Final report

Validation Market Desirability Useability of Ovine Collagen – Phase 2

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Abstract

The global collagen market size is expected to reach US $16.7 billion by 2028. Consumer interest in collagen-based products is growing with the nutraceutical collagen market forecasted to account for 40% of collagen product sales in 2025. Currently the bulk of the global collagen market is largely serviced by bovine, porcine and marine skin collagen. However, cost, safety and religious/cultural concerns around their use has created a significant opportunity for ovine collagen to enter this growing space, especially given its broad acceptance across several religions and culture.

Australia produces 32 million sheep skins each year and being the only disease/prion-free sheep producer in the world, Australian sheep producers and processors stand to benefit significantly by processing their skins into collagen hydrolysates. This is even more critical given the steady decline in global leather demand that's subsequently caused a similar downward trend on the prices of skins, leading to at times, skins being dumped as landfill.

Sheep skins are rich in collagen. Up to 30% of the skin weight is from collagen with the rest being contributed by water, wool and fat. The growing global demand for collagen and collagen hydrolysate products presents a huge opportunity for Australia's sheep industry to create a high-value income stream from processing sheep skins.

Challenges however exist for sheep producers to achieve full valorisation of their skins. Current commercial collagen manufacturing processes stretch over days, often taking as long as 4-6 weeks or more to process raw skins into a finished collagen hydrolysate product. Apart from the high infrastructure set up and holding costs, the extended processing times means the industry is unable to process the high throughputs required to meet the collagen market demanded.

To overcome this challenge and to enable Australian ovine processors in capturing a significant chunk of the global collagen market, OTH, an innovative Australian industrial technology developer and MLA decided to invest in developing industrially scalable high throughput sheep skin processing technologies.

Project P.PSH.1297 'Validation Market Desirability and Useability of Ovine Collagen – Phase 1 successfully developed new proof of concept benchtop technologies that enable quick processing of sheep skins, extracting not just collagen hydrolysate but also clean intact wool that can be further converted into a high value keratin protein concentrate as ingredients in the food, nutraceutical, and cosmetic industries. These novel technologies can enable end to end processing of raw sheep skins into collagen hydrolysates and wool keratin concentrates in just a single eight-hour shift, potentially permitting high throughput processing of ovine skins. By achieving a full valorisation of ovine skins, these technologies have the potential to deliver significantly more returns to Australian sheep producers than is currently achieved from selling fresh skins.

The outcomes of this project were i) Design specifications and recommendations for scale up of each module of the Phase 1 process to 50 to 100 kg hide batch sizes, ii) Identification of scale up challenges of the new process with respect to equipment and processing constraints, iii) Undertaking trials to validate process and product quality iv) Production of up to 5kg sample sizes of ovine collagen hydrolysate and wool keratin concentrate and then undertake biochemical analysis to confirm molecular weight and specifications to validate consistency of process and product quality, and v) New Me Pty Ltd a functional beverage manufacturer conducted preliminary assessment of useability and desirability with 'Watch me Think' and assessed viability for inclusion in functional beverage.

Executive Summary

Consumer interest in collagen-based products is growing in various applications, including food and beverage, nutraceutical supplements, cosmetics, and medical products. Consumers are particularly focusing on health and performance nutrition, with the nutraceutical collagen market estimated to account for 40% of collagen product sales in 2025 [1]. Collagen's characteristics as a bioavailable bonding material has resulted in growth in both cosmetic and medical applications. Its most prevalent use among cosmetic consumers is in skincare products, with this popularity due to its 'revitalising' and 'renewing' properties.

The global collagen market size is expected to reach US $16.7 billion by 2028, expanding at a revenue based CAGR of 9.0% [2]. Bovine, porcine, and marine by-products are the four main sources currently used in the manufacture of collagen. Collagen from bovine source accounts for a substantial share of 38% as of 2020, as opposed to other sources, on account of the abundance of bovine sources and relatively lower price compared to marine and porcine sources. The cost of collagen product obtained from marine is relatively higher than from bovine and porcine, which is likely to restrain the growth of the segment.

The increase in the world's population and advances in healthcare and functional foods awareness is resulting in an ever-growing demand for high purity collagen hydrolysate peptides and protein rich keratin hydrolysates.

Collagen products obtained from Australian sheep have unique market advantages, i) isolated disease-free herd in Australia, (only prion-free ovine in the world) ii) safe, fully traceable from the "farm to the consumer" and iii) culturally acceptable worldwide (acceptable to Muslim, Hindu and Buddhist populations as opposed to porcine and bovine collagen).

Despite the significant global demand for collagen hydrolysate products, no company worldwide is currently able to meet the ever-growing market demand for collagen hydrolysates, in particular ovine sourced collagen. Similarly, while there are a small number of global manufacturers and suppliers of keratin hydrolysates, no Australian sheep processor is currently producing this valuable product.

