Buffalo, Camel, Crocodile, Emu, Kangaroo, Ostrich and Rabbit Meat

New value added products

A report for the Rural Industries Research and Development Corporation

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Foreword

People’s lifestyles have changed dramatically in recent times. From spending many hours in the kitchen preparing meals, they now expect meals to be presented at the table within 30 minutes. There is a huge opportunity for any industry to tap into the pre-prepared food market, in the form of supermarket retail ready packs complete with garnishes and condiments. These niche markets exist not only in Australia but also in Asian countries where ex-patriots frequent exclusive supermarket chains. Value added retail-ready products have proven successful with lamb and chicken products and so paves the way for new and emerging meats. It is critical that the development of products like these includes the maintenance of food safety and a reliably defined shelf life.

The objective of this project was to develop one new value added product for each of buffalo, kangaroo, emu, ostrich, crocodile, camel, and rabbit meat. As part of the development of these products the microbiological safety and shelf-life was validated, and the acceptance of the products was assessed by consumer tasting and accessing the market place.

The report details organoleptic and microbiological assessment of the seven value added new and emerging meat products developed in the project.

This project was funded from RIRDC Core Funds which are provided by the Federal Government.

This report, an addition to RIRDC’s diverse range of over 900 research publications, forms part of our New Animal Products R&D program, which aims to accelerate the development of viable new animal industries.

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Simon Hearn
Managing Director
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- Geoff Gordon (Hela Schwarz)
- Ken Lang (Yarra Valley Game Meats)
- Mrs Toh Guek Hong (Austrade, Singapore)
- Consumer panel participants

Abbreviations

ASA Australian Standard
AOAC Association of Official Analytical Chemists
AQIS Australian Quarantine Inspection Service
AVA Agri-food and Veterinary Authority of Singapore
BSM Buffalo with Smokey Mountain BBQ Pepper glaze
cfu/g colony forming units per gram
CT Crocodile with Tandoori Masala seasoning
CW Camel with Winzersteak encapsulated coating
DPI Victorian Department of Primary Industries
ENMM Emu with Native Mint and Mustard coating
KM Kangaroo with Madras Curry encapsulated coating
MIRINZ Meat Industry Research Institute of New Zealand
OSM Ostrich with Smokey Mountain BBQ Pepper glaze
RIRDC Rural Industries Research and Development Corporation
RLMC Rabbit with Lemon Myrtle and Chilli glaze
TVC Total viable count at 25°C
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Executive Summary

The prototypes developed and evaluated in this project are

- Buffalo leg cuts coated with Smokey Mountain BBQ Pepper glaze
- Camel rump coated with Winzersteak encapsulated coating
- Crocodile boneless body meat coated with Tandoori Masala seasoning
- Emu steak/small fillets coated with Native Mint and Mustard
- Kangaroo topside or rump coated with Madras Curry encapsulated coating
- Ostrich steak coated with Smokey Mountain BBQ Pepper glaze
- Rabbit thigh fillets coated with Lemon Myrtle and Chilli glaze.

There is the opportunity to expand this range with these, as yet unexplored, products

- Buffalo coated with Bush tomato salsa glaze
- Buffalo coated with Buffalo encapsulated coating
- Camel coated with Native mint and mustard coating
- Camel with Native pepper leaf seasoning
- Crocodile coated with Native mint and mango glaze
- Crocodile coated with Wild lime, honey ginger and chilli glaze
- Crocodile coated with Lemon myrtle and chilli glaze
- Emu coated with Wild lime, honey ginger and chilli glaze
- Emu with Cajun seasoning
- Kangaroo coated with Wattleseed and garlic glaze
- Kangaroo with Native pepper leaf seasoning
- Rabbit coated with Bush tomato salsa glaze.

All prototypes were assessed by an untrained consumer taste panel with the crocodile, kangaroo and rabbit products proving the most acceptable, followed by the ostrich, buffalo and emu products, with camel being the least acceptable of the products. However, overall all products were well received with the majority of panellists grading the products as either average and would buy on some occasions, above average and would probably buy the product or premium and would definitely buy the product.

The individual components of the prototypes, the dry ingredients and the different meat species, and combined as the prototype were of good microbiological quality with respect to foodborne pathogenic bacteria that can be associated with such products.

- The types of products developed in this project have limited shelf life potential, therefore it is not recommended that they be stored aerobically. Under aerobic conditions at temperatures at or above 4°C such products will usually spoil within days of preparation. The shelf life of such products can be extended by packaging under vacuum or replacing the atmosphere with 100% CO₂. Specifically,
  - The buffalo prototype can be expected to exhibit a one week storage life under either vacuum or gas flushed packaging at 4°C
  - The camel prototype can be expected to have a 2 week shelf life in either packaging system at 4°C
  - At 4°C, the crocodile prototype will survive 2 weeks of storage in both packaging systems
  - The emu product performed best in vacuum packaging where it would exhibit a 2 week shelf life at 4°C, but only a 1 week storage life under gas at 4°C
  - The kangaroo product could reasonably be expected to reach at least a 3 week storage life at 4°C when packaged either under vacuum or gas
  - The ostrich product should survive 2 weeks of storage at 4°C, under modified atmosphere conditions
  - The rabbit prototype has at least a 3 week shelf life potential at 4°C under vacuum but only a 2 week shelf life under CO₂.
There are opportunities for industry to explore the Singapore food service sector as a potential marketplace for the products developed in this project. In particular, there is the opportunity to introduce these products into Singapore by way of an official launch, as has been done for Australian pork. Some issues regarding the importation of these products into this country would require attention by industry in consultation with AQIS.

These products have not been as well received on the domestic market as expected, despite the outcomes of the consumer evaluation of the prototypes. Further marketing of these products, perhaps presented as a range of products for each meat species, would go some way towards the uptake of these products in the food service sector and retail sectors. In-store promotions of these products may give retailers more confidence in consumer acceptance.

There is the opportunity to showcase these products to the domestic market via an industry workshop which is proposed in a research proposal, NAP 03-08, currently under consideration by RIRDC.
1. Introduction

People’s lifestyles have changed dramatically in recent times. From spending many hours in the kitchen preparing meals, they now expect meals to be presented at the table within 30 minutes. There is a huge opportunity for any industry to tap into the pre-prepared food market, in the form of supermarket retail ready packs complete with garnishes and condiments. These niche markets exist not only in Australia but also in Asian countries where ex-patriots frequent exclusive supermarket chains. This has proven successful with lamb and chicken products and so paves the way for new and emerging meats.

The development of such new products gives the new and emerging meat industries the opportunity of commercialisation targeted at the retail market or food service sector. The range of products developed can be used to 'tempt' new markets as they can be readily prepared and shipped to different destinations and used in product 'launches'.

It is critical that the development of products like this is accompanied by scientifically based shelf life information, with respect to how long the product can reasonably be expected to last at a nominated storage temperature. Food safety issues associated with the value added products, particularly microbiological, are also addressed.

1.1 Objectives

- Develop one new product for each of buffalo, kangaroo, emu, ostrich, crocodile, camel, and rabbit.
- Investigate the most appropriate packaging systems for the new and emerging meat industries, eg. vacuum packaging, modified atmosphere packaging, frozen or fresh aerobic storage.
- Identify most appropriate cuts for value added products.
- Develop recipes for value adding in consultation with industry, supermarkets and restaurants.
- Validate safety and shelf-life of those products. Assess acceptance of such products into the market place.
- Send at least one trial consignment of each product to a potential market for evaluation.
2. Methodology

2.1 Prototype development

2.1.1 Meat cuts
The meat cuts used in the prototype development of each of the products were selected on the basis of availability and below premium cuts for each species. Refer to the section below on Value added prototypes for descriptions.

2.1.2 Flavours
Staff from Hela Schwarz Australia, were consulted as experts in flavour technology for food processing, with experience in the development and production of meat products. A selection of flavours were presented as candidates for assessment by project team members to determine which flavour and meat combinations were chosen as the final prototype product for each meat species. Most of the flavours proposed were tasted as either the dry ingredient or combined with meat. The suggested combinations for value added prototypes were as follows:

Table 1: Proposed flavours to complement each meat species as presented by Hela Schwarz to project team members.

