RURAL INDUSTRIES RESEARCH
& DEVELOPMENT CORPORATION

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

New value added products

A report for the Rural Industries Research and Development Corporation

by Joanne Bobbitt

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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
Rural Industries Research and Development Corporation

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- Ken Lang (Yarra Valley Game Meats)
- Mrs Toh Guek Hong (Austrade, Singapore)
- Consumer panel participants

Abbreviations

AS	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% CO_2. 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 CO_2.

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.

Species	Flavour	Tasted dry	Tasted combined
Emu	Native mint and mustard coating		
	Wild lime, honey ginger and chilli glaze		
	Cajun seasoning	✔	✔
Camel	Native mint and mustard coating		
	Winzersteak encapsulated coating	✔	✔
	Native pepper leaf seasoning		
Buffalo	Bush tomato salsa glaze	✔	✔
	Smokey mountain pepper glaze	✔	
	Buffalo encapsulated coating		✔
Rabbit	Bush tomato salsa glaze	✔	
	Lemon myrtle and chilli glaze	✔	✔
Kangaroo	Wattleseed and garlic glaze		
	Native pepper leaf seasoning		
	Madras curry encapsulated coating	✔	✔
Crocodile	Native mint and mango glaze	✔	✔
	Tandoori seasoning	✔	✔
	Wild lime, honey ginger and chilli glaze		
	Lemon myrtle and chilli glaze	✔	
Ostrich	Smokey mountain pepper glaze	✔	✔

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 2: New and emerging meat value added prototypes

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

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 10^7cfu/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)
- *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).

2.5.2 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 CO_2 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 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)
- *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
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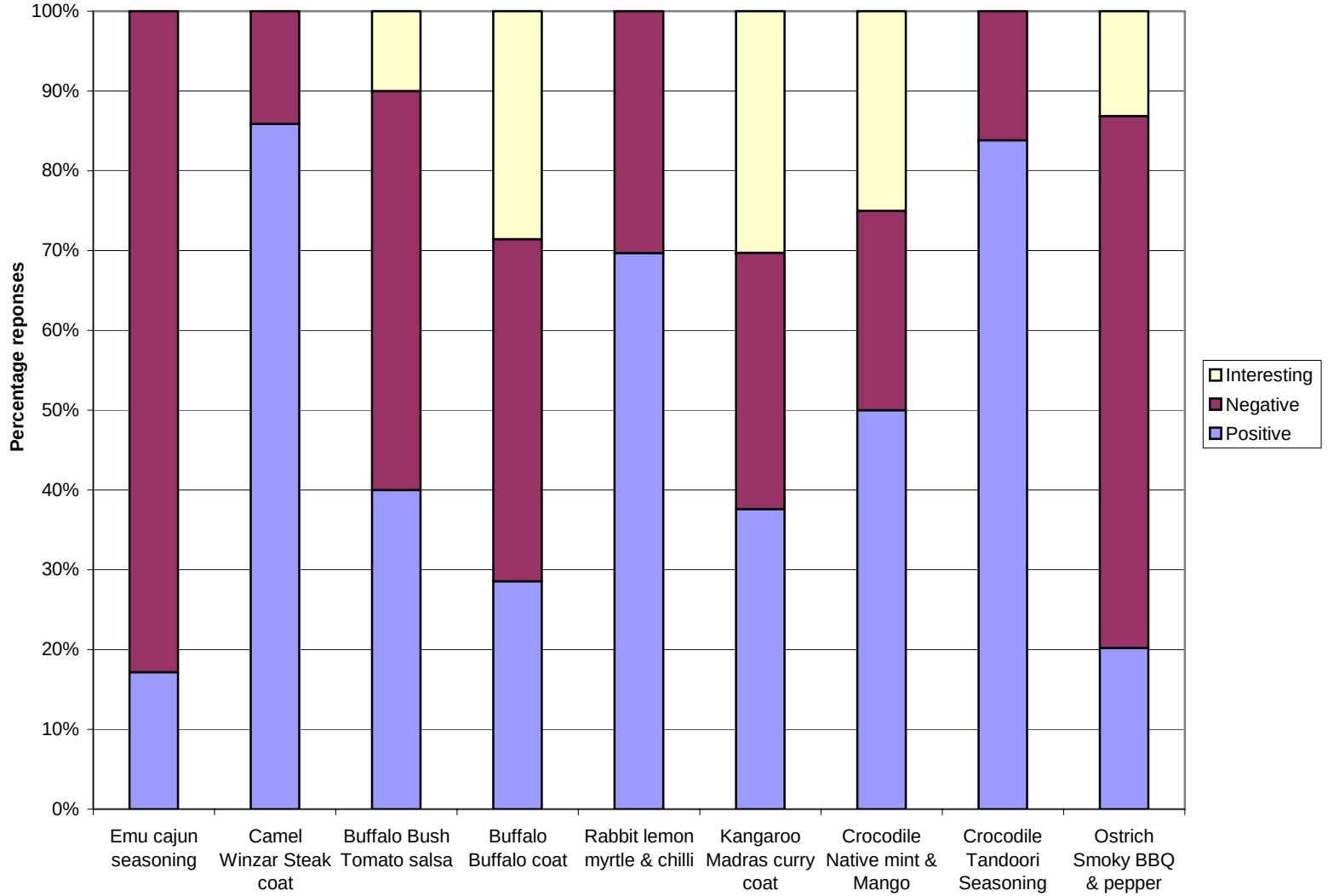


Figure 1: Project team member responses to proposed prototypes

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.

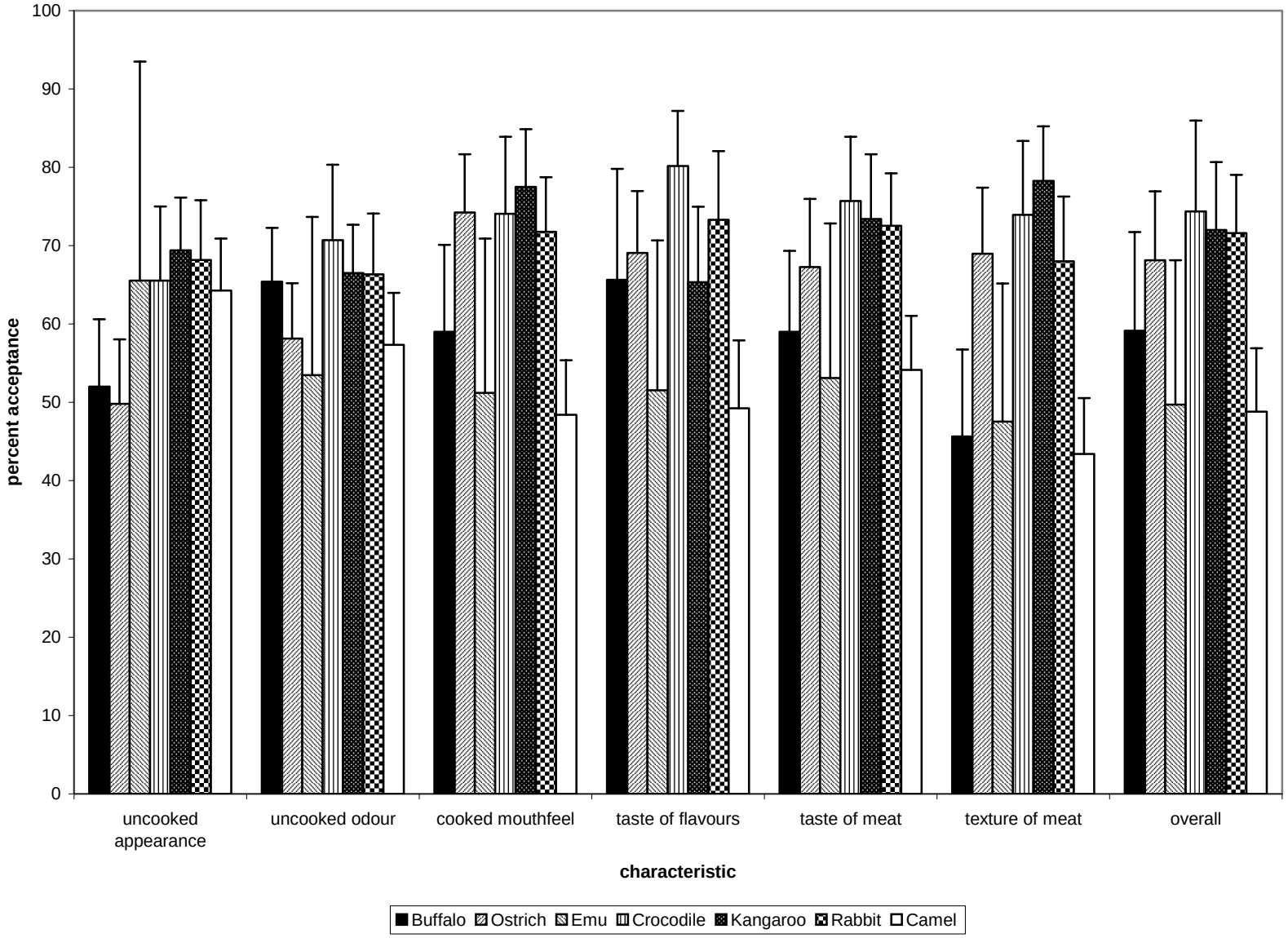
Meat species	**Overall consumer opinion of product**				
	Unsatisfactory	Below average	Average	Above average	Premium
Buffalo	6%	17%	35%	24%	19%
Camel	3%	27%	47%	23%	0%
Crocodile	0%	0%	12%	23%	65%
Emu	17%	17%	35%	31%	0%
Kangaroo	4%	7%	11%	39%	39%
Ostrich	5%	5%	43%	47%	0%
Rabbit	0%	11%	12%	35%	42%

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

Respondent	Product Characteristic						
	Uncooked appearance Low/High	**Uncooked odour** Low/High	**Cooked mouthfeel** Low/High	**Taste of flavours** Low/High	**Taste of meat** Low/High	**Texture of meat** Low/High	**Overall product** Low/High
1	23/75	36/76	5/96	35/95	35/97	6/89	21/92
2	19/96	30/91	16/99	60/99	40/98	6/98	18/99
3	47/94	47/94	44/91	44/95	24/91	24/87	43/91
4	31/92	35/89	23/90	31/90	45/85	22/85	35/85
5	48/90	9/86	23/96	19/96	21/90	43/95	16/95
6	23/86	34/80	24/83	27/85	18/97	27/83	39/74
7	23/90	31/89	40/86	49/90	51/94	43/94	64/92
8	48/81	42/81	47/96	46/95	67/95	29/95	58/95
9	43/83	43/86	45/83	53/90	49/85	35/99	47/99
10	46/81	65/82	16/84	51/91	44/89	19/88	36/84
11	30/72	47/85	44/89	8/96	42/96	17/97	21/85
12	66/96	76/97	53/99	53/98	53/99	53/99	53/99
13	23/96	5/97	13/97	14/94	14/91	4/86	5/91
14	44/70	51/74	40/77	30/80	38/78	36/81	1/79
15	48/74	48/94	48/99	6/99	48/99	20/99	98/33
16	50/65	11/68	40/85	20/81	14/81	18/88	3/82
17	60/71	52/73	39/85	17/82	23/84	40/79	6/77

Figure 2: Representation of the average percent acceptance of all meats for each characteristic



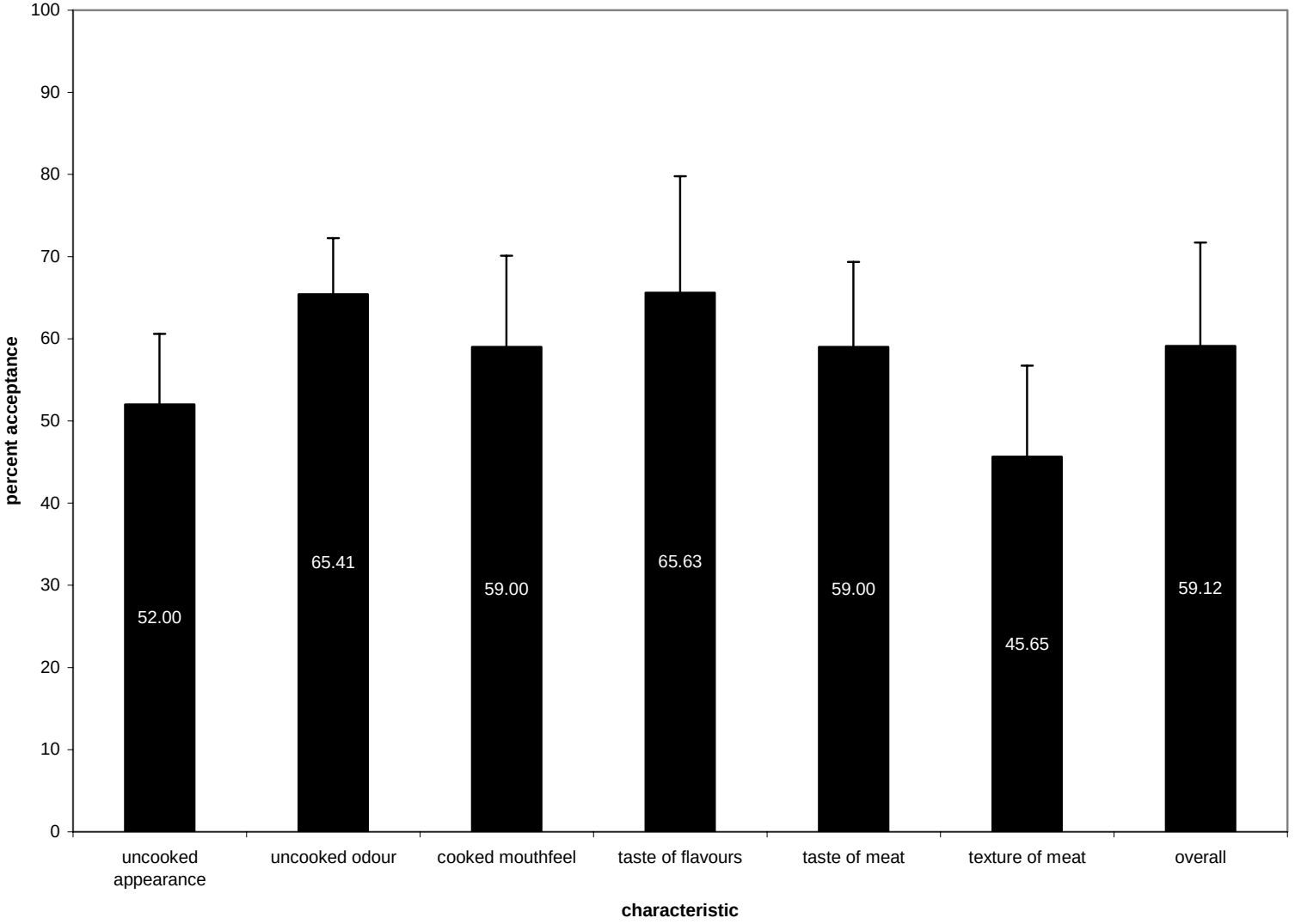
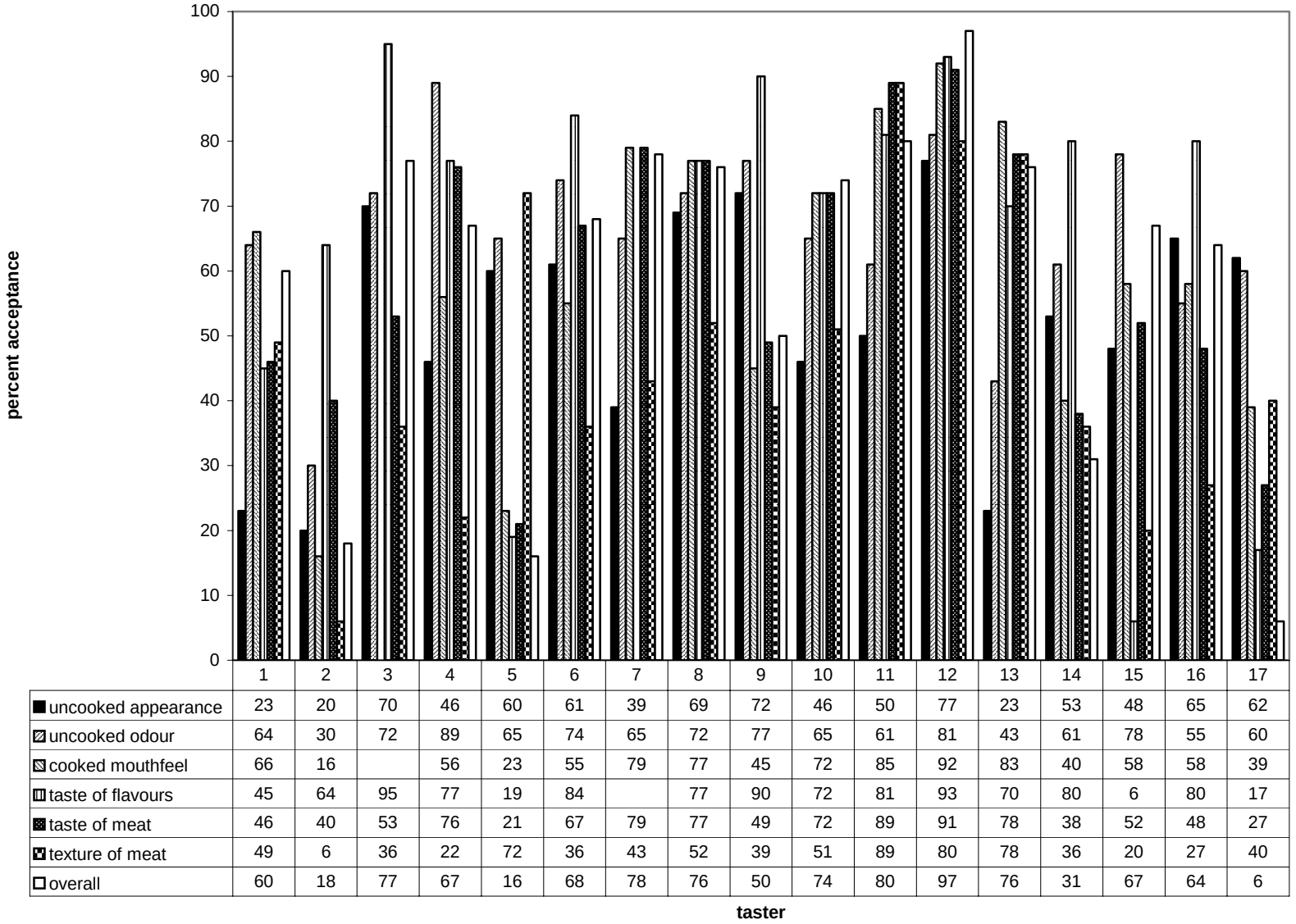