The outcomes from this project were 1) validation of scalability of extraction process for collagen peptides and clean wool from ovine skins from benchtop to mid-scale levels, 2) confirmation of reproducible and consistent collagen peptide quality, 3) functionality validated by satisfactory product application trials and 4) confirmation of consumer desirability with consumer insights using Watch me Think.

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1. Background

1.1 Australian Ovine Skin Supply and Valorisation Opportunity

Australian sheep processors are usually one of the largest suppliers of salted sheep skins to the world market. Australia annually produces 32 million woolskins; however, the Australian sheep skin industry has virtually collapsed with prices at an all-time low. Premium merino skins command a market price of just 2000c/skin and those in second and third grades make about 200c/skin to 1300c/skin while small, short or damaged lamb skins have no value in the current market.

With the cost of prepping and shipping untanned skins to be tanned overseas being greater than the value of the final products, it is leading to most Australian sheep skins being disposed off as landfill.

Ironically, sheep skins are rich in collagen, a high value nutraceutical ingredient experiencing double digit demand growth globally. Up to 30% of the skin weight is from collagen with the rest being contributed by water, wool and fat.

Similarly, apart from having an inherent value, wool is a rich source of keratin protein that if processed into a high-quality keratin concentrate could be used in various cosmetic and feed applications.

However, the valorisation potential of sheep skins is presently restricted by current collagen manufacturing technologies. With manufacturing processes ranging from several weeks to months, it imposes inherent constraints in high throughput processing of skins. Additionally, the current processes of collagen extraction do not recover intact wool and it often ends up as a waste sludge causing significant environmental issues downstream.

Despite the availability of surplus low value skins, Australian sheep processors are currently unable to fully leverage its valorisation potential and take advantage of the increasing global market demand for collagen and keratin.

An industrially feasible technology that can overcome these constraints can thus be of immense benefit to Australian sheep processors.

1.2 Sheep Producer Value

While bovine collagen is the largest consumed collagen, there is a growing global market opportunity for ovine collagen as it isn't limited by cultural/religious sensitivities (e.g., porcine collagen) or unsustainability and price concerns (marine collagen). Australian ovine is the only disease and prion-free ovine in the world. Australian sheep grade is certified by the US Department of Agriculture to be free from disease. The no-risk-of-BSE classification can enable Australian ovine producers assure consumers that their products are 100% disease free.

As above, Ovine (sheep) collagen has a unique market advantage,

1) obtained from an isolated disease-free herd in Australia, (only prion-free ovine in the world)

2) safe, fully traceable from the "farm to the consumer" and

3) culturally acceptable worldwide (acceptable to Muslim, Hindu and Buddhist unlike porcine and bovine collagen). Collagen sourced from bovine has raised concerns with consumers regarding diseases such as Transmissible Spongiform Encephalopathies, BSE (Mad Cow Disease) while ovine sources are regarded as disease free.

The creation of another business in the Australian sheep meat sector that can more efficiently and effectively extract and purify novel biomolecules like collagen as also wool keratin protein from sheep skins for the food, feed and nutraceutical industries, could deliver increased profits back to sheep producers, and potentially much more than from their core business.

1.1.1 Sheep Skin Collagen

Collagen is the most abundant protein in vertebrates and is the major component of sheep skin and can be as high as 30% w/w. There are about 28 different types of collagen of which the most common are type I, II, III, IV and V [3]. Of these variants, Type I collagen is essential for providing elasticity and tensile strength to the skin and bones of humans [4]. As 90% of the total collagen present in sheep skin is type I, the convergence of food and cosmetic sectors provides a potential market for the sheep industry to maximize their revenue from sheep skins.

Biochemically, collagen is mainly composed of the amino acid glycine (33%), proline and hydroxyproline (22%) [5]. Proline and hydroxyproline play an important role in protein synthesis, metabolism and wound healing which expands the end market applications of collagen hydrolysate to pharmaceutical products. [6].

In skin, collagen is present in its native form, which is composed of 3 polypeptide chains coiled into a helix, giving it a triple helical structure [3]. Partial hydrolysis of this native collagen leads to the formation of gelatin while further hydrolysis forms collagen hydrolysate. Collagen hydrolysate is characterized by smaller sized peptides (<25kDa) and is most preferred in nutraceutical applications due to its increased bioactivity and absorbability into the bloodstream [7].

Collagen hydrolysate has been reported to deliver antioxidation capacity, anti-aging effects, preventing osteoporosis, enhancing wound healing and reducing the risk of cardiovascular diseases [8].

The production levels of ovine collagen in volume terms however have been very small, (<100MT/yr) of food and cosmetic grade collagen combined. Additionally, the current collagen manufacturing process typically takes more than several days which severely limits production volumes and makes it impossible to meet the market demand.

Thus, unless a new commercial method of fast collagen production is developed that can enable high throughputs, the potential for the wider Australian and New Zealand Sheep producers to capture the growing ovine collagen market will remain largely unrealised.