<table>
<thead>
<tr>
<th>Species</th>
<th>Flavour</th>
<th>Tasted dry</th>
<th>Tasted combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emu</td>
<td>Native mint and mustard coating</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wild lime, honey ginger and chilli glaze</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cajun seasoning</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Camel</td>
<td>Native mint and mustard coating</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Winzersteak encapsulated coating</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Native pepper leaf seasoning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buffalo</td>
<td>Bush tomato salsa glaze</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Smokey mountain pepper glaze</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Buffalo encapsulated coating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rabbit</td>
<td>Bush tomato salsa glaze</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lemon myrtle and chilli glaze</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Kangaroo</td>
<td>Wattleseed and garlic glaze</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Native pepper leaf seasoning</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Madras curry encapsulated coating</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Crocodile</td>
<td>Native mint and mango glaze</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tandoori seasoning</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wild lime, honey ginger and chilli glaze</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Ostrich</td>
<td>Lemon myrtle and chilli glaze</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Smokey mountain pepper glaze</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

The Wild lime, honey ginger and chilli glaze was not available for tasting in any form at the time of prototype development as it was under development as a dry flavour. At the time of presentation this flavour was only available as a sauce which was not suitable for application on meat products.

Native pepper leaf seasoning was unavailable for tasting because of a scarcity of the native pepper at the time of prototype development.

Wattleseed and garlic glaze was at the time of pre-evaluation in the form of a premix for addition to further processed meats such as sausages and the like, and required further development for use as a dry coating to retail meat cuts.
2.1.3 Value added prototypes

The value added prototypes selected for organoleptic and microbiological assessment, based on availability of dry ingredients and preliminary taste testing by the project team are as listed below:

<table>
<thead>
<tr>
<th>Species</th>
<th>Cut</th>
<th>Flavour</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo</td>
<td>Leg cuts</td>
<td>Smokey Mountain BBQ Pepper</td>
<td>BSM</td>
</tr>
<tr>
<td>Camel</td>
<td>Rump</td>
<td>Winzersteak</td>
<td>CW</td>
</tr>
<tr>
<td>Crocodile</td>
<td>Boneless body meat</td>
<td>Tandoori Masala</td>
<td>CT</td>
</tr>
<tr>
<td>Emu</td>
<td>Steak/small fillets</td>
<td>Native Mint and Mustard</td>
<td>ENMM</td>
</tr>
<tr>
<td>Kangaroo</td>
<td>Topside or rump</td>
<td>Madras Curry</td>
<td>KM</td>
</tr>
<tr>
<td>Ostrich</td>
<td>Steak</td>
<td>Smokey Mountain BBQ Pepper</td>
<td>OSM</td>
</tr>
<tr>
<td>Rabbit</td>
<td>Thigh fillets</td>
<td>Lemon Myrtle and Chilli</td>
<td>RLMC</td>
</tr>
</tbody>
</table>

2.2 Assessment of consumer acceptance

The panellists were recruited from DPI, VIAS Attwood and Werribee. The consumer panel consisting of approximately 30 people, was untrained, and was made up of approximately equal numbers of men and women of diverse ethnic backgrounds ranging in age from 23 to 62 years. The panel was made up of a core group of 17 participants who evaluated all 7 products. Other panellists were involved, though many of these were transitory due to time constraints and were not available to evaluate all 7 products. Participants completed a consumer product evaluation form. The form was developed in consultation with the Meat Science group at VIAS, who have extensive experience in conducting such trials for the pork and beef industries. A copy of the evaluation form can be found in Appendix 2.

A risk assessment was conducted to meet the requirements defined by the on site Occupational Health and Safety officer, so all panellists were aware of the risks associated with participating in the tasting. A copy of the risk assessment can be found in Appendix 1.

Panellists assessed each of the value added products described above. These ready-to-cook products were assembled at Hela Schwarz by adding the appropriate seasoning to each of the meat species at a rate of 3%w/w. Uncooked product was evaluated by the panellists after a brief description of the seasoning used was given.

The value added meat products were cooked in a Silex grilling system. Each product was cooked at 190°C for 4 minutes, except the rabbit fillets which were cooked for 1.5 minutes. Each product was cut into bite-size portions and served to the panellists.

Panellists were required to cleanse their palate with bread and water prior to tasting the products. The products were presented for assessment for the panellists in the following order; BSM, OSM, ENMM, RLMC, CT, KM, CW, so the strongest flavoured seasonings did not mask the flavour of subsequent products.

Panellists recorded their responses as a mark across a 14.3cm line scale. Each response was measured from its distance from the left hand end of the line and converted to a percentage of the 14.3cm line. The Hedonic scores used for uncooked appearance, uncooked odour, taste of flavours, flavour of meat and overall liking were 0 = dislike extremely to 100 = like extremely. The Hedonic scores used for mouthfeel of the products were 0 = extremely dry and course to 100 = extremely juicy and fine, and those for texture of the meat were 0 = extremely tough to 100 = extremely tender. Individual responses from each respondent for each of the products were graphed according to the percent acceptance of the product, and for each product an average percent acceptance was graphed.

Each consumer was also asked to grade the products into one of five categories based on intention to purchase. The grading score used were:
• 1 = unsatisfactory (terrible, definitely would not buy)
• 2 = below average (was not nice, probably would not buy)
• 3 = average (product okay, may buy on some occasions)
• 4 = above average (product good, probably buy)
• 5 = premium (top quality, enjoyable, definitely would buy).
The grading of each product was tabulated as a percentage of total responses.

2.3 Microbiological investigation of coatings applied to meats

A microbiological investigation of bulk, dry ingredients was undertaken for indicator and pathogenic bacteria. The dry ingredients sampled were
• Hela Outback Spirit Glaze, Smokey Mountain Pepper, 2kg
• Hela, Winzersteak encapsulated coating, 1kg
• Hela, Tandoori Masala seasoning, 1kg
• Sample, Native Mint and Mustard coating, 500g
• Hela, Madras Curry encapsulated coating, 1kg
• Hela Outback Spirit Glaze, Lemon Myrtle and Chilli coating, 2kg.

Ingredients were sampled by mass, that is, 10 gram of product was macerated with 90 ml of diluent (0.1% peptone water) according to Australia Standard AS1766.4-1987 from which microbiological tests were performed.

The dry ingredient samples were tested for the following bacteria according to Australian standard methods (or other similarly recognised methods):
• Total viable count at 25°C (TVC) (AS 1766.1.3-1991)
• Escherichia coli by Petrifilm™
• Coliforms by Petrifilm™
• Staphylococcus aureus (AS 1766.2.4-1994, surface spread method)
• Clostridium perfringens (AS 1766.2.8-1991, spread plate method)
• Bacillus cereus (AS 1766.2.6-1991, surface spread method).

The purpose of this was to determine if the dry ingredients would add significantly to the microbiological load of the meat cuts. Total viable count gives an overall indication of hygiene of the sample. E.coli and coliforms give an indication of faecal contamination. Staphylococcus aureus at high levels give an indication of poor personal hygiene of food handlers. Clostridium perfringens and Bacillus cereus are spore forming that can be potentially pathogenic in large numbers and are not uncommon in dry spices and seasoning.

2.4 Microbiological investigation of different meats prior to value adding

A microbiological investigation of fresh rabbit carcasses and vacuum packaged, frozen buffalo, camel, crocodile, emu, ostrich primal cuts and vacuum packaged kangaroo primal cuts were undertaken for indicator, spoilage and pathogenic bacteria. Buffalo, camel, crocodile, emu and ostrich packs were thawed prior to sampling. Primal meats were sampled by mass, that is, 10 gram of product was macerated with 90 ml of diluent (0.1% peptone water) Australia Standard AS1766.3.1-1991, from which most tests were performed. However, for Salmonella and Listeria monocytogenes testing, further 25 gram samples were collected for each and diluted with the appropriate enrichment medium. Rabbit was sampled by whole carcass wash (AS 1766.3.2-1979). The samples were tested for the following bacteria according to Australian standard methods (or other similarly recognised methods):
• Total viable count at 25°C (TVC) (AS 1766.1.3-1991)
• *Escherichia coli* by Petrifilm™
• Coliforms by Petrifilm™
• Salmonellae (AS 1766.2.5-1991)
• *Staphylococcus aureus* (AS 1766.2.4-1994, surface spread method)
• *Listeria monocytogenes* (AS1766.2.16.1-1998)
• *Clostridium perfringens* (AS 1766.2.7-1991, spread plate method)
• *Pseudomonas* spp. (MIRINZ)
• *Lactobacillus* spp. (MIRINZ)
• *Brochothrix thermosphacta* (MIRINZ).

The purpose of this investigation was to establish the baseline microbiology of each species of meat prior to the application of the dry ingredients. *Salmonella* is a foodborne pathogen of faecal origin. *Listeria monocytogenes* is a pathogen often associated with food processing. *Pseudomonas*, *Lactobacillus* and *Brochothrix* are meat spoilage bacteria, which by definition spoil meat at numbers at or in excess of $10^7$ cfu/g.

### 2.5 Shelf life trial

#### 2.5.1 Vacuum packaged products

Primal cuts of the 7 new and emerging meat species were butchered into retail size cuts at the Meat Research and Training Centre located at VIAS, Werribee. Sufficient retail cuts were packaged to ensure that each product could be sampled and tested over a potential storage period of 6 weeks at approximately 4.0°C. The appropriate flavours were added to each species retail cut and were placed onto black PLIX food trays. Each tray was vacuum packaged using a Henkovac heavy duty High 3000 packaging machine. Three packs of each product were collected on the day of packaging, and from then on at weekly intervals for microbiological analysis. Packs were sampled by mass, that is, 10 gram of product was macerated with 90 ml of diluent (0.1% peptone water) from which most tests were performed. However, for Salmonellae and *Listeria monocytogenes* testing further 25 gram samples were required for addition to the appropriate enrichment medium. Packs were tested for indicator, spoilage and pathogenic bacteria, the day after packaging and on the final day of the packaging trial. The products were tested at weekly intervals for indicator and spoilage bacteria until the product was spoiled. Microbiological spoilage is determined as $10^7$ cfu per gram or whole carcass of any of the spoilage organisms (*Pseudomonas*, *Lactobacillus* or *Brochothrix*). The shelf life of the product was therefore set as the sampling day before this level was reached.

The samples were tested for the following bacteria according to Australian standard methods (or other similarly recognised methods):

- Total viable count at 25°C (TVC) (AS 1766.1.3-1991)
- *Escherichia coli* by Petrifilm™
- Coliforms by Petrifilm™
- Salmonellae (AS 1766.2.5-1991)
- *Staphylococcus aureus* (AS 1766.2.4-1994, surface spread method)
- *Clostridium perfringens* (AS 1766.2.7-1991, spread plate method)
- *Bacillus cereus* (AS1766.2.6-1991, surface spread method)
- *Pseudomonas* spp. (MIRINZ)
- *Lactobacillus* spp. (MIRINZ)
- *Brochothrix thermosphacta* (MIRINZ).

#### 2.5.2 Gas flushed packaged products

Primal cuts of the 7 new and emerging meat species were butchered into retail size cuts at the Meat Research and Training Centre located at VIAS, Werribee. Sufficient retail cuts were packaged to
ensure that each product could be sampled and tested over a potential storage period of 6 weeks at approximately 4.0°C. The appropriate flavours were added to each species retail cut and were placed onto black PLIX food trays. Each tray was gas flushed with food grade CO₂ using a Vacumatic 282 packaging machine. Three packs of each product were collected on the day of packaging, and from then on at weekly intervals for microbiological analysis. Packs were sampled by mass, that is, 10 gram of product was macerated with 90 ml of diluent (0.1% peptone water) from which most tests were performed. However, for Salmonellae and Listeria monocytogenes testing further 25 gram samples were required for addition to the appropriate enrichment medium. Packs were tested for indicator, spoilage and pathogenic bacteria, the day after packaging and on the final day of the packaging trial. The products were tested at weekly intervals for indicator and spoilage bacteria until the product was spoiled. Microbiological spoilage is determined as 10⁷ cfu per gram or whole carcass of any of the spoilage organisms (Pseudomonas, Lactobacillus or Brochothrix). The shelf life of the product was therefore set as the sampling day before this level was reached.

The samples were tested for the following bacteria according to Australian standard methods (or other similarly recognised methods):

- Total viable count at 25°C (TVC) (AS 1766.1.3-1991)
- Escherichia coli by Petrifilm™
- Coliforms by Petrifilm™
- Salmonellae (AS 1766.2.5-1991)
- Staphylococcus aureus (AS 1766.2.4-1994, surface spread method)
- Listeria monocytogenes (AS1766.2.16.1-1998)
- Clostridium perfringens (AS 1766.2.7-1991, spread plate method)
- Bacillus cereus (AS1766.2.6-1991, surface spread method)
- Pseudomonas spp. (MIRINZ)
- Lactobacillus spp. (MIRINZ)
- Brochothrix thermosphacta (MIRINZ).

2.6 Investigation of potential markets

2.6.1 Export

The Singapore export market was investigated as a potential market for the products developed. The Agri-food and Veterinary Authority of Singapore (AVA) currently prohibits the importation of so-called marinated meat products, of which the products developed in this project were identified. The problem was overcome by preparing products in Singapore for presentation to potential Singaporean customers. One on one interviews of at least 1 hour duration were held with the representatives listed below

- Restaurant Association Singapore
- Xie Chung Trading
- Herman Laue (associated company of Hela Schwarz Australia)
- Cold Storage Supermarket Tanglin Market Place
- Classic Fine Foods (S) Pte Lte.

Interviews were accompanied by a taste testing of the crocodile, ostrich and kangaroo products where facilities were available. During the interviews discussion centred on the likelihood of adoption of the product within Singapore, consumer expectations and supply.
2.6.2 Domestic

Contact was made with the following potential domestic customers Spotless Services Limited and (Melbourne based catering company)
- Epicure Catering (Melbourne based catering company)
- RMIT Union Catering
- The Mode Group (Sydney based catering company)
- Coles Myer
- Yarra Valley Venison.

Contact was made by either electronic communication, telephone calls or one to one meetings to gauge the likelihood of adoption of the product within these companies and food sector in general, consumer expectations and supply.

To protect confidentiality the results and discussion are a summary of general opinion.
3. Results

3.1 Prototype development

The staff at Hela Schwarz compiled the flavour/meat combinations for each species based on their expertise in the field of the development of such value added meat products.

Those flavours not available for tasting either as the dry ingredient or added to meat cuts at the time of prototype development were:
- Wild lime, honey ginger and chilli glaze
- Native pepper leaf seasoning
- Wattleseed and garlic glaze
- Native mint and mustard.

The Native mint and mustard remained in consideration because of the application concept of a schnitzel style product. The other, untasted flavours were not considered for prototype development within this project.

The following flavours were tasted by project team members as the dry ingredient and applied to one of the meat species:
- Cajun seasoning
- Winzersteak encapsulated coating
- Bush tomato salsa glaze
- Smokey mountain pepper glaze
- Lemon myrtle and chilli glaze
- Madras curry encapsulated coating
- Native mint and mango glaze
- Tandoori seasoning.

These flavours were assessed according to their taste in the dry form and more importantly as applied to meat. Figure 1 overleaf groups the responses of the project team members to the taste of each of the proposed prototypes. A positive response indicated that the product was considered palatable, a negative response indicated that the product was considered unpalatable, and an interesting response, which indicated that the product was considered palatable though could not be considered as the ideal product.

The emu with Cajun seasoning returned largely negative responses, which was also the case for the dry form and therefore was not considered for further evaluation. It was decided to use the Native mint and mustard coating as a schnitzel type product as the emu prototype.

The Camel with Winzersteak encapsulated coating was positively regarded as was the dry form, and thus was chosen as the final prototype.

Buffalo with Bush tomato salsa was not as favourably received as was expected, as the flavour of the dry form was popular. The Buffalo encapsulated coating was not well received in the final product form. The Smokey mountain pepper BBQ glaze was liked as the dry form and so was chosen as the flavour to accompany the buffalo.

Rabbit with Lemon Myrtle and Chilli glaze was positively received by the project team and was selected as the prototype product for this species.

Madras curry encapsulated coating was chosen as the prototype flavour for kangaroo, despite not being as favourably received as would be desirable at this stage. However, there was no other viable option available for this species.
Both the Native mint and mango glaze and the Tandoori seasoning returned positive responses from the team members however, the Tandoori seasoning was by far more popular. Therefore, the Tandoori seasoning was chosen as the flavour for the crocodile prototype.

At this stage, the Smokey mountain pepper BBQ glaze with ostrich was not well received, but no alternative flavour was available and so became the prototype for this species.
Figure 1: Project team member responses to proposed prototypes
3.2 Assessment of consumer acceptance

The products can be ranked by their overall acceptance by the panellists in the following order (Figure 2):

- Crocodile with Tandoori Masala
- Kangaroo with Madras Curry
- Rabbit with Lemon Myrtle and Chilli
- Ostrich with Smokey Mountain BBQ Pepper
- Buffalo with Smokey Mountain BBQ Pepper
- Emu with Native Mint and Mustard
- Camel with Winzersteak.

3.2.1 Buffalo with Smokey Mountain BBQ glaze

Based on the Hedonic testing of the sensory attributes (Figure 3) this product was reasonably well received, with scores given consistently for attributes before and after tasting. Individual responses from each of the panellists for this product are represented in Figures 4. The overall consumer opinion was that this product was of average quality or that the product was considered okay and it might be purchased on some occasions (Table 3).

3.2.2 Camel with Winzersteak encapsulated coating

Based on the Hedonic testing of the sensory attributes (Figure 5) this product was reasonably well received as the uncooked product, however, the scores declined after tasting which was in contrast to opinion of the project team during the prototype selection process. Individual responses from each of the panellists for this product are represented in Figures 6. The overall consumer opinion was that this product was of average quality or that the product was considered okay and it might be purchased on some occasions (Table 3).

3.2.3 Crocodile with Tandoori Masala seasoning

This product was the most favourably received (Figure 7) with high scores given before and after tasting. Individual responses from each of the panellists for this product are represented in Figures 8. The overall consumer opinion was that this product was of premium quality or that the product was considered top quality, it was enjoyable and it would definitely be purchased (Table 3).

3.2.4 Emu with Native Mint and Mustard coating

Based on the Hedonic testing of the sensory attributes (Figure 9) this product was reasonably well received as the uncooked product, however, the scores declined after tasting. Individual responses from each of the panellists for this product are represented in Figures 10. The overall consumer opinion was that this product was of average quality or that the product was considered okay and it may be purchased on some occasions (Table 3).

3.2.5 Kangaroo with Madras Curry encapsulated coating

This product was the second most favourably received (Figure 11) with high scores given before and after tasting. Individual responses from each of the panellists for this product are represented in Figures 12. The overall consumer opinion was that this product was of above average to premium quality or that the product was considered good to top quality, it was mostly enjoyable and it would definitely be purchased on most occasions (Table 3).
3.2.6 Ostrich with Smokey Mountain BBQ glaze

The Hedonic testing of the sensory attributes of this product (Figure 13) showed that acceptance was increased after tasting, with lower scores given for the uncooked appearance and odour. Individual responses from each of the panellists for this product are represented in Figures 14. The overall consumer opinion was that this product was of average to above average quality or that the product was considered okay to good and it may be purchased on more than the odd occasion (Table 3).

3.2.7 Rabbit with Lemon Myrtle and Chilli glaze

This product was the third most favourably received (Figure 15) with high scores given before and after tasting. Individual responses from each of the panellists for this product are represented in Figures 16. The overall consumer opinion was that this product was of premium quality or that the product was considered top quality, it was enjoyable and it would definitely be purchased (Table 3).

Table 3: The grading given each of the meat products by the untrained consumer panel, expressed as a percentage of total responses.

<table>
<thead>
<tr>
<th>Meat species</th>
<th>Overall consumer opinion of product</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unsatisfactory</td>
</tr>
<tr>
<td>Buffalo</td>
<td>6%</td>
</tr>
<tr>
<td>Camel</td>
<td>3%</td>
</tr>
<tr>
<td>Crocodile</td>
<td>0%</td>
</tr>
<tr>
<td>Emu</td>
<td>17%</td>
</tr>
<tr>
<td>Kangaroo</td>
<td>4%</td>
</tr>
<tr>
<td>Ostrich</td>
<td>5%</td>
</tr>
<tr>
<td>Rabbit</td>
<td>0%</td>
</tr>
</tbody>
</table>

Respondent 9 and 12 scored all characteristics high irrespective of the product evaluated. The other respondents gave a wide range of scores for each of the product characteristics, that is, neither giving consistently high scores nor consistently low scores (Table 4).
Table 4: Range of scores given by each of the core 17 respondents regardless of product

<table>
<thead>
<tr>
<th>Respondent</th>
<th>Product Characteristic</th>
<th>Uncooked appearance Low/High</th>
<th>Uncooked odour Low/High</th>
<th>Cooked mouthfeel Low/High</th>
<th>Taste of flavours Low/High</th>
<th>Taste of meat Low/High</th>
<th>Texture of meat Low/High</th>
<th>Overall product Low/High</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>23/75</td>
<td>36/76</td>
<td>5/96</td>
<td>35/95</td>
<td>35/97</td>
<td>6/89</td>
<td>21/92</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>19/96</td>
<td>30/91</td>
<td>16/99</td>
<td>60/99</td>
<td>40/98</td>
<td>6/98</td>
<td>18/99</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>47/94</td>
<td>47/94</td>
<td>44/91</td>
<td>44/95</td>
<td>24/91</td>
<td>24/87</td>
<td>43/91</td>
</tr>
<tr>
<td>4</td>
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<td>31/92</td>
<td>35/89</td>
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<td>45/85</td>
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</tr>
<tr>
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<td>9/86</td>
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<td>19/96</td>
<td>21/90</td>
<td>43/95</td>
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</tr>
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<td>23/86</td>
<td>34/80</td>
<td>24/83</td>
<td>27/85</td>
<td>18/97</td>
<td>27/83</td>
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</tr>
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<td>31/89</td>
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<td>43/94</td>
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</tr>
<tr>
<td>8</td>
<td></td>
<td>48/81</td>
<td>42/81</td>
<td>47/96</td>
<td>46/95</td>
<td>67/95</td>
<td>29/95</td>
<td>58/95</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>43/83</td>
<td>43/86</td>
<td>45/83</td>
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<td>49/85</td>
<td>35/99</td>
<td>47/99</td>
</tr>
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<td></td>
<td>46/81</td>
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<td>51/91</td>
<td>44/89</td>
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<td>47/85</td>
<td>44/89</td>
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<td>17/97</td>
<td>21/85</td>
</tr>
<tr>
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<td></td>
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<td>13/97</td>
<td>14/94</td>
<td>4/86</td>
<td>5/91</td>
<td>1/79</td>
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<tr>
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<td></td>
<td>44/70</td>
<td>51/74</td>
<td>40/77</td>
<td>30/80</td>
<td>38/78</td>
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<td>20/81</td>
<td>14/81</td>
<td>18/88</td>
<td>3/82</td>
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<tr>
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<td></td>
<td>60/71</td>
<td>52/73</td>
<td>39/85</td>
<td>17/82</td>
<td>23/84</td>
<td>40/79</td>
<td>6/77</td>
</tr>
</tbody>
</table>
Figure 2: Representation of the average percent acceptance of all meats for each characteristic
Figure 3: Representation of the average percent acceptance of Buffalo with Smokey Mountain BBQ Pepper for each characteristic.
Figure 4: Representation of individual percent acceptance of Buffalo with Smokey Mountain BBQ Pepper for each characteristic.
Figure 5: Representation of the average percent acceptance of Camel with Winzersteak for each characteristic.
Figure 6: Representation of individual percent acceptance of Camel with Winzersteak for each characteristic
Figure 7: Representation of the average percent acceptance of Crocodile with Tandoori Masala for each characteristic
Figure 8 Representation of individual percent acceptance of Crocodile with Tandoori Masala for each characteristic.
Figure 9: Representation of the average percent acceptance of Emu with Native Mint and Mustard for each characteristic
Figure 10: Representation of the individual percent acceptance of Emu with Native Mint and Mustard for each characteristic.
Figure 11: Representation of the average percent acceptance of Kangaroo with Madras Curry for each characteristic
Figure 12: Representation of the individual percent acceptance of Kangaroo with Madras Curry for each characteristic
Figure 13: Representation of the average percent acceptance of Ostrich with Smokey Mountain BBQ Pepper for each characteristic
Figure 14: Representation of the individual percent acceptance of Ostrich with Smokey Mountain BBQ Pepper for each characteristic.
Figure 15: Representation of the average percent acceptance of Rabbit with Lemon Myrtle and Chilli for each characteristic.
Figure 16: Representation of the individual percent acceptance of Rabbit with Lemon Myrtle and Chilli for each characteristic
3.3 Microbiological investigation of prototype components prior to combination into product

3.3.1 Dry ingredients

Each of the seasonings exhibited a reasonably low TVC for the type of sample under test, however, of the organisms of concern none were detected except for Bacillus cereus which was found in low numbers in the Lemon myrtle and chilli glaze (Table 5).

3.3.2 Meat

The microbiology of the different meat species prior to combining with the dry ingredients in terms of indicator, pathogenic and spoilage bacteria is given in Table 6. The Australian Meat Standards Committee grades into the following categories based on the TVC and E.coli counts:

- Excellent, TVC <1000 cfu/g, E.coli not detected
- Good, TVC 1000-10000 cfu/g, E.coli 1-10 cfu/g
- Acceptable, TVC 10000-100000 cfu/g, E.coli 10-100 cfu/g
- Marginal, TVC 100000-1000000 cfu/g, E.coli 100-1000 cfu/g.

Buffalo meat produced a high TVC of which the spoilage organism Lactobacillus made up the majority of the count. The other spoilage organisms Pseudomonas and Brochothrix were also present in significant numbers. Faecal indicators, spore forming pathogens and Staphylococcus aureus were below the limit of detection of the test. Salmonella was not detected, though Listeria spp. were present.

Camel meat produced a high TVC of which the spoilage organism Lactobacillus made up the majority of the count. Pseudomonas was also present, though Brochothrix was not detected. E.coli was not detected though coliforms were present in low numbers. Spore forming pathogens and Staphylococcus aureus were below the limit of detection of the test. Salmonella was not detected, though Listeria spp. were present.

Crocodile meat produced a relatively low TVC of which the spoilage organism Pseudomonas made up the majority of the count. Lactobacillus was also present though Brochothrix was not detected. E.coli was not detected though coliforms were present in low numbers. Spore forming pathogens and Staphylococcus aureus were below the limit of detection of the test. Salmonella and Listeria were not detected.

Emu meat produced a reasonable TVC of which the spoilage organism Lactobacillus made up the majority of the count. The other spoilage organisms Pseudomonas and Brochothrix were also present in lower numbers. Faecal indicators, spore forming pathogens and Staphylococcus aureus were below the limit of detection of the test. Salmonella and Listeria were not detected.

Kangaroo meat produced a reasonable TVC of which the spoilage organisms made up the majority of the count. Faecal indicators were present in relatively high numbers. Spore forming pathogens and Staphylococcus aureus were below the limit of detection of the test. Salmonella and Listeria were not detected.

Ostrich meat produced a low TVC of which the spoilage organisms Lactobacillus and Pseudomonas made up the majority of the count. Brochothrix was not detected. Faecal indicators, spore forming
pathogens and *Staphylococcus aureus* were below the limit of detection of the test. *Salmonella* and *Listeria* were not detected.

Rabbit meat produced a reasonable TVC of which the spoilage organism *Brochothrix* made up the majority of the count. The other spoilage organisms *Pseudomonas* and *Lactobacillus* were also present in significant numbers. Faecal indicators, spore forming pathogens and *Staphylococcus aureus* were below the limit of detection of the test. *Salmonella* was not detected, though *Listeria* spp. were present.
Table 5: Microbiology of dry seasonings. Results expressed as cfu/g, those preceded with ‘<’ indicate the result is below the limit of detection of the test.

<table>
<thead>
<tr>
<th>MICROORGANISM</th>
<th>SEASONING</th>
<th>Smokey Mountain BBQ Pepper</th>
<th>Winzersteak</th>
<th>Tandoori Masala</th>
<th>Native Mint and Mustard</th>
<th>Madras Curry</th>
<th>Lemon Myrtle and Chilli</th>
</tr>
</thead>
<tbody>
<tr>
<td>TVC</td>
<td>8.4 x 10^4</td>
<td>4.9 x 10^5</td>
<td>4.3 x 10^5</td>
<td>6.1 x 10^4</td>
<td>1.1 x 10^6</td>
<td>1.6 x 10^4</td>
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</tr>
<tr>
<td>E. coli</td>
<td>&lt;5</td>
<td>&lt;5</td>
<td>&lt;5</td>
<td>&lt;5</td>
<td>&lt;5</td>
<td>&lt;5</td>
<td></td>
</tr>
<tr>
<td>Coliforms</td>
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<td>&lt;5</td>
<td>&lt;5</td>
<td></td>
</tr>
<tr>
<td>Bacillus cereus</td>
<td>&lt;5.0 x 10^1</td>
<td>&lt;5.0 x 10^1</td>
<td>&lt;5.0 x 10^1</td>
<td>&lt;5.0 x 10^1</td>
<td>&lt;5.0 x 10^1</td>
<td>1.0 x 10^2</td>
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</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>&lt;5.0 x 10^1</td>
<td>&lt;5.0 x 10^1</td>
<td>&lt;5.0 x 10^1</td>
<td>&lt;5.0 x 10^1</td>
<td>&lt;5.0 x 10^1</td>
<td>&lt;5.0 x 10^1</td>
<td></td>
</tr>
<tr>
<td>Clostridium perfringens</td>
<td>&lt;5.0 x 10^1</td>
<td>&lt;5.0 x 10^1</td>
<td>&lt;5.0 x 10^1</td>
<td>&lt;5.0 x 10^1</td>
<td>&lt;5.0 x 10^1</td>
<td>&lt;5.0 x 10^1</td>
<td></td>
</tr>
</tbody>
</table>

Table 6: Microbiology of different meat species. Results expressed as cfu/g, except Salmonellae and Listeria, which are expressed as detected (D) or not detected (ND) per 25 g of product. Results preceded with ‘<’ indicate the result is below the limit of detection of the test, and with ‘>’ indicate the result is above the limit of detection of the test.

<table>
<thead>
<tr>
<th>MICROORGANISM</th>
<th>MEAT SPECIES</th>
<th>Buffalo</th>
<th>Camel</th>
<th>Crocodile</th>
<th>Emu</th>
<th>Kangaroo</th>
<th>Ostrich</th>
<th>Rabbit</th>
</tr>
</thead>
<tbody>
<tr>
<td>TVC</td>
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<td>&gt;1.0 x 10^6</td>
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<td>2.4 x 10^4</td>
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<td>1.1 x 10^2</td>
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<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
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</tr>
<tr>
<td>Listeria</td>
<td>D</td>
<td>D</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
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</tr>
<tr>
<td>Bacillus cereus</td>
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<td>&lt;5.0 x 10^1</td>
<td>&lt;5.0 x 10^1</td>
<td>&lt;5.0 x 10^1</td>
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<td>&lt;5.0 x 10^4</td>
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<td>&lt;5.0 x 10^1</td>
<td>&lt;5.0 x 10^1</td>
<td>&lt;5.0 x 10^1</td>
<td>&lt;5.0 x 10^4</td>
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</tr>
<tr>
<td>Clostridium perfringens</td>
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<td>&lt;5.0 x 10^1</td>
<td>&lt;5.0 x 10^1</td>
<td>&lt;5.0 x 10^1</td>
<td>&lt;5.0 x 10^1</td>
<td>&lt;5.0 x 10^4</td>
<td>&lt;1.8</td>
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<td>3.5 x 10^4</td>
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<tr>
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<td></td>
</tr>
<tr>
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<td>3.9 x 10^2</td>
<td>3.1 x 10^4</td>
<td>5.4 x 10^4</td>
<td>1.1 x 10^2</td>
<td>1.5 x 10^4</td>
<td></td>
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</table>
3.4 Shelf life trial

3.4.1 Vacuum packaging

_Clostridium perfringens_ and _Salmonella_ were not detected on any of the products tested from the day following packaging nor after 4 weeks of storage. _Bacillus cereus_ was detected, in low numbers, on the camel, crocodile and kangaroo products. _Listeria_ spp. was detected on the buffalo product on the day following packaging. _Staphylococcus aureus_ was detected, in low numbers on the kangaroo product after 4 weeks storage and on the rabbit, in low numbers on the day following packaging.

**Buffalo with Smokey Mountain Pepper BBQ**
The TVC for this product was high from the day following packaging, largely comprised of spoilage _Lactobacilli_, which continued for 3 weeks of storage at which stage the product was spoiled. _Brochothrix_ did not contribute to the spoilage of this product as its levels remained below log 4 for the duration of the trial. _Pseudomonas_ decreased in number during the trial as expected when oxygen has been excluded from the atmosphere. _E.coli_ was not detected on this product throughout the trial and coliforms were present in low numbers (Figure 17). This product would have a shelf life of 2 weeks at 4°C.

**Camel with Winzersteak**
The TVC for this product was high from the day following packaging, largely comprised of spoilage _Lactobacilli_, which continued for 3 weeks of storage at which stage the product was spoiled. _Brochothrix_ did not contribute to the spoilage of this product as its was not detected on this product, as was the case for _Pseudomonas_. _E.coli_ was not detected on this product throughout the trial and coliforms when present were in low numbers (figure 18). This product would have a shelf life of 2 weeks at 4°C.

**Crocodile with Tandoori**
The TVC for this product increased throughout the trial and was largely comprised of spoilage _Lactobacilli_. _Brochothrix_ did not contribute to the spoilage of this product and remained below log 4 for the duration of the trial. _Pseudomonas_ increased in number during the trial but remained below spoilage levels. _E.coli_ was not detected on this product throughout the trial and coliforms were present in low numbers (Figure 19). This product would have a shelf life of 2 weeks at 4°C.

**Emu with Native Mint and Mustard**
The TVC for this product remained low until the third week of storage. _Lactobacillus_ was the dominant spoilage organism on this product, the other two spoilers remained at low levels throughout the trial. _E.coli_ and coliforms were present in low numbers throughout the storage period (Figure 20). This product would have a shelf life of 2 weeks at 4°C.

**Kangaroo with Madras Curry**
The TVC for this product increased throughout the trial and was largely comprised of spoilage _Lactobacilli_. _Brochothrix_ and _Pseudomonas_ increased in number during the trial though remained below spoilage levels. _E.coli_ and coliforms were present in low numbers throughout the storage period (Figure 21). This product would have a shelf life of at least 3 weeks at 4°C.

**Ostrich with Smokey Mountain Pepper BBQ**
The TVC for this product remained relatively low until the third week of storage. This count was largely comprised of spoilage _Lactobacilli_. _Brochothrix_ was not detected on this product. _Pseudomonas_ when present was in low numbers. _E.coli_ was not detected on this product and coliforms when present were in low numbers (Figure 22). This product would have a shelf life of 2 weeks at 4°C.

**Rabbit with Lemon Myrtle and Chilli**
The TVC for this product increased throughout the trial. All three spoilage organisms were present in large numbers, with neither organism dominating the flora and contributing to an overall spoilage effect. _E.coli_ was not detected on this product and coliforms when present were in low numbers (Figure 23). This product would have a shelf life of at least 3 weeks at 4°C.
Figure 17: Microbiological shelf life of vacuum packaged Buffalo with Smokey Mountain BBQ Pepper
Figure 18: Microbiological shelf life of vacuum packaged Camel with Winzersteak
Figure 19: Microbiological shelf life of vacuum packaged Crocodile with Tandoori Masala
Figure 20: Microbiological shelf life of vacuum packaged Emu with Native Mint and Mustard
Figure 21: Microbiological shelf life of vacuum packaged Kangaroo with Madras Curry
Figure 22: Microbiological shelf life of vacuum packaged Ostrich with Smokey Mountain BBQ Pepper
Figure 23: Microbiological shelf life of vacuum packaged Rabbit with Lemon Myrtle and Chilli
3.4.2 Gas flushed packaging

_Clostridium perfringens_ and _Salmonella_ were not detected on any of the products tested from the day following packaging nor after 4 weeks of storage. _Bacillus cereus_ was detected, in low numbers, on the camel, crocodile and kangaroo products. _Listeria_ spp. was detected on the buffalo product after 4 weeks storage and on the ostrich product. _Staphylococcus aureus_ was detected, in low numbers on the rabbit on the day following packaging.

__Buffalo with Smokey Mountain BBQ Pepper__
The TVC for this product remained high from the day following packaging. _Lactobacillus_ was the dominant spoilage organism throughout the storage period. _Brochothrix_ did not contribute to the spoilage of this product. _Pseudomonas_ remained below spoilage levels throughout the trial. _E.coli_ was not detected on this product throughout the trial and coliforms when present were in low numbers (Figure 24). This product would have a shelf life of 1 week at 4°C.

__Camel with Winzersteak__
The TVC for this product increased as did the count for _Lactobacillus_ until it reached spoilage levels by week 3 of the trial. _Brochothrix_ was not detected on this product. _Pseudomonas_ was detected in low numbers on week 1 only. _E.coli_ was not detected on this product throughout the trial and coliforms when present were in low numbers (Figure 25). This product would have a shelf life of 2 weeks at 4°C.

__Crocodile with Tandoori Masala__
The TVC for this product remained static until week 3 of the trial. _Lactobacillus_ was the dominant spoilage organism for this product. _Brochothrix_ was not detected on this product. _Pseudomonas_ was present in low numbers during the trial. _E.coli_ was not detected on this product throughout the trial and coliforms were present in low numbers (Figure 26). This product would have a shelf life of 2 weeks at 4°C.

__Emu with Native Mint and Mustard__
The TVC for this product remained low until the third week of storage. _Lactobacillus_ was the dominant spoilage organism on this product, the other two spoilers remained at low levels throughout the trial. _E.coli_ and coliforms were present in low numbers throughout the storage period (Figure 27). This product would have a shelf life of 1 week at 4°C.

__Kangaroo and Madras Curry__
The TVC for this product remained high throughout the trial. _Lactobacillus_ dominated the flora and was approaching spoilage levels by the third week of the trial. _Brochothrix_ and _Pseudomonas_ numbers static and below spoilage levels during the trial. _E.coli_ and coliforms were present in low numbers throughout the storage period (Figure 28). This product would have a shelf life of at least 3 weeks at 4°C.

__Ostrich with Smokey Mountain BBQ Pepper__
The TVC for this product remained relatively low until the third week of storage. This count was largely comprised of spoilage Lactobacilli. _Brochothrix_ and _Pseudomonas_ when detected was in low numbers. _E.coli_ and coliforms when present were in low numbers (Figure 29). This product would have a shelf life of 2 weeks at 4°C.

__Rabbit with Lemon Myrtle and Chilli__
The TVC for this product increased throughout the trial as did the _Lactobacillus_ count which was the dominant spoilage organism. _Brochothrix_ and _Pseudomonas_ were present in reasonable numbers throughout the trial. _E.coli_ was not detected on this product and coliforms when present were in low numbers (Figure 30). This product would have a shelf life of 2 weeks at 4°C.
Figure 24: Microbiological shelf life of CO$_2$ packaged Buffalo with Smokey Mountain BBQ Pepper
Figure 25: Microbiological shelf life of CO₂ packaged Camel with Winzersteak
Figure 26: Microbiological shelf life of CO₂ packaged Crocodile with Tandoori Masala
Figure 27: Microbiological shelf life of CO₂ packaged Emu with Native Mint and Mustard
Figure 28: Microbiological shelf life of CO₂ packaged Kangaroo with Madras Curry
Figure 29: Microbiological shelf life of CO₂ packaged Ostrich with Smokey Mountain BBQ Pepper
Figure 30: Microbiological shelf life of CO₂ packaged Rabbit with Lemon Myrtle and Chilli
3.5 Investigation of potential markets

3.5.1 Export

In general, the concept of value added meat products brought much interest from Singaporean contacts, despite the fact that marinated meat products cannot be directly imported into that country. There are opportunities for industry to explore the Singapore food service sector as a potential marketplace for the products developed in this project. In particular, there is the opportunity to introduce these products into Singapore by way of an official launch, as has been done for Australian pork. Some issues regarding the importation of these products into this country would require attention by industry in consultation with AQIS.

Concerns were raised regarding the importation of buffalo and rabbit meat into Singapore, with the possibility that kangaroo, emu, ostrich and crocodile products would be best suited to this market. Malaysia was suggested as a possible market place for some of the value added products as it is a much larger market than Singapore, providing it is Halal processed. The rabbit product might be readily accepted into this market, as rabbit is farmed in Malaysia.

It was suggested that a range of flavours for each of the different meats would be more acceptable and would not limit the uptake of these products. Some feedback was that the addition of the flavours to the meats masked the taste of the meat and their company would usually only import wholesale rather than retail meat.

3.5.2 Domestic

Feedback from the domestic market for these products was scant. Conflicting feedback about the use of so-called ‘game’ meat in the food service sector was received therefore this sector would have to be approached on a company to company basis as a commercial venture. These products are currently under considered by the retail sector with little feedback returned other than that these products were interesting.

The products have not been as well received on the domestic market as expected, despite the outcomes of the consumer evaluation of the prototypes. Further marketing of these products, perhaps presented as a range of products for each meat species, would go some way towards the uptake of these products in the food service sector and retail sectors. In-store promotions of these products may give retailers more confidence in consumer acceptance.

There is the opportunity to showcase these products to the domestic market via an industry workshop that is proposed in a research proposal, NAP 03-08, currently under consideration by RIRDC.
4. Discussion

4.1 Product prototypes
The prototypes developed and evaluated, both by an untrained consumer taste panel and by microbiological analysis, in this project are

- Buffalo leg cuts coated with Smokey Mountain BBQ Pepper glaze
- Camel rump coated with Winzerstack encapsulated coating
- Crocodile boneless body meat coated with Tandoori Masala seasoning
- Emu steak/small fillets coated with Native Mint and Mustard
- Kangaroo topside or rump coated with Madras Curry encapsulated coating
- Ostrich steak coated with Smokey Mountain BBQ Pepper glaze
- Rabbit thigh fillets coated with Lemon Myrtle and Chilli glaze.

The opportunity to expand this range to give a selection of flavours for each of the meat species exists, except for ostrich, as at least one other flavour/meat combination is available for industry to assess. These, as yet unexplored, products are

- Buffalo coated with Bush tomato salsa glaze
- Buffalo coated with Buffalo encapsulated coating
- Camel coated with Native mint and mustard coating
- Camel with Native pepper leaf seasoning
- Crocodile coated with Native mint and mango glaze
- Crocodile coated with Wild lime, honey ginger and chilli glaze
- Crocodile coated with Lemon myrtle and chilli glaze
- Emu coated with Wild lime, honey ginger and chilli glaze
- Emu with Cajun seasoning
- Kangaroo coated with Wattleseed and garlic glaze
- Kangaroo with Native pepper leaf seasoning
- Rabbit coated with Bush tomato salsa glaze.

4.2 Consumer assessment of prototypes
The prototypes selected for evaluation in this project were assessed by an untrained consumer taste panel and can be ranked by their overall acceptance by the panellists in the following order:

1. Crocodile with Tandoori Masala
2. Kangaroo with Madras Curry
3. Rabbit with Lemon Myrtle and Chilli
4. Ostrich with Smokey Mountain BBQ Pepper
5. Buffalo with Smokey Mountain BBQ Pepper
6. Emu with Native Mint and Mustard
7. Camel with Winzerstack.

Most panellists had not tasted the meat species prior to the assessment. Some had tasted a selection of the meats prior to the assessment but generally on a “once off” basis. Despite their lack of eating experience with the meats presented, all products were well received. A small percentage of panellists rated the products as unsatisfactory and as such would not purchase them if they were available from the retail shelf. Otherwise, the majority of panellists graded the products as either average and would buy on some occasions, above average and would probably buy the product or premium and would definitely buy the product.
4.3 Microbiology of prototypes

The dry ingredients and the different meat species were assessed prior to combing into the prototypes. This gave some insight as to how the prototypes would perform in the modified atmospheres of vacuum and gas flushed packaging. Although the TVC of the dry ingredients was high, the ingredients did not harbour spore forming pathogenic bacteria. The raw meats exhibited a high TVC that was made up predominantly of at least one spoilage organism that limited the potential shelf life of these meats.

Once combined the product prototypes, in general, did not harbour pathogenic bacteria. *Salmonella* was not detected on the products, nor was *Clostridium perfringens*. On the occasions that *Staphylococcus aureus* and *Bacillus cereus* were detected they were below the level of concern. *Listeria* spp. was detected on the buffalo and ostrich prototypes, and if this was the case in a commercial setting, steps would need to be taken to control this organism.

The types of products developed in this project have limited shelf life potential, therefore it is not recommended that they be stored aerobically. Under aerobic conditions at temperatures at or above 4°C such products will usually spoil within days of preparation. The shelf life of such products can be extended by packaging under vacuum or replacing the atmosphere with 100% CO₂.

The buffalo prototype did not perform well under either atmospheric conditions and would be considered spoiled by the microbiological definition; any spoilage or being present at 10⁷ cfu/g, within the first week of storage.

The camel prototype performed better under gas than under vacuum, though by definition had reached spoilage by week 3 of storage under both packaging systems.

The crocodile prototype had spoiled by week 3 of storage in both packaging systems.

The emu product performed best in vacuum packaging where it had spoiled by 3 weeks at 4°C, while it reached these same levels by week 2 of storage under gas.

The kangaroo product performed well under both packaging systems and although approaching spoilage by week 3 of storage, this product had the potential for another week storage at 4°C. The ostrich product was spoiled at 3 weeks of storage at 4°C.

The rabbit prototype had not spoiled by storage for 3 weeks under vacuum and so had the potential for a further week of storage under these conditions. The product did not perform as well under CO₂ as it had spoiled by third week of storage.

4.4 Potential markets

There are opportunities for industry to explore the Singapore food service sector as a potential marketplace for the products developed in this project. Issues of AVA import regulations would have to be investigated by industry in consultation with AQIS as many so called game meats, if allowed into Singapore, must not be chilled and therefore can only enter the country frozen. Rabbit meat and meat products are prohibited from importation into Singapore, and heresay suggests buffalo is not permitted in Singapore. In general, based on the microbiological analysis of the various raw meats, those species which can be imported into Singapore would meet the AVA microbiological specifications. Despite these obstacles, there is the opportunity for industry to introduce these products into Singapore by way of an official launch, as has been done for Australian pork.

These products have not been as well received on the domestic market as expected, despite the outcomes of the consumer evaluation of the prototypes. Further marketing of these products is required, perhaps presented as a range of products for each meat species, to the food service sector and retail sectors. In-store promotions of these products may give retailers more confidence in consumer acceptance of these products.
5. References

AOAC Official Method 991.14 Coliform and *Escherichia coli* Counts in Foods. Dry Rehydratable Film (Petrifilm *E.coli* Count Plate and Petrifilm Coliform Count Plate) Methods, 1991.

Australian Standard AS 1766.1.3 - 1991, Food Microbiology, Method 1.3: General Procedures and techniques – Colony count – Pour plate method

Australian Standard AS 1766.2.4 - 1994, Food Microbiology, Method 2.4: Examination of specific organisms – Coagulase – positive Staphylococci

Australian Standard AS 1766.2.5 - 1991, Food Microbiology, Method 2.5: Examination of specific organisms – Salmonellae

Australian Standard AS 1766.2.6 - 1991, Food Microbiology, Method 2.6: Examination of specific organisms – *Bacillus cereus*

Australian Standard AS 1766.2.8 - 1991, Food Microbiology, Method 2.8: Examination of specific organisms – *Clostridium perfringens*


Australian Standard AS 1766.3.1 - 1991, Food Microbiology, Method 3.1: Examination of specific products – Meat and meat products other than poultry

Australian Standard AS 1766.3.2 - 1979, Methods for the microbiological examination of food, Part 3 Examination of specific products, Section 2 Poultry

Australian Standard AS 1766.4 - 1987, Methods for the microbiological examination of food, Part 4 Sampling of foods


MIRINZ, Lactic acid bacteria in Microbiological methods for the meat industry, 2nd edition.

6. Appendices
6.1 Appendix 1: Risk assessment of the taste testing of value added meats

Introduction
As part of the development of new food products, in this case value added meats, it is essential to get information from taste panel assessment. Such panels can be comprised of either professional or amateur panellists, who are either trained or untrained.

The taste panel trial is part of a RIRDC/NRE funded project that is developing value-added products for meat derived from:
- Emu
- Ostrich
- Camel
- Buffalo
- Crocodile
- Rabbit
- Kangaroo

The trial will take place at VIAS, Attwood. The taste panellists have been recruited by their expression of interest in participating in the trial and are all untrained.

Each of the meats has been value added by the addition of spice/flavour coatings supplied by Hela Schwarz:
- Emu with Native Mint and Mustard coating
- Ostrich coated with Smokey Mountain Pepper BBQ glaze
- Camel coated with Winzersteak ‘C’
- Buffalo coated with Smokey Mountain Pepper BBQ glaze
- Crocodile coated with Tandoori Masala
- Rabbit coated with Lemon Myrtle and Chilli glaze
- Kangaroo coated with Madras curry

Meats have been supplied by a Victorian Meat Authority (VMA) registered game meat wholesaler, who sources the meat from either domestic (VMA) or export (AQIS) registered facilities. Spices have been supplied and applied onto meats by Hela Schwarz, an ingredients company.

Potential Risks

Meat
Meat from certain species (such as pig) can cause allergic reactions.

Monosodium glutamate (MSG)
The Food and Drug Administration (FDA) states there is evidence that mild reactions to MSG may occur in a small portion of the population.

According to the American College of Allergy, Asthma and Immunology, MSG is not an allergen. Adverse reactions are referred to as a sensitivity or intolerance. There are numerous symptoms that are sometimes caused or exacerbated by ingestion of MSG. They can affect the heart, respiratory tract, muscles, eyes, skin, gastrointestinal tract, circulation, and neurological functions.

The severity and specific nature of a reaction usually depends on the amount of MSG ingested and whether it was eaten on an empty stomach or with other food.
Alcohol can affect the intensity or severity of a reaction, as well as exercise just prior to, or immediately following ingesting MSG. Different times of the menstrual cycle play a role in some women's varied reactions.

The onset of adverse reactions vary with each individual. Some suffer immediately after ingestion, while others may suffer 48 hours later. Reactions are normally dose related. Large amounts of MSG can cause problems whereas small amounts usually don't. A reaction is most likely if the MSG is eaten in a large quantity or in a liquid, such as a clear soup.

Mustard
Morales et al (1995) report three cases of systemic reaction to ingestion of mustard sauce, however, very few cases of hypersensitivity due to ingestion of mustard have been described in the literature. This study presented three cases of anaphylactic reactions to ingestion of a small amount of mustard sauce.

Spices
Clinical symptoms from spices are infrequent but occasionally severe and a minority of spice allergens may give clinical symptoms (Niinimäki et al, 1995). This study examined coriander, caraway, paprika, cayenne, mustard, and white pepper challenges in 49 patients. These spice extracts, except white pepper, elicited positive skin test reactions in half those with other reported allergies, 75% of the patients with positive skin tests to these native spices were positive to birch pollen and one-half to a vegetable. Mild clinical symptoms were reported by one-third of the patients.

Salmonella
Salmonella is commonly found on meats derived from camel, buffalo, kangaroo, rabbit and crocodile, it has also been reported from paprika and pepper. Ingestion of sufficient numbers of this organism (approximately $10^3$ cells) can cause gastroenteritis.

Staphylococcus aureus
This organism may be present on meat and can contaminate foods by operator handling (up to 50% of the human population harbours Staphylococcus aureus in the mucous membranes and/or skin). Staphylococcus aureus is tolerant to high salt content in foods (10-20% NaCl). Enterotoxin production, sufficient to cause food poisoning, can occur if the organism is allowed to grow to numbers $10^6$ cells per gram in the contaminated food.

Listeria monocytogenes
Listeria monocytogenes is ubiquitous and as such can be found on a range of food products. It may be present on meat, though this does not pose a large problem as the cooking process will inactivate the vegetative cells.

Clostridium perfringens
This organism is commonly found on meat and in spices. Enterotoxin production in the intestine can occur following consumption of food contaminated with more than $10^5$ cells per gram, that has not been kept either below 15°C or above 55°C.

Bacillus cereus
This organism contaminates between 10-53% of spices. If allowed to grow in food to numbers in excess of $10^6$ per gram can produce sufficient toxin (either emetic or diaorrhetic) to cause food poisoning.
Risk controls

Meat
Taste panellists will be surveyed to ensure they have no known allergies or reactions to any of the meats under test in the taste panel.

Monosodium glutamate (MSG)
Taste panellists will be surveyed to ensure they have no known allergies or reactions to this compound.

Mustard
Taste panellists will be surveyed to ensure they have no known allergies or reactions to this compound.

Spices
Taste panellists will be surveyed to ensure they have no known allergies or reactions to any spices.

Salmonella
Meat is kept below 7°C (as required by Australia Standard AS 4696:2002) to prevent growth of this organism and cooking at 63°C to destroy it.

Staphylococcus aureus
Adequate personal hygiene of food handlers, handwashing and wearing gloves, limits the amount of contamination of food from this source. Meat will be cooked above 100°C to control the organism.

Listeria monocytogenes
Storing food likely to harbour Listeria monocytogenes below 5°C will limit the growth of this organism, and cooking food adequately will also control growth.

Clostridium perfringens
Maintain meat temperatures between either below 5°C prior to cooking or above 60°C after cooking.

Bacillus cereus
Maintain meat temperatures between either below 5°C prior to cooking or above 60°C after cooking. Cooking meat in excess of 100°C will ensure spores are destroyed.

References
6.2 Appendix 2: Consumer product evaluation form

Panellist Number: _____________________
Date: _____________________

- Please cleanse your palate with the water and bread provided before tasting each sample
- We are interested in your opinion, so please do not talk to anyone else in the room about the samples given to you.
- Please eat at least half of each sample.

Product: ______

DO NOT EAT THE MEAT YET!

Please examine and taste the samples and evaluate the following characteristics. Mark each line scale using a vertical stroke | at the appropriate point.

Look at the sample — and mark on the line scale below what you think of its overall appearance

1. How much do you like the uncooked appearance?
Dislike Extremely | Like Extremely

2. Smell the sample. How much do you like the odour?
Dislike Extremely | Like Extremely

Now eat some of the meat and answer the questions below.

3. What do you think about the mouthfeel of the meat?
Extremely dry and coarse | Extremely juicy and fine

4. What do you think about the taste of the flavours used with the cooked meat?
Dislike Extremely | Like Extremely

5. What do you think about the flavour of the meat?
Dislike Extremely | Like Extremely

6. What do you think about the texture of the meat?
Extremely tough | Extremely tender

7. Overall, how much do you like this sample?
Dislike Extremely | Like Extremely
Place a tick √ in one box based on your opinion of the overall quality of the meat.

☐ Unsatisfactory

- This is a terrible piece of meat.
- The flavours used were horrible.
- I didn’t enjoy it at all.
- I definitely would not buy it.

☐ Below Average

- This wasn’t a nice piece of meat
- The flavours used were not good
- I didn’t really enjoy it
- I probably would not buy it

☐ Average

- This piece of meat was OK
- The flavours used were okay
- Overall I enjoyed it, but it could have been better in quality
- I may buy this on some occasions

☐ Above Average

- This piece of meat was better than usual
- The flavours used were good.
- I enjoyed it a lot, but it could have been a bit better in quality
- I probably would buy this on most occasions

☐ Premium

- This was top quality meat
- I really enjoyed it. The flavours used were great.
- I would definitely buy this

Comments:

_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________