Figure 3: Representation of the average percent acceptance of Buffalo with Smokey Mountain BBQ Pepper for each characteristic



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
uncooked appearance	23	20	70	46	60	61	39	69	72	46	50	77	23	53	48	65	62
uncooked odour	64	30	72	89	65	74	65	72	77	65	61	81	43	61	78	55	60
cooked mouthfeel	66	16		56	23	55	79	77	45	72	85	92	83	40	58	58	39
taste of flavours	45	64	95	77	19	84		77	90	72	81	93	70	80	6	80	17
taste of meat	46	40	53	76	21	67	79	77	49	72	89	91	78	38	52	48	27
texture of meat	49	6	36	22	72	36	43	52	39	51	89	80	78	36	20	27	40
overall	60	18	77	67	16	68	78	76	50	74	80	97	76	31	67	64	6

Figure 4: Representation of individual percent acceptance of Buffalo with Smokey Mountain BBQ Pepper for each characteristic

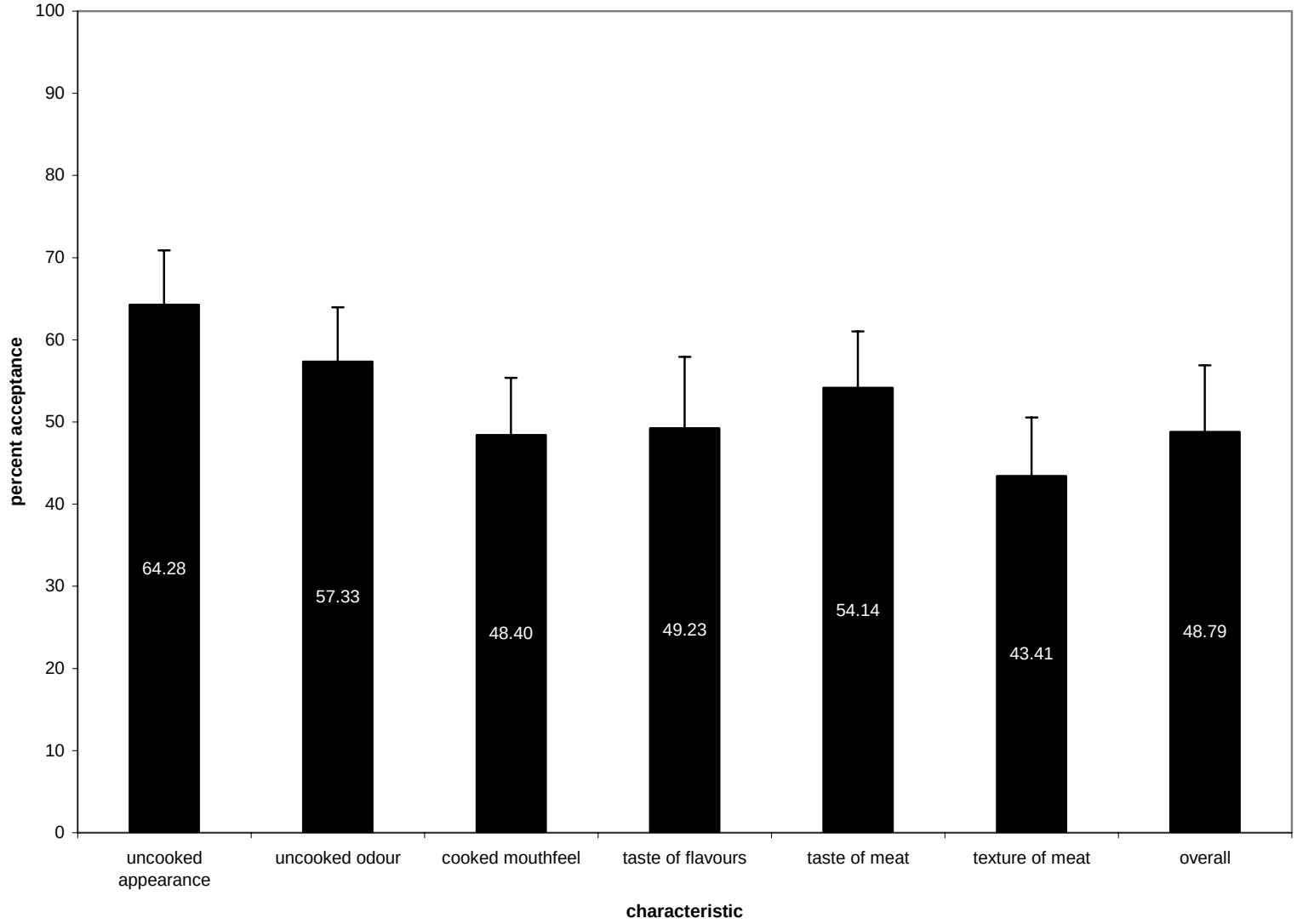
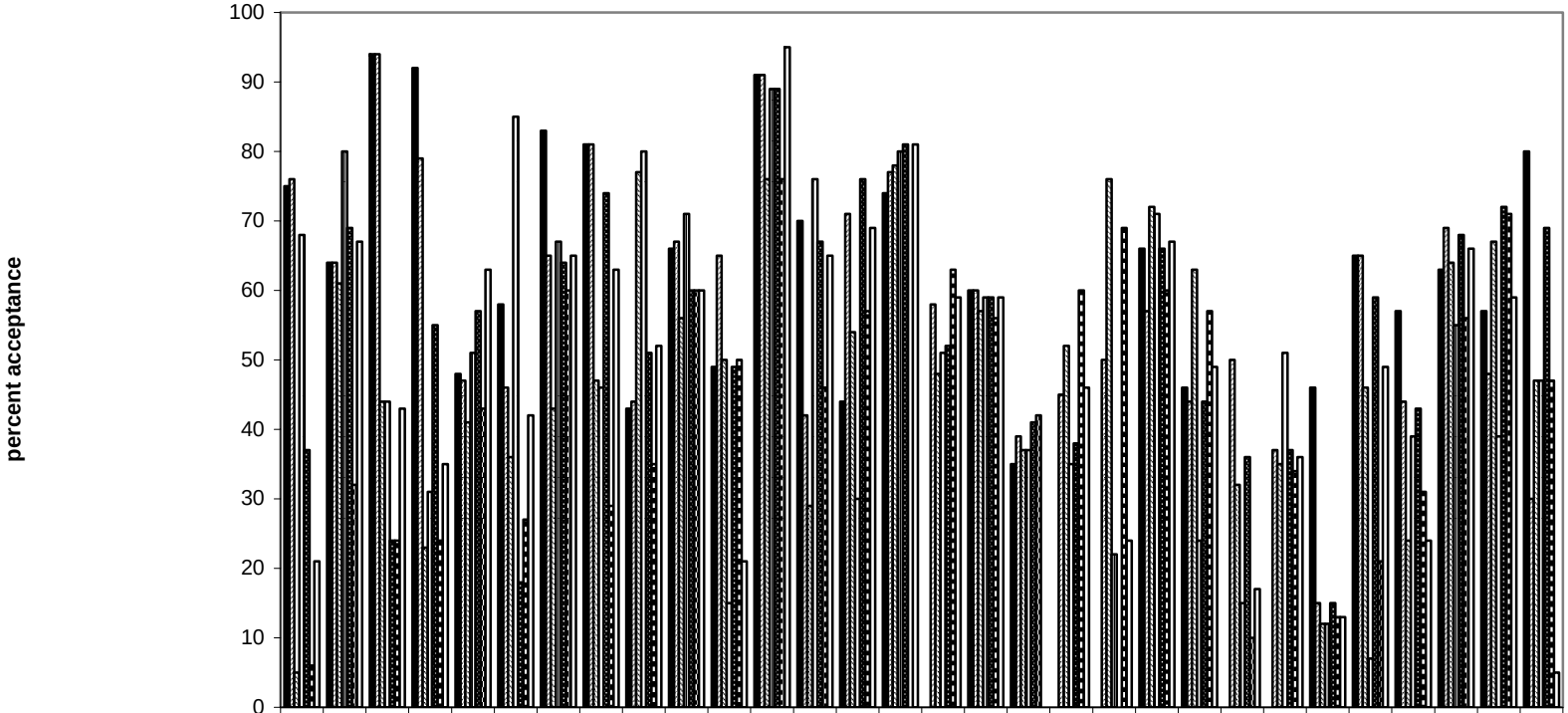


Figure 5: Representation of the average percent acceptance of Camel with Winzersteak for each characteristic



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	*	*	*	*	*	*	*	*	*	*	*	*	*
uncooked appearance	75	64	94	92	48	58	83	81	43	66	49	91	70	44	74		60	35			66	46			46	65	57	63	57	80
uncooked odour	76	64	94	79	47	46	65	81	44	67	65	91	42	71	77	58	60	39	45	50	57	44	50	37	15	65	44	69	48	30
cooked mouthfeel	5	61	44	23	41	36	43	47	77	56	50	76	29	54	78	48	57	37	52	76	72	63	32	35	12	46	24	64	67	47
taste of flavours	68	80	44	31	51	85	67	46	80	71	15	89	76	30	80	51	59	37	35	22	71	24	15	51	12	7	39	55	39	47
taste of meat	37	69	24	55	57	18	64	74	51	60	49	89	67	76	81	52	59	41	38		66	44	36	37	15	59	43	68	72	69
texture of meat	6	32	24	24	43	27	60	29	35	60	50	76	46	57		63	56	42	60	69	60	57	10	34	13	21	31	56	71	47
overall	21	67	43	35	63	42	65	63	52	60	21	95	65	69	81	59	59		46	24	67	49	17	36	13	49	24	66	59	5

taster

Figure 6: Representation of individual percent acceptance of Camel with Winzersteak for each characteristic

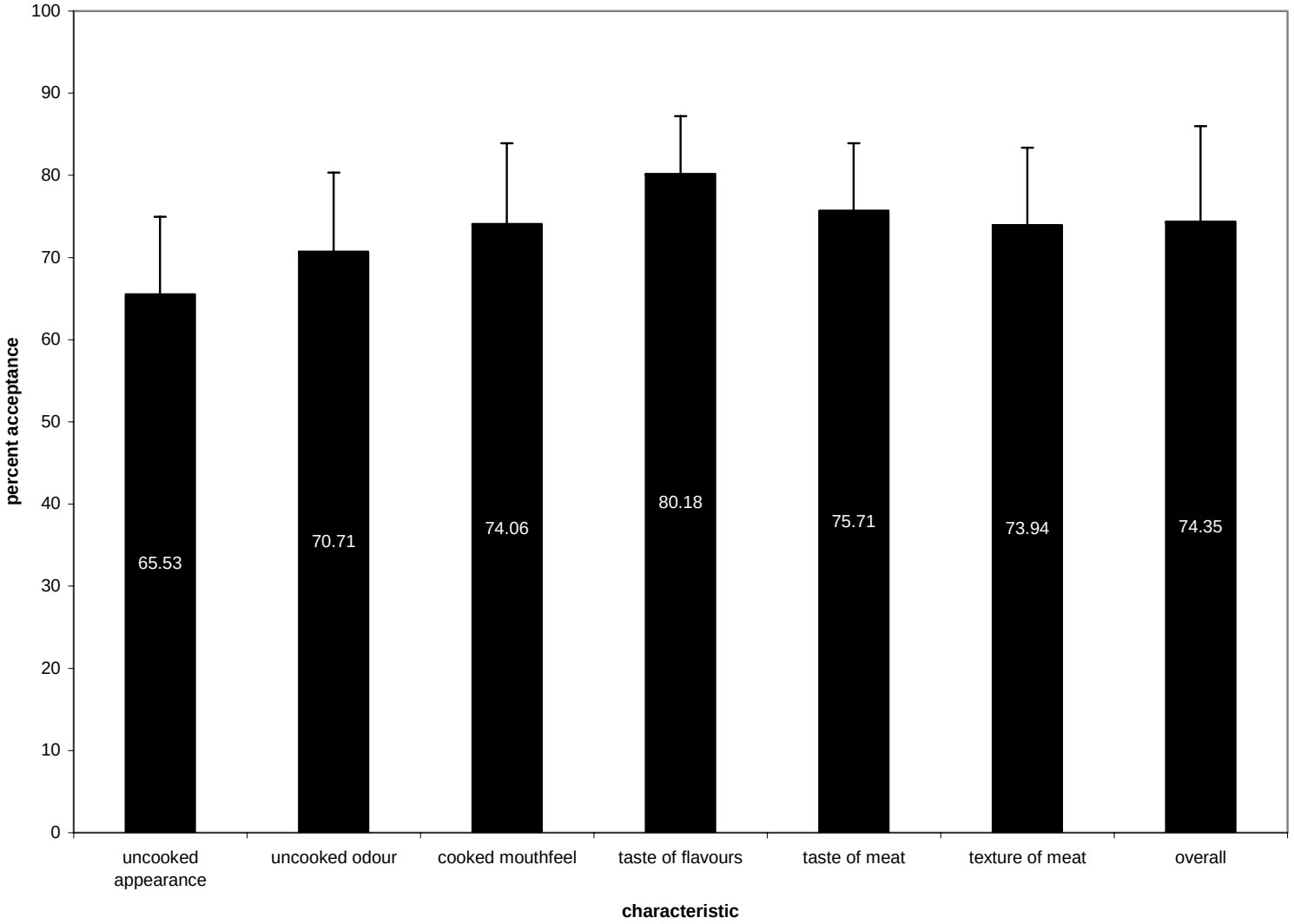
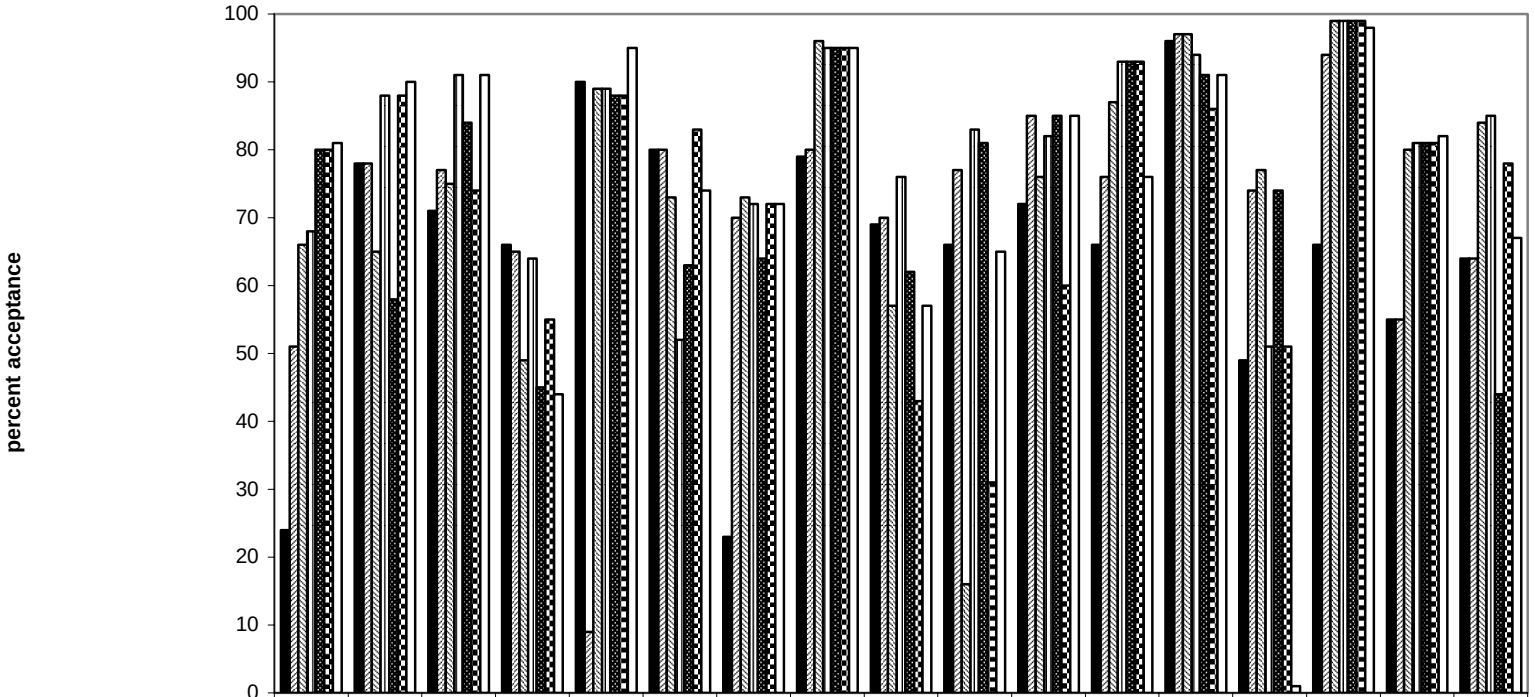


