteins (protease) and carbohydrates (amylase).

Pancreatic peptides (colipase and trypsin) needed to activate proteolytic enzymes.

Beef Spleen

Manufactures white blood cells and disposes of expired red blood cells. Also acts as a reservoir of red blood cells in an emergency (e.g. haemorrhage).

Spleen powder may be used in formulations supporting a healthy immune system

Spleen is a nutrient dense organ rich in well-absorbed heme iron, minerals, fats, enzymes and peptides that support immune health

Beef Spleen is rich in protein, healthy fats and heme iron: a highly absorbed form of iron that can only be obtained from red meat. NXGEN Beef Spleen Capsules contain all of the naturally occurring nutrients in a healthy spleen, including minerals, fats and peptides such as Tuftsin & Splenopentin to boost immune health.

Bovine spleen extracts have been used for centuries to support allergy and are known to modulate and improve immunity.

Spleen meat may also contain proteins such as tuftsin and splenopentin

Beef Adrenal Gland

Amongst others the adrenals produce hormones in response to stress –e.g. epinephrine (adrenalin) and nor epinephrine (nor adrenaline) and cortisol. These hormones have an effect on blood glucose and blood pressure.

The adrenal gland also produces steroid hormones- e.g. progesterone and testosterone.

Adrenal powder may be used in formulations for generalised energy boost, and relieving stress.

Adrenal Cortex promotes healthy adrenal function and balanced stress responses. It provides the nutrient building blocks for your adrenals to produce cortisol. Healthy cortisol levels support energy, alertness, immune system function, and glucose metabolism