To overcome this supply demand barrier and enable maximum valorisation of sheep skins by the sheep processor, the industry needs to explore the possibilities of using a novel extraction process for collagen hydrolysate wherein the skins can be processed to collagen concentrates in a single shift (8hrs).

1.1.2 Sheep Wool

Australia is one of the world's largest wool producers, producing around 345 million kilos (25 percent) of greasy wool sold in the world market [11]. Currently wool from sheep has been utilized primarily in the textile industry. However, dry seasonal conditions have lowered the quality of superfine wools since 2019. This influences the variation in prices across different wool grades and puts pressure on finer grade wool. Supply of lower quality superfine wool is assumed to continue to 2023-24 owing to the continued dry seasons. Merino ewes make up 75% of all Australian breeding ewes [MLA and AWI, 2018]. In 2021, prices for superfine Merino fleece eased by 15c while medium Merino eased by 50c in Australia [Queensland Country Life, 2020]

Keratin waste from farm breeding, wool fibre by-products from textile processing, poor-quality raw wool not fit for spinning, have been estimated worldwide at more than 5 million tons per year [12]. The increase in quantity of poor-quality raw wool, fluctuating price of high-quality wool, change in seasonal conditions together with the increased substitution of synthetic fibres in the clothing industry puts pressure on sheep producers to maximize their revenue from sheep skins.

Keratin is the major component of hair, feathers, wool, nails and horns of mammals, reptiles, and birds. Sheep wool is a natural fibre with unique attributes and is composed of 95 wt% of keratin proteins [12].

Intact wool fibres contain 20 different amino acids, mainly glutamic acids, serine and glycine. Glutamic acid is a key amino acid that controls cellular metabolism in human body, increases brain function and mental activity [11]. Similarly, wool is also very rich in sulphur containing amino acids, especially cysteine [14]. Cysteine provides resistance to the body against harmful effects by enhancing the white blood cell activity and is essential for the proper functioning of the skin [1].

Keratin from wool has many properties such as biodegradability, biocompatibility, and self-extinguishing ability [13]. It is for this reason that keratin hydrolysates derived from chicken feathers and human hair have been extensively used for biomedical, cosmetic, industrial, and agricultural applications. Keratin films and keratin-based films are used in ocular surface reconstruction, drug delivery systems and treatment of myocardial infarction. They also find applications in anti-aging creams, hair rebuilding shampoo, hair cream, organic fertilizers etc. [15]

Wool keratin however is tightly packed in α-helices and β-sheets into a super coiled polypeptide chain, with high degree of disulphide cross-linkages, salt bonds, hydrogen bonds and other bonds which makes it difficult to break down for keratin protein extraction [13]. Additionally, the current processes of collagen extraction is unable to recover intact wool and with its high resistance to breakdown, often ends up as a waste sludge causing significant environmental issues downstream.

Thus, an industrially feasible process that could efficiently extract wool from sheep skins during collagen extraction and convert it into an application friendly form for use in cosmetic, feed and industrial industries could deliver significant additional revenue to Australian sheep processors whilst also eliminating environmental issues currently associated with sheep skin processing.

1.3 OTH Technologies

Organic Technology Holdings (Innovation) Pty Limited (OTH) is a unique Australian industrial technology development company that helps create foods and ingredients without having to grow any additional food. It does this by developing unique technologies that help primary processors such as abattoirs transform their ‘waste’ by-products into highly valuable, superior quality ingredients for the food, nutraceutical, and pharmaceutical sectors,

- Pet Care
- Stock and Aqua Feed
- Human food and flavouring
- Nutraceutical and pharmaceutical
- Wellness and beauty
- Medical

OTH’s Advanced Food and Nutrient Research Centre facility is based in Brisbane. This facility is quite unique in that it encompasses 3 different processing capacities and scalabilities, Laboratory, Pilot and Pre-commercial. The Laboratory Scale, can process up to 10kg batches, and is where the

conceptualization and proof-of-concept breakthrough technologies are developed. The Pilot Scale line is where the developed technology is scaled up to 50-100kg batches with the focus on validating process and product quality and producing sufficient samples for in-depth biochemical analysis and preliminary market feedback.

Once the product quality and market demand for the end products have been validated, the technology is then scaled up using the Pre-commercial Scale platform. OTH's dedicated multi-product pilot facility can process several 500kg -1MT batch trials under simulated industrial conditions and produce 100-500kg samples of finished products. Several repeat trials can be conducted to confirm the consistency of the process and end product quality.

The process data generated from these trials assist the process and chemical engineers to develop a blueprint for a larger commercial manufacturing plant, and the 100-500kg samples can be supplied to end-users - large food, feed, and nutraceutical manufacturers to undertake critical application trials and provide validation of market and price acceptance. Together this helps generate a validated P/L model inclusive of capex, opex and market pricing required to justify the establishment of commercial plants to convert by-products waste streams into high purity, high value, contaminate-free food grade ingredients.