Figure 7: Representation of the average percent acceptance of Crocodile with Tandoori Masala for each characteristic



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
uncooked appearance	24	78	71	66	90	80	23	79	69	66	72	66	96	49	66	55	64
uncooked odour	51	78	77	65	9	80	70	80	70	77	85	76	97	74	94	55	64
cooked mouthfeel	66	65	75	49	89	73	73	96	57	16	76	87	97	77	99	80	84
taste of flavours	68	88	91	64	89	52	72	95	76	83	82	93	94	51	99	81	85
taste of meat	80	58	84	45	88	63	64	95	62	81	85	93	91	74	99	81	44
texture of meat	80	88	74	55	88	83	72	95	43	31	60	93	86	51	99	81	78
overall	81	90	91	44	95	74	72	95	57	65	85	76	91	1	98	82	67

Figure 8 Representation of individual percent acceptance of Crocodile with Tandoori Masala for each characteristic

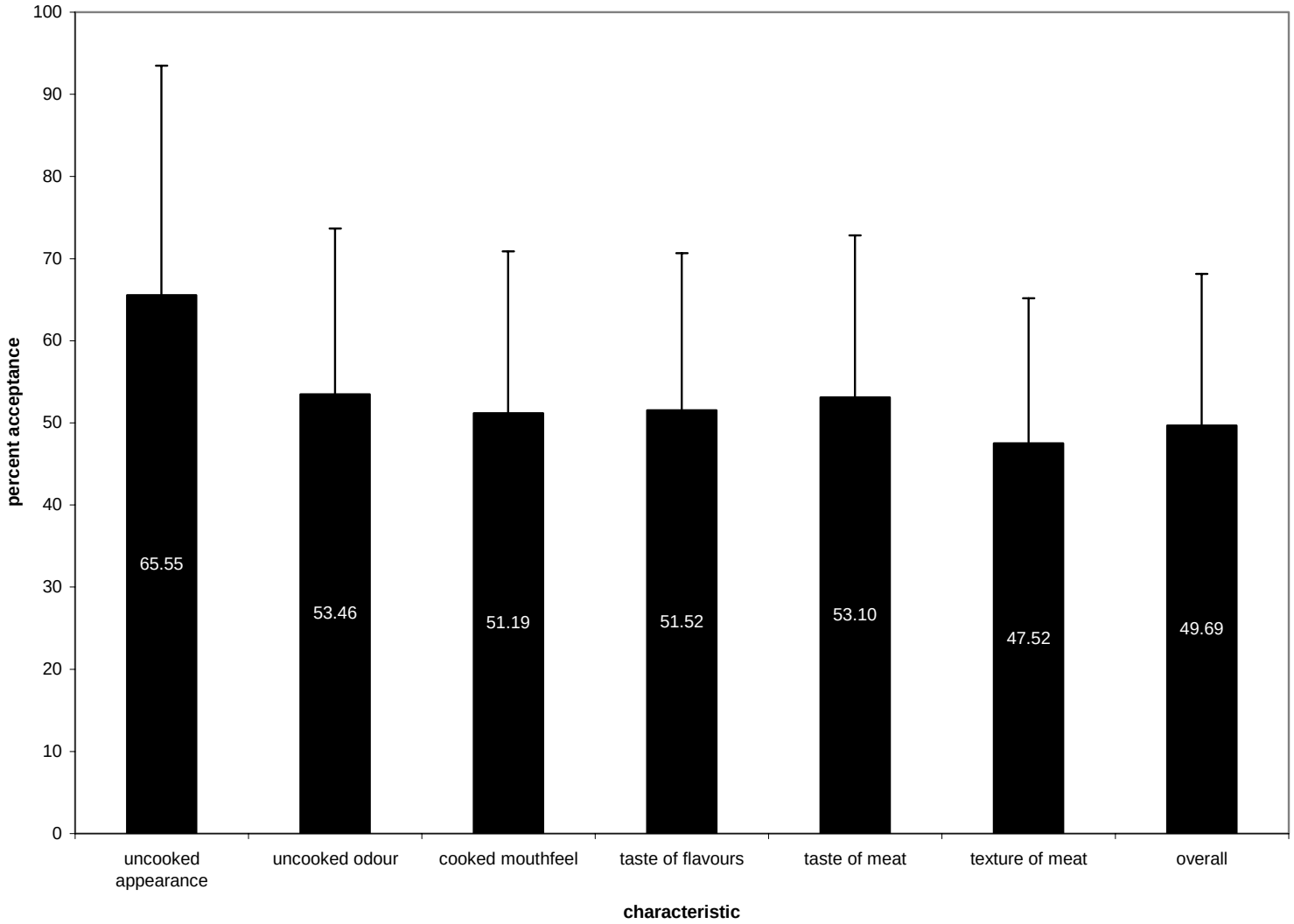
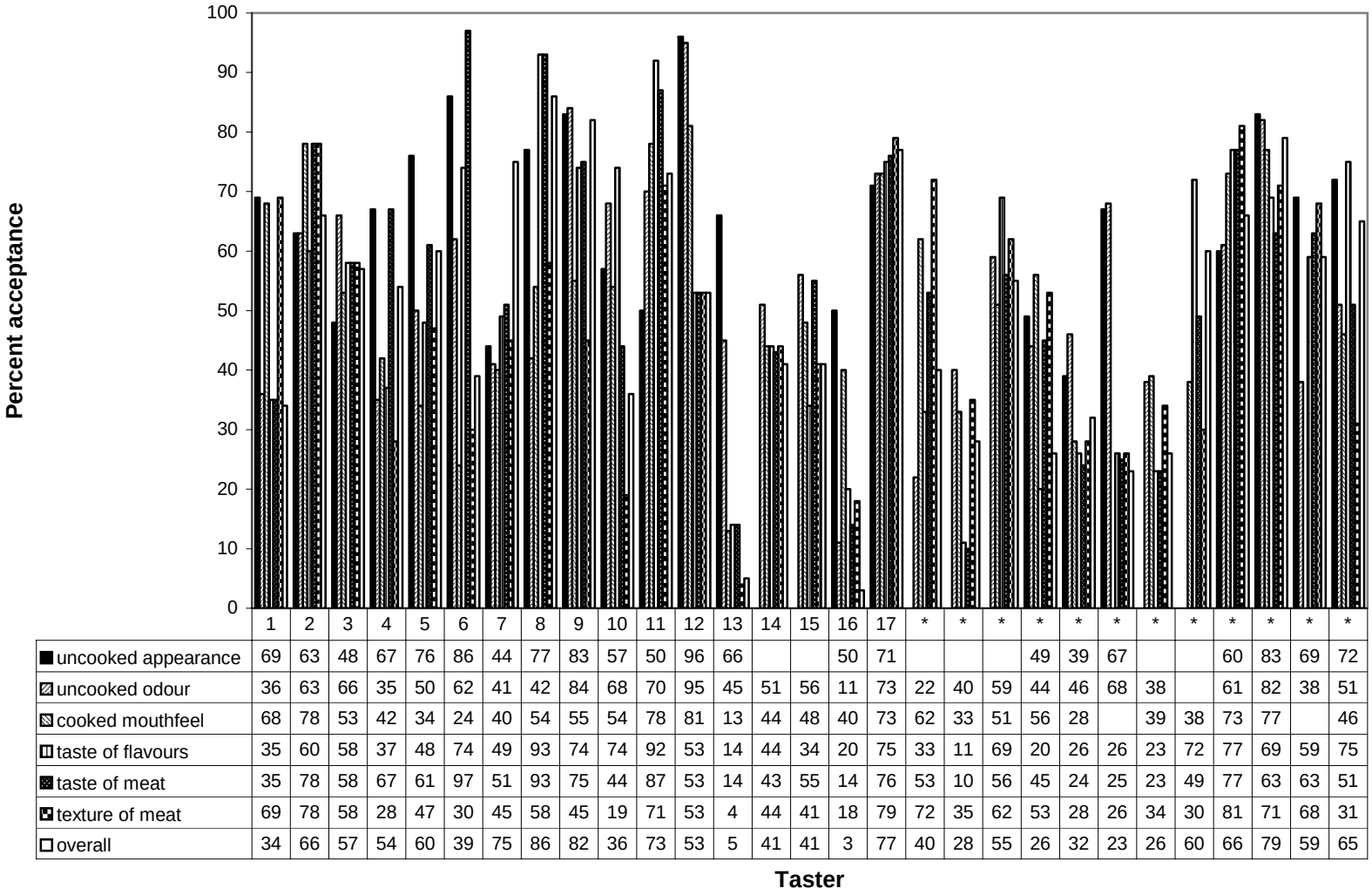


Figure 9: Representation of the average percent acceptance of Emu with Native Mint and Mustard for each characteristic



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	*	*	*	*	*	*	*	*	*	*	*	*
uncooked appearance	69	63	48	67	76	86	44	77	83	57	50	96	66			50	71				49	39	67			60	83	69	72
uncooked odour	36	63	66	35	50	62	41	42	84	68	70	95	45	51	56	11	73	22	40	59	44	46	68	38		61	82	38	51
cooked mouthfeel	68	78	53	42	34	24	40	54	55	54	78	81	13	44	48	40	73	62	33	51	56	28		39	38	73	77		46
taste of flavours	35	60	58	37	48	74	49	93	74	74	92	53	14	44	34	20	75	33	11	69	20	26	26	23	72	77	69	59	75
taste of meat	35	78	58	67	61	97	51	93	75	44	87	53	14	43	55	14	76	53	10	56	45	24	25	23	49	77	63	63	51
texture of meat	69	78	58	28	47	30	45	58	45	19	71	53	4	44	41	18	79	72	35	62	53	28	26	34	30	81	71	68	31
overall	34	66	57	54	60	39	75	86	82	36	73	53	5	41	41	3	77	40	28	55	26	32	23	26	60	66	79	59	65

Figure 10: Representation of the individual percent acceptance of Emu with Native Mint and Mustard for each characteristic

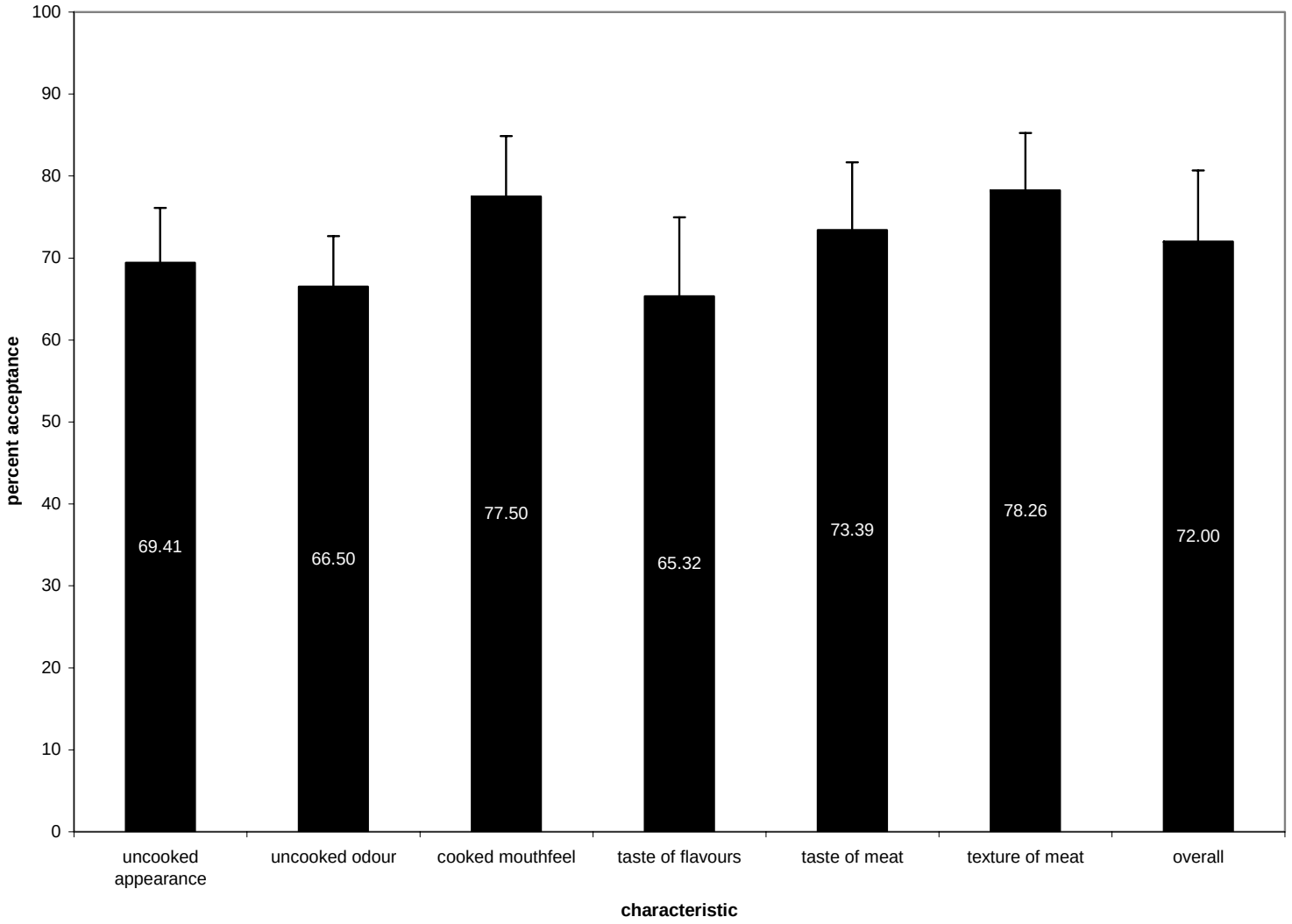
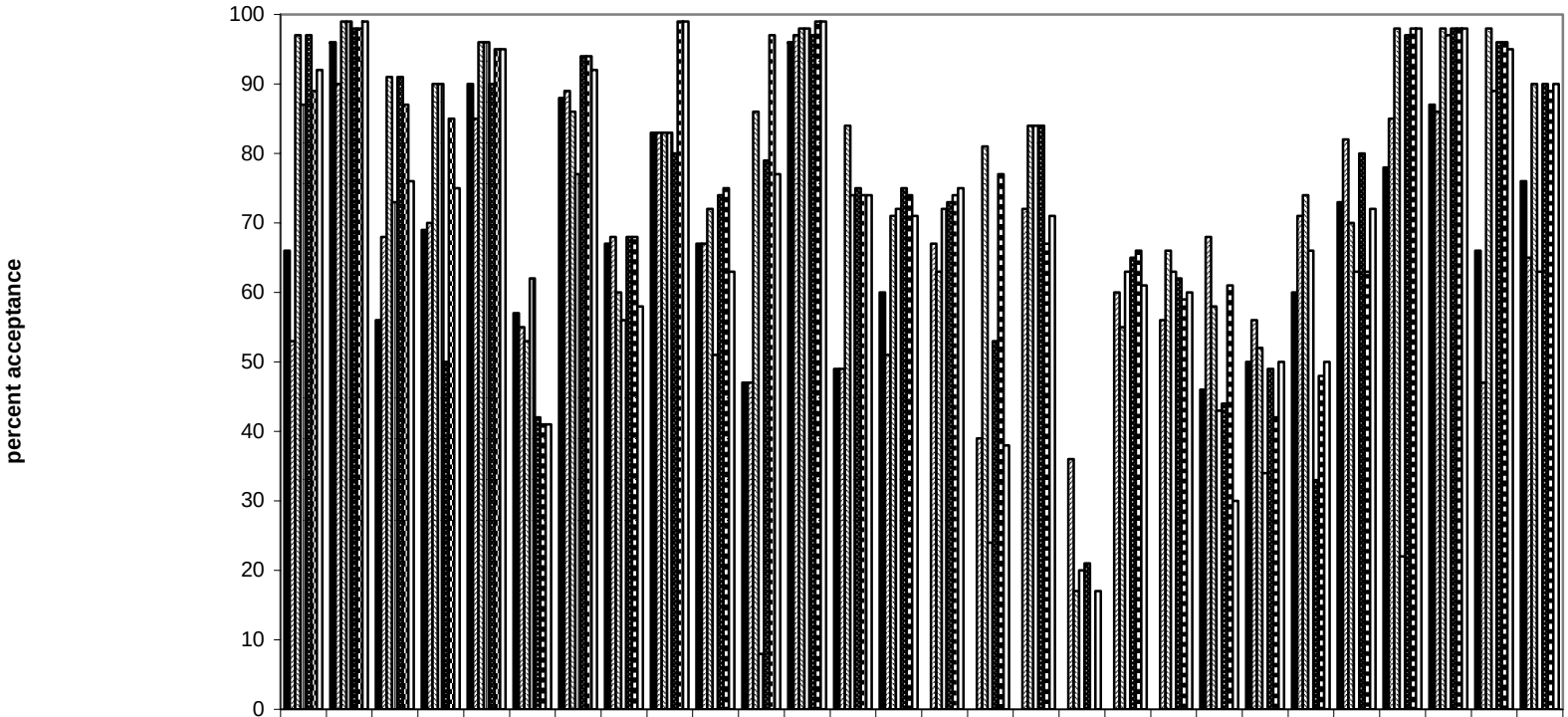


Figure 11: Representation of the average percent acceptance of Kangaroo with Madras Curry for each characteristic



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	*	*	*	*	*	*	*	*	*	*	*
uncooked appearance	66	96	56	69	90	57	88	67	83	67	47	96	49	60							46	50	60	73	78	87	66	76
uncooked odour	53	90	68	70	85	55	89	68	83	67	47	97	49	51	67	39	72	36	60	56	68	56	71	82	85	86	47	65
cooked mouthfeel	97	99	91	90	96	53	86	60	83	72	86	98	84	71	63	81	84	17	55	66	58	52	74	70	98	98	98	90
taste of flavours	87	99	73	90	96	62	77	56	83	51	8	98	74	72	72	24	84	20	63	63	43	34	66	63	22	97	89	63
taste of meat	97	98	91	50	90	42	94	68	80	74	79	97	75	75	73	53	84	21	65	62	44	49	33	80	97	98	96	90
texture of meat	89	98	87	85	95	41	94	68	99	75	97	99	74	74	74	77	67		66	59	61	42	48	63	98	98	96	89
overall	92	99	76	75	95	41	92	58	99	63	77	99	74	71	75	38	71	17	61	60	30	50	50	72	98	98	95	90

Figure 12: Representation of the individual percent acceptance of Kangaroo with Madras Curry for each characteristic

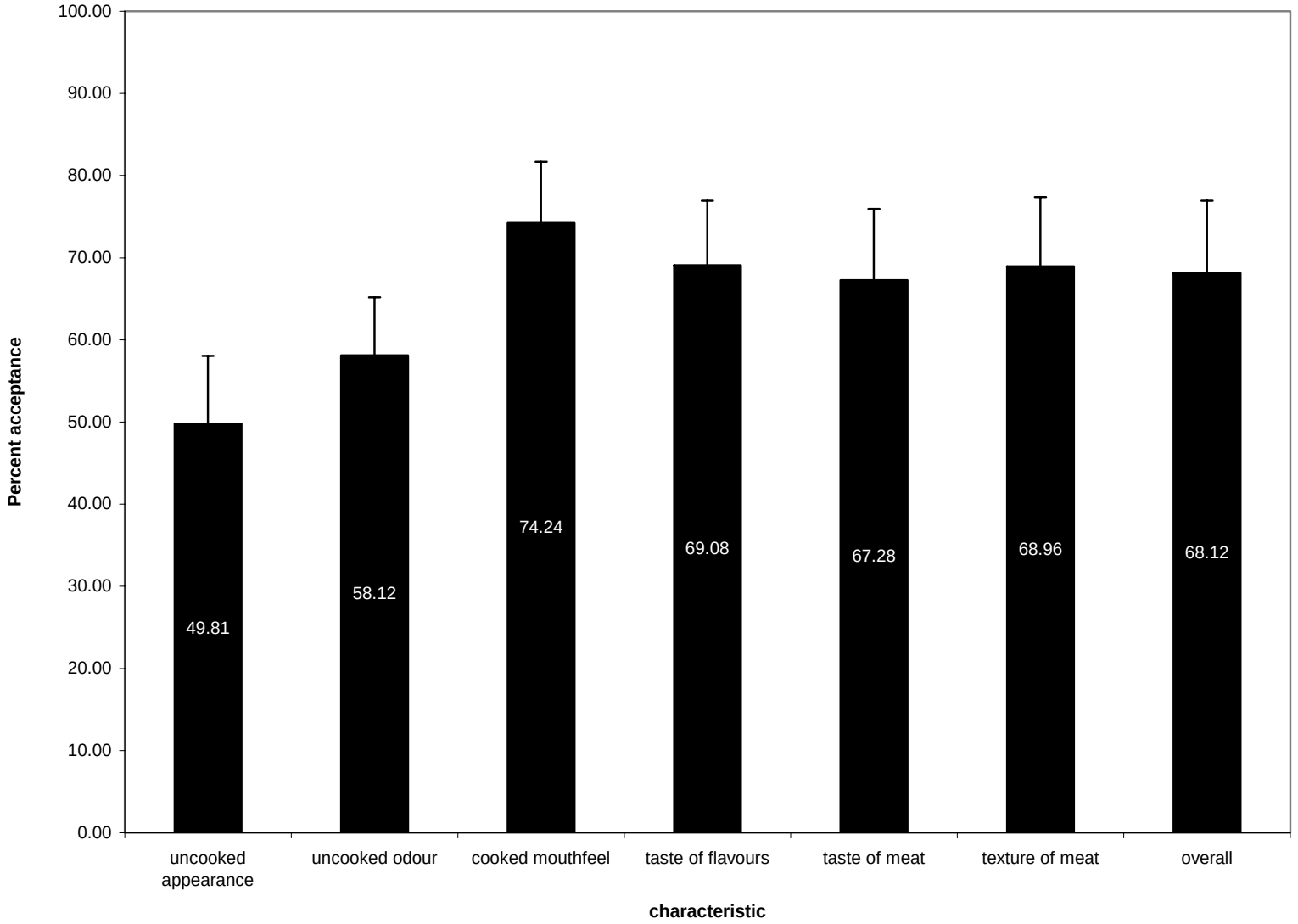
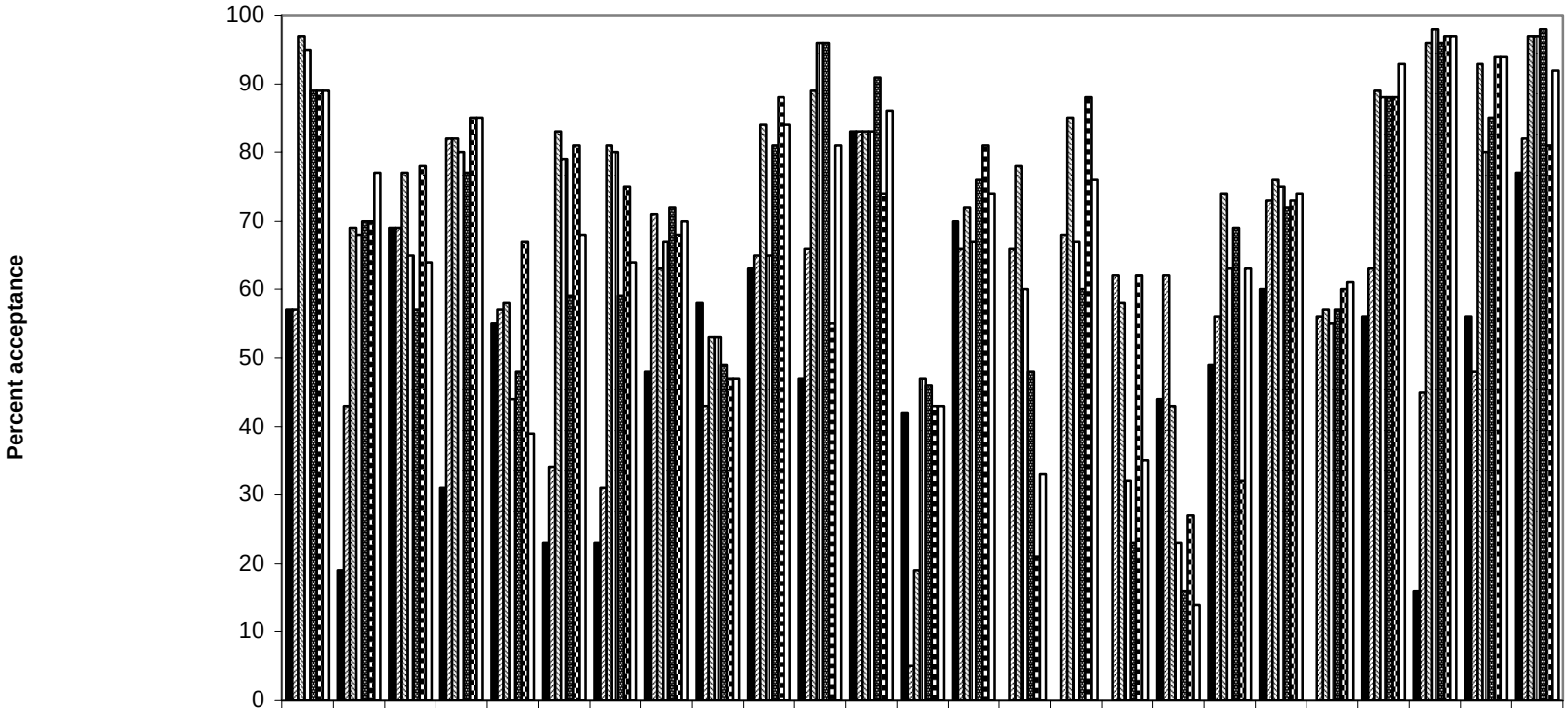


Figure 13: Representation of the average percent acceptance of Ostrich with Smokey Mountain BBQ Pepper for each characteristic



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	*	*	*	*	*	*	*	*
uncooked appearance	57	19	69	31	55	23	23	48	58	63	47	83	42	70				44	49	60		56	16	56	77
uncooked odour	57	43	69	82	57	34	31	71	43	65	66	83	5	66	66	68	62	62	56	73	56	63	45	48	82
cooked mouthfeel	97	69	77	82	58	83	81	63	53	84	89	83	19	72	78	85	58	43	74	76	57	89	96	93	97
taste of flavours	95	68	65	80	44	79	80	67	53	65	96	83	47	67	60	67	32	23	63	75	55	88	98	80	97
taste of meat	89	70	57	77	48	59	59	72	49	81	96	91	46	76	48	60	23	16	69	72	57	88	96	85	98
texture of meat	89	70	78	85	67	81	75	68	47	88	55	74	43	81	21	88	62	27	32	73	60	88	97	94	81
overall	89	77	64	85	39	68	64	70	47	84	81	86	43	74	33	76	35	14	63	74	61	93	97	94	92

Figure 14: Representation of the individual percent acceptance of Ostrich with Smokey Mountain BBQ Pepper for each characteristic

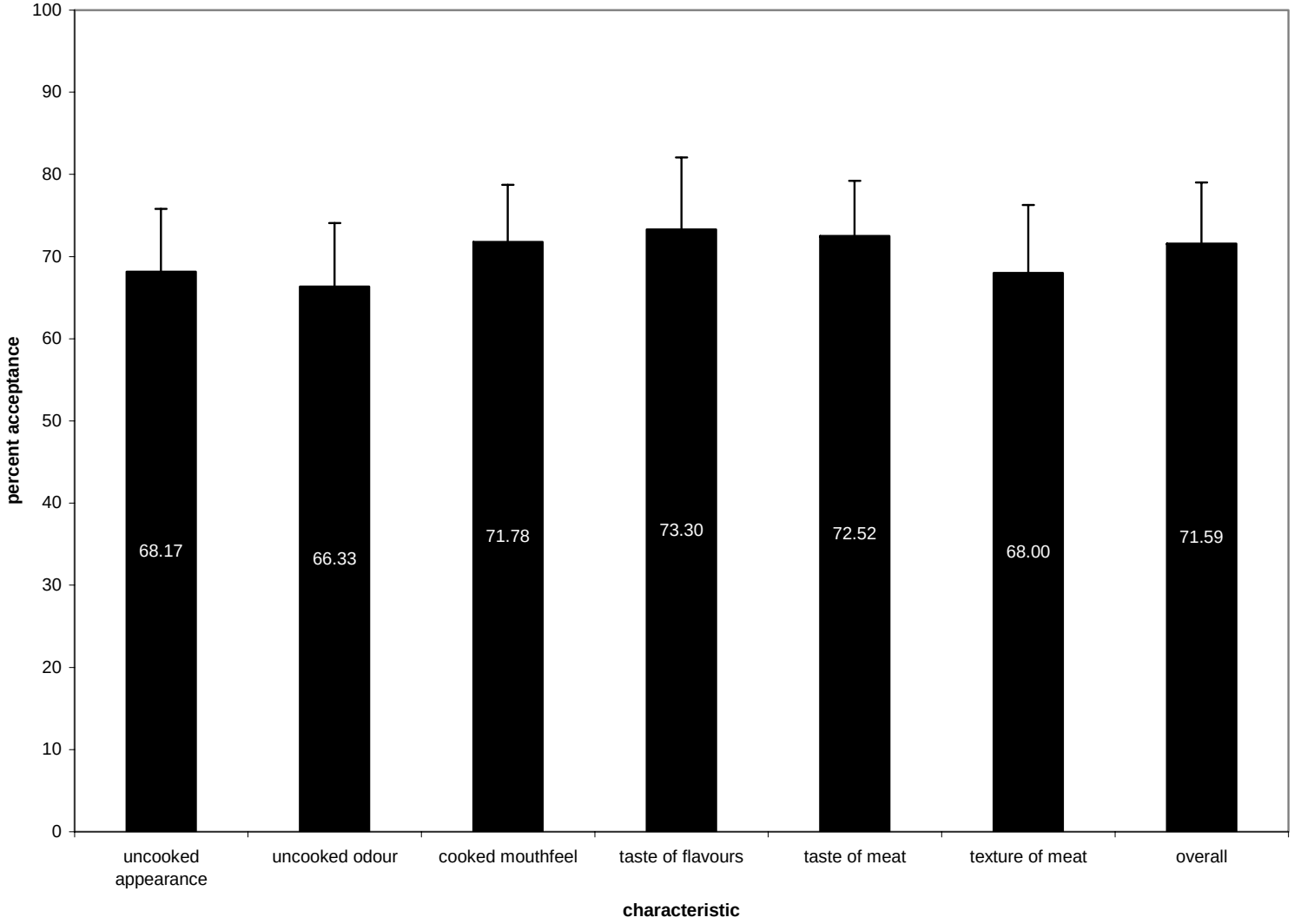
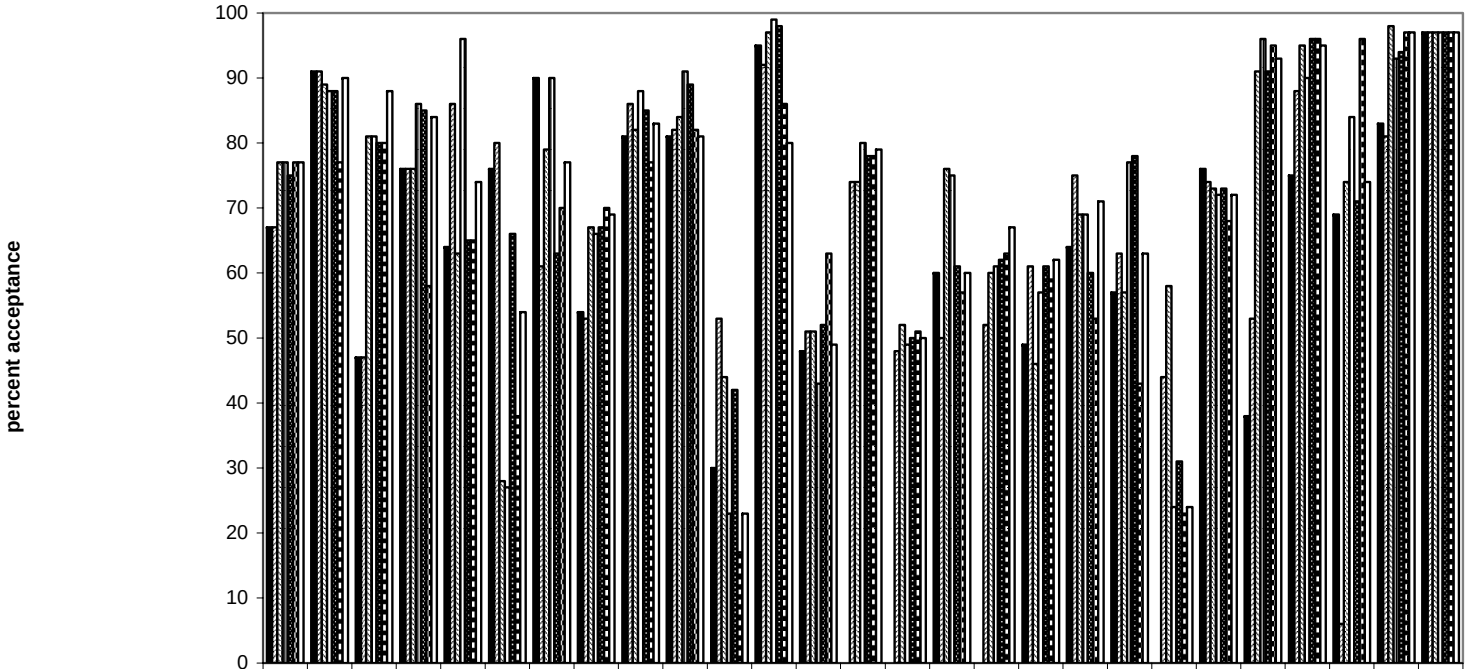


Figure 15: Representation of the average percent acceptance of Rabbit with Lemon Myrtle and Chilli for each characteristic



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	*	*	*	*	*	*	*	*	*	*
uncooked appearance	67	91	47	76	64	76	90	54	81	81	30	95	48			60		49	64	57		76	38	75	69	83	97
uncooked odour	67	91	47	76	86	80	61	53	86	82	53	92	51	74	48	50	52	61	75	63	44	74	53	88	6	81	97
cooked mouthfeel	77	89	81	76	63	28	79	67	82	84	44	97	51	74	52	76	60	46	69	57	58	73	91	95	74	98	97
taste of flavours	77	88	81	86	96	27	90	66	88	91	23	99	43	80	49	75	61	57	69	77	24	72	96	90	84	93	97
taste of meat	75	88	80	85	65	66	63	67	85	89	42	98	52	78	50	61	62	61	60	78	31	73	91	96	71	94	97
texture of meat	77	77	80	58	65	38	70	70	77	82	17	86	63	78	51	57	63	59	53	43	23	68	95	96	96	97	97
overall	77	90	88	84	74	54	77	69	83	81	23	80	49	79	50	60	67	62	71	63	24	72	93	95	74	97	97

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 preceeded with '<' indicate the result is below the limit of detection of the test.

MICROORGANISM	SEASONING					
	Smokey Mountain BBQ Pepper	Winzersteak	Tandoori Masala	Native Mint and Mustard	Madras Curry	Lemon Myrtle and Chilli
TVC	8.4×10^4	4.9×10^5	4.3×10^5	6.1×10^4	1.1×10^6	1.6×10^4
E. coli	<5	<5	<5	<5	<5	<5
Coliforms	<5	<5	<5	<5	<5	<5
Bacillus cereus	$<5.0 \times 10^1$	$<5.0 \times 10^1$	$<5.0 \times 10^1$	$<5.0 \times 10^1$	$<5.0 \times 10^1$	1.0×10^2
Staphylococcus aureus	$<5.0 \times 10^1$	$<5.0 \times 10^1$	$<5.0 \times 10^1$	$<5.0 \times 10^1$	$<5.0 \times 10^1$	$<5.0 \times 10^1$
Clostridium perfringens	$<5.0 \times 10^1$	$<5.0 \times 10^1$	$<5.0 \times 10^1$	$<5.0 \times 10^1$	$<5.0 \times 10^1$	$<5.0 \times 10^1$

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 preceeded 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.

MICROORGANISM	MEAT SPECIES						
	Buffalo	Camel	Crocodile	Emu	Kangaroo	Ostrich	Rabbit
TVC	$>1.0 \times 10^6$	$>1.0 \times 10^6$	2.6×10^3	2.4×10^4	1.5×10^4	1.1×10^3	6.2×10^4
E. coli	<5	<5	<5	<5	1.1×10^2	<5	<0.2
Coliforms	<5	<5	<5	<5	2.0×10^2	<5	<0.2
Salmonella	ND	ND	ND	ND	ND	ND	ND
Listeria	D	D	ND	ND	ND	ND	ND
Bacillus cereus	$<5.0 \times 10^1$	$<5.0 \times 10^1$	$<5.0 \times 10^1$	$<5.0 \times 10^1$	$<5.0 \times 10^1$	$<5.0 \times 10^1$	<1.8
Staphylococcus aureus	$<5.0 \times 10^1$	$<5.0 \times 10^1$	$<5.0 \times 10^1$	$<5.0 \times 10^1$	$<5.0 \times 10^1$	$<5.0 \times 10^1$	<1.8
Clostridium perfringens	$<5.0 \times 10^1$	$<5.0 \times 10^1$	$<5.0 \times 10^1$	$<5.0 \times 10^1$	$<5.0 \times 10^1$	$<5.0 \times 10^1$	<1.8
Pseudomonas	3.5×10^4	2.5×10^2	1.8×10^3	5.0×10^1	5.0×10^3	1.0×10^2	3.5×10^4
Brochothrix	1.4×10^5	$<5.0 \times 10^1$	$<5.0 \times 10^1$	2.3×10^3	4.3×10^3	$<5.0 \times 10^1$	1.5×10^5
Lactobacillus	1.0×10^6	2.6×10^5	3.9×10^2	3.1×10^4	5.4×10^3	1.1×10^2	1.5×10^4

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 which was approaching spoilage levels by the third week of the trial. *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 trail. 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.

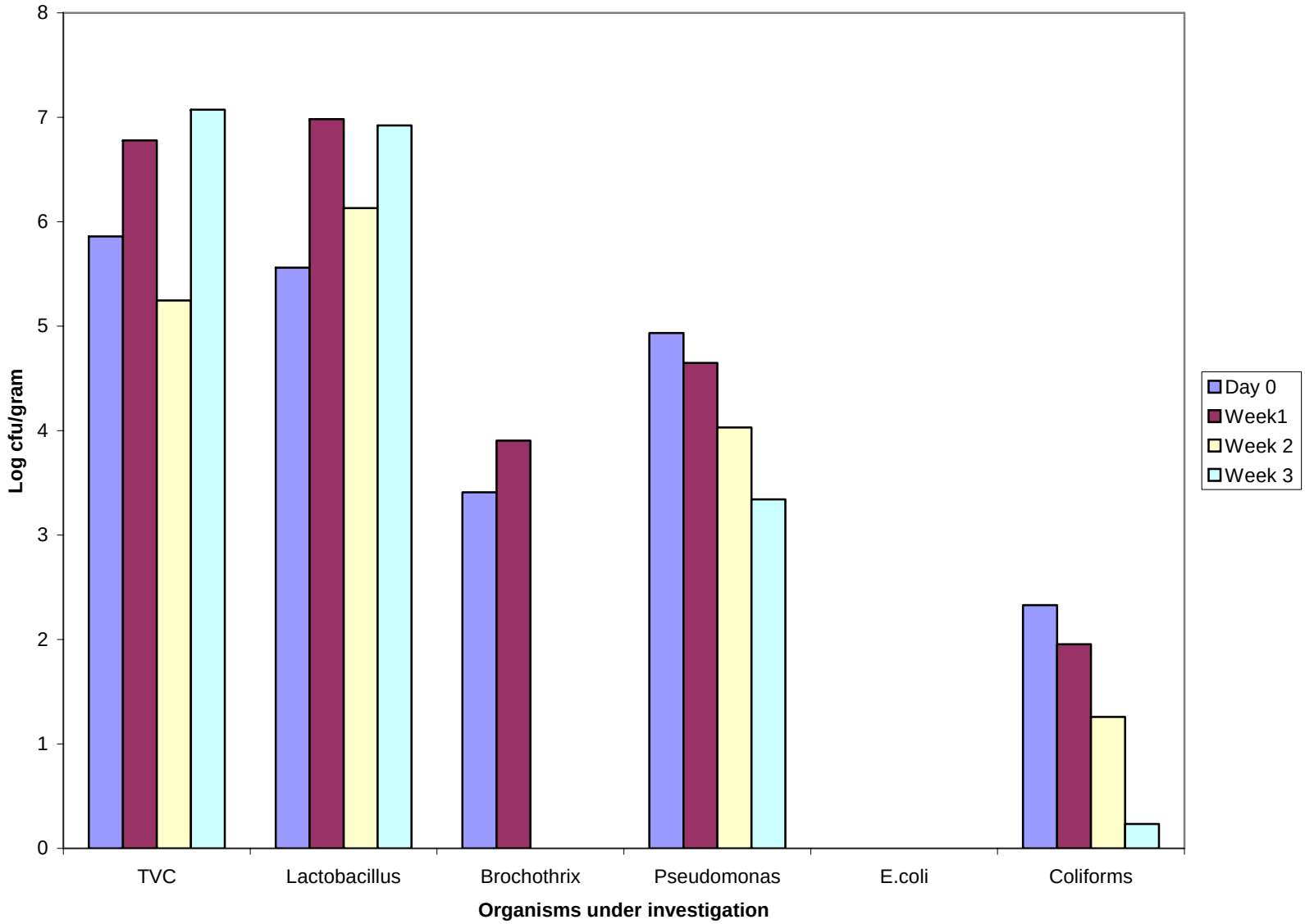


Figure 17: Microbiological shelf life of vacuum packaged Buffalo with Smokey Mountain BBQ Pepper

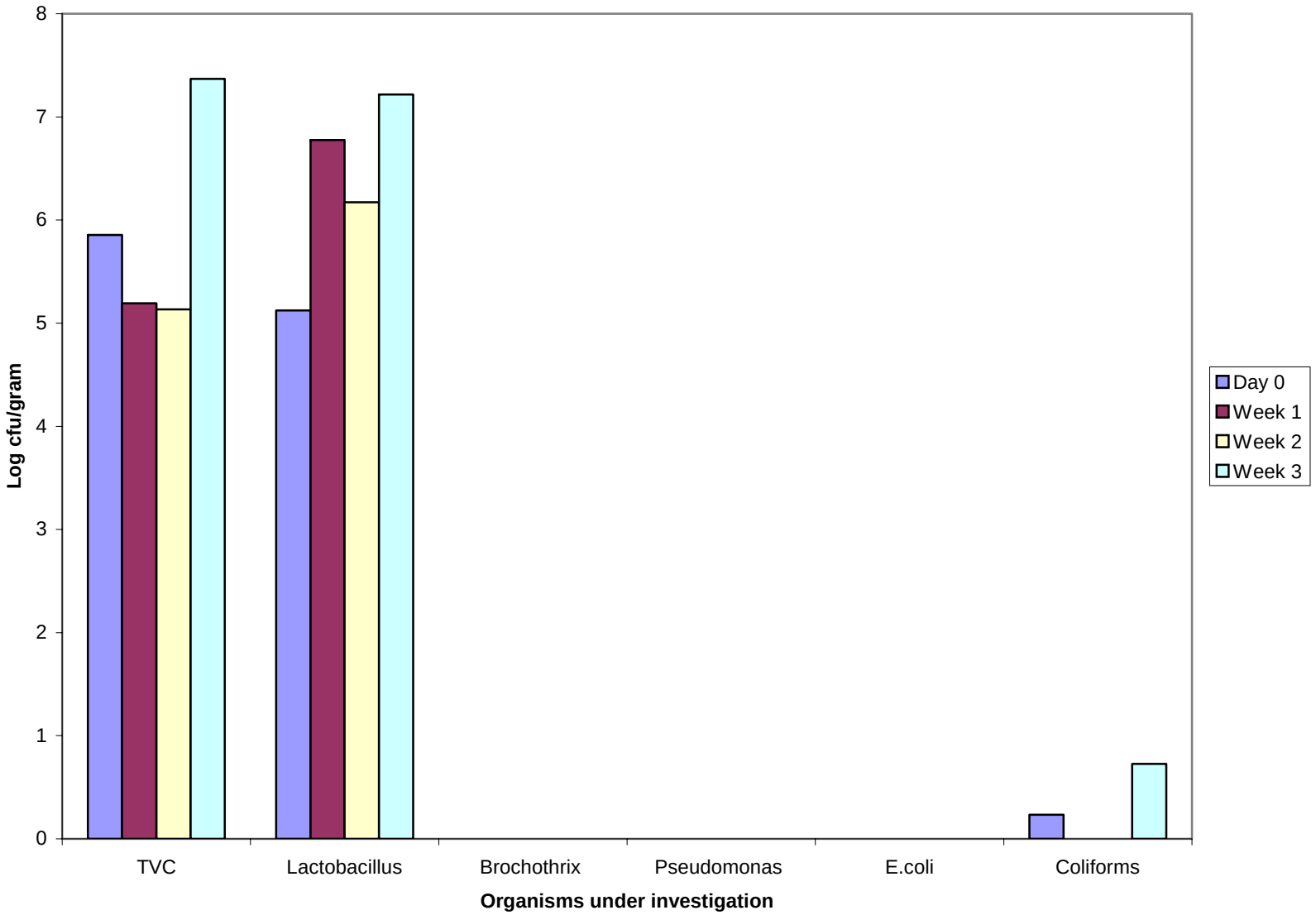


Figure 18: Microbiological shelf life of vacuum packaged Camel with Winzersteak

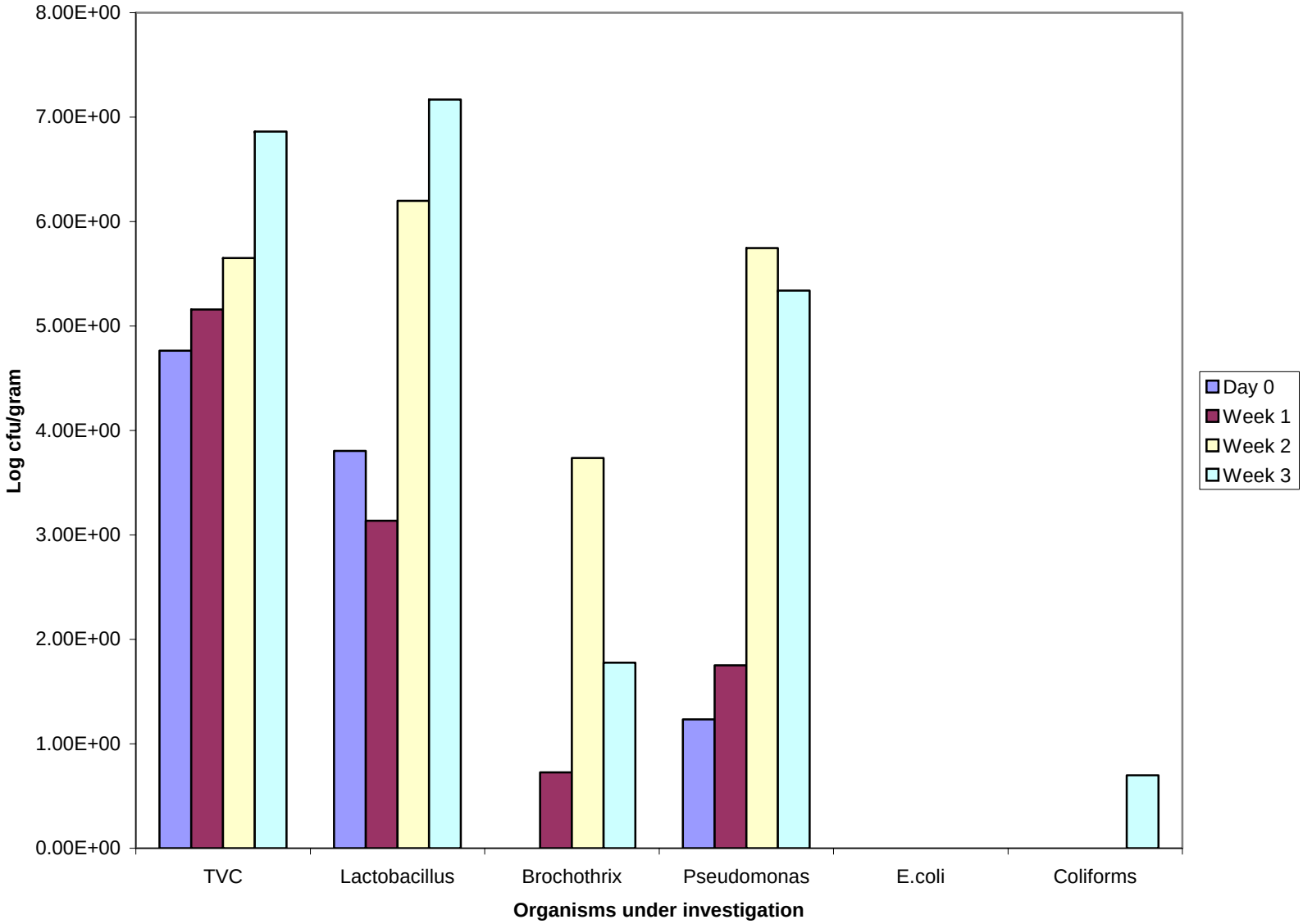


Figure 19: Microbiological shelf life of vacuum packaged Crocodile with Tandoori Masala

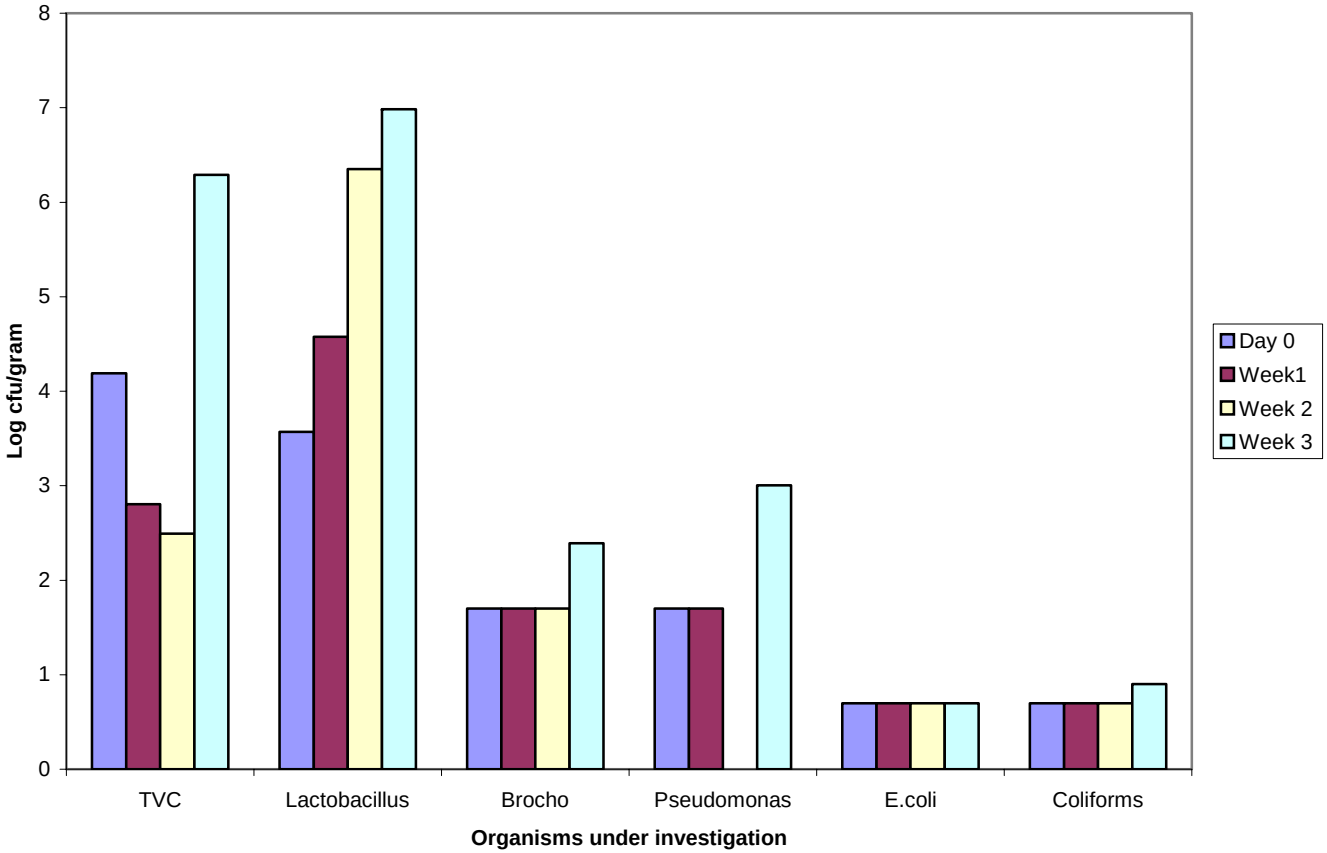


Figure 20: Microbiological shelf life of vacuum packaged Emu with Native Mint and Mustard

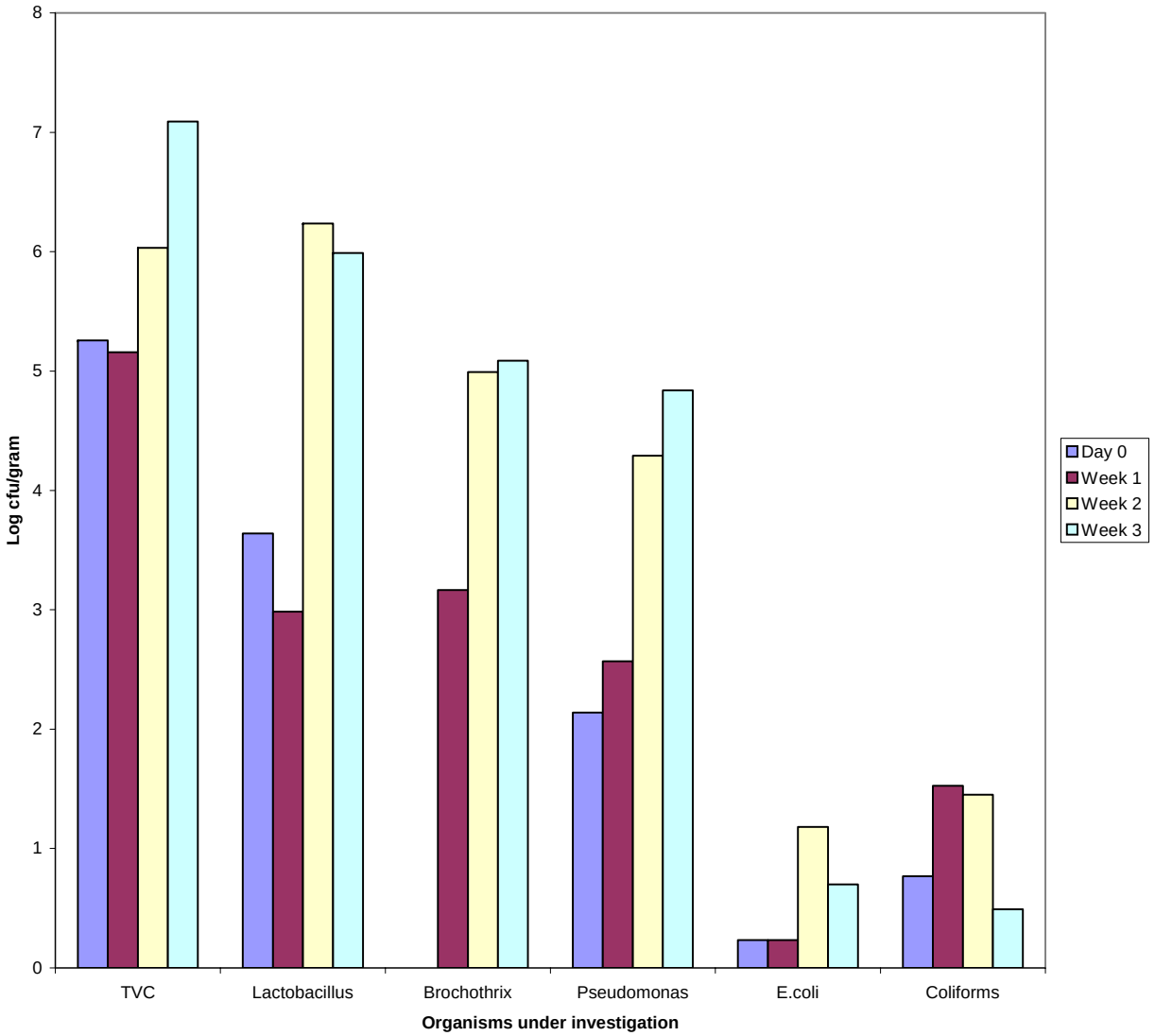


Figure 21: Microbiological shelf life of vacuum packaged Kangaroo with Madras Curry

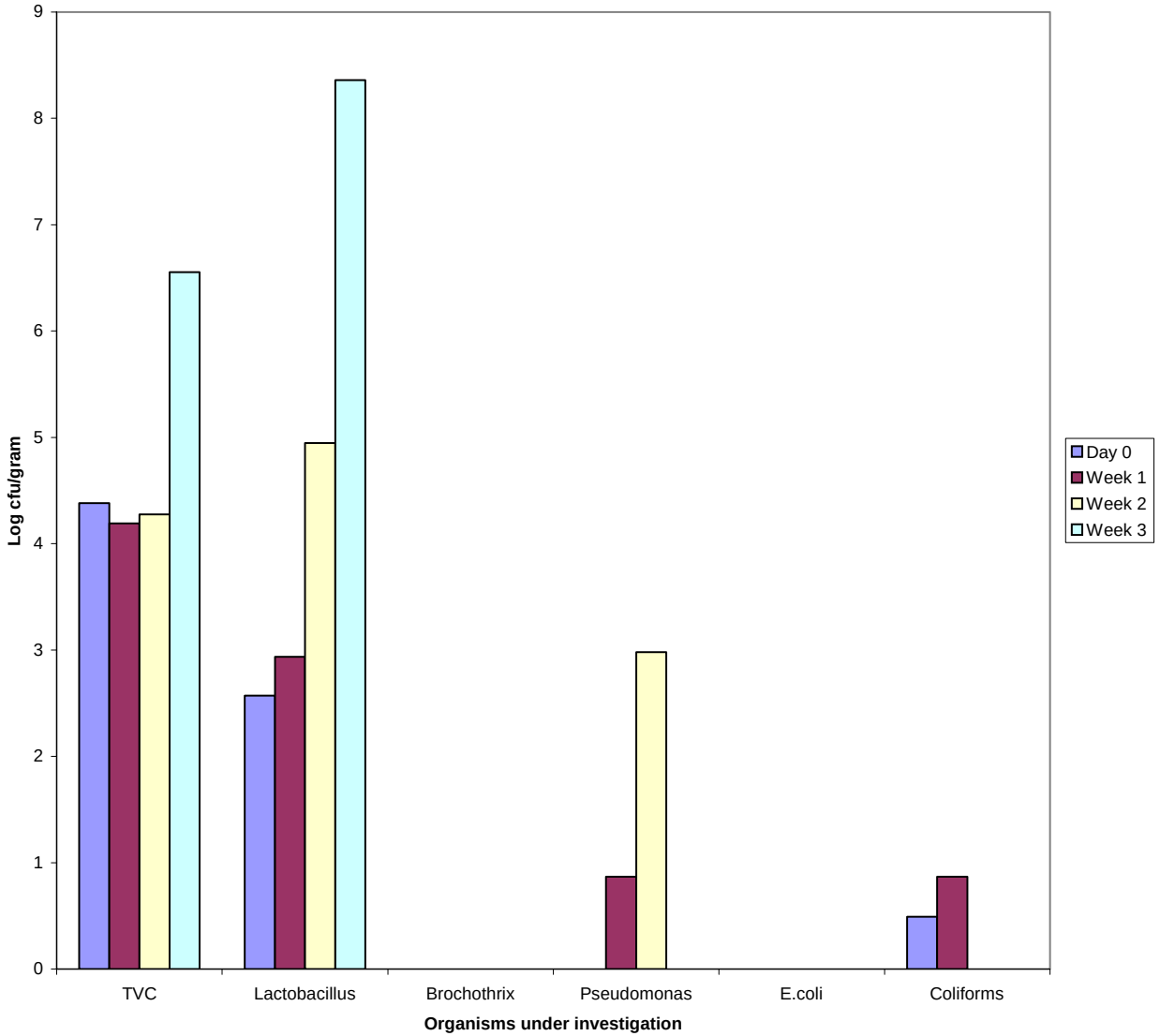


Figure 22: Microbiological shelf life of vacuum packaged Ostrich with Smokey Mountain BBQ Pepper

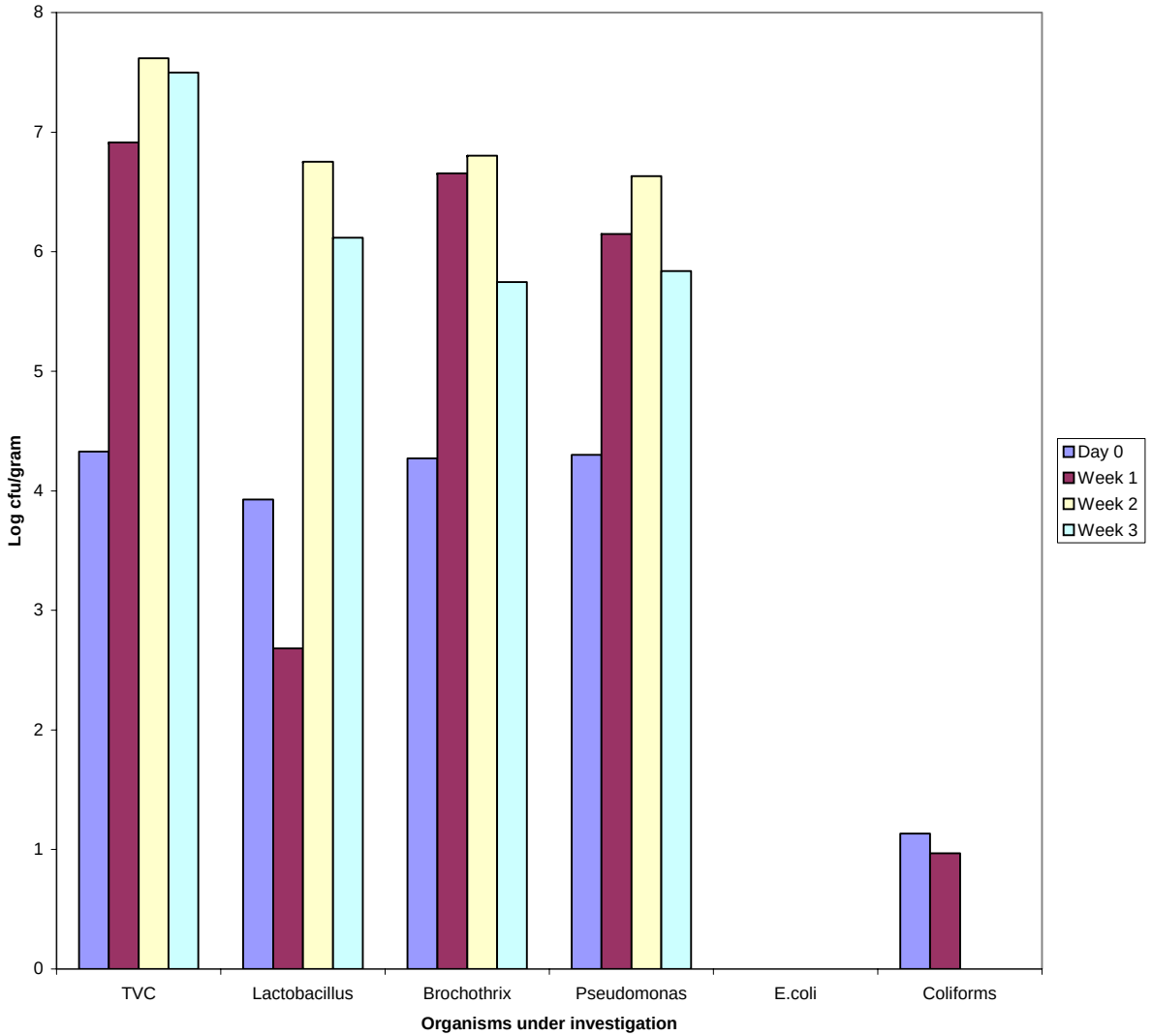


Figure 23: Microbiological shelf life of vacuum packaged Rabbit with Lemon Myrtle and Chilli

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 trail. *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 trail 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.

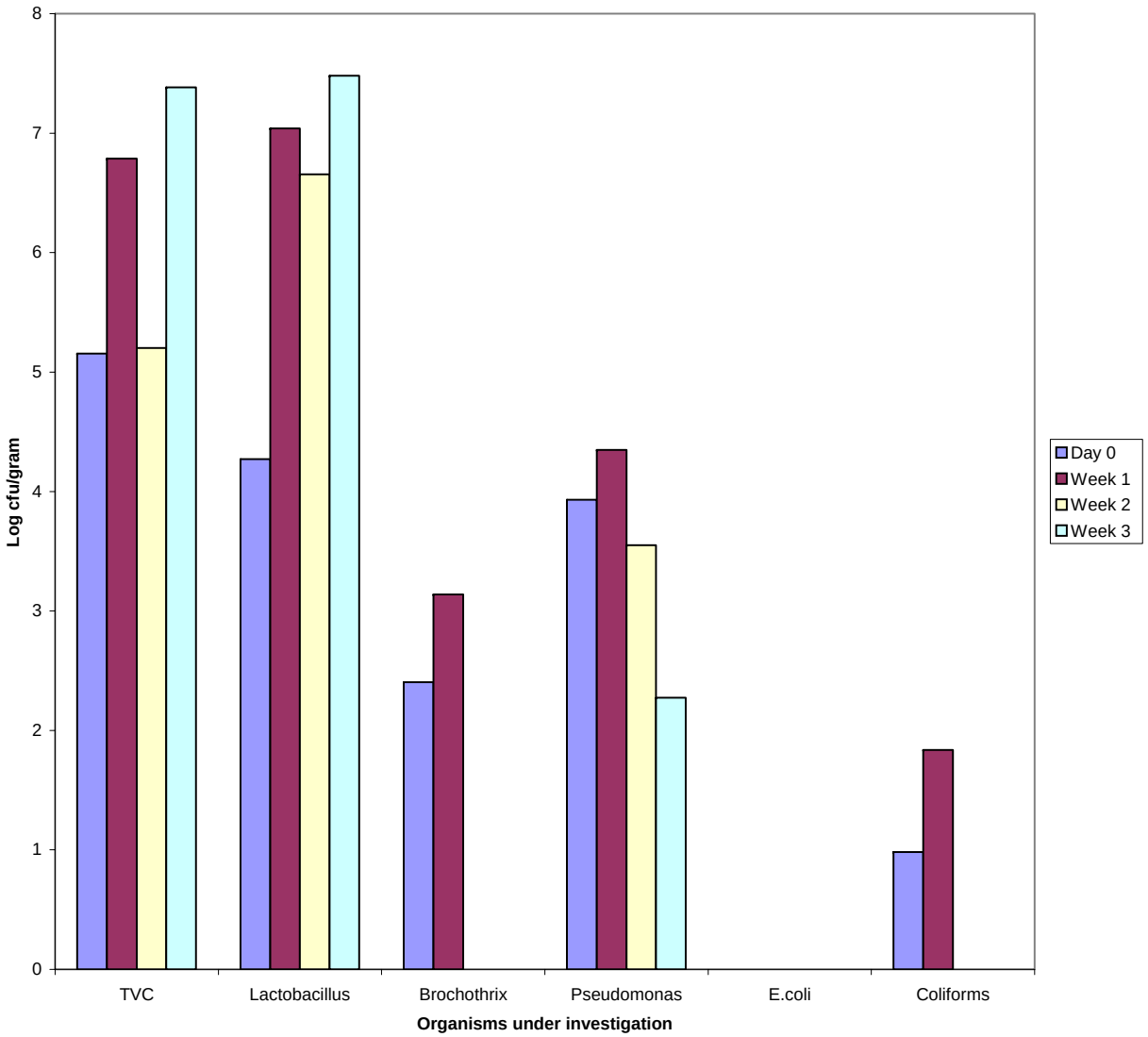


Figure 24: Microbiological shelf life of CO_2 packaged Buffalo with Smokey Mountain BBQ Pepper

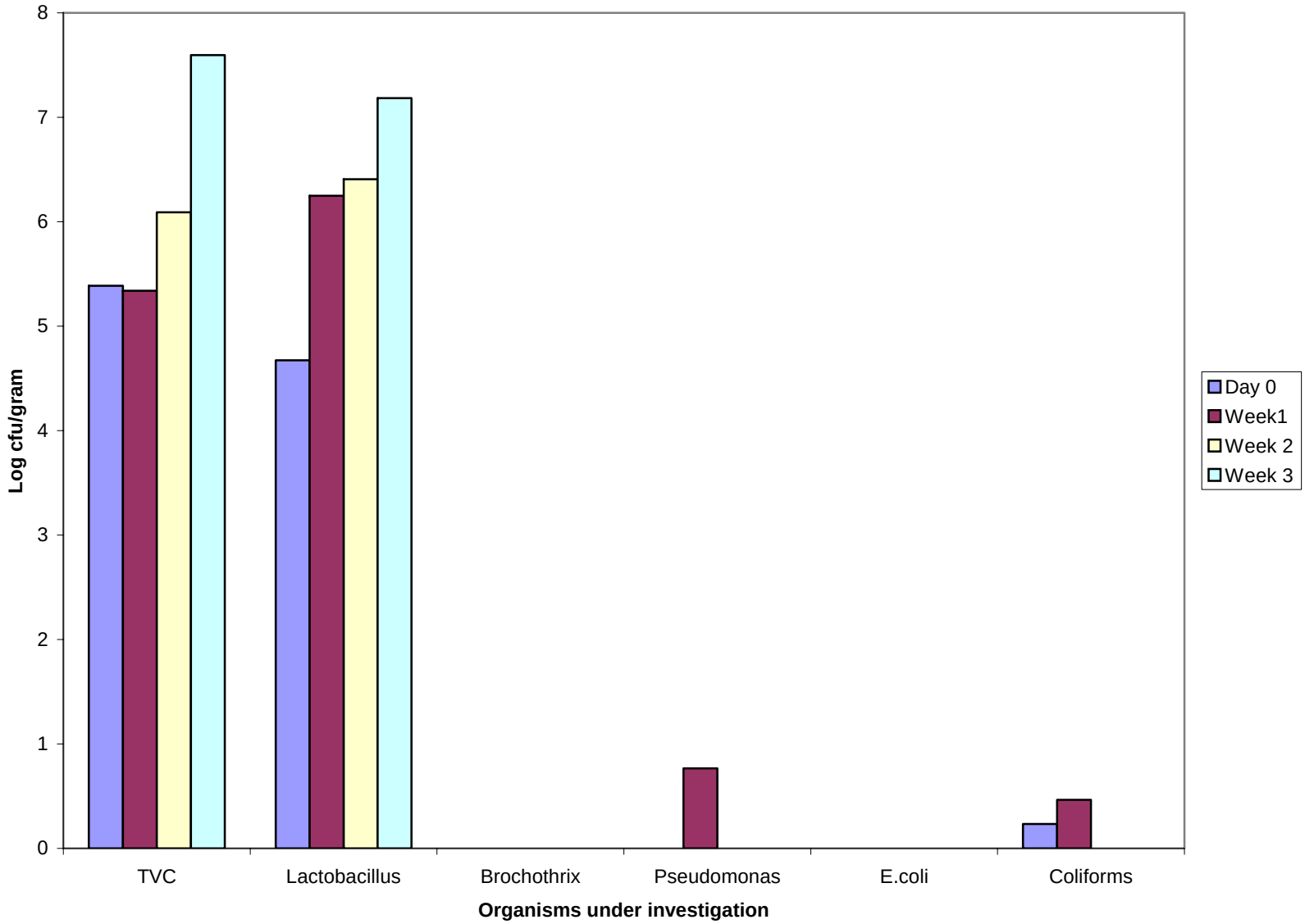


Figure 25: Microbiological shelf life of CO_2 packaged Camel with Winzersteak

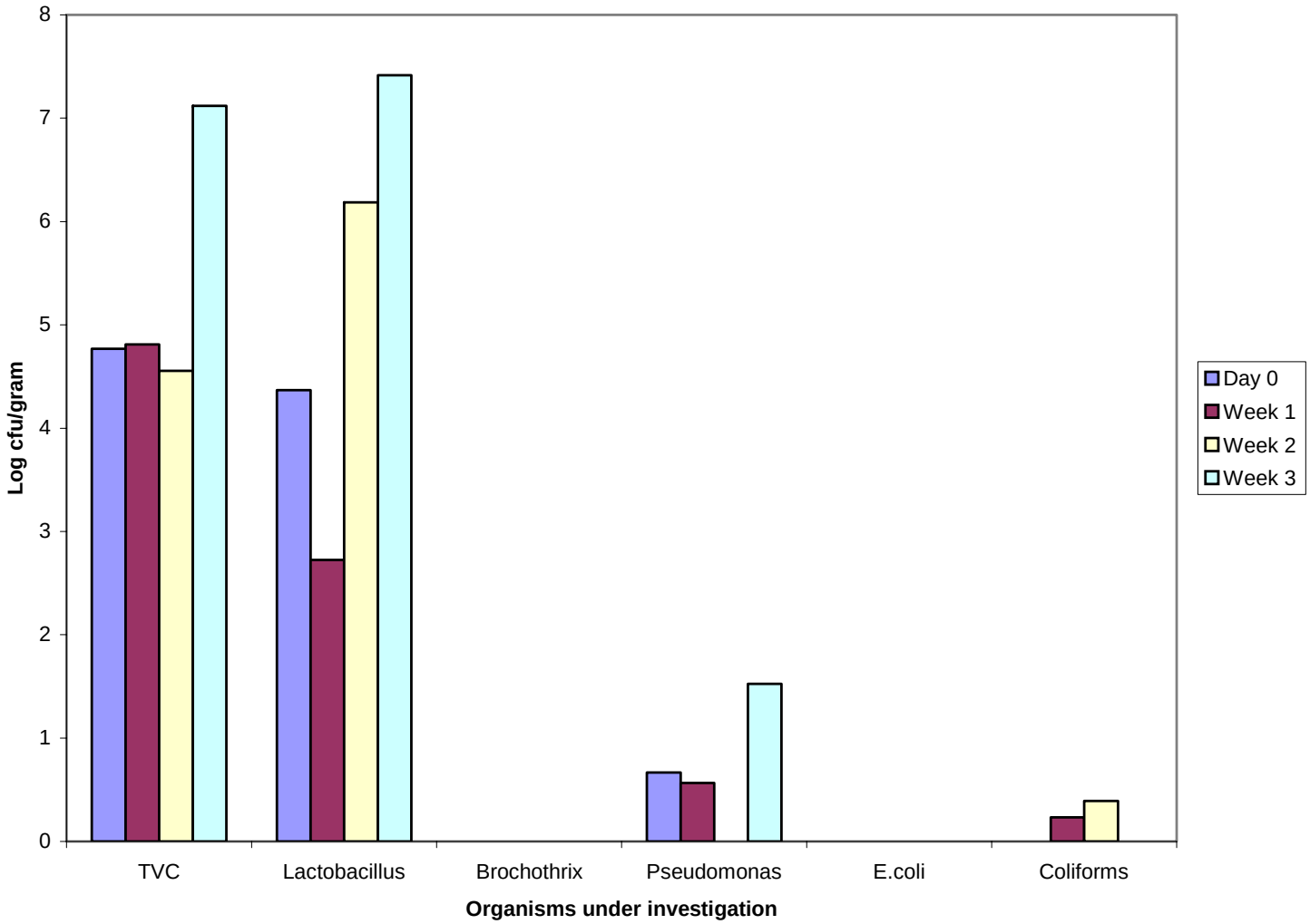


Figure 26: Microbiological shelf life of CO_2 packaged Crocodile with Tandoori Masala

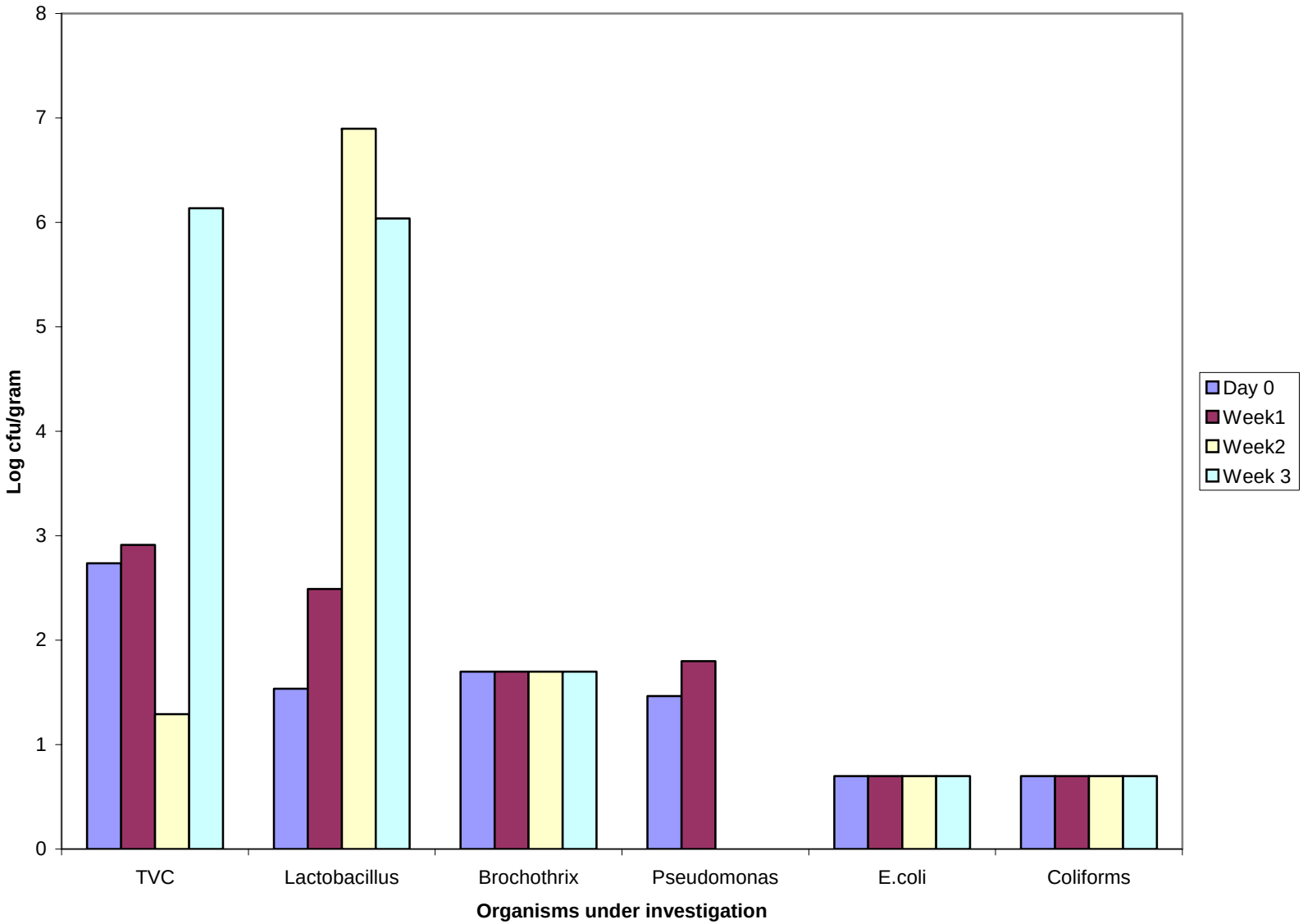


Figure 27: Microbiological shelf life of CO_2 packaged Emu with Native Mint and Mustard

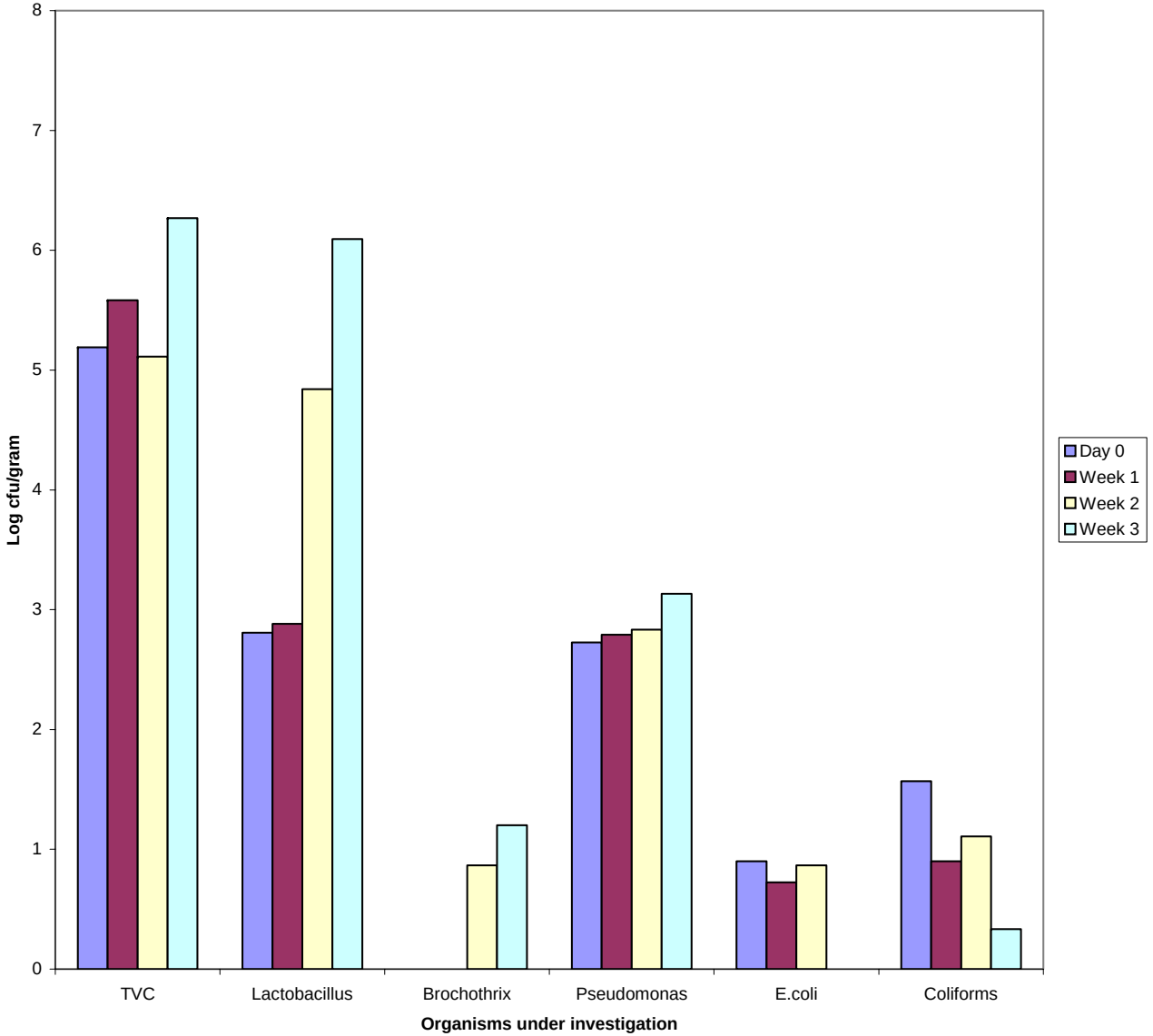


Figure 28: Microbiological shelf life of CO_2 packaged Kangaroo with Madras Curry

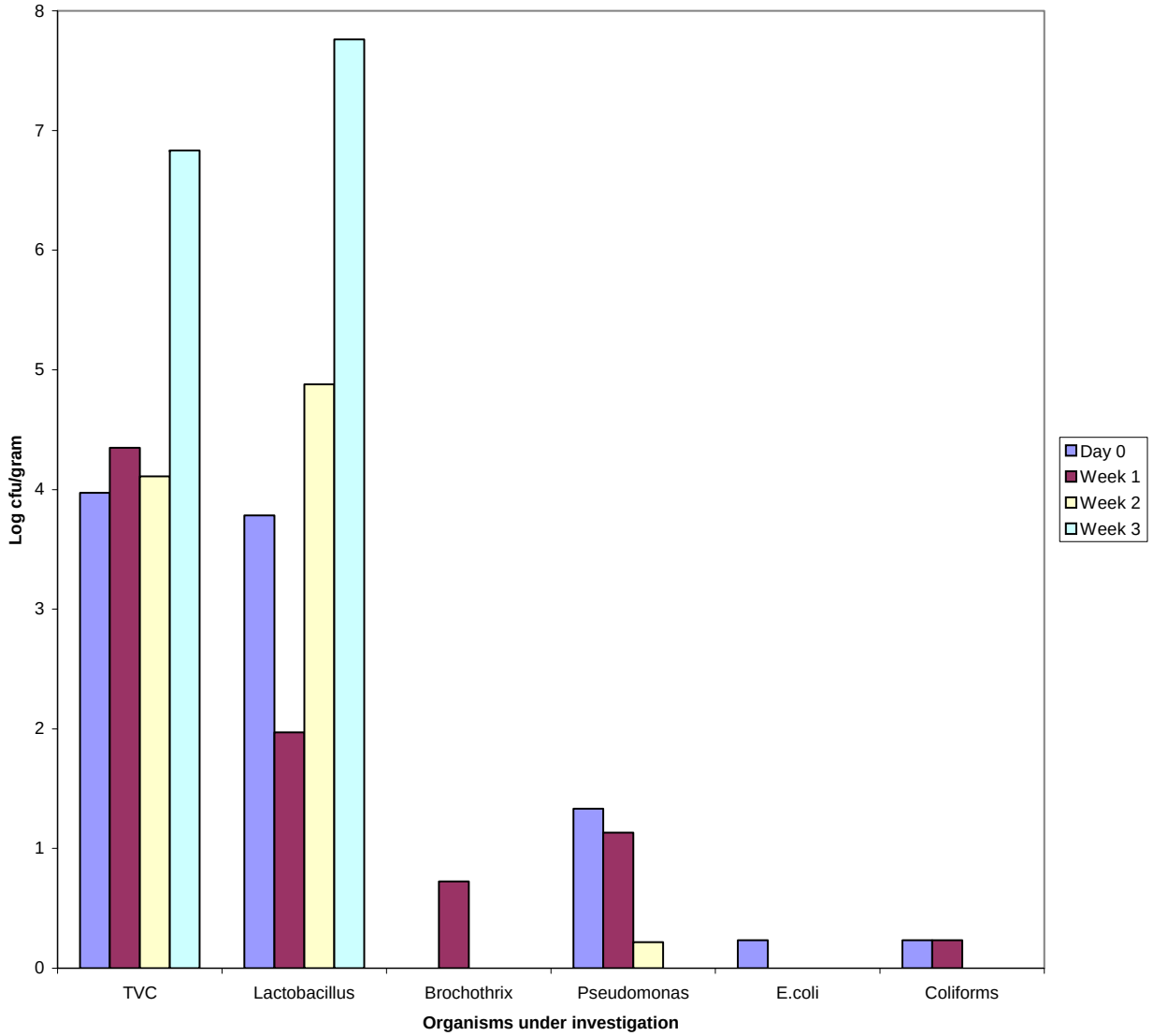


Figure 29: Microbiological shelf life of CO_2 packaged Ostrich with Smokey Mountain BBQ Pepper

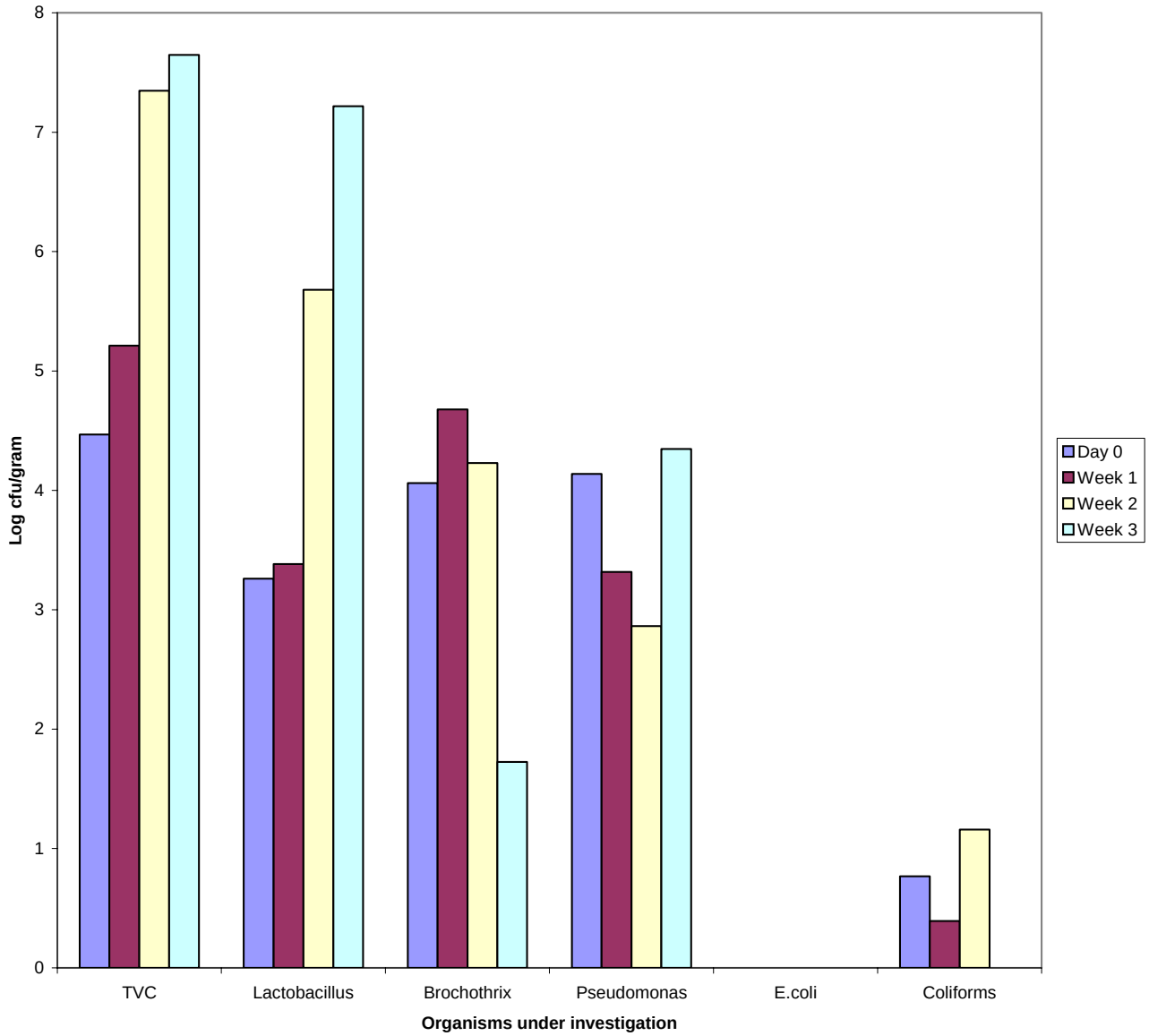


Figure 30: Microbiological shelf life of CO_2 packaged Rabbit with Lemon Myrtle and Chilli

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 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.

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 Winzersteak.

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% CO_2.

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 10^7 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 CO_2 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 1766.2.16.1 - 1991, Food Microbiology, Method 2.16.1: Examination of specific organisms – Food and animal feeding stuffs – Horizontal method for the detection and enumeration of *Listeria monocytogenes* – Detection method

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, *Pseudomonas* in Microbiological methods for the meat industry, 2nd edition.

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

MIRINZ, *Brochothrix thermosphacta* 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 *eta 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 10^5 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
Adams, M.R. and Moss, M.O. 1995. Food Microbiology. The Royal Society of Chemistry, Cambridge.
Hocking, A.D. *et al* (ed.s) 1997. Foodborne Microorganisms of Public Health Significance. 5th Edition. AIFST (NSW Branch) Food Microbiology Group, North Sydney.
Jay, J.M.1996. Modern Food Microbiology, 5th Edition. Chapman and Hall, New York.
Kanerva, L. 2001. Skin contact reactions to spices. A review. Acta Dermatovenerologica Alpina, Pannonica et Adriatica.
Patil, S.P. *et al*. 1997 Allergy to fenugreek (*Trigonella foenum graecum).*Annals of Allergy, Asthma & Immunology. 78. Pp 297-300.
Roberts, T.A., *et al* (ed.s) 1996. Microorganisms in Foods 5, Microbiological Specifications of Food Pathogens. ICMSF, Blackie Academic and Professional, London.

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: