

final report

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High Pressure Processing (HPP) – Frontier red meat development Project

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Abstract

In 2014, there are minimal beef and no lamb sandwich meat products in all major supermarket retailers in Australia compared to over 20 pork and chicken sandwich meat products. There are very few, if any pre-cooked red meat roasts available in the major retail supermarket retailers in Australia. This project considered the commercial upscaling of High Pressure Processing (HPP) and addressing technical hurdles to the development of red meat pre-cooked products as well as developing a cost benefit analysis of a toll manufacturing model for commercial scale HPP production model.

The cooked cold meat segment in retail is worth \$1,204 million for 88,000 tons in 2010 and is expected to grow to \$1,298 million for 94,000 tons in 2013 Data Monitor (2010), "Meat Market Data – Asia Pacific – Australia". There is thus a substantial and growing need for pre-cooked meats in which red meat is under-represented and which therefore represents an opportunity to develop pre-cooked red meat products for retail and food service markets. High Pressure Processing technology may enable such products to have a competitive advantage in terms of shelf-life/food safety, reduced yield loss and superior visual and flavour attributes. The expectation is that these superior products will drive benefit for the Australian Red Meat Industry through increased demand for the secondary cuts used to produce these products.

To date ham has dominated the cooked cold meat market due to its ubiquitous use of preservatives and brining in order to prolong shelf life. This option is not open to red meat firstly because there are very few preserved red meat products in the market currently and given consumer preference is moving away from preservatives/additives it is unlikely that developing the market opportunity by way of preservatives to achieve extended shelf-life is a viable. HPP however represents an alternative route for red meat into the cooked cold meat market without the use of preservatives: unique in its ability to non-thermally sterilise whilst still maintaining 'just-cooked' flavour and colour.

During the course of this project an ownership change from Frontier to Longfresh occurred and the project was terminated before completion. However, the first in Australia HPP red meat products was successfully launched being several Roast Beef and marinated beef and lamb strips supplied chilled into WA foodservice market channels as well as NSW Safefoods approving facilities quality assurance program to operate. A third party CBA was also completed and is presented in the final report.

Executive Summary

The evolution of trends in consumer demands in the food industry has developed into an increased demand for food products that have the following attributes:

- Minimally processed;
- Additive free or less reliant on additive preservatives such as sulphite, nitrite, benzoate and sorbate;
- Nutritionally healthy and natural;
- Convenient to use; and
- Fresh.

These drivers have caused the food industry to look to processes such as High Pressure Processing (HPP) to deliver safe food products that do not require additives and do not compromise the overall sensory qualities of the product.

This project aimed to investigate the potential of HPP in the red meat industry to produce pre prepared meat products, ready meals and cold cuts and deliver premiums to the industry. Currently, red meat products are significantly underrepresented in the sandwich meat market at both the retail and commercial food service levels. HPP represents a potential method for red meats to enter into this market, differentiated in the fact that traditional preservation methods for sandwich meats utilising additives and brining would not be required. Instead, HPP proposes a non-thermal additive free sterilisation process that maintains the 'just-cooked' flavour and colour of the product.

The objective of this project was to firstly identify and address the technical hurdles associated with the development of pre-cooked red meat products utilising HPP. Due to an ownership change by partner Frontier, the project was terminated before completion however, several products were developed and launched and an initial cost benefit analysis completed listing an indicative toll manufacturing cost of \$0.50/kg higher for HPP than retort processing.

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1 Projective Objectives

The project initially was to :

- ❖ Establish shelf life parameters
- ❖ Determine impact of HPP protein denaturation on eventual degree of cook on pre-cooked products
- ❖ Trial packaging types in order to minimise colour changes through oxidation in cooked red meat products
- ❖ Determine the impacts of combined pH and HPP conditions on shelf-life and eating qualities of cooked red meat products
- ❖ Establish competitive advantage at commercial scale of HPP red meat products over conventionally cooked and retorted products

Works completed prior to project termination, were factory and machinery commissioning and initial market launch for several HPP red meat products and stage 1 CBA undertaken by GHD.

2 Results

2.1 Product development – red meat HPP

Two technologies were compared against similar production outputs with similar products.



The products displayed above were successfully launched into WA Foodservice channel as chilled products sourced by Mining camps. Cycle time of 3 ½ minutes and 450 MPa was validated and approved by NSW Safefoods, with a chilled shelf life of 16 weeks attained, removing the need for frozen supply. The following HPP products displayed below were relaunched under Longfresh company brand post project ending – these included, added value to beef topside and outside flats and lamb leg and shoulder portions. The burgers were derived from Beef 85-90CL trimmings. The distributor and mining camp kitchens found benefit in chilled product over frozen in both storage and ease of use to prepare meals.



2.2 SWOT Analysis – uptake of HPP, barriers to entry

Discussions were held with a representative sample of the Australian foodservice market including large corporations, supermarkets, national and emerging franchises and chains, and small-to-medium size independent businesses. The milestone identified the key 'Strengths' HPP beef and lamb sandwich fillings products as being a combination of significant improvements to food safety standards through the delivery of a complete pathogen kill; significant extension of the fresh-chilled shelf life of the products, thereby eliminating the reliance on frozen distribution channels nationally and internationally; development of a unique selling proposition for the products which is capable of delivering significant new business opportunities both domestically and abroad.

The key 'Weakness' identified was the potential market intolerance of the increased sale price due to the added processing cost of the HPP process.

The key 'Opportunity' identified was the ability for businesses to grow and expand their traditional range of the sandwich fillings as well as extend into other ready-to-eat HPP beef and lamb products such as burger patties, steaks, ready meals, Bolognese sauces and beef nacho toppings.

The identified key 'Threat' was being the sudden unavailability of HPP technology to manufacturers due to any unforeseen equipment breakdown and/or insufficient capacity of dedicated HPP toll processing services in Australia.

Current Category Competitors | Non-HPP Sandwich Fillings

There is a significant range of non-HPP beef, ham and chicken sandwich fillings being sold throughout Australian supermarkets, which are delivered to the end-user in various formats [shaved, sliced, small pieces, large pieces], and which HPP beef and lamb sandwich fillings will be in direct competition. These competitor products include the following major national lines:

Roast Beef



Ham



Chicken



Current Category Competitors | HPP Sandwich Fillings

3 Australia

There is a limited range of HPP chicken sandwich fillings being sold throughout Australian supermarkets which HPP beef and lamb sandwich fillings will be in direct competition. These competitor products include the following national lines:



4 USA

There is an extensive range of HPP protein sandwich fillings being sold throughout supermarkets in the USA which exported Australian HPP beef and lamb sandwich fillings will be in direct competition.



SWOT Analysis

5 Strengths

1. Complete pathogen kill delivering a zero plate count for the product.
2. Significantly extended chilled shelf-life of the product, potentially up to 5+ months.
3. The combination of 1 and 2 [above] means the product has one of the most exciting and innovative unique selling propositions [USP] to hit the Australian foodservice market.
4. Elimination for the need and necessity of foodservice businesses to rely on frozen product when manufacturers are located far-away from them. For example, when the manufacturer is located in Sydney and the foodservice business they are supplying is located in Perth.
5. Significant increase in the quality of product being sold into foodservice operators in geographical far-reach places in Australia, where the product is not readily available in a 'fresh chilled format' through local traditional food wholesalers and distributors.
6. Ability for manufacturers to conduct longer more economically viable production runs of lower volume bespoke versions of the product, and then 'rely' on the significantly extended shelf life to stockpile the product and draw-down to service the customer as and when they require.
7. Based on the manufacturer's ability to conduct longer more efficient production runs, the manufacturer should also be able to achieve cost savings in the raw ingredients used due to the buying power generated as a direct result of them having to purchase larger volumes of these ingredients to service these runs.
8. In foodservice businesses where there is currently a heavy reliance on ready-to-eat [RTE] meats and, as such, a similar reliance on having the necessary freezer storage in those stores/facilities to store these products, there is now an opportunity for these types of businesses to reduce the amount of freezer storage they require [by potentially transitioning

existing freezers to chillers], thereby reducing both their up-front capital expenditure on equipment and/or their on-going operating costs [power and servicing].

9. Increase in productivity in foodservice businesses due to the fact that there would no-longer be a requirement to use frozen product and to have to manage defrosting it, which should translate into time savings and a reduction in labour costs.

10. The transition from the use of frozen RTE meats to fresh-chilled HPP product significantly reduces the risk of potential product damage, contamination and/or spoilage, which occurs from time-to-time due to poor handling practices and/or temperature abuse, usually during the traditional methods of defrosting.

11. Extended shelf-life of decanted product being used in-store, being up-to 4x the shelf-life currently being achieved with non-HPP product. For example, from 2 days shelf-life for a decanted non-HPP product up to 8 days shelf-life for a decanted HPP product. This assumes correct storage and handling policies and procedures are being adhered to at all times, and that the product is not being exposed to or cross-contaminated by other unrelated products.

12. An increase in consistency in product quality for national franchises and chains, thereby enabling them to leverage and promote these products more confidently and consistently, which in-turn will drive end user awareness, trial and overall sales in the category.

13. Delivers a significant potential reduction in product waste for foodservice businesses, due to the extended shelf-life of the product [unopened or decanted]. If managed correctly, this could result in zero waste being achieved.

14. Potentially delivers genuine cost savings to food distributors who sell the product, as they may not have to deliver to customers as frequently due to the extended shelf-life. For example, if a cafe normally orders 5kg of product three times a week, this customer's total weekly order of 15kg could potentially be delivered to them at the one-time, without concern that the product will go past its expiry date. This benefit is of course contingent on the customer's ability and willingness from a cash flow and/or storage perspective to hold that amount of stock at once.

15. Leveraging the side-benefit to HPP of tenderisation, thereby opening-up the opportunity to process 'cheaper cuts of meat' to produce the product and sell into the foodservice market nationally. This is particularly relevant to value-added sliced and shredded versions of the product.

16. Reduced staff training costs and increased operations compliance for foodservice businesses, due to the HPP product being 'operationally easier to handle and manage' on-site/in-store.

17. Notable reduction in exposure to food contamination events will translate into actual savings for foodservice businesses, who can incur significant expense due to contaminated product recalls, which may also result in compensation, business interruption, reputational damage, lost business and wasted stock.

18. The availability of HPP technology in Australia is a 'very good news story' for all state and federal food regulatory agencies, each of who dedicate enormous amounts of resources monitoring manufacturers and foodservice business trading in this 'high risk' RTE category. This benefit is further enhanced given the capability of HPP to 'clean' contaminated product, which may need to be recalled from the market.

6 Weakness

1. The cost of the HPP process per kilogram, as it applies to this part of the highly price sensitive foodservice market. For example, an upward shift in price of say \$0.50 per kilogram for the product may still be unacceptable to some foodservice businesses despite their genuine demand for the product, and notwithstanding the current price to HPP toll-process this type of product in Australia is approximately \$1.00 per kilo.

2. The manufacturer of the product having to partially or fully absorb the cost of HPP in their sale price, in order to meet an accepted market price threshold. This results in the manufacturer having to accept a reduced margin for the product overall, in what is already a low-margin product category.

Assuming the manufacturer decides to pass-on the cost of the HPP processing in-full or in-part to the foodservice business, that business then has to either accept the increase in price from the manufacturer and choose to either absorb this cost in order to protect their own current sale price to the end-user [thereby eroding their own existing margin], or pass-on the cost to the end user either wholly or in-part.

4. The current 'unknown' of how much more the end user will be willing to pay for a HPP product, in the context that to the 'unaware' consumer, the product is effectively 'the same as they bought yesterday', so why would they have to pay more?

5. Not having a straightforward and clearly articulated educational communications platform which explains to the end-user/consumer why the HPP product has a significantly longer shelf-life than they would normally expect from the product.

6. Manufacturers not committing the necessary resources to fully developing 'HPP ready' products, which have the capability to deliver not only a premium quality version of the product, but also a commercially viable product [for all stakeholders] by way of highly efficient packaging solutions which are not only practical and meet a minimum standard on aesthetics, but also enable the maximum fill-rate and through-put ratios for the HPP process, thereby reducing the processing cost per kilogram to and commercially viable level.

7. Whilst there are some existing businesses which have HPP as part of their own internal production processes and which do offer toll processing opportunities to external businesses on an ad-hoc basis, there is currently no dedicated 'back-up' HPP toll processing provider in Australia who could service the demands of the market in the event the dedicated HPP toll processing business in Australia becomes inactive for any reason [extended breakdown, full capacity, etc].

7 Opportunities

1. Will provide foodservice businesses the opportunity to grow and expand their range of this type of product, not only within the sandwich filling category but also beyond that category into products such as RTE burger patties and steaks, ready meals, Bolognese sauces and beef nacho toppings.

2. More efficient food safety policies, procedures and regulatory reviews, whereby these HPP products quickly generate a highly regarded industry reputation as being operationally simple, very safe and reliable.

3. On-going development and launch of new domestic markets, which would include major market segments such as:

* Supermarkets and Convenience Stores

- * Remote Mining Camps
 - * Military
 - * Cruise Ships and Airlines
 - * Major Sporting & Entertainment Venues
 - * Hospitals
 - * Home Delivery
4. Development of new export markets, including:
- * New Zealand
 - * Pacific Islands
 - * Asia
 - * USA
5. To promote HPP as an 'all natural pasteurisation process', which doesn't affect the quality or nutritional value of the product.
6. For HPP to become the benchmark for this type of product nationally and throughout the Asia-Pacific Region.
7. For meat producers to achieve a higher value/yield per animal, through the development of a range of these products using lower-value cuts.
8. For this range of HPP products [and others] to become significantly embraced, endorsed and promoted by the major supermarkets nationally, the result of which will be a significant awareness, understanding and acceptance of these types product by the mass consumer market which in-turn will positively filter into the other segments of the foodservice market and generate interest and demand for the products there too.
9. For all state and federal food regulators to endorse and promote the existence, benefits and availability of HPP technology in Australia, and to strategically assist in the positive promotion of these products, along with other HPP product categories.

8 Threats

1. Rejection by the market of the necessary price increases to the product due to the cost of the HPP process.
2. Sudden unavailability due to breakdown and/or insufficient capacity of dedicated HPP toll processing services in Australia due to no dedicated toll processing operation facility.
3. In the event there was a significant break in the availability of dedicated HPP toll processing services in Australia (as noted in 2 above), there would be significant disruption to the supply of this range of products to the market, which could potentially result in one or more of the following outcomes for the foodservice businesses who become heavily reliant on selling this range [and others]:
 - * disruption to site and/or in-store operations;
 - * commercial loss, through loss of sales;
 - * reputational loss;
 - * damage to brand equity;
 - * loss of business growth opportunities, such as new accounts and store openings.
4. Potential creation of complacency in foodservice businesses, whereby existing food handling and safety policies, procedures and standards are 'unofficially relaxed' due to the perception that HPP product is 'bullet-proof'. This could result in significant negative exposure for the business.

Key Market Requirements

Based on the observations noted in the SWOT Analysis, it was concluded that the key market requirements for range of HPP red meat products are as follows:

1. Validated pathogen kill.
2. Validated extended shelf-life and organoleptic testing.
3. Acceptable toll processing cost, which will be commercially viable for all stakeholders throughout the supply chain and by the end-user.
4. Approval and endorsement of HPP by all state and federal food regulatory agencies.
5. Development of a communications platform capable of educating end-users of the benefits of HPP and why the product has such an extended shelf-life.
6. Promote HPP as an 'all natural pasteurisation process', delivering a higher quality better long-life product when compared to traditional methods.
7. Uninterrupted continuity of supply.
8. Availability of HPP technology for on-going new product development.

Third party Cost Benefit Analysis (CBA) – HPP vs Retort toll manufacturing

In order to compare the equivalent costs of processing for HPP and conventional retort processing the two technologies were compared against similar production outputs with similar products.

Table 1 and Table 2 respectively show the per kilogram processing costs of HPP and retort processing for both the meat in sauce and sliced meat products. In both tables the processing costs are based on production outputs of 500 tonnes per year and 1000 tonnes per year. These figures were chosen as representative of a typical small to medium food processor.

For the purposes of this comparison the Multivac HPP 160L High Pressure Processing System and the CapKold CKCT-10 Automatic Cook Chill Retort Tank were used in the cost model.

Table 1 High Pressure Processing Cost Scenarios

Production Throughput	Product	
	1 kg meat and sauce product	1 kg sliced product
500 tonnes/year	\$1.06/kg	\$1.27/kg
1000 tonnes/year	\$0.64/kg	\$0.85/kg

Table 2 Retort Processing Cost Scenarios

Production Throughput	Product	
	1 kg meat and sauce product	1 kg sliced product
500 tonnes/year	\$0.24/kg	\$0.34/kg
1000 tonnes/year	\$0.17/kg	\$0.28/kg

It is clear from Table 1 and Table 2 that HPP represents a significant cost over that of conventional retort processing. This is primarily attributed to the difference in capital outlay between HPP equipment and retort equipment rather than their respective operating costs. Typically the supply and installation costs for a HPP system would be in the order of AUD 2 million compared to AUD 200,000 for a conventional retort system. For the equivalent processing scenarios summarised in Table 1 and Table 2 the per kilogram processing cost of conventional retorting represented approximately 20-30% of the cost for HPP.

It is evident from the cost comparison that if a food processor is to invest in a HPP system, the processing costs must be justified by the unique benefits that HPP provides to the products and to the food processor. The key benefit of HPP lies in the range of products made available through the process and the shelf life attainable without adversely affecting the sensory qualities of the product. Recent MLA research has also showcased HPP when used in combination with high temperature, can also provide meat tenderising effect (A.MQT.0053).

Table 3 below summarises the key advantages and disadvantages of HPP and conventional retort processing.

Table 3 High Pressure Processing and Retort Processing Comparison

	Advantages	Disadvantages
High Pressure Processing	<ul style="list-style-type: none"> ▶ The process has minimal effects on the sensory and nutritional qualities of the products. ▶ HPP is a non-thermal pasteurisation technique which allows the development of products such as rare red meat products either whole or sliced, and pre-prepared meat and sauce products. ▶ HPP provides a significant increase in the refrigerated shelf life of meat products. A review of available literature has revealed a typical figure of 100 days. This has the potential to open up new and wider markets for the food processor to distribute refrigerated products in lieu of frozen products. ▶ The pressure treatment is uniform throughout the volume of the product which allows the pasteurisation of large portions of sliced meats and minced meat products such as hamburger patties without thermal intervention which would otherwise cause significant moisture losses in larger products. 	<ul style="list-style-type: none"> ▶ High processing costs. ▶ Relationship between processing conditions and pathogen lethality is not fully defined. As a result current food safety regulations do not typically recognise HPP. However this issue can be managed through QA programs.
Conventional Retorting	<ul style="list-style-type: none"> ▶ Low processing costs. ▶ The relationship between processing conditions and pathogen lethality/shelf life is well defined and prescribed in both Australian and international food safety regulations and codes. 	<ul style="list-style-type: none"> ▶ The severity of the thermal pasteurisation process results in significant adverse effects on the sensory qualities of many product types including: <ul style="list-style-type: none"> – Moisture losses from whole and sliced meat products render the products unattractive and unacceptable to food service customers. – Products with meat and sauce combinations are affected by the splitting of the sauce. Also the moisture losses from the meat constituents deteriorates the look and flavour of the sauce. ▶ The potential benefits of increased product shelf life does not outweigh the severe negative impacts on product quality. For example, in trials undertaken by Frontier on their beef strip products even a mild form of retort processing severely affected the sensory characteristics of the product while only providing a refrigerated shelf life of 8 weeks as opposed to 4-6 weeks if the product was not treated.

9 Conclusions/Recommendations

Outcomes from this partially completed project included successful launch of several first in Australia red meat HPP products. These included marinated beef and lamb strips and roasts beef and burgers. Further, approved quality programs were validated that delivered chilled product and desired shelf life solutions.

The technical discoveries such as determining the ideal HPP settings for rare roast beef (that is extending shelf life, with reduced nitrites and maintaining pink rare centre) were not completed prior to project termination during the dissolution of Frontier and commencement of Longfresh company which decided to not pursue the research partnership project with MLA. Frontier thanks MLA for their support during this transition.

The 3rd party CBA along with SWOT analysis following market input showed HPP red meat is possible and can deliver benefits but will typically incur a 20-30% increased cost which needs to be recovered in premiums with value creation and capture to benefit required for all participants for HPP to be a more viable platform than conventional retort (or steam cabinet methods).