The success of OTH in understanding the exact market needs is underpinned by its unique business model. Unlike the conventional 'build and they'll come' approach of technology companies, OTH is 100% industry-led, developing industrially feasible solutions to problems or requirements that the industry has clearly identified, and which are not currently being met.

To enable the development of effective solutions, OTH conducts extensive market as well as scientific research, liaising closely with key commercial and technical end-users and raw material stakeholders to understand their pain points and specific requirements, to enable customized technology solutions to be developed that industry needs.

OTH have developed a unique collagen extraction process that has been shown to work on bovine hides. In addition, this process can selectively extract out intact and clean hair and using a separate proprietary process, convert it into a high value keratin concentrate for application in the feed and cosmetic industry.

Given the structural and biochemical differences between bovine hides and sheep skins, further R&D was required to develop a customized technology that could extract high value and high-quality collagen and keratin concentrates from sheep skins.

Therefore, OTH in collaboration with MLA are investing in the development of an industrially feasible process for producing collagen hydrolysates and wool keratin from sheep skins and generate samples to validate market acceptability, demand, and price points of these products with the overall objective to deliver increased economic returns to Australian sheep producers.

2. Objectives

Organic Technology Holdings successfully completed Project P.PSH.1297 'Validation Market Desirability and Useability of Ovine Collagen – Phase 1. The project developed new proof of concept benchtop technologies that enable quick processing of ovine skins, extracting not just collagen hydrolysate but also clean intact wool that can be further converted into a high value keratin protein concentrate as ingredients in the food, nutraceutical, and cosmetic industries. These novel technologies enable end to end processing of raw ovine skins into collagen hydrolysates and wool keratin concentrate in just eight

hours, potentially permitting high throughput processing of ovine skins. By achieving a full valorisation of ovine skins, these technologies have the potential to deliver significantly more returns to Australian sheep producers than is currently achieved from selling fresh skins.

This project achieved the following objectives,

1. Scale up of each module of the Phase 1 process to 50 - 100 kg hide batch sizes using a combination of existing pilot plant equipment and new or rented fit for purpose mid-scale equipment.

2. Identified scale up challenges with respect to equipment and processing constraints and accordingly made suitable adjustments to the process to ensure it can be scaled up to large volume production using established industrial equipment.

3. Conducted repeatable trials to ensure process and product quality is consistent and reproducible and collected process modelling data for design of commercial scale processing line.

4. Generated up to 5kg sample sizes of ovine collagen hydrolysate and wool protein concentrate and undertook a detailed biochemical analysis using an external laboratory to confirm molecular weight and specifications, consistency of process and product quality.

5. Provided collagen peptide samples to New Me Pty Ltd for preliminary consumer assessment, preliminary COGs estimates and for assessment of consumer desirability using Watch me Think.

6. Produce a Final report summarising key findings and approach.

3. Methodology

The following methodology was used to undertake this project.

3.1 Review market opportunity.

New Me reviewed Australian and global market data for functional beverages containing collagen peptides and refined assumptions on potential sales and value at year 1 and year 5. Discussion were held with MLA's In-Market team is doing regarding analysis of key Southeast Asian markets for value-added meat-based products and ingredients.

3.2 Establish mid-scale extraction process capable of processing 50-100 kg batches.

Based on the outcomes from Phase 1 project P.PSH.1297, a pilot scale manufacturing process was developed, and equipment selected. This involved a review of the technical feasibility and equipment requirements for scale up of each module of the Phase 1 process to be able to process 50 to 100 kg hide batch sizes using a combination of existing pilot plant equipment and new or rented fit for purpose mid-scale equipment.

3.3 Determine ovine collagen application functionality and quality.

Output from the mid-scale process were assayed to determine consistency of mass balance yields and specifications of the extracted collagen and wool protein concentrate. Up to 5kg samples were produced for biochemical profiling and quality assessment. NewMe Co undertook an assessment of the suitability of ovine collagen peptide in a beverage applications, in relation to flavour and functionality.

3.4 Initial assessment of economic impact on Australia's sheep industry.

OTH have developed modelling of the ROI of investing in OTH's technology for potential licensees to assess the opportunity. OTH conducted a high-level evaluation of potential economic impact on Australia's sheep sector, using their financial modelling.

3.5 Assessing consumer desirability & useability.

NewMe used design thinking principles to assess useability and desirability of ovine collagen. New Me are planning to manufacturer a lightly carbonated functional drinks range for skin, bone and gut health that incorporates ovine collagen peptides. NewMe used consumer insights company, Watch Me Think to undertake preliminary validation of consumer desirability and useability.

4. Results

4.1 Review market opportunity

NOTE: SOME CONFIDENTIAL COMMERCIAL INFORMATION HAS BEEN REMOVED FROM THIS PUBLICALLY RESEASED FINAL REPORT

4.1.1 Functional Collagen Market Assumptions

Nutritional and performance drinks are becoming an increasingly popular meal option due to evolving dietary habits of on-the-go consumers and positive functional attributes. One third (35%) of US Consumers state that they do not take care of themselves as well as they should because of their busy lifestyle, 39% of consumers use nutritional and performance drinks as a replacement for breakfast [16]. 58% of consumers currently use nutritional and performance drinks as a meal replacement, and 48% consume them as part of a meal. In addition, 7 in 10 (69%) consumers agreeing that nutritional and performance drinks are a more effective source of nutrients, and more convenient (79%) than whole foods. With consumers viewing their efficacy favourably, 40% are consuming nutritional and performance drinks before, during or after exercising.

Driven by their functional attributes, nutritional drinks and performance drinks are gaining a larger market share of the overall health beverage category, which also includes sports drinks and weight loss drinks. From 2010-2015, performance drinks experienced 86% sales growth, while nutritional drinks saw 67% growth (Mintel). The overall market grew 38%, reaching $13 billion in 2015. MLA Report V.RMH.0079, 'Collagen Business Case' [1] found that the global collagen market size has an estimated valuation of US$3.136 billion in 2018. The market is expected to experience compounded annual growth (CAGR) of 5.09%, resulting in an estimated market size of US$4.150 billion in 2025.

IBIS World have estimated the functional Beverage market in Australia to be valued at AU$451 million in 2022 and they expect it to grow by 2.8% this year [17]. The global collagen drinks market is in its initial

stages of growth and is experiencing significant growth due to development of the cosmetic and nutraceutical industries. There is an increase in demand for collagen drinks due to a rise in awareness for health and beauty drinks.

The collagen drinks market is witnessing consistent growth over the last few years owing to the rise in health and beauty consciousness among individuals. This is attributed to strong influence of social media advertising. Hectic lifestyles, and unhealthy dietary patterns are leading to premature aging issues among the millennial population.

4.1.2 Nutraceutical Opportunities for Australian Red Meat (MLA Report)

MLA's Category and Market Insights Team have released a report on Nutraceutical Opportunities for Australian Red Meat initially exploring the Japanese market [18]. The study found that the global nutritional supplements market is expected to reach a market valuation of US$237.6 billion by 2027, driven by increasing health consciousness, changing lifestyle and willingness to buy nutritional supplements.

The report identified a huge opportunity in the Japanese market where there is an ageing population seeking functional foods and supplements that can assist with ageing conditions such as bone and joint health. They also found that young Japanese female consumers (40.8%) are seeking foods, beverages and supplements containing collagen for beauty.

4.1.3 Preliminary Manufacturing Assumptions

The Australian contract manufacturer that New Me has commenced discussions with has a minimum order quantity which is 3,000 cases of 24's (72,000 bottles) per SKU.

New Me Pty Ltd are developing 3 core lightly carbonated functional beverage products that are, for skin, bones & joints and gut. Only skin and bones & joint will contain the collagen peptide. ach drink will have 3 flavours giving 6 SKUs containing collagen peptides.

New Me Pty Ltd will develop one SKU, 'New Skin' as a MVP to evaluate consumer acceptance. The initial market testing will involve production of 36,000 bottles. If initial consumer acceptance of the beauty drink is positive then New Me will market test the other two SKUs, 'New Bones' and 'New Gut'. This represents 72,000 bottles (2 production runs) of New Bones and New Gut. Then finally 108,000 bottles of New Skin, New Bones and New Gut will be released into the market for preliminary market acceptance evaluation.

New Me Pty Ltd will use this initial market testing to identify the maximum selling price and then produce detailed COGs analysis for the business. Initial product RRP is estimated to be between $2.50 and $3 per 330ml SKU.

4.2 Establish mid-scale extraction process capable of processing 50-100 kg batches.

OTH undertook an assessment of technical feasibility of a pilot manufacturing process for the production of ovine collagen peptide and wool collagen hydrolysate from Australian sheep skin supply at mid-scale (50-100 kg batches) levels.

This required a process engineering review and the design of a pilot scale process for extraction and refinement of collagen peptides from sheep skin. Assessment of scale-up technical feasibility and

challenges involved in extrapolating the benchtop process to mid-scale levels. Mid-scale process developed involved:

- Sourcing large quantities of pelts initially 10-20 (50-100kg) and subsequently up to 100 (500kg) and the establishment of a suitable receival and storage system on site.
- Identifying and sourcing suitably sized equipment to process these skins at scale.
- Conducting several repeatable trials to ensure process and product quality is consistent and reproducible.
- Setting up a system of trial data collection and analysis of product and process quality for each key step.
- Using generated samples to confirm initial market feedback from end users on quality and functional acceptance and suitability.

4.3 Determine ovine collagen application functionality and quality.

A 200gm sample of OTH's ovine collagen peptide was sent to New Me's food technologist, Food Smarts to assess the collagen peptide in terms of its solubility, flavour, and functionality.

Food Smarts undertook the following testing against fish and beef collagen the industry standard collagen peptide sources for beverages, foods, capsules and creams.

