



Final Report

Commercial feasibility of banana waste utilisation in the processed food industry

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Media Summary

From 5-20% of the total banana crop is rejected at the pack-house because it does not meet retailer specifications for sale as fresh fruit. Of the reject crop up to 80% is food grade quality and is suitable for processing with an estimated 50,000-60,000 tonnes/year readily accessible from the main north Queensland growing area. This project aimed to identify opportunities for recovery of value from these cosmetically damaged bananas.

The research characterised the extent, location and fate of the reject crop by interviewing and surveying the banana growing, packing and marketing industries. Food grade bananas are currently primarily disposed of as mulch or animal feed and not separated from other wastes. A review of banana products showed that from July 2009-January 2010 over 1000 new products containing banana were launched into overseas markets. The breadth of banana product types found internationally is not present in Australia and implies that there are opportunities for further local processing of the reject crop. New approaches for processing were investigated through review of the scientific and patent literature and six concept processed banana products were developed for consideration of market viability by industry.

There were two types of processing options. The first was for the production of banana ingredients such as frozen banana, pulp, juice and syrups where there is no or limited point of differentiation from imported ingredients other than “local” or “Australian sourced” labeling. The second option was for niche products where differentiation from imported products can be achieved. Examples were fresh-cut banana snacks where a short shelf life confers market access barriers, products based on new technologies such as high pressure cold pasteurization of juices and functional foods based on the health benefits of bananas.

Recommendations are for future research and development to focus on both option areas. A review of the logistics for processing or semi-processing at a centralised depot in the main banana growing area is required to determine cost efficiencies that could be gained from vertical integration between the grower and processor. Novel niche products featuring the health and taste of bananas should be developed through innovative processing companies. Such products would not only utilise local bananas but would also highlight the benefits of banana products for fresh fruit sales.

Technical Summary

From 5-20% but sometimes up to 40% of the banana crop is rejected at the pack-house because it does not meet retailer specifications for sale as fresh fruit. Of the reject crop an estimated 50,000-60,000 tonnes/year of processing grade fruit could be being readily accessible from the main north Queensland growing area stretching 200km from Mareeba south to Tully. There are sufficient supplies in other banana growing areas to service local niche processing.

This project was to identify opportunities for recovery of value from these cosmetically damaged bananas. Puree can be imported for around (AUS)\$1.20/kg depending on the exchange rate and frozen diced or sliced banana for between \$2.50 - \$2.80/kg. Therefore simple options such as processing fruit into bulk ingredient forms are sensitive to raw material supply costs and processing efficiencies due to heavy price competition from these imported products.

The research characterised the extent, location and fate of the reject crop by interviewing and surveying the banana growing, packing and marketing industries. Food grade bananas are currently primarily disposed of as mulch or animal feed and not separated from other wastes. In some cases food grade bananas incur a waste cost for disposal. Banana for processing is being sold for as low as \$100 per tonne but the cost for growing and picking was estimated at \$600 per tonne. This cost however is incurred regardless of the fate of the banana as all fruit is picked and graded. This is in contrast to other products like apple where a choice can be made not to pick low value fruit. A bulk value added product such as an Australian puree would therefore only be worth \$1200-\$2000 per tonne. At least 4 fruit processors are currently processing banana with some frozen sliced material being supplied to the juice industry and at least 2 operators making dried banana products. These value added products are worth 2-4 times bulk ingredients but have greater issues accessing consumer markets.

An international market scan of processed banana products showed that from July 2009-January 2010 there were 1209 new products containing banana launched into overseas markets. Only 17 banana containing products were launched into the Australian market over the same time. On-pack ingredient information lists included mashed banana, banana pulp, dried banana, banana puree, banana chips, and freeze dried banana. Processed banana products were used both as major and minor components. Product claims or promotional messages included references to “real banana”, fruit serve equivalents, energy and performance benefits, nutritional quality, and good eating experience. Banana products were spread across categories with the most frequent being soft drinks, bakery/cereal products, baby food and dairy products.

A review of the scientific and technical literature on banana processing and banana products was undertaken to understand what is currently known and where possible gaps may be in developing new products. An international patent search was also undertaken. From this information concept ideas were presented at the first industry forum covered (1) Naturally non-browned dried products (2) Functional pulps (3) Fresh cut fruit (4) Functional juices and (5) Flour, fibre, starch products. From feedback on viability concepts were prepared around (1) fresh ready-to-eat snacks (2) frozen ready-to-eat snacks (3) natural energy squeeze pack of banana pulp (4) high pressure processed pulp (5) high pressure processed whole and slice (6) Smooth banana spread with a further researcher contribution of (7) banana juice and (8) syrup.

The options for the production of banana ingredients such as frozen banana, pulp, juice and syrups have no or limited point of differentiation from imported ingredients other than “local” or “Australian sourced” ingredient labeling. Commercial success would be dependent on cost structure improvements. These improvements could include efficiencies generated by vertical integration between growers and processors to eliminate supply chain issues and efficiencies in processing such as automated peeling.

The options are for products which have points of differentiation from imported banana products and ingredients are fresh-cut banana snacks where a short shelf life that confers market access barriers; products based on new technologies such as high pressure cold pasteurization of juices and products offering novel concepts; and attributes such as nutritional or functional food products targeting specific health benefits. Market linkages are required to guide development of these products to formats and values that will find acceptance by consumers.

Recommendations are for future research and development to focus on both option areas. A review of the logistics for processing or semi-processing at a centralised depot in the main banana growing area is required to determine cost efficiencies that could be gained from vertical integration between the grower and processor. Novel niche products featuring the health and taste of bananas should be developed through innovative processing companies. Such products would not only utilise local bananas but would also highlight the benefits of banana products for fresh fruit sales.

Introduction

There are significant volumes of banana which do not meet retailer specifications and thus cannot be sold through the fresh fruit retail avenues. It has been estimated that between 15-50% of the total banana production, which reaches the packing shed, does not meet retailer specifications and is rejected (1). In many cases this rejected fruit is simply shredded and spread over paddocks. The use of waste banana in generating energy has been explored (1) but no formal review of possible options for utilization of waste banana by the food industry has been undertaken. Thus the present study was commissioned by Horticulture Australia on behalf of the banana industry to determine the opportunities for increasing utilization of this waste banana, through further use(s) in the food industry.

A recent article published in 'Trends in Food Science and Technology' described some of the food industry uses of banana but encouraged further capitalisation of processing of banana for food products (2). Products listed included juice, fruit drinks, fermented drinks, stewed fruit, puree, marmalade, jam, flakes, confectionary and pastry ingredients, sorbets and ice-creams, and snack foods.

In determining the best opportunities for increasing utilization the following were undertaken;

- Survey of current banana growing and sorting practices, with a specific focus towards waste fruit
- Survey of current Australian banana processing activities
- Survey of use of processed banana products in Australia
- Survey of processed banana products available internationally
- Review of scientific and technical literature
- Development of concept products and presentation at industry forums.

Materials & Methods

Industry Survey

Growers and Processors

A survey of banana farms, pack houses and banana processing facilities was undertaken to determine the current volumes, specification and use(s) of fresh fruit which cannot be sold through retail avenues and current banana processing activities. The full details of this are in Appendix 1.

To get a representative group of farms contact with industry members was facilitated by Tony Heidrich, ABGC CEO, and Lou Lardi (ABGC). Contacts with processors were facilitated by DEEDI colleagues based in Cairns. The tour commenced in Mareeba on Monday 16th November 2009, incorporated Innisfail and Tully, and concluded in Townsville on Tuesday 24th November. The tour consisted of eleven banana farms, both large and small, and three processors of banana.

At each farm casual interviews were conducted asking the following questions,

- At what critical points does fruit waste occur?
- What are the volumes of waste fruit?
- What characterizes waste banana?
- What do you do with waste fruit?
- Current incomes from different uses of waste fruit?
- Do you process the waste? If so how do you do this?

Processors were asked a range of questions regarding the banana products they made.

Processed Banana product users

To determine the opportunities for utilization of Australian grown and processed banana products, fourteen companies were contacted by phone to ascertain their use. Seven companies were agreeable to answering questions and were thus emailed the following questions,

- What Australian banana products does your company use? (eg., fresh, puree, frozen slice, dried etc.)
- What imported banana products do you use?
- What product features/specifications/sourcing issues do you consider when buying banana products? This might be quality, flavour, viscosity, freshness, source reliability, or even just price.
- What would increase your use of/encourage you to use Australian banana products?

Literature Review and Patent search

A review of the scientific and technical literature on banana processing and banana products was undertaken to understand what is currently known and where possible gaps may be in developing new products. An international patent search was also undertaken.

Market Research

A food product innovation scan was completed to identify current commercial usage of bananas in processed foods being sold in the retail market. Food industry innovation

and development of processed foods utilising banana products was tracked using the Innova Database. Incorporating 73 developed countries, the online database provides a global snap-shot of new product development activity in the food, beverage and nutrition arena. Search results include high resolution images of packaging and provide information on unit pricing, ingredients, marketing messages and market positioning.

A global and local Australian only scan was performed. Both searches were restricted to the six months between July 2009 and January 2010 in order to summarise only the most recent trends. A free text search for the term “banana” in the product ingredient list was submitted with no additional limitations other than launch date. Products identified in search results were categorised by market category and product positioning. Information about the type of processed banana product listed in the ingredient declaration and any product or promotional claim displayed on packaging was also recorded. Current banana products available in the Australian market were also investigated through surveys of retail products on supermarket shelves.

Concept product development

Phase 1

Following the industry survey and market and literature review, five concepts were presented at a forum (February 2010) for banana growers and processors. The purpose of this was to present the information collected so far and get feedback regarding the concept ideas.

Phase 2

Following the feedback from the February forum, and further discussion within the project team, six concept products were decided upon for further assessment and presentation at a second industry forum in June.

Prior to presentation at the industry forum, description and assessment of the concepts was undertaken by the project team to answer the following questions,

- Product form
 - What does it look like? How is it used?
- Product attributes
 - What are the reasons why customers might buy it?
 - What benefits would they be seeking from it?
 - What are the points of difference/targeted selling proposition?
- Potential market demand
 - Who is the potential buyer?
 - What is the competitive position relative to imports?
 - What advantages in using Australian banana as raw material?
 - What advantages in processing in Australia?
- Potential market value
 - What is known about the size of the market?
 - What price points are established for current products?
- Technical challenges
 - What ripeness of fruit is required?
 - What are the processing infrastructure requirements?
 - What are the other technical issues/challenges to be solved?
- Intellectual property
 - Are they free to operate issues?
 - Is there IP potential?

- Is there know how or other barriers to competition or reverse engineering?
- Commercialisation pathway
 - What is the estimated commercial development time?
 - What is the estimated investment scale and return?
- Who are the (potentially) interested parties? (processor, food ingredient supplier, food ingredient user)

Prototype Production

Prototypes were produced for four of the naturally preserved and high pressure processed products to illustrate the concept being put forward and to enable forum participants to evaluate their qualities in their proposed packed format. Prototypes were produced under strict food processing standards in the facilities of the lead researchers and transported to Cairns on the day of the forum. Packed, market ready product mock-ups were passed around during presentations for assessment and small samples were offered for tasting. Flow diagrams summarizing the processing protocol for the two classes of concepts and relevant technical specifications can be found in Appendix 2.

Naturally preserved banana products samples were produced at DEEDI's facilities using a combination of fresh-cut preservation technology and packaging techniques that were optimised specifically for Cavendish banana fruit. A formulated dip was developed using a selection of permitted food additives to extend the shelf life, maintain fresh quality and maximise consumer appeal through prevention of surface browning. High pressure processed pulp and fruit in syrup were produced by CSIRO in their Werribee plant.

Industry Forum – June 2010

The six product concepts from the project team were presented at the industry forum to a panel which included growers, processors, ingredient suppliers and ingredient users. Two concepts, banana syrup and banana juice, were also presented by Minh Nguyen (Newcastle University). For each concept the panel were asked to rate the following key assessment criteria using a 1-7 scale (where 1= 'extremely low, poor' and 7='extremely high, good'):

- Technical feasibility (ease of implementation, technical risk, development status)
- Market opportunity (volume, size)
- Competitiveness against imports (differentiation, non-imported, substitution)
- Potential usage of banana by-product or waste
- Overall ranking

The mean scores were collated and products were ranked accordingly.

Teleconference

A teleconference was held on Friday 13th August to discuss the action items from the June industry forum and examine the various product opportunities in more detail. The following people were able to attend; John Tyas (HAL), Karen Symes (HAL), Brittany Pearce (Howe Farms), Godfrey O'Neill (Foodpack), Mike Newbold (Tropico), Minh Nguyen (Newcastle University), Amy White (Bond University), Tor Hundloe (Bond University), Jason Martin (Soudan Lane), David Ball (Australian Institute of

Commercialisation), Robyn Reeve (DEEDI), Lloyd Simons (CSIRO), Roger Stanley (DEEDI), Kent Fanning (DEEDI).

Results

Industry Survey

Growers

The collated responses following the tour were as follows,

- At what critical points does fruit waste occur?
 - Generally speaking all waste is removed from the harvest as fruit is sorted in the packing shed. The majority of waste is collected after hands are cut from the bunch. Most waste occurs from growing time with limited amount generated during transport from plant to packing shed or central pack-house.
- What are the volumes of waste fruit?
 - 5-40% of total production depending on time of year, environmental conditions and market supply/demand. Probably averages at 20%.
- What characterizes waste banana?
 - Skin blemishes is the major reason for fruit to be rejected – dry scarring, wet scarring, maturity bronzing, scabbing and rust thrip, sun burn, insect pests and birds/flying foxes. For most of this, the blemishing is simply cosmetic and the fruit is left undamaged. ~80% of waste fruit could be ripened and converted into a good eating product.
 - Small fruit, misshapen fruit, fused fruit.
 - Cut fruit.
- What do you do with waste fruit?
 - Waste banana is shredded with stalks and then spread back over farm
 - Stock feed
 - Biogas trials
 - Peeling and freezing whole fruit for non-industrial ingredient market
 - Compost.
- Current incomes from different uses of waste fruit?
 - \$40-90/tonne for stock feed
 - \$2.50/kg for peeled, frozen whole fruit for non-industrial ingredient market.

Discussions with Amy White and Tor Hundloe (both of Bond University) confirmed figures of 20% of total production being waste, with 80% of this being suitable for food processing. Their figures were generated from rigorous audits of packing sheds (3).

Estimated total amount of waste fruit (tonnes/year) suitable for food processing =
Total banana production (~300,000 tonnes fruit reached market in 2009/10 x 1.2
(assuming waste fruit is 20% of total production)) x amount of waste fruit (0.2) x
amount of waste fruit suitable for food processing (0.8)
=57,600 tonnes/year.

Suggestions from growers included,

- Developing a local facility to process bananas to reduce the cost of transport.
- Manual peeling of bananas is a major hurdle to processing in general and specifically to whole fruit products.
- Make it as easy a process as possible for getting fruit to processing. This includes the process for sorting fruit in the packing shed, storage in the packing shed, transport from the packing shed etc.

Processors

Drying and freezing are the major current activities of banana processors in Australia. A small amount of puree is made using Australian bananas. The price paid for bananas was \$0.10/kg.

The major challenges for processing Australian grown bananas and selling the products were:

- access to markets
- Competition with imports – puree ~\$1.20/kg; diced, sliced, quartered, halved frozen product ~\$2.50-2.80/kg; banana chip ~\$3/kg.
- Consistency, volume, price and quality of supply
- Grower-processor agreements
- Lack of automated handling/preparing fruit for processing.

End users

Collated responses to the questions were as follows,

- What Australian banana products does your company use?
 - Two companies used Australian product and these were both fresh banana.
 - Another company uses a banana flavour which is manufactured in Australia from imported ingredients.
- What imported banana products do you use?
 - Five companies used imported product and the products were chips, dried powder, dehydrated, frozen sliced/diced banana, and puree.
- What product features/specifications/sourcing issues do you consider when buying banana products?
 - Price.
 - Quality. Imported banana products are supplied to every market segment (dairy, bakery, foodservice, confectionary) and there have been no issues with import over local.
 - Regularity.
 - Preference for trends toward health attributes with puree and frozen banana.
 - Preferably product is sulphur dioxide free.
- What would increase your use of/encourage you to use Australian banana products?
 - No responses.

Price is very important for the industrial ingredient products and local sourcing is not considered primarily due to cost and lack of supply. For local production the most cost prohibitive activity was post harvest handling & manual peeling which tripled the overall cost structure for local frozen banana supply. If automated machinery could be used to reduce labour costs in post-harvest handling and peeling then products may be competitive.

Current Australian sourced and made banana products include whole dried bananas being sold through health food shops and online. However these are organic products. The baby food and premium priced kids snack market are also becoming exclusively the province of organically grown banana (examples – Holle baby foods, Healtheries).

Literature Review and Patent Search

The results of the literature review and patent search are attached in full in Appendix 3. The literature was grouped under four headings, banana beverages, minimally

processed banana products, banana pulp and puree, and banana flour, fibre and starch. The key opportunities for developing new products were,

- Banana beverages
 - Development of nutritional product
- Minimally processed banana products
 - technology to enable fresh cut products through prevention of browning and softening.
- Banana pulp and puree
 - Development of products with new functionality(ies)
 - Utilisation of new technologies – high pressure processing etc.
- Banana flour, fibre and starch
 - Banana starch/flour could add functionality including prebiotic effect from resistant starch, fat replacement, high potassium, high dietary fibre, increased antioxidant activity, slowly digestible carbohydrates.

Market research

Global Innovation

A total of 1209 retail food products utilizing banana-derived raw materials were launched globally in the second half of 2009. Regionally Europe recorded the highest level of activity with retailers in the United Kingdom introducing 88 new products into the market just ahead of Germany with 74. The United States of America recorded 70 with the Netherlands following closely with 65. These products utilized a range banana inputs as reflected in ingredient declarations. On-pack ingredient information lists included mashed banana, banana pulp, dried banana, banana puree, banana chips, and freeze dried banana. Percentage addition information accompanying their ingredient listing showed various levels of usage.

Processed banana products were used both as major and minor components in application. Some products used the banana component as a characterising ingredient and would refer specifically to the fruit in either the product name or description. This type of usage would also commonly include images of banana fruit displayed predominantly on labels or packaging. Other products incorporated banana as a minor component where it was typically included in a fruit or tropical blend along with a number of addition fruits. In these cases, there was no specific promotion of banana content apart from it being named in the ingredient listing.

A number of product claims or promotional messages were displayed on packaging where banana represented a major component of the formulation. These included:

Real Banana Fruit - *“moist, real banana”*

Fruit Equivalents - *“one full portion of fruit”, “contains 1 banana”*

Energy - *“combines energy of banana....provide an important energy boost”, “Bananas are packed with carbohydrate energy”*

Nutrition - *“not only is banana the greatest sources of potassium around, it is also a natural antacid”, “natural fruit fibre and nutrients”, “contain various vitamins and minerals like potassium and magnesium”*

Eating Quality - *“all natural freeze-dried banana. Light crispy texture with sweet banana taste”*

Banana products were not limited to use in a specific category but spread across a number. A category analysis (Figure 1) shows they appeared most frequently in soft drinks, bakery/cereal products, baby food and dairy products.

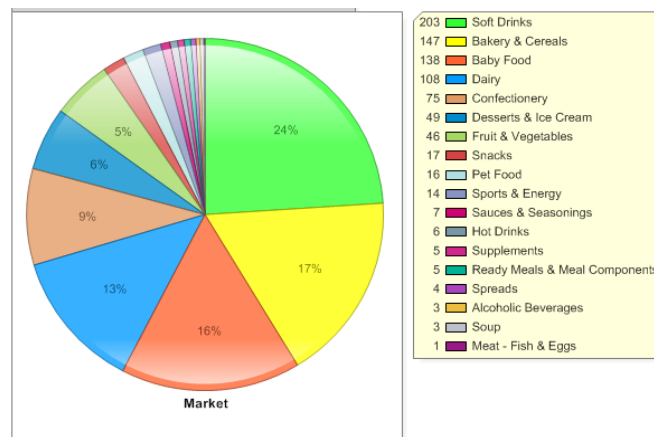


Figure 1 Global category analysis of products utilizing processed banana ingredients (July 2009 – January 2010, Innova Database)

Foods containing processed banana were predominantly positioned in the market as convenience options and as passive health contributors (Figure 2). This was followed to a lesser extent by choice, juice and active health.

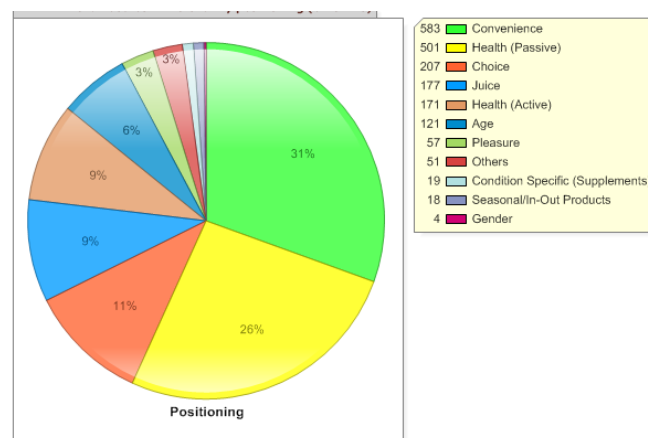


Figure 2 Global positioning analysis of products utilizing processed banana ingredients (July 2009 – January 2010, Innova Database)

Australian Innovation

A total of 17 new processed foods containing banana were introduced into the Australian retail market during this period. These products included baby foods (6), soft drinks such as juices and smoothies (5), bakery items (3), processed fruits (2) and snacks (1). In accordance with global trends, most of these items were again positioned for their passive health and convenience attributes. Detailed product records are summarised in Appendix 4.

Concept Products phase 1

The following concept ideas were presented at the first industry forum,

- Naturally non-browned dried products
- Functional pulps
- Fresh cut

- Functional juices
- Flour, fibre, starch, extruded

Details of forum format, presentations, proposed concepts and stakeholder feedback are included in Appendix 5. The concepts which received the most support were functional pulps, fresh cut and functional juices.

Concept Products phase 2

The following concept products were presented by the project team at the second industry forum,

- fresh ready-to-eat snacks,
- frozen ready-to-eat snacks,
- natural energy squeeze pack of banana pulp,
- high pressure processed pulp,
- high pressure processed whole and slice,
- smooth banana spread.

Detailed concept assessment summaries for these concept products presented at the second industry forum in June can be found in Appendix 6. Figure 3 shows the concept scores rated by stakeholders at the forum. There were no significant differences between the mean scores of the concepts. Figure 4 is a comparison of overall scores for each proposed new product discussed on the day.

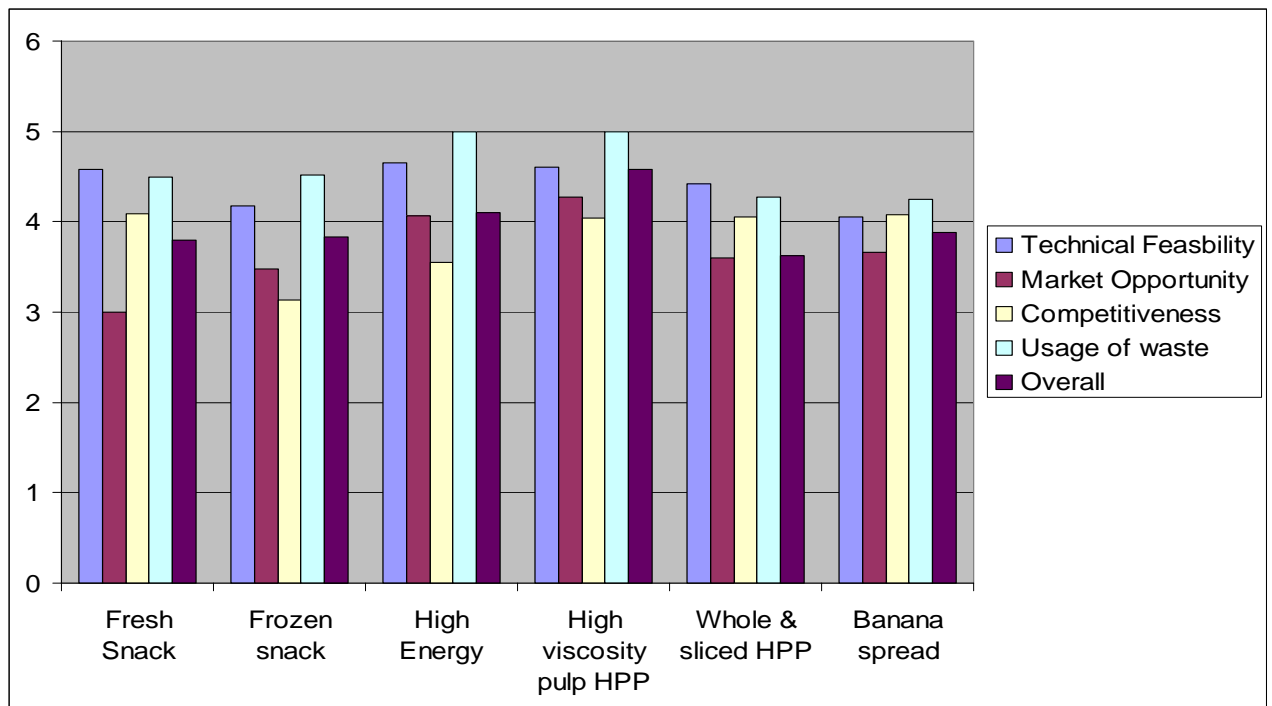


Figure 3 Concept product assessment scores as rated by forum participants

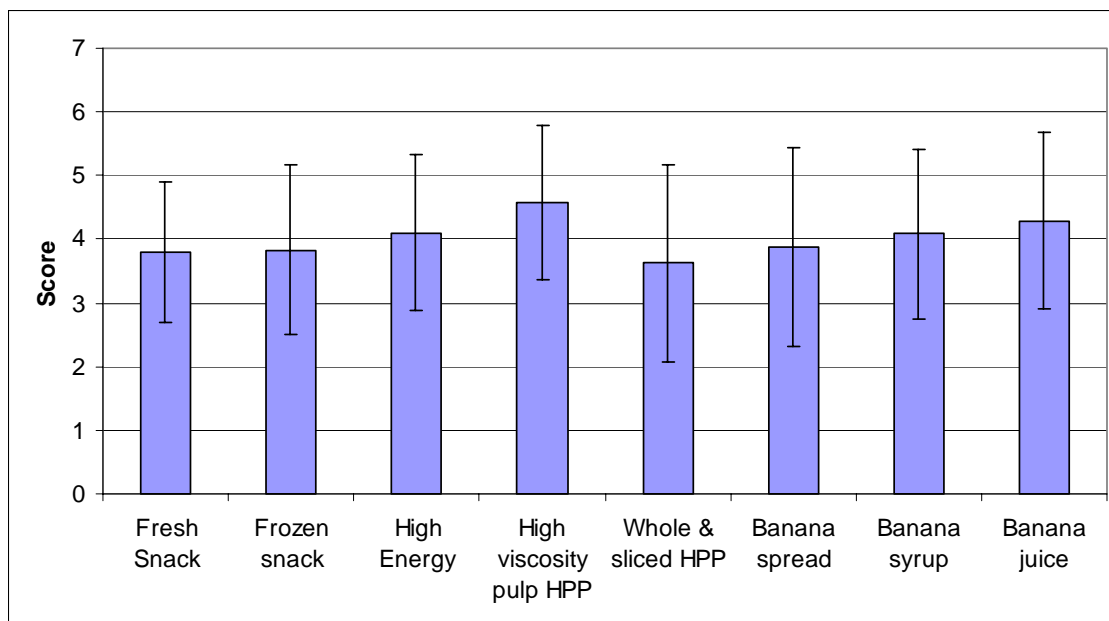


Figure 4 Overall concept product scores as by forum participants

Key comments/questions from the panel for each product were

Fresh ready-to-eat snacks

- Distribution main issue
 - Is shelf-life long enough for national distribution?
 - Cost of many middle-men?
- What is the costing model for this product?

Frozen ready-to-eat snacks

- Distribution major issue.
- Point(s) of differentiation from imported product? Expensive without automated peeling.

Natural energy squeeze pack of banana pulp

- Point(s) of differentiation from imported products?
 - Health functionality?

High pressure processed pulp

- Point(s) of differentiation from imported products?
- What is the costing model for this product?
- Is automation required?

High pressure processed whole and slice

- What is the costing model for this product?
- What is the shelf-life?

Smooth banana spread

- What is the costing model for this product?
- Use as a mix with peanut butter, chocolate etc.

Banana juice

- What is the competitive advantage? Need technology/product functionality differentiation.
- What is the costing model for this product?

Banana syrup

- What is the competitive advantage? Need technology/product functionality differentiation.
- What is the costing model for this product?

Discussion

Specification of waste fruit available for processing

The estimated figure of 50,000-60,000 tonnes/year of retail-rejected fruit, suitable for food processing, is in good agreement with other recently published work (3).

Product Opportunities

The two types of opportunities are for products which have no point of differentiation from imported products and those that do have a point(s) of differentiation.

Option 1: Cost structure dependent improvement

This is for local production of products such as frozen banana, pulp, juice and syrup that have no or limited point of differentiation from imports. Cost structure improvement to be based on (1) agreed pricing structure between growers and processors for skin blemished banana product specification, and [where required] (2) automated peeling equipment. Otherwise, there is no feasibility for commercial development.

Pulp

Currently two processors, Foodpack and Tropico, are interested in investigating making pulp. Two methods of sorting fruit were suggested,

- Have fruit rejected from retail markets but suitable for processing (rots, cut fruit excluded) put into bulk bin at end of packing line and sent to processor for further sorting by processor. (agreeable to most pack house situations)
- Have three streams of sorting set up in pack house; 1) fresh fruit for retail sale, 2) fruit for processing, 3) fruit unsuitable for fresh markets or processing (rot, cut, sunburnt etc.).

Payment for fruit could be based on recovery of overheads for sorting/packing/storing fruit. Profit sharing is a possible mechanism to share risk and reward for raw material costs.

The current options for automated peeling need adaptation for efficient operation. Peeling efficiency is a function of banana ripeness and must be matched to the machinery being used.

Product quality of imported products is high with light colour and high sugar content targeting 22° Brix. Unripe banana has a lower Brix which can be boosted by enzymated ripening to convert starch into free sugars.

Juice

Major markets for clarified juice are carbonated beverages and enhanced water. A business case needs to be developed considering the following,

- Markets
 - Opportunities
 - Current products
 - Volume
- Price points
- Price of production

As the concept product for this was presented by Minh Nguyen, Newcastle University, he will lead ongoing work. The potential is to couple local banana juice products to premium applications such as high pressure processed juice.

Option 2: Point(s) of Differentiation

Products which have a point(s) of differentiation from imported banana product/ingredient based on (1) market access (eg. fresh-cut short shelf life), (2) new technology (eg., cold pasteurisation) offering novel concepts & product quality, (3) nutritional/functional characteristics.

Fresh ready-to-eat snacks

Rob Munton (One Harvest), a leading representative of the fresh cut industry, advised that fresh cut banana had no current commercial prospects due to,

- their being only a very small fresh cut fruit industry in Australia
- little value to consumers in regards to convenience

If the Australian fresh cut fruit industry does increase substantially then fresh cut banana may become a viable product supplying into areas that whole fresh banana does not adequately serve such as the ready-to-eat dessert market.

High Pressure Processed products

Product & Technology Opportunity:

High pressure processing cold pasteurisation technology may potentially be used to produce superior quality banana products for retail and ingredient markets. These products may include;

- Smooth high viscosity pulp,
- Chunky pulp (smooth with pieces),
- Spiced banana pulp (Savoury and dessert versions*)
- Spread (olive oil, or dairy based*)
- Dip (Savoury and dessert versions*)
- Energy single serve
- Cold pasteurised juice

*Flavours; vanilla, cinnamon, chocolate, caramel, peanut, coffee, cream, cheese.

A suite of products provides opportunity for greater overall volume & impact for utilising waste, improves risk management and potential commercial feasibility. Advantage provided by high pressure processing for chilled products with long shelf-life, potentially exists for 1 to 3 months. Quality of ingredient must be better than any heat treated product to improve competitiveness against import.

Market Strategy:

This strategy follows trends and business model emerging for Avocado products by Austchilli/Simpson Farms¹ and Preshafruit™ fruit products by Preshafood², for which premium is differentiated on quality and nutrition, and competing against lower cost juice and fruit product offerings, based on imported concentrate and frozen fruit ingredients or heated processed product. Preshafood is effectively marketing three key messages of 100% local fruit, freshness picked taste and nutrition and cold pasteurised. An international trend is developing for whole raw healthy fruit and vegetable foods, for which cold pasteurisation can competitively position in marketed convenience value-added products. Any direct competition with fresh whole retail banana should be avoided, such as whole peeled or fresh-cut pieces. However featuring the benefits of banana in products that do not compete directly with fresh banana is likely to improve consumer perceptions of banana benefits and thus aid the overall market.

¹ <http://www.pressurefresh.com.au>

² <http://www.preshafood.com.au/>

Risk:

Risk relates to (1) cost structure for new technology for which experience and improvements are being achieved by local high pressure processing operations and (2) sufficient quality differentiation from conventional technology. Industry support of lead examples to lower the risk to individual companies may help the whole industry maintain the place of banana in consumers' diets.

Future Project Activity & Commercial Development:

Potential for Horticulture Australia Voluntary Contribution funded project involving banana grower(s) with existing high pressure processing processor(s) to undertake product prototyping, market testing and commercial development. This activity may also involve technology consultation and product evaluation with CSIRO/DEEDI and business planning activity between the stakeholders.

Simpson Farms and Preshafood are the two lead companies interested in developing products in this space. For high value products where there is currently no market, Simpson Farms have indicated that thorough market opportunity assessments are the next step.

Dried product

A product idea, utilising a specific technology, developed external to the project team is currently being investigated for feasibility. This will be communicated as appropriate.

R&D Proposals

As ongoing discussions and planning proceed with key industry players, it is anticipated that one or more R&D proposals will be generated by the project team together with growers, processors and end users. These proposals will be submitted back to HAL. The general scope for these proposals is outlined in the Recommendations.

Technology Transfer

An industry tour (see Appendix 1) and two industry forums were undertaken as part of this project (see Appendix 5 & 6). The attendees of these forums included banana growers, ABGC representatives, food processors, food ingredient users, university researchers, other DEEDI staff, and a brand development company. The purpose of these forums was to

- Communicate back regarding project progress including findings and developments
- Get feedback and input
- Foster collaboration with the project team and across industries.

Many invited attendees were unable to attend these forums. Following the forums the major points/outcomes/action items of the forum were communicated by email or mail, as appropriate, to help keep people in the loop.

A teleconference was held on Friday 13th August with a group of the key players interested in developing options discussed at the forum in June. From this, smaller working groups have been established to pursue specific options.

Articles, to inform those in the banana industry of the progress project, were published in the June edition of Bananas Australia and HAL's Banana Industry Annual Report.

The project received a significant amount of media exposure in December 2009, following a DEEDI media release. Media outlets which covered the story included, Television

- Sky News Australia
- NBN News Gold Coast
- Channel 10
- ABC
- SBS
- Channel 9
- Channel 7

Radio

- ABC 612 (Brisbane)
- ABC North Queensland (Townsville)
- ABC 666 (Canberra)
- ABC Far North (Cairns)
- Radio National
- Radio 4KZ (Innisfail)
- 4BC (Brisbane)

Newspapers

- Townsville Bulletin
- Cairns Post
- Herald Sun
- Sunshine Coast Daily
- Sunday Morning Herald
- North Queensland Register
- Fraser Coast Chronicle
- Gladstone Observer
- Innisfail Advocate
- Queensland Times

Another DEEDI media release in August 2010 was covered by the following media outlets:

Radio

- ABC Far North (Cairns)
- ABC 612
- ABC Western Queensland
- ABC North West Qld
- ABC North Queensland (Townsville)
- ABC local radio Perth

Newspaper

- Tablelands Advertiser
- Cairns Post

Television

- WIN News (Cairns)

Internet

- ABC news - <http://www.abc.net.au/news/stories/2010/08/25/2992573.htm>

The working groups, as mentioned in the discussion, will continue in discussion to formulate targeted approaches for the development of specific products.

Recommendations

Further industry support and investment will be required to significantly increase the utilisation of cosmetically damaged bananas into added value products. The most likely market opportunity for substantial return of value to the grower base is through large scale processing into ingredients with economies of scale and efficacies in production that can approach prices of imported products. The recommendation is therefore:

Improve the ability of the Australian industry to compete on price for the bulk banana ingredient market

Outcomes needed to achieve this include:

- Close integration of the grower – processor supply chain. This would require:
 - Agreement on the pricing structure or profit sharing between growers and processors for reject skin blemished bananas
 - Agreement on the quality and quantity of supply of raw material to ensure continuous processing factory operation
- Feasibility demonstration for scale and efficiency of processing in the growing region through:
 - Developing options for semi-processing in the growing region eg peeling with bulk shipment to other factories for on-processing
 - Centralisation of processing operations in one or two large plants with short supply chains from the growers
 - Development of improved automated peel removal for both purée and whole/diced banana
- Improvements to technical know-how to match quality of imported products such as:
 - Research and development to better address the key quality aspects of product such as sugar content and light colour of purée.

Recommended action:

- Industry funding support for a lead feasibility project between 2 or more major producers and at least one major (potential for > 1000 tonne product per year) processor to:
 - Develop a raw material pricing and supply model that could be economic for large scale production
 - Demonstrates peeling and processing automation needed to meet price points set by imported products
 - Develops any quality improvement technologies needed by the market such as light colour and sweetness using enzymatic ripening for juice and puree production.

Additionally, although niche value added products are not likely to be able to consume a significant percentage of the available reject bananas, local production of such projects should be further fostered. These projects can be in any area where sufficient banana can be sourced. The presence of added value consumer products being sold with banana eating and/or health benefit attributes will enhance consumer identification of bananas as being a valuable part of the diet. Such products appropriately marketed will

add to rather than detract from fresh fruit sales in the way that selling messages for fresh and processed apples are now intimately linked. The recommendation is therefore:

Foster local production of examples of added value banana products that feature eating and health benefits

Outcomes needed to achieve this include:

- Engagement of one or more innovative fruit product companies to develop concept(s) to market needs
- Project concepts developed that address the fresh, natural, healthy, convenience targets
- Adequate research and development support for the innovations to achieve products that will have sufficient added value for consumers

Recommended action:

- Industry funding support for one or more lead product innovation projects that will feature eating and/or health benefits of banana

References

- (1) Waste to energy in the Australian banana industry (2005). Clarke et al. Commissioned report for the ABGC.
- (2) Bananas, raw materials for making processed food products (2009). Aurorea, Parfait & Fahrasmane. Trends in Food Science & Technology 20, 78-91.
- (3) The Cost of Perfection – The environmental, economic and social impacts of fresh produce specifications: A case study of the North Queensland Banana Industry (2008). White, Masters Thesis, Queensland University of Technology

Appendices

Appendix 1 – Industry Survey Report

North Queensland banana growing and processing industry survey

BA09025

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Introduction

A tour of North Queensland banana farms and fruit processors marked the start of the industry and HAL funded study *Commercial feasibility of banana waste in the processed food industry*. Both small and large farms, a central packing and marketing facility as well as small and medium enterprise fruit processors were visited (Appendix A). Casual interviews were conducted by DEEDI employees Jessica Sanderson and Katrina Gething using a predetermined questioning route (Appendix B). The questioning route was sent to willing respondents prior to the DEEDI visit in order to expedite the interview process and limit its impact on time-pressured growers. Essentially, information was sought to give a clear understanding of environmental and market causes of banana fruit waste, what constituted fruit waste and current ways of disposing of it. An appreciation of current banana fruit processing methods was also desirable. Contact with the industry members was facilitated by Tony Heidrich, CEO of The Australian Banana Growers Council, semi-retired banana farmer Lou Lardi and DEEDI employees stationed in Cairns, South Johnstone and Townsville research centres.

The tour commenced in Mareeba on Monday 16th of November 2009, incorporated Innisfail and Tully, and concluded in Townsville on Tuesday 24th November 2009.

Banana industry

There were 19 883 467 cartons (258 485 tonne) of bananas supplied to the Australian market for the calendar year 2009. Queensland is the dominant supplier with 18 783 529 cartons (244 185 tonne) going to market during this time. While the smaller growers tend to sell product only to marketing agents, the larger growers also sell fruit directly to retailers Coles and Woolworths in what is termed 'green loads'. The prices that growers receive vary greatly, mostly as a result of market conditions, and can range between \$12 and \$40 per carton. Last financial year the average return estimated by some growers was \$23.80/carton. It has been suggested by several growers that the cost of a packed carton of bananas (considering only growing, harvesting and packing expenses) and consequently the break-even point for cost recovery is \$10 per carton. A further \$10 is required for transporting fruit to central markets bringing the total cost to around \$20 per carton. However the price of fruit is highly variable and has been known to sell for as low as \$8 per carton. At the time of the tour, market prices were abnormally high due to low production volumes resulting from slow plant development brought about by unfavourable weather last season.

Woolworths offers price sight unseen and growers invoice them directly. However, the retailer retains the right to reject fruit if deemed to be out of specification. Alternatively, agents in the central markets pay for product after fruit is sold. This process may take up to 5 weeks for funds to be transferred.

Some growers differentiate their product for diverse markets. There is a minor market for 1 kg shrink-wrapped clusters of smaller bananas. This is essentially for the Western Australian market where this format is the convention. There is also a small but growing demand in Brisbane from the large retailers. The pre-packed Western Australian product is purported to have an extended shelf-life due to the permeable wrap and is said to transport well.

Another farm specialises in supplying cartons of extra-large green hands of bananas. This is an ultra-premium fruit sold to upmarket grocery retailers such as Thomas Dux. The remainder of the farm's product that does not meet the ultra-premium specifications is sold on to agent and marketer La Manna.

Banana farms

Banana farms visited ranged in size from 162 to 1200 hectares with staff numbers of between 5 and 350. Many large banana plantations visited also produced other agricultural products. These included but were not limited to sugar cane, avocados and cattle. Larger operations can produce upward of 30 000 cartons a week or up to 1.5 million 13 kg cartons a year. Smaller farms produce anywhere in the vicinity of 16 000 to 200 000 cartons a year.

Growing and processing

In order to understand banana waste issues, it is useful to first understand some growing issues. The North Queensland banana growing areas essentially extend from Mareeba south to Tully. This represents a distance of around 200km. However, the difference in growing conditions between Mareeba and the more coastal areas present distinct challenges to fruit appearance and therefore waste.

Most causes of waste fruit tend to come from skin markings, a distinct imperfection that is unwelcome in the market. A major cause of skin imperfections in the northern growing areas is dry scarring which occurs as the fruit is growing in the field and presents as a dark black stain on the skin. According to Mareeba farmers, fruit tends to display a more defined “curl” in the area, and bunches tend to be tightly packed. This means the flower ends of bananas are more likely to come into contact with the fruit above them on the bunch which causes scarring. Although bagging of bunches is standard practice across all regions, fruit in this area is commonly double bagged to prevent wind rub which can exacerbate dry scarring. Another method to minimise skin marking is the utilisation of clip sheets which provide a physical separation of fruit within a bunch.

Further skin damage is from wet scarring, maturity bronzing, scabbing and rust thrip, sun burn, insect pests, and birds/flying foxes. Examples of reject fruit are shown in Appendix C. In the case of most reject fruit, flesh inside is left untouched and pristine. Regardless of its internal quality, the bananas are deemed unsuitable for retail markets with external blemishes strictly regulated by stringent product specifications and contracted supplier agreements.

Farmers manage fruit scarring in diverse ways. Processes adopted include applying talc powder to bunches before bagging to provide lubrication (also used to provide extra calcium which is thought to produce an aesthetically pleasing yellow colour to skin) and double bagging using either two plastic bags or a cotton inner bag. Farmers also had very individual preferences for the style of bunch cover bags, with the argument given that different colours filtered certain fraction of light out while designs distributed the heat evenly within the bunch, protecting outward facing fruit from sunburn and overheating.

Other aspects said to affect the low waste rates are good soil management, cushions between bunches when placed on trucks and shoulder pads for humpers (the name given to the men who carry bunches from tree to truck). One small farmer felt that his organisational culture, which is rooted in maintaining a product of very high quality, is responsible for his consistently low waste levels of five per cent. He believed that employees are at the heart of waste management with some staff producing up to 30 per cent more waste. For this reason farm and packing staff are carefully vetted. However, he did admit that the processes he adhered to would not be feasible for large scale operations.

Generally speaking, all waste is removed from the harvest as fruit is sorted in the packing shed. The majority of waste is collected after hands are cut from the bunch. Usually all grades of waste fruit are collected together and unless the grower or packer has a buyer for the fruit waste, stems and detritus are also included.

Due to the discrepancy in farming and handling practices, waste amounts varied quite considerably between farms. Some groups who were adopting minimisation strategies reported average waste production of around five per cent of total yield while others provided a much higher figure of 20-40 per cent. These figures translate to volumes of 10 – 20 tonne per week. It was explained that waste production was highly dependant on season, weather conditions and other uncontrolled factors and that the green waste generated in most banana packing sheds also contains plant stalks which are considered to account for approximately ten per cent of overall waste volume..

Some farmers estimate that 80% of waste could be food grade and ripened to produce good quality eating product with rejection a result of size or shape or skin rather than fruit integrity or inferior internal quality. The remaining 20% is unsuitable for consumption having suffered sunburn, cuts, rot or other physical damage.

When asked what type of return would be acceptable for out of specification or surplus to market requirement fruit, farmers differed markedly in opinion. Suggestions ranged from a return of \$4 per carton to \$10. Anecdotal evidence suggests that growing, cutting and packing amounts to \$10 per carton.

Banana fruit waste and surplus to market requirement fruit

As previously noted, the market during the tour was experiencing high prices due to low yields. As a consequence, low volumes of fruit waste were evident due to growers and pack-houses packing single bananas as well as clusters. It is unusual for there to be a demand for single fruit and these would normally be discarded.

Specs, length and girth: Due to the large volume of retail supply, much waste fruit is determined by their specifications. The girth of this fruit must not exceed 30cm. The maximum length of fruit must not be less than 220 cm, nor longer than 260cm. A premium length fruit equals maximum return. For this reason, the bottom hands of fruit are often pruned out and discarded (However, other grower/packers have found a market for the smaller fruit – see Mackay's).

Seasonality: Large variations of fruit can occur through the year. During winter fruit tends to be smaller and curlier.

Market forces: During high fruit yeilds, price of crop will go down and retailers will only pay maximum price for premium fruit. For example if fruit is out of spec it may only fetch \$14 per 13 kg carton. This price does not cover costs and market agents such as La Manna will direct farmers to stop cutting and crops will be felled.

Blemishes: Skin blemishes at this early stage usually only affect the skin of the banana, leaving the fruit pristine. Blemishes can be an affect of weather, maturity bronzing from rapid growing, rust thrip, and flying foxes/birds. Others include bag rub, wet scar, cigaring and sap stains.

The market does not tolerate malformed fruit such as fused fingers and cigar ends. For this reason, waste also stems from wing fruit which are the large, slightly distorted fruit that flank banana hands. Other waste bananas are a result of sunburn and abrasions. Further market causes of waste fruit are discussed below.

Current waste management practice and market

Much of the waste generated in the banana industry will find its way back onto banana paddocks as fertilizer. Before this is done the waste stream (which also includes large stalks) is usually shredded which reduces the size of larger pieces and creates a more manageable, homogeneous mass. Collections of shredded farm waste are shown in Figure 1. Most growers will shred their waste until a sufficient stockpile is created before transferring it to a spreader. This piece of machinery is towed behind a tractor and distributes the waste evenly where required in the paddock. Others will allow the stockpile to decompose before spreading it on fallow fields. Both of these practices are thought to be important for potassium load and soil management. Few farmers have experimented with more complex methods of composting with fish frames and other additives. A microbial system is being marketed to farmers that will allow waste to be fed back through irrigation systems. However, capital outlay for this system is thought to be inhibitive with outlay estimated at around \$40 000.



Figure1 Shredded 'waste' that includes rejected fruit and stalks

A number of farmers sell fruit waste as stockfeed. Volumes sold this way tend to be greater in the Mareeba area, with between 50 -60% of fruit being sold this way. However, this does not represent an organised market, and is usually based on casual agreements with small and hobby cattle farmers. Fruit has also been sold to deer farmers. Waste is usually sold as feed for approximately \$40 - \$90 a tonne. It has been suggested by farmers that cattle feed may represent a good market if some value adding is incorporated to produce a superior, nutritionally appropriate product that meets livestock needs.

Other waste management practices include farmers diversifying the operations and using waste fruit in processing. An example of this approach is Red Rock bananas in Mareeba who have installed a ripening room and are exploring avenues for value addition. Some growers have been approached directly by equipment agents looking to sell manufacturing equipments such as driers. Another method is to selling product outside the mainstream markets in road-side stalls and other local outlets. One grower estimates he sells approximately 40 cartons a week in this way. Other suggestions include:

- Turning waste into garden fertiliser
- Producing herbicide from banana acid,
- Biogas, this is currently under experiment at Bush Holdings farm.

An alternative to the fresh fruit market is the food processing industry. A large amount of processed banana formats are currently used by Australian food businesses however only a small amount of this is produced domestically with virtually none is manufactured using suitable waste fruit. Portions of some formats such as frozen whole peeled fruit that is typically used by food service

outlets are made using fruit that has travelled through standard fresh fruit distribution channels which incurs unnecessary additional costs and limits control of raw materials. Major obstacles quoted by growers considering processing included the capital expenditure required to establish appropriate food handling facilities and access to mechanised peeling to minimise manual handling and labour costs.

Pack-house

Australian Banana Company (ABC) is part of the La Manna group of companies and is a pack-house situated in Innisfail. The premise serves as a central pack-house and marketing agent (via La Manna) for farmers in the area without on-farm packing facilities. There are between 13 - 24 farms in the area that supply the organisation. This equates to around 485 hectares of farm and 1 million cartons packed and marketed a year. Farmers pay transport costs per kilometre to the central pack-house where bananas are packed and marketed. They are then paid per carton packed, rather than by the bunch. La Manna is operated as a manufacturing unit, first with the raw ingredient (bunch), then the work in process (de-handing, clustering, quality control), to the finished product (packing and palletising). Fifty per cent of La Manna packed bananas are green loads that are sold to Woolworths and ripened at their facilities. The remainder are transported to their own distribution centres for ripening and sale.

La Manna's own quality control is rigorous and is based on demerit points system. External appearance and other quality indices are graded and defects counted and documented. Many of the causes of defects are those listed in the previous paragraph however additional damage incurred during transit is also common. Fruit graded below 70% is discarded.

Twenty-five per cent of product trucked to the pack-house is discarded as waste. Half of this is estimated to be stalk. It is to be expected that a large portion of this fruit waste is suitable for ripening and then processing. During times of lower market value, large one tonne waste bins are emptied six times a day.

Waste costs associated with removal can be a significant expense to the business. La Manna use a contractor to remove the waste who then on-sells to cattle farmers. Alternatively, some waste will go to a small business that retails compost. This contractor will pay for waste removal. Finally, during the dry season, some waste is sent back to a farm contractor for spreading.

The company has tried some value adding. This includes feed for cattle and zoos. However, transportation costs are prohibitive. La Manna has also approached dairy companies to market a banana puree, but found they could not compete with cheaper imports. Other processed food products known to them is a fried and salted snack food marketed similar to potato chips. They believe that skinning bananas is major hurdle for developing a full fruit product.

Suggestions from La Manna:

Bananas are harvested 12 months of the year, and 80 per cent of crop is grown in a 100 km radius. This has positive implications for supply and means transportation costs to a facility located within this area would be minimal. Some modification to packing sheds is required to separate stalks from fruit. Regular pick ups of waste fruit would also be required. La Manna management believe waste supply from farmers would be viable if minimal effort was required from growers. Due to their waste removal costs, La Manna believe any price given for waste would be attractive.

Processors

Three processors were visited. Two, Able farms and Ivycove, are small enterprises. Bestlan could be described as medium enterprise.

Able Farms / Tropical Harvest

Able Farms are fruit processors situated in Tully and were previously banana growers. Their current operations source surplus to market requirement banana fruit which is ripened and dried. Product is sold in local retail outlets and at regional markets. Able farms expressed several concerns related to expanding their product range and accessing markets for distribution: These included:

- Knowledge and access to markets such as retail chains,
- Competing with imports on price,
- Difficulties managing business expansion,
- Accessing funding for new product development.

Ivycove Pty. Ltd.

Ivycove situated in Mareeba and are involved in both farming and processing of fruits including mango, banana, pineapple and avocado. They supply retailers with a private label dried mango and pineapple fruit, and the food service industry with a range of frozen products. Ivycove management suggest that problems associated with the commercial supply are due to buyer perceptions that processed fruit is a product of lower grade waste fruit and therefore should be cheaper than the fresh equivalent. Ivycove have received feedback that consumer perceive these products as somehow inferior and of poor quality. They explain the higher price for processed fruits as simply recovery of the additional inputs required for value addition. Expenses such as labour, operation overheads, capital expenditure and distribution are all incurred on top of raw material costs.

The input costs of fruit used for processing is also affected by pre-processing steps such as removal of skin which increases the price per kilo. In the case of bananas, fresh whole bananas can either be purchased directly from the farm or through fresh fruit markets for between \$0.99 to \$2.40/kg. However, processing dictates the skin be removed, halving the yield which essentially doubles the cost when only the edible portion is considered.

Competition in the dried fruits category stems primarily from overseas product. These products often contain high levels of chemical preservatives such as sulphites and are dried rather than dried like the domestic alternative. These differences result in products with lighter colour which is better received by consumers and therefore requested by retailers. Some retailers have declined to carry Ivycove's dried banana product because of the darker colour which is a result of the dehydration methodology and absence of traditional chemical preservatives. They have gained some acceptance though and are now supplying retail packs of naturally dehydrated banana to another supermarket chain.

Ivycove also commented that effective mechanisation is essential to increase the profitability of banana processing as it currently takes four people six hours to peel 2 tonne of bananas for processing.

Bestlan Group

Bestlan Group of Companies (formally known as Bestlan Bananas) is an Australian owned medium sized enterprise located in Far North QLD whose operations include a purpose built drying facility

in Townsville and a puree processing plant in Tully. Their product range includes fruit pieces, purees, juices and value added fruit pastes. An interview was attended by Nadia Moulds (Technical Sales Officer), Walter Rigoni (Product Development Director), and Mickael Saget (Research and Technical Manager of Liquid Division) to gauge a processor perspective of the current domestic use and international supply of processed banana products.

While a number of banana formats are utilized by food manufacturers, the Australian market for processed banana product is primarily puree. Current domestic supply of puree cannot satisfy the processor requirements for processed banana product in terms of either volume or price.

The greater reliance on overseas product is due to retailer pressure to reduce processed food prices. It is theorised that those manufacturers currently paying up to an additional 20c/kg for Australian puree are doing so in order to utilize the premium country of origin labelling claim "Product of Australia" on retail packaging. Product sourced from overseas is of satisfactory quality and competitively priced in comparison to the Australian equivalent. As such, the proposition of purchasing waste bananas for processing is not considered necessary or attractive.

Value-added product (diced, sliced, quartered and halved), can be sourced internationally for between \$2.50 - \$2.80/kg. Due to importation restrictions, diced frozen banana is currently only coming from Korea. There seems to be little market for concentrates with this particular format representing only a fraction of total banana products being purchased.

Summary

For the best part, farm waste management practices are individual. One large farming organisation is developing a market for frozen fruit. A competitive advantage for this company is its volume of waste, access to facilities and equipment to process product efficiently and effectively.

Issues that may need to be addressed are:

- Some farmers expressed concern that a waste banana product would impact the market for fresh bananas, effectively pushing product price down,
- Logistics would seem to dictate that processing may be better located close to banana growers,
- The price of waste fruit for processors must reflect that the skin, which equals 50 per cent of fruit weight, is not required,
- Many farmers consider spreading waste back over land is of great benefit,
- Fruit waste seems to be a great concern for the central pack-house due to the variations in quality and volumes of product received,
- Sorting of appropriate waste fruit from stem and other matter may be an issue,
- Consistency, volumes and price of supply are issues for food processors,
- Automation of handling/preparing fruit for processing is needed.

Appendices

Appendix A Contact details for project participants

Location	Date	Business Type	Business Name	Contact Person/s	Phone	email	Physical Address	Restrictions on visit- times etc.
Mareeba (Monday 16 th)	Mon 16 th	Large grower	Howe Farming	Dennis Howe	(07) 4093 3660 0427 933 791	dhowe@howefarms.com	Chewko Road Walkamin	Start 8am
		Small grower	Red Rock Bananas	Fabian Dellabosca	(07) 4086 8154 (shed) 0417 781 975	fabiandb@bigpond.com	6079 Kennedy Highway	Start 10-11am
		Processor	Ivycove	Aldo Piagno & Joe Moreno	(07) 4093 2121 0417 644 317	ivycove1@bigpond.com piagno@bigpond.com	72 Macbean Road, Mareeba 4880,	Around 2pm
Innisfail (Tuesday 17 th & Wednesday 18 th)	Tues 17 th	Large pack-house & small grower	Aust. Banana Co.	Craig Hunter & Derek Pregl	(07) 4061 3344	craighunter2@bigpond.com	Clifford Road Innisfail	Start 8am Tuesday 17 th
		Small growers supplying ACB						9am Tuesday 17 th
		Large grower		Bill Devaney	907) 4067 6427 (shed) (07) 4061 3466	dereck.devaney@bigpond.com	Wooden Creek Road Mirriwinni	Start after lunch on Tuesday 17 th
	Wed 18 th	Large Grower		Mark Nucifora	0438 654 934	fakuba@bigpond.com	Aldridge Road Cowley	Start 9-10am Wednesday 18 th
		QPI&F	Sth Johnstone	Yan, Jeff, Rebecca Blundell		jeff.daniells@deedi.qld.gov.au	Sth Johnstone Rd, Sth Johnstone	Wed arvo- call with time!
		Processor (banana & mango)	Sunmade Tropical Fruits	Peter	07 4063 3829		Sunset Rd, Garradunga ~ 20 min North of Innisfail	Wednesday after 3pm
Tully (Thursday 19 th & Friday 20 th)	Thurs 19 th	Large Grower	Mackays Bananas	Gavin & Steve Mackay	0419 751 301	gavin@mackays.au.com		Start 8am Thursday 19 th
		Small Grower & Processor	Abell Farm	Abell	(07) 4068 2851	labell@westnet.com.au	Dingo Pocket Road Tully	10am Thursday 19 th
		Large Grower	Banana Exchange	Colin Rostedt	0438 158 933	colin.rostedt@costaexchange.com.au	891 Syndicate Road Jarrack Tully	Start lunchtime Thursday 19 th
	Fri 20 th	Large Grower	Bush Holdings Pty Ltd	Graham Bush	(07) 4066 0014	bushholdings@bigpond.com	512 Kennedy Creek Road Kennedy 4816	
		Small Grower	Ugana Plantation	Andrew Apap	(07) 4068 1718	ugana@aapt.net.au	132 Nicotra Road Tully	Start 1pm Friday 20 th
Townsville Monday 23 rd & Tuesday 24 th	Mon 23 rd	Processor	Bestlan Group of Companies	Walter Rigoni Nadia Moulds Mickael Saget	(07) 4729 8813	walter@bestlan.com.au	Head Office 21-23 Reward Court Townsville Q 4818	1pm Monday 23 rd
		QPI&F	Townsville	Vic O'Keefe (Trade & Business fficer)	07 4760 1589 0418 322 971	vic.okeefe@dpi.qld.gov.au	180 - 202 River Boulevard Oonoonba QLD 4811	3pm Monday 23 rd

Appendix B Correspondence to project participants



Commercial feasibility of banana waste in the processed food industry

Thank you for your interest in this Banana industry/HAL funded study. The aim of this research is to identify alternative commercial opportunities for banana fruit that do not meet retail specifications. To help us in our study, we ask that you consider the following topics prior to our visit at your premises:

- (A) At what critical points does fruit waste occur? For example, is it during harvest, selection of hands, trimming, washing, packing, processing or some other factor?
- (B) If possible, we would like you to consider volumes of waste fruit currently produced. This may be influenced by many different factors such as the time in the season, the weather and cultivars grown etc.
- (C) What characterizes waste banana? For example, fruit may not reach market specification because of cuts, disease, bruising etc.
- (D) How do you currently dispose of/market banana fruit waste?
- (E) In order to research ways to increase income from banana fruit waste, we would like an indication of current incomes expected from different waste disposal streams. This information will remain confidential.
- (F) If you process waste streams yourself, we would like an understanding of these methods.

You may have further insights into banana fruit waste that will be useful for this study. Please record these, as we welcome feedback from growers.

It is important to note that past studies may have asked similar information from you. These studies have been reviewed and we have found it necessary to gather a more detailed understanding of banana waste practices as they pertain to fruit only.

Thank you

Appendix C Examples of reject banana fruit



Sunburnt fruit



Under-developed fruit



Cut fruit



Sunburnt fruit



Rub marks



Wing fruit (right)



Cut fruit



Mechanical Damage



Speckling of skin



Cut fruit



Rust thrip



Bird or bat markings



Sunburnt fruit



Flower-end marking

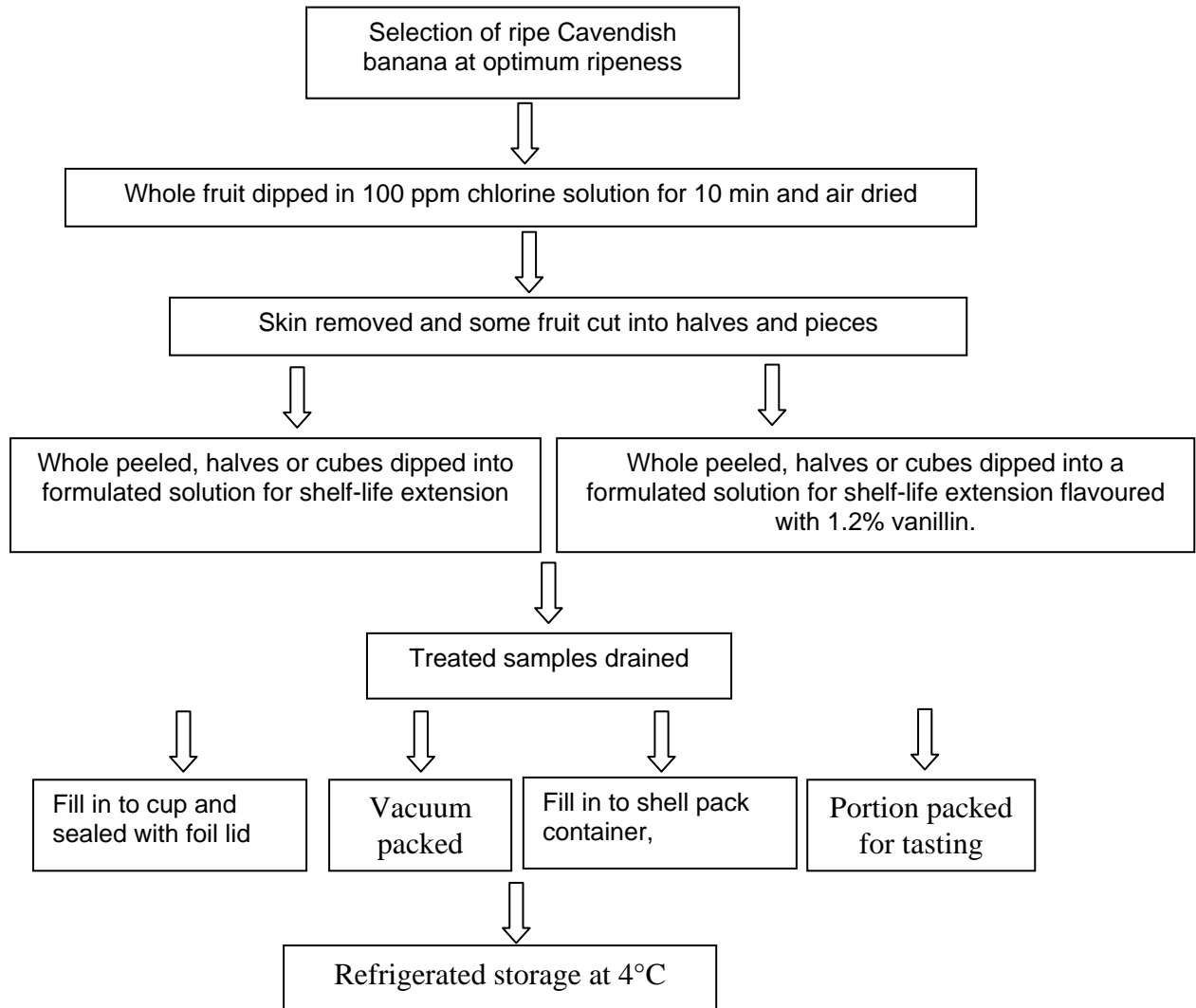


Fused fruit

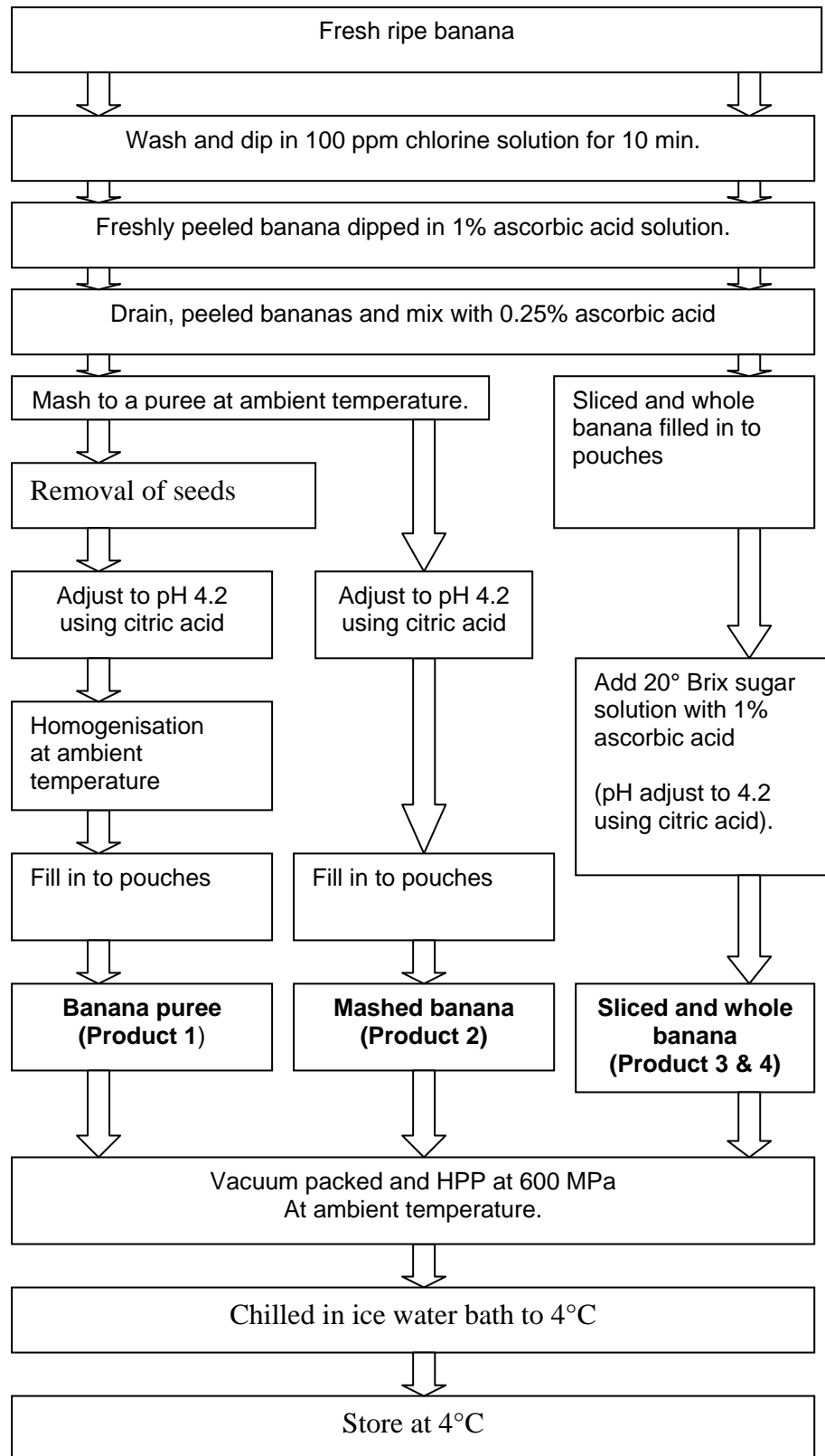
Appendix 2 – Prototype Processing Protocol

Appendix 2 – Prototype Processing Protocols

Naturally preserved fresh-cut banana products



High pressure processed (HPP) banana products



Appendix 3 – Literature and Patent Review Report

Literature review and freedom to operate

BA09025

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Introduction

This report was generated as part of the HAL funded study *Commercial feasibility of banana waste in the processed food industry*. A review of the scientific and technical literature on banana processing was undertaken and is presented in four separate sections,

1. Banana beverages,
2. Minimally processed banana products,
3. Banana pulp and puree, and,
4. Banana flour, fibre and starch.

To assist in making industry relevant recommendations, food processors, food ingredient suppliers and food companies were approached to ascertain

- What, if any, Australian banana products are used?
- What, if any, imported banana products are used?
- What product features/specifications/ sourcing issues are considered when buying banana products?
- What would increase use of/encourage use of Australian banana products?

The pertinent information from these discussions is presented together with the key points from the literature review in a summary as opportunities and issues.

An international patent search was also undertaken and is presented together with a freedom to operate.

The summary of this information was presented at the project workshop *Getting it straight: Options now and later for reject bananas*.

Summary

In preparing these main points it is important to note that Australian sourced and produced processed banana products cannot generally compete with imported products on price in the industrial manufactured ingredient market. From discussions across the food industry (food processors, food ingredient suppliers and end users of banana products) the advice is clearly to target markets which are advantageous for both local supply and local production. Further information on this is provided in other project reports, *Appendix 1 North Queensland banana growing and processing industry survey* and *Workshop one summary and recommendations*.

Banana beverages

Opportunities

- Development of nutritional banana beverage.
- Rejected or waste bananas can be used for alcohol and banana vinegar production.

Issues

- Competing with existing nutritional 'health' drinks from other fruits.
- Developing facility to manufacture banana vinegar and alcohol.
- Generating markets for these products.

Market Information

- Imported puree/pulp is currently used for beverages due to cost and supply.
- There is little or no information on alcoholic banana beverage in Australia.

Minimally processed banana products

Opportunities

- There could be an opportunity to export minimally processed banana to European or Japanese markets.

Issues

- Short shelf life associated with minimally processed products - prevention of browning and softening of peeled and cut banana during storage.
- The need of a technology that can inactivate quality related enzymes and micro organisms.
- Manual processing costs.
- Need to find niche markets within Australia.

Market Information

- Imported frozen banana can be purchased for \$1/kg.
- Imported dried banana chips for wholesale and food manufacturing can be purchased for \$3/kg.

Banana pulp and puree

Opportunities

- Development of products with new functionality(ies).
- Utilisation of new technologies – high pressure processing etc.
- Finding/developing new markets, e.g., food service industry.

Issues

- Competing with imported products
- Require consistent supply of significant volumes.

Market Information

- Imported puree can be purchased for \$1.20/kg (and less depending on the exchange rate).

Banana flour, fibre and starch

Opportunities:

- Green (unripe) bananas are an interesting source of starch/flour and (over)ripe bananas could be an interesting source of a cell wall-based food structuring agent.
- Recent studies have suggested banana starch/flour could add the following functionalities when used in food product (particularly pasta); prebiotic effect from resistant starch, fat replacement, high potassium, high dietary fibre, increased antioxidant activity and slowly digestible carbohydrates.
- There seems to be very little (no?) use of banana starch/flour in Australia.

Issues:

- Achieving reliable sourcing of fruit of the desired ripeness to achieve required standard.
- Developing facility to manufacture banana starch/flour.
- Developing market for product.
- Competing with (cheaper) imports

Market Information:

- An Australian company tried to develop fibre products for ingredient market but have ceased with this. Apparently the product exceeded the pesticide limits.

Literature Review

Banana beverages

Alcoholic

Banana pulp has been used in wine production [1]. Pre-treatment of pulp with pectinase and amylases improved the wine production process and quality. Treatment with these enzymes has increased the juice extraction yield and decreased the viscosity of banana, which resulted in formation of simple sugars and oligosaccharides that facilitated accelerated yeast growth and fermentation [2].

Waste overripe bananas have been mixed with sprouted sorghum grains to produce high alcoholic content beverages [3]. In Uganda and many parts of Africa, traditional fermented alcoholic beverages '*tonto*' and '*waragi*' have been prepared from banana pulp and banana juice [4, 5]. Fermentation process for these beverages is predominantly carried out by a mixed population of yeasts.

Wine produced from ripe and rejected bananas has been subjected to oxidative fermentation for banana vinegar production [6].

Banana skin has been used for alcohol and single cell protein production [7, 8].

Banana fruit pulp and green banana have been used for ethanol production [9, 10].

Non- Alcoholic

Commercial pectinase enzyme preparation has been used to compare the enzymatic and mechanical juice extraction process from ripe banana [11].

Banana puree has been mixed with melon seed milk to develop a pasteurised and UHT processed beverage with shelf-life of 12 days [12].

Banana juice/pulp has been used with apples, mango and litchis pulp and mixed with reconstituted skim milk to develop a novel beverage product [13].

Banana fruit solid components has been characterised to develop a suitable combination of insoluble solids and whey proteins of natural clouding agent in juice [14, 15].

Minimally processed banana products

The major sensory quality related problems associated with minimal processing of banana are browning and softening [16]. Both green and ripe bananas are susceptible to browning after cutting or wounding. Wounding causes cell damage and resultant decompartmentalization of enzymes and substrate. This leads to browning and softening. In addition to this minimal processing induce wound related metabolism in plant tissues. As a result wounding related plant hormone ethylene is produced. Wounding related enzymes and stress proteins are also produced in plant tissues. Phenylalanine ammonia-lyase (PAL) is a key enzyme involved in plant wound

related phenylpropanoid metabolism while heat shock proteins (HSPs) are involved in abiotic, including wounding, and biotic stress responses in plants [17].

Expression patterns of PAL and HSPs in fresh-cut and intact banana fruit pulp has been characterized by Northern and Western blot analyses. Cutting enhanced Ma-PAL2 mRNA accumulation, new PAL protein synthesis, and PAL activity; thereby resulting in accumulation of total phenolics. PAL, sHSP, HSP90 and HSP101 were regulated by cutting both at translational and transcriptional levels while HSP70 (Ma-HSP70-1) was regulated by cutting only at transcription level [17].

Browning in banana is caused by the activity of polyphenol oxidase (PPO) on polyphenolic compounds. Polyphenol oxidase (PPO) from Anamur banana, grown in Turkey, has been characterised [18].

Pilar-Cano et al reported that browning of banana is correlated with PPO activity and total phenol content [19]. Dopamine is considered as the most reactive polyphenolic substrate of banana PPO [20]. Browning potential of banana is correlated with the dopamine content. The dopamine content varies among banana varieties [20]. The dwarf Cavendish bananas are more susceptible to browning due to their high polyphenol content and low ascorbic acid content [20]. Browning potential of banana is also dependent on season and storage time [21]. During storage, untreated minimally processed banana slices demonstrated a decrease in polyphenol content with the increase of browning [22].

The loss of desirable texture in fresh-cut products is a major problem. In fruit this is largely due to a continuation of cell wall disassembly events that are a normal component of ripening, and which result in declining cell wall strength and reduced intercellular adhesion. In some species the process is exacerbated by wound-response ethylene. However, wounding, water loss and ripening-related turgor changes are also important contributors to textural deterioration. In fresh-cut vegetables, water loss and damage-induced lignifications are common problems. The effects of factors such as maturity at harvest, processing conditions and various treatments to mitigate quality decline are used by the fresh cut industry [23]. Softening of banana is controlled by texture related enzymes pectin methylesterase, polygalacturonase and pectate lyase [24]. Wounding related ethylene production also enhances the softening process [23].

Shelf life extension of minimally processed products

Shelf life extension of minimal processed products are achieved by using surface disinfection of fruit prior to cutting, gamma radiation, anti oxidant dips and calcium chloride dips, ethylene scavenging, modified atmosphere packaging (MAP) or citric acid (CA) and refrigeration [22, 25].

Chemical dips

Generally ascorbic acid (AA) and CA dips are used to control enzymatic browning while calcium chloride (CC) is used for prevention of softening in minimally processed fruit and vegetables.

A 2-min dip in a mixture of 1% (w/v) CC +1% (w/v) AA +0.5% (w/v) cysteine effectively prevented browning and softening of the ripe (stage 4) Grand Nain banana slices (15 mm) for 6 days at 5°C. Dips in less than 0.5% cysteine promoted pinking of fresh-cut banana slices, while concentrations between 0.5 and 1.0% cysteine delayed browning and softening and extended the post-cutting life to 7 days at 5°C [16].

Green (Dwarf Cavendish) banana slices treated with anti-browning agents (AA 0%, 2%; CC 0%, 2% and 4%), packed at 55% vacuum level in laminated barrier film (35 cm³/m²/24hrs) and stored at 10°C for 12 days demonstrated that the colour parameters were mainly controlled by AA whereas

the firmness was controlled both by the combined use of AA and CC. A combination of 2% CC and 2%AA significantly minimized enzymatic browning of green peeled bananas under partial vacuum in barrier packages, while retaining the firmness of the produce and maintaining a shelf life of 12 days at 10°C [20].

Ethylene scavenging

Abe and Watada reported that the amount of ethylene generated due to physical wounding of fresh-cut banana is sufficient to have an effect on product quality [26]. Ethylene scavenging may have a potential in reducing excessive softening after minimal processing.

1-methylcyclopropene treatment

Softening and respiration rates were decreased in response to 1-methylcyclopropene (1-MCP) treatment (1µL/L for 6h at 14°C) of fresh-cut banana slices (after processing), but their ethylene production and browning rates were not influenced by this treatment [16].

MAP or CA

Low levels of O₂ (2 and 4kPa) and high levels of CO₂ (5 and 10kPa), alone or in combination, did not prevent browning and softening of ripe (stage 4) fresh-cut banana (Grand Nain) slices (15 mm) [16].

Bico et al (2009) reported that chemical dip (3-min; 1% (w/v) CC, 0.75% (w/v) AA and 0.75% (w/v) cysteine) and/or edible coating (carrageenan) together with CA (3% O₂+10% CO₂) decreased weight loss and respiration rate of banana slices as indicated by titratable acidity and total soluble solids.

Refrigeration

Nguyen et al reported that the browning of whole banana at refrigerated storage temperatures is correlated with chilling injury [27]. Chilling related browning correlated with storage temperature, increased PPO activity and decrease in polyphenol content during storage.

High Pressure processing

High pressure processing (HPP) is a non thermal technology that could be used to preserve banana products. HPP has the potential to inactivate vegetative micro organisms and inactivate some enzymes with minimal effects of quality of heat sensitive foods. It is reported that Banana polyphenol oxidase is only partially inactivated (21%) by HPP at 689 MPa for 10 min. However the combined use of steam blanching for 7 min and high pressure processing at 689 MPa for 10 min at 21°C reduced the residual PPO activity to a level <5% [28].

LyNguyen reported the effect of high pressure on the inactivation of Banana PME [29]. Banana PME inactivation kinetics are described by a fractional conversion model in the pressure range of 600- 700 MPa. This indicates the presence of a pressure sensitive PME fraction with a first order inactivation kinetics and a pressure stable PME fraction which contributes to about 8% of the total activity.

Inactivation of both PPO and PME are important to retain the quality of HPP banana products.

Hurdle approach

Danyen et al (2008) reported that 2% CC and 2% AA could minimise browning in green peeled banana slices packed under partial vacuum (55%) in laminated low density polyethylene vacuum bags (80 µm; 35 cm³/ m²/24 hr at 23°C) [20]. The resulting product demonstrated good texture retention and the shelf life was 12 days at 10°C.

The combined effect of chemical dip (3-min; 1% (w/v) CC, 0.75% (w/v) AA and 0.75% (w/v) cysteine) and/or edible coating (carrageenan) and/or controlled atmosphere (CA 3% O₂+10% CO₂) on the quality of ripe (stage 4) fresh-cut banana (*Maderia* cv. *Cavendish*) was investigated by Bico *et al* (2009). The combined dipping and CA treatment was the best for minimising weight loss and polyphenol oxidase activity in banana slices during the 5 days of storage at 5°C. Colour, firmness, pH, titratable acidity and total soluble solids values and total phenolic content showed minimal changes. Microbial analysis showed that minimally processed bananas were within the acceptable microbial count limits during 5 days of storage at 5°C.

Combined use of blanching and HPP are reported to be effective in inactivating PPO and PME in banana [28, 29].

Banana pulp and puree

Banana puree is generally made from ripe bananas [30] and is used in many applications. Stover and Simmonds [31] give the following list of uses for banana puree,

Dairy	Sherbet, ice-cream, egg-nog, yoghurts, cottage cheese
Bakery	Banana bread, cake, tarts, muffins, doughnuts, icing, banana cream pie
Beverages	Drink mixes, fruit drinks, nectars, baby-food drinks
Food processors	Banana apple sauce, baby food, cereals, baby-food fruit
Special diets	Nursing homes, hospitals

Other uses include: green banana pulp used in a spicy sauce [32]; green pulp used in macaroni formulation and suggested as possible in mayonnaise, juices, flours, jams, ice creams [33]; flakes made of banana pulp and soya flour [34]. The effect of various parameters have been investigated including; pulp density versus brix and temperature [35], performance in emulsions [36], optimal viscosity for use in spray drying [37] and starch content versus viscosity [38].

Banana flour, fibre and starch

Historically the use of waste unripe Cavendish bananas as a flour or a starch source has been around for 35 years [30, 31]. Using waste bananas for this is attractive due to the fact that fruit do not need to be ripened and can be processed once discarded.

On the question of banana starch, a key paper was published in 2005 [39]. In this paper Zhang *et al* examined the potential of using 'green cull' bananas as a starch source. The major points in conclusion/outlook were,

- Banana starch has 10-20% amylose content, which is relatively low, and protein content of 1-2%, which is relatively high (<0.6%) compared to commercial starches.

- 'restricted swelling, low solubility, and negligible retrogradation'.
- 'Sufficient strength to maintain granule integrity during prolonged heating. Pasting and paste properties of banana starch suggest it behaves as if it were slightly cross-linked....High break down and cooling viscosities for banana starch pastes.'
- Banana starch has shown significant resistance to enzyme degradation both in vitro and in vivo.
- 'The challenge with banana starch is to determine and exploit its uniqueness'.
- Further work needs to be done to,
 - More fully understand banana starch structure, properties and applications
 - Understand difference between cultivars
 - Understand the differences between raw and uncooked starch, particularly in regards to digestibility.

Several recent trials for developing applications of banana starch have been undertaken. Green banana (unripe Cavendish) meals have been shown to have similar properties to wheat flours and corn starches [40]. Unripe banana flour or starch (hard green *Musa paradisiaca* L. – Ovando-Martinez, Mexico) has been utilized as a replacement to wheat in pasta (Agama-Acevedo et al 2009 – unripe banana, *Musa paradisiaca* L., cooking banana, Mexico) [41, 42], spaghetti (unripe banana starch, *Musa paradisiaca* L., Mexico) [43] and noodles (Green banana, *Musa acuminata* × *balbisiana* Colla cv. Awak, Malaysia) [44]. A brief summary of the results of these studies is provided below.

Ovando-Martinez et al compared 15, 30 and 45% banana flour with 100% durum wheat spaghetti. They found the banana flour product had

- Lower moisture content
- Lower protein content
- Increased cooking loss
- Lower digestible starch
- Higher resistant starch
- Higher total polyphenolics and antioxidant activity.

Agama-Acevedo et al compared 15, 30 and 45% banana flour with 100% durum wheat spaghetti. They found the banana flour product had

- Altered water absorption (increased and decreased)
- Lowered diameter of raw spaghetti
- Lowered diameter of cooked spaghetti
- Similar hardness
- Increased adhesiveness
- Similar elasticity
- Increased chewiness
- Colour change
- Higher consumer preference for banana-flour enriched spaghetti over control.

Hernandez-Nava et al compared 5, 10, 15, 20 % banana starch with 100% durum wheat spaghetti. They found the banana starch product had

- Increased resistant starch content
- Reduced diameter
- Colour change
- Increased cooking loss
- Decreased firmness
- Increased acceptance by testers (15% - best, 5/10 – next best, 20/0 – same, lowest acceptance).

Choo et al compared 30% banana flour and 100% wheat flour noodles. They found the banana flour product had

- Increased resistant starch, potassium and magnesium
- Increased insoluble fibre
- Lowered glycemic index
- Increased phenolic content – increased inhibition of peroxidation
- Increased firmness
- Same elasticity, flavour and overall acceptability
- Less smooth surface
- Different colour.

Starch from unripe banana (*Musa paradisiaca* L, Mexico) may have a utilization opportunity due to it having a high crystallinity level [45]. Further natural starch has potential opportunities in processes involving high temperatures, jellies, sausages, bakery and canned products [46], and pineapple gels [47] and modified banana starches may have use as additives in frozen desserts and thickening agents in soups [48].

Extruded products have been made using banana (Cavendish) powder and rice powder [49]. The effect of ripeness of starting bananas was examined on physical properties of extruded product, nutrient content and sensory acceptability [49]. Bananas at 'stage 4' (more green than yellow) when compared with 'stage 6' (all yellow, no green tips) had

- Higher expansion ratio
- Lower % moisture retention
- Higher wac
- Lower wsi%
- Lower amino acid content
- Less sensory acceptability in regards to colour and flavour
- Higher sensory acceptability in regards to texture.

In conclusion, banana starch seems to have opportunities in the area of health products where it can provide certain functionality(ies). These include

- Prebiotic properties from resistant starch of bananas [50, 51]
- Fat replacement ability for making low fat snacks [52]
- High potassium content [53]
- High dietary fibre [44]
- Increased phenolic content [44, 54]
- Slowly digestible carbohydrates [41-44, 55, 56].

Patent search

Beverages

Non alcoholic

Preservative and artificial colour free, natural, and nutritive banana beverage has been prepared by enzymatic digestion of ripened fruit pulp [57].

Health drink containing banana (carbohydrate, protein, vitamin C, E and potassium) mixed with other fruit juices and vegetable extracts from carrot, kiwi fruits, tomato, apple, citrus fruits cabbage, sea weed, soybean, cinchona bark powder and egg [58], Japanese radish, turnip, garlic, onion, cabbage, spinach, carrot, parsley, aubergine, green pepper, cucumber and other fruits [59] has been developed. These healthy drinks have been reported effective against allergic diseases, disease of blood vessels, cancer, diabetes, cardiopathy, cerebral infarction, hay fever, fracture, eye disease, osteoporosis, skin disease, asthma, and has immunopotential effect when consumed continuously [58].

Nutritional banana beverage formulation comprises whole oats, ground cocoa, cream of tartar, cinnamon, nutmeg, banana, honey, Aloe vera, sea water, and liquid multivitamin with iron; has been prepared by heat treatment at 62-100 degree C [60].

An appetite stimulating beverage has been developed by mixing 90% purified water with banana head, Angelica root, paederiae, geshanhaogen, barley malt, lotus leaf, hay, yam and papaw [61] and [62].

Banana mixed with pineapple beverage has been reported with unique taste, special flavour, attractive colour and rich in nutrients [17].

Banana base concentrate has been prepared by treating banana paste with preparation obtained out of *Mortierella alpina* micromycete biomass for cloudy beverages so as to eliminate juice opalescence of base [63, 64].

Flavoured banana milk beverage of short or long term storage shelf-life has been made with cow or goat milk. The beverage was developed for human or animal consumption with vanilla, strawberry and pineapple flavour [65].

Alcoholic

Alcoholic beverage has been prepared by mixing banana and banana extracts with sterilized honey, adding yeast to the mixture and fermenting [66].

Banana pulp based liqueur [67], cocktail flavoured with aniseeds liqueur [68] has been reported with milk or products derived from milk.

Processing technologies

HPP and Others

High pressure (100-1000 MPa) has been used as pre-treatment and sterilization of raw materials from fruits, such as mulberry, black berry, bramble, strawberry, pear, grape, apple, hami melon, water melon, **banana**, tomato, waxberry or Chinese gooseberry for fermented cider preparation [69].

Fruit pulp from mango, strawberry, kiwi, papaya, pineapple, apricot, peach, nectarine, cherries, blueberries, raspberries, apple, pear, chestnut, **banana**, blackberry, cranberry, passion fruit, grapefruit, mandarin, orange, melon, and grapes has been mixed with insoluble fibre, pectinmethylesterase and divalent metal ion salt to promote gel formation during ultra high pressure processing [70]. This process was used to develop restructured fruit products.

Banana pulp has been treated by hot enzymes for colour stability and pectin processing, followed by high speed shearing, emulsification and homogenizing using high pressure spray for banana powder production. The original colour and taste of banana pulp was maintained, with good pourable viscosity good water restoring performance, easy storage and transportation [71].

High pressure homogenizer along with plant tissues degrading enzymes have been used for the preparation of low viscosity fruit juices, such as **banana**, apple, melon, mandarin orange, grape. Use of this technology has been further extended for preparing vegetable juice such as carrot, Japanese radish, burdock, spinach, Chinese cabbage, cabbage and lettuce [72].

Ultrasonic Technology

High frequency ultrasonic vibrations in the presence of binding material has been used to produce processed food product from fruit pieces such as **banana**, strawberry, apple; and to vegetables, e.g. onion, tomato, paprika; to cereals or to nuts [73].

Banana as Ingredient

Banana pieces, cuts and long slices have been used in the preparation of refrigerated or frozen banana pies [74], frozen fruit salads and confectionary product [75].

Unripe plantains banana and ripe banana fruit mixed with wheat or potato starch have been used in making liquid or solid edible paste. These products have been used in the preparation of a variety of sweet and savoury dishes, spread on bread, cakes, biscuits or waffles, or as a garnish in fish and meat dishes [76].

Fresh banana pulp has been subjected to pectinase, cellulose, amylase, hemi-cellulase, protease and lignin degrading enzymes for the production of banana juice, banana jam and instant banana powder products with improved colour and quality [77].

Banana pulp has been mixed with other fruits and vegetables to make high nutritive and healthy fruit/vegetable puff products [78].

Banana fruit has been used with glutamic acid in reactor to produce gamma-amino butyric (GABA) acid as an additive suitable for food/beverage products to improve constipation and preventing arteriosclerosis [79].

Banana puree and powder has been with minor quantity of cocoa mass or powder to develop a flavouring ingredient to be used in food and dairy products such as ice cream, milk drinks and milk shakes [80].

Banana puree has been used as flavouring and coating agent for low moisture foods [81].

Banana puree could be used as an ingredient in sheet-formed sweet potato product [82].

Waste utilisation

Unripe green banana fruit has been used for banana starch production and for the isolation of granular starch by alkaline hydrolysis [83] and steeping with sodium bi-sulphite solution to activate naturally occurring enzymes [84]. Banana starch obtained by these processes has high whiteness, silky lustre and rich in fluidity.

Frozen and waste green banana has been used for pectin production. The process involved in heating waste with acid in the presence of enzyme followed by solvent extraction/separation [85].

Food grade banana fruit powder has been prepared by drying banana pulp in microwave oven followed by grinding [86].

Banana utilisation –Freedom to operate (Patent protected activities)

Banana patent reviewed topics		Fruit part/type	Novelty	Title	Patent no	Year
Beverages						
	(a) Non-alcoholic	Ripened banana	Enzymatic digestion of pulp. The beverage retains the characteristic colour, aroma and flavour of banana. No preservative and colour Natural health care food	Natural banana beverage production	CN1147915-A; CN1072460-C	2001
		Banana juice	Nutritive juice mixed with veritable juice. High in Vitamins B1, C, and E Effective against allergies	Juice for use as health beverage, contains carrot, kiwi fruits, tomato, apple, banana, citrus fruits, cow's milk and honey, optionally water melon, pear, peach, grape, persimmon, prune and cherry, as ingredients	JP2002338485-A	2002
		Banana juice	Immunopotential effect.	Beverage, contains juice of vegetables such as onion, cabbage, spinach, carrot, parsley, and/or fruits such as banana, apple, pineapple, watermelon, grape, pear, strawberry, and preset amount of ginger juice	JP2001190252-A; JP3502315-B2	2001
		Banana	Nutritional beverage formulation comprises whole oats, ground cocoa, and cream	Nutritional beverage formulation comprises whole oats, ground cocoa, cream of tartar, cinnamon, nutmeg, banana, honey, <i>Aloe vera</i> , sea water, and liquid multivitamin with iron.	US2008241318-A1	2008
		Banana head	Beverage for stimulating appetite and invigorating spleen	Beverage preparation for stimulating appetite and invigorating spleen, comprises mixing of purified water with banana head, angelica root, paederiae, geshanhaogen, barley malt, lotus leaf, hay, yam, papaw and hawthorn.	CN101053432-A	2007
		Banana fruit	Banana and pineapple beverage	Method of preparing banana and pineapple beverage, involves adding enzyme, white sugar, acidic agent, stabilizing agent and	(CN101473982-A).	2009

				auxiliary materials to banana and pineapple extracts and then homogenizing, degassing and sterilizing mixture.		
		Banana fruit	Banana base as clouding agent	Method for producing of banana base for cloudy beverages.	RU2214117-C1 and RU2213500-C1	2003 and 2003
		Banana	Flavoured milk	Flavoured milk beverage of short or long term storage - made of cows or goats milk is flavoured with vanilla, strawberry, banana, pineapple, etc.	FR2665056-A1	1992
	(b) Alcoholic	Banana pulp	Alcoholic beverage with good aroma and taste	Preparation of alcoholic beverage, involves adding yeast to mixture of banana and sterilized honey, and fermenting.	JP2001197881-A	2001
		Banana pulp	Banana liqueur	Louis, M. A. Banana liqueur - based on rum or ethanol, banana pulp and milk	WO9802519-A; FR2742764-A1; WO9802519-A1; EP876475-A1	1997 and 1998
Used ingredients	Salad	Banana cuts and slices	Frozen fruit salad	Preparation of frozen fruit salad having organoleptic properties similar to fresh fruit salad.	ES2203919-T3	2004
	Powder and jam	Banana pulp	Use of hydrolytic enzyme Banana jam and instant banana powder products	Processing of banana juice, banana jam and instant banana powder products, involves peeling off fresh banana to obtain pulp, adding composite enzyme, amount of adding quantity depends on temperature and length of enzymolysis time.	CN101253964-A	2008
	Dairy products	Banana puree and powder	Flavouring ingredient for food and dairy products (ice cream and shakes)	Banana with chocolate flavour - from puree and defatted cocoa.	US3663718-A	1970
	Gamma amino butyric acid	Banana fruit	GABA as an additive for food and beverage preparations	Gamma-amino butyric acid containing composition for use in food/beverage products for improving constipation and preventing arteriosclerosis, is obtained by reacting banana with glutamic acid or its salt containing material.	JP2007143487-A	2007
	Savoury,	Banana fruit,	Refrigerated or frozen banana	Banana-based confectionary product	BR200502781-A	2005

	cakes, pies and confectionary	cuts and slices	pies	manufacture for making e.g. banana pie, involves arranging banana slices and mixture of predetermined ingredients to form banana pie, cutting banana pie in blocks, and packing and refrigerating cut blocks.		
		Banana fruit mix	Solid edible paste as a garnish	Liquid or solid edible paste product made from plantain bananas with added starch, raising agent, oil or butter and other ingredients.	BE1013838-A6	2002
		Banana pulp	Healthy vegetable puffs	Mixed fruit and vegetable puffed food useful as health food, comprises cucumber, spinach, celery and banana.	CN101467639-A	2009
		Banana puree	Flavouring and coating agent for low moisture foods	Banana flavoured food production of low moisture content - by coating starchy food with low moisture content with banana puree and drying.	US4935254-A	1990
		Banana puree	Dehydrated fruit sheets	Sheet-formed food prepn. from sweet potato - comprises steaming, peeling, pulverising, mixing with apple puree and banana, adding maltose, sucrose, saccharose, oligosaccharide and calcium, forming and cutting etc.	KR9400324-B1	1994
Waste	Starch	Green banana	Granular amorphous starch with silky, white appearance	1. Banana starch production - from waste green bananas.	JP51079742-A	1976
				2. Isolating starch granules from green bananas - by steeping in sodium bi:sulphite solution to activate naturally occurring enzymes.	US5797985-A	1998
	Pectin	Green banana	Acid hydrolysis in presence of enzyme. Followed by solvent extraction	Pectin prepn. from waste and frozen green bananas - involves breaking raw material, treatment with acid, heating, alcohol pptn. or enzyme extraction.	CN1054774-A	1991
	Powder	Banana slices	Microwave drying of slices	Fruit powder preparation. - by cutting fruit into small pieces, drying in microwave oven and grinding to give product for food or feed	JP3091454-A	1990-91

				use.		
New processing technologies	Cider	Banana pulp	Pre-treatment and sterilization of raw materials (100-1000MPa)	Fermented cider preparation involves pre-treating fruit and vegetable, fruit pressing, hydrolyzing, filtering and adjusting element, high pressure processing, fermenting and aging.	CN101182444-A	2008
	Restructured product	Banana pulp	Flexible film packaged, shelf-stable, gelled natural fruit pulp products	Flexible film packaged, shelf-stable, gelled natural fruit pulp, comprises natural pectins of the fruit pulp demethoxylated by action of pectinmethylesterase enzyme under ultra-high pressure, antioxidant, and divalent metal ion salt.	WO2007010271-A1; GB2428365-A; EP1827131-A1; AU2006271456-A1; US2008014303-A1; NO200706017-A; EP1827131-B1; CN101227833-A; DE602006001932-E; JP2009502130-W; ES2312136-T3; GB2428365-B.	2007, 2008- and 2009
	Spray dried powder	Banana pulp	Hot enzymes processing Homogenizing using high pressure spray for banana powder production.	Technological process of producing banana powder.	CN1432293-A; CN1180705-C	2003 2004
	Fruit juice	Banana fruit	Enzymes processing and high pressure homogenisation. Low viscosity fruit juice	Preparing low viscosity vegetable juice e.g. tomato juice or fruit juice, involves processing vegetable or fruit juice using high pressure homogenizer, and treating vegetable or fruit juice with enzyme that degrades plant tissue.	JP2008301811-A	2008
	Restructured product	Fruit pieces	High frequency ultrasonic vibrations to produce new products	Production of a processed food product from food pieces, by admixing a binder with food pieces, forming the mixture into a product of desired shape and vibrating the product under high frequency.	WO200021385-A; WO200021385-A1; AU9959935-A; ZA200103071-A.	2000 and 2001

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Appendix 4 – Australian Banana Product Innovation

Coles Tropical Fruit Juice

Product ID: 744594
Company: COLES
Country: Australia
Category: Juice & Juice Drinks
Event: New Product
Event Date: 10/2009
Region: Australasia
Currency: AUD
Price in US \$: 1.62
Price in Euro: 1.25
Local Price: 2.45
Price / Litre in US \$: 0.81
Price / Litre in Euro: 0.62



Product Description

Description: Tropical fruit juice in a 2L plastic bottle.
Claims / Features: Good source of vitamin C. No added sugar. Comes in a recyclable packaging.

Ingredients and Nutrition

Ingredients: Reconstituted fruit juices [Apple (45.5%), Grape (20%), Orange (17%), Pineapple (10%), Peach (5%), Passion fruit (0.5%)], fruit purees [paw paw (1%), banana (0.9%)], vitamin (300), flavor.

Nutrition : Per Serving size: 200ml, Fat: <1 g, Protein: <1 g, Carbohydrate: 11.0 g, Energy(kj): 195, Energy(kcal): 46, Sugar: 10.7g, Saturated Fat(g/mg): 0g, Dietary Fibre(g/mg): <1g, Sodium(g/mg): 4mg, Vitamin C(g/mg): 40mg
Fat: <1 g; Protein: <1 g; Carbohydrate: 11.0 g

Product Analysis

Primary Package: Plastic Bottle
Individual Pack Size: 2 litres
Total Pack Weight: 2 litres
Quantity Per Pack: 1
Shelving Details: Ambient
Barcode: 9300601019762

Product Variants

Product Variants	Flavours / Taste	Positioning
Coles Tropical Fruit Juice	Tropical Fruit, not specified	100% reconstituted, Ethical, No Added Sugar

Holle Pear Flavored Baby Dessert

Product ID: 736522
Company: HOLLE
Country: Australia
Category: Baby meals - fruits & vegetables
Event: New Product
Event Date: 09/2009
Region: Australasia



Product Description

Description: Baby dessert with pear flavor, in a jar. Ideal for babies from 4 to 6 months old.
Claims / Features: Organically grown. No added sugar or salt. No milk protein. No thickeners. No yeast. No egg. No lactose. Gluten free. Low in allergens. Just stir and feed.

Ingredients and Nutrition

Ingredients: Peach, banana, water, rice flour, apple juice concentrate and lemon juice.
Nutrition : Per 100g,

Product Analysis

Primary Package: Jar
Individual Pack Size: 0.19 kg
Total Pack Weight: 0.19 kg
Quantity Per Pack: 1
Shelving Details: Fridge

Product Variants

Product Variants	Flavours / Taste	Positioning
Holle Pear Flavored Baby Dessert	Pear	Consumption, Time Saving, Low Sodium, No Added Sugar, Gluten Free, Organic, Allergy, Lactose Free

Holle Banana & Peach Flavored Baby Dessert

Product ID: 736519
Company: HOLLE
Country: Australia
Category: Baby meals - fruits & vegetables
Event: New Product
Event Date: 09/2009
Region: Australasia



Product Description

Description: Baby dessert with banana and peach flavor, in a jar. Ideal for babies from 4 to 6 months old.
Claims / Features: Organically grown. No added sugar or salt. No milk protein. No thickeners. No yeast. No egg. No lactose. Gluten free. Low in allergens. Just stir and feed.

Ingredients and Nutrition

Ingredients: Peach, banana, water, rice flour, apple juice concentrate, and lemon juice.
Nutrition : Per 100g,

Product Analysis

Primary Package: Jar
Individual Pack Size: 0.19 kg
Total Pack Weight: 0.19 kg
Quantity Per Pack: 1
Shelving Details: Fridge

Product Variants

Product Variants	Flavours / Taste	Positioning
Holle Banana & Peach Flavored Baby Dessert	Banana; Peach	Consumption, Time Saving, Low Sodium, No Added Sugar, Gluten Free, Organic, Allergy, Lactose Free
Holle Pear Flavored Baby Dessert	Pear	Consumption, Time Saving, Low Sodium, No Added Sugar, Gluten Free, Organic, Allergy, Lactose Free

Organic Bubs Organic Superfoods Blueberry, Banana & Quinoa for Babies

Product ID: 733347
Company: ORGANIC BUBS
Country: Australia
Category: Baby meals - fruits & vegetables
Event: New Product
Event Date: 09/2009
Region: Australasia



Product Description

Description: Twelve individual tubs of blueberry, banana and quinoa puree for babies.

Claims / Features: New blueberry, banana and quinoa value carton (save 10 dollars). Value cartons contain 12 meal boxes, each valued at 3.98 dollars. Save 10 dollars on each carton. Individual meal boxes are not sold individually online. Silky and smooth. Allergy friendly. For babies 4 to 6 months old. Organic.

Ingredients and Nutrition

Ingredients: Organic banana (72%), organic blueberries (14%), organic quinoa porridge (14%), natural vanilla bean flavor (1%) and nasties (1%).

Nutrition : Per 100g,

Product Analysis

Primary Package: Tub
Secondary Package: Cardboard Box
Individual Pack Size: 0.1 kg
Total Pack Weight: 1.2 kg
Quantity Per Pack: 12
Shelving Details: Fridge

Product Variants

Product Variants	Flavours / Taste	Positioning
Organic Bubs Organic Superfoods Blueberry, Banana & Quinoa for Babies	Blueberry; Banana	Time Saving, Economy, Organic

Organic Bubs Organic Superfoods Mango, Banana & Pomegranate for Babies

Product ID:	733338
Company:	ORGANIC BUBS
Country:	Australia
Category:	Baby meals - fruits & vegetables
Event:	New Product
Event Date:	09/2009
Region:	Australasia
Currency	AUD
Price in US \$:	25.06
Price in Euro:	19.29
Local Price:	37.90
Price / Kg in US \$:	20.88
Price / Kg in Euro:	16.07



Product Description

Description:	Twelve individual tubs of mango, banana and pomegranate fruit puree for babies.
Claims / Features:	New mango, banana and pomegranate value carton (save 10 dollars). Value cartons contain 12 meal boxes, each valued at 3.98 dollars. Save 10 dollars on each carton. Individual meal boxes are not sold individually online. Silky and smooth. Allergy friendly. For babies 4 to 6 months old. Organic.

Ingredients and Nutrition

Ingredients:	Organic banana (69%), organic mango 930%, pomegranate (1%) and nasties (0%).
Nutrition :	Per 100g,

Product Analysis

Primary Package:	Tub
Secondary Package:	Cardboard Box
Individual Pack Size:	0.1 kg
Total Pack Weight:	1.2 kg
Quantity Per Pack:	12
Shelving Details:	Fridge

Product Variants

Product Variants	Flavours / Taste	Positioning
Organic Bubs Organic Superfoods Mango, Banana & Pomegranate for Babies	Banana; Mango; Superfruit, Pomegranate	Time Saving, Economy, Organic

Abundant Earth Healthy Handfulls Organic Banana & Strawberries Flavored Cookies

Product ID: 733279
Company: AUSSIE BODIES
Country: Australia
Category: Sweet Biscuits/Cookies
Event: New Product
Event Date: 08/2009
Region: Australasia
Currency: AUD
Price in US \$: 2.93
Price in Euro: 2.25
Local Price: 4.43
Price / Kg in US \$: 23.43
Price / Kg in Euro: 18.04



Product Description

Description: Banana and strawberry flavored organic cookies in a resealable plastic pouch.
Claims / Features: Dairy free. 35% less sugar and salt when compared to standard children cookies. Organic.

Ingredients and Nutrition

Ingredients: Organic self raising flour, organic palm oil, organic plain flour, organic raw sugar, water, free range egg pulp, natural banana and strawberry flavor (1%).

Nutrition : Per Serving size: 25g, Fat: 5.5 g, Protein: 1.7 g, Carbohydrate: 15.2 g, Energy(kj): 499, Energy(kcal): 119, Sugar: 4.6g, Saturated Fat(g/mg): 2.6g, Dietary Fibre(g/mg): 0.4g, Sodium(g/mg): 43mg
Fat: 5.5 g; Protein: 1.7 g; Carbohydrate: 15.2 g

Product Analysis

Primary Package: Plastic Pouch
Individual Pack Size: 0.125 kg
Total Pack Weight: 0.125 kg
Quantity Per Pack: 1
Shelving Details: Ambient
Barcode: 9311868500207

Product Variants

Product Variants	Flavours / Taste	Positioning
Abundant Earth Healthy Handfulls Organic Banana & Strawberries Flavored Cookies	Banana; Strawberry; Cookie/biscuit, not specified	Packaging, Low Sodium, Organic, Allergy, Low Sugar, Children (5-12)

Nudie Smoothie Dairy Drink: Mango, Banana, Passion Fruit, Yogurt and More

Product ID: 725142
Company: NUDIE
Country: Australia
Category: Dairy & Soy Drinks
Event: New Product
Event Date: 08/2009
Region: Australasia
Currency: AUD
Price in US \$: 2.02
Price in Euro: 1.55
Local Price: 3.05
Price / Litre in US \$: 8.07
Price / Litre in Euro: 6.21



Product Description

Description: A yogurt, banana, mango, and passion fruit based dairy drink in a plastic bottle.
Claims / Features: No additives or preservatives!

Ingredients and Nutrition

Ingredients: Typical contents (Not that you'd call them typical!) 3/4 pressed apple (39%), 2/3 crushed mango (33%), a small dollop of low fat yogurt (milk solids, cream, and culture) (11.5%), a small pieces of mashed banana (7%), 1/5 squeeze orange (6%), 1 crushed passion fruit (3.5).

Nutrition : Per Serving size: 250ml, Fat: 1.75 g, Protein: 2.5 g, Carbohydrate: 33.3 g, Energy(kj): 673, Sugar: 22.3g, Saturated Fat(g/mg): 1g, Dietary Fibre(g/mg): <1g, Sodium(g/mg): 60mg, Calcium(mg): 73mg
Fat: 1.75 g; Protein: 2.5 g; Carbohydrate: 33.3 g

Product Analysis

Primary Package: Plastic Bottle
Individual Pack Size: 0.25 litres
Total Pack Weight: 0.25 litres
Quantity Per Pack: 1
Shelving Details: Fridge
Barcode: 9332991005049

Product Variants

Product Variants	Flavours / Taste	Positioning
Nudie Smoothie Dairy Drink: Mango, Banana, Passion Fruit, Yogurt and More	Banana; Passion Fruit; Mango	No Additives/Preservatives

Nudie Smoothie Dairy Drink: Yogurt, Honey, Vanilla Bean and More

Product ID: 725140
Company: NUDIE
Country: Australia
Category: Dairy & Soy Drinks
Event: New Product
Event Date: 08/2009
Region: Australasia



Product Description

Description: A yogurt, honey, and vanilla based dairy drink in a plastic bottle.
Claims / Features: No additives or preservatives!

Ingredients and Nutrition

Ingredients: Typical contents (Not that you'd call them typical!), A good serving of low fat yogurt (63.5%), 1/3 pressed apple (19.96%), 1/5 mashed banana (10%), honey dollop (6.5%), a brief encounter with vanilla bean (0.04%).

Nutrition : Per Serving size: 250ml, Fat: 3.8 g, Protein: 10.5 g, Carbohydrate: 34.8 g, Energy(kj): 925, Sugar: 33.5g, Saturated Fat(g/mg): 2.3g, Dietary Fibre(g/mg): 2.3g, Sodium(g/mg): 78mg, Calcium(mg): 350mg
Fat: 3.8 g; Protein: 10.5 g; Carbohydrate: 34.8 g

Product Analysis

Primary Package: Plastic Bottle
Individual Pack Size: 0.25 litres
Total Pack Weight: 0.25 litres
Quantity Per Pack: 1
Shelving Details: Fridge
Barcode: 9332991005018

Product Variants

Product Variants	Flavours / Taste	Positioning
Nudie Smoothie Dairy Drink: Yogurt, Honey, Vanilla Bean and More	Yogurt; Honey; Vanilla, natural	No Additives/Preservatives
Nudie Smoothie Dairy Drink: Mango, Banana, Passion Fruit, Yogurt and More	Banana; Passion Fruit; Mango	No Additives/Preservatives

GC Raw Citrus Crush Fruit & Veg Juice

Product ID: 725124
Company: GOLDEN CIRCLE
Country: Australia
Category: Juice & Juice Drinks
Event: New Product
Event Date: 08/2009
Region: Australasia
Currency: AUD
Price in US \$: 1.65
Price in Euro: 1.27
Local Price: 2.49
Price / Litre in US \$: 4.12
Price / Litre in Euro: 3.17



Product Description

Description: An deliciously refreshing blend of fruity flavors and unexpected vegetable goodness. With approximately 2 serves of fruit and 2 serves of vegetables in every bottle, it's a great natural energy boost at any time of the day.
Claims / Features: No preservatives. No added sugar.

Ingredients and Nutrition

Ingredients: Fruit juice [orange juice (22%), reconstituted pineapple juice (21.4%), apple juice (10.4%), banana puree (4%), mango puree (2.9%), reconstituted passion fruit juice (1.7%)], vegetable juice [reconstituted carrot juice (36.2%), reconstituted spinach juice (1.2%)], food acid (330), vitamin C, flavor.

Nutrition : Per Serving size: 200ml, Fat: 0.4 g, Protein: 1 g, Carbohydrate: 21.4 g, Energy(kj): 408, Sugar: 19.2g, Saturated Fat(g/mg): 0g, Dietary Fibre(g/mg): 0.4g, Sodium(g/mg): 12mg, Vitamin C(g/mg): 80mg, Vitamin C: 200%
Fat: 0.4 g; Protein: 1 g; Carbohydrate: 21.4 g

Product Analysis

Primary Package: Plastic Bottle
Individual Pack Size: 0.4 litres
Total Pack Weight: 0.4 litres
Quantity Per Pack: 1
Shelving Details: Fridge
Barcode: 9310179196024

Product Variants

Product Variants	Flavours / Taste	Positioning
GC Raw Citrus Crush Fruit & Veg Juice	Fruit, not specified; Vegetables, not specified	Nectars (25-99% juice), Consumption, Energy/Alertness, No Added Sugar, No Additives/Preservatives

Green's Divine Banana Coconut Cake Mix

Product ID: 719727
Company: GREENS GENERAL FOODS
Country: Australia
Category: Baking Ingredients & Mixes
Event: New Product
Event Date: 08/2009
Region: Australasia
Currency: AUD
Price in US \$: 3.17
Price in Euro: 2.44
Local Price: 4.79
Price / Kg in US \$: 5.66
Price / Kg in Euro: 4.35



Product Description

Description: Dry ingredient pack mix to make banana and coconut flavored sponge cake and vanilla flavored frosting.
Extra Notes: Contains wheat, milk and sulfites. Maybe present: egg, soy and tree nuts. Nutritional information is based on prepared cake per slice.
Claims / Features: No artificial colors or flavors.

Ingredients and Nutrition

Ingredients: Sugar, wheat flour, coconut (5%) [preservative (sodium metabisulfite)], vegetable fats and oils [emulsifier (471, 477), antioxidant (320)], raising agents (450, sodium bicarbonate), non fat milk solids, thickener [1442 (from maize)], banana powder (1%) [anti-caking agent (551)], wheat starch, emulsifiers (433, 471, 475), salt, natural flavors, natural colors (annatto, turmeric).

Nutrition : Per Serving size: 89g, Fat: 12.3 g, Protein: 4.0 g, Carbohydrate: 45.7 g, Energy(kj): 1290, Energy(kcal): 309, Sugar: 31.8g, Saturated Fat(g/mg): 3.4g, Sodium(g/mg): 373mg
Fat: 12.3 g; Protein: 4.0 g; Carbohydrate: 45.7 g

Product Analysis

Primary Package: Plastic Pouch
Secondary Package: Cardboard Box
Individual Pack Size: 0.56 kg
Total Pack Weight: 0.56 kg
Quantity Per Pack: 1
Shelving Details: Ambient
Barcode: 9310273123162

Product Variants

Product Variants	Flavours / Taste	Positioning
Green's Divine Banana Coconut Cake Mix	Banana; Coconut; Vanilla, not specified	Dry, Easy-to-Prepare, No Additives/Preservatives

SPC Two Fruits in Banana Flavoured Jelly

Product ID: 715309
Company: ARDMONA
Country: Australia
Category: Ambient Desserts
Event: Range Extension
Event Date: 07/2009
Region: Australasia
Currency: AUD
Price in US \$: 2.63
Price in Euro: 2.02
Local Price: 3.97
Price / Kg in US \$: 5.47
Price / Kg in Euro: 4.21



Product Description

Description: Four cups of two fruits in banana flavored jelly.
Claims / Features: All natural. No artificial colors. No artificial flavors. No preservatives. Contains fruit juice.

Ingredients and Nutrition

Ingredients: Jelly (water, pear juice, sugar, food acids (citric, calcium lactate), vegetable gums (gellan gum, xanthan, locust bean), natural banana flavor, natural color (cochineal)), (72%), pears & peaches (28%); Product may contain seed or seed fragments.

Nutrition : Per Serving size: 120g, Fat: 0.1 g, Protein: 0.4 g, Carbohydrate: 23.6 g, Energy(kj): 386, Sugar: 21.8g, Saturated Fat(g/mg): <0.1g, Sodium(g/mg): 67mg
Fat: 0.1 g; Protein: 0.4 g; Carbohydrate: 23.6 g

Product Analysis

Primary Package: Plastic Cup
Secondary Package: Cardboard Sleeve
Individual Pack Size: 0.12 kg
Total Pack Weight: 0.48 kg
Quantity Per Pack: 4
Shelving Details: Ambient
Barcode: 9310006011636

Product Variants

Product Variants	Flavours / Taste	Positioning
SPC Two Fruits in Banana Flavoured Jelly	Fruit, not specified; Banana	Packaging, Natural, No Additives/Preservatives

Goulburn Valley Peach with Banana & Mango Puree

Company: ARDMONA
Country: Australia
Category: Fruit
Event: Range Extension
Event Date: 07/2009
Region: Australasia
Currency: AUD
Price in US \$: 0.92
Local Price: 1.39
Price / Kg in US \$: 6.57
Price / Kg in Euro: 5.05



Product Description

Description: A single serve of peach with banana and mango puree, in a plastic cup.
Extra Notes: May contain pit, pit fragments or stems.
Claims / Features: No artificial colors, flavors or preservatives. Ready-to-eat.

Ingredients and Nutrition

Ingredients: Diced peaches (52% minimum), refined fruit (pear, apple, pineapple), juice, banana (11%), and mango (10%) purees, banana juice (1%), colors (carthamus, turmeric), antioxidant (ascorbic acid).

Nutrition : Per Serving size: 140g, Fat: <0.1 g, Protein: 2.0 g, Carbohydrate: 15.1 g, Energy(kj): 305, Sugar: 11.9g, Saturated Fat(g/mg): 0.1g, Dietary Fibre(g/mg): 2.1g, Sodium(g/mg): 20mg
Fat: <0.1 g; Protein: 2.0 g; Carbohydrate: 15.1 g

Product Analysis

Primary Package: Plastic Cup
Individual Pack Size: 0.14 kg
Quantity Per Pack: 1
Shelving Details: Ambient

Product Variants

Product Variants	Flavours / Taste	Positioning
Goulburn Valley Peach with Banana & Mango Puree	Peach; Banana; Mango	Consumption, Ready Prepared, No Additives/Preservatives
Goulburn Valley Apple with Guava Puree	Apple, red; Guava	Consumption, Ready Prepared, No Additives/Preservatives
Goulburn Valley Fruit Salad in Juice	Fruit, not specified	Consumption, Ready Prepared, No Additives/Preservatives
Goulburn Valley Peach in Juice	Peach	Consumption, Ready Prepared, No Additives/Preservatives
Goulburn Valley Pear with Pomegranate & Blueberry Juice	Pear; Superfruit, Pomegranate; Blueberry	Consumption, Ready Prepared, No Additives/Preservatives

Lion Pineapple Coconut and Banana Flavored Hummingbird Cake Mix

Product ID:	711903
Company:	ANCHOR
Country:	Australia
Category:	Baking Ingredients & Mixes
Event:	Range Extension
Event Date:	07/2009
Region:	Australasia
Currency	AUD
Price in US \$:	2.31
Price in Euro:	1.78
Local Price:	3.49
Price / Kg in US \$:	4.20
Price / Kg in Euro:	3.23



Product Description

Description: A packet mix for making pineapple, coconut, and banana flavored hummingbird cake. Included with cream cheese icing in a plastic sachet. Comes in a recyclable packaging.

Claims / Features: No artificial flavors or colors.

Ingredients and Nutrition

Ingredients: Wheat flour (thiamine), sugar, brown sugar, dried pineapple pieces (7.7%) [pineapple, sugar, food acid (330), preservative (220)], thickener (1422), vegetable fat (antioxidant 310), coconut (4.8%), raising agents (339, 341, 450, 500), wheaten cornflour, cream cheese powder [cream solids, milk solids, sugar, emulsifier (471), mineral salt (331), salt, antioxidant (306 contains soy), culture], maize starch, banana flakes (0.6%), spices, natural banana flavor, lemon flavor.

Nutrition : Per Serving size: 41g, Fat: 10.4 g, Protein: 1.6 g, Carbohydrate: 21.4 g, Energy(kj): 554, Energy(kcal): 792, Sugar: 14.3g, Saturated Fat(g/mg): 2.8g, Dietary Fibre(g/mg): 0.5g, Sodium(g/mg): 93mg
Fat: 10.4 g; Protein: 1.6 g; Carbohydrate: 21.4 g

Product Analysis

Primary Package:	Plastic Bag
Secondary Package:	Cardboard Box
Individual Pack Size:	0.55 kg
Total Pack Weight:	0.55 kg
Quantity Per Pack:	1
Shelving Details:	Ambient
Barcode:	9300609222089

Product Variants

Product Variants	Flavours / Taste	Positioning
Lion Pineapple Coconut and Banana Flavored Hummingbird Cake Mix	Banana; Pineapple; Coconut	Dry, Ethical, Easy-to-Prepare, No Additives/Preservatives

Go Natural Apple Apricot and Banana Popcorn Fruit Bars

Product ID: 711731
Company: GO NATURAL
Country: Australia
Category: Cereal & Energy Bars
Event: Range Extension
Event Date: 07/2009
Region: Australasia
Currency: AUD
Price in US \$: 3.29
Price in Euro: 2.53
Local Price: 4.97
Price / Kg in US \$: 18.78
Price / Kg in Euro: 14.45



Product Description

Description: Five individually wrapped apple apricot and banana popcorn fruit bar.
Extra Notes: This product is marketed in the health food aisle of the supermarket.
Claims / Features: 97% fat free. Gluten free. Less than 1 gram of fat per serve. Cholesterol free.

Ingredients and Nutrition

Ingredients: Fruit (dried apple (17%), dried bananas (7%), dried apricots (7%), containing preservative (223, 220)), glucose (from corn), honey, puffed rice (may contain sugar, salt, vitamins, minerals, emulsifier (471)), corn flakes (corn sugar, salt, emulsifier (471), vitamins), puffed corn (5%), coconut (contains preservative (220)), soy grits (from soybeans).

Nutrition : Per Serving size: 35g, Fat: 0.84 g, Protein: 1.21 g, Carbohydrate: 26.28 g, Energy(kj): 489, Sugar: 18.00g, Saturated Fat(g/mg): 0.50g, Polyunsaturated Fat(g/mg): 0.15g, Monounsaturated Fat(g/mg): 0.09g, Trans Fatty Acids(g/mg): 0.03g, Dietary Fibre(g/mg): 1.43g, Sodium(g/mg): 53mg, Vitamin B3(g/mg): 0.99mg, Vitamin B9/B11(g/mg): 20ug, Other Essential Vitamins: Potassium; 110.25mg
Fat: 0.84 g; Protein: 1.21 g; Carbohydrate: 26.28 g

Product Analysis

Primary Package: Foil Wrap
Secondary Package: Cardboard Box
Individual Pack Size: 0.175 kg
Total Pack Weight: 0.175 kg
Quantity Per Pack: 1
Shelving Details: Ambient
Barcode: 9310846152155

Product Variants

Product Variants	Flavours / Taste	Positioning
Go Natural Apple Apricot and Banana Popcorn Fruit Bars	Apple, red; Apricot; Banana	Consumption, Low Fat, Low Cholesterol, Gluten Free, Allergy
Go Natural Apple Sultana & Cranberry Popcorn & Fruit Bar	Apple, red; Sultana; Cranberry	Consumption, Low Fat, Low Cholesterol, Gluten Free, Allergy

Rafferty's Garden Banana Milk Rusks for Babies 6 Months Onwards

Product ID: 710232
Company: QUAKER
Country: Australia
Category: Baby Cereals & Biscuits
Event: Range Extension
Event Date: 07/2009
Region: Australasia
Currency: AUD
Price in US \$: 2.44
Price in Euro: 1.88
Local Price: 3.69
Price / Kg in US \$: 25.42
Price / Kg in Euro: 19.56



Product Description

Description: Twelve individually wrapped milk rusks with banana flavor, for babies 6 months onwards. Rafferty's Garden is 100% premium goodness for baby.
Claims / Features: Relieves tender gums. No added sugar. No artificial colors. No artificial flavors. No preservatives. No egg. Great for home, out-and-about or traveling.

Ingredients and Nutrition

Ingredients: Wheat flour, banana (5%), skimmed milk powder (1.5%), wheat germ, yeast, natural flavor, salt, mineral (iron).

Nutrition : Per Serving size: 8g, Fat: 0.1 g, Protein: 1.2 g, Carbohydrate: 5.6 g, Energy(kj): 116, Energy(kcal): 28, Sugar: 0.3g, Saturated Fat(g/mg): 0.0g, Dietary Fibre(g/mg): 0.3g, Sodium(g/mg): 26mg, Iron: 1.7mg, Other Essential Vitamins: Potassium: 15mg
Fat: 0.1 g; Protein: 1.2 g; Carbohydrate: 5.6 g

Product Analysis

Primary Package: Plastic Wrapper
Secondary Package: Cardboard Box
Individual Pack Size: 0.016 kg
Total Pack Weight: 0.096 kg
Quantity Per Pack: 6
Shelving Details: Ambient
Barcode: 9421901088309

Product Variants

Product Variants	Flavours / Taste	Positioning
Rafferty's Garden Banana Milk Rusks for Babies 6 Months Onwards	Banana; Milk, not specified	Oral Health, Indulgent and Premium, Packaging, No Added Sugar, No Additives/Preservatives

Appendix 5 – Forum One Report



Workshop One Summary and Recommendations

Getting it straight: Options now and later for reject
bananas
BA09025

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Workshop presentations	Error! Bookmark not defined.

Introduction

This report describes the workshop titled *Getting it straight: Options now and later for reject bananas*, held as part of the project *Commercial feasibility of banana waste utilisation in the processed food industry*. This workshop was the first of two workshops to be run as part of this project. The second workshop will take place in June 2010 and will include the presentation of detailed feasibility assessments together with physical samples of conceptual processed banana products.

Workshop format

The workshop was held at South Johnstone Research Station on Friday the 12th of February. Invitations were sent out to banana growers, Australian Banana Growers Council (ABGC) representatives, HAL representatives, banana processors and other food processors by email, phone, fax and/or through grower group meetings. Twenty-two people attended the workshop; three banana growers, two ABGC reps, five food processors, six DEEDI/CSIRO project team members, DEEDI communications officer, two DEEDI banana industry extension officers and two university researchers. The agenda was as follows.

12:00pm	Registration and Lunch
12:30	<i>Welcome, introductions and workshop program overview</i> Sara Dobson (facilitator)
12:40	<i>Project background and target outputs</i> Roger Stanley (DEEDI)
12:50	<i>Findings of industry survey on waste fruit</i> Katrina Gething (DEEDI)
1:10	<i>Quantification of edible waste and the economic and environmental impacts</i> Amy White (Bond University) and Professor Tor Hundloe (Griffith University)
1:30	<i>Banana processing supply chain</i> Andrew Mead (Simpson Farms)
1:50	<i>Potential opportunities for further utilisation of waste fruit</i> <ul style="list-style-type: none">• <i>Critical factors and current processing (Kent Fanning, DEEDI)</i>• <i>Global Scan (Jessica Sanderson, DEEDI)</i>• <i>Freedom to operate – International Patent Search (Kamal Vilkhur, CSIRO)</i>• <i>Product concept ideas (Kent Fanning, DEEDI)</i>• <i>Facilitated discussion of proposed concepts</i>
2:35pm	<i>Short listing of opportunities for feasibility assessment</i>
2:45pm	Conclusion of workshop. Light refreshments.

Presentations

Each of the presentations has been attached in the appendix.

Findings of industry survey of waste fruit

Katrina Gething presented the information contained in *North Queensland banana and processing industry survey*. Some key questions for growers from this presentation include,

- How much fruit is needed to spread back over paddocks for each banana farm?
- How much fruit surplus to this amount could be diverted to processing?
- What are the costs involved in sorting/storing fruit to be sent to processor?

Stewart Lindsay, DEEDI extension officer, mentioned that the higher end hospitality industry in Cairns (e.g., hotels, resorts, etc.) often wanted single banana fruit rather than bunches. This may be an avenue to sell non-marked single fruit commonly rejected in the fresh retail market.

Quantification of edible waste and the economic and environmental impacts

Amy White (Bond University) provided data including,

- ~78% of waste fruit is edible (with 83% being rejected because of minor blemish)
- On average ~15% of total production is edible waste. This fluctuates significantly over the year depending on market supply and demand (also described by Katrina Gething).
- ~52 770 tonnes of edible waste per year.

Her honours/masters thesis "The cost of perfection: the environmental, economic and social impacts of fresh produce specifications, a case study of the North Queensland Banana Industry" will be published shortly and will be referenced in the next stage of the project once the thesis is approved.

Amy suggested that one possible way of increasing utilisation of this waste fruit was to have graded retail banana product, for example premium and second grade fruit. This was dismissed by several workshop members due to its potential to bring down the price of the premium fruit. Professor Tor Hundloe (Griffith University) said this may be true but encouraged a look at the statistics on how having second grade fruit in a retail setting affects the price of premium fruit.

Another suggested utilisation of waste fruit was through provision of aid. Linda Abell, a local processor, suggested banana processed products could be generated using Australian Government aid money and exported across the world.

Banana processing supply chain

Andrew Mead (Simpson Farms) provided some critical points on changing the historical paradigm for processing bananas. These included,

- A detailed strategy would be required to effectively exploit the opportunity for processed banana,
- Understanding that processing banana is all about the relationships along the supply chain from grower to end consumer.
- Processors have specifications for the fruit they buy from growers. Sending fruit to processors has to be viewed differently than a waste disposal system.
- The importance of selecting profitable markets
- Competing with imported products in the industrial ingredient market may not be profitable. Australian products cannot be price competitive. (Linda Abell supported this by mentioning

how, in the industrial ingredient market, as little as 5c/kg difference in price can mean you are not even considered by ingredient supply/food manufacturing companies).

- Some, if not most, of the market opportunities will be in the food service industry and quick service restaurant industry (Hungry Jacks, KFC etc.).
- Simpson Farms is very interested in pursuing banana processing and have high pressure processing facilities available through their joint venture with AustChilli.

Stewart Lindsay made the comment that what is needed in processing bananas is an entrepreneur(s). He mentioned how, on the whole, growers don't have the time or the capital to look at processed products on a large scale.

Short listing of opportunities for feasibility assessment

Critical factors and current processing

Kent Fanning (DEEDI) followed on from Andrew Mead with similar points on the approach needed to process bananas in Australia, using Australian bananas.

- A whole of value chain commitment is needed for banana processing to be successful.
- For a successful supply chain, banana growers need to commit to providing a consistent supply to processors.
- Products processed from Australian bananas need to have 'local advantage' to compete with imports. Local advantages may include,
 - Fresh or similar shorter shelf life
 - Technologies which can be owned and can't easily be reverse engineered
 - Finding/developing premium value markets

Global scan

Jessica Sanderson (DEEDI) undertook a scan of the Innova market database for new products, in both Australian and worldwide markets, released in the last six months.

Freedom to operate – International Patent Search

Kamal Vilkh (CSIRO) presented the findings of the international patent search on processed banana products. This information is contained in *Literature review and freedom to operate*.

Product concept ideas

Kent Fanning emphasised the need to develop products which had

- local advantage versus imported products,
- extra/increased functionality than current products
- potential to find a place/develop a place in premium value markets.

The following list of potential concepts/products was presented for discussion.

1. Naturally non-browned dried products
 - A) Chips
 - B) Whole banana
2. Functional pulps
 - A) Improved emulsifying properties
 - B) Fat substitute
 - C) High flavour
3. Fresh cut
 - A) Cut fresh fruit (with/without chocolate sauce)

- B) Cut frozen fruit
- C) Whole frozen fruit with coating (chocolate)
- D) Cut whole fruit into dairy applications
- 4. Functional juices
 - A) High end functional juice
 - B) Banana syrup
- 5. Flour, fibre, starch, extruded
 - A) Sports gel/powder type product for athletes, body builders etc.
 - B) Functional flour/starch

Facilitated discussion of proposed concepts

The concepts/products which received most support from the workshop attendees were Functional pulps, Fresh cut and Functional juices.

Linda Abell mentioned the need to have strategies to deal with retailers developing private label products based on concepts developed in Australia, from cheaper, imported products.

Roger Stanley proposed a banana infused with berry fresh cut product, with the idea that the convenience is in pairing using banana as a carrier.

Product concepts for further feasibility assessment

Table 1 shows the product concept list to be assessed in the next stage of the project and presented at workshop two. The assessment will include selling proposition/point of difference/market opportunities, costing information, technology and equipment, and relevant technical information involved in producing the product. A physical sample (with enough for workshop attendees to taste) will be presented at workshop two together with the feasibility assessment. These will be concept products and will not have the optimised production process.

Tropical Harvest, Simpson Farms and Langtech are three companies who have expressed interest in being directly involved in presenting concept products at workshop two. All processors attending workshop two will be invited to present any sample product(s)/concept(s) (including current product).

Table 1: Proposed product concepts for feasibility assessment and presentation at workshop two

Product	Form	Target selling proposition or point of difference	Technology/ equipment needs	Potentially Interested parties /company	Investigation
Naturally non-browned dried products	Chips	Natural no artificial additives, non-browned			
	Whole or split banana			Tropical Harvest	Infuse fresh or partially dried product to make better coloured dried banana e.g., berry-banana
	Puff Expanded dried				Expansion of infused banana to puffed form
Functional pulps	Superior emulsifying properties for dairy	Ice-cream stabiliser?			Check emulsifying or ice crystal properties in a test system
	Fat substitute for spreads and bakery	Mouth feel on spreads Moisture retention in bakery			Test in bakery system
	High flavour for beverage and bakery	Natural flavour			Check if overripe has additional flavour
	Gut health (e.g., anti diarrheal activity)	Quick natural recovery			Test?
Fresh cut	Fresh cut fruit (with/without chocolate sauce)	Convenience snack without the skin			Concept fresh cut in pack possibly modified atmosphere
Fresh like processed	Whole/slice	Extended shelf life, good flavour , convenience	High pressure processing	Simpson Farms	
	Pulp			Simpson Farms	
Functional juices	High end functional juice	Dopamine? Athletic stamina? Mood?	Squeeze tube for energy on the go		
	Banana syrup	Natural flavour?		Langtech	
Flour, fibre, starch, extruded	Sports gel/powder type product for athletes				Food Spectrum concept product
	Functional flour/starch	Maltodextrin substitute for glass transition e.g., freeze dried orange and banana		Nutradry	Test % banana needed to freeze dry different proportions of orange concentrate to a

					powder
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Global Scan: Utilisation of processed banana products in the food manufacturing industry

Jessica Sanderson (DEEDI)
BA09025 Banana Workshop I
February 12th 2010
Sth Johnstone Research Station

Food innovation using processed banana

- Food industry is continually developing new products that use processed banana ingredients
- New and novel products are created by technological advances and market demands
- Global innovation scan conducted to capture new product launches where banana products used
- Activity in last 6 months gives a snap-shot of most recent product trends



Concept Banana Juice Carton

Fruit Juice Packaging design by [Naoto Fukasawa](#)

New banana product activity: July 09 – Jan 10

- 1209 retail products launched
- Most prolific activity in Europe:
 - UK (88)
 - Germany (74)
 - USA (70),
 - Netherlands (65)
 - Australia (17)
- Diversity in application with banana products appearing in a wide range of market categories

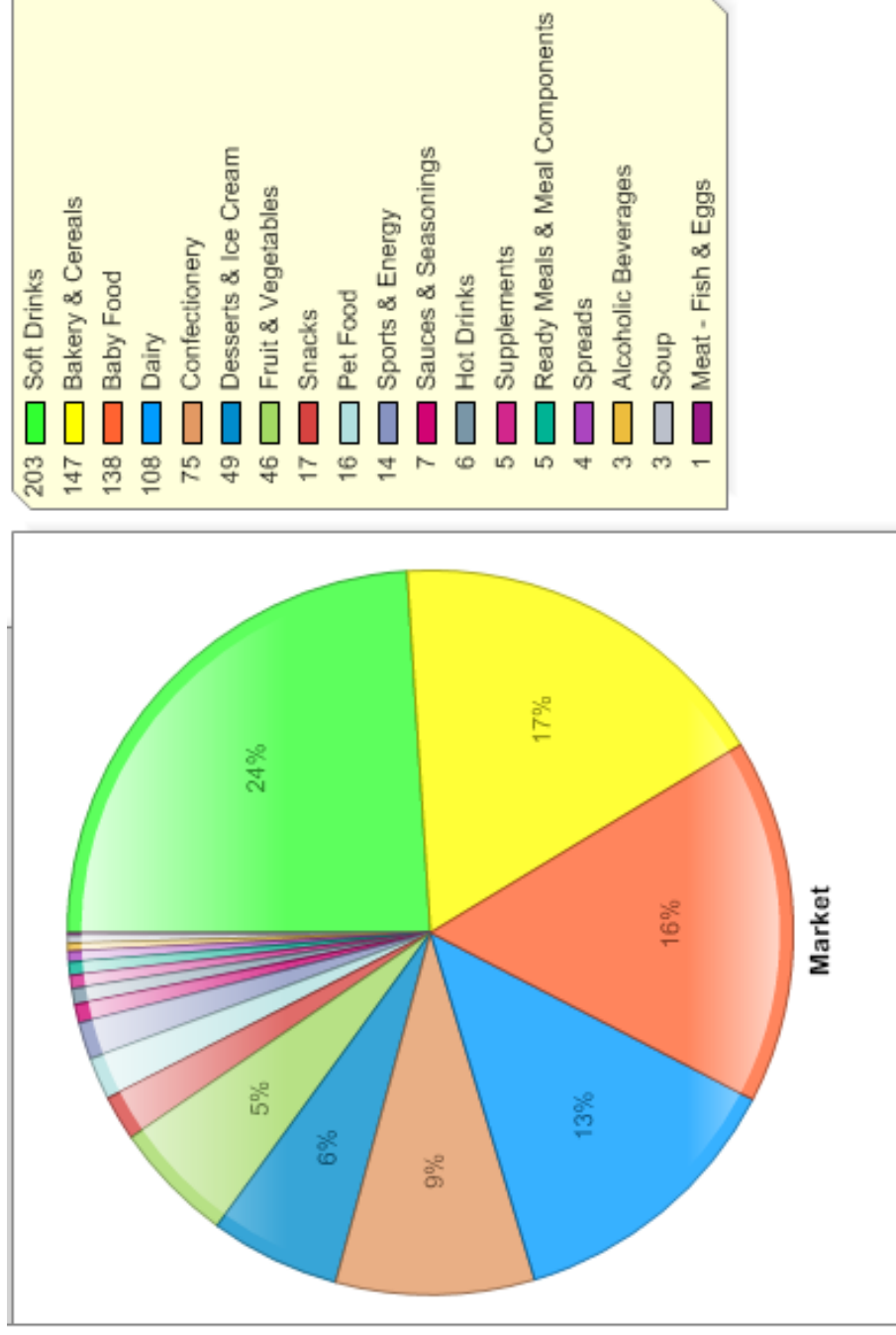


Hema Squeeze It:
Netherlands
(25% banana puree)

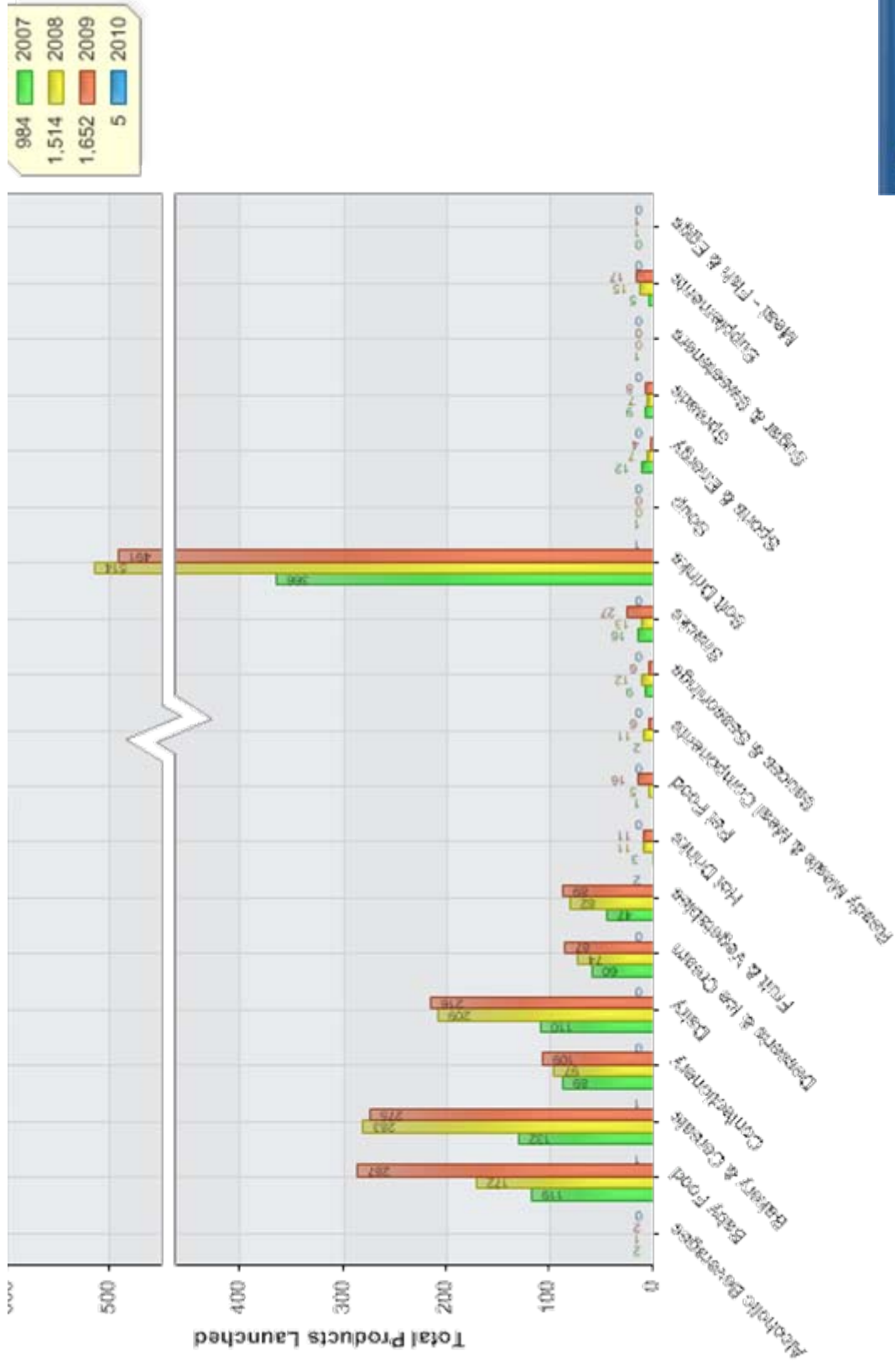


*Dole Ready-Cut
Frozen Fruit:*
USA

Global banana category analysis – last 6 months



Continuing trend – banana products past 3 years



Juice & Juice Drinks – 175 banana containing products



Russia



Austria



Bulgaria



Ukraine

Baby Meals – 90 banana containing product launches



USA



Russia



France



Argentina

Breakfast cereals – 49 banana containing products



UK



Italy



UK

Bananas as ingredients

- A range of processed banana formats are used.
- Usage rate variable by product type and style
- Used as major and minor components of processed foods.

Ingredients: Purified water and Soyabean (10%), Sugar, Mango pulp (10%), Banana pulp, Stabilizer (440), Tri-calcium Phosphate, Citric acid (330), Ascorbic Acid (Vit C), Vitamin-E-Acetate, Thiamin Mononitrate, Riboflavin, Cyanocobalamin and Vitamin-A-Acetate

Typical contents

(Not that you'd call them typical)
 ¾ pressed apple (39%)
 ¾ crushed mango (33%)
 a small dollop of low fat yoghurt (milk solids, cream & culture) (11.5%)
 ½ small piece of mashed banana (7%)
 ½ squeezed orange (6%)
 1 crushed passion fruit (3.5%)

Cake Mix: Sugar, wheat flour (thiamine), vegetable fats and oils (emulsifiers (477, soy lecithin), antioxidant (320)), thickener (1442), raising agents (450, sodium bicarbonate), freeze dried banana (2%), flavour, emulsifiers (471, 475 (soy)), salt, glucose syrup, dextrose, fibre, vegetable gum (412), colour (beta-carotene).

INGREDIENTS

Wheat flour (thiamin), sugar, brown sugar, dried pineapple pieces (7.7%) [pineapple, sugar, food acid (330), preservative (220)], thickener (1422), vegetable fat (antioxidant 319), coconut (4.8%), raising agents (339, 341, 450, 500), **wheaten** cornflour, cream cheese powder [cream solids, milk solids, sugar, emulsifier (471), mineral salt (331), salt, antioxidant (306 contains soy), culture], maize starch, banana flakes (0.6%), spices, natural banana flavour, lemon flavour.

INGREDIENTS

FRUIT (DRIED APPLE (17%), DRIED BANANAS (7%), DRIED APRICOTS (7%), CONTAINING PRESERVATIVES (223, 220)), GLUCOSE (FROM MAIZE), HONEY, PUFFED RICE (MAY CONTAIN - SUGAR, SALT, VITAMINS, MINERALS, EMULSIFIER (471)), CORN FLAKES (CORN, SUGAR, SALT, EMULSIFIER (471), VITAMINS), PUFFED CORN (5%), COCONUT (CONTAINS PRESERVATIVE (220)), SOY GRITS (FROM SOY BEANS).

INGREDIENTS: WATER, BANANA PUREE, STRAWBERRY PUREE, MANGO PULP AND PINEAPPLE DICES (MIN. 18%), SUGAR, CITRIC ACID, ALLURA RED COLOR, PECTIN, NATURAL STRAWBERRY FLAVOUR AND VITAMIN C. PRODUCED BY: ALLIAN INDUSTRIES Co., DUBAI, UNITED ARAB EMIRATES. NET CONTENTS: 240ML. FOR PRODUCTION & EXPIRY DATES, SEE BASE OF CAN.

Bananas as major & minor components

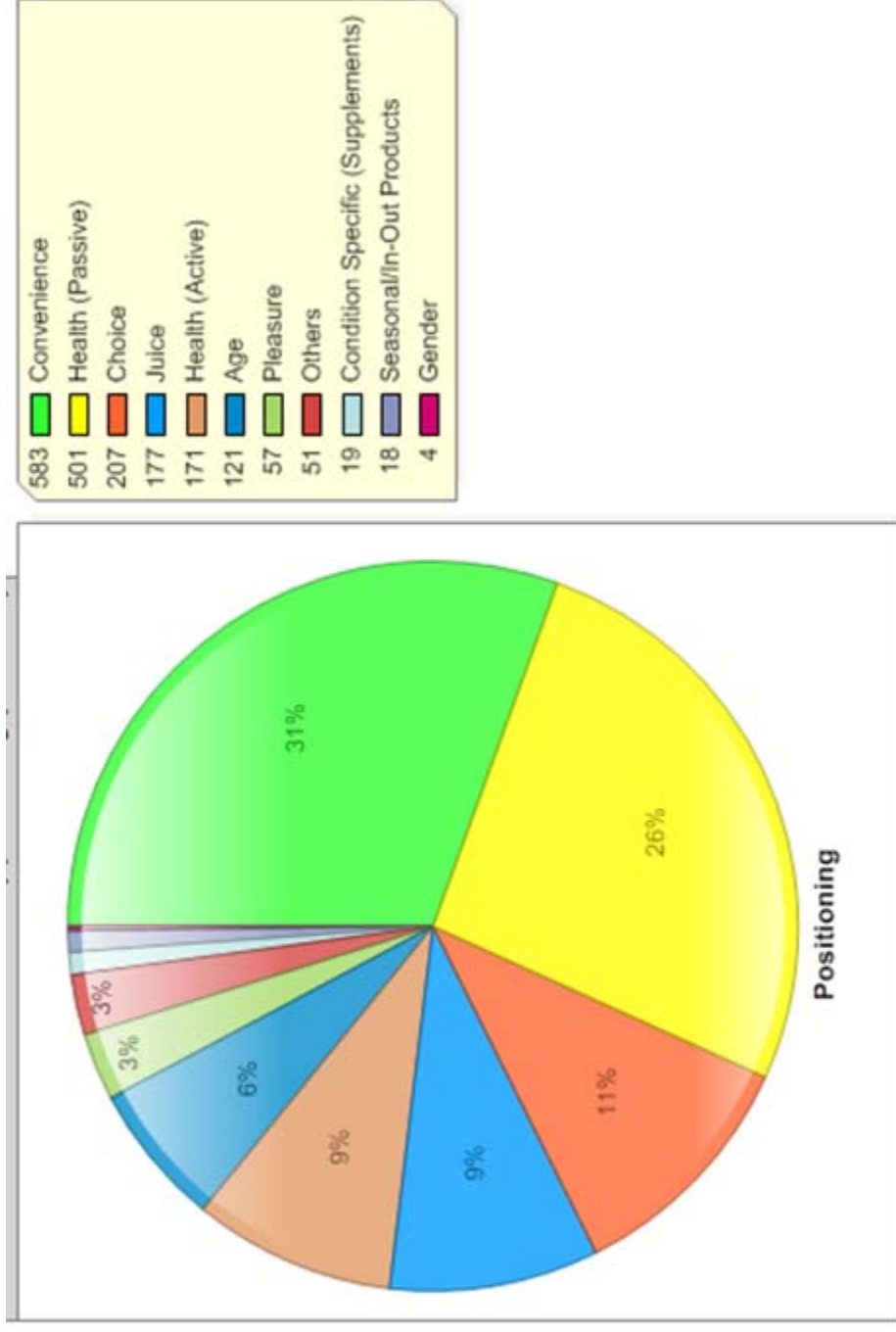


Asda Really Fruity Banana
Sticks: UK
15% banana puree

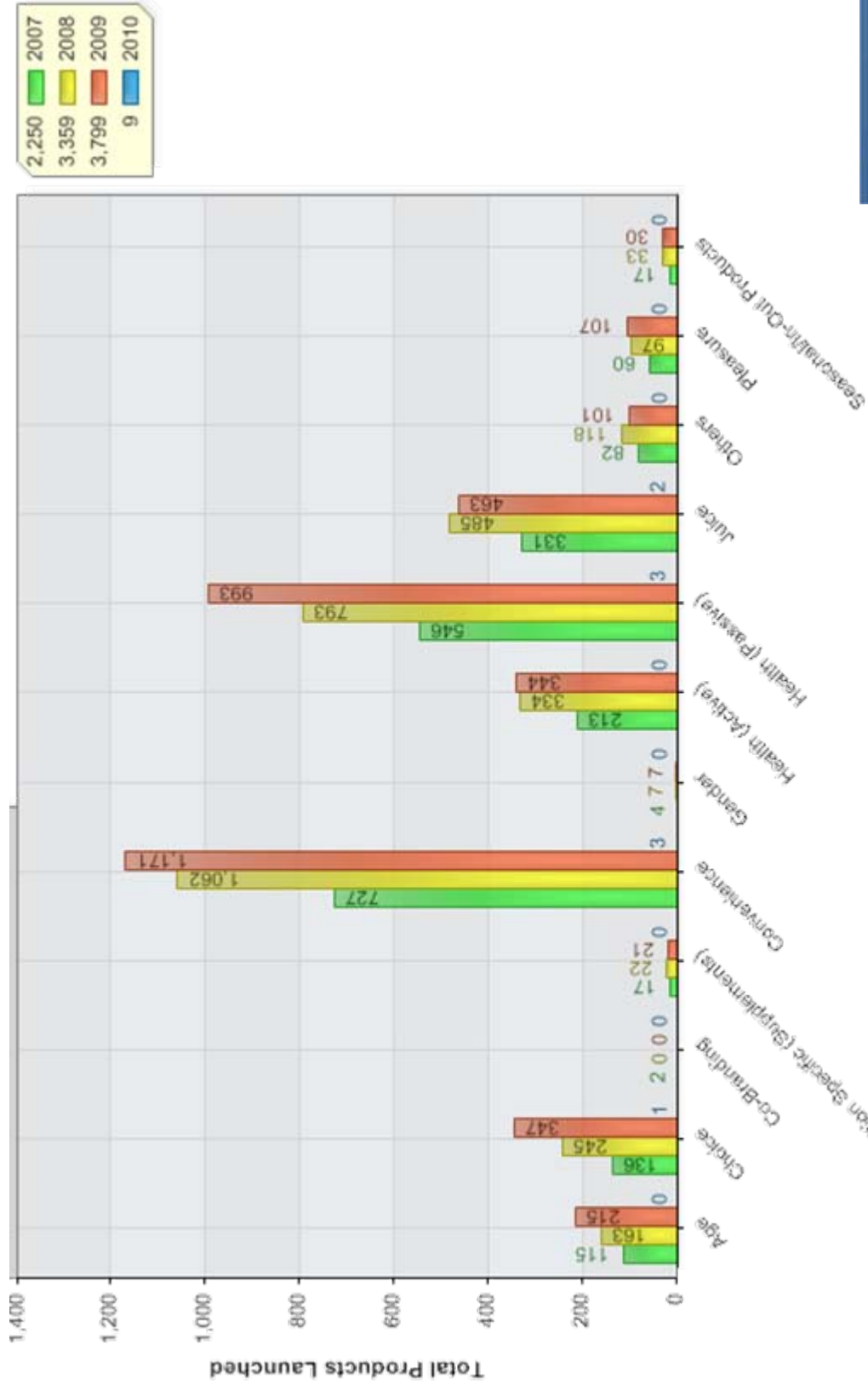


Coles Tropical fruit juice:
Australia
0.9% banana puree

Global positioning analysis – banana products last 6 months



Previous positioning – banana products past 3 years



Claim and Benefits around bananas – 1. Real Fruit



“Traditional. Moist, real banana. Ready made”



“Made with fresh milk. Pasteurized. With real bananas. No artificial flavours, colours or preservatives. Suitable for vegetarians. Good source of calcium.”



“High calcium. Lowering cholesterol. No sugar added. Certified Halal. With real banana.”

1

2. Fruit Equivalents



The bananas used came from Rainforest Alliance Certified plantations. Made for kids. No added sugar. No sweeteners, preservatives or bits. Great for lunchboxes. 100% pure fruit. 1 full portion of fruit.



100% pure juice. No added sugars, sweeteners or other artificial additives. This product meets international recommendations for healthier foods with less saturated fat, sugars, and salt (sodium). Each bottle contains 6 oranges, and 1 banana.



A 250ml glass of Tropicana smoothie which contains 330g fruit which are 10 strawberries, 1/2 orange, 1 banana, 1/3 apple, 20 grapes, 7 black grapes.

2. Fruit Equivalents cont.



“1 bottle is equivalent to 1 banana.
Contains dietary fiber and vitamin C.”

Ingredients :Banana pulp (80%), fruit extract based on concentrate (20%).



“A whole banana inside the bag. 1 of your 5 a day. 100% natural goodness. 0% additives or salt. Reduced fat – at least a third less fat than most kids snacks”

Ingredients :Banana (81%), light coating of palm oil (18%).

3. Energy Source



The organic Overstim's Energy Bar combines the energy of bananas and dates to provide an important energy boost which can be useful for sports practice and/or leisure activities.



Bananas are packed with carbohydrate energy. They also contain various vitamins and minerals like potassium and magnesium. Magnesium is important for optimum muscle functioning in tandem with calcium, imperative for healthy bones and teeth.

4. Nutrition & Eating Quality



While we consider our little ones sweet peas, the peas they eat are definitely little in size, but they boast large nutritional benefits. Peas contain insoluble fiber, and twice the protein as most vegetables. Not only is the banana the greatest source of potassium around, but it is also a natural antacid. Give your baby their first taste of sweet summer corn with our super-sweet corn. Your little ones are sure to enjoy it. No added sugar. No added salt. No artificial preservatives. USDA organic. Certified kosher.



All natural freeze-dried banana slices. Light, crispy texture with sweet banana taste. No additives or preservatives. No fat. No cholesterol. Natural fruit fiber and nutrients. Only 55 calories per bag.

Interesting.....



Jelly drink



Cream cheese



Blueberry cream

Australian banana NPD

- 17 new product launches in the last six months
 - Total of 48 in the previous two years, and
 - 74 in previous three years
- Category use consistent with global trends
- Upward trend in the number of launches
- Passive health and convenience remain positioning favourites



6 months of Australian NPD with banana ingredients





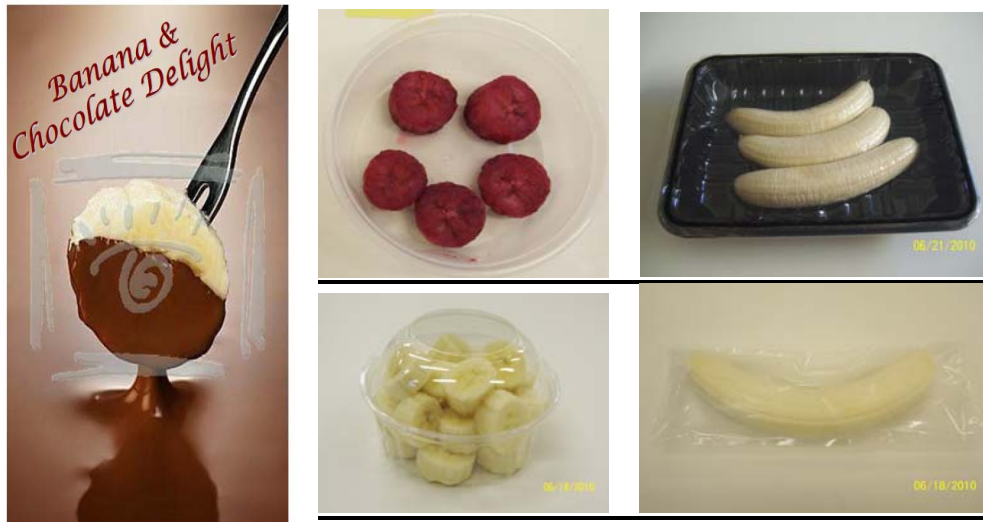
Banana Products in Woolworths (Brisbane, August 2010)

Beverages	\$4.99/750ml	Nudie crushie (cloudy - 5% banana juice, 48% apple juice)
	\$2.99/250ml	Nudie smoothie (7% banana juice, 39% apple juice)
	\$3.99/1.25l	Spring Valley mango and banana nectar (17% banana puree)
	\$2.08/600ml	Golburn Valley smooth banana (4.1% banana juice from concentrate and banana flavour)
Fried	\$2.49/300g	Banana chips
Dried	\$5.75/200g	Soland dried bananas
	\$12.50/250g	Willowvale Organics organic dried banana

Appendix 6 – Product Concepts and Specifications

Appendix 6 – Product Concepts and Specifications

Concept One: Fresh ready to eat banana snacks



Concept description:

1. Product form

What does it look like?

- Banana pieces with cup/fork/dip in 100 g serve size
- Whole peeled ready to eat banana in single serve rip-top cling tray

How is it used?

- Eaten as snack away from home in place of fresh banana
- Snack pieces eaten directly from the cup with disposable fork and a dip (e.g chocolate, carmel)
- Whole banana eaten directly from thin plastic sleeve which is peeled apart to hold after opening packaging

2. Product attributes

What are the reasons why customers might buy it?

- Convenience snack with no peel
- Disposal is an issue for consumption in car, school, office
- Ready-to-eat no waiting for ripening
- Natural healthy snack in place of candy
- Attractive to kids, adults with fun dips and flavours
- 10 day shelf life (approx) when kept in the fridge

3. Potential market demand

Who is the potential buyer?

- Consumer purchased at grab-and-go supermarkets, service stations, tuck shops in place of fresh fruit or candy
- Food service healthy serve offering in place of chips or high sugar desserts eg McDonalds fruit bag

What advantage(s) in using Australian banana as raw material?

- Fresh banana not subject to import competition
- Australian grown branding advantage

4. Potential market value:

What is known about the size of the market?

- Banana is the number 1 fresh fruit but almost entirely for home fruit bowl consumption; large potential additional market in snack and quick service industry

Estimated value

- Snack products are in the \$2:00-\$3:50 per serve range retail
- Banana added value is approximately \$20 kg

Feasibility assessment:

Technical issues and challenges to be solved

- Shelf life known to be approx 7-10 days but needs verification
- Requires optimisation of anti-browning and anti-micro dip
- Would have best shelf-life in modified atmosphere packs
- Need to show there is no anaerobic bacterial toxin potential
- Current dip process FSANZ approved for vegetable not fruit applications
- Optimisation of packaging format and distribution systems needed
- Optimum ripeness of fruit required – different consumers prefer banana fruit at different stages so consumer work would be required to work out 'best' ripeness

Intellectual property

- No freedom to operate issues known
- IP potential only in trade marking
- High content of know-how and need for tight cold chain distribution would hinder competition

Commercialization pathway

- Estimated commercial development time 6-12 months
- Estimated investment scale: relatively low capital needs for production if hand peeling used; requires appropriate dip treatment and packaging equipment

Concept Two: Fresh cut banana snack frozen



Concept description:

1. Product form

What does it look like?

- Sliced or whole banana frozen and bulk or individually packaged ready-to-thaw and use
- Ice cream form with stick and chocolate or sprinkles coating

How is it used?

- Bulk in food service, individual pack as away form snack lunch in place of fresh banana, eaten directly after thawing

2. Product attributes

What are the reasons why customers might buy it?

- Frozen form preserves optimal ripened state
- Does not go off in the 2-4 day window that fresh product does
- Convenience to put into lunch box frozen, ready to use when thawed
- No peel to deal with
- 100 day plus shelf life frozen, up to 1 day thawed

What benefits would they be seeking from it?

- The convenience of not having to have ripe ready banana for lunches
- The freedom of not having to dispose of a skin (that rapidly degrades) away from home.

What are the points of difference/targeted selling proposition?

- Convenience ready to use

3. Potential market demand

Who is the potential buyer?

- Mothers, health conscious for lunch snacks away from home

What advantage(s) in using Australian banana as raw material?

- Quality control of banana and processing
- Branding of Australian grown

4. Potential market value:

What is known about the size of the market?

- Current market for convenience snacks growing faster than fresh

Estimated value

- Snack products are in the \$2:00-\$3:50 per serve range retail

Feasibility assessment

Technical issues and challenges to be solved

- Rate of freezing has large impact on the product acceptability after thawing
- Browns after thawing so may need to thaw under modified atmosphere
- Dip treatments may be needed to inhibit browning after thawing

Intellectual property

- No known freedom to operate issues
- IP potential is in branding and packaging

Commercialization pathway

- Estimated commercial development time 1-2 years
- Estimated investment scale and return: low because of existing industry capacity

Concept Three: Natural energy squeeze pack of banana pulp for energy on the go



Concept description:

1. Product form

What does it look like?

- Banana pulp in a squeeze pack
- UHT to be shelf stable
- Formulated to have nutraceuticals, natural colour

How is it used?

- Single serve 150 ml banana shape and colour, squeeze with one hand while driving, cycling, exercising

2. Product attributes

What are the reasons why customers might buy it?

- Because it provides natural sustained energy release and can be used during sustained physical activity
- Provides potassium for electrolytes, slow release and fast release sugars from banana (mix of ripe and unripe?)

What benefits would they be seeking from it?

- Sustained energy release to perform easier, better, longer

What are the points of difference/targeted selling proposition?

- Natural product, not high in free sugars,

3. Potential market demand

Who is the potential buyer?

- Athletes (runners; hikers; cyclists; footballers etc.) and those undertaking sustained physical exertion (tradesmen, manual labourers.)

What advantage(s) in using Australian banana as raw material?

- As shelf stable subject to import competition
- Potential to tailor the quality of the puree to have fresh taste, higher quality

4. Potential market value:

What is known about the size of the market?

- Requires market research, natural nutraceutical products are a growing trend

Estimated value

- Price points for performance energy products are above snack food

- Typically \$3-4 per serve for energy

Feasibility assessment:

Technical issues and challenges to be solved

- Requires the development of the nutraceutical formulation
- Needs athlete endorsement
- Sterilisation and packaging in squeeze pack need specialist equipment

Intellectual property

- No known freedom to operate issues
- High IP potential for proven formulation that gives sustained energy release
- Specialist packaging and sterilisation are barriers to competitive entry

Commercialization pathway

- Estimated commercial development time 12-24 months
- Estimated investment scale: \$200k using contract packaging

Concept Four: Smooth Banana Spread

Concept description:

1. Product form

What does it look like?

- Smooth spread product – a margarine, peanut butter or vegemite like texture.

How is it used?

- Can be used as spread on sandwiches, toasts, biscuit and wafers like any dairy spread

2. Product attributes

What are the reasons why customers might buy it?

- Low fat banana product – ready to eat.

What benefits would they be seeking from it?

- Rich in flavour, healthy spread (can be made with olive oil). Convenient to use and attract young kids through banana taste.

What are the points of difference/targeted selling proposition?

- Advantage over peanut butter as low fat substitute, banana used as a fat replacer ingredient.

3. Potential market demand

Who is the potential buyer?

- Consumer purchase from supermarkets. Fast food retailers (Subway, Sizzler, Hungry Jacks etc.).

What is the competitive position relative to imports, what advantage(s) in using Australian banana as raw material?

- Novel product for dairy industry. Utilise Australian grown bananas.
- Reducing waste in Australia banana processing

What advantage(s) in processing in Australia?

- Australian knowhow and processing capabilities will be used

4. Potential market value:

What is known about the size of the market?

- Look at current dairy and non-dairy based spread figures in supermarket, fast food retailers and food service industry

What price points are established for current products?

- Consider similar products pricing currently available in the supermarket.

Feasibility assessment:

Technical issues and challenges to be solved

- Product evaluation needed to work out consumer acceptance based on ripeness
- Commercial margarine or dairy blends processing infrastructure can be modified and used
- Prototype product development and evaluation

Intellectual property

- Low possibility for IP development depending upon the finished product.

Commercialization pathway

Timeline:

- Option 1: Joint venture, partner of Toll Processing with existing commercial margarine or dairy blends processing facility in Australia.
- Option 2: Development of prototype products and market testing via CSIRO food processing facility and subsequent purchase of required equipment and technology from equipment supplier.
- For both option 1 and 2, commercial development time, including market testing, would be 6-12 months.

Estimated investment scale and return:

- Estimation of \$35-60K for prototyping, market testing activity via CSIRO facility.
- Capital equipment costs \$500K to \$1M, depending on system volume.

Concept Five: High viscosity pulp (HPP)

Concept description:

1. Product form

What does it look like?

- Smooth, viscous, fresh-like and non-thermally processed banana puree.

How is it used?

- Smooth textured product used in beverages needing high viscosity, smoothies, baby food, dessert or topping for ice-cream, filling in soft centred chocolate bars etc.

▪

2. Product attributes

What are the reasons why customers might buy it?

- High viscosity, smooth texture, nutritional product

What benefits would they be seeking from it?

- Flavour rich, fresh like with no cooked flavour (due to non-thermal temperature) product. Due to high viscosity this product might require less quantity to achieve desired viscosity in beverage production.

3. Potential market demand

Who is the potential buyer?

- Beverage and dairy products manufacturers, food service industry.

What is the competitive position relative to imports, what advantage(s) in using Australian banana as raw material?

- Novel product - such product is not available in Australia and overseas.

What advantage(s) in processing in Australia?

- Australian knowhow and processing capabilities will be used. Better quality than the imported products.

4. Potential market value:

What is known about the size of the market?

- Need to look at current Australian and imported puree product figures and statistics.

What price points are established for current products?

- Consider similar product currently available in the market.

Feasibility assessment:

Technical issues and challenges to be solved

- Product evaluation required to work out consumer acceptance based on ripeness.
- Commercial HPP infrastructure can be used and modified if required.
- Shelf-life and browning issues must be addressed

Intellectual property

Are there free to operate issues?

- Yes

Is there IP potential?

- Low possibility depending upon the finished product.

Commercialization pathway

Estimated commercial development time

- Option 1: Joint venture, partner or toll processing with existing commercial HPP facility in Australia.
- Option 2: Development of prototype products and market testing via CSIRO HPP facility and subsequent purchase of HPP technology from equipment supplier.
- For both Option 1 & 2 – commercial development time, including market testing is 6 to 12 months.

Estimated investment scale and return:

- HPP toll processing rates to be provided by commercial HPP operators.
- Estimation of \$35-\$70K for prototyping, market testing activity via CSIRO facility.
- Capital equipment costs \$800K to \$2M, depending on system volume.

Technical Product Specifications

PRODUCT CHARACTERISATION	
Product description	HPP banana puree
Single or multiple component food?	Multiple component
pH of the final components	pH adjusted to 4.2 with citric and ascorbic acid
Water activities of the final product?	0.98 – 0.99
Brix of final product	
Viscosity (Bostwick units)	
Product structure – i.e. fluid, solid, puree etc	Puree, mash, slices or whole peeled banana
Principal process(es)	High pressure processed at 600 Mpa 3 min (treatment time may be reduced subject to further investigations)
Will it undergo a kill or microbial reduction step in the process? (Y/N)	Yes
Other control step(s) including heating before consumption	Served chilled
Packaging	Pouched filled and vacuum sealed prior to HPP Tub filled and cooled in a ice water to <4C
Proposed shelf life	10 days (Shelf life may be further extended subject to product stability and safety assessments)
Storage conditions of the final product	Refrigerated at 4°C
Distribution conditions	Refrigerated distribution 4°C

PRODUCT CHARACTERISATION

Product description	HPP mashed banana
Single or multiple component food?	Multiple component
pH of the final components	pH adjusted to 4.2 with citric and ascorbic acid
Water activities of final components?	0.98 – 0.99
Brix of final product	
Viscosity (Bostwick units)	
Product structure – i.e. fluid, solid, puree etc	Puree, mash, slices or whole peeled banana
Principal process(es)	High pressure processed at 600 Mpa 3 min (treatment time may be reduced subject to further investigations)
Will it undergo a kill or microbial reduction step in the process? (Y/N)	Yes
Other control step(s) including heating before consumption	Served chilled
Packaging	Pouched filled and vacuum sealed prior to HPP Tub filled and cooled in a ice water to <4C
Proposed shelf life	10 days (Shelf life may be further extended subject to product stability and safety assessments)
Storage conditions of the final product	Refrigerated at 4°C
Distribution conditions	Refrigerated distribution 4°C

Concept Six: Whole and sliced banana in syrup (HPP processing)

Concept description:

1. Product form

What does it look like?

- Fresh like and vacuum packed processed whole and sliced banana in a sugar or fruit juice based syrup.

How is it used?

- Can be used as dessert, banana topping for desserts, fresh consumer product consumed directly from the pack using spoon.

2. Product attributes

What are the reasons why customers might buy it?

- Fresh-cut type mouth feel, product ready to eat.

What benefits would they be seeking from it?

- Rich in flavour with no cooked flavour. Convenient to use in desserts and topping.

3. Potential market demand

Who is the potential buyer?

- Food service industry

Australian banana as raw material?

- Novel product - such products are not available in Australia and overseas.

What advantage(s) in processing in Australia?

- Australian knowhow and processing capabilities will be used.

4. Potential market value:

What is known about the size of the market?

- Market opportunities research required.

What price points are established for current products?

- Consider similar products currently available in the market.

Feasibility assessment:

Technical issues and challenges to be solved

- Product evaluation required to work out product integrity during processing and consumer acceptance based on projects.
- Commercial HPP infrastructure can be used and modified if required.
- Shelf-life and browning issues must be addressed

Intellectual property

- Freedom to operate issues.
- Low IP potential depending upon the finished product.

Commercialization pathway

Timeline:

- Option 1: joint venture, partner or toll processing with existing commercial HPP facility in Australia.
- Option 2: Development of prototype products and market testing via CSIRO HPP facility and subsequent purchase of HPP technology from equipment supplier.

- For both Option 1 & 2 – commercial development time, including market testing is 6 to 12 months.

Estimated investment scale and return:

- HPP toll processing rates to be provided by commercial HPP operators.
- Estimation of \$35K to \$70K for prototyping, market testing activity via CSIRO facility.
- Capital equipment costs \$800K to \$2M, depending on system volume.
- user)

Technical Product Specifications

PRODUCT CHARACTERISATION	
Product description	HPP banana slices in syrup
Single or multiple component food?	Multiple component
pH of the final components	pH adjusted to 4.2 with citric and ascorbic acid
Water activities of final components?	0.98 – 0.99
Brix of final product	
Viscosity (Bostwick units)	Not applicable
Product structure – i.e. fluid, solid, puree etc	Puree, mash, slices or whole peeled banana
Principal process(es)	High pressure processed at 600 Mpa 3 min (treatment time may be reduced subject to further investigations)
Will it undergo a kill or microbial reduction step in the process? (Y/N)	Yes
Other control step(s) including heating before consumption	Served chilled
Packaging	Pouched filled and vacuum sealed prior to HPP Tub filled and cooled in a ice water to <4C
Proposed shelf life	10 days (Shelf life may be further extended subject to product stability and safety assessments)
Storage conditions of the final product	Refrigerated at 4°C
Distribution conditions	Refrigerated distribution 4°C
PRODUCT CHARACTERISATION	
Product description	HPP whole peeled banana in syrup
Single or multiple component food?	Multiple component
pH of the final components	pH adjusted to 4.2 with citric and ascorbic acid

Water activities of final components?	0.98 – 0.99
Brix of the final product	
Viscosity (Bostwick units)	Not applicable
Product structure – i.e. fluid, solid, puree etc	Puree, mash, slices or whole peeled banana
Principal process(es)	High pressure processed at 600 Mpa 3 min (treatment time may be reduced subject to further investigations)
Will it undergo a kill or microbial reduction step in the process? (Y/N)	Yes
Other control step(s) including heating before consumption	Served chilled
Packaging	Pouched filled and vacuum sealed prior to HPP Tub filled and cooled in a ice water to <4C
Proposed shelf life	10 days (Shelf life may be further extended subject to product stability and safety assessments)
Storage conditions of the final product	Refrigerated at 4°C
Distribution conditions	Refrigerated distribution 4°C