1. Solubility in cold water. Samples were dissolved in water at 20°C, pH 7.0 and pH 4.0 (adjusted with citric acid) with the time to solubilise recorded.
2. Solubility in warm water. Samples were dissolved in water at 50°C, pH 7.0 and pH 4.0 (adjusted with citric acid) with the time to solubilise recorded.
3. Solubility in cold water. Samples were dissolved in water at 80°C, pH 7.0 and pH 4.0 (adjusted with citric acid) with the time to solubilise recorded.
4. Subjective assessment of clarity at 5% and 10% inclusion in water
5. Subjective assessment of viscosity at 5% and 10% inclusion in water

Comparison analysis found that fish collagen from supplier PB Leiner dissolved the fastest with the least amount of effort. Beef collagen from PB Leiner was the most difficult to dissolve as it formed a paste requiring longer and greater effort to dissolve. It was also cloudy especially at pH 4.0. It would require pre-mix in powder to improve solubility. Subjectively the clarity and viscosity of fish collagen was the same as water.

A Specification Sheet for OTH's ovine collagen peptide is included as Attachment 1. Comparison of the preliminary manufacturing performance of different collagen peptide sources is shown in Attachment 2: Ovine Collagen Peptide Application Performance.

4.4 Initial assessment of economic impact on Australia's sheep industry.

OTH have developed an economic modelling tool to enable them and their customers to better understand the potential ROI which enables meat processing companies to assess viability of implementation of OTH's proprietary technology platform and production process. This modelling was also used for initial assessment of the potential impact on Australia's sheep industry.

Assumptions: Sheep processes 3000 heads/day, Average Sheep Pelt Weight 4kg, 240 working days/year.

Avg Pelt Wt	Avg Annual Pelt wt for Processing (MT)	Estimated Ovine Collagen yield (MT)	Estimated Wool Keratin Concentrate (MT)	Estimated Market Price/MT		Estimated Annual Revenue	
				Ovine Collagen	Wool Keratin	Ovine Collagen	Wool Keratin
4kg	2880	570	60	$18-25K	$30-40K	~$13M	~$2.5M
Estimated TOTAL Annual Revenue				~$15M			
Estimated OPEX	Administration, Processing Aids, Utilities, Labour, Packaging, Site Rental, Equipment Maintenance, Testing and QA, Audit and Regulatory Compliance, Technology License Fees			~$10M			
Estimated Annual Net Margin				~$5M			

In 2024 the national flock's growth is projected to moderate and plateau, reaching 79.5 million head, a rise of 1%, or 750,000 head year-on-year [19].

4.5 Assessing consumer desirability & useability.

NewMe Pty Ltd engaged the services of Watch Me Think (https://watchmethink.com/) to validate consumer useability and desirability of ovine collagen peptides as the 'hero' ingredient in their range of functional beverages. Consumer insights into likelihood to consume functional beverages containing collagen peptides were gathered. Watch Me Think and New Me defined a representative sample of likely consumers for the consumer insight research. Target Consumers attributes were,

- Eighteen Australian consumers,
- Six who seek out supplements / food & drink for skin/beauty (collagen etc), six who seek out supplements / food & drink for gut health (Kombucha, probiotic yoghurt etc) and six who seek out supplements / food & drink for bone health (calcium enriched).
- All consumers were required to be open to consuming food and drink with functional benefits (not just supplements).
- 50% Male and 50% Female.
- A mix of age, life stage and ethnicity.
- Non rejectors of carbonated beverages

The volunteer consumer insight cohort were sent two separate storyboards in sealed envelopes. Participates opened the first envelope which presented the storyboard for the beverage with the functionality they sought. Consumer insights were solicited via the storyboard while participants video their own responses and insights. Participants were then required to open the second sealed envelope which contained a story board which presented the whole beverage range, New Skin, New Bones and New Gut. The Consumer Insights 'Do Guide' is included as an attachment.

4.5.1 Insights

The whole is greater than the sum of its parts.

Only when people see the full range do they really understand the proposition and get excited about each product.

Individually, though mostly positive, each execution generates somewhat lukewarm reviews. People show some interest but are not sold on the concept. Until they are exposed to the full New Me Co range.

Multiple usages translate into interest in more than one product.

Consumers don't limit themselves to a single type of supplement. Most people have multiple products in their stash that they take on a regular basis. This common behaviour explains why most people are interested in purchasing more than one (if not all 3) products from the New Me Co range.

That being said, not all executions generate the same level of traction. New Gut is likely to be the hero product thanks to a higher level of familiarity. New Skin also appeals to a broad audience who is sensitive to skin health from a relatively young age. New Bones probably needs more explanation and organically appeals to an older demographic.

Emulating Remedy and Nexba pack, pricing, and distribution strategy would make sense.

People intuitively associate the New Me Co range with kombucha, although noticing that it doesn't limit itself to gut health. Still, in their view, that natural association means the New Me Co range should be priced similarly, available in similar pack sizes & multipacks, and be available in the same locations.

Collagen peptides

Consumers who already mix collagen powder with liquid are already familiar with the idea of drinking a product to assist with skin health. However, for many people who mainly use skin care products and tablets, New Skin comes in a format they don't understand yet. It appears there is still significant education to do to appeal to a broader audience.

Even collagen powder users are surprised by some of New Skin's content. They are familiar with collagen peptides, but the presence of hyaluronic acid in a beverage is unusual and something they need reassurance for.

"Drinking hyaluronic acid… Don't you just put it on your face?" - Amanda

Ingredient	Familiarity
Collagen peptide	Known by most and naturally associated with skin health / elasticity
Acerola cherry	Limited knowledge but doesn't raise eyebrows
Hyaluronic acid	Known and especially familiar to skin care product users but associated with skin application only. Drinkability is questioned

5. Conclusion

The outcome of this project has been the successful development of a 3-step pilot scale process for processing sheep pelts. The first technology enables sheep skins to be easily processed using established industrial equipment, solving a significant industrial feasibility issue in high volume processing of raw sheep skins. The second technology generates high and consistent quality food and nutraceutical grade skin collagen hydrolysate from the processed ovine pelts and separates out intact and clean wool. The third technology enables the separated-out wool to be converted into a high value wool keratin protein concentrate.

Furthermore, satisfactory application trial results have validated the high process and product quality of the OTH technologies.

5.1 Benefits to Industry

Currently the only way Australia's sheep industry can generate more revenue and profitability is either to cut costs or grow and processing more sheep or taking advantage of the occasional positive market conditions. OTH's technology has the unique ability to consistently produce high quality food ingredients from low value sheep skins generating a new income stream. The technology also has the potential to deliver sustained and significantly increased profits and new products streams to Australian sheep producers without needing to process more sheep & deliver increased profits back to Australia's sheep producers.

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Attachment 1: Ovine Collagen Specification Sheet

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OVINE COLLAGEN HYDROLYSATE

DESCRIPTION

Hydrolysed Collagen Peptides from Ovine feedstock treated with proprietary OTH technologies

PHYSICAL SPECIFICATIONS	
Form	Powder
Colour	White
Taste & Smell	Taste and Odour free
INGREDIENTS	
Ovine Collagen Hydrolysate	
BIOCHEMICAL SPECIFICATIONS	**% (w/w)**
Protein	> 90%
Fat	< 1%
Moisture	< 8%
Ash	< 1%
Carbohydrates	< 1%
Sodium	< 1%
Arsenic	NMT 1 mg/kg
Cadmium	NMT 0.5 mg/kg
Lead	NMT 0.1 mg/kg
Mercury	NMT 0.3 mg/kg
MICROBIOLOGY	
Aerobic Plate Count	NMT 10,000 cfu/g
Yeast & Mould	NMT 100 cfu/g
E.Coli	Not Detected in 25g
Salmonella spp	Not Detected in 25g
Clostridium perfringens sp	NMT 10 cfu/g
Cfu: Colony forming unit; NMT: Not more than	

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TYPICAL AMINO ACID PROFILE

Amino Acid	Mole %
Hydroxyproline	8.3
Histidine	0.9
Serine	4.5
Arginine	4.2
Glycine	25.9
Aspartic Acid	7.1
Glutamic Acid	8.6
Threonine	2.6
Alanine	11.0
Proline	11.6
Lysine	3.6
Tyrosine	1.0
Methionine	0.9
Valine	3.1
Isoleucine	1.9
Leucine	4.3
Phenylalanine	1.5

PACKAGING

10 kg in polyliner lined 20L white plastic pails with lids

STORAGE INSTRUCTIONS

At ambient temperatures. For optimum stability store refrigerated at 4-6°C

SHELF LIFE

24 months

HALAL STATUS

Suitable

KOSHER STATUS

Suitable

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ALLERGEN STATUS

YES	NO	ALLERGENS
	X	Cereals containing Gluten (Wheat, Rye, Barley, Oats or Spelt or their hybridized strains)
	X	Crustacea & their products
	X	Eggs & egg products
	X	Fish & fish products
	X	Peanuts & their products
	X	Soybeans & their products
	X	Milk & milk products (Lactose)
	X	Nuts & nut products
	X	Sesame seeds & their products
	X	Added sulphites in concentration of 10mg/kg or more (Sodium Metabisulphite – approx. 20 ppm)

PURITY STATUS

Complies with Food Chemical Codex Standards for food products

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Attachment 2: Ovine Collagen Peptide Application Performance

COLLAGEN SOLUBILITY TEST				
Collagen (1%)	**Additional Notes**	**Time to fully solubilise**	**Collagen**	**Clarity & Viscosity Compared to Water:**
Ovine (OTH), 20°C, PH7	Fast Hand Mixing	43.84s	Ovine 5%	Yellowish, Same Viscosity
Ovine (OTH), 20°C, PH4	Fast Hand Mixing & Pressing (Lumps)	39.55s	Ovine 10%	Yellow, Same Viscosity
Ovine (OTH), 50°C, PH7	Fast Hand Mixing	29.31s		
Ovine (OTH), 50°C, PH4	Fast Hand Mixing	17.87s	Fish (IP) 5%	Yellowish, Same as water
Ovine (OTH), 80°C, PH7	Fast Hand Mixing	18.60s	Fish (IP) 10%	Yellowish, Same as water, Foam won't disappear
Ovine (OTH), 80°C, PH4	Fast Hand Mixing	15.97s		
			Fish (PB) 5%	Yellowish, Same as water
Fish (IP), 20°C, PH7	Hand Mixing	23.67s	Fish (PB) 10%	Yellowish, Same as water
Fish (IP), 20°C, PH4	Hand Mixing	10.10s		
Fish (IP), 50°C, PH7	Hand Mixing	15.63s	Beef 5%	Won't dissolve, Forms a paste
Fish (IP), 50°C, PH4	Hand Mixing	09.50s	Beef 10%	Won't dissolve, Forms a paste - Very hard to mix & dissolve
Fish (IP), 80°C, PH7	Hand Mixing	10.81s		
Fish (IP), 80°C, PH4	Hand Mixing	11.46s		
			Label	
Fish (PB), 20°C, PH7	Easy Hand Mix	15.00s	IP:	Ingredients Plus
Fish (PB), 20°C, PH4	Easy Hand Mix	12.00s	PB:	PB Leiner

Fish (PB), 50°C, PH7	Easy Hand Mix	08.35s	OTH:	Organic Technology Holdings
Fish (PB), 50°C, PH4	Easy Hand Mix	04.05s		
Fish (PB), 80°C, PH7	Easy Hand Mix	03.00s		
Fish (PB), 80°C, PH4	Easy Hand Mix	03.00s		
Beef (PB), 20°C, PH7	Hard Hand Mixing & Pressing (Lumps)	268.0s		
Beef (PB), 20°C, PH4	Hard Hand Mixing & Pressing (Lumps)	300.0s		
Beef (PB), 50°C, PH7	Hard Hand Mixing & Pressing (Lumps)	105.85s		
Beef (PB), 50°C, PH4	Hard Hand Mixing & Pressing (Lumps)	152.25s		
Beef (PB), 80°C, PH7	Hard Hand Mixing & Pressing (Lumps)	113.0s		
Beef (PB), 80°C, PH4	Hard Hand Mixing & Pressing (Lumps)	076.0s		

Attachment 3: Watch Me Think 'Do Guide'

Do Guide

New Me Co - Concept Test

Target Consumers

n=18 Australian consumers

- 6 who seek out supplements / food & drink for **skin/beauty** (collagen etc)
- 6 who seek out supplements / food & drink for **gut health** (Kombucha, probiotic yoghurt etc)
- 6 who seek out supplements / food & drink for **bone health** (calcium enriched)

- All to be open to consuming food and drink with functional benefits (not just supplements)
- 50% Male and 50% Female
- A mix of age, lifestage and ethnicity
- Non rejectors of carbonated beverages

Film 1 – Current stash

Location: at home
Objective: see what consumers currently have at home, what drives them to purchase these types of products and what they understand about the benefits
Filming instructions: Please record this in a space where you are able to show us your stash of supplements, food and/or drink you use for either beauty, gut health, or bone health. Please set your camera up so we are able to see as you show us your products.

No selfies will be accepted so please set your camera up so you are handsfree!

Show us the products you currently have at home and talk about:

- Primary purpose of each
- How you use them
- What made you first try
- Likes and dislikes
- Your favourite product and why
- Which has the best packaging and show us why

Tell us:

- What is most important to you when shopping for supplements or food & drink for [beauty / gut health / bone health; depending on recruitment cell]?
    - For example, is it the benefits, certain claims, certain ingredients, the packaging design, the format, the country of manufacture, etc.?

Finally, tell us:

- Where you shop for these products and why
- If it's online, please show us the websites you choose to shop on and why

Film 2 – Concept review

Location: at home

Objective: review the New Me Co concepts

Filming instructions: **Please set your camera up so we are able to see you as you look at the idea and the concepts that were sent to you, and respond to the questions provided.**

No selfies will be accepted so please set your camera up so you are handsfree!

Now, please open **envelope A** , look at the concept, read it and tell us about:

- Your first impression
- Like and dislikes and why
- Comparisons with the items you showed us in your stash
- What stands out and why
- Anything you don't understand
    - If so, tell us about that
- What this product will do that other products don't

Now, look at the packaging and tell us about:

- Your feelings about the packaging design
- What stands out
- Likes and dislikes
- If there is anything missing or anything that is not clear
- The name and what it says about the product
- The flavours
    - Your favourite one
    - Any that don't sound so good
- What size/volume of drink would be ideal

Now looking at the list of ingredients, tell us:

- Which are familiar
- Which are unfamiliar
- Which benefits are most compelling

Now knowing what you know about this concept, tell us: