Processing of redclaw crayfish for improvement of quality and shelf-life.

S.L.Slattery

Queensland Government
Department of Primary Industries

FISHERIES RESEARCH & DEVELOPMENT CORPORATION

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CONTENTS

1 NON-TECHNICAL SUMMARY

99/423 Processing of redclaw crayfish for improvement of quality and shelf-life.

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Objectives:

1. To investigate a suitable cooking process for redclaw crayfish which will ensure good shelf-life.
2. To investigate the best possible product types and packaging for production by industry
3. To determine fresh shelf-life of vacuum skin packed raw and cooked redclaw
4. To determine fresh shelf-life of modified atmosphere packed cooked redclaw
5. To research the viability of producing redclaw pate

NON TECHNICAL SUMMARY:

OUTCOMES ACHIEVED

Definitive boiling times have been determined for redclaw for two size groups. The sensory characteristics of cooked redclaw flesh have been determined with respect to a number of other crustaceans. The fresh shelf life of cooked and uncooked redclaw, both whole and as tails, have been determined. Vacuum packaging, while extending shelf life, is not suitable for redclaw because of the appearance of the product in the packs. Modified atmosphere packaging increased the shelf life of both raw and cooked redclaw significantly and the appearance of these packs was acceptable to buyers. Frozen uncooked redclaw had good shelf life and acceptability by buyers. This product was thought by industry to be the most suitable to their needs. The meat recovered from the cephalothorax did not yield suitable material for pate production because of high bacterial counts. Due to difficulties in increasing production there may be some delay in these products being adopted by industry.

- The Capricorn Crayfish Farmer's Association wanted to adopt alternate forms of packaging for their redclaw. Currently all redclaw are shipped alive and high mortalities can occur due to inappropriate handling and storage.

- All of the project objectives were achieved through this research. A cooking procedure that will ensure good shelf life has been defined for two sizes of redclaw. A range of

product types and packaging conditions have been evaluated and significant increases in shelf life were achieved.

- When cooking redclaw they should be placed in vigorously boiling water and remain in the cooker for the following times after the water returns to the boil:
  4 minutes for redclaw <80g
  6 minutes and 30 seconds for redclaw >80g.

- Large redclaw have characteristics similar to Moreton Bay bugs and tropical lobster. Small redclaw have better sensory attributes than yabbies. Neither size tasted as sweet as prawns. It would be inappropriate to place redclaw in the market where it would have to compete directly with prawns.

- Vacuum packed redclaw, while nearly as effective in extending shelf life as MAP, is not visually appealing when several layers of barrier bag are required to retain vacuum.

- Cooked redclaw packed in a modified atmosphere can be a viable product if the initial bacterial load is kept low by chemical pre-packaging treatment.

- The demand by caterers and chefs however is for uncooked redclaw because of the way the product is presented to consumers. This market because of its nature also has a preference of fresh over frozen product.

- The number of days shelf life that raw unfrozen redclaw retains acceptable to consumers is directly dependent on the number and type of bacteria present.

- A chemical treatment that reduces the initial microbiological count and one that inhibits blackspot are necessary for the production of MAP uncooked redclaw.

- Uncooked redclaw tails will have a longer shelf life than whole raw redclaw by several days. Redclaw tails stored in MAP will have more than double the shelf life of those stored in air.

- Whole uncooked redclaw will remain acceptable for consumption for between 1.6 and 1.9 times more days than air stored whole uncooked redclaw.

- As the cost of production for raw redclaw tails is higher, the appearance of whole redclaw on a plate more visually appealing and the margin for whole redclaw more profitable, whole uncooked redclaw should be the product to focus on for any future packaging enterprise.

- The utilisation of meat extracted from cooked heads for pate production has limited application. The high bacterial load present makes this process a risky proposition. The utilisation of uncooked tail meat removed from second grade redclaw is not economically viable when other high quality raw seafood materials can be obtained for $6.50 per kilogram.

- The only further work needed is for the industry to adopt standardised grading and handling practices to ensure that the new products can be produced consistently.

KEYWORDS: **Redclaw freshwater crayfish, vacuum packaging, modified atmosphere packaging, cooking methods**

2 BACKGROUND

Capricorn Crayfish Farmer's Association was formed in May, 1993. Initially the aims of the association were to provide an avenue for discussion amongst interested growers and prospective crayfish farmers in the Central Queensland region. The association expanded in membership as more committed growers established farms. This led to a change in the outcomes of the association to meet the needs of this pro-active grower group. Capricorn Crayfish Farmer's Association is an affiliated member of the Queensland Crayfish Association, sharing information with the other grower groups to promote the development of this industry.

The CCFA has an active membership of 22 producers with a number of affiliates. At this time it is not essential for local growers to belong to our association, however our aim is to provide a group of services that will encourage serious producers to belong to CCFA. The association is currently in the process of developing a 5 year market plan and quality assurance guidelines. This involves the writing of a quality assurance program along with significant contributions to the DPI document on postharvest techniques. Also our marketing committee is designing and printing a pamphlet in conjunction with the DPI for distribution to growers throughout Queensland. This pamphlet is to be included in consumer packaging advising consumers of appropriate handling techniques. The marketing committee have organised and undertaken a promotion of redclaw into the Sydney Fish Markets as part of Aquafood '99. Another initiative of CCFA is the launching of a website that links local producers and the DPI Fish Line. Wholesalers can seek contact with producers via this website.

Recent surveys of the producer members of CCFA indicate that they are responsible for at least 30% of the redclaw production in Queensland. These producers are currently growing 15 tonnes of redclaw crayfish with a turnover of approximately 0.3 million dollars per annum. This survey also determined that these growers anticipate these production figures will increase with the introduction of more appropriate marketing packages. Projected production including current growout ponds is expected to be 25 Ha producing in excess of 50 to 75 tonnes per annum. The anticipated gross turnover would be up to one million dollars per annum, accounting for 50% of the state's production.

Many members of CCFA have indicated a desire to expand their operations, and to meet the requirements of quality assurance in the presentation of their product to the consumer. The development of a streamlined marketing system from the outcomes of research, will supply the incentives for growers to improve their operation and increase their levels of production. It is the objectives of the executive of CCFA to assist and encourage the expansion of growout production while achieving quality outcomes.

The increased marketability of redclaw flesh relies on presentation packs that meet the needs of the different consumer groups. Studies into vacuum skin and modified atmosphere packs that are used widely in the seafood industry would allow redclaw to become a more competitive seafood line that would be transportable domestically and internationally. As redclaw is a tropical species of cray it grows faster and is available for southern markets when other colder crayfish are inactive.

As best-practice production methods become the industry norm, the association has altered focus to address marketing issues. Over the previous 18 months, growers have participated in a number of workshops investigating marketing of redclaw. Three concerns had become self-evident to the association through the workshops:

1. The difficulties experienced in the transportation and storage of live animals
2. The short shelf-life of processed crays, and

3. The need to diversify the product into a number of consumer convenient packages.

The executive approached the Central Queensland office of the Queensland Department of Primary Industries for assistance and were directed to the Centre for Food Technology as the most suitable agency for these investigations. These trials need to be performed using appropriate scientific methodology to produce a range of redclaw products with the best possible quality and extended shelf life. After a meeting with the staff at the Centre for Food Technology, our association believed that this organisation was the most appropriate vehicle to undertake our testing. A quotation was completed after consultation and the methodologies determined.

As no previous product development research into the processing of redclaw has been undertaken, duplication of research will not occur. The association had previously investigated processing of similar species to determine if any comparable value-adding research had been completed. To the knowledge of CCFA this research has not been undertaken within Australia.

3 NEED

The CCFA is actively seeking the methods to enhance the marketing of its product, ensuring that it is very transportable from Central Queensland to domestic and international markets. Preliminary overseas marketing at this time has established an international interest in this product. Europe is very keen on crayfish in their diet, and currently is suffering from the devastating effects of the Crayfish Plague. It would be ideal if our product were able to penetrate these markets and establish an identity.

The redclaw crayfish industry is maturing and has become a viable commercial product in the marketplace. The opportunity to expand production is hampered by the difficulties in the marketing and mortalities during transportation of the product. Redclaw do not respond well to being held in aquaria after they have arrived at their markets. Within the Association the executive is aware that there are a significant number of ponds available to boost production. Often people enter the industry in a part-time capacity and are unwilling to expand their production because of lack of facilities to identify appropriate markets and the preferred product market types.

Investigations through ad-hoc grower approaches to their own markets have identified problems with the transportation of live crays. These include costs, packaging difficulties, and the physiological stress experienced by the animals leading to mortalities. After an extensive marketing presentation into the Sydney Fish Markets for Aquafood '99, the Association determined that the consumer in large cities prefer the product to be presented in a more "user-friendly" pack, allowing them greater freedom of choice with the redclaw flesh. Further investigations by the organisation has identified that the only information available on the processing of redclaw was an article in the Australian Fisheries (Vol 94, No 11, 1990) on the acceptability of redclaw and that no research has been conducted on the extension of shelf-life, packaging or product development of this crayfish.

4 OBJECTIVES

1. To investigate a suitable cooking process for redclaw crayfish which will ensure good shelf-life.
2. To investigate the best possible product types and packaging for production by industry
3. To determine fresh shelf-life of vacuum skin packed raw and cooked redclaw
4. To determine fresh shelf-life of modified atmosphere packed cooked redclaw
5. To research the viability of producing redclaw paté

5 GENERAL MATERIALS AND METHODS

As the amount of funding was limited the focus of this investigation was on identifying an appropriate processing method for packaging redclaw. The experiments were conducted by testing as many packaged types possible at the expense of replicating each trial.

The experiments have been separated into different chapters for each trial. Each chapter has a methods section that describes the handling and testing that was unique for the packages produced.

Because a standard cooking method had not been defined for this species this aspect was of high priority. Any experiments on packaging cooked redclaw could not be conducted until this was defined. The comparison of cooked redclaw with other crustacean species could also not be conducted until effective cooking parameters were defined.

Because of the amount of work required uncooked redclaw packaging was evaluated at a different time to cooked product. While redclaw are normally transported alive these experiments were initiated because of the high mortality rates encountered through incorrect storage by customers. To package dead redclaw and still obtain an acceptable shelf life, some chemical treatment was required to reduce the high bacterial load these animals inherit from their growing environment. This treatment was the first aspect investigated and is present in the chapter on raw redclaw.

A large number of handling practices and testing procedures were used during this investigation. As some were applied during all of the trials they have been described in this section here. Methods that are specific to each trial are present in those chapters.

5.1 Chemical treatment for the prevention of blackspot

The two appropriate treatments for preventing blackspot in crustaceans are sodium metabisulphite and 2,4 hexylresorcinol. The former has been known to cause allergic reactions in consumers and is being phased out by western nations. The latter chemical under the brand name of Everfresh is an active inhibitor of polyphenol oxidase and has been studied for its effect on consumers. It has not been found to cause any adverse reactions in consumers. Everfresh was chosen as the most suitable treatment to be applied for redclaw.

Everfresh was applied during the initial killing of the redclaw in an ice slurry. A 200g sachet was dissolved in 95L of freshwater and an equal volume of ice was added. After 30 minutes emersion the redclaw were packaged or cooked and then packaged.

5.2 Physical measurements

Empty packs were weighed before and after filling with redclaw, prior to storage at 4°C. At the end of the storage period the packs were removed for evaluation. After the demerit scores had been recorded and samples removed for microbiological and sensory testing (the methods for these procedures are present below in this section) the empty packs were weighed to identify drip loss and pack yield. The heads were then removed from the sensory samples and the pH of the tail meat from three individuals was measured.

The composition of the atmosphere present in the MAP packs was determined by Gas Chromatography using an Alltech CTR 1 column and Application Note programming. The results are expressed as a percentage of the total gas present.

5.3 Demerit appraisal of packs and product

Packs were appraised using a demerit point system. Scores were associated with particular levels of change in visual and odour characteristics on a score sheet. Examples of score sheets for raw and cooked redclaw can be seen in Appendix 1. The scores were collated for each parameter and a total demerit score calculated for replicates of the packs being appraised. Comments about the various conditions observed were also recorded. The scores were analysed statistically for significant differences between the different treatments and packs.

If the level of visual or odour characteristics of the redclaw within the packs were so poor that a consumer would not accept the product they were not presented for sensory evaluation.

5.4 Microbiological methods

Samples of whole redclaw were taken before and after various treatments and evaluated for microbiological quality. A number of different media and incubation conditions were utilised to obtain counts of particular classes of bacteria. A 10g meat sample from several redclaw was diluted in 90mL of Peptone water and homogenised in a stomacher bag. Aliquots were then plated out using a variety of methods. These methods follow below.

Standard Plate Count (**SPC**) was carried out by the surface spread method (Australian Standard, 1991b) using nutrient agar. The plates were incubated at 30°C to enumerate **Mesophiles** & 4°C to enumerate **Psychrotrophs.**

Hydrogen disulphide (**H_2S**) **producer** counts were estimated by the pour plate method (Australian Standard, 1991a) using iron agar developed by Gram *et al* (1987), when set, the agar was overlayed with the same agar. The plates were incubated aerobically at 25°C for 3 days.

Enumeration of *Clostridium* species

Aliquots of the 1:10 sample preparation were treated in one of three ways:

- 1mL of appropriate dilutions were spread plated directly onto egg yolk agar (EYA) and differential reinforced Clostridial agar (DRCA);
- 10mL was combined with 10mL absolute ethanol and allowed to stand at 20^{o}C for 1h, then appropriate dilutions were spread plated onto EYA and DRCA;
- 10mL was held at 80^{o}C for 10 min, then appropriate dilutions spread plated onto EYA and DRCM

The direct plating enumerates vegetative cells present in the sample. The latter two treatments kill any vegetative cells present in the sample and hence allow enumeration of spores present. EYA plates were incubated at 35^{o}C for 48h and DRCA plates at 30^{o}C for 5-10d. All plates were incubated under anaerobic conditions.

Enumeration of *Vibrio* species

Appropriate dilutions of the 1:10 sample preparation were spread onto thiosulphate citrate bile salts agar (TCBS) plates. Plates were incubated at 35ºC for 18h and colonies typical of *V.cholerae* and *V.parahaemolyticus* noted.

All microbiological counts are expressed as Colony Forming Units per gram of sample (**cfu/g**). This term is used because, theoretically, a single bacterium grown on a plate will produce an entire colony as it divides and increases in numbers.

If the standard plate count (total count) of the redclaw within the packs was expected to be greater than 1,000,000 cfu/g they were not presented for sensory evaluation. This was determined by extrapolating the growth rate for that product trial from the count of the last sample tested to see if the total count would be above or below the acceptable limit.

5.5 Sensory Methods

5.5.1 Background

A trained taste panel is most effective at identifying when subtle changes have occurred in a food product. With proper training good correlation is achieved between a taste panel's sensory scores and microbiological and/or chemical parameters. The results obtained from sensory analysis can be used to identify the limit for storage of a product or the impact on a product of a particular treatment.

Sauces and dips can impact on the flavour of a food item so that samples evaluated by taste panel must be prepared in a simple manner. They can be boiled, steamed, baked or cooked in a microwave oven but invariably without the addition of condiments. Because of the plain nature of the samples presented to taste panel, the scores awarded may be less than the scores an untrained consumer would rate for the product when it is served prepared by an experienced chef. The cooking times applied are usually those known to be best practice or times that give similar characteristics to commercially produced product.

Redclaw samples for this investigation were prepared for sensory analysis by either boiling or steaming. The boiling conditions identified in the early part of this investigation and described in the cooking chapter were used to prepare boiled samples. When the samples were the tail section only, it was impossible to boil them without some loss of flavour and/or odour attributes so they had to be steamed. Intact animals sampled at the same time as stored tails were deheaded prior to steaming. The steaming conditions were developed by steaming tails in a covered aluminium pot for a range of times. The time which produced a similar texture to the boiled samples was used for all other samples evaluated by taste panel. This time would be different to one that would be suitable for steaming whole animals so is not reported here.

5.5.2 Sensory Evaluation

Panellists were selected from staff at the Centre for Food Technology who had previous experience of rating similar seafood products to redclaw.

Two round table training sessions were held for seventeen panellists using different samples of redclaw and the questionnaire to be used for the trial.

A minimum of 14 panellists from the pool of 17 assessed the samples using a standard rating test (AS2542.2.3, 1988) with unstructured line scales. Panellists were also able to choose standard descriptors and add any other additional comments relevant to the sample. Panellists had tasting notes in their booths to which they could refer whilst making the assessments. Panellists were instructed to remove the tail meat from the shell and to cut the sample in half longitudinally. Appearance assessments were made looking at the internal appearance of the flesh, and one half of the tail was used to make the flavour assessment and the other half, the texture assessment. A copy of the tasting notes can be found in Appendix 2.

Assessments were carried out in individual tasting booths illuminated with white light (day light equivalent). Samples were presented on a white plate labelled with a three digit code in a sequential monadic fashion in a randomised order. The plates of samples were served to the panellists on a white tray with a sharp knife to cut the tail meat and a disposable cloth to wipe their hands on. Purified, room temperature water and plain unsalted crackers were available during the sessions for palate cleansing. All samples to be assessed were presented to the panellist simultaneously but the actual order of assessment was randomised and balanced across the panel.

The training and assessments were carried out during 2000. Samples were not served to the sensory panel where the microbiological standard plate count was estimated to be greater than 10^6. Data was collected directly into computers using an integrated software package, Compusense five ver. 3.6 (Compusense Inc, Canada).

5.6 Statistical Analysis

Results from four individual redclaw were used for the major cooking experiments while 10 were tested from the two bulk cooking studies. Each pack of redclaw was sampled in duplicate. From each pack a number of individuals were sampled with the replication within each pack varying depending on the type of test. Only one weight or gas content per pack could be recorded. Originally two individuals per pack were combined for each bacterial extract but when it became apparent that the microbial counts were quite variable this was increased to four redclaw. Four pH measurements were made per pack. Three different staff members recorded their demerit scores for each pack opened.

A minimum of 14 people from a pool of 17 evaluated the sensory attributes. For each attribute panellist scores were analysed in a randomised block factorial analysis of variance with individual panellists considered as a blocking factor and packaging treatment and days stored as factors. Where a significant ($P<0.05$) F ratio was found between treatments then pairwise comparisons were made using Fishers least significant difference (LSD).

The data obtained for the other parameters were analysed using one-way ANOVA with each pack type and storage day an individual treatment. Where a significant ($P<0.05$) F ratio was found between treatments then pairwise comparisons were made using Fishers least significant difference (LSD). Where there was uneven replication the F ratio is reported rather than a collection LSD values.

6 COOKING OF REDCLAW

6.1 Methods

6.1.1 Protease activity evaluation

All animals produce digestive enzymes to help process their food. When an animal dies these enzymes remain active and contribute to the degradation process of the carcass. One group of these enzymes are the proteases. These attack the muscle protein causing loss of texture in most food items. They are highly active in crustaceans and because of the animals body design quickly leak out of the head (cephalothorax) into the tail section (abdomen). If allowed to act after the death of the animal quality will quickly fail.

Protease activity was measured using 0.17% azocasein as substrate. The procedure followed that of Jensen et al. (1980), and one unit of activity was defined as the amount of enzyme required to produce an increase in absorbance at 366nm of 0.01 per hour under the standard assay conditions.

The protease activity of the redclaw digestive enzymes was determined by incubating the enzyme extract with a dye linked protein called azocasein. When the proteases attacked the azocasein, a soluble colour component of the molecule was released into solution while the remaining intact azocasein was precipitated and filtered out of the test solution. A Spectrophotometer measured the colour intensity and the protease activity present equated to the number of units present per millilitre of extract.

6.1.1.1 Protease test optimisation

The azocasein method requires optimisation of the test conditions to ensure sensitivity and accuracy. Sensitivity of the azocasein test is lost above an absorbance of 1.0. Optimisation of the test method involved removal of the hepatopancreas from the head of several individuals. The organs were homogenised with an equal amount of buffer and spun to separate the fat and solids from the extract. The liquid remaining was then diluted further to a number of different concentrations which were then evaluated by the azocasein test. A dilution of 1:100 was found to be optimal for this method.

6.1.1.2 Thermal stability methodology

The thermal stability of the digestive enzymes determines the amount of heating required during cooking to ensure that there is no residual activity. This information was determined using extracts from the hepatopancreas and heating them for a range of times at different temperatures. Extracts were placed into small glass tubes and heated in water at 75°C, 80°C, 85°C and 90°C for up to 330 seconds. The extracts were then tested for residual protease activity using the azocasein test.

6.1.2 Experimental cooking procedure

Redclaw that were to be cooked were counted, weighed and then killed by immersion in an ice slurry for 30 minutes containing Everfresh. After draining for 5 minutes temperature probes (thermocouples) were inserted into the centre of the head (cephalothorax) and the tail (abdomen) of a number of individual redclaw. The thermocouples were attached to a datalogger which recorded the temperature at 5-second intervals. Extra thermocouples were attached to the basket in which the redclaw were held during cooking to monitor the water temperature.

Fresh clean tap water was added to a standard gas fired prawn cooker to a level that would ensure that the redclaw would be covered during cooking. Enough course salt was added to

make a 2% solution in the cooking water. The gas was ignited and kept at a maximum flow bring the water to the boil. The basket containing the redclaw was placed in the boiling water. The cool temperature of the redclaw brought the water off the boil and it took up to several minutes, depending on the weight of product being cooked, for the water to return to the boil. When the water was again boiling vigorously the gas flow was turned down till the water was at a rolling boil with little foaming at the surface.

When the parameters that controlled the particular cooking experiment were attained, the basket was removed from the cooker and placed in an ice slurry that covered all the redclaw. The redclaw were kept in the ice slurry until their internal temperatures were below 20°C. The redclaw were then removed from the ice slurry, drained for 5 minutes and weighed.

6.1.3 Mechanical Texture Measurement

The Instron Universal testing machine fitted with a modified Lee-Kramer shear cell can measure actions that take place in the mouth during chewing of a food product. Research laboratories that evaluate the texture of food use this equipment routinely. In this investigation the **Peak load for mechanical texture** (expressed in kilo Newtons) measured the maximum resistance to shearing that occurs when the teeth cut into a sample. The total amount of the energy required for shearing was expressed as the **Work done for mechanical texture** (expressed in Joules). Both of these measurements were adjusted for the weight of the sample to accommodate sample variation.

6.1.4 Statistical Analysis

The numbers of individuals present in a cook were different for the various trials. A bulk cook had more individuals available for testing than the small batch cooks. Where a significant ($P<0.05$) F ratio was found between treatments then pairwise comparisons were made using Fishers least significant difference (LSD). Because the number of LSD's used were many only the F ratio has been reported.

6.2 Results and Discussion

6.2.1 Thermal denaturation of an extract of redclaw digestive enzymes

Figure 1 in Appendix 3 shows the stability of redclaw digestive proteases after heating at several different temperatures. This data was used to develop a formula that would ensure protease denaturation in whole redclaw.

6.2.2 Cooking of individual whole redclaw

A range of parameters were tried during boiling studies of two sizes of redclaw. Basically they relate to a time that the product needs to be in boiling water. As the boiling time effective for small redclaw did not result in total destruction of the proteases present in the hepatopancreas of large sized crayfish, the times were increased incrementally until there was little residual protease present after cooking.

Table 1 in Appendix 3 contains the data collected for batch size and average weight, boiling times, yield after cooking, residual protease activity and for the two mechanical texture parameters for the various methods applied to control cooking.

There was little weight difference between the two grades of redclaw supplied by growers. Several shipments were required before a consistent grading was achieved. A residual

protease activity of less than 50 units per mL was used as an indication that cooking has been effective. There was no difference between the two sizes for cooked yield for individuals, mechanical texture blackspot development. There was only a difference between the sizes for the protease level. The larger redclaw retained a higher residual protease activity after cooling.

An increase in boiling time did not result in a loss of cooked yield or a change in the texture. Blackspot developed within the head and on the shell in small patches for all of the small batch cooks. This indicated that even though the digestive proteases had been destroyed, the enzyme polyphenol oxidase was still active after effective cooking and able to produce the black pigment melanin. This makes it necessary to apply a chemical treatment which prevents this defect from developing.

The preliminary data indicated that boiling times of 6 minutes for large redclaw (60-100g) and approximately 4 minutes for the small redclaw (40-60g) would produce a product that had little residual protease. The effectiveness of these conditions was then confirmed for large batch size during the bulk cook trials.

6.2.3 Cooking of redclaw in bulk

Baskets containing 16 to 18kg of redclaw were cooked to the above times for each size. The internal temperatures attained during these cooks can be seen in Figures 2 and 3 in Appendix 3. The bulk yield was determined by weighing the full basket of cooked and then cooled redclaw after a standard five minutes draining time. The bulk cooking yields were 98.8% for small (40-60g) redclaw and 96% for large (<100g) redclaw. These were higher than the individual cooked weight recoveries because of the longer drainage time that occurred for the probed individuals and the presence of two holes left after the temperature probes were withdrawn which could have allowed some leakage of internal fluid from individual cooked animals.

After cooling the cooked redclaw residues for 4-hexylresorcinol were 1.4mg/kg for large and 1.7mg/kg for small redclaw. While it has been approved for domestic application, the Australian and New Zealand Food Authority has not applied a maximum residue for 4-hexylresorcinol residue. Some overseas countries have maximum permitted levels ranging between 0.5 and 1mg/kg. If the packaged redclaw products currently under trial are intended for export then the concentration of the Everfresh treatment will have to be reduced. The time this chemical is applied probably can remain the same as redclaw appear to recover quickly after removal from this dip.

While the average residual protease activity was quite low after cooking several individuals did have activities close to or above the 50 units/mL threshold. An increase of the boiling time for the large redclaw to 6 minutes and 30 seconds or more would be appropriate to ensure that all individuals were adequately cooked. The texture of the cooked redclaw from the bulk cooking trial was firmer than previously tested. The size of individuals was similar to those used for a similar boiling time suggesting that there is a difference between the textures of redclaw from the two suppliers. This may be an artefact of different water conditions, feeding regimes or genetic origins of the two different supplies of redclaw.

7 COMPARISON OF COOKED REDCLAW WITH OTHER CRUSTACEAN SPECIES.

7.1 Methods

7.1.1 Sensory comparison of crustacean species

Taste panel evaluated a range of crustacean species. This helped establish the sensory characteristics of redclaw and how consumers placed it as a seafood commodity. Panellists were selected from staff at CFT who had previous experience of rating crustacean species and had used the same questionnaire to rate redclaw in other trials. The samples presented to panel were:

1. Cooked, frozen small whole redclaw
2. Cooked, frozen large whole redclaw
3. Cooked, frozen whole tropical lobster
4. Cooked, frozen whole yabbie
5. Cooked, frozen black tiger prawns with heads removed
6. Cooked, frozen whole Moreton Bay bug

All samples were received in a frozen state. The small and large redclaw were received in an open plastic crate. The lobsters were covered in shrink-wrap plastic and frozen. The yabbies were in an unsealed cardboard box with quite a lot of frost on them. Samples were drawn from the bottom of the box where the degree of icing was less. The prawns were received in a double layer, zip lock plastic bag. One batch of Moreton Bay bug was frozen open in a plastic crate and the others were in a plastic bag and wrapped in paper.

The lobster, prawns and Moreton Bay bug had been purchased commercially already cooked and frozen. Both sizes of redclaw and the yabbies were cooked and frozen by Seafood R&D staff at CFT, however the yabbie had been in frozen storage for a longer period of time.

Samples were allowed to thaw overnight at 2^{o}C. The heads were pulled off the yabbies and redclaw samples and rinsed if necessary to remove any extraneous matter. The lobster tails were removed and the tail cut into five portions. The extreme ends of the tail were not used. The samples were stored at 4^{o}C prior to serving. The evaluation was similar to that described earlier.

7.2 Results and Discussion

7.2.1 Sensory scores

The tables presented in Appendix 4.1 highlight the sensory profile of the species tested.

7.2.1.1 Appearance

Table 2 shows the flesh of the crustacean species tested was mainly described as being white in colour with the exception of the yabbie. While 37% of panellists described the flesh of the yabbie as being white, this was used much less frequently describe the other species. Yellow was used to describe the yabbie more than any of the other species. Forty-one percent of panellists chose pink tinge as a descriptor for the lobster flesh. None of the samples tested had black spot present. The small and large redclaw and yabbie were more often described as being moist rather than dry in appearance than the other species rated.

7.2.1.2 Odour

Yabbie had the lowest level of crustacean odour and was significantly different ($P<0.01$) to all the other species except for the small redclaw (Table 3 in Appendix 4.1). Small redclaw had a slightly higher level of crustacean odour and was similar to the Moreton bay bug and large redclaw. The large redclaw and the lobster had similar levels of crustacean odour. The prawn, which had the highest level of crustacean odour, was very similar to the lobster. All species had low levels of fishy odour and there were no significant differences between samples.

The prawn and lobster had the lowest level of 'other' odours and were not significantly different to each other. Yabbie, Moreton Bay bug and large redclaw had similar levels of 'other' odour, which were significantly higher ($P<0.01$) than the levels found in prawn, lobster and small redclaw level. The descriptors selected (Table 4) and comments for the yabbie indicate stale, muddy, musty and sulphury type odours.

Comments and descriptors selected for the Moreton Bay bug suggest the 'other' odour was ammoniacal, musty and cabbagy. Odour comments and descriptors selected suggest cabbagy, musty and off odours was the 'other' for the large redclaw. These comments and descriptors suggest that the quality of these species is not optimum. A full list of the comments made can also be found in Appendix 4.2.

7.2.1.3 Flavour

The lobster, prawn and large redclaw had a similar level of crustacean flavour which was higher than the level found in the small redclaw, yabbie and Moreton Bay bug (Table 5).

There were no significant differences ($P>0.05$) between species for salty, muddy, cabbagy and fishy flavours or for the level of aftertaste.

The Moreton Bay bug had a very low level of sweetness which was significantly lower than all the other species. The yabbie, small redclaw, and lobster had similar levels of sweetness. Of these three the lobster had the highest level of sweetness which was also similar to the sweetness of the large redclaw. The prawn had the highest level of sweetness and was significantly ($P<0.01$) sweeter than all the other species tested.

Some stale flavours were perceived in the samples, in particular the Moreton Bay bug and the yabbie, which both had significantly higher ($P<0.01$) levels of stale flavour than the other species. Although there were some differences between the levels of stale flavours in the other samples, the actual level these were perceived at was very low (below 13 on a 100 point scale).

The Moreton Bay bug and the yabbie both had significantly higher levels of off flavours than the other four samples. However, these were still below 10 on a 100 point scale.

Very low levels of 'other' flavour were found for prawn and large redclaw. The lobster and small redclaw were also similar with slightly higher levels of other flavour present. The Moreton Bay bug and yabbie had significantly higher levels of 'other' flavours than all the other species. The descriptors selected (Table 6) and the comments made indicate that the Moreton Bay bug had cardboard, vegetable and weedy/herbaceous flavours present although over all it was very bland. The yabbie also had vegetable and weedy/herbaceous flavours present and was described as a very watery flavour. Once again this suggests these samples tested may not be of optimum quality.

7.2.1.4 Texture

The firmest sample was the prawn, which was similar to the lobster (Table 7 in Appendix 4.1). The Moreton Bay bug was less firm than the prawn and lobster but firmer than both sizes of redclaw and the yabbie. The large and small redclaw and the yabbie were very similar in their firmness.

The prawn was significantly springier than all the other species. The lobster, large redclaw and Moreton Bay bug were similar and were all springier than the yabbie and small redclaw.

The large redclaw was significantly ($P<0.01$) moister than all the other species tested. The small redclaw and yabbie were similar and were the samples with the next highest level of moistness after the large redclaw. The lobster and Moreton Bay bug were similar and were the driest samples.

None of the samples were rated as being particularly mushy and there were no significant differences between the samples. There were no significant differences ($P>0.05$) in toughness between both sizes of redclaw and the yabbie. The prawn, lobster and Moreton Bay bug were also very similar and had much higher levels of toughness than the other three species.

From the descriptors (Table 8), the small and large redclaw were described as being chewy and fibrous less often than any of the other species tested. From the comments panellists selecting 'Other' for the small and large redclaw indicate that the flesh was soft (see Appendix 4.2). It is likely that the Moreton Bay bugs had been previously been frozen rather than being freshly cooked as requested when purchased. A second freezing would have caused the stale, dry, tough product encountered by the taste panel.

7.2.1.5 Overall Quality

The mean sensory scores for overall quality are displayed in Table 9 in Appendix 4.1.

The poor quality of some of the commercially supplied species has led to large differences between the scores of the samples tested. There were significant differences ($P<0.01$) in the overall quality of the samples of species tested. The prawn and large redclaw were similar and were the best quality samples. The Moreton Bay bug and the yabbie were both of very poor quality which was significantly lower quality than all the other samples. The lobster and small redclaw were also of similar quality which was higher than the Moreton Bay bug and yabbie but lower than the prawn and large redclaw.

7.3 Summary

The sensory appraisal indicates that small and large redclaw, while being acceptable, should be marketed differently. Large redclaw can match the attributes of Moreton Bay bug, tropical lobster and can be a cost effective alternative for caterers.

While small redclaw can be more acceptable than yabbies they should never be placed in direct competition with prawns as the sweetness and cost of the latter will be more acceptable to consumers.

8 PACKAGING OF FRESH COOKED REDCLAW

8.1 Methods

8.1.1 Preparation

The redclaw were prepared (Section 5.1) and cooked (Section 6.2.3) as described in the preceding sections. Packs were then prepared as described below.

8.1.2 Modified Atmosphere packs

The modified atmosphere packs (MAP) were composed of polystyrene trays lined with a polypropylene barrier film that was bonded to a 50μm polypropylene barrier film with antifogging characteristics. To fit the redclaw into the tray the antennae were removed using scissors. An absorbent pad was placed onto the bottom of the tray and the product placed on top of the pad. The tray was placed into the packing machine and the film pulled over the tray. The machine closed, the chamber and tray evacuated of all air and the modified atmosphere, containing 60% carbon dioxide and 40% nitrogen, introduced between the film and the tray. After several seconds of gas flushing the lidding film was then heat sealed onto the lip of the tray. The packs were stored in a cold room at 4°C. The packs were weighed empty, after the redclaw had been loaded and after removal of the redclaw at the end of storage.

8.1.3 Vacuum packs

Because of the sharp spikes present on the claws, arms and head of the redclaw a number of layers of barrier bag were required to produce a vacuum pack of redclaw. Two layers of barrier bag, one of them 150μm thick were insufficient to prevent piercing. Three layers of barrier film were required to retain vacuum within the packs. Ten individual whole redclaw or 20 redclaw tails were placed in a 150μm polyethylene barrier bag. The bag was covered by a layer of cellophane on the side dorsal to the redclaw to prevent piercing of a second 150μm polyethylene barrier bag. The outer bag was evacuated and heat-sealed. The packs were stored in a cold room at 4°C.

8.1.4 Air packs

Redclaw were placed into open plastic bags containing an absorbent pad and stored at the same time as the other packs in a cold room at 4°C. This is not best practice for most seafood but these packs were intended as a control for the other types of pack. The packs were weighed empty, after the redclaw had been loaded and after removal of the redclaw at the end of storage.

8.1.5 Testing procedure

The redclaw were stored in the air, MAP or vacuum packs for up to 14 days at 4°C. When opened after the demerit point scores were recorded, the microbiological samples were taken. The remaining redclaw were then sent to the sensory evaluation unit for testing.

8.2 Results and Discussion

The recommended cooking conditions of 4 minutes boiling time applied to three batches of small to medium sized redclaw (average 50g) resulted in very good yields (98.5 to 100%), regardless of batch size, and an absence of residual protease activity.

A photograph of cooked redclaw in MAP can be seen as Figure 4 in Appendix 5. The sharp spines present on the cephalothorax easily penetrated the barrier membrane used for the vacuum packs so that several layers had to be used. This reduced the view of the product within the packs and could have a negative impact on consumers purchasing this product. Because there were several layers to the vacuum packs the product yield at the end of storage was impossible to calculate.

8.2.1 Demerit scores

The mean demerit scores recorded for the various packs of cooked redclaw are present in Appendix 5 as Table 10. There were significant differences between the treatments on different days for shell colour, odour at unpacking and total demerit points scored. The chemical treatment and cooking conditions were sufficient to prevent blackspot from developing. The absorbent pads placed in the packs were able to remove all of the drip from each of the different packs resulting in zero drip scores. As could be expected, the scores for most of the parameters did increase with storage time.

Off odours were detectable after four days storage but they did not become strong until day 11. This was due to the absence of any hydrogen disulphide (H_2S)-producing bacteria (Table 11), the main cause of off seafood odours. By day 11, MAP redclaw had better scores than those that were stored in air or vacuum pack. The MAP redclaw were the only ones evaluated by taste panel because of the poor quality present in the other packs at this time. A much longer shelf life should be possible if a chemical treatment is used to reduce the initial bacterial load prior to packing.

8.2.2 Physical and microbiological measurements

A breakdown of the gas analyser prevented the measurement of the composition of the headspace in the MAP packs before and after storage. Table 11 in Appendix 5 shows the microbiological and physical data collected for this trial.

Bacterial numbers increased rapidly from low initial counts. There was no significant difference ($P>0.05$) between the counts of redclaw from any storage environment. There were significant increases ($P<0.01$) of bacteria as storage progressed. Even the MAP stored redclaw developed high counts within 11 days. This was unexpected and suggested that there was a source of contamination coming from the animal itself. Many species of bacteria are motile and they could have originated from outside the shell. The packaging materials were clean and kept covered and the handling was appropriate for this type of product so that the contamination of the tail meat must have been coming from other parts of the redclaw body. While the total counts rose to high levels after 7 days at 4°C resulting in a loss of quality, no bacteria that could compromise the safety of the food were identified.

While there were significant differences ($P<0.01$) between the different treatments for pH of redclaw the actual level did not change much during storage. MAP stored redclaw had a lower pH than those stored in air or vacuum. This is one of the reasons that MAP product has lower microbiological counts during storage. The product yield from the packs dropped as MAP storage progressed, as expected, but it does not constitute an excessive drip loss.

8.2.3 Sensory scores

The sensory panellists appraised only the cooked meat from the tail. This was supplied shell-on and they removed the flesh themselves. The tables in Appendix 5 show the percentages of panellists who selected a particular descriptor for a sample at each time point. For example, in Table 12, 81% of panellists selected white to describe the air-stored samples at day 0. This means that 11 out of 14 panellists selected white to describe that sample. The comments recorded by the panellists are also present in Appendix 5.

8.2.3.1 Appearance

Initially the flesh from all three redclaw treatments was frequently described as being white or cream in colour with pink tinges (Table 12 in Appendix 5). They were also described the flesh as looking moist and being intact. Over the 11 days of storage, the MAP stored redclaw was described as being white less often and cream more often. Black spot was not visible at any of the time points for any of the treatments.

Over time there was a tendency for the vacuum packed redclaw to become slightly drier in appearance whereas there was no change in the moistness of the air stored or MAP product.

8.2.3.2 Cooked Odour

For each table of mean sensory scores, the individual means for each packaging treatment is listed for each time point assessed. No significant differences ($P>0.05$) were found between treatments for any of the attributes measured. The 'Day' row in the table gives the mean of all treatments for each time point and these values are used to indicate whether there are significant ($P<0.05$) changes over time. The LSD value in the 'Day' row provides a measure of variability and has been used to identify significant differences between days.

Table 13 displays the mean of the sensory scores for the cooked odour. No significant differences ($P>0.05$) were found between the different packaging treatments at any of the time points for any of the cooked odour attributes. However, overall, significant differences ($P<0.05$) were found over time. By day 7 the crustacean odour was significantly lower ($P<0.05$) than at day 0 and 4. At day 4, the level of fishy odour was significantly higher ($P<0.05$) than at day 0 however this difference was not found at day 7.

Overall the level of 'other' odour was significantly higher ($P<0.05$) at day 7 than at days 0 and 4. From the descriptors (Table 14) and comments, the increase in 'other' odours can be attributed to increasing levels of stale, sulphury, sweaty, vegetable and herbaceous odours (see Appendix 5 for full list of comments).

8.2.3.3 Flavour

As with cooked odour, no significant differences ($P>0.05$) were found between the three packaging treatments for any of the flavour attributes. The level of crustacean flavour decreased significantly ($P<0.05$) from day 0 to day 4 but no difference was found between day 4 and day 7 (Table 15). Initially there was no change in the level of staleness but this increased significantly ($P<0.05$) at day 7.

No significant differences ($P>0.05$) were found for salty, sweet, muddy, cabbagy, fishy, off, 'other' or aftertaste. From the descriptors (Table 16), the redclaw were also described as being peppery, vegetable and weedy/herbaceous, although the frequency of selection of these was similar throughout the storage period.

8.2.3.4 Texture

Again, no significant differences (P>0.05) were found between packaging treatments but significant differences (P<0.05) were found for texture over time (Table 17). The samples were significantly (P<0.05) less moist after 4 days and again after 7 days of storage.

At day 7 the samples were also found to be significantly less (P<0.05) mushy than at days 0 or 4, although at all 3 time points the level of mushiness was very low. No significant differences (P<0.05) were found in the firmness, springiness or toughness of the samples over time. The main descriptor (Table 18) selected for the samples at days 0 and 4 was stringy.

8.2.3.5 Overall Quality

No significant differences (P>0.05) were found between the three packaging treatments for the overall quality of cooked redclaw (Table 19). There was no significant difference (P>0.05) from days 0 to 4 but there was a significant decrease (P<0.05) in the overall quality of the samples at day 7. By this time the average overall quality score was 52 on a 100-point scale, where 0 is very poor quality and 100 is very good quality.

8.3 Summary

The cooked redclaw stored in MAP had the longest shelf life. The number of days attained before the product became unsuitable for consumption, for all of the treatments, was limited by the high bacterial count present that developed during storage. A chemical treatment is required. Only MAP packed redclaw was safe to send to tasters by day 11.

As could be expected the product stored in air had the shortest shelf life. The vacuum packed cooked redclaw were difficult to pack because of the sharp spines on the carapace and claws so that several layers of barrier bag were required before an effective seal could be achieved. The vacuum packed product had similar bacterial counts on the days of evaluation but received lower scores both visually at unpacking and by the taste panel to MAP product. This was due to a number of parameters listed in the tables but one of the most pertinent aspects was that redclaw meat packed under vacuum appeared and tasted drier than MAP stored product.

9 FEASIBILITY OF USING MAP ON UNCOOKED REDCLAW

As discussions between the redclaw growers and a number of redclaw customers identified that an uncooked product was of more value to the catering industry, they pushed for storage trials to be carried out principally on raw redclaw.

9.2 Methods

9.2.1 Source of bacterial contamination in cooked redclaw

High bacterial counts limited the shelf life of cooked redclaw even though the cooking process applied was prolonged. Some bacteria produce spores that are activated by heating. To be able to package uncooked redclaw the initial bacterial load must be greatly reduced from what is present in normal supplies, probably by chemical treatment. To identify the source of these bacteria, the processing water and the shell of cooked MAP and freshly killed uncooked redclaw were sampled for bacterial load.

9.2.2 Evaluation of uncooked redclaw in MAP

Several MAP packs of uncooked redclaw tails were prepared as for the cooked redclaw trials and stored at 2°C. They were then evaluated visually and through touch during storage at 4°C using the procedures previously described.

9.2.3 Chemical treatment of uncooked redclaw

A number of different chemical treatments were applied to uncooked redclaw progressively through five separate trials to reduce the bacterial load. Chlorine dioxide (ClO_2) has been promoted as being effective at reducing bacterial numbers without any effect on a product's flavour so this chemical was applied to uncooked redclaw that had been recently killed. A drainage time of 10 minutes followed all chemical treatments.

9.2.3.1 Trail 1

The first trial incorporated a control batch (no chemical treatment) was compared with redclaw dipped in 50ppm or 200ppm activated (with acetic acid) solutions of chlorine dioxide for 5 minutes and drained for 10 minutes before sampling.

9.2.3.2 Trial 2

Stronger dips in 200ppm & 500ppm chlorine dioxide solutions activated with acetic acid for 5 minutes were compared with no chemical treatment (control) during the second trial.

9.2.3.3 Trial 3

A new supply of chlorine dioxide was obtained and evaluated using the previous treatments but also including an even stronger solution of 1000ppm chlorine dioxide and another chlorine compound (sodium hypochlorite at 1%) during trial three.

9.2.3.4 Trial 4

During trial four the sodium hypochlorite dip concentration was increased to 2%.

9.2.3.5 Trial 5

The final trial evaluated weaker dip strengths, 1% sodium hypochlorite and 500ppm chlorine dioxide, for a longer dip time of 10 minutes, to minimise flavour carryover.

9.3 Results

9.3.1 Source of bacterial contamination in cooked redclaw

The tap water used to cool the cooked redclaw could be a source of contamination as well as the animal itself. Testing the shell of the redclaw found that it had a higher bacterial load than the flesh. While this was not anticipated in the purged redclaw supplied by the growers, it is understandable as the animal lives on and in the sediment of ponds. To ensure that the effect from both sources was minimised, it was obvious that a chemical treatment was required to reduce the bacterial load before packaging.

9.3.2 Evaluation of MAP uncooked redclaw

There was no discolouration of the shell apparent after 21 days storage. The carbon dioxide present in the mix had no effect on the natural pigments present in the shell indicating that this type of packaging could be suitable for uncooked redclaw.

After one week of storage at 2°C, the standard plate count was 4,200 cfu/g. After four weeks of storage at 4°C the standard plate count was 12,000,000 cfu/g. A high count such as this would not be unexpected after four weeks storage of raw seafood. Within this research study a count greater than 1,000,000 cfu/g is considered unfit for consumption by the taste panel. The cooked texture was acceptable with only minor mushiness of the muscle tissue that penetrates the cephalothorax. There appeared to be little effect on the texture of the meat within the posterior part of the tail.

After 14 days storage there had been some increase in the extent of tissue softening but it was still only present in the anterior portion of the tail meat. The period of starvation before packaging was obviously sufficient to limit the amount of digestive enzymes present. These results indicated that an acceptable MAP or vacuum pack of whole redclaw could have been possible to produce so the chemical treatment experiments were conducted.

9.3.2 Chemical treatment of uncooked redclaw

9.3.2.1 Trail 1

Table 20 shows that neither concentration of chlorine dioxide was very effective in reducing the total count of bacteria present on the various components from the control level. The application of stronger dips was required.

9.3.2.2 Trial 2

Table 21 shows there was still very little impact of the stronger chlorine dioxide dips on the bacterial load. These were high levels of treatment for this chemical, certainly much higher than recommended by the distributor, which should have been effective. This suggested that there was sometime wrong with the chlorine dioxide supplied so the concentration of the 5% bulk solution was tested. The actual concentration was only 1.5% so a new supply of chlorine dioxide (tested at 5.3%) was obtained and evaluated in conjunction with a sodium hypochlorite solution.

9.3.2.3 Trial 3

Table 22 displays the microbial counts obtained for all of the five treatments. There was a similar reduction in bacterial numbers for all of the chemical treatments. While effective, these chemical treatments resulted in only a one log reduction (10% of original count). There was no trend of lower counts obtained from using a higher chlorine dioxide

concentration. The extent of reduction provided by sodium hypochlorite might be improved by an increase in dip concentration.

9.3.2.4 Trial 4

The higher concentration of sodium hypochlorite (2%) resulted in a microbial count for the shell of 4.732 cfu/g and the flesh of 4.403 cfu/g. This result is not much different from that obtained for the 1% dip. The product did have a strong smell of chlorine which dissipated when the redclaw were cooked. To avoid excessive chlorine odour developing in the packs a longer dip time in a lower concentration would be more appropriate.

9.3.2.5 Trial 5

The data obtained from the final trial (Table 23) shows the application of a lower dose of chemical for a longer dip time to be more effective in reducing the bacterial load of the flesh than the previous trial. There were much larger reductions in the microbial count present than observed in any of the other chemical trials.

9.4 Summary

The information gained through these experiments indicates that the packaging of uncooked redclaw was feasible when a chemical treatment was used prior to packing.

The use 500ppm CLO2 for a dip time of 10 minutes is the most suitable for treatment prior to packaging redclaw as there is less chemical odour due to fewer chlorine ions present when this chemical is used.

The next packaging trials could now be focused on packaging of uncooked redclaw.

10 PACKAGING OF FRESH UNCOOKED REDCLAW

As the behaviour of uncooked redclaw flesh when exposed to the conditions of the modified atmosphere was now known because of the feasibility study, raw redclaw packed under MAP were evaluated. The growers were mainly interested in producing a chilled uncooked redclaw product so that both MAP and vacuum packs were evaluated in a storage trial. An attempt was made to increase the statistical validity of the outcome by repeating the trial. Because of the poor performance of the packaging materials, vacuum packs were not prepared for this second experiment.

While the demand for whole uncooked redclaw had been identified from discussions with caterers, the extent of textural loss resulting from MAP storage of this commodity could not be quantified by the preliminary trial. A direct comparison of head-on and deheaded uncooked redclaw in the various packages during storage was required to determine consumer acceptability of either product. This meant the testing of 6 different products after various intervals during storage at 4°C.

10.1 Methods

10.1.1 Preparations for packaging fresh uncooked redclaw

Live redclaw were obtained from farms owned by members of the Capricorn Crayfish Growers Association. The redclaw were air freighted dry to the laboratory where they were kept in aerated tanks overnight. The next day the redclaw were killed by holding in an ice slurry containing 2,4 hexylresorcinol (trade name Everfresh) at a concentration of 0.2% for 30 minutes to prevent blackspot. The redclaw were then drained for 5 minutes and immersed in a 500ppm chilled solution of chlorine dioxide (trade name Zydox) for 10 minutes to reduce the bacterial load. The redclaw were then drained for 10 minutes before packing. The redclaw that were to be packed as tails had the head removed by holding each section in a hand while twisting and pulling the sections apart.

10.1.2 Packaging conditions

The packs were prepared as described in the earlier cooked packaged redclaw section (8.1.2-4). On the first day of storage the packs were opened soon after packing for testing.

10.1.3 Statistical model

Due to the structure of each trial, it is not possible to combine results and perform one analysis. Trial 1 has six treatments while trial 2 has four treatments and different methods of applying Everfresh and chlorine dioxide effectively changes the nature of the treatments.

10.1.3.1 MAP, Vacuum and air stored uncooked redclaw, Trial 1.

Data was analysed by analysis of variance as a randomised block split plot factorial with six redclaw treatments:

1. Modified atmosphere packaged (MAP) green redclaw tails
2. Vacuum packaged green redclaw tails
3. Air stored green redclaw tails
4. Modified atmosphere packaged (MAP) whole green redclaw
5. Vacuum packaged whole green redclaw
6. Air stored whole green redclaw

as one factor and storage time (up to day 12) as a split plot factor. Panellists were considered as a blocking factor. At day 15 treatments reduced to three and these are not included in the analysis.

10.1.3.2 MAP and air stored uncooked redclaw, Trial 2.

The data from this trial was analysed at each time as it was not efficient to consider an across time analysis as in trial 1. This is because only at times 0, 5 and 8 days were all treatments available:

1. Modified atmosphere packaged (MAP) green redclaw tails
2. Air stored green redclaw tails
3. Modified atmosphere packaged (MAP) whole green redclaw
4. Air stored whole green redclaw

At each time, treatment data were compared in a randomised block analysis of variance with panellists considered as a blocking factor.

Some bacterial colonies grown during the first raw redclaw storage trial appeared to suggest the possible presence of Vibrio species, so a TCBS plate was added to the range of microbiological test media during the second trial to determine the count of these species. To cope with the amount of individual variation present the replicate number was increased for this trial.

For both trials, where a significant ($P<0.05$) was found, then treatment means were compared using Fishers LSD.

10.2 Results and Discussion

A photograph of redclaw in MAP can be seen as Figure 5 in Appendix 7.

10.2.1 Uncooked Redclaw Stored In Map, Vacuum Packs And Air, Trial One.

10.2.1.1 Gas content of MAP packs

To achieve extension of shelf life when using MAP the oxygen content within a pack should be below 1%. This inhibits the growth of aerobic bacteria. Figure 6 in Appendix 7 shows the composition of the different gases in MAP packs during storage for trial one.

The oxygen content of the packs was low for the whole storage time and only rose above 1% occasionally. The carbon dioxide content dropped initially because of uptake by the product. The whole redclaw packs contained a larger mass and water content than tails and this led to a greater uptake of carbon dioxide. The nitrogen present was sufficient to maintain pack configuration and prevent the lid from being drawn inwards.

10.2.1.2 Pack yield and pH

Table 24 in Appendix 7 displays the physical data collected during testing. The product yield from most packs during storage was good, usually greater than 95%. The whole redclaw packs had significantly ($P<0.05$) lower yields than the ones containing tails. The vacuum packs resulted in significantly ($P<0.01$) lower yields of approximately 3% from air and MAP storage. The packs that resulted in markedly the lowest yields were whole redclaw in vacuum packs.

The redclaw in MAP had significantly ($P<0.01$) lower pH than vacuum packed redclaw which was in turn significantly lower than air stored redclaw, whether they were tails or whole. There was a tendency for pH to increase during storage. The pH of air-stored product increased quicker than in the MAP and vacuum packs. Overall the final pH of the products was not very much different to the starting levels.

10.2.1.3 Demerit scores

Table 25 in Appendix 7 displays the demerit scores recorded during storage for trial one. The pre-packaging treatments were very effective in maintaining the quality of redclaw. The application of Everfresh was able to prevent blackspot development for up to 12 days in air and 15 days in MAP vacuum pack. The pack of whole MAP redclaw exhibited individuals with only slight discolouration but this was not significant. As high residues of Everfresh were present at the start of storage increased dip concentrations for this chemical would not be feasible.

There were only some minor differences between the other demerit scores of the two forms of redclaw packed. Whole redclaw scored significantly ($P<0.01$) higher for drip loss that was reflected by the lower product yields. The vacuum packed redclaw had higher drip scores that resulted in lower yields than air and MAP stored product.

The colour of the shell deteriorated significantly ($P<0.01$) with storage time and air storage led to more extensive discolouration ($P<0.01$) than the other treatments. There was no difference between tails and whole redclaw. As noted during the preliminary evaluation, the modified atmosphere did not cause any change to the shell colour.

They also exhibited more extensive ($P<0.05$) staining of the flesh by the hepatopancreas. The air-stored product exhibited more staining than the MAP while the vacuum packs were similar to both. The rate of deterioration of the colour of the flesh was not different for any treatment. There were concerns that the acid nature of MAP would accelerate the denaturation of the flesh giving it a blanched appearance.

Off odours developed quicker ($P<0.01$) during air and vacuum storage, compared to MAP. This aspect is difficult to explain with respect to the microbiological findings because the counts did not develop very quickly. This was probably due to the low number of hydrogen disulphide producers present. There was no difference between the odours scores for whole redclaw and tails.

The total demerit scores reflected the trends of the individual parameters. MAP redclaw had significantly ($P<0.01$) lower scores than air-stored product with vacuum packed redclaw similar to both. There was no difference between the total scores for whole redclaw and tails.

10.2.1.4 Microbiological counts

Table 26 in Appendix 7 contains the counts for the various microbiological groups obtained from packs of air, MAP and vacuum stored uncooked redclaw over a storage period of 19 days. Dipping redclaw in a 500ppm chlorine dioxide solution for 10 minutes and draining for 10 minutes prior to packing was effective in reducing the initial microbial load by one to two log counts. Even though this treatment produced a reduction in bacterial load, there was a large amount of microbiological variability between the samples. This can be seen with the large range of counts present on the day of packing and an apparent reduction in numbers for some products after further storage. There were no differences between whole and tail redclaw packs for any count.

Vacuum product had significantly ($P<0.01$) lower total counts than air stored product while the MAP was similar and between both counts. The trend was similar but of lower significance ($P<0.05$) for the psychrotroph count. Unexpectedly, the air-stored product had significantly ($P<0.01$) higher anaerobic counts than in MAP, while the vacuum stored counts were similar to both. The anaerobic counts obtained from the pasteurised flesh extracts show that these bacteria presented little risk to consumers.

Air stored redclaw had the shortest shelf life as the acceptability threshold (total log counts of 6) was exceeded by the 8th day. Off odours had become detectable by this time even though there were no hydrogen disulphide-producing bacteria present on any of the products produced. As these bacteria are the main contributors to seafood off odours and off flavours this would explain why few off odours and off flavours were detected until the total counts reached a log count of 6. Over the length of the trial the taste panel never identified any off flavours.

Whole redclaw in MAP and vacuum packs had excessive total counts by 12 days while the packs containing only tails had unacceptable counts after day 15.

10.2.1.5 Sensory scores

10.2.1.5.1 Appearance

The appearance descriptors (Table 27 in Appendix 7) show that the flesh of all the redclaw samples was initially described as white. With storage, there was little change in the percentage of panellists selecting white to describe the vacuum packed and air stored redclaw tails, however, for the MAP tails and whole redclaw, the vacuum packed whole and the air stored whole, white was chosen much less frequently over time. The percentage of panellists selecting pink tinge to describe the appearance of the flesh increased over time for all samples. For the air stored whole redclaw at time 12, beige, grey and yellow were also selected to describe the sample. The sensory panel did not assess the sample at time 15.

Black spot was only selected by a very small percentage of panellists at time 12 for the MAP whole and the air stored whole samples. Black spot was not selected for any other samples at any storage time. All treatments were similar in moistness of appearance at day 0. However, at day 12, moist was selected more often to describe the three tail meat only treatments than the three whole treatments, and dry was selected more to describe the MAP and vacuum packed whole samples at day 12. Apart from day 0, gaping was selected to describe the whole vacuum packed redclaw more than any other samples at all time points. This could be due to a problem with redclaw being crushed under the vacuum.

10.2.1.5.2 Odour

No significant differences ($P>0.05$) were found in the level of crustacean odour between treatment types or over time (Table 28 in Appendix 7). For fishy odour, no significant differences ($P>0.05$) were found between the different packaging treatments. While over the duration of the storage time the level of fishy odour was significantly ($P<0.05$) lower at days 5 and 8 than day 0 and increased again day 12, the actual level of fishy odour at all time points was very low.

In general the level of ‘other’ odour tended to increase with storage time. From the descriptors (Table 29 in Appendix 7) and tasters comments this may be due to the development of sulphury, cabbagy and ammoniacal type odours.

10.2.1.5.3 Flavour

Although quite a variation in the level of crustacean flavour was identified between treatments at day 0, after 8 or 12 days storage no significant differences ($P>0.05$) were found between the six treatments (Table 30 in Appendix 7). Where the level of crustacean flavour started lower, the level tended to remain more constant (vacuum packed tails, air stored tails and whole MAP) than where the levels started higher. Although not significant ($P>0.05$), it is noticeable that the whole air stored product had the lowest level of crustacean flavour at day 12.

No significant differences (P>0.05) were found for saltiness or sweetness between any of the packaging treatments (Table 30b and 30c in Appendix 7). Over all treatments the level of saltiness was perceived at days 8 and 12 as being significantly (P<0.05) lower than at days 0 and 5. However, no salt was added during cooking and the actual level of saltiness perceived is very low at all time points (all being below 10 on a 100 point scale where 0 is no saltiness and 100 is very salty).

For all treatments, the level of sweetness decreased significantly (P<0.05) up to day 8 then appears to stabilise after this point. No significant differences (P>0.05) were found in the level of muddy flavour for any of the packaging treatments or over time (Table 30d in Appendix 7).

At 12 days storage in air and vacuum the whole redclaw had the highest levels of cabbagy flavour (Table 30e in Appendix 7), although a significant (P<0.05) difference was only found between the air stored whole redclaw (highest level) and the MAP whole redclaw (lowest level). The amount of cabbagy flavour in the MAP, vacuum and air stored tails and whole MAP tended to remain more constant than the levels in the vacuum and air stored whole which increased significantly from day 0 to day 12. From the mean scores at day 0 however, there is evidence that the level of cabbagy flavour is variable between treatments, even though the redclaw were randomly allocated to each of the six treatment types.

No significant differences (P>0.05) were found between packaging treatments for the level of fishy flavour (Table 30f in Appendix 7). Over time, the level of fishy flavour followed the same pattern as the fishy odour in that at days 5 and 8 there was significantly less (P<0.05) fishy flavour than at day 0, but at day 12 there was no significant difference (P>0.05) from day 0. Again, it should be noted however that at all days the actual level of fishy flavour perceived was very low.

No significant interaction (P>0.05) between packaging treatments and days of storage was found in the level of 'other' flavour (Table 30g in Appendix 7). On average, the air-stored tails and vacuum packed whole redclaw were perceived to have more 'other' flavours present. The descriptors (Table 31 in Appendix 7) and comments do not give conclusive evidence as to what these may be.

As expected, all treatments started with low levels of staleness (Table 30h in Appendix 7). At 12 days storage, the air-stored tails and vacuum and air stored whole redclaw had the highest levels of stale flavour. Although at all time points the levels of off flavour was low, at day 12 the three whole samples had significantly (P<0.05) more off flavour than the three packaging types of tails only (Table 30i in Appendix 7). No significant differences (P>0.05) were found in the level of aftertaste, either between packaging treatments or over time (Table 29j in Appendix 7).

10.2.1.5.4 Texture

At day 12 all samples were significantly (P>0.05) less firm than they had been at days 0, 5 and 8 (Table 32a in Appendix 7). On average, the MAP packaged tails and whole redclaw were significantly (P<0.05) firmer than either the vacuum packed or air stored redclaw (whole and tails), and the vacuum packed air stored whole redclaw were the least firm.

Overall, treatments were most springy at day 0, although after an initial decrease in springiness, there were no significant differences (P>0.05) between days 5, 8 and 12 (Table 32b in Appendix 7). Over all days, the MAP redclaw tails were significantly (p<0.05) springier than the other treatments.

All treatments started with similar levels of moistness (Table 32c in Appendix 7). Whilst the perceived level of moistness remained stable in the vacuum packed and air stored tails, the MAP whole and tails and whole vacuum packed and air stored samples became drier over time.

The level of mushiness was low for all treatments at day 0 (Table 32d in Appendix 7). The MAP tails and whole and vacuum packed tails showed little change in this level of mushiness throughout the storage. Although not significant ($p>0.05$), the air stored tails also showed a slight increase in the level of mushiness. The most noticeable effect is found with the vacuum packed and air stored whole redclaw that became significantly ($p<0.05$) mushier by day 12.

Again, all treatments started with low levels of toughness (Table 32e in Appendix 7). No significant differences ($P<0.05$) were found in this level of toughness for the vacuum packed or air stored tails or whole redclaw. However, both the MAP tails and whole redclaw became significantly ($P>0.05$) tougher at day 5. Although still significantly ($P>0.05$) tougher than at day 0, the actual level of toughness started to decrease at day 8 and again at day 12.

The descriptors (Table 33 in Appendix 7) also show that the both MAP samples were described as being chewy more frequently at days 5 and 8 than the other treatments. More panellists also selected fibrous/stringy to describe the samples after 5 days storage than at day 0 (Table 33 in Appendix 7). The selection of descriptors also shows that the three whole samples were described as being chalky/floury at days 12 and 15 more than the three tail only samples.

10.2.1.5.5 Overall Quality

Table 34 in Appendix 7 shows the overall quality of the MAP tails decreased rapidly initially but no significant ($P>0.05$) change was found after day 5. The overall quality of the vacuum and air stored tails and MAP whole redclaw did not change significantly over the 12 days storage.

A significant ($P<0.05$) decrease in overall quality of the vacuum packed whole redclaw was found at 5 days storage and the air stored whole redclaw at 12 days. The overall quality of both the vacuum and air stored whole redclaw was significantly ($P<0.05$) lower than the other four treatments at day 12 and both were significantly below 50 on a scale where 0 is very poor quality and 100 is very good quality. At the same time these samples received the lowest mean score for crustacean flavour and sweetness and the highest scores for stale, off, muddy and cabbagy. They also had the lowest mean scores for firmness, springiness and had higher levels of mushiness.

10.2.1.6 Summary for trial one

The vacuum packs exhibited off odours after 12 days while MAP redclaw were free of off odour until day 15.

While the initial bacterial load was higher than at the start of the cooked redclaw storage trial the growth of bacteria was slower. This and the absence of hydrogen disulphide producers led to longer shelf life for the raw product. The chlorine dioxide treatment applied had obviously provided some benefit.

The microbiological counts were found to be quite variable between individuals indicating that the sampling should be doubled from two to include four individuals for the next trial. The MAP tails and vacuum packed whole redclaw lasted the longest with no real difference between their counts for 19 days. When the microbiological count increased the sensory scores dropped, especially the overall quality.

The yield from packs was good, greater than 95%. The whole vacuum packed redclaw produced the worst, generally 3% lower than the other packs.

The Everfresh treatment was unable to totally prevent black spot as some individuals stored in air for 12 days and in air, MAP or vacuum for 15 days exhibited small amounts of pigmentation.

Staining of the flesh just posterior to the cephalothorax became evident after 5 days storage. While it was present in both whole and tailed redclaw the former was affected to a greater degree. The whole redclaw stored in air exhibited the worst staining. The hepatopancreas had more of an impact on quality than just discolouration as the taste panel identified a loss of texture after 12 days of storage. Air stored whole redclaw were not as firm as those in the other packs while these and the vacuum stored whole redclaw exhibited noticeable mushy traits.

The overall acceptability of redclaw recorded by the taste panel fluctuated. This is not surprising considering the low starting scores for any of the packs and the variability of bacterial counts between packs. There was a noticeable difference in sensory attributes between the two sources of redclaw used in these trials. Redclaw from Calliope were used for training prior to the raw storage trial and these received much higher overall quality scores (75%) from the taste panel than those from Biloela. Finding the reasons for many of the different overall quality scores recorded were difficult especially for air stored redclaw. These remained above 50% even though the bacterial counts were high and off odours were detectable at unpacking. On the last evaluation day of the trial air stored redclaw and vacuum tail packs were not presented to the taste panel because the high bacterial counts could have comprised the health of consumers.

Overall, whole redclaw had a shelf life of 12 days while the tails had a shelf life of up to 15 days. After discussion with the growers about the results obtained so far, it was decided that vacuum packed redclaw were not feasible because of the limited view of the product in the packs and to drop this treatment from the next trial.

10.2.2 Uncooked Redclaw Stored In Map And Air, Trial Two.

10.2.2.1 Gas content of MAP packs

Figure 7 in Appendix 7 shows the oxygen content of the packs was again low for the whole storage time and did not rise above 1%. Like the first trial, the carbon dioxide content dropped initially because of uptake by the product with the whole redclaw packs exhibiting a greater uptake of carbon dioxide. The proportion of nitrogen present was again able to maintain pack configuration and prevent the lid from being drawn inwards.

10.2.2.2 Pack yield and pH

Table 35 in Appendix 7 shows the data collected for pH and pack yield. The pH rose only slightly during storage for all treatments and did not suggest any major chemical deterioration of the flesh except for air-stored redclaw at the end of its storage life which had the highest pH measurements. The drip loss from redclaw was again within commercial limits and there was not difference between packs containing tails and whole individuals. MAP conditions did not lead to higher drip losses.

10.2.2.3 Demerit scores

Table 36 in Appendix 7 displays the demerit scores recorded during storage for trial two. Again the colour of the shell did not fade quickly, reaching scores above 1 only after 15 days

in MAP. The development of blackspot on the shell was evident during this trial but only to a minor extent and again it was mainly present on air-stored whole individuals. The hepatopancreas is a major storage organ of those enzymes responsible and it is difficult for any chemical treatment to penetrate this in the whole animal during a short dip so that enough chemical is present to inhibit them. The amount of blackspot present should not cause too much impact on the commercial success of the MAP product.

The appearance of the flesh deteriorated slowly with whole individuals exhibited no greater loss of integrity ($P>0.05$) until the end of shelf life. The flesh became progressively more opaque due to muscle protein denaturation but there was no difference between tails and whole individuals. The tails in MAP were significantly different ($P<0.01$) only to the tails stored in air. The whole redclaw, as found during the previous trial, exhibited significantly ($P<0.01$) more staining of the flesh because of the continued presence of the hepatopancreas in the cephalothorax during storage.

The amount of drip visible in all types of packs was minimal because the drip loss was only small (refer to the yield data in Table 35 in Appendix 7) and the absorbent pads present.

The odour, in conjunction with the microbiological counts and the taste panel scores, was one of the main demerit parameters that determined the end of shelf life. The odour of the packs at opening quickly became unacceptable to the extent that both whole redclaw and tails stored in air were not sent to taste panel after 12 days storage. The whole MAP redclaw were sent to taste panel for up till 15 days of storage while the MAP tails were tasted up until day 22.

The total demerit points, for each of the treatments that were repeated, were consistently higher than the previous trial due to the odour at pack opening. Within the trial there was little difference between the treatments. As could be expected the total demerit points increased progressively with storage.

10.2.2.4 Microbiological counts

The counts for the different bacteria are present in Table 37 in Appendix 7. Growth did occur on the TCBS plates from redclaw stored for five days in air but the majority of colonies were atypical. Of the suspicious colonies, Gram Stain and biochemical type methods identified none as *Vibrio* species. Any concern that numbers of *Vibrio* species were present in enough numbers to cause problems was unfounded.

This time the starting counts were similar for all treatments. The total count increased during storage at a slower rate than the previous trial for all of the treatments. This was consistent even for air stored redclaw which did not achieve counts above 1,000,000 until day 12.

This trial was different to the previous one in that it was the odour at unpacking (see demerit score in Table 36 in Appendix 7) and the taste panel scores, which determined whether shelf life had ended, rather than the total microbiological count. Unlike the previous trial there was a significant count of hydrogen dioxide producing bacteria present that would have been responsible for this off odour. The MAP conditions were able to restrict the growth of this group so that redclaw packed under these conditions had significantly lower counts.

MAP also was able to limit the growth of psychrotrophs so that there were significantly lower counts of them compared with product stored in air. They were only found in redclaw flesh that had been stored in air for 5 days.

The increase replicate number limited what samples could be placed in the anaerobic jars so that no air stored product were tested for this group of bacteria. The anaerobe counts remained low for up to 15 days in MAP. Several colonies grew on the media used to identify *Clostridial* species. When tested further it was found that they also grew happily in the presence of oxygen proving that they were not *Clostridial* species.

10.2.2.5 Sensory scores

10.2.2.5.1 Appearance

The selection of sensory appearance descriptors are present in Table 38 in Appendix 7. For all four treatments, initially white was the colour most frequently selected to describe the colour of the flesh (Table 38 in Appendix 7). Over time however, white was selected less frequently and pink tinge increased, especially for the MAP samples. Beige was also selected to describe the MAP whole redclaw at time 8, 12 and 15. The MAP tails were described as beige less than the whole MAP redclaw. Visible black spot was not selected for either the MAP tails or whole redclaw at any time point and was only selected by a very small percent of panellists for the air stored whole redclaw at one time point.

There was little change in how moist both the tails and whole air stored samples looked, however, for both the MAP samples the selection of dry increased and moist decreased over time.

All four treatments were frequently described as being intact more than gaping. However, gaping was selected more for air stored whole than the other treatments up to day 12.

10.2.2.5.2 Odour

Table 39 in Appendix 7 shows there were no significant ($P>0.05$) differences in the level of crustacean odour between any of the treatments at any day of testing. Overall, the level of crustacean odour remained fairly constant for all treatments except for the whole MAP at day 15 which had a slightly lower level. The whole air stored samples had a lower level of crustacean odour at day 0 but this is probably due to a large variation in the individual samples of that batch as at day 5 the level is very similar to the other three treatments.

Again, no significant differences ($P>0.05$) were found in the level of fishy odour between treatments at any time point and the actual level present was very low. The highest levels of fishy odour were found in the MAP tails at days 19 and 22. The other three treatments were not tested on these days.

All treatments started with very low levels of ‘other’ odour but at day 12 the two MAP treatments had significantly ($P<0.05$) higher levels of ‘other’ odour than the air stored tails. The level of ‘other’ odour continued to increase for the MAP tails at days 19 and 22. From the descriptors (Table 40 in Appendix 7) and comments these ‘other’ odours were ammoniacal, musty, stale and sweaty. This result suggests that some of the off odour present at unpacking, which increased as storage time progressed, remained in the cooked samples supplied to the taste panel. The panel described the odour as musty, stale, sulphury and sweaty.

10.2.2.5.3 Flavour

No significant differences (P>0.05) were found in the level of crustacean flavour at any day of testing (Table 41a in Appendix 7). The level also remained fairly constant in all treatments during storage. As with the level of crustacean odour, the level of crustacean flavour was slightly lower in the whole air stored samples although not significantly so (P>0.05). This slight difference was also found in the level of sweetness of this sample at day 0 (Table 41c in Appendix 7).

Although a significant difference (P<0.05) was perceived in the saltiness of the samples at day 8, the levels are so low that this has negligible effect (Table 41b in Appendix 7). Again, no salt was added during the cooking.

At day 5, a significant (P<0.05) difference was perceived in the level of sweetness (Table 41c in Appendix 7). This difference was not found at any other day of assessment and is more likely to be due to natural variation than an effect of storage.

The muddy flavour was very low for all samples and no significant (P>0.05) difference was found in the level of muddy flavour at any time point (Table 41d in Appendix 7).

At day 5, 8 and 12 the level of cabbagy flavour was perceived to be lower in both the MAP whole and tails than in either of the air stored treatments (Table 41e in Appendix 7). However, this difference was only significant (P<0.05) at day 8, where both MAP and treatments were significantly (P<0.05) less cabbagy than the air stored tails. The air stored redclaw was not significantly (P>0.05) different to the other three treatments.

Very low levels of fishy flavour were perceived in all treatments at all time points, and no significant (P<0.05) differences were found between treatments (Table 41f in Appendix 7). At days 19 and 22 the level of fishy flavour had started to increase in the MAP tails but was still at low levels.

Although a significant difference (P<0.05) was found in the level of stale flavour at day 5, at all days, including day 5, the actual level of stale flavour was very low in all treatments (Table 41g in Appendix 7). At days 19 and 22 the level of stale flavour had started to increase in the MAP tails but was still at low levels.

No significant differences (P>0.05) were found in the levels of off flavour for any treatment at any day and the actual levels of off flavours present was negligible (Table 41h in Appendix 7).

The level of ‘other’ flavours present was very low and no significant (P>0.05) differences were found for any treatment at any day (Table 41i in Appendix 7). At day 12, the level of aftertaste in the MAP whole redclaw was significantly higher (P<0.05) than in either the MAP or air stored tails only. The air stored whole redclaw was not tested at this time.

Table 42 in Appendix 7 shows vegetable and weedy/herbaceous were selected regularly to describe all treatments.

10.2.2.5.4 Texture

Table 43 in Appendix 7 contains the mean scores for texture attributes. At day 0, the air stored whole redclaw were found to be significantly (P<0.05) mushier and less springy than the other three treatments. Several moult redclaw were noted in all treatments at all days and although the individual redclaw were randomly allocated to each of the four treatments, the day 0 result for the whole air stored may be due to a higher proportion of moult animals.

At day 5, the MAP whole redclaw were significantly (P<0.05) firmer than the air stored whole samples. The MAP tails were also slightly firmer than the air stored treatments although the difference was not large enough to be significant (P>0.05).

By day 8, the air stored whole redclaw were significantly (P<0.05) softer and less springy than the other three treatments. At day 12, the MAP whole and tail only redclaw were significantly (P<0.05) firmer than the air stored tails and the air stored whole redclaw were not tested. The MAP tails were also significantly (P<0.05) firmer than the air stored tails.

Over time, the firmness of both MAP whole and tail only samples appears to remain fairly constant, whereas on the last day of assessment both air-stored samples became softer.

All samples were initially similar in the level of moistness but over storage the MAP whole and tail only samples were drier than the air stored whole or tail samples. As mentioned previously the air stored whole redclaw were significantly (P<0.05) mushier at day 0, possibly due to the distribution of moult animals. At day 8 the whole air stored redclaw were again mushier, less firm and less springy. These are consistent with changes we would expect in stored redclaw.

At days 5, 8 and 12, both MAP samples were tougher than the air stored samples with significant differences being found at days 5 and 12. The selection of descriptors (Table 44 in Appendix 7) also show that the MAP samples were more chewy at day 5 than the air stored samples and tended to be more fibrous/stringy.

Although at day 12 the MAP samples were tougher than the air stored samples, they were less tough than at day 5. From the selection of descriptors, at days 12, 15 and 19 the MAP tails were more frequently described as being chalky/floury as were the MAP whole redclaw at days 8, 12 and 15.

10.2.2.5.5 Overall Quality

Table 45 in Appendix 7 shows that at day 0 the air stored whole redclaw were found to be of significantly (P<0.05) lower overall quality than the other three treatments. At day 0, the air stored whole redclaw were found to be significantly (P<0.05) mushier and less springy than the other three treatments. The air-stored sample at day 0 also had slightly lower crustacean flavour and sweetness. As mentioned previously, several moult redclaw were noted in all treatments at all days and although the individual redclaw were randomly allocated to each of the four treatments, the day 0 result for the whole air stored may be due to a higher proportion of moult animals.

No significant differences (P>0.05) were found in the overall quality between treatments at any other time point, although the mean overall quality scores tended to decrease with storage. The MAP redclaw tails were tested at 19 and 22 days but at day 19 these samples only had an average score of 41.2, where 0 is very poor quality and 100 is very good quality. At days 19 and 22 the samples also looked drier and were less often described as being white, and had more ammoniacal and sweaty odours present. More stale flavour and aftertaste was present and higher levels of 'other' flavour were also perceived in these samples. From the descriptors and comments present in Appendix 7 these were bitter, sweaty and meaty flavours.

10.2.2.6 Summary for trial two

The pack yields for those treatments that were repeated were similar to that obtained from the previous trial and certainly makes the MAP product commercially viable.

Small amounts of black spot did develop, again with the whole redclaw exhibiting significantly more than tails. The extent of discolouration was only minor and is probably of little commercial impact.

The pre-packaging treatment with chlorine dioxide was quite effective in reducing the initial bacterial load for some species so that, unlike the previous trial, the end of shelf life was determined by the odour at unpacking or acceptability by taste panel rather than the microbiological total count.

Overall the bacterial counts remained acceptable for longer than the previous trial. The air stored redclaw lasted for up to 12 days before the counts became excessive, a significantly longer time than the previous shelf life of 5 days. The MAP count for tails became excessive after 15 days. The majority of these bacteria were psychrotrophs and after MAP storage anaerobes. Whole redclaw packed under a modified atmosphere had a shelf life of 15 days.

The taste panel was able to detect some of the off odour that was present at unpacking and this led to the end of shelf life for some treatments.

11 FROZEN REDCLAW

11.1 Methods

11.1.1 Preparation and packaging

The redclaw were prepared as described in the preceding section *10.1.1*. All samples for freezing were received on 21 November 2000 and frozen on 22 November 2000. Eight redclaw were placed in aluminium freezer trays lined with plastic film. A hand full of ice was placed on top of the redclaw and then they were covered with fresh water. The plastic film was folded over the redclaw and the trays were then placed in a plate freezer. The refrigeration was turned on to produce the frozen blocks. After for 2 hours the blocks were removed from the plate freezer, placed inside cardboard packs and stored in a normal freezer at -24°C.

11.1.2 Sensory evaluation of frozen redclaw

Frozen redclaw were compared with freshly harvested redclaw from each of the two supplying farms. The samples from individual farms were kept separate and stored at -24ºC until required for testing. At each time the frozen samples were tested, a new delivery of fresh redclaw was received from each farm for comparison.

Sensory evaluation was carried out on the samples at day 0 (fresh only), 2 weeks (14 days), 7 weeks (49 days) and 12 weeks (84 days). The actual dates of testing were 22 November, 6 December 2000, 10 January and 14 February 2001. All panellists evaluated the redclaw from both farms at each assessment time.

Sensory and Consumer Science received the fresh and thawed redclaw (with the heads removed and discarded) on the morning of testing. The redclaw tails were cooked by steaming in a plastic basket for 4 minutes 50 seconds. This is the cooking method that had been used in the previous green redclaw trials. This time was obtained by conducting a preliminary cooking trial where the samples were cooked for a further minute once the internal temperature reached 80ºC. The average temperature recorded at the end of cooking was 90ºC $\pm$ 2ºC. Each sample type for a panel was cooked as one batch (16 to 18 redclaw, except for frozen redclaw from Farm 1 at 12 weeks where there were only 13 redclaw). Samples were cooled quickly by placing them on ice in a 2ºC room. The samples were then removed from the ice and stored at 4ºC until required by the panellists. No salt was added during the cooking process.

Panellists were selected from staff at the Centre for Food Technology who had previous experience of rating redclaw and other crustacean species using the same questionnaire.

A minimum of 11 panellists assessed the above samples at each time point using a standard rating test (AS2542.2.3, 1988). Panellists made their assessments on unstructured line scales and were also able to choose standard descriptors and add any other additional comments relevant to the sample. In their booths, panellists had tasting notes and a copy of the average scores given to a good quality sample presented during training. Panellists were instructed to remove the tail meat from the shell and to cut the sample in half longitudinally. Appearance assessments were made looking at the internal appearance of the flesh, and one half of the tail was used to make the flavour assessment and the other half the texture assessment.

Assessments were carried out in individual tasting booths illuminated with white light (day light equivalent). Samples were presented on a white plate labelled with a three digit code in a sequential monadic fashion in a randomised order. The samples on plate were served to the panellists on a white tray with a sharp knife to cut the tail meat and a disposable cloth to wipe their hands on. Purified, room temperature water and plain unsalted crackers were available during the sessions for palate cleansing.

11.1.3 Statistical evaluation of sensory data for frozen redclaw

A two way analysis of variance (ANOVA), using the farms as blocks and the testing days and treatment (ie fresh or frozen) as factors, was performed on the panel averages from the line scale data.

A one way ANOVA without the factorial breakdown, using the farms as blocks was performed to confirm treatment/time effects. Where a significant F-ratio ($P<0.05$) was found between treatments, pair wise comparisons between means were made using Fishers least significant difference (LSD). These are the means which are presented in the results and discussion section.

Data collected from the selection of descriptors for the two fresh samples and the two frozen samples was averaged separately. These values are presented as percentages of panellists selecting each descriptor.

11.2 Results and Discussion

Because the CFT does not possess a plate freezer the redclaw were frozen using a brine emersion freezer and a blast freezer. This method allowed the evaluation of freezing raw redclaw but would not reflect the same amount of recovery that a plate freezer system would produce.

Redclaw were prepared as before using an ice slurry containing Everfresh to protect from blackspot followed by a dip in chlorine dioxide to reduce the bacterial load. The redclaw were placed in plastic prawn baskets and immersed in the refrigerated brine (-22°C) for 20 minutes. They were removed and dipped immediately into chilled water. Due to the surface temperature of the redclaw the freshwater froze onto the surface. The redclaw were then returned to the immersion brine freezer for another 10 minutes and dipped again. This resulted in a thick glaze which covered all surfaces. The redclaw were returned to the brine freezer for a further 5 minutes and placed in the blast freezer (-26 to -30°C) for several hours. After removal from the blast freezer the redclaw were stored in the freezer room (-30°C). A later marketing study funded outside this project utilised plate freezing equipment in a commercial facility. Figures 8-13 in Appendix 8 show the different stages of preparation of frozen redclaw using this commercial equipment.

After two weeks storage one batch from each farm were removed and thawed immersed in tap water in the cold room (2°C). These redclaw were compared at the same time with freshly harvested redclaw from each farm. Other samples were removed after 7 and 12 weeks.

11.2.1 Physical measurements for packs after frozen storage.

The yield from the thawed packs ranged from 98.4% to 104.5%. The buccal cavity can retain significant amounts of water that can lead to recoveries in excess of 100%. It also indicates the glazing was sufficient to prevent dehydration during frozen storage. This result indicates that good recoveries can be achieved from frozen redclaw. Table 46 in Appendix 8 displays the pH data and demerit point scores recorded during testing.

While there were statistical differences between fresh and frozen redclaw and between the different sampling times for pH, these were not large enough to indicate any difference in quality. Freezing did cause some small loss of colour from the shell but it could not be described as faded. Blackspot is most likely to develop when crustaceans are thawed but this did not occur with the redclaw, indicating that the treatment with Everfresh was effective. Freezing led to changes to the appearance and colour of the flesh in the form of a slight gaping of the muscle bundles and a loss of translucency. These are a normal consequence of freezing seafood.

Statistically, redclaw from Biloela exhibited more gaping while redclaw from Calliope exhibited a little more staining and had lost more of the fresh odour but the levels for all the parameters were very low. Overall there was some loss of physical quality due to the freezing of redclaw but it was only minor.

11.2.2 Microbiological counts

The counts obtained for bacteria are present in Table 47 in Appendix 8. Because of convenience and the need to show the importance of using chlorine dioxide, only the first batch of fresh redclaw was treated with chemicals. The microbiological counts show that it is imperative that redclaw, when not shipped alive, be treated with chemicals to reduce the initial bacterial load and to limit the growth during storage. The chlorine dioxide dip resulted in a reduction of the initial total count by two or more log counts (100 or 1,000 fold reduction).

Freezing resulted in a decreased count for all types of bacteria tested. This could be due to retention of the dip by the glaze, thus increasing the exposure time. Redclaw from Calliope had slightly higher counts than those from Biloela but when the treatments were analysed individually there was no difference between the two supplies for any microbiological count. There were some differences between the counts for different sampling days but no consistent trend. The H_2S producer count of fresh supplied redclaw increased with each shipment. This could have been due to the weather experienced over the period of the study.

11.2.3 Sensory scores

From the two way ANOVA, no significant differences ($P>0.05$) were found between blocks (farms) for any of attributes and no significant interaction was found between treatments and time. The results from the one way ANOVA are presented in the tables of mean scores. Where no significant differences ($P>0.05$) were found the LSD value is presented only to give a measure of variability across all treatments.

The tables of descriptors show the percentages of panellists selecting each descriptor. For example in Table 48 in Appendix 8, 91% of panellists selected white to describe fresh

redclaw at day 0. This means, on average 10 out of 11 panellists selected white to describe the fresh redclaw samples.

11.2.3.1 Appearance

At all days of testing, white, cream and pink tinge were selected at similar levels in both the fresh and frozen samples. Of these, white was the most frequently selected colour used to describe the flesh colour (Table 48 in Appendix 8).

Neither the fresh or frozen samples were described as having visible black spot at any testing time. At 12 weeks, the frozen redclaw were slightly drier/less moist in appearance than the fresh redclaw and may have had slightly more gaping.

11.2.3.2 Odour

No significant differences ($P>0.05$) were found in the level of crustacean odour between samples (Table 49a in Appendix 8). However, over time looking at the average of all samples, a significant difference ($P<0.05$) was found in the crustacean odour of the redclaw (day 0 = 65.2; 2 weeks = 65.4; 7 weeks = 59.7; 12 weeks = 61.1; LSD =4.12). The redclaw at 7 weeks had the lowest level of crustacean odour. This level was not significantly different ($P>0.05$) to the redclaw at 12 weeks, which in turn was not significantly different ($P>0.05$) to the redclaw at day 0.

Although significant differences ($P<0.05$) were found in the level of fishy odour, in all samples the actual level of fishy odour was minimal (Table 49b in Appendix 8) and can be ignored. Although the difference is not significant ($P>0.05$), higher levels of 'Other' odours were noted in the fresh redclaw at 7 and 12 weeks (Table 49c in Appendix 8). From the selection of descriptors (see Table 50 in Appendix 8), this may be due to the presence of a musty odour at these times and comments made also suggest a cabbagy odour

11.2.3.3 Flavour

Significant differences ($P<0.05$) were found in the level of crustacean flavour and sweetness (Table 51a and c in Appendix 8). For crustacean flavour, no differences were found between the fresh redclaw at time 0 and 2 weeks and the frozen redclaw at any testing time. This suggests that the level of crustacean flavour prior to freezing has been captured and not lost by the freezing process. The level of crustacean flavour in the fresh samples did differ significantly ($P<0.05$) at the four testing times suggesting that there is natural variation in the product.

The level of sweetness was significantly lower ($P<0.05$) at 7 and 12 week testing than at day 0 and 2 weeks for both the fresh and frozen samples suggesting the initial sweetness may not be preserved. However, there is no significant difference ($P>0.05$) between the levels of sweetness found in the fresh and frozen redclaw at any single day of testing.

As with the odour, the fresh samples had slightly higher levels of 'other' flavour (Table 51i in Appendix 8) at the 7 and 12 week tests, although this difference is not significant ($P>0.05$). From the descriptors selected (Table 52 in Appendix 8), this may be due to slightly higher levels of metallic and musty flavours at 7 and 12 weeks and peppery flavour at 12 weeks.

No significant differences ($P>0.05$) were found in salty, muddy, cabbagy, fishy, stale or off flavour and the levels of all these attributes were low (Table 51b,d,e,f,g,h in Appendix 8). Although no significant differences ($P>0.05$) were found between samples for aftertaste, looking at the average of all samples, the level of aftertaste increased significantly ($P<0.05$) over time (day 0 = 10.7; 2 weeks = 12.4; 7 weeks = 17.7; 12 weeks = 20.3; LSD=6.06). From the tasters selection of descriptors (Table 52 in Appendix 8) and the comments recorded, the aftertaste could be described as bitter, peppery and metallic.

11.2.3.4 Texture

No significant differences (P>0.05) were found between fresh and frozen redclaw for any of the texture attributes (Table 53a – e in Appendix 8). From the descriptors however, fibrous was selected more to describe the frozen redclaw after 7 and 12 weeks than the frozen at previous testing days or any of the fresh samples. 'Other' was also selected to describe the fresh redclaw more than the frozen and the comments suggest that the fresh redclaw was softer and more moist, however no significant differences (P>0.05) were found in these two attributes in the statistical analysis of the line scale data.

11.2.3.5 Overall Quality

Table 55 in Appendix 8 shows that although significant differences (P<0.05) were found in the overall quality of the redclaw, there was no significant difference (P>0.05) between fresh and frozen redclaw at any one testing time.

The overall quality of the first fresh sample (day 0) was the highest but neither the fresh or frozen redclaw at 2 weeks were significantly different (P<0.05) from this. At the end of the trial (12 weeks frozen storage) the frozen redclaw were not significantly (P>0.05) different from the frozen redclaw tested at 2 or 7 weeks. The frozen sample had significantly (P<0.05) lower overall quality than the fresh sample at day 0 but had significantly higher overall quality than the fresh redclaw tested at the 7 weeks.

12 MEAT EXTRACTION AND PATÉ POTENTIAL

12.1 Methods

Cooked heads left from the packaging experiments of redclaw tails were frozen without any further treatment. A total of 31.6kg of cooked heads were shipped to Geraldton Fishermen's C0-0perative Ltd. The company has a deboning machine which was ideal for extracting the meat from the claws and legs.

12.2 Results and Discussion

After 9 months 10.64kg of extract was returned from Geraldton. This results in a 33.7% recovery of material from redclaw heads. The processor noted that it was high in water content. This was due to the heads being extracted while still frozen so that the water present in the meat melted and was expelled during extrusion while the meat remained stuck to the shell. The hepatopancreas was present in the heads when they were separated from the tails and consequently extracted and this resulted in the orange colour of the extract. The colour was not unattractive and could enhance the acceptability of the paté. As all of the proteolytic enzymes had been destroyed there was no concern with problems for paté production using this material. The extract was frozen and returned to the laboratory. When the extract was thawed there was little meat present.

The total microbiological count of a sample of the unfiltered extract was an incredible 1,600,000 cfu/g. A 1.5kg sample of the extract was thawed and the solids separated using cheesecloth. Approximately 13% of the extract is composed of solid material. This gives a final recovery of 4.4% of meat solids that were obtained from cooked redclaw heads. The cost of extraction under normal operating conditions is $3.40 per kilogram of heads. This places the final value of the solid meat extract at $77.61 per kilogram even without the costs of transport being incorporated. When compared with normal seafood ingredient costs of $6.50 per kilogram that pate producers do pay, this aspect alone makes meat extracted from redclaw heads exceedingly expensive and would be of little use to industry for pate production. As it had taken so long to obtain this first sample and no more heads were available, a second extraction from redclaw heads was abandoned.

A shipment of 10kg of live second grade redclaw was obtained to provide an alternate source of redclaw meat. This resulted in a 35% recovery of raw meat from the tails. Sam's Seafood, at $1.30 per kilogram of whole redclaw, quoted a price for producing this meat commercially.

Samples of meat solids, the water component after filtration, a block of frozen extract and the peeled tail meat were taken to Rubens Fine Foods for evaluation. From the discussions about the extract it was apparent that the solids filtered from the extract and the peeled tails were too expensive to use. The whole extract however could be used if heating could reduce the bacterial count. A pasteurisation trial was conducted using the thawed extract.

A commercial extract of red claw flesh and liquid was subjected to three temperatures and time regimes. These included a standard pasteurisation temperature of 75°C for 15 seconds and then cooling to ambient. A second method was to bring the extract to the boil (100°C) and then cool to ambient. A third method was a thermophilic sporulation test which involved the product being held at 80°C for 10 minutes followed by a cool to ambient.

In carrying out the small heat treatment trial with red-claw extract two-aspects have to be considered, namely the temperature achieved and the total exposure time for the heat

treatment. The total time needed to reach 100°C was 5 minutes, whilst both the pasteurisation and heat sporulation trials ranged from 10 to 20 minutes respectively. The combined time and temperature regime could well assist in explaining the higher microbiological counts derived from the higher temperature trial. A note for caution is recommended because the post treatment presence and types of organisms has not been established.

It is likely that given the experimental results that the vegetative organisms have been deactivated and the resulting microbiological counts are indicative of the heat activation of spores that may be derived from the processing of the heads before the heat treatment trials.

Though these organism have not been identified it is recommended that caution is exercised if it is intended to use heat based processing stages which include both the extract and original red claw. The presence of possible heat activated spores in the extract certainly suggests that the same spores could well reside in the original samples. It is presumed that the heat-activated organisms in the absence of competition will certainly grow to predominate the sample in any further value-added, shelf life extended product.

Even though the bacterial levels may be considered low after heat treatment any thought of using this process should proceed with caution, as the low levels enumerated are benign. It is recommended that the species of the heat activated organisms be identified with a view to establishing the potential impact on food safety and shelf life integrity further use of this material is attempted.

13 BENEFITS

The redclaw aquaculture industry will directly benefit from this research by being able to produce viable alternate products to the present live form. Because there is a high percentage of mortality for redclaw being returned to the ponds after harvesting, there will be the ability to reduce losses by being able to stockpile frozen redclaw. The other forms of packaging will also result in longer shelf life and better appearance. Sensory comparison with other types of crustacean seafood shows that redclaw can compete with premium products. Trial shipments of frozen uncooked redclaw have already identified new overseas markets that the industry can service. This will lead to more secure operations and allow for increases in production.

The customer will benefit by more efficient grading of redclaw in packs because of the ability to stockpile. The customer will also benefit from lower bacterial counts in the food. These benefits and beneficiaries were identified in the original grant application.

14 FUTURE DEVELOPMENTS

At the conclusion of the project the Capricorn Crayfish Growers Association were not able to apply the packaging technology because of limited production. The association, while wanting to expand out into new markets via these new products, were still having difficulty in servicing existing clients and this situation may continue for some time. The other associations, while uninterested in investing and participating in this project, may utilise the technology in the future. During the editing phase of this report the author has been made

aware that the association has attempted to use some of the findings identified from the investigation.

This research shows that the association needs to combine their production to be able to take advantage of the new markets. A single processing site would be advisable to produce these new products.

15 PLANNED OUTCOMES

The research shows that redclaw can be marketed in better ways so that a premium can be obtained for the product. There is now the choice of several different types of product that can be produced. The establishment of a centralised processing facility will create employment opportunities in an economically depressed region of Queensland.

16 CONCLUSION

This project aimed to investigate a suitable cooking process for redclaw crayfish which will ensure good shelf-life. This has been achieved with boiling times being defined for two size groups. The next objective was to investigate the best possible product types and packaging for production by industry. A wide range of different product forms and packaging conditions were evaluated, including frozen raw redclaw. In attempting to achieve the objective of determining the fresh shelf-life of vacuum skin packed raw and cooked redclaw it became apparent that this type of packaging was not suitable for marketing redclaw. The fresh shelf-life of modified atmosphere packed cooked redclaw (objective 5) and also for raw redclaw have been determined. The objective to research the viability of producing redclaw paté has been investigated but suitable raw material could not be extracted from the cephalothorax. Outside the objectives identified at the start of the investigation but essential for the packaging redclaw, methods for reducing the bacterial load, prevention of blackspot and packing frozen uncooked redclaw have also been defined.

16.1 Pre-packaging treatment of redclaw

It is necessary to use some chemical treatments before packaging redclaw. To prevent blackspot developing during storage of uncooked redclaw they should be treated at the same time as they are euthanised by holding in 100L of ice slurry containing 200g of Everfresh for 30 minutes. As an alternative they can be dipped using 1kg of sodium metabisulphite in 100L of water for 30 seconds after being euthanised, keep in mind that a percentage of the population is allergic to sulphite and that there are residue restrictions for this chemical. After Everfresh treatment but before sodium metabisulphite, dipping for 10 minutes in a 500ppm Chlorine Dioxide solution will reduce the initial bacterial by at least 10 fold. Cooked redclaw should also be treated with chlorine dioxide prior to packaging.

16.2 Cooking of redclaw

Redclaw should be killed by immersion in an ice slurry for 30 minutes. The batch to be cooked should be drained for five minutes to ensure a rapid return to the boil when placed in the cooker. They should then be boiled in 2% salt water. They can be cooked in batches of up to 15kg in standard gas fired prawn cookers. Redclaw should be placed in vigorously

boiling water and remain in the cooker for the following times after the water returns to the boil:
4 minutes for redclaw <80g
6 minutes and 30 seconds for redclaw >80g.

The amount of heating can be reduced once the water has returned to the boil. Excessive bubbling can lift the shell of recently moulted redclaw so a good rolling boil is sufficient once the water has returned to the boil. The redclaw should be quickly cooled in an ice slurry after cooking and drained for 5 minutes before packing.

16.3 Comparison of redclaw with other crustacean species.

Overall the small redclaw is most similar to the yabbie. These samples had similar odour, flavour and texture profiles although more stale and off flavours were present in the yabbie.

The large redclaw had a similar level of crustacean odour to the Moreton bay bug and lobster. A similar level of crustacean flavour was found in the large redclaw, lobster and prawn. The large redclaw was most similar, in terms of sweetness, to the lobster, and the prawn was the only sample which was sweeter than the large redclaw. Although there were no significant differences between samples for muddy, cabbagy and fishy flavour, the large redclaw had very low levels of these present.

The firmness of the large redclaw is most similar to the small redclaw and yabbie, but is more similar to the Moreton Bay bug and lobster in terms of springiness. The large redclaw was the moistest sample. The large redclaw had a very low score for toughness and was similar to the small redclaw and yabbie in this respect.

It is important to note that the overall quality score for the samples tested varied greatly with significant differences at $P<0.01$. Therefore, caution should be exercised when looking at the differences between the species. If all the samples had been of similar quality the comparison would have been fairer, however, the Moreton Bay bug, lobster and prawns were bought frozen from a commercial outlet and may be representative of what is commercially available.

Further studies need to be employed to investigate these avenues further before definitive conclusions can be drawn about the sensory profile of each species.

16.4 Cooked redclaw in MAP

Cooked redclaw stored in MAP had a longer shelf life than vacuum packed cooked redclaw. The number of days attained before the product became unsuitable for consumption, for all of the treatments, was limited by the high bacterial count present when the redclaw were packed. A chemical treatment is required. Only MAP packed redclaw was safe to send to tasters by day 11.

As could be expected the product stored in air had the shortest shelf life. The vacuum packed cooked redclaw were difficult to pack because of the sharp spines on the carapace and claws so that several layers of barrier bag were required before an effective seal could be achieved.

The vacuum packed product had similar bacterial counts on the days of evaluation but received lower scores both visually at unpacking and by the taste panel to MAP product. This was due to a number of parameters listed in the tables but one of the most pertinent aspects was that redclaw meat packed under vacuum appeared and tasted drier than MAP stored product.

16.5 Uncooked redclaw in MAP

Whole redclaw can be packaged without any real loss of quality for a storage period of 5 days. Problems of staining and softening of texture develop after 8 days. Bacterial counts also become excessive by this time. The exception to this was MAP redclaw which can be acceptable for many quality indicators for up to 12 days. MAP whole uncooked redclaw could be produced for buyers where the supply of fresh product would be on a weekly basis. The reduced costs for shipping could help offset the cost of packaging.

Better quality and shelf life can be attained for packed redclaw tails. The cost of producing this product would result in much higher prices per kilogram for customers.

16.6 Frozen redclaw

Redclaw intended for freezing should be treated for blackspot and bacterial load in the same way as fresh packed redclaw.

The appendages of redclaw can be quite brittle when frozen. To avoid damage and loss of yield they should be frozen in a similar manner to prawns; i.e. with enough freshwater applied to cover all of the contents and the blocks frozen using a plate freezer. The frozen blocks should then be placed in waxed cardboard boxes. With this treatment the product will retain good flavour and texture when keep at -24°C for at least 3 months.

Few significant differences ($P<0.05$) have been identified between the fresh redclaw and redclaw frozen for up to 12 weeks. Where differences were found, for example in the crustacean flavour, more difference was noted between fresh redclaw samples than in the frozen redclaw, and the level of crustacean flavour at the time of freezing has been maintained throughout the 12 weeks of frozen storage. The increasing use of the descriptor fibrous as storage time increased could indicate that the changes that occur due to frozen storage could become greater with further storage. It is well known that frozen seafood is drier than fresh product. This is the reason why chefs have a preference for fresh. This aspect has implications for shelf-life labelling of frozen redclaw packs.

Although differences are apparent in the overall quality of the redclaw samples, the overall quality of the frozen redclaw has not deteriorated any more than the variation found in the fresh redclaw.

16.7 Meat extraction and Pate potential

It is unlikely that meat separation is a viable method of waste utilisation for cooked redclaw meat. The high bacterial count this method produces prohibits its use on uncooked redclaw heads. The cost of producing fresh redclaw tail meat is expensive when second grade redclaw can be returned to the ponds and fed until their next moult, usually resulting in a better grade individual. The final cost of both materials makes them too expensive for pate production. The costs from peeling may be recovered if a new prestige product such as smoked redclaw meat were produced.

Based on the results uncovered by the small heat treatment trial it is likely that the heat treatment provided has essentially activated spores residing with the sample. Caution is advised for the use of meat extracted from the head shell because of the possibility of pathogens being present.

17 CONTRIBUTING STAFF

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COOKED REDCLAW STORED AT 4°C IN MAP/VSP/AIR

SAMPLE A

TIME IN CO2 PACK TIME IN AIR DATE SAMPLED

COLOUR Shell Overall V.Bright red/Red/ Dull Red / Orange or Yellow
0 1 2 3

BLACKSPOT Absent / Slight / Moderate / Extensive
0 1 2 3

FLESH APPEARANCE Intact / Sl gaping / soft / mushy
0 1 2 3

FLESH COLOUR V.Bright white/White/ Dull white / Grey
0 1 2 3

DRIP None / Slight / Excessive
0 1 2

COOKED ODOUR Fresh cooked/No off odours/Slight/Excess Off Odour
0 1 2 3

Description .....

HEAD SPACE GASES .....

PH .....

SAMPLE B

COLOUR Shell Overall V.Bright red/Red/ Dull Red / Orange or Yellow
0 1 2 3

BLACKSPOT Absent / Slight / Moderate / Extensive
0 1 2 3

FLESH APPEARANCE Intact / Sl gaping / soft / mushy
0 1 2 3

FLESH COLOUR V.Bright white/White/ Dull white / Grey
0 1 2 3

DRIP None / Slight / Excessive
0 1 2

COOKED ODOUR Fresh cooked/No off odours/Slight/Excess Off Odour
0 1 2 3

Description .....

HEAD SPACE GASES .....

PH .....

RAW REDCLAW STORED AT 4°C IN MAP/VSP/AIR/FROZEN

SAMPLE A

TIME IN CO2/Vac PACK TIME IN AIR DATE SAMPLED

COLOUR Shell Overall V.Bright /Faded/ Dull/ Discoloured
0 1 2 3

BLACKSPOT Absent / Slight / Moderate / Extensive
0 1 2 3

FLESH APPEARANCE Intact / Sl gaping / soft / mushy
0 1 2 3

FLESH COLOUR Translucent/Dull/ Sl opaque/ Opaque
0 1 2 3

STAINING No stain/Sl stain/Moderate stain/V. Stained
0 1 2 3

DRIP None / Slight / Excessive
0 1 2

RAW ODOUR Fresh /No off odours/Slight/Excess Off Odour
0 1 2 3

Description .....

HEAD SPACE GASES .....

PH .....

SAMPLE B

COLOUR Shell Overall V.Bright /Faded/ Dull/ Discoloured
0 1 2 3

BLACKSPOT Absent / Slight / Moderate / Extensive
0 1 2 3

FLESH APPEARANCE Intact / Sl gaping / soft / mushy
0 1 2 3

FLESH COLOUR Translucent/Dull/ Sl opaque/ Opaque
0 1 2 3

STAINING No stain/Sl stain/Moderate stain/V. Stained
0 1 2 3

DRIP None / Slight / Excessive
0 1 2

RAW ODOUR Fresh /No off odours/Slight/Excess Off Odour
0 1 2 3

Description .....

HEAD SPACE GASES .....

PH .....

APPENDIX 2 TASTING NOTES FOR TASTE PANEL

APPEARANCE

Please select any words which describe the internal appearance of your sample. (as many as you as are appropriate)

For the terms *Gaping* and *Intact* look **within each section**. (Each tail piece is made up of several sections.)

ODOUR

Crustacean	Aromatic odour of shellfish associated with redclaw and lobster.
Fishy	Old fish odour.
Other	Intensity measure of all other odours (not crustacean or fishy).

FLAVOUR

Crustacean	Shellfish type flavour associated with redclaw, lobster.
Salty	The taste of sodium chloride.
Sweet	The taste of sucrose.
Muddy	A wet earthy flavour.
Cabbagy	Boiled cabbage type flavour.
Fishy	A measure of old fish type flavour as opposed to crustacean type flavour.
Stale	Lacking in freshness, old, but no actual off flavours.
Off	Presence of spoilage flavours not associated with fresh redclaw.
Other	Intensity measure of any other flavour(s).
Aftertaste	Intensity of flavour remaining in mouth approximately 10 seconds after you have swallowed the sample.

TEXTURE

Firm	Force required to bite completely through the sample with your molars.
Springy	Resilience or bounce back when first chewed.
Moist	Amount of moisture perceived when chewing the sample 'Very moist' will express fluid on initial chewing.
Mushy	Lacking in structure, pulpy, when chewing.
Tough	Difficult to break the sample down on chewing.

OVERALL QUALITY

Even weighting to be placed on appearance, odour, flavour and texture.
A good quality redclaw should have creamy white flesh which is firm and slightly springy (NOT mushy) and should be moist but not excessively so. It should have a sweet, crustacean type flavour.

Figure 1. Protease activity of heat treated redclaw hepatopancreatic extract

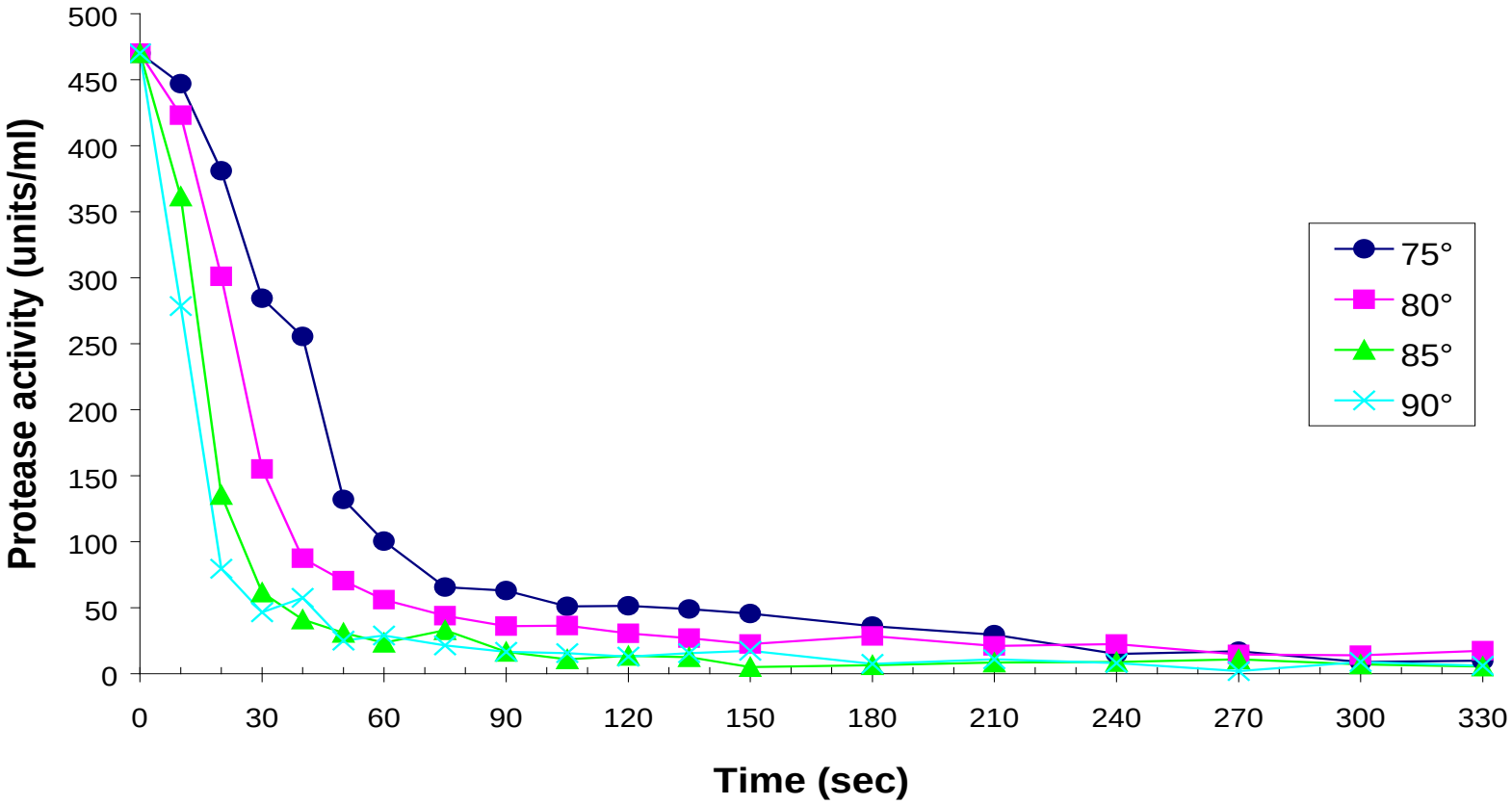

Table 1. Batch and cooking conditions, product yield, chemical and mechanical condition, presence of blackspot of redclaw cooked for using a range of formulae and boiling times.

Experiment label	A		B		C		D		E		F	F	G	G	H	H	F ratio
Batch size for cook	4		4		4		4		4		4	4	4	4	Bulk 18kg	Bulk 16kg	
Basis to stop cook	Formula		Formula		Formula		Formula		Formula		Boiling time	Boiling time	Boiling time	Boiling time	Boiling time	Boiling time	
Boiling time (minutes:seconds)	3:35	4:30	4:50	3:40	3:35	3:25	4	3:10	4:10	3:50	6:00	5:00	7:00	6:00	6:00	4:00	
Size grade cooked (labelled by producer)	*Large?* (Small)	Small	Large	Small	Large	Small	*Large?* (Small)	Small	*Large?* (Small)	Small	Large	Small	Large	Small	Large	Small	
Weight of largest (g)	65	57	88	61	96	58	69	58	74	63	109	66	137	78	162	71	
Average weight (g)	61.9^{cde}	50^{e}	70.8^{cd}	51.5^{de}	76.3^{c}	53.3^{de}	64.5^{cde}	55.5^{de}	66.3^{cde}	60.3^{cde}	100.5^{b}	59^{cde}	106^{b}	61.2^{cde}	120.3^{a}	62.6^{cde}	24
Yield based on individuals (%)	97.2^{abcd}	97.3^{abc}	96.1^{abcd}	94.7^{cd}	96.2^{abcd}	93.9^{d}	94.6^{cd}	96.4^{abcd}	94.6^{cd}	94.6^{cd}	95.0^{bcd}	97.3^{abcd}	97.6^{ab}	98.4^{a}	94.7^{cd}	95.0^{cd}	3.18
Protease activity (units/mL) Raw=447	71^{ab}	12^{cd}	13^{cd}	38^{bc}	80^{a}	16^{cd}	73^{a}	14^{cd}	21^{cd}	25^{cd}	12^{cd}	14^{cd}	21^{cd}	9^{cd}	23^{cd}	6^{d}	8.29
Blackspot presence after 3 days storage	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	
Peak load for mechanical texture (kN/g)	-	-	-	-	-	-	-	-	0.014^{c}	0.015^{c}	0.012^{c}	0.014^{c}	0.014^{c}	0.015^{c}	0.026^{b}	0.030^{a}	75.6
Work done for mechanical texture (J/g)	-	-	-	-	-	-	-	-	0.121^{b}	0.145^{b}	0.134^{b}	0.134^{b}	0.156^{b}	0.130^{b}	0.254^{a}	0.274^{a}	21.9

^{abcd} Means followed by a different letter are significantly different ($p<0.01$)

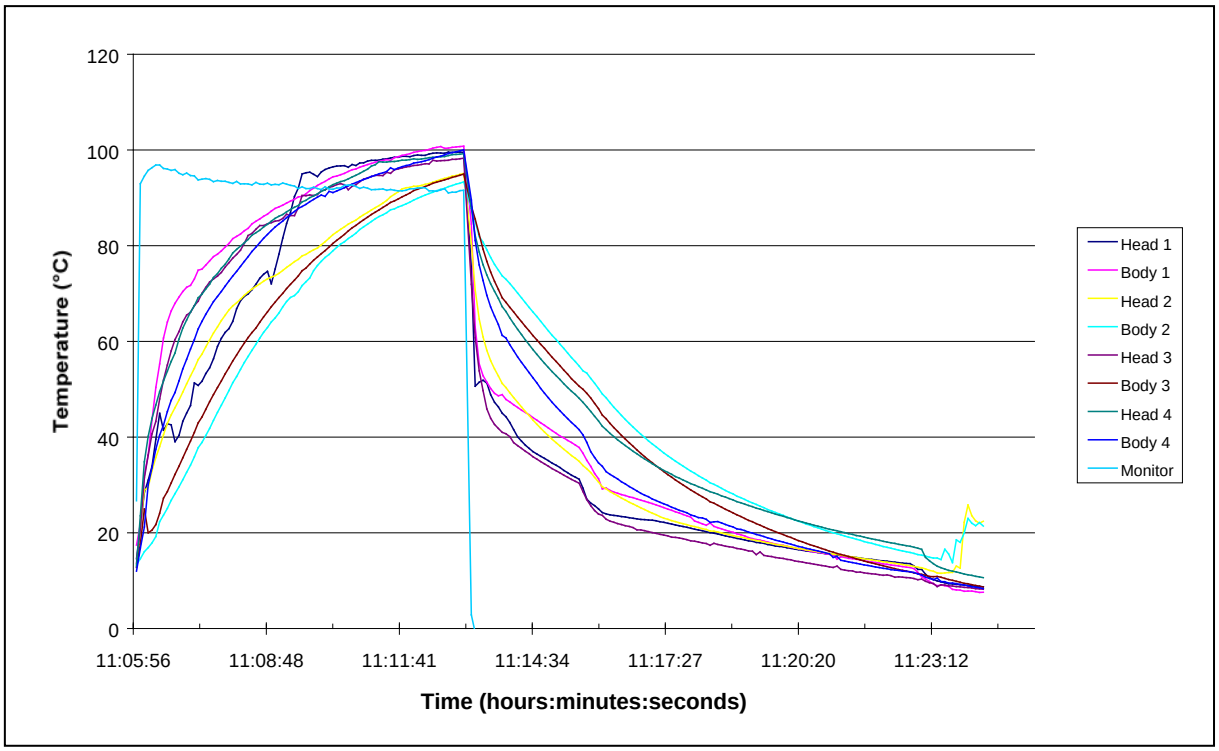

Figure 2 Temperature during boiling of large redclaw.

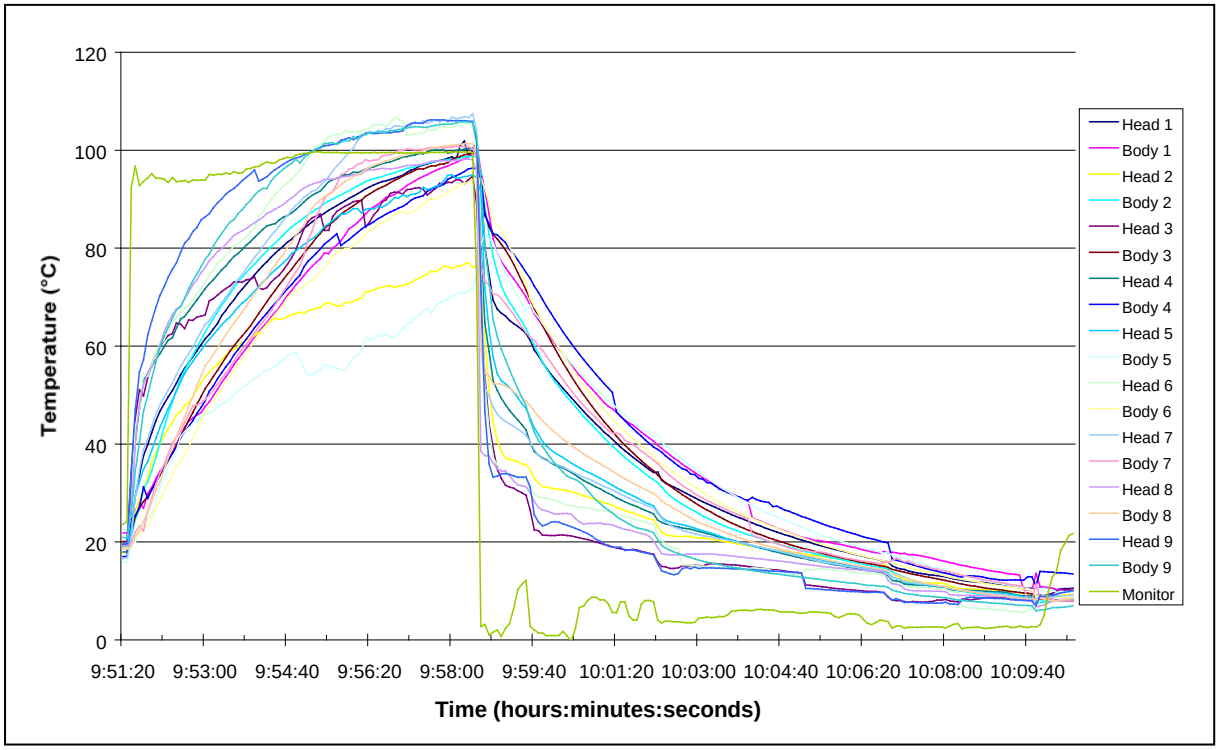

Figure 3. Temperature during boiling of small redclaw.

APPENDIX 4 COMPARISON OF CRUSTACEAN SPECIES

4.1 Mean sensory scores for a range of crustacean species

Appearance

Table 2. Percentages of panellists selecting appearance descriptors for the crustacean species.

Sample	White	Cream	Beige	Grey	Green	Pink tinge	Yellow
Prawn	85	7	0	4	0	19	0
Lobster	81	15	0	0	0	41	0
Small redclaw	63	33	22	15	0	11	7
Large redclaw	70	33	37	11	4	15	11
Moreton Bay bug	96	15	4	0	0	11	11
Yabbie	37	33	30	11	0	33	41

Sample	Visible black spot	Other	Dry	Moist	Intact	Gaping	Other
Prawn	0	11	15	52	89	0	11
Lobster	0	4	48	33	74	11	4
Small redclaw	0	0	0	74	74	7	0
Large redclaw	0	7	0	85	78	11	7
Moreton Bay bug	0	0	59	26	67	15	0
Yabbie	0	7	4	70	67	11	7

Odour

Table 3. Mean sensory scores for the odour attributes of the crustacean species.

Species	Crustacean Odour**	Fishy Odour	Other Odour**
Prawn	57 d	6 a	6 a
Lobster	56 cd	6 a	7 ab
Small redclaw	45 ab	9 a	13 bc
Large redclaw	51 bc	5 a	16 cd
Moreton Bay bug	50 b	8 a	19 cd
Yabbie	42 a	10 a	22 d
LSD	6.0	8.2	6.9

***** Difference between crustacean samples significant (P<0.05)
****** Difference between crustacean samples significant (P<0.01)

Within a column, means followed by a common letter are not significantly different. Scales used for the above attributes were all from not (0) to very (100).

Table 4. Percentages of panellists selecting odour descriptors for the crustacean species.

Species	Ammoniacal	Muddy	Musty	Plastic	Stale	Sulphury	Sweaty	Other
Prawn	0	4	11	0	11	7	0	30
Lobster	7	0	15	7	11	0	4	30
Small redclaw	4	15	22	7	22	15	7	19
Large redclaw	4	15	19	4	11	7	11	33
Moreton Bay bug	15	11	15	7	7	11	11	41
Yabbie	11	22	19	0	30	19	15	33

Flavour

Table 5. Mean sensory scores for the flavour attributes of the crustacean species.

Species	Crustacean*	Salty	Sweet**	Muddy	Cabbagy
Prawn	56 bc	19 a	52 d	2 a	3 a
Lobster	60 c	19 a	28 bc	6 a	17 a
Small redclaw	44 abc	11 a	27 b	6 a	10 a
Large redclaw	55 bc	14 a	37 c	5 a	7 a
Moreton Bay bug	28 a	22 a	7 a	7 a	16 a
Yabbie	38 ab	17 a	21 b	13 a	16 a
LSD	20.5	22.6	9.2	6.9	14.1

Species	Fishy	Stale**	Off*	Other**	After taste
Prawn	2 a	5 a	1 a	4 a	19 a
Lobster	3 a	13 b	3 ab	16 b	21 a
Small redclaw	4 a	11 b	1 a	13 b	8 a
Large redclaw	2 a	9 ab	2 a	9 ab	12 a
Moreton Bay bug	6 a	29 c	8 bc	26 c	24 a
Yabbie	5 a	23 c	9 c	26 c	18 a
LSD	3.9	5.7	5.7	8.3	17.4

***** Difference between crustacean samples significant (P<0.05)
****** Difference between crustacean samples significant (P<0.01)

Within a column, means followed by a common letter are not significantly different.
Scales for all attributes were from not (0) or none (0) to very (100).

Table 6. Percentages of panellists selecting flavour descriptors for the crustacean species.

Sample	Ammoniacal	Bitter	Cardboard	Metallic	Musty	Peppery
Prawn	0	0	0	0	4	7
Lobster	7	26	19	15	30	19
Small redclaw	0	4	4	7	7	0
Large redclaw	0	19	4	7	11	11
Moreton Bay bug	7	15	26	15	19	15
Yabbie	0	7	7	7	22	7

Sample	Peppery	Plastic	Soapy	Sweaty	Vegetable	Weedy/ herbaceous	Other
Prawn	7	4	0	0	19	7	11
Lobster	19	4	4	11	41	22	4
Small redclaw	0	0	4	7	33	22	19
Large redclaw	11	0	0	4	30	19	4
Moreton Bay bug	15	7	11	7	22	22	37
Yabbie	7	4	7	19	52	30	30

Texture

Table 7. Mean sensory scores for the texture attributes of the crustacean species.

Species	Firm**	Springy**	Moist**	Mushy	Tough**
Prawn	71 c	44 c	44 b	2 a	34 b
Lobster	67 c	30 b	30 a	6 a	40 b
Small redclaw	45 a	22 a	58 c	15 a	5 a
Large redclaw	49 a	29 b	69 d	13 a	8 a
Moreton Bay bug	60 b	29 b	33 a	7 a	40 b
Yabbie	44 a	20 a	61 c	18 a	14 a
LSD	4.9	5.8	7.4	11.5	10.1

***** Difference between crustacean samples significant (P<0.05)
****** Difference between crustacean samples significant (P<0.01)

Within a column, means followed by a common letter are not significantly different.

Scales:
Firm soft (0) – firm (100)
Springy; mushy; tough; not (0) – very (100)
Moist very dry (0) – very moist (100)

Table 8. Percentages of panellists selecting texture descriptors for the crustacean species.

Species	Chalky/ Floury	Chewy	Crunchy	Fibrous	Flaky
Prawn	0	44	30	19	0
Lobster	37	56	22	30	0
Small redclaw	11	11	0	15	4
Large redclaw	0	19	11	15	15
Moreton Bay bug	22	63	0	52	4
Yabbie	4	26	4	37	4

Species	Gritty	Rubbery	Sticky	Stringy	Other
Prawn	15	22	4	7	0
Lobster	11	7	0	15	7
Small redclaw	0	4	11	4	15
Large redclaw	4	7	0	0	19
Moreton Bay bug	4	19	0	33	7
Yabbie	0	4	4	11	15

Overall Quality

Table 9. Mean sensory scores for the overall quality of the crustacean species tested.

Crustacean Species	Overall quality**
Prawn	59 c
Lobster	49 b
Small redclaw	47 b
Large redclaw	60 c
Moreton Bay bug	25 a
Yabbie	31 a
LSD	6.7

****** Difference between crustacean samples highly significant (P<0.01)
Within a column, means followed by a common letter are not significantly different.

Scale used: very poor quality (0) – very good quality (100)

4.2 Sensory comments for a range of crustacean species

List of appearance, odour, flavour, texture and other comments made by the panellists for each of the species tested.

SMALL REDCLAW

APPEARANCE
- brown colouration throughout sample
- around the head end there is quite a bit of greenish brown staining on the flesh
- looks stringy
- dirty looking at top
- only a tinge of grey
- just a little gaping

ODOUR
- smells like sewage
- smells like cooked cold egg
- weedy
- low level of fresh odour
- fresh and pleasant
- vegie
- again a warm rubbery smell

FLAVOUR
- a real sewage taste about it (not that I have eaten sewage)
- can't describe the aftertaste but it is not very pleasant
- vegemite sharp flavour
- quite sweet and crustaceany flavour no off or unpleasant flavours
- lacks flavour, watery.
- watery and bland
- not a lot of flavour but what there is OK
- pretty tasteless - bland and what flavour there was did not typify good crustaceans
- slightly metallic/acid on tongue

TEXTURE
- seems to lack body/firmness
- extremely soft and tender and quite mushy
- texture quite good but not a lot of taste
- soft
- a little 'soft'

OTHER
- a nothing sample
- no bad texture needs to be a little more crunchy and have discernible segments
- rather disappointing for flavour and texture
- sample did not seem as fresh as some I've tasted

LARGE REDCLAW

APPEARANCE

- looks quite appetising
- beige around the head end
- beige around the head end on the pieces which would go up into the head
- looks mushy and stringy
- looks generally rather grey but with the other colours I ticked in the previous question
- **slight greyness to it and slightly darker grey where the tail was pulled away from the body**

ODOUR

- odour like raw sewage
- sweet odour
- like boiled cabbage or vegetables
- slightly vegetably/cabbagy
- wet grass
- a slightly putrid smell about this one
- sort of putrid smell mixed with the other odours
- smells like a dirty toilet
- that old rubbery note again
- almost smelt 'salty'

FLAVOUR

- a quite tinny aftertaste
- crustacean type aftertaste
- no flavour at all except vegetable sort of bitter flavour, absolutely terrible
- bland lacking in flavour not very sweet flavour slight pepper metallic flavour initially but peppery aftertaste
- watery and bland
- yum
- fantastic - best yet
- watery
- tastes much better than it looks or smells
- low level crustacean flavour but no off flavours

TEXTURE

- a bit sloppy
- had gristly bits in it the texture was quite tough for a redclaw but the size was monsterous
- flaky means can discern segments I hope
- very soft and tender a bit mushy
- perfect
- good texture like I would expect in this type of food
- some initial resistance , generally soft but not mushy

OTHER

- not as good as 703 (small redclaw) because lacking flavour
- more please
- best redclaw ever
- **this is good.**
- too much water in sample
- marked down because of the unattractive colour and smell

LOBSTER

APPEARANCE
- quite an orange tint right through the sample
- the whole cross section of the flesh looks a pale pinky/orange colour
- flaky firm clean
- looks good, the different muscles have large fissures between them but I think it is not gaping
- some 'holes' or spaces between the muscles are evident

ODOUR
- sweet lobster odour
- typical sweet lobster aroma
- sharp peppery smell
- old soapy or stagnant water eg. the water which collects around fishing boats
- fresh and pleasant smelling
- smells like the sea at Redcliffe which is sort of weedy, the ocean at surf beaches smells totally different
- beautiful sea smell
- smells beautifully of the sea

FLAVOUR
- aftertaste of meaty crustacean type flavour
- bitter
- bitter near skin as usual with lobster
- slightly putrid flavour, quite a dirty taste overall
- not at all pleasant with a bitter aftertaste developing
- disgusting

TEXTURE
- lots of small pieces remain in mouth after you have swallowed the sample
- very tough chewy skin on sample, lots of small chalky type particles left in mouth after swallowing, hard to get rid of all the bits in your mouth
- cottonwoolly
- like cottonwool
- hard to chew
- too chewy, lacks succulent character
- tough skin

OTHER
- very poorly frozen tropical lobster the pigment just under the shell was very bitter and peppery and the texture was dry and chalky
- very disappointing, looks great but taste and texture are not good
- glad I didn't buy this one
- **one of the worst lobsters I've ever tasted**

YABBIE

APPEARANCE

- weak outer shell
- several small patches of yellow
- **sample just fell apart when removed from shell, very little meat inside for the size of the shell**
- badly discoloured from head
- lots of yellowness and chalky looking, not very appealing to look at
- fair bit of yellow stuff/spots on flesh (not in flesh)
- creamish pink gunk in the vein
- some slight brown discolouration rather like when an apple has a bad bit in it
- the yellowness is not great but appears throughout the tail

ODOUR

- sewage smell
- other odour is earthy and cabbagy
- weedy/herbaceous
- mealy grainy
- smells like stale old 'uncooked' mud crab, that has been sitting in the sun for half the day
- cabbagy/herbaceous
- no odour
- not a pleasant odour
- smells good fresh crab like
- not real crustacean but a bit muddy/musty
- slightly rubbery smell

FLAVOUR

- not a pleasant flavour, tastes off
- mealy meaty aftertaste
- tastes like vegemite toast
- stale and watery
- cabbagy
- very watery washed out flavour
- nearly rancid
- very watery flavour nothing like a redclaw
- no flavour
- **there is a peculiar flavour in addition to those I marked not very pleasant and hard to describe - sort of dirty flavour**

TEXTURE

- soft, wet and just falling apart
- **this sample seemed to have been frozen and defrosted eg the water was no longer bound into the flesh, the flesh had become kind of dehydrated and stringy and tough**
- soft, cottonwoolish
- mush
- the skin is a bit leathery and the flesh soft
- soft

OTHER

- meaty mealy taste, texture stringy
- yuk

- terrible
- good flavour but texture not so good
- glad I didn't buy this one too
- not nice enough to swallow even!

MORETON BAY BUG

APPEARANCE

- slightly yellowish at head end
- **looks generally pretty good except for yellowness at the end where the tail joins the body**
- slight gaping between segments

ODOUR

- a very off odour
- **smells like a freshwater pond a tiny bit muddy and brown like but not enough to select from the descriptors but redclaw don't smell like a marine crustacean at all**
- vegetable
- rainforest like - wet leaf matter?
- chemical
- pleasant and fresh
- medium level putrid or cabbage smell
- terrible strong smell, I think it is ammoniacal for want of a better name
- cabbagy
- cabbagy
- cabbage
- freshly autoclaved rubber

FLAVOUR

- dirty - bland flavour
- very bland
- this sample has no flavour, just watery and bland
- practically no flavour at all
- dirty dishwater, can't even swallow it
- very, very bland and lacking flavour
- bland
- very salty
- watery - obviously frozen
- yuk
- very bland, no real flavour
- tasteless, watery
- strong salt flavour
- very bland and watery. almost no flavour and very boring. not a nice thing to have in the mouth
- there's a hint of mint - like a touch of toothpaste
- VERY salty with a cabbagy (slight) undertone and very unpleasant
- shocking fishy, off taste
- disgusting
- terrible
- sharp

TEXTURE

- dry and cottonwool like

- I’m sorry but couldn’t swallow tastes like awful
- it's like eating cottonwool soaked in brine for a while with a distinct off taste too
- wet cottonwoolish
- very dry
- **sort of meat like but weird and unpleasant probably because it's so bland and unexpected.**
- hugely disappointing
- in a word –YUK
- **the flavour is so unpleasant I didn't keep it in my mouth long enough to describe the nuances of texture**
- watery texture - after chewing in mouth have free water there different from usual

OTHER
- dry cottonwoolly texture flavour like has been soaked in dishwater with ashtrays and stale old detergent no rating just too bad
- very dry with no flavour
- very bland, no real flavour
- not a good bug
- very unpleasant, virtually no flavour except for salt
- old been frozen for a long time NEVER tasted a bug like that

PRAWN

APPEARANCE
- very grey alimentary canal and quite a large dark grey area where head has been removed
- **almost looks slightly transparent in parts**
- firm and moist
- opaque uneven
- opaque uneven
- distinctly different coloured muscle pattern, varies from dense white to translucent off white
- **muscles appear to be different visually some are dense white and others translucent, they make an attractive pattern in the prawn flesh**

ODOUR
- sweet odour
- metallic
- no very strong prawn smell
- off and old/stale type odours
- slight savoury smell – vegemitey
- fresh and pleasant and typical

FLAVOUR
- typical prawn - very sweet taste and aftertaste
- aftertaste is of meaty crustacean type flavour
- sweet aftertaste
- very sweet and like artificial sweet taste
- strong sweet aftertaste
- very sweet
- not much flavour
- **very sweet but little crustacean flavour, not much salt either, the sweetness is as if they have sugar added**

- **overpowering sugar sweet flavour and little else, but very nice just not quite what I'd expect**
- a little fruity - and remains as aftertaste

TEXTURE
- nice texture firm and crunchy but not chewy at all
- pretty good texture
- good texture

OTHER
- bit too fake sweet flavour cloying and sweet taste hangs around afterwards
- rated on prawns a nice sample
- I have rated it on the low side because of the lack of typical fresh prawn flavour, the texture and sweetness are nice but not typical
- very pleasant and I like the sweetness

APPENDIX 5 PACKAGED COOKED REDCLAW

Figure 4. Cooked redclaw in a modified atmosphere package.

Table 10. Mean demerit scores for cooked redclaw stored at 4°C in air, MAP, or vacuum for up to 14 days.

Total storage days for the different	Shell colour	Blackspot presence	Flesh appearance	Flesh colour	Drip score	Odour	Total demerits
0d fresh	0^{d}	0	0	0	0	0^{d}	0^{e}
4d air	0.5^{c}	0	0.25	0.25	0	0.25^{d}	1.25^{de}
4d MAP	0.5^{c}	0	0	0.38	0	1.2^{bc}	2.2^{cd}
4d vacuum pack	0.5^{c}	0	0	0.25	0	1.2^{bc}	2.33^{bcd}
7d air	0^{d}	0	0	0.4	0	1.25^{bc}	1.65^{d}
7d MAP	0.38^{c}	0	0.13	0.14	0	1.21^{bc}	2.35^{bcd}
7d vacuum pack	0.65^{bc}	0	0	0.5	0	1.1^{c}	3.38^{abc}
11d air	1^{a}	0	0.13	0.33	0	1.7^{ab}	3.32^{abc}
11d MAP	0.5^{c}	0	0	0.38	0	1.38^{bc}	2.25^{cd}
11d vacuum pack	0.5^{c}	0	0.32	0.63	0	2.13^{a}	3.57^{ab}
14d MAP	0.94^{ab}	0	0.5	0.58	0	2.03^{a}	4.04^{a}
LSD	**0.31**	**-**	**-**	**-**	**-**	**0.57**	**1.30**

^{abcde} Different letters signify significant differences between treatments (P<0.01).

Table 11. Mean microbiological counts (log cfu/g), pH and drip loss in cooked redclaw stored at 4°C in air, MAP, or vacuum for up to 14 days.

Total storage days for the different conditions	Total count	Psychrotrophic count	H_2S producer count	Anaerobic count	Pasteurised anaerobic count	Clostridial count	pH	Drip loss (%)
0d fresh	1.78^{e}	1.3^{g}	0	0.00^{f}	0	0	7.20^{c}	-
4d air	2.62^{e}	2.58^{fg}	0	1.77^{e}	0	0	7.47^{bc}	-
4d MAP	3.26^{de}	3.08^{ef}	0	2.64^{de}	0	0	7.31^{c}	1.95
4d vacuum pack	3.22^{de}	3.40^{ef}	0	2.02^{e}	0	0	7.43^{c}	-
7d air	5.44^{bc}	5.55^{bcd}	0	4.42^{c}	0	0	-	-
7d MAP	4.57^{cd}	4.70^{de}	0	3.55^{cd}	0	0	7.58^{bc}	2.96
7d vacuum pack	5.42^{bc}	5.16^{cd}	0	0.00^{f}	0	0	8.31^{a}	-
11d air	7.95^{a}	8.04^{a}	0	4.90^{bc}	0	0	8.41^{a}	-
11d MAP	6.20^{bc}	6.43^{abc}	0	6.19^{ab}	0	0	7.46^{c}	4.91
11d vacuum pack	6.92^{ab}	7.23^{a}	0	6.23^{ab}	0	0	7.88^{b}	
14d MAP	6.39^{ab}	6.86^{ab}	0	6.85^{a}	0	0	7.32^{c}	4.48
LSD	**1.64**	**1.65**	**-**	**1.50**	**-**	**-**	**0.42**	**-**

^{abcde} Different letters signify significant differences between treatments (P<0.01).

Table 12. Selection of appearance descriptors (%).

Attribute	White				Cream				Beige				Grey				Dry				Moist				Intact				Gaping				Other			
Time point (day)	0	4	7	11	0	4	7	11	0	4	7	11	0	4	7	11	0	4	7	11	0	4	7	11	0	4	7	11	0	4	7	11	0	4	7	11
Air stored	81	86	80	NT	44	21	27	NT	19	14	20	NT	0	0	0	NT	0	7	0	NT	69	64	60	NT	81	93	73	NT	0	0	7	NT	0	7	13	NT
MAP	88	86	67	69	25	29	40	38	19	7	20	6	0	0	0	6	6	0	7	6	69	64	60	75	75	86	80	81	0	0	7	6	6	14	7	6
Vacuum	88	86	87	NT	19	14	40	NT	13	14	7	NT	0	0	0	NT	6	7	13	NT	69	57	47	NT	75	86	67	NT	19	0	13	NT	6	7	13	NT

NT = not tested

Table 13. Mean sensory score for the cooked odour attributes.

Attribute	Treatment	Day 0	Day 4	Day 7	LSD	Day 11
Crustacean	Air stored	60	55	55		NT
	MAP	59	58	47	7.9	53
	Vacuum	63	61	51		NT
	Day	61[a]	58[a]	51[b]	4.6	
Fishy	Air stored	5	9	9		NT
	MAP	3	7	4	4.8	11
	Vacuum	4	11	7		NT
	Day	4[b]	9[a]	7[ab]	2.8	
Other	Air stored	4	7	9		NT
	MAP	6	5	12	7.3	12
	Vacuum	6	6	15		NT
	Day	5[a]	6[a]	12[b]	4.2	

NT = not tested. [abc] = Within a row, means followed by a common letter are not significantly different (P>0.05). Scales used: Crustacean; Fishy not (0) - very (100); Other none (0) - very (100)

Table 14. Selection of cooked odour attributes (%).

Attribute	Ammoniacal				Muddy				Musty				Plastic				Stale				Sulphury				Sweaty				Other			
Time point (day)	**0**	**4**	**7**	**11**	**0**	**4**	**7**	**11**	**0**	**4**	**7**	**11**	**0**	**4**	**7**	**11**	**0**	**4**	**7**	**11**	**0**	**4**	**7**	**11**	**0**	**4**	**7**	**11**	**0**	**4**	**7**	**11**
Air stored	0	0	0	NT	25	14	7	NT	0	7	20	NT	0	0	0	NT	6	14	27	NT	6	14	7	NT	13	14	13	NT	13	29	20	NT
MAP	0	0	0	0	25	14	7	6	6	7	7	6	6	7	7	13	0	14	27	31	6	0	13	19	0	0	20	13	13	14	27	19
Vacuum	0	0	0	NT	6	21	13	NT	6	7	7	NT	0	0	7	NT	19	7	27	NT	0	0	20	NT	19	0	27	NT	19	43	20	NT

NT = not tested

Table 15. Mean sensory scores for the flavour attributes.

Attribute	Treatment	Day 0	Day 4	Day 7	LSD	Day 11
Crustacean	Air	64	52	53		NT
	MAP	60	54	53	8.0	60
	Vacuum	60	61	54		NT
	Day	61[a]	56[b]	53[b]	4.6	
Salty	Air	12	9	12		NT
	MAP	9	12	11	3.7	16
	Vacuum	11	12	14		NT
	Day	11[a]	11[a]	12[a]	2.1	
Sweet	Air	34	30	28		NT
	MAP	33	31	32	8.3	34
	Vacuum	34	34	28		NT
	Day	34[a]	32[a]	29[a]	4.8	
Muddy	Air	2	4	5		NT
	MAP	6	3	4	3.8	5
	Vacuum	4	5	4		NT
	Day	4[a]	4[a]	4[a]	2.2	
Cabbagy	Air	3	4	6		NT
	MAP	5	8	5	4.9	9
	Vacuum	7	6	6		NT
	Day	5[a]	6[a]	6[a]	2.8	
Fishy	Air	5	6	8		NT
	MAP	3	7	4	4.5	8
	Vacuum	3	4	5		NT
	Day	4[a]	6[a]	6[a]	2.6	
Stale	Air	2	5	10		NT
	MAP	3	2	7	4.5	5
	Vacuum	3	5	9		NT
	Day	3[b]	4[b]	9[a]	2.6	
Off	Air	2	1	1		NT
	MAP	1	1	4	2.5	3
	Vacuum	1	1	2		NT
	Day	1[a]	1[a]	3[a]	1.4	
Other	Air	7	6	9		NT
	MAP	5	9	12	6.8	7
	Vacuum	5	9	7		NT
	Day	6[a]	8[a]	9[a]	3.9	
Aftertaste	Air	13	12	17		NT
	MAP	16	13	16	5.6	14
	Vacuum	13	18	17		NT
	Day	14[a]	14[a]	17[a]	3.2	

NT = not tested abc Within a row, means followed by a common letter are not significantly different (P>0.05).

Scales used:
Crustacean; Salty; Sweet; Muddy; Cabbagy; Fishy; Stale; Off: not (0) – very (100)
Other; Aftertaste: none (0) – very (100)

Table 16. Selection of flavour descriptors (%).

Attribute	Treatment	Day 0	Day 4	Day 7	Day 11
Ammoniacal	Air	0	0	7	NT
	MAP	0	0	0	0
	Vacuum	0	0	0	NT
Bitter	Air	19	14	13	NT
	MAP	25	14	13	19
	Vacuum	19	7	20	NT
Cardboard	Air	0	0	7	NT
	MAP	0	0	7	0
	Vacuum	6	0	7	NT
Metallic	Air	19	7	7	NT
	MAP	19	7	13	6
	Vacuum	6	7	7	NT
Musty	Air	6	7	7	NT
	MAP	13	7	13	6
	Vacuum	0	7	7	NT
Peppery	Air	13	21	27	NT
	MAP	6	29	20	13
	Vacuum	19	21	20	NT
Plastic	Air	0	0	0	NT
	MAP	0	0	0	6
	Vacuum	0	7	7	NT
Soapy	Air	0	0	0	NT
	MAP	0	0	0	6
	Vacuum	0	0	0	NT
Sweaty	Air	6	0	13	NT
	MAP	6	0	0	13
	Vacuum	6	0	13	NT
Vegetable	Air	19	21	33	NT
	MAP	31	21	27	25
	Vacuum	25	21	20	NT
Weedy/ herbaceous	Air	19	21	20	NT
	MAP	44	14	33	31
	Vacuum	19	14	7	NT
Other	Air	0	7	7	NT
	MAP	0	0	20	31
	Vacuum	6	7	7	NT

NT = not tested

Table 17. Mean sensory scores for the texture attributes.

Attribute	Treatment	Day 0	Day 4	Day 7	LSD	Day 11
Firm	Air	49	51	52		NT
	MAP	50	53	50	8.5	51
	Vacuum	48	49	52		NT
	Day	49[a]	51[a]	52[a]	4.9	
Springy	Air	18	18	19		NT
	MAP	21	19	18	6.6	18
	Vacuum	20	19	19		NT
	Day	20[a]	19[a]	19[a]	3.8	
Moist	Air	59	57	53		NT
	MAP	65	54	55	5.9	55
	Vacuum	60	58	48		NT
	Day	61[a]	56[b]	52[c]	3.4	
Mushy	Air	9	11	9		NT
	MAP	13	9	4	6.2	10
	Vacuum	10	14	8		NT
	Day	11[a]	11[a]	7[b]	3.6	
Tough	Air	7	4	7		NT
	MAP	4	7	6	5.2	7
	Vacuum	7	8	4		NT
	Day	6[a]	6[a]	6[a]	3.0	

NT = not tested. [abc] Within a row, means followed by a common letter are not significantly different (P>0.05). Scales used:Firm soft (0) – firm (100)
Springy; Mushy; Tough not (0) – very (100), Moist dry (0) – moist (100)

Table 18. Selection of texture descriptors (%).

Attribute	Treatment	Day 0	Day 4	Day 7	Day 11
Chalky/floury	Air	6	7	0	NT
	MAP	0	0	0	0
	Vacuum	0	7	0	NT
Chewy	Air	6	21	20	NT
	MAP	6	14	13	19
	Vacuum	13	21	7	NT
Crunchy	Air	6	7	13	NT
	MAP	6	7	0	13
	Vacuum	6	7	7	NT
Fibrous	Air	25	0	13	NT
	MAP	6	14	13	31
	Vacuum	13	7	13	NT
Flaky	Air	0	0	7	NT
	MAP	0	0	0	6
	Vacuum	0	0	0	NT
Gritty	Air	0	0	0	NT
	MAP	0	0	0	6
	Vacuum	0	0	7	NT
Rubbery	Air	6	7	0	NT
	MAP	0	7	0	6
	Vacuum	6	7	0	NT
Sticky	Air	0	0	0	NT
	MAP	6	7	7	6
	Vacuum	0	14	13	NT
Stringy	Air	6	14	0	NT
	MAP	13	14	0	0
	Vacuum	0	7	0	NT

NT = not tested

Table 19. Mean sensory scores for overall quality.

Attribute	Treatment	Day 0	Day 4	Day 7	LSD	Day 11
Overall Quality	Air	60	56	51		NT
	MAP	60	59	54	8.6	54
	Vacuum	60	57	51		NT
	Day	60[a]	58[a]	52[b]	5.0	

NT = not tested [abc] Within a row, means followed by a common letter are not significantly different (P>0.05).Scale used: Overall quality very poor (0) – very good (100)

List of appearance comments made for the redclaw.

Day 0 MAP.
- a fresh looking cooked redclaw
- slightly yellow gut lining
- great appearance
- bright yellow specks along the vein line
- looks sort of moist but dry at the same time - more moist though

Day 0 vacuum packed.
- could appear moister, but it doesn't appear dry??
- yellow spots from gut cavity
- it was hard to get out of the shell so looked a mess and I can't be sure if there is any gaping

Day 0 Air stored.
- very slight on the yellow stuff, more a yellow fluid evident AROUND the tail area of the sample, not so much a yellowing of the flesh, maybe old oiliness like stuff, or rancid matter, seeing how the intestinal tract is intact and full
- yellow in the alimentary canal and under side of the tail
- some pink specks
- visible yellow spots along the vein line and more creamy colour

Day 4 MAP.
- little to whinge about
- very obvious grey vein
- intestinal tract full

Day 4 Vacuum packed.
- very slight yellowing around extremities of the intestinal tract region. not evident within the flesh
- vein grey down the back
- it's hard to say if the sample is dry or moist visually

Day 4 Air stored.
- nice and white
- pink tinge is quite pronounced in this sample
- slight dirty appearance
- had distinct yellow dots
- yellow patches along the side where the legs are, and especially down at the very tail end

Day 7 MAP.
- hard to remove from shell so got a bit damaged getting the flesh out, hard to assess intactness
- green around where head would have been
- beige around the head end, mostly on the back side

Day 7 Vacuum packed.
- slight greying around the edges, underside, appears dry, and intermuscular segments are more noticeable
- creamy coloured vein some bright/intense yellowness apparent
- slightly dry on the surface cut
- looks firm and fresh

Day 7 Air stored.
- there is evidence of a slight amount of yellowing around the extremities
- very dirty vein down the back
- very slightly dry
- flaky like fish fillet looks a little drier than usual
- very moist looking
- quite beige/greenish along intestinal tract

Day 11 MAP packed.

- a rather full intestinal tract, yet no discolouration in the area, ie. CLEAN

very obvious black vein

List of odour comments made for the cooked redclaw.

Day 0 MAP.

- fresh and very pleasant
- vegetable odour but not cabbagy or peppery more like a powdered vege stock?
- sample had very little odour at all

Day 0 Vacuum packed.

- cabbagy
- slight cabbage
- fresh and very pleasant
- almost a smell of cabbage here

Day 0 Air stored.

- very slight sulphury/muddy....
- cabbagy, slightly peppery and herbaceous
- fresh and very pleasant
- smells weedy/herbaceous
- bland

Day 4 MAP.

- a slight muddy taint, and a hint of the sea...
- herbaceous
- slightly unclean smell
- clean and fresh

Day 4 Vacuum packed.

- very slight on the ammonia, cabbagy/weedy like nose, slighter clean crustacean odour
- herbaceous
- fresh and clean
- I don't know but the sample was very cold difficult to smell
- weedy smell

Day 4 Air stored sample.

- fresh sweet redclaw like odour....
- only very slight crustacean odour
- slightly cabbagy and herbaceous
- sweet fresh
- don't know just a non typical smell

Day 7 MAP.

- peppery?
- cabbagey
- weedy sort of smell vegetation like plant matter
- vegetable, weedy

Day 7 Vacuum packed.

- more really no odour as any other odour??
- nearly an off type odour, but more just a strong sulphury/stale type odour
- fresh and pleasant
- sweet smell
- smelt very muddy
- weedy

Day 7 Air stored.

- not all that on the fresh kinda side?
- fresh and pleasant
- a little milky
- sweet odour - different to crustacean

Day 11 MAP.

- a plasticy muddy taint??/ not strong, but there???
- very slight unusual smell and lacks the clean fresh smell I would expect with top quality crustaceans
- mild fishy odour
- soapy smell

List of flavour and aftertaste comments for the redclaw.

Day 0 MAP.

- No comments

Day 0 Vacuum Packed.

- very slight in the veggie department, and a rather sweet tasting beastie, more so than the previous.....
- lacks much flavour
- fresh and very pleasant
- just crustacean
- much stronger flavour

Day 0 Air stored.

- a bit old, oily?? like tongue taint????,,, slight peppery/vegie???
- very pleasant
- unpleasant
- beautifully clean tasting
- had background flavour of meaty vegetable

Day 4 MAP.

- really bland, washed out in the flavour region, slight vege/cabbagy after taint, and the 'other' is a watery flavour???? i.e. nothing?
- crustacean
- good flavour and pleasant
- little bit stronger peppery taste during eating but not unpleasant good strong flavour

Day 4 Vacuum packed.

- a metally taint?, not STRONG redclaw flavour, but still redclaw
- watery washed out flavour, ie lacks flavour
- slight savoury flavour - like very dilute vegemite
- peppery aftertaste slight
- strong shellfishy/sea aftertaste (crustacean)

Day 4 Air stored.

- a VERY SLIGHT metallicy taint, more a raising of the taint from the tongue to the nether region of the palate in a soft, almost pleasant manner....
- very bland in flavour
- very nice clean flavour
- slightly less flavour than with some samples
- Very little flavour

Day 7 MAP.
- not as strong as the texture would of lead me to expect...
- bland in flavour
- very bland
- slightly fragrant / flowery flavour and sweet aftertaste

Day 7 Vacuum packed.
- not all that fresh an impression ?
- mainly a staleness, lacking freshness/clean and sweet
- lacks flavour but what flavour there is OK
- strong crustacean flavour
- was very low in flavour low crustacean flavour

Day 7 Air stored.
- the metallic is a slight one.... the as with the rest....
- flavour builds up

Day 11 MAP packed.
- after-taste off kind of plastic/watery???
- tastes very good
- prawn flavour
- aspartame sweet
- crabby

List of texture comments made for the redclaw.

Day 0 MAP.
- a pleasant texture, firm not tough, moist not mushy??
- it's sort of soft but not in a detrimental way
- this one was good and different from the last one!!
- firmer flesh more texture and more like prawn but still too soft not mushy at all this time

Day 0 Vacuum packed.
- soft texture
- slight jelly like aspic texture

Day 0 Air stored.
- bit soft, moist, but not all that much resilience in the texture department?? though not totally un-appealing....
- this one was definitely a little mushy - kind of dissolved too quickly in the mouth
- much firmer

Day 4 MAP.
- impression of FIRM on the initial mastication, then subsequent chomping proved MUSHY....
- slight resistance when chewing otherwise - soft
- much better texture firm but still tender and slightly crunchy excellent

Day 4 Vacuum packed.
- a little soft, but still a noticeable crunch??
- soft and not a lot of resistance when chewing
- Firm initial bite then too soft.
- tiny bit sticky like fish flesh
- a little mushy and tough at the same time

Day 4 Air stored.
- pleasant, firm, slightly springy and redclawy like.....
- good texture - but soft - which is not a detrimental characteristic
- firm initial bite - then very soft almost mushy texture. Doesn't hold together.

- pasty when first chewed, forms a wad in the mouth like wet cotton wool

Day 7 Map.
- there was a couple of harder/stringy like bit present, but very minimal
- perfect mouth feel
- soft

Day 7 Vacuum packed.
- dry and a little stringy
- more texture in this than 267 and 142 which were soft compared to this one
- very slightly floury
- soft/ slightly mushy
- much better texture...firmer and there is some structure to the segments

Day 7 Air stored.
- initial chew hinted to firm, and springy, but it was a little flaky, and all texture dissolved after about the third mastication
- soft but OK
- no resistance at all no clear segments to the body

Day 11 MAP packed.
- rather resilient in the textural region
- soft and pleasant tasting
- lack of structure at all

APPENDIX 6 FEASIBILITY OF MAP UNCOOKED REDCLAW

Table 20. The microbial counts of the flesh, tail shell and head of uncooked redclaw treated with 50 and 200ppm chlorine dioxide.

Treatment	Sample type	Total count	H_2S producer count
No chemical	Flesh	3.455	0
	Tail shell	4.954	3.519
	Head	5.484	0
50ppm ClO_2	Flesh	3.638	2.130
	Tail shell	4.097	3.301
	Head	4.690	0
200ppm ClO_2	Flesh	3.312	2.778
	Tail shell	3.255	3.634
	Head	4.744	0

Table 21. The microbial counts of the flesh, tail shell and head of uncooked redclaw treated with stronger chlorine dioxide dips for 5 minutes.

Treatment	Sample type	Total count
No chemical	Flesh	3.415
	Tail shell	5.286
	Head	4.911
200ppm ClO_2	Flesh	4.623
	Tail shell	4.544
	Head	4.922
500ppm ClO_2	Flesh	4.633
	Tail shell	4.653
	Head	3.648

Table 22. The microbial counts from flesh and shell of uncooked redclaw treated with a fresh supplied chlorine dioxide solution and sodium hypochlorite for 5 minutes.

Treatment	Sample type	Total count	H_2S producer count
No chemical	Tail shell and head	6.000	0
	Flesh	4.875	0
200ppm ClO_2	Tail shell and head	4.000	0
	Flesh	3.380	0
500ppm ClO_2	Tail shell and head	4.000	0
	Flesh	3.531	0
1000ppm ClO_2	Tail shell and head	3.342	0
	Flesh	3.477	0
1% NaOCl	Tail shell and head	4.127	0
	Flesh	3.455	0

Table 23. The microbial counts from flesh and shell of uncooked redclaw treated with chlorine dioxide and sodium hypochlorite for 10 minutes.

Treatment	Sample type	Total count	H_2S producer count
500ppm ClO_2	Tail shell and head	4.512	4.477
	Flesh	2.903	2.477
1% NaOCl	Tail shell and head	4.398	4.255
	Flesh	2.978	3.204

APPENDIX 7 PACKAGED UNCOOKED REDCLAW

Figure 5. Raw redclaw in a modified atmosphere package.

Trial 1

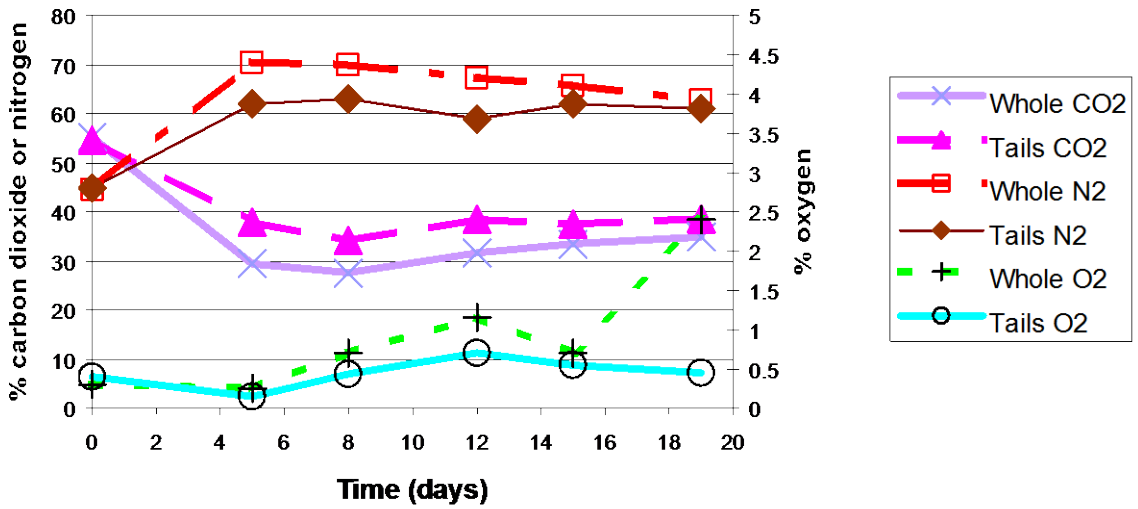

Figure 6. Composition of MAP headspace in raw redclaw packs stored at 4°C during trial 1.

Table 24. Mean pH and drip loss in uncooked whole and redclaw tails stored in air, MAP, or vacuum during trial 1.

Storage time (days)	Pack conditions	Product form	pH	Pack yield (%)
0	Air	Whole	6.89^{fghij}	100^{a}
0	Air	Tails	6.89^{fghij}	100^{a}
0	MAP	Whole	6.89^{fghij}	100^{a}
0	MAP	Tails	6.89^{fghij}	100^{a}
0	Vacuum	Whole	6.89^{fghij}	100^{a}
0	Vacuum	Tails	6.89^{fghij}	100^{a}
5	Air	Whole	7.13^{bcdef}	99.3^{ab}
5	Air	Tails	7.33^{abcd}	97.4^{bcde}
5	MAP	Whole	6.80^{ghij}	97^{cdef}
5	MAP	Tails	6.64^{j}	97.6^{bcd}
5	Vacuum	Whole	6.94^{efghij}	91.5^{k}
5	Vacuum	Tails	6.75^{hij}	93.9^{ij}
8	Air	Whole	7.07^{defgh}	97.4^{bcde}
8	Air	Tails	7.43^{abc}	95.6^{defghi}
8	MAP	Whole	6.71^{ij}	96.2^{cdefgh}
8	MAP	Tails	6.95^{efghij}	97.9^{bc}
8	Vacuum	Whole	6.99^{efghi}	92.4^{jk}
8	Vacuum	Tails	6.99^{efghi}	95.5^{defghi}
12	Air	Whole	7.19^{abcdef}	96.7^{cdefg}
12	Air	Tails	7.25^{abcde}	97.1^{cdef}
12	MAP	Whole	7.05^{defgh}	96.7^{cdefg}
12	MAP	Tails	6.96^{efghij}	97.9^{abc}
12	Vacuum	Whole	6.93^{efghij}	94.7^{ghi}
12	Vacuum	Tails	7.12^{bcdefg}	95.4^{efghi}
15	Air	Whole	7.33^{abcd}	96.9^{cdef}
15	Air	Tails	7.34^{abcd}	m
15	MAP	Whole	7.08^{defg}	96.7^{cdefg}
15	MAP	Tails	7.02^{defghi}	96.7^{cdefg}
15	Vacuum	Whole	7.13^{bcdef}	91.6^{k}
15	Vacuum	Tails	7.22^{abcde}	94.2^{hij}
19	Air	Whole	7.46^{a}	97.1^{cdef}
19	Air	Tails	7.44^{ab}	96.2^{cdefgh}
19	MAP	Whole	7.10^{cdefg}	96^{cdefghi}
19	MAP	Tails	7.08^{defg}	97.5^{bcde}
19	Vacuum	Whole	7.32^{abcd}	91.5^{k}
19	Vacuum	Tails	7.26^{abcde}	95.2^{fghi}
LSD			**0.33**	**2.12**

* ^{abcde} Different letters signify significant differences between treatments (P<0.01).

Table 25. Demerit scores for uncooked whole and redclaw tails stored in air, MAP, or vacuum during trial 1.

Storage time (days)	Pack conditions	Product form	Colour of shell	Presence of blackspot	Flesh appearance	Flesh colour	Staining	Drip	Odour	Total demerit points
0	Air	Whole	0^{g}	0^{d}	0^{e}	0^{h}	0^{h}	0^{f}	0^{j}	0^{n}
0	Air	Tails	0^{g}	0^{d}	0^{e}	0^{h}	0^{h}	0^{f}	0^{j}	0^{n}
0	MAP	Whole	0^{g}	0^{d}	0^{e}	0^{h}	0^{h}	0^{f}	0^{j}	0^{n}
0	MAP	Tails	0^{g}	0^{d}	0^{e}	0^{h}	0^{h}	0^{f}	0^{j}	0^{n}
0	Vacuum	Whole	0^{g}	0^{d}	0^{e}	0^{h}	0^{h}	0^{f}	0^{j}	0^{n}
0	Vacuum	Tails	0^{g}	0^{d}	0^{e}	0^{h}	0^{h}	0^{f}	0^{j}	0^{n}
5	Air	Whole	0^{g}	0^{d}	0^{e}	0^{h}	0^{h}	0^{f}	0^{j}	0^{n}
5	Air	Tails	0^{g}	0^{d}	0^{e}	0^{h}	0^{h}	0^{f}	0^{j}	0^{n}
5	MAP	Whole	0^{g}	0^{d}	0.15^{de}	1.7^{abc}	0^{h}	0.15^{ef}	0^{j}	2^{lmn}
5	MAP	Tails	0.13^{fg}	0^{d}	0.13^{de}	0.9^{defg}	0^{h}	0^{f}	0^{j}	1.2^{mn}
5	Vacuum	Whole	0^{g}	0^{d}	0^{e}	0^{h}	0.9^{defgh}	1.38^{ab}	0.33^{hij}	2.6^{klmn}
5	Vacuum	Tails	0^{g}	0^{d}	0.38^{cde}	1^{cdefg}	0.1^{gh}	0.7^{cde}	0^{j}	2.2^{lmn}
8	Air	Whole	0^{g}	0^{d}	0^{e}	0^{h}	0.25^{fgh}	0.5^{def}	1.2^{efg}	2.0^{lmn}
8	Air	Tails	0.25^{efg}	0^{d}	0.25^{cde}	1.13^{cdefg}	0.6^{defgh}	0.25^{ef}	0.9^{fghi}	3.4^{ijklm}
8	MAP	Whole	0^{g}	0^{d}	1^{abcde}	0.68^{fgh}	0.5^{efgh}	0.2^{ef}	0.2^{ij}	2.6^{klmn}
8	MAP	Tails	0.35^{efg}	0^{d}	0.5^{bcde}	1.25^{bcdef}	0.45^{efgh}	0^{f}	0.33^{hij}	2.9^{klm}
8	Vacuum	Whole	0^{g}	0^{d}	0.6^{bcde}	1^{cdefg}	0.88^{defgh}	1.2^{bc}	0.2^{ij}	3.9^{hijkl}
8	Vacuum	Tails	0^{g}	0^{d}	0.5^{bcde}	1^{cdefg}	0.13^{gh}	0.63^{cdef}	0.75^{ghi}	3.0^{klm}
12	Air	Whole	0.75^{defg}	1.5^{b}	1^{abcde}	1^{cdefg}	2^{ab}	0.25^{ef}	1.8^{cde}	8.3^{bcd}
12	Air	Tails	0.25^{efg}	0^{d}	0.2^{cde}	0.4^{gh}	0.25^{fgh}	0.3^{ef}	1.85^{cde}	3.3^{jklm}
12	MAP	Whole	0.3^{efg}	0^{d}	0.75^{bcde}	0.7^{fgh}	0.55^{efgh}	0.3^{ef}	0.8^{ghi}	3.4^{ijklm}
12	MAP	Tails	0.15^{fg}	0^{d}	0.25^{cde}	0.8^{efg}	0.1^{gh}	0.15^{ef}	0.95^{fgh}	2.4^{lmn}
12	Vacuum	Whole	0.3^{efg}	0^{d}	1.1^{abcd}	1.2^{cdef}	1.3^{abcde}	1.45^{ab}	1.8^{cde}	7.2^{bcdef}
12	Vacuum	Tails	0.2^{fg}	0^{d}	0.5^{bcde}	0.8^{efg}	0.1^{gh}	0.1^{ef}	1.9^{cde}	3.6^{ijklm}
15	Air	Whole	1.38^{bcd}	3^{a}	2^{a}	2^{ab}	2^{ab}	0.5^{def}	1.9^{cde}	12.8^{a}
15	Air	Tails	1.5^{bcd}	0.8^{c}	1.2^{abc}	1.25^{bcdef}	1.5^{abcd}	0^{f}	2.65^{ab}	8.9^{bcd}
15	MAP	Whole	0.88^{cdef}	0.4^{cd}	0.78^{bcde}	1.38^{abcdef}	1.23^{bcde}	0.1^{ef}	1.25^{efg}	6.0^{efghi}
15	MAP	Tails	0.75^{defg}	0^{d}	0.55^{bcde}	1.15^{cdefg}	0.5^{efgh}	0^{f}	1.33^{defg}	4.3^{ghijkl}
15	Vacuum	Whole	0.8^{def}	0^{d}	0.6^{bcde}	1.2^{cdef}	1.15^{bcdef}	2^{a}	2^{bcd}	7.8^{bcde}
15	Vacuum	Tails	0.2^{fg}	0^{d}	0.4^{cde}	1.3^{abcdef}	0^{h}	0.7^{cde}	2.5^{abc}	5.1^{fghijk}
19	Air	Whole	2.5^{a}	2^{b}	0.7^{bcde}	2^{ab}	1.9^{abc}	1^{bcd}	2.4^{abc}	12.5^{a}
19	Air	Tails	1.75^{ab}	0.5^{cd}	0.35^{cde}	1.6^{abcd}	2.15^{a}	0.2^{ef}	3^{a}	9.6^{b}
19	MAP	Whole	1^{bcde}	0.1^{d}	0.75^{bcde}	2.05^{a}	1^{cdefg}	0.1^{ef}	1.45^{defg}	6.5^{defgh}
19	MAP	Tails	1.15^{bcd}	0^{d}	0.7^{bcde}	1.65^{abcd}	0.55^{efgh}	0.2^{ef}	1.55^{def}	5.8^{efghij}
19	Vacuum	Whole	1.65^{bc}	0^{d}	1.5^{ab}	1.65^{abcd}	1.15^{bcdef}	1.4^{ab}	1.85^{cde}	9.2^{bc}
19	Vacuum	Tails	1.15^{bcd}	0^{d}	0.2^{cde}	1.55^{abcde}	0.1^{gh}	0.65^{cde}	3^{a}	6.7^{cdefg}
LSD			**0.79**	**0.61**	**1.01**	**0.77**	**0.91**	**0.63**	**0.74**	**2.64**

^{abcde} Different letters signify significant differences between treatments (P<0.01).

Table 26. Microbiological counts (log cfu/g) of uncooked whole and redclaw tails stored in air, MAP, or vacuum during trial 1.

Storage time (days)	Pack conditions	Product form	Total	Psychrotroph	H_2S producer	Anaerobic	Pasteurised anaerobic
0	Air	Whole	4.28^{ghijk}	2.69^{kl}	0	3.23^{cdefgh}	1.00^{bc}
0	Air	Tails	4.73^{fghijk}	3.60^{ijk}	0	3.67^{cdefgh}	0.85^{bc}
0	MAP	Whole	5.69^{cdefgh}	4.77^{fghi}	0	3.42^{cdefgh}	1.44^{ab}
0	MAP	Tails	3.36^{jkl}	2.76^{kl}	0	2.95^{efgh}	0^{c}
0	Vacuum	Whole	3.25^{kl}	1.95^{lm}	0	3.44^{cdefgh}	1.18^{bc}
0	Vacuum	Tails	3.73^{jkl}	2.83^{kl}	0	2.82^{efgh}	2.75^{a}
5	Air	Whole	2.09^{lm}	0.00^{n}	0	1.90^{gh}	0^{c}
5	Air	Tails	$5.02^{defghij}$	3.02^{kl}	0	5.02^{abcde}	1.65^{ab}
5	MAP	Whole	3.89^{ijk}	2.89^{kl}	0	3.18^{defgh}	0^{c}
5	MAP	Tails	3.98^{hijk}	3.28^{jk}	0	2.81^{efgh}	0.77^{bc}
5	Vacuum	Whole	1.39^{m}	0.98^{mn}	0	1.68^{h}	0^{c}
5	Vacuum	Tails	3.67^{jkl}	2.40^{kl}	0	2.79^{efgh}	0.70^{bc}
8	Air	Whole	6.79^{abc}	6.68^{abc}	0	6^{ab}	0.85^{bc}
8	Air	Tails	6.83^{abc}	6.86^{ab}	0	6^{ab}	0.77^{bc}
8	MAP	Whole	4.78^{fghijk}	4.30^{hij}	0	3.05^{efgh}	0.35^{bc}
8	MAP	Tails	5.76^{cdefg}	5.41^{defgh}	0	4.05^{bcdefg}	0^{c}
8	Vacuum	Whole	$4.98^{efghijk}$	4.45^{ghij}	0	4.47^{abcdef}	0.35^{bc}
8	Vacuum	Tails	6.00^{cdefg}	5.52^{cdefg}	0	6^{ab}	0.50^{bc}
12	Air	Whole	6.64^{abcde}	6.61^{abcd}	0	5.44^{abcd}	0^{c}
12	Air	Tails	7.79^{ab}	7.68^{a}	0	6^{ab}	1.33^{b}
12	MAP	Whole	6.65^{abcde}	5.54^{cdefg}	0	2.70^{fgh}	0.50^{bc}
12	MAP	Tails	$5.00^{defghij}$	5.32^{efgh}	0	4.39^{bcdef}	0.70^{bc}
12	Vacuum	Whole	6.92^{abc}	6.82^{ab}	0	6^{ab}	0.35^{bc}
12	Vacuum	Tails	$5.50^{cdefghi}$	5.51^{cdefgh}	0	4.89^{abcdef}	0.85^{bc}
15	MAP	Whole	7.92^{a}	5.00^{fgh}	0	3.61^{cdefgh}	0^{c}
15	MAP	Tails	6.06^{cdef}	5.24^{efgh}	0	4.48^{abcdef}	0^{c}
15	Vacuum	Whole	6.04^{cdef}	5.82^{bcdef}	0	5.49^{abc}	0^{c}
15	Vacuum	Tails	6.09^{bcdef}	5.00^{fgh}	0	5.04^{abcde}	0^{c}
19	MAP	Tails	6.24^{abcdef}	5.96^{bcdef}	0	6.04^{ab}	0^{c}
19	Vacuum	Whole	6.73^{abcd}	6.39^{bcde}	0	6.69^{a}	0^{c}
LSD			**1.73**	**1.21**	**-**	**2.3**	**1.33**

^{abcde} Different letters signify significant differences between treatments (P<0.01).

Table 27. Selection of appearance descriptors during trial 1 (%).

Descriptor	White					Cream					Beige					Grey					Green					Pink tinge				
Time point (day)	0	5	8	12	15	0	5	8	12	15	0	5	8	12	15	0	5	8	12	15	0	5	8	12	15	0	5	8	12	15
MAP redclaw tails	69	71	75	33	38	49	29	8	42	31	8	0	8	8	8	0	0	0	0	0	0	0	0	0	0	31	21	67	75	69
Vacuum packed redclaw tails	85	71	92	75	NT	23	21	0	17	NT	0	0	0	0	NT	8	0	0	0	NT	0	0	0	0	NT	31	21	42	33	NT
Air stored redclaw tails	85	93	83	83	NT	15	7	8	17	NT	0	0	8	0	NT	0	0	8	8	NT	0	0	0	0	NT	23	21	42	50	NT
MAP whole redclaw	77	64	58	33	38	31	29	25	50	15	8	7	8	17	15	0	7	0	0	0	0	0	0	8	0	8	29	50	75	77
Vacuum packed whole redclaw	77	57	67	42	62	15	29	17	58	31	15	29	8	8	0	8	0	8	8	0	0	0	0	0	0	0	29	25	50	69
Air stored whole redclaw	85	79	67	33	NT	23	14	25	42	NT	8	14	8	33	NT	0	0	0	17	NT	0	0	0	0	NT	15	29	17	42	NT

Descriptor	Yellow					Visible Black Spot					Dry					Moist					Intact					Gaping					Other				
Time point (day)	0	5	8	12	15	0	5	8	12	15	0	5	8	12	15	0	5	8	12	15	0	5	8	12	15	0	5	8	12	15	0	5	8	12	15
MAP redclaw tails	8	7	8	0	0	0	0	0	0	0	8	29	25	25	46	62	43	42	42	23	85	71	67	75	77	8	0	0	0	0	8	0	8	0	15
Vacuum packed redclaw tails	8	7	0	8	NT	0	0	0	0	NT	15	0	8	17	NT	62	57	50	50	NT	77	71	50	83	NT	8	7	17	0	NT	0	0	8	0	NT
Air stored redclaw tails	8	0	0	8	NT	0	0	0	0	NT	15	14	8	25	NT	54	50	58	50	NT	77	64	58	75	NT	8	7	8	8	NT	8	0	0	0	NT
MAP whole redclaw	0	0	0	8	8	0	0	0	8	0	23	14	25	42	38	62	43	25	33	46	85	50	58	75	62	0	14	33	8	15	0	7	8	0	8
Vacuum packed whole redclaw	0	0	0	8	0	0	0	0	0	0	15	14	0	42	31	69	57	58	25	54	92	36	42	25	46	0	43	33	33	31	8	7	25	17	15
Air stored whole redclaw	0	0	0	25	NT	0	0	0	8	NT	8	7	17	17	NT	69	57	42	33	NT	85	50	42	33	NT	0	21	25	33	NT	8	7	25	25	NT

NT = not tested

Table 28. (a)(b)(c). Mean scores for the odour attributes during trial 1.

(a) *Crustacean*

Treatment	Day 0	Day 5	Day 8	Day 12	**Treatment mean** (NS)	Day 15
MAP redclaw tails	63.6	56.9	60.8	55.6	**59.3**	44.7
Vacuum packed redclaw	56.4	62.2	58.5	50.0	**56.8**	NT
Air stored redclaw tails	53.3	58.2	52.7	55.3	**54.9**	NT
MAP whole redclaw	56.9	56.8	57.7	56.7	**57.0**	53.2
Vacuum packed whole	56.9	57.9	54.4	54.9	**56.0**	48.0
Air stored whole redclaw	54.7	57.8	53.8	45.8	**53.1**	NT
Day average (NS)	**57.0**	**58.3**	**56.3**	**56.1**	*4.68*	
					3.94	

Scale: not (0) – very (100) NT = not tested NS = not significant (P>0.05)

(b) *Fishy*

Treatment	Day 0	Day 5	Day 8	Day 12	**Treatment mean** (NS)	Day 15
MAP redclaw tails	7.4	3.8	3.2	2.7	**4.3**	6.5
Vacuum packed redclaw	7.1	2.5	2.4	1.5	**3.4**	NT
Air stored redclaw tails	8.1	0.3	1.8	9.3	**4.9**	NT
MAP whole redclaw	9.1	2.8	2.1	3.8	**4.5**	8.7
Vacuum packed whole	6.7	1.9	4.7	7.5	**5.2**	4.6
Air stored whole redclaw	7.2	2.2	2.6	4.6	**4.1**	NT
Day average (P<0.05)	**7.6**[a]	**2.2**[b]	**2.8**[b]	**4.9**[ab]	***2.00***	
					2.72	

Scale: not (0) – very (100) NT = not tested NS = not significant (P>0.05)

(c) *Other*

Treatment	Day 0	Day 5	Day 8	Day 12	**Treatment mean** (NS)	Day 15
MAP redclaw tails	4.2	7.4	11.5	12.4	**8.9**	14.9
Vacuum packed redclaw	10.2	7.5	7.3	6.9	**8.0**	NT
Air stored redclaw tails	7.5	13.4	14.9	9.9	**11.4**	NT
MAP whole redclaw	6.8	6.2	15.9	10.3	**9.8**	12.3
Vacuum packed whole	11.1	7.7	4.6	12.2	**8.9**	12.8
Air stored whole redclaw	1.6	5.5	7.2	16.6	**7.7**	NT
Day average (P<0.05)	**6.9**	**7.9**	**10.2**	**11.4**	*4.43*	
					3.41	

Scale: not (0) – very (100) NT = not tested NS = not significant (P>0.05)

Table 29. Selection of odour descriptors during trial 1 (%).

Descriptor	Ammoniacal					Muddy					Musty					Plastic				
Time point (day)	**0**	**5**	**8**	**12**	**15**	**0**	**5**	**8**	**12**	**15**	**0**	**5**	**8**	**12**	**15**	**0**	**5**	**8**	**12**	**15**
MAP redclaw tails	0	7	8	8	8	31	14	8	0	8	15	21	8	8	15	0	0	0	8	15
Vacuum packed redclaw tails	8	0	8	8	NT	38	21	25	8	NT	23	0	8	0	NT	0	0	0	8	NT
Air stored redclaw tails	0	0	8	0	NT	46	14	25	8	NT	15	21	25	8	NT	0	14	8	0	NT
MAP whole redclaw	8	7	8	0	15	38	23	33	17	15	31	14	17	8	15	0	0	0	8	8
Vacuum packed whole redclaw	0	0	0	0	0	31	36	17	8	23	15	7	17	8	23	0	0	0	0	8
Air stored whole redclaw	8	0	0	0	NT	15	21	0	25	NT	8	0	25	25	NT	8	7	0	0	NT

NT = not tested

Descriptor	Stale					Sulphury					Sweaty					Other				
Time point (day)	**0**	**5**	**8**	**12**	**15**	**0**	**5**	**8**	**12**	**15**	**0**	**5**	**8**	**12**	**15**	**0**	**5**	**8**	**12**	**15**
MAP redclaw tails	0	0	0	8	31	0	7	0	17	8	0	0	8	8	8	23	21	33	17	0
Vacuum packed redclaw tails	0	0	8	8	NT	0	0	0	0	NT	0	7	8	8	NT	15	21	0	8	NT
Air stored redclaw tails	0	0	8	8	NT	0	7	8	8	NT	8	7	0	8	NT	15	50	17	8	NT
MAP whole redclaw	0	0	8	0	31	0	7	8	17	8	23	0	8	8	8	23	14	25	0	15
Vacuum packed whole redclaw	0	0	8	17	23	0	7	8	8	8	0	7	8	25	8	23	7	17	8	8
Air stored whole redclaw	0	0	0	33	NT	0	0	0	8	NT	0	7	0	33	NT	8	0	25	17	NT

NT = not tested

Table 30 (a)–(j). Mean scores for flavour attributes during trial 1.

(a) *Crustacean*

Treatment	Day 0	Day 5	Day 8	Day 12	*LSD*	Day 15
MAP redclaw tails	61.0	53.3	49.3	52.8	*8.23*	46.0
Vacuum packed redclaw tails	47.6	55.4	56.8	52.6		NT
Air stored redclaw tails	49.0	61.3	50.4	51.1		NT
MAP whole redclaw	50.7	51.7	50.2	50.2		50.5
Vacuum packed whole redclaw	58.4	57.6	54.7	50.8		48.4
Air stored whole redclaw	55.7	56.5	50.2	45.6		NT
LSD	*9.35*					

Scale: not (0) – very (100) NT = not tested

(b) *Salty*

Treatment	Day 0	Day 5	Day 8	Day 12	**Treatment mean** (NS)	Day 15
MAP redclaw tails	8.9	8.9	3.9	3.1	**6.2**	6.5
Vacuum packed redclaw tails	8.2	8.1	6.8	4.5	**6.9**	NT
Air stored redclaw tails	6.5	7.2	8.4	8.6	**7.7**	NT
MAP whole redclaw	6.4	5.4	5.0	5.8	**5.7**	3.5
Vacuum packed whole redclaw	6.9	8.0	4.7	5.7	**6.3**	5.6
Air stored whole redclaw	6.7	7.6	6.5	6.7	**6.9**	NT
Day average (P<0.05)	**7.3**[a]	**7.5**[a]	**5.9**[b]	**5.8**[b]	*1.99*	
Overall					*1.34*	

Scale: not (0) – very (100) NT = not tested NS = not significant (P>0.05)

(c) *Sweet*

Treatment	Day 0	Day 5	Day 8	Day 12	Treatment mean (NS)	Day 15
MAP redclaw tails	19.7	23.2	15.7	20.4	**19.7**	20.6
Vacuum packed redclaw tails	18.9	16.5	18.7	16.9	**17.8**	NT
Air stored redclaw tails	22.7	20.1	19.4	16.3	**19.6**	NT
MAP whole redclaw	21.2	19.2	15.0	18.1	**18.4**	20.4
Vacuum packed whole redclaw	26.0	18.4	14.7	12.3	**17.9**	17.2
Air stored whole redclaw	24.0	18.6	16.5	12.9	**18.0**	NT
Day average (P<0.05)	**22.1**[a]	**19.4**[b]	**16.7**[c]	**16.2**[c]	*3.99*	
					2.47	

Scale: not (0) – very (100) NT = not tested NS = not significant (P>0.05)

(d) *Muddy*

Treatment	Day 0	Day 5	Day 8	Day 12	Treatment mean (NS)	Day 15
MAP redclaw tails	6.1	3.8	5.2	5.2	**5.1**	4.8
Vacuum packed redclaw tails	8.1	6.1	5.7	2.3	**5.5**	NT
Air stored redclaw tails	14.0	9.0	5.9	6.0	**8.7**	NT
MAP whole redclaw	8.7	6.1	11.5	2.9	**7.3**	4.3
Vacuum packed whole redclaw	12.0	7.3	5.4	7.4	**8.0**	7.9
Air stored whole redclaw	4.3	6.6	5.4	13.1	**7.3**	NT
Day average (NS)	**8.9**	**6.5**	**6.5**	**6.2**	*3.76*	
					2.74	

Scale: not (0) – very (100) NT = not tested NS = not significant (P>0.05)

(e) *Cabbagy*

Treatment	Day 0	Day 5	Day 8	Day 12	*LSD*	Day 15
MAP redclaw tails	5.0	5.4	6.6	7.7		5.3
Vacuum packed redclaw tails	10.0	10.0	7.7	7.8		NT
Air stored redclaw tails	5.8	9.5	12.8	7.2	*4.93*	NT
MAP whole redclaw	9.3	6.4	10.1	5.0		4.7
Vacuum packed whole redclaw	3.8	9.4	7.8	10.6		3.1
Air stored whole redclaw	3.2	6.6	2.5	12.4		NT
LSD	*5.68*					

Scale: not (0) – very (100) NT = not tested

(f) *Fishy*

Treatment	Day 0	Day 5	Day 8	Day 12	Treatment mean (NS)	Day 15
MAP redclaw tails	6.6	1.6	5.1	1.8	**3.8**	3.0
Vacuum packed redclaw tails	8.3	2.0	3.4	2.2	**3.9**	NT
Air stored redclaw tails	5.8	4.5	0.0	8.6	**4.7**	NT
MAP whole redclaw	6.9	1.0	1.1	1.9	**2.7**	4.3
Vacuum packed whole redclaw	4.4	2.8	3.5	7.6	**4.6**	2.2
Air stored whole redclaw	5.3	1.7	2.0	1.5	**2.6**	NT
Day average (P<0.05)	**6.2**[a]	**2.3**[b]	**2.5**[b]	**3.9**[ab]	*2.29*	
					2.77	

Scale: not (0) – very (100) NT = not tested NS = not significant (P>0.05)

(g) *Stale*

Treatment	Day 0	Day 5	Day 8	Day 12	*LSD*	Day 15
MAP redclaw tails	2.2	3.1	4.9	6.7	*5.38*	7.7
Vacuum packed redclaw tails	5.0	3.0	3.4	3.8		NT
Air stored redclaw tails	4.5	2.8	4.8	11.6		NT
MAP whole redclaw	3.7	6.7	7.3	7.5		9.9
Vacuum packed whole redclaw	1.8	2.9	1.5	12.1		8.4
Air stored whole redclaw	2.1	2.2	3.4	14.3		NT
LSD	*5.63*					

Scale: not (0) – very (100) NT = not tested

(h) *Off*

Treatment	Day 0	Day 5	Day 8	Day 12	*LSD*	Day 15
MAP redclaw tails	0.8	0.6	3.3	0.6	*2.85*	3.7
Vacuum packed redclaw tails	0.7	0.6	1.0	0.9		NT
Air stored redclaw tails	0.9	1.9	2.0	1.8		NT
MAP whole redclaw	1.8	0.4	2.8	5.1		2.2
Vacuum packed whole redclaw	1.1	0.4	0.0	6.4		0.5
Air stored whole redclaw	1.3	0.4	2.7	7.9		NT
LSD	*2.99*					

Scale: not (0) – very (100) NT = not tested

(i) *Other*

Treatment	Day 0	Day 5	Day 8	Day 12	**Treatment mean** (P<0.05)	Day 15
MAP redclaw tails	3.6	7.1	9.3	3.9	**6.0**^{c}	8.6
Vacuum packed redclaw tails	2.9	6.7	9.7	6.7	**6.5**^{c}	NT
Air stored redclaw tails	14.0	9.6	12.6	13.8	**12.5**^{a}	NT
MAP whole redclaw	7.6	5.7	12.1	9.2	**8.6**^{bc}	10.5
Vacuum packed whole redclaw	8.3	10.2	6.1	16.5	**10.3**^{ab}	8.4
Air stored whole redclaw	7.5	4.3	5.2	7.7	**6.2**^{c}	NT
Day average (NS)	**7.3**	**7.3**	**9.2**	**9.6**	*3.59*	
					2.87	

Scale: none (0) – very (100) NT = not tested NS = not significant (P>0.05)

(j) *Aftertaste*

Treatment	Day 0	Day 5	Day 8	Day 12	**Treatment mean** (NS)	Day 15
MAP redclaw tails	16.5	14.5	16.4	14.0	**15.4**	13.9
Vacuum packed redclaw tails	14.5	14.1	14.7	11.9	**13.8**	NT
Air stored redclaw tails	9.7	21.6	16.6	17.6	**16.4**	NT
MAP whole redclaw	16.3	15.2	18.6	17.3	**16.8**	17.3
Vacuum packed whole tail redclaw	14.2	15.7	14.8	21.0	**16.4**	13.7
Air stored whole redclaw	10.5	14.0	17.9	17.2	**14.9**	NT
Day average (NS)	**13.6**	**15.9**	**16.5**	**16.5**	*3.0*	
					2.56	

Scale: none (0) – strong (100) NT = not tested NS = not significant (P>0.05)

Table 31. Selection of flavour descriptors during trial 1 (%).

Descriptor	Ammoniacal					Bitter					Cardboard					Metallic				
Time point (day)	0	5	8	12	15	0	5	8	12	15	0	5	8	12	15	0	5	8	12	15
MAP redclaw tails	0	7	8	8	0	0	0	8	0	0	8	7	17	17	15	23	7	8	0	0
Vacuum packed redclaw tails	0	0	0	8	NT	8	0	17	8	NT	8	7	25	0	NT	15	14	17	0	NT
Air stored redclaw tails	0	7	8	0	NT	8	7	8	8	NT	0	0	17	8	NT	15	7	25	17	NT
MAP whole redclaw	0	0	17	0	8	23	14	17	0	0	0	14	33	0	23	15	14	8	8	0
Vacuum packed whole redclaw	0	0	0	0	0	0	7	0	8	0	8	14	17	0	23	15	21	8	17	8
Air stored whole redclaw	8	0	0	0	NT	8	0	0	17	NT	0	7	17	25	NT	8	14	0	0	NT

Descriptor	Musty					Peppery					Plastic					Soapy				
Time point (day)	0	5	8	12	15	0	5	8	12	15	0	5	8	12	15	0	5	8	12	15
MAP redclaw tails	15	7	25	0	8	0	14	8	0	8	0	7	17	0	0	0	0	17	8	8
Vacuum packed redclaw tails	8	21	25	0	NT	8	14	25	8	NT	0	0	0	8	NT	0	14	8	17	NT
Air stored redclaw tails	23	14	17	0	NT	15	29	8	8	NT	0	0	8	0	NT	0	14	0	8	NT
MAP whole redclaw	15	14	17	17	15	8	14	8	8	0	0	0	17	8	0	0	0	0	0	15
Vacuum packed whole redclaw	15	14	25	8	23	15	21	8	0	8	0	7	17	17	8	0	0	8	0	15
Air stored whole redclaw	8	7	8	33	NT	8	7	17	17	NT	0	0	8	8	NT	0	0	8	0	NT

Descriptor	Sweaty					Vegetable					Weedy/Herbaceous					Other				
Time point (day)	0	5	8	12	15	0	5	8	12	15	0	5	8	12	15	0	5	8	12	15
MAP redclaw tails	0	0	0	0	8	23	21	42	33	8	31	14	25	17	23	0	21	8	8	0
Vacuum packed redclaw tails	0	0	0	8	NT	23	29	25	25	NT	15	21	25	33	NT	15	7	25	8	NT
Air stored redclaw tails	0	14	0	8	NT	8	43	42	25	NT	54	43	8	17	NT	15	7	8	25	NT
MAP whole redclaw	0	0	17	8	0	31	14	33	8	15	38	14	33	33	15	23	7	8	17	15
Vacuum packed whole redclaw	0	0	8	8	0	31	29	17	42	15	23	43	33	25	31	8	14	17	8	15
Air stored whole redclaw	0	7	0	33	NT	8	14	33	25	NT	31	21	33	42	NT	8	0	8	17	NT

NT = not tested

Table 32 (a)-(e). Mean scores for the texture attributes during trial 1.

(a) Firm

Treatment	Day 0	Day 5	Day 8	Day 12	Treatment mean (P<0.05)	Day 15
MAP redclaw tails	61.9	69.6	58.5	60.2	**62.5**[a]	63.4
Vacuum packed redclaw tails	56.5	54.6	52.9	49.9	**53.5**[bc]	NT
Air stored redclaw tails	57.2	51.9	50.6	51.8	**52.9**[bc]	NT
MAP whole redclaw	56.3	63.1	58.7	55.2	**58.3**[ab]	57.8
Vacuum packed whole redclaw	51.8	48.4	53.3	44.5	**49.5**[cd]	46.9
Air stored whole redclaw	50.6	49.9	45.2	33.3	**44.7**[d]	NT
Day average (P<0.05)	**55.7**[a]	**56.3**[a]	**53.2**[a]	**49.1**[b]	*5.58*	
					3.74	

Scale: soft (0) – firm (100) NT = not tested

(b) Springy

Treatment	Day 0	Day 5	Day 8	Day 12	Treatment mean (P<0.05)	Day 15
MAP redclaw tails	30.3	30.8	24.9	24.0	**27.5**[a]	24.5
Vacuum packed redclaw tails	24.1	20.8	20.2	19.8	**21.2**[b]	NT
Air stored redclaw tails	28.5	14.7	19.1	22.5	**21.2**[b]	NT
MAP whole redclaw	22.6	19.9	21.4	23.2	**21.8**[b]	21.8
Vacuum packed whole redclaw	20.8	16.9	20.0	9.3	**16.7**[b]	19.0
Air stored whole redclaw	23.5	18.3	15.2	10.9	**17.0**[b]	NT
Day average (P<0.05)	**25.0**[a]	**20.2**[b]	**20.1**[b]	**18.3**[b]	*5.13*	
					3.73	

Scale: not (0) – very (100) NT = not tested

(c) Moist

Treatment	Day 0	Day 5	Day 8	Day 12	*LSD*	Day 15
MAP redclaw tails	47.2	30.5	40.1	37.6		35.0
Vacuum packed redclaw tails	46.1	49.1	54.1	44.8		NT
Air stored redclaw tails	48.6	46.1	57.5	50.8	*8.96*	NT
MAP whole redclaw	43.3	40.0	37.2	35.6		40.4
Vacuum packed whole redclaw	53.6	48.6	47.9	31.4		45.5
Air stored whole redclaw	42.2	51.0	48.3	37.3		NT
LSD	*9.74*					

Scale: very dry (0) – very moist (100) NT = not tested

(d) Mushy

Treatment	Day 0	Day 5	Day 8	Day 12	*LSD*	Day 15
MAP redclaw tails	5.0	1.4	12.1	6.0		5.8
Vacuum packed redclaw tails	5.8	6.7	11.6	6.4		NT
Air stored redclaw tails	6.6	5.0	14.1	9.7	*8.08*	NT
MAP whole redclaw	6.2	2.5	7.7	6.5		10.9
Vacuum packed whole redclaw	7.7	12.3	12.5	33.8		17.8
Air stored whole redclaw	8.3	16.0	21.7	26.2		NT
LSD	*8.73*					

Scale: not (0) – 100 (very) NT = not tested

(e) Tough

Treatment	Day 0	Day 5	Day 8	Day 12	*LSD*	Day 15
MAP redclaw tails	5.5	34.6	16.5	12.3	*7.98*	17.1
Vacuum packed redclaw tails	4.8	5.7	10.6	7.6		NT
Air stored redclaw tails	5.3	5.1	5.8	6.3		NT
MAP whole redclaw	7.0	27.8	19.7	13.0		10.9
Vacuum packed whole redclaw	3.4	7.8	10.8	6.8		4.5
Air stored whole redclaw	7.0	0.2	7.7	6.4		NT
LSD	*8.57*					

Scale: not (0) – 100 (very) NT = not tested

Table 33. Selection of texture descriptors during trial 1 (%).

Descriptor	Chalky/Floury					Chewy					Crunchy				
Time point (day)	**0**	**5**	**8**	**12**	**15**	**0**	**5**	**8**	**12**	**15**	**0**	**5**	**8**	**12**	**15**
MAP redclaw tails	8	7	33	17	31	31	86	42	25	62	23	7	0	17	23
Vacuum packed redclaw tails	0	21	33	17	NT	15	57	33	25	NT	15	7	8	0	NT
Air stored redclaw tails	0	21	8	17	NT	23	21	25	0	NT	38	0	0	17	NT
MAP whole redclaw	0	0	25	25	46	46	71	75	8	23	8	0	8	0	0
Vacuum packed whole redclaw	8	21	17	58	62	23	21	33	8	23	31	14	8	0	0
Air stored whole redclaw	8	7	17	50	NT	54	14	33	17	NT	23	0	0	8	NT

Descriptor	Fibrous/stringy					Flaky					Gritty				
Time point (day)	**0**	**5**	**8**	**12**	**15**	**0**	**5**	**8**	**12**	**15**	**0**	**5**	**8**	**12**	**15**
MAP redclaw tails	8	29	33	33	23	8	0	8	0	0	0	0	0	8	0
Vacuum packed redclaw tails	8	50	8	33	NT	0	0	0	0	NT	0	7	0	0	NT
Air stored redclaw tails	8	29	25	17	NT	0	7	0	0	NT	0	0	0	0	NT
MAP whole redclaw	8	36	33	33	23	8	0	0	0	8	0	0	8	0	0
Vacuum packed whole redclaw	15	29	42	25	0	0	0	0	8	0	0	0	0	8	0
Air stored whole redclaw	15	7	8	17	NT	0	0	0	0	NT	0	0	0	0	NT

Descriptor	Rubbery					Sticky					Other				
Time point (day)	**0**	**5**	**8**	**12**	**15**	**0**	**5**	**8**	**12**	**15**	**0**	**5**	**8**	**12**	**15**
MAP redclaw tails	0	21	17	0	8	0	0	17	0	0	0	7	0	8	8
Vacuum packed redclaw tails	0	0	0	0	NT	8	0	8	0	NT	15	0	0	0	NT
Air stored redclaw tails	0	0	0	0	NT	0	7	8	8	NT	23	14	25	0	NT
MAP whole redclaw	0	21	8	0	8	8	0	8	0	8	15	0	8	0	8
Vacuum packed whole redclaw	0	7	0	0	0	0	7	17	8	15	0	0	17	8	15
Air stored whole redclaw	0	0	NT	0	NT	0	0	25	17	NT	8	14	8	8	

NT = not tested

Table 34. Mean scores for overall quality of the redclaw treatments during trial 1.

Treatment	Day 0	Day 5	Day 8	Day 12	*LSD*	Day 15
MAP redclaw tails	64.7	51.2	44.0	50.9	*9.20*	48.0
Vacuum packed redclaw tails	56.9	54.3	53.9	56.9		NT
Air stored redclaw tails	53.0	59.7	52.5	56.0		NT
MAP whole redclaw	52.7	53.5	44.4	54.1		45.0
Vacuum packed whole redclaw	62.1	51.6	49.9	37.2		41.1
Air stored whole redclaw	56.7	60.3	51.5	33.3		NT
LSD	*10.04*					

Scale: very poor quality (0) – very good quality (100) NT = not tested

Trial 2

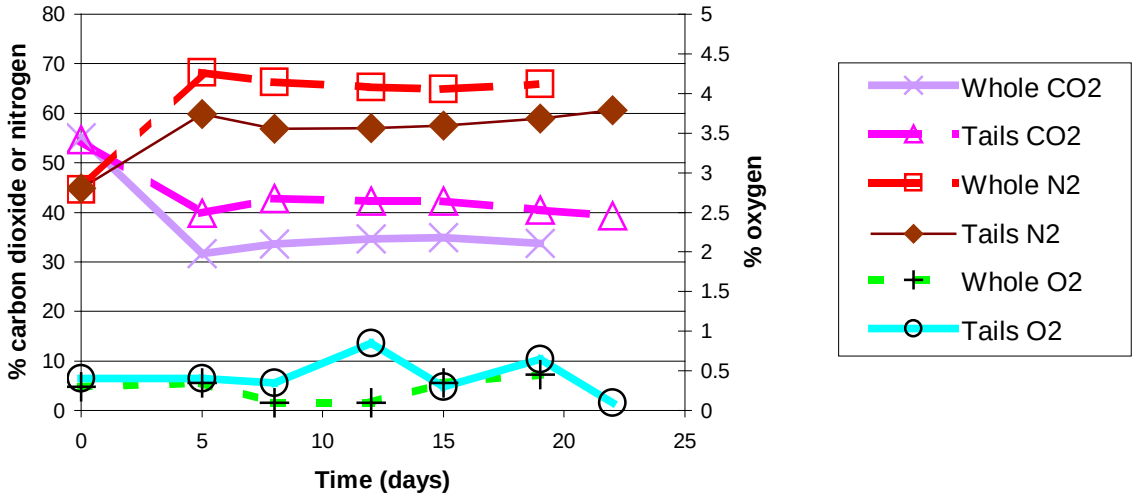

Figure 7. Composition of MAP headspace in raw redclaw packs stored at 4°C during trial 2.

Table 35. Mean pH and drip loss in uncooked whole and redclaw tails stored in air or MAP during trial 2.

Storage time (days)	Pack conditions	Product form	pH	Pack yield (%)
0	Air	Whole	6.80^{cde}	100^{a}
0	Air	Tails	6.58^{def}	100^{a}
0	MAP	Whole	6.80^{cde}	100^{a}
0	MAP	Tails	6.58^{def}	100^{a}
5	Air	Whole	6.68^{cdef}	98.15^{ab}
5	Air	Tails	6.99^{bc}	97.9^{b}
5	MAP	Whole	6.31^{f}	96.03^{dc}
5	MAP	Tails	6.43^{ef}	97^{bcd}
8	Air	Whole	6.96^{bc}	97.9^{b}
8	Air	Tails	6.67^{cdef}	97.1^{bcd}
8	MAP	Whole	6.72^{cde}	96.9^{bcd}
8	MAP	Tails	6.68^{cde}	96.9^{bcd}
12	Air	Whole	7.25^{ab}	95.65^{d}
12	Air	Tails	7.46^{a}	96.9^{bcd}
12	MAP	Whole	6.78^{cde}	96.28^{dc}
12	MAP	Tails	6.78^{cde}	97.6^{bc}
15	MAP	Whole	6.89^{cd}	96.8^{bcd}
15	MAP	Tails	6.87^{cd}	96.75^{bcd}
19	MAP	Whole	6.96^{bc}	95.93^{d}
19	MAP	Tails	6.93^{bcd}	96.65^{bcd}
22	MAP	Tails	6.97^{bc}	97.3^{bcd}
F ratio			**7.7**	**11.2**

* ^{abcde} Different letters signify significant differences between treatments (P<0.01).

Table 36. Demerit scores for uncooked whole and redclaw tails stored in air or MAP during trial 2.

Storage time (days)	Pack conditions	Product form	Colour of shell	Presence of blackspot	Flesh appearance	Flesh colour	Staining	Drip	Odour	Total demerit points
0	Air	Whole	0^{de}	0^{c}	0^{d}	0^{g}	0^{e}	0	0^{e}	0^{g}
0	Air	Tails	0^{de}	0^{c}	0^{d}	0^{g}	0^{e}	0	0^{e}	0^{g}
0	MAP	Whole	0^{de}	0^{c}	0^{d}	0^{g}	0^{e}	0	0^{e}	0^{g}
0	MAP	Tails	0^{de}	0^{c}	0^{d}	0^{g}	0^{e}	0	0^{e}	0^{g}
5	Air	Whole	0.10^{de}	0^{c}	0.13^{d}	0.35^{fg}	0.58^{bcde}	0.37	1.33^{bcd}	2.87^{def}
5	Air	Tails	0.23^{cde}	0.07^{c}	0.07^{d}	0.07^{g}	0.07^{e}	0.2	0.9^{de}	1.6^{fg}
5	MAP	Whole	0^{e}	0^{c}	0.57^{bcd}	0.47^{efg}	0.07^{e}	0	0.97^{de}	2.07^{fg}
5	MAP	Tails	0.13^{de}	0^{c}	0.13^{d}	0.77^{cdef}	0.17^{e}	0	1.5^{abcd}	2.7^{ef}
8	Air	Whole	0.37^{bcde}	0.97^{a}	0.63^{bcd}	0.70^{defg}	1^{abcd}	0.33	1.6^{abcd}	5.6^{abc}
8	Air	Tails	0.87^{abcd}	0.03^{c}	0.27^{cd}	0.67^{defg}	0.43^{de}	0.23	1.2^{cd}	3.7^{cdef}
8	MAP	Whole	0.45^{bcde}	0.2^{bc}	0.27^{cd}	1^{bcdef}	0.5^{cde}	0.27	1.13^{d}	3.82^{cdef}
8	MAP	Tails	0.30^{cde}	0^{c}	0.50^{bcd}	1.1^{abcde}	0.17^{e}	0.1	1.4^{abcd}	3.57^{cdef}
12	Air	Whole	0.67^{abcde}	0.57^{ab}	0.87^{abc}	1.27^{abcd}	1.13^{ab}	0.3	2.2^{ab}	7^{ab}
12	Air	Tails	0.67^{abcde}	0^{c}	0.90^{ab}	1.1^{abcde}	0.13^{e}	0.27	2.07^{abc}	5.13^{bcd}
12	MAP	Whole	0.63^{abcde}	0^{c}	0.63^{bcd}	1.37^{abc}	0.57^{bcde}	0.03	1.4^{abcd}	4.63^{bcde}
12	MAP	Tails	0.60^{abcde}	0.15^{bc}	0.85^{abc}	1.55^{ab}	0.17^{e}	0.03	2.27^{a}	5.62^{abc}
15	MAP	Whole	1.03^{abc}	0^{c}	1.27^{a}	1.73^{a}	1.07^{abc}	0.1	1.43^{abcd}	6.63^{ab}
15	MAP	Tails	0.97^{abc}	0^{c}	0.85^{abc}	1.52^{ab}	0.17^{e}	0	1.55^{abcd}	5.05^{bcde}
19	MAP	Whole	1.30^{a}	0.37^{bc}	1.47^{a}	1.7^{a}	1.37^{a}	0	1.5^{abcd}	7.7^{a}
19	MAP	Tails	1.13^{ab}	0^{c}	0.87^{abc}	1.5^{ab}	0.5^{cde}	0.1	1.37^{bcd}	5.47^{abc}
22	MAP	Tails	0.97^{abc}	0^{c}	0.60^{bcd}	1.73^{a}	0.17^{e}	0.23	2.17^{ab}	5.87^{abc}
F ratio			**3.65**	**3.48**	**6.44**	**11.8**	**6.99**	**1.03**	**7.55**	**12.75**

* ^{abcde} Different letters signify significant differences between treatments (P<0.01).

Table 37. Microbiological counts (log cfu/g) of uncooked whole and redclaw tails stored in air or MAP during trial 2.

Storage time (days)	Pack conditions	Product form	Total**	Psychrotroph**	H_2S producer**	Anaerobic	Pasteurised anaerobic	*Vibrios*
0	Air	Whole	2.77^{efg}	0.39^{ij}	2.19^{def}	-	0	0
0	Air	Tails	3.18^{defg}	0.33^{j}	2.19^{def}	-	0	0
0	MAP	Whole	2.77^{efg}	0.39^{ij}	2.19^{def}	2.71	0	0
0	MAP	Tails	3.18^{defg}	0.33^{j}	2.19^{def}	2.71	0	0
5	Air	Whole	2.96^{efg}	1.87^{ghij}	0.76^{fg}	-	0	0
5	Air	Tails	3.03^{efg}	2.75^{efgh}	2.37^{def}	-	0	0
5	MAP	Whole	3.04^{efg}	1.84^{ghij}	1.55^{efg}	2.80	0	0
5	MAP	Tails	2.06^{g}	0.67^{hij}	1.54^{efg}	2.64	0	0
8	Air	Whole	4.09^{bcdefg}	4.49^{bcdef}	3.85^{abcd}	-	0	0
8	Air	Tails	5.37^{abcd}	4.94^{abcd}	4.39^{abc}	-	0	0
8	MAP	Whole	2.86^{efg}	2.48^{fghi}	2.43^{def}	3.17	0	0
8	MAP	Tails	2.77^{efg}	1.89^{ghij}	2.07^{def}	2.82	0	0
12	Air	Whole	5.92^{ab}	5.52^{ab}	5.15^{ab}	-	0	0
12	Air	Tails	7.35^{a}	6.85^{a}	5.73^{a}	-	0	0
12	MAP	Whole	3.40^{cdefg}	3.38^{cdefg}	3.04^{cde}	2.16	0	0
12	MAP	Tails	3.98^{bcdefg}	3.24^{defg}	3.33^{bcde}	2.92	0	0
15	MAP	Whole	6.01^{ab}	5.79^{ab}	5.68^{a}	3.66	0	0
15	MAP	Tails	2.27^{fg}	2.25^{ghij}	0^{g}	2.93	0	0
19	MAP	Whole	5.52^{abc}	5.41^{abc}	4.89^{abc}	5.50	0	0
19	MAP	Tails	4.38^{bcdef}	4.44^{bcdef}	3.55^{bcd}	4.15	0	0
22	MAP	Tails	4.69^{bcde}	4.73^{abcde}	4.47^{abc}	4.54	0.43	0
F ratio			**5.46**	**13.03**	**9.59**	**1.66**	**1.0**	**-**

** ^{abcde} Different letters signify significant differences between treatments (P<0.01). * ^{abcde} Different letters signify significant differences between treatments (P<0.05).

Table 38. Selection of appearance descriptors during trial 2 (%).

Descriptor	White							Cream							Beige						
Time point (day)	0	5	8	12	15	19	22	0	5	8	12	15	19	22	0	5	8	12	15	19	22
MAP redclaw tails	86	79	60	21	31	27	33	14	14	20	29	38	18	44	0	0	0	0	8	18	0
Air stored redclaw tails	86	93	73	71	NT	NT	NT	21	7	13	14	NT	NT	NT	0	0	0	0	NT	NT	NT
MAP whole redclaw	93	64	47	36	15	NT	NT	14	29	27	29	31	NT	NT	0	0	20	21	15	NT	NT
Air stored whole redclaw	93	64	73	NT	NT	NT	NT	14	21	7	NT	NT	NT	NT	0	0	7	NT	NT	NT	NT

Descriptor	Grey							Green							Pink Tinge						
Time point (day)	0	5	8	12	15	19	22	0	5	8	12	15	19	22	0	5	8	12	15	19	22
MAP redclaw tails	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	29	53	100	54	64	78
Air stored redclaw tails	0	0	0	0	NT	NT	NT	0	0	0	0	NT	NT	NT	36	36	33	57	NT	NT	NT
MAP whole redclaw	0	0	0	0	8	NT	NT	0	0	0	0	0	NT	NT	29	43	67	64	85	NT	NT
Air stored whole redclaw	0	0	7	NT	NT	NT	NT	0	0	0	NT	NT	NT	NT	14	43	33	NT	NT	NT	NT

Descriptor	Yellow							Visible Black Spot							Dry						
Time point (day)	0	5	8	12	15	19	22	0	5	8	12	15	19	22	0	5	8	12	15	19	22
MAP redclaw tails	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	21	60	79	54	64	67
Air stored redclaw tails	0	0	0	0	NT	NT	NT	0	0	0	0	NT	NT	NT	21	7	0	7	NT	NT	NT
MAP whole redclaw	0	0	0	0	0	NT	NT	0	0	0	0	0	0	0	0	29	33	36	54	NT	NT
Air stored whole redclaw	0	0	0	NT	NT	NT	NT	0	7	0	NT	NT	NT	NT	0	29	13	NT	NT	NT	NT

Descriptor	Moist							Intact							Gaping						
Time point (day)	0	5	8	12	15	19	22	0	5	8	12	15	19	22	0	5	8	12	15	19	22
MAP redclaw tails	50	57	27	7	15	18	0	50	64	87	71	85	73	78	21	14	0	0	0	18	22
Air stored redclaw tails	64	64	87	79	NT	NT	NT	50	79	87	57	NT	NT	NT	21	7	7	21	NT	NT	NT
MAP whole redclaw	79	50	40	36	15	NT	NT	57	64	73	64	69	NT	NT	7	7	7	7	15	NT	NT
Air stored whole redclaw	71	50	60	NT	NT	NT	NT	36	57	47	NT	NT	NT	NT	29	14	27	NT	NT	NT	NT

Descriptor	Other						
Time point (day)	0	5	8	12	15	19	22
MAP redclaw tails	7	0	7	7	8	27	11
Air stored redclaw tails	0	0	7	14	NT	NT	NT
MAP whole redclaw	7	7	7	7	8	NT	NT
Air stored whole redclaw	7	21	13	NT	NT	NT	NT

NT = not tested

Table 39 (a)(b)(c). Mean scores for odour attributes during trial 2.

(a) Crustacean

Treatment	Day 0 (NS)	Day 5 (NS)	Day 8 (NS)	Day 12 (NS)	Day 15 (NS)	Day 19	Day 22
MAP redclaw tails	53.4	62.8	64.0	63.6	59.5	58.6	56.9
Air stored redclaw tails	55.3	60.1	58.1	60.8	NT	NT	NT
MAP whole redclaw	61.0	65.6	64.2	59.0	52.3	NT	NT
Air stored whole redclaw	49.8	63.1	59.2	NT	NT	NT	NT
LSD	*9.56*	*5.95*	*7.6*	*4.90*	*7.98*	*n/a*	*n/a*

(b) Fishy

Treatment	Day 0 (NS)	Day 5 (NS)	Day 8 (NS)	Day 12 (NS)	Day 15 (NS)	Day 19	Day 22
MAP redclaw tails	2.3	2.9	1.9	3.5	4.5	11.6	14.6
Air stored redclaw tails	2.3	1.1	2.1	4.8	NT	NT	NT
MAP whole redclaw	2.7	1.8	5.2	7.9	4.1	NT	NT
Air stored whole redclaw	2.8	1.5	2.7	NT	NT	NT	NT
LSD	*1.50*	*2.60*	*4.25*	*4.08*	*3.90*	*n/a*	*n/a*

(c) Other

Treatment	Day 0 (NS)	Day 5 (NS)	Day 8 (NS)	Day 12	Day 15 (NS)	Day 19	Day 22
MAP redclaw tails	6.1	4.0	7.2	10.2[a]	9.5	16.2	16.4
Air stored redclaw tails	5.8	7.9	10.7	4.6[b]	NT	NT	NT
MAP whole redclaw	3.8	3.5	10.3	11.1[a]	11.6	NT	NT
Air stored whole redclaw	3.4	1.8	7.7	NT	NT	NT	NT
LSD	*4.11*	*5.32*	*7.88*	*5.54*	*5.8*	*n/a*	*n/a*

Scale: none (0) – very (100) NT = not tested NS = not significant (P>0.05) abc Within a column, means followed by a common letter are not significantly different (P>0.05).

Table 40. Selection of odour descriptors during trial 2 (%).

Descriptor	Ammoniacal							Muddy							Musty						
Time point (day)	0	5	8	12	15	19	22	0	5	8	12	15	19	22	0	5	8	12	15	19	22
MAP redclaw tails	7	7	7	14	0	55	22	14	7	13	7	0	0	0	0	7	7	21	8	9	44
Air stored redclaw tails	7	14	0	7	NT	NT	NT	14	7	20	0	NT	NT	NT	7	14	7	7	NT	NT	NT
MAP whole redclaw	7	0	0	21	8	NT	NT	14	0	20	7	0	NT	NT	0	0	7	0	38	NT	NT
Air stored whole redclaw	0	7	7	NT	NT	NT	NT	7	0	20	NT	NT	NT	NT	7	0	20	NT	NT	NT	NT

Descriptor	Plastic							Stale							Sulphury						
Time point (day)	0	5	8	12	15	19	22	0	5	8	12	15	19	22	0	5	8	12	15	19	22
MAP redclaw tails	0	0	7	0	15	0	0	0	7	7	14	31	36	44	7	14	20	29	15	18	11
Air stored redclaw tails	0	0	0	7	NT	NT	NT	0	0	0	7	NT	NT	NT	14	7	13	0	NT	NT	NT
MAP whole redclaw	0	0	7	0	0	NT	NT	0	0	7	21	23	NT	NT	0	7	20	14	15	NT	NT
Air stored whole redclaw	7	7	7	NT	NT	NT	NT	0	0	7	NT	NT	NT	NT	0	7	7	NT	NT	NT	NT

Descriptor	Sweaty							Other						
Time point (day)	0	5	8	12	15	19	22	0	5	8	12	15	19	22
MAP redclaw tails	7	7	7	21	15	45	22	14	14	20	29	15	9	11
Air stored redclaw tails	7	7	0	0	NT	NT	NT	14	21	20	29	NT	NT	NT
MAP whole redclaw	14	7	7	21	23	NT	NT	21	14	20	14	15	NT	NT
Air stored whole redclaw	0	0	7	NT	NT	NT	NT	14	29	20	NT	NT	NT	NT

NT = not tested

Table 41. Mean scores for flavour attributes during trial 2.

(a) Crustacean

Treatment	Day 0 (NS)	Day 5 (NS)	Day 8 (NS)	Day 12 (NS)	Day 15 (NS)	Day 19	Day 22
MAP redclaw tails	55.4	57.3	61.3	52.6	54.6	57.3	56.7
Air stored redclaw tails	57.4	58.6	60.4	56.3	NT	NT	NT
MAP whole redclaw	57.6	64.9	58.3	57.7	56.1	NT	NT
Air stored whole redclaw	48.4	61.6	55.5	NT	NT	NT	NT
LSD	*10.9*	*7.85*	*6.75*	*8.05*	*7.32*	*n/a*	*n/a*

(b) Salty

Treatment	Day 0 (NS)	Day 5 (NS)	Day 8	Day 12 (NS)	Day 15 (NS)	Day 19	Day 22
MAP redclaw tails	6.7	6.3	5.8[ab]	7.5	6.8	9.8	9.6
Air stored redclaw tails	7.1	5.1	6.8[ab]	6.1	NT	NT	NT
MAP whole redclaw	6.3	6.8	8.3[a]	7.4	8.6	NT	NT
Air stored whole redclaw	6.3	4.5	4.3[b]	NT	NT	NT	NT
LSD	*3.71*	*3.38*	*3.36*	*3.12*	*3.13*	*n/a*	*n/a*

(c) Sweet

Treatment	Day 0 (NS)	Day 5	Day 8 (NS)	Day 12 (NS)	Day 15 (NS)	Day 19	Day 22
MAP redclaw tails	23.1	19.0[ab]	21.3	19.2	21.3	18.6	17.2
Air stored redclaw tails	22.4	15.6[b]	21.1	17.8	NT	NT	NT
MAP whole redclaw	25.7	22.9[a]	20.3	22.1	19.7	NT	NT
Air stored whole redclaw	17.7	20.0[ab]	15.9	NT	NT	NT	NT
LSD	*8.56*	*5.53*	*6.3*	*7.44*	*3.59*	*n/a*	*n/a*

(d) Muddy

Treatment	Day 0 (NS)	Day 5 (NS)	Day 8 (NS)	Day 12 (NS)	Day 15 (NS)	Day 19	Day 22
MAP redclaw tails	2.6	0.9	1.8	1.5	3.0	2.5	0.8
Air stored redclaw tails	4.5	2.2	4.9	3.8	NT	NT	NT
MAP whole redclaw	2.1	1.6	2.8	1.2	0.7	NT	NT
Air stored whole redclaw	3.0	1.3	3.6	NT	NT	NT	NT
LSD	*3.36*	*2.06*	*3.95*	*4.03*	*3.75*	*n/a*	*n/a*

(e) Cabbagy

Treatment	Day 0 (NS)	Day 5 (NS)	Day 8	Day 12 (NS)	Day 15 (NS)	Day 19	Day 22
MAP redclaw tails	6.0	4.5	4.5[b]	7.1	9.2	7.7	11.7
Air stored redclaw tails	7.8	9.9	11.3[a]	5.3	NT	NT	NT
MAP whole redclaw	9.6	3.4	4.4[b]	10.5	10.2	NT	NT
Air stored whole redclaw	7.8	5.2	7.2[ab]	NT	NT	NT	NT
LSD	*6.15*	*5.09*	*5.57*	*6.34*	*4.94*	*n/a*	*n/a*

Scale: not (0) – very (100) NT = not tested NS = not significant (P>0.05) abc Within a column, means followed by a common letter are not significantly different (P>0.05).

(f) Fishy

Treatment	Day 0 (NS)	Day 5 (NS)	Day 8 (NS)	Day 12 (NS)	Day 15 (NS)	Day 19	Day 22
MAP redclaw tails	1.0	0.5	2.1	2.7	2.2	6.4	7.4
Air stored redclaw tails	2.8	0.4	1.3	1.4	NT	NT	NT
MAP whole redclaw	2.1	1.3	4.2	2.5	2.3	NT	NT
Air stored whole redclaw	1.7	1.5	1.6	NT	NT	NT	NT
LSD	*2.23*	*1.18*	*3.47*	*3.57*	*0.82*	*n/a*	*n/a*

(g) Stale

Treatment	Day 0 (NS)	Day 5	Day 8 (NS)	Day 12 (NS)	Day 15 (NS)	Day 19	Day 22
MAP redclaw tails	1.5	3.4[a]	2.1	8.8	6.5	14.2	9.8
Air stored redclaw tails	2.0	1.6[a]	4.3	7.0	NT	NT	NT
MAP whole redclaw	1.6	0.8[b]	4.6	9.0	7.7	NT	NT
Air stored whole redclaw	5.9	3.4[a]	4.2	NT	NT	NT	NT
LSD	*4.17*	*2.55*	*3.67*	*4.27*	*3.51*	*n/a*	*n/a*

(h) Off

Treatment	Day 0 (NS)	Day 5 (NS)	Day 8 (NS)	Day 12 (NS)	Day 15 (NS)	Day 19	Day 22
MAP redclaw tails	0.7	0.4	0.8	1.9	1.6	3.1	1.3
Air stored redclaw tails	0.7	1.9	0.7	2.0	NT	NT	NT
MAP whole redclaw	0.7	0.6	1.3	1.8	2.4	NT	NT
Air stored whole redclaw	0.8	0.5	0.6	NT	NT	NT	NT
LSD	*0.27*	*1.98*	*0.88*	*2.48*	*1.34*	*n/a*	*n/a*

(i) Other

Treatment	Day 0 (NS)	Day 5 (NS)	Day 8 (NS)	Day 12 (NS)	Day 15 (NS)	Day 19	Day 22
MAP redclaw tails	2.9	8.3	5.2	5.9	7.5	11.6	12.6
Air stored redclaw tails	6.0	5.9	7.7	4.8	NT	NT	NT
MAP whole redclaw	5.5	3.7	7.9	8.8	7.5	NT	NT
Air stored whole redclaw	1.8	6.2	10.3	NT	NT	NT	NT
LSD	*4.3*	*5.04*	*6.8*	*6.08*	*6.65*	*n/a*	*n/a*

(j) Aftertaste

Treatment	Day 0 (NS)	Day 5 (NS)	Day 8 (NS)	Day 12	Day 15 (NS)	Day 19	Day 22
MAP redclaw tails	11.4	11.2	10.6	10.4[b]	12.0	14.6	16.1
Air stored redclaw tails	10.6	11.7	9.8	10.5[b]	NT	NT	NT
MAP whole redclaw	11.5	8.0	7.8	15.8[a]	15.4	NT	NT
Air stored whole redclaw	10.0	10.1	9.8	NT	NT	NT	NT
LSD	*4.27*	*4.33*	*4.23*	*4.69*	*3.60*	*n/a*	*n/a*

Scale: none (0) – very (100) NT = not tested NS = not significant (P>0.05) abc Within a column, means followed by a common letter are not significantly different (P>0.05).

Table 42. Selection of flavour descriptors during trial 2 (%).

Descriptor	Ammoniacal							Bitter							Cardboard						
Time point (day)	**0**	**5**	**8**	**12**	**15**	**19**	**22**	**0**	**5**	**8**	**12**	**15**	**19**	**22**	**0**	**5**	**8**	**12**	**15**	**19**	**22**
MAP redclaw tails	0	0	0	7	0	0	0	14	21	0	14	8	36	22	0	21	0	29	15	18	11
Air stored redclaw tails	0	0	0	7	NT	NT	NT	0	7	13	14	NT	NT	NT	7	7	13	7	NT	NT	NT
MAP whole redclaw	0	0	7	7	0	NT	NT	21	7	0	0	8	NT	NT	0	14	20	14	15	NT	NT
Air stored whole redclaw	0	0	0	NT	NT	NT	NT	29	7	7	NT	NT	NT	NT	21	0	13	NT	NT	NT	NT

Descriptor	Metallic							Musty							Peppery						
Time point (day)	**0**	**5**	**8**	**12**	**15**	**19**	**22**	**0**	**5**	**8**	**12**	**15**	**19**	**22**	**0**	**5**	**8**	**12**	**15**	**19**	**22**
MAP redclaw tails	14	0	0	7	15	0	0	0	7	0	14	8	18	0	7	43	20	14	31	18	0
Air stored redclaw tails	7	0	0	0	NT	NT	NT	7	0	7	7	NT	NT	NT	7	29	20	29	NT	NT	NT
MAP whole redclaw	0	0	20	7	15	NT	NT	0	7	7	7	0	NT	NT	14	21	13	7	15	NT	NT
Air stored whole redclaw	7	0	20	NT	NT	NT	NT	0	7	7	NT	NT	NT	NT	7	29	27	NT	NT	NT	NT

Descriptor	Plastic							Soapy							Sweaty						
Time point (day)	**0**	**5**	**8**	**12**	**15**	**19**	**22**	**0**	**5**	**8**	**12**	**15**	**19**	**22**	**0**	**5**	**8**	**12**	**15**	**19**	**22**
MAP redclaw tails	0	0	7	7	8	18	11	7	0	0	0	8	9	11	0	0	7	0	0	18	22
Air stored redclaw tails	0	7	0	7	NT	NT	NT	7	0	7	14	NT	NT	NT	0	7	0	0	NT	NT	NT
MAP whole redclaw	7	0	0	0	8	NT	NT	0	0	0	7	0	NT	NT	0	0	0	0	8	NT	NT
Air stored whole redclaw	7	7	0	NT	NT	NT	NT	0	7	7	NT	NT	NT	NT	0	14	0	NT	NT	NT	NT

Descriptor	Vegetable							Weedy/Herbaceous							Other						
Time point (day)	**0**	**5**	**8**	**12**	**15**	**19**	**22**	**0**	**5**	**8**	**12**	**15**	**19**	**22**	**0**	**5**	**8**	**12**	**15**	**19**	**22**
MAP redclaw tails	7	36	33	43	46	36	33	21	29	27	29	31	27	56	14	14	13	21	8	9	22
Air stored redclaw tails	29	50	33	21	NT	NT	NT	36	7	20	29	NT	NT	NT	7	14	27	7	NT	NT	NT
MAP whole redclaw	50	29	40	50	38	NT	NT	7	14	20	29	46	NT	NT	7	14	13	21	8	NT	NT
Air stored whole redclaw	14	43	33	NT	NT	NT	NT	21	14	20	NT	NT	NT	NT	0	7	7	NT	NT	NT	NT

NT = not tested

Table 43. Mean scores for texture attributes during trial 2.

(a) Firm

Treatment	Day 0	Day 5	Day 8	Day 12	Day 15 (NS)	Day 19	Day 22
MAP redclaw tails	63.5[a]	65.0[ab]	65.5[a]	67.1[a]	64.7	57.5	59.2
Air stored redclaw tails	59.3[a]	59.5[b]	57.6[a]	48.2[b]	NT	NT	NT
MAP whole redclaw	56.4[ab]	69.5[a]	60.7[a]	63.0[a]	64.6	NT	NT
Air stored whole redclaw	40.2[b]	61.2[b]	46.1[b]	NT	NT	NT	NT
LSD	*8.90*	*5.9*	*7.18*	*6.69*	*8.81*	*n/a*	*n/a*

(b) Springy

Treatment	Day 0	Day 5 (NS)	Day 8	Day 12	Day 15 (NS)	Day 19	Day 22
MAP redclaw tails	38.8[a]	32.7	30.4[a]	29.1[a]	26.3	18.2	23.6
Air stored redclaw tails	34.4[ab]	28.9	26.5[a]	18.3[b]	NT	NT	NT
MAP whole redclaw	29.2[b]	33.6	25.4[a]	21.8[ab]	28.4	NT	NT
Air stored whole redclaw	18.0[c]	29.8	16.8[b]	NT	NT	NT	NT
LSD	*8.60*	*7.4*	*7.70*	*7.45*	*10.21*	*n/a*	*n/a*

(c) Moist

Treatment	Day 0 (NS)	Day 5	Day 8	Day 12	Day 15 (NS)	Day 19	Day 22
MAP redclaw tails	46.8	42.5_b	40.8^c	34.1^b	38.0	34.7	36.7
Air stored redclaw tails	47.0	48.9^{ab}	56.5^a	55.2^a	NT	NT	NT
MAP whole redclaw	50.6	44.8^{ab}	42.9^{bc}	35.2^b	38.7	NT	NT
Air stored whole redclaw	50.9	52.8^a	50.1^{ab}	NT	NT	NT	NT
LSD	*9.13*	*8.1*	*8.42*	*7.65*	*6.13*	*n/a*	*n/a*

(d) Mushy

Treatment	Day 0	Day 5 (NS)	Day 8	Day 12	Day 15	Day 19	Day 22
MAP redclaw tails	0.8^b	3.3	3.8^b	2.2	6.0	7.0	1.2
Air stored redclaw tails	5.0^b	3.4	8.4^b	9.8	NT	NT	NT
MAP whole redclaw	6.2^b	1.1	7.4^b	5.2	3.3	NT	NT
Air stored whole redclaw	25.5^a	0.9	23.5^a	NT	NT	NT	NT
LSD	*12.31*	*3.7*	*10.26*	*6.22*	*8.77*	*n/a*	*n/a*

(e) Tough

Treatment	Day 0 (NS)	Day 5	Day 8 (NS)	Day 12	Day 15 (NS)	Day 19	Day 22
MAP redclaw tails	5.5	11.1^{ab}	5.6	8.0^a	5.8	8.7	10.3
Air stored redclaw tails	5.2	1.4^c	3.5	1.1^b	NT	NT	NT
MAP whole redclaw	1.9	14.0^a	5.3	9.1^a	5.1	NT	NT
Air stored whole redclaw	0.9	5.2^{bc}	1.1	NT	NT	NT	NT
LSD	*4.90*	*6.86*	*5.23*	*6.56*	*3.06*	*n/a*	*n/a*

Scale: not (0) – very (100) NT = not tested NS = Not significant (P>0.05) abc Within a column, means followed by a common letter are not significantly different (P>0.05).

Table 44. Selection of texture descriptors during trial 2.

Descriptor	Chalky/Floury							Chewy							Crunchy						
Time point (day)	0	5	8	12	15	19	22	0	5	8	12	15	19	22	0	5	8	12	15	19	22
MAP redclaw tails	0	7	7	36	31	45	0	21	43	20	21	23	18	22	21	14	13	14	23	9	33
Air stored redclaw tails	0	0	13	14	NT	NT	NT	21	29	7	7	NT	NT	NT	7	14	13	0	NT	NT	NT
MAP whole redclaw	7	7	40	36	23	NT	NT	14	43	13	29	23	NT	NT	7	21	7	0	15	NT	NT
Air stored whole redclaw	14	7	33	NT	NT	NT	NT	14	21	7	NT	NT	NT	NT	7	21	7	NT	NT	NT	NT

Descriptor	Fibrous/stringy							Flaky							Gritty						
Time point (day)	0	5	8	12	15	19	22	0	5	8	12	15	19	22	0	5	8	12	15	19	22
MAP redclaw tails	14	21	7	29	38	45	44	7	0	0	0	0	0	0	0	0	7	0	0	0	0
Air stored redclaw tails	21	7	20	14	NT	NT	NT	7	0	0	0	NT	NT	NT	0	0	0	7	NT	NT	NT
MAP whole redclaw	14	43	20	36	8	NT	NT	7	7	7	0	8	NT	NT	0	0	0	0	0	NT	NT
Air stored whole redclaw	0	21	13	NT	NT	NT	NT	14	0	0	NT	NT	NT	NT	0	0	0	NT	NT	NT	NT

Descriptor	Rubbery							Sticky							Other						
Time point (day)	0	5	8	12	15	19	22	0	5	8	12	15	19	22	0	5	8	12	15	19	22
MAP redclaw tails	0	14	7	7	8	9	11	7	7	13	7	8	9	0	14	7	0	7	15	18	11
Air stored redclaw tails	7	0	7	0	NT	NT	NT	14	0	7	14	NT	NT	NT	0	14	27	14	NT	NT	NT
MAP whole redclaw	0	7	7	7	8	NT	NT	21	14	7	0	0	NT	NT	7	7	20	7	15	NT	NT
Air stored whole redclaw	0	0	0	NT	NT	NT	NT	14	14	13	NT	NT	NT	NT	21	21	7	NT	NT	NT	NT

NT = not tested

Table 45. Mean scores for overall quality during trial 2.

Treatment	Day 0	Day 5 (NS)	Day 8 (NS)	Day 12 (NS)	Day 15 (NS)	Day 19	Day 22
MAP redclaw tails	61.6[a]	59.1	55.5	49.5	52.6	41.2	49.7
Air stored redclaw tails	56.7[a]	59.6	58.4	54.5	NT	NT	NT
MAP whole redclaw	59.2[a]	62.7	55.2	52.1	51.5	NT	NT
Air stored whole redclaw	44.9[b]	63.7	49.9	NT	NT	NT	NT
LSD	*10.1*	*6.91*	*7.93*	*7.09*	*3.46*	*n/a*	*n/a*

Scale: very poor quality (0) – very good quality (100) NT = not tested NS = Not significant (P>0.05) abc Within a column, means followed by a common letter are not significantly different (P>0.05).
pe flavour.

Appearance comments for trial 1.

	MAP redclaw tails	Vacuum packed tails	Air stored redclaw tails
Time 0	looks great pinky/orange tinge very white and clean appearance, and moistish good slight amount of gaping within segments more like fibrous appearance	slight grey appearance doesn't appear overly moist, but it doesn't appear to be all that dry either back of flesh not as red and appealing as sample 200 *(air tails)*	very dark/dull exterior of flesh (under shell) and a pink tinge all the way internal, not all that moist to look at between segments still translucent only slight yellow tinge around vein had green blobs on it - could be from the fact that the intestines were very full
	MAP whole redclaw	**Vacuum packed whole redclaw**	**Air stored whole redclaw**
	clean white and intact with a hint of moist? drier and more curled looks stringy	looks great free surface moisture a bit fibrous slight grey tinge	stringy and fibrous
Time 5	**MAP redclaw tails**	**Vacuum packed tails**	**Air stored redclaw tails**
	appear moistish, and a nice white intact surface	white intact and moistish to look at some yellow blotchiness	moderate gaping, appears rather dry, staining evident
	MAP whole redclaw	**Vacuum packed whole redclaw**	**Air stored whole redclaw**
	not technically gaping but not completely in tact hint of a grey tinge to this one orange tinge very little in the gap, barely visible.... creamish in colour, more white, but a hint of cream, as in NOT BEIGE?? slightly dry	the flesh is intact within muscle bundles but at the head end it has just fallen apart and you can't see muscle fibres any more just white clumpy bits flesh is bit fragmented but not as much as 529 *(whole air)* it fell way apart on the cut, like five bits, moist no doubt, but gaping flesh adhered to shell; very hard to get out of shell intact	pink tinge through all of tail and whole tail looks very intact as well as just between sections the meat in this animal is very messy and disconnected; it feels soft and was hard to remove from the shell fell apart a little on cutting slightly dryish starting to flake apart - looks dry and mushy
Time 8	**MAP redclaw tails**	**Vacuum packed redclaw tails**	**Air stored redclaw tails**
	very full intestinal tract, unpurged pink tinge throughout; shell soft and frothy firm and clean	out of shell and peeled easy. white moist and intact bubbles appealing looking sample	moist and white, little sloppy on the peeling, hence maybe the gaping?? red pink back tinge otherwise normal and fresh looking

Time 8	**MAP whole redclaw**	**Vacuum packed whole redclaw**	**Air stored whole redclaw**
	gaped but only slightly, moist, easy to shell dirty intestinal tract looks stringy	flesh falling apart band looking very messy read gaping as in fallen apart, difficult to separate from shell and it FELL into ten thousand bits? VERY moist looking, free water. soft and mushy , large gaps between segments completely fell apart looks a bit moister but still stringy and gaping	flesh falling apart although gaping not evident - looks messy sample fell apart on peeling hard to shell, stiff and sticky?? looks more dry than moist the sample was so sludgy that it completely fell apart dark pink back and good overall appearance
Time 12	**MAP redclaw tails**	**Vacuum packed redclaw tails**	**Air stored redclaw tails**
	pink tinge not as severe as with 360 *(vacuum tails)*	pink tinge particularly on outer edges of animal	pink tinge on edges of flesh only
	MAP whole redclaw	**Vacuum packed whole redclaw**	**Air stored whole redclaw**
	beige/greenish parts are around where the head would have been beautiful exterior clean and bright but shell very soft and easy to remove	the sample is just falling apart, the tail sections are almost separate altogether starting to fall apart flaky and very rough when taken from shell as if flesh is breaking down dry and stringy	bottom side is a browny grey colour flesh falling apart and looking very messy looks awful outer edge of sample is grey brown tinge to outside of flesh as if came from very muddy environment When cracked seemed frothy and dirty; very soft looking flesh fell to pieces as peeled
	MAP redclaw tails	**MAP whole redclaw**	– **Vacuum packed whole redclaw**
Time 15	very orange along the alimentary canal some slight yellowy patches a little drier than usual dry and pastey	colour on back of flesh darker than usual looks dry and pastey, gluggy	shell was very soft tore rather than breaking dry flaky looking - fell apart on extracting from shell well not exactly - but flesh fell apart when trying to shell the beastie looks a bit stringy

Odour comments from trial 1.

	MAP redclaw tails	Vacuum packed redclaw tails	Air stored redclaw tails
Time 0	fresh and pleasant slightly musty..? not as muddy as 200 *(air tails)* dirty water odour weedy smells like copper coins	good and fresh a slight metallic type of odorous taint? probably more herbaceous than musty sounds funny but has a chalky smell	lacks that fresh crustacean odour - a bit muddy smelling lite on the sweat herbaceous/cabbagy smelt like seaweed and quite salty
	MAP whole redclaw	**Vacuum packed whole redclaw**	**Air stored whole redclaw**
	fresh and pleasant herbaceous doesn't smell as fresh as it could be, just and oldish hint, but not old fish? typical shellfish herby/cabbagy	slight vegetable smell lacks fresh crustacean odour salty???? nose?? sorry don't know but some other odour there	fresh & pleasant almost a plastic nose seaweedy type smell - fresh sea but wasn't typical of a crustacean
Time 5	**MAP redclaw tails**	**Vacuum packed redclaw tails**	**Air stored redclaw tails**
	smells fresh and pleasant cabbagy/herbaceous almost a slight metallic note???, not as crustacean as it could be, and maybe a hint of the old fishy taint?? definite fishy smell	fresh smelling herbaceous/cabbagy very slight on the sweaty, not pleasant like? actually smells a little of the sea	green vegetable sort of odour weedy/herbaceous/cabbagy 'other' is a non-pleasant one, appears to be rather old, not off, just and old / musty kind of odour, no real nice crustacean ones to be found, personal concern towards eating being expressed..... weedy fresh odour virtually no odour at all a little 'boiled veg' ... most like overcooked cauliflower
Time 5	**MAP whole redclaw**	**Vacuum packed whole redclaw**	**Air stored whole redclaw**
	smells pretty good - fresh seafood herbaceous the other note, it's not actually an old fish odour, more the fish like odour you get when you open a tin of John West tinned salmon kind of fish note??, that make sense, not an OLD fish, but fishy more so then I'd of expected? weedy herbaceous bland	herbaceous/cabbagy bit of mud, hint of cabbage?	smells fresh typical clean crustacean odour, reminds me of mud crab the smell of clean mud?? yum

Time 8	**MAP redclaw tails**	**Vacuum packed redclaw tails**	**Air stored redclaw tails**
	smells like canned tuna fresh and pleasant smells a bit like an old mullet, with a hint of mud... still crustacean smelling sweet aroma not strong at all don't know bit fishy but not off fishy extremely strong ammonia smell - wouldn't really normally eat it	smells fresh very slight on the musty a hint of muddy, dirty, not crisp crustacean	fresh smelling as I'd expect good quality redclaw to smell slight musty aroma with a plastic like taint? weedy normal and fresh cabbagy slight ammonia smell
	MAP whole redclaw	**Vacuum packed whole redclaw**	**Air stored whole redclaw**
	strange smell - a bit like onions smells good a hint of muddy. and a bit of cabbage almost no odour smells chalky and cabbagy strong ammonia	smells fresh old musty water smell, muddy/dirty taint, as in dirt??? not very crustacean, rather fishy normal minimal smell	a bit cabbagy smells almost steaky, as in a bbq steak????? a little fishy? only slightly musty a sweet type of odour normal and fresh minimal odour sweet peppery sort of odour
Time 12	**MAP redclaw tails**	**Vacuum packed redclaw tails**	**Air stored redclaw tails**
	smells fine but not a lot of crustacean odour sweet odour meaty odour very strong ammonia smell	smells fresh normal leathery odour extremely strong ammonia	smells fine not strong lacks odour garlic
	– **MAP whole redclaw**	**Vacuum packed whole redclaw**	**Air stored whole redclaw**
	fresh and pleasant	smells good meaty milky	low level odour virtually no odour not even the normal crustacean smell old leathery smell
Time 15	**MAP redclaw tails**	**MAP whole redclaw**	**Vacuum packed whole redclaw**
	almost no odour at all nearly total domination of any odours by ammonia smell odour very weak a little plastic like in odour leathery sweaty odour	smells good very old seaweedy smell vegetable	vegetable/herbaceous

Flavour comments made for trial 1.

	MAP redclaw tails	Vacuum packed redclaw tails	Air stored redclaw tails
Time 0	aftertaste is slightly metallic slightly muddy taste but nothing to worry about cardboard might be a bit harsh, but there is not all that much flavour present, salt or sweet or redclaw meaty kind of taste, even the standard peppery/cabbagy taint ain't really there?? steamed in alfoil??? cabbagy aftertaste quite strong	briny type flavour and aftertaste very good pleasant fresh flavour this sample severely lacks any real redclaw or other flavours, has a crustacean flavour, but only just, all other aspects are basically non-existent, not salty, not sweet, moistish though, just BLAND, as if cooked in fresh water, chilled in fresh water cooked in stewed dirty water?? cabbagy aftertaste	muddy taste bland and watery peppery and a touch of weedy/herb are the only really flavours that stand out, and then hardly at all, I selected stale only 'cause there is no real flavour, figuring that it must just be old and stale, like frozen for long time like lack of flavours?? slight dirt flavour not offensive
	MAP whole redclaw	**Vacuum packed whole redclaw**	**Air stored whole redclaw**
	fresh and very pleasant a really pepper like feel down the sides of the back of the tongue and down into the throat, rather weak, VERY weak in the actual flavour dept', more moist sloppy stuff with no redclaw/crustacean flavour, and feels less then fresh to the palette sour like soil and boiled cabbage initially very crustacean like but the after taste very vegetable slight taste of dirt, had muddy flavour and a muddy odour - was easy to detect	flavour not so good musty taste overpowers the other attributes peppery/vegie/metallic are towards the aftertaste.... a kind of cleanish with a hint of muddy cabbage during the chewing vegemite a very metallic aftertaste - quite overpowering	very fresh and pleasant a nice slight vegetable/cabbagy taint, not overly peppery cabbage taint, just a nice cabbagy taint?? rather clean and crisp crustacean flavour cooked milk aftertaste
Time 5	**MAP redclaw tails**	**Vacuum packed redclaw tails**	**Air stored redclaw tails**
	very good flavour - as good as they get nothing else more then a bit of weed and a strong hint of RUBBER (texturally).... something strange quite bland flavour very bland bland again low crust - unpleasant flavours emerging - especially fishy and ammonia	a hint of cardboard taste - and lacks the very fresh flavour and sweetness - but still acceptable not flash, a bit matured to my feel?? low in flavour - not high qual flavour	aftertaste is a meaty/crustacean type flavour unusual flavour - not quite to my liking the sweetness I taste is not the normal sweet of pleasant redclaw, more the sickenly sweet taste of mould? green bread like mould? I am not consuming this bit (for the record) it tastes strange to me? pasty flavour different from the odour the slight veg taste was of raw peas. maybe this is just 'weedy'

Time 5	– **MAP whole redclaw**	**Vacuum packed whole redclaw**	**Air stored whole redclaw**
	very nice - as good as it gets the other flavour would be the taste of rubber, well to match the texture it should normal crustacean BLAND - no flavour at all very low crustacean flavour - stale unpleasant flavours emerging	sort of dirty flavour but not off - like muddy water lacks flavour peppery cabbage after with a bit of metallic, but maybe the pepper? flavour is quite there for a change, ie. It has a flavour other than weak watery soup? tasteless very very slight vegetable taste	tasted very good fresh and clean the fish is more cooked fish as to an old fish??, hint of muddy, slight peppery/cabbagy aftertaste? crustacean flavour a bit watery no taste hardly at all
Time 8	**MAP redclaw tails**	**Vacuum packed redclaw tails**	**Air stored redclaw tails**
	lacks flavour in favourable attributes and while there are no off flavours it is a bit muddy bit cabbagy and musty, with a hint of old mullet?????? bit of a bitter feel initially stale as in not totally a fresh taste bit weak in the overall crustacean flavour odd/pasty low in crustacean - stale and generally unwanted flavours emerging	fishy comes through in the aftertaste but not initially when chewing the sample slight dirty flavour and not a lot of crustacean flavour lite card/weedy taint, it's there, peppery/musty taint is there slightly..... cardboardy after taste? slightly like mild vegemite flavour	low level crustacean flavour and a hint of mud slightly bitter on the taste, even after, tastes a bit musty, muddy and plastic..... more musty then anything tasteless normal and fresh low in crustacean - other off and other flavours emerging - metallic and ammonia
	– **MAP whole redclaw**	**Vacuum packed whole redclaw**	**Air stored whole redclaw**
	low level flavour but no off flavours save a hint of mud very slight on the must, just a hint... crustacean flavour a bit washed out? the aftertaste IS CARDBOARD very little flavour yuk overcooked? aspirin aftertaste sweaty/ammonia flavour - not nice aftertaste	low level flavour and a hint of mud a dry cardboardy taste, even tho there is moisture, almost a geosmin like cardboardy/dirt feel to the sides of the tongue?? not really redclawy tasteless same strange chemical / aspirin aftertaste but not as strong as 106 *(whole MAP)* metallic aftertaste	briny a bit muddy tasting with low level crustacean and sweet flavours slight weedy/cabbage taint, SLIGHT cardboardish in taste, not overly bright in the crustacean flavour, bit staleish, but not off?? tasteless normal and fresh little cabbagy plastic flavour
Time 12	**MAP redclaw tails**	**Vacuum packed redclaw tails**	**Air stored redclaw tails**
	no taste at all quite sweet not bad flavour but still faintly raw cabbage flavour very sweet compared to other redclaw in this trial	bitter earth flavour like dirty raw cabbage leaves	aftertaste is very fishy slightly muddy watery still bit vegetable but not dirty bitter cabbage

	– MAP whole redclaw	Vacuum packed whole redclaw	Air stored whole redclaw
Time 12	aftertaste is a strong fishy type flavour generally pleasant flavour in quite high levels buttery meaty flavour	only slight vegetable taste basically awful bland and unappealing very bland meaty fishy quite strong metallic	did not eat as looked yuk peculiar flavour not muddy exactly -but with some fresh notes too like bitter old socks leathery cardboard
	MAP redclaw tails	**MAP whole redclaw**	**Vacuum packed whole redclaw**
Time 15	aftertaste is crustacean type flavour and slightly metallic but not as much as the other not a lot of flavour but sort of sweet very little flavour kind of mouldy aftertaste wasn't any flavour five secs after chewing initially very sweet flavour but tastes like its added not natural	metallic aftertaste low level flavour all up but a sweet (sugar) taste not much flavour muddy quite normal but not strong very old sweaty green pea aftertaste mild taste	flavour is very savoury meaty type; aftertaste is metallic lacks sweet fresh taste no flavour no flavour really at all hard to describe because hardly any flavour left

Texture comments made for trial 1.

	MAP redclaw tails	**Vacuum packed redclaw tails**	**Air stored redclaw tails**
Time 0	good firm text not really crunchy, but a bit, moist and flavour does finally appear, but very pathetically? even for redclaw?	good firm texture a very firm sample, plenty of body to the chew drier texture than other two samples	good firm texture slightly soft/mushy around edges there was one part of the sample that was tough to bite through dry and cottony woolly?? rather firm, unmoist and bland, if not for the peppery/weedy/metallic taint, it would be really bland.... are these seeing any salt during the cooking phase??? just a thought typically shellfish slightly more chewy than usual
	MAP whole redclaw	**Vacuum packed whole redclaw**	**Air stored whole redclaw**
	good texture cottony almost, and I really dislike the taint/feeling along the back of the palette, like pepper with out the pleasant taste, if I purchased, I'd take back and whinge to the manager? dry 2nd taste just as bad, cabbage flavour	great texture crunchy on the first few chews, then it wasn't? was reasonably dry and pastey	great texture slighlty mushy edges not overly resilient in the chewing department?, bit dry, but eatable much less firm and a little drier

Time 5	**MAP redclaw tails**	**Vacuum packed redclaw tails**	**Air stored redclaw tails**
	the texture was pretty firm but it has such a nice flavour that it doesn't detract at all dry chicken breast, cooked slowly on an open grill for 14 hours?? rubbery, flavourless? extremely dry and flaky	again, cotton woolly with past stuff around it but not to the same degree as 984 *(whole vacuum packed)* bit cottony woolly, but not the worst today? a lot of 'free' water present in mouth after first few chews dry texture - powdery mouthfeel	quite soft texture and dryish more like old musty cotton wool with a redclaw soup pouch thrown on it??? neither pieces consumed, after taste of a sweet/peppery taint, don't like it? very pasty - almost as if harvested at the wrong stage of growth? dry and flaky
	MAP whole redclaw	**Vacuum packed whole redclaw**	**Air stored whole redclaw**
	forms a wet mass like cottonwool in the mouth after chewing the texture of this one required a lot of chewing but it has a good flavour so I didn't mind make a good redclaw flavoured gum product??? the texture was shocking, EXTREMEMLY RUBBERY and rather resilient very chewy a bit tougher than usual but still ok awful texture - firm and chewy	although eating a longitudinal part of the tail, it feels fibrous and stringy and then you can feel pasty type stuff around it. small bits remain in the mouth and are hard to get rid of. soft texture initial chew was good, sample quickly lost structure and integrity prior to the second chew, moist, but NO BODY, a.k.a frozen flesh like activity sort of thing?? very soft - falling apart in mouth	although the visual aspects of the texture are very poor once you have a collection of fragments of flesh in your mouth the texture is very acceptable very even throughout texture no real texture, the texture of something cooked and long time frozen sort of texture, moist, flavourish and a structure that fails when chewed? completely feel apart - no texture really
Time 8	**MAP redclaw tails**	**Vacuum packed redclaw tails**	**Air stored redclaw tails**
	dry and cottonwoolly dry dry, stringy..... could be a lot moister, not overly tough, more dry and stringy, but I said that??? stays around for a long time soft throughout dry and cotton woolly was initially quite soft - then mushy	OK resilience to the chew, didn't mushy up or fall apart.... could be firmer too soft slightly dry and heading towards cotton woolly sample was quite like cotton wool to chew	soft but sort of chewy more just a tad on the mushy side really moist though almost wet.. normal and fresh very metallic was moist and mushy

Time 8	**MAP whole redclaw**	**Vacuum packed whole redclaw**	**Air stored whole redclaw**
	eventually mushy, put up a good fight.....crunchy to start and a fair bit of chewing to get rid of, stringy near the end overcooked!! dry cotton wool texture	soft with chewy bits sticky to the teeth, but floury/chalky on the palette. firm to start, no real resilience, texture strange and dry considering the free moisture expressed during chew??? like frozen , cooked, then frozen then served, very not redclaw fell apart when pulling out from shell goes like cotton wool very firm texture for a redclaw	soft a little fibrous, maybe from the dryness..... nice body, good chew, stays around a bit sludgy normal and fresh good
Time 12	**MAP redclaw tails**	**Vacuum packed redclaw tails**	**Air stored redclaw tails**
	soft mushier the more it is chewed cotton woolly can tell segments very dry and the sweetness is like artificial as an aftertaste crunchy and crisp		soft
Time 12	**MAP whole redclaw**	**Vacuum packed whole redclaw**	**Air stored whole redclaw**
	good ok	dryish texture but quite good flavour just goes to pulp on chewing cotton wool	very soft texture cotton woolly
Time15	**MAP redclaw tails**	**MAP whole redclaw**	**Vacuum packed whole redclaw**
	a bit dry and sweet drier mouthfeel than usual cotton wool	soft dry cotton woolly	pasty heading towards cotton wool

General comments made for trial 1.

Time 0	**MAP redclaw tails**	**Vacuum packed redclaw tails**	**Air stored redclaw tails**
	quite bland much stronger crustacean smell and flavour not really bad in any way, just not overly enticing?? bland pretty good	in some aspects better than 200 *(air stored tails)* but in others poorer no real crustacean flavour quite like overboiled cabbage with watery flavour texturally a rather pleasant experience, but flavourably BORING bland flavour very good in all respects; the slight grey appearance did not indicate any problems with flavour odour and texture	if this is the best there is - its plain dull and boring too muddy very good overall if not for mud hard to pick a crustacean smell as freshwater but these samples have very mild odour and are too cold really to smell BLAND and possibly ancient?? It's the muddy flavour that makes me rate it this low
	MAP whole redclaw	**Vacuum packed whole redclaw**	**Air stored whole redclaw**
	tastes awful long time cooked, long time frozen, not flash at all??	a bit on the overly moist sort of side and the overall 'body' wasn't there in the texture department, but nice, maybe a little over musty flavour makes this less desirable for me	better than 834 *(whole MAP)* bit washy in the overall texture/flavour dept' was low in flavour and the texture wasn't optimal - quite tough and a little chewy great little mouthful
Time 5	**MAP redclaw tails**	**Vacuum packed redclaw tails**	**Air stored redclaw tails**
	very non-descript, had little flavour and was a bit tough overcooked ??	tastes overcooked softer shell but flesh a bit tougher than usual middle of the road, texture and flavour not all that shocking, bit bland and chewy though	very soft shelled animal and texture and flavour unusual - like undercooked? texture not as rubbery or dry as 827 *(whole MAP),* but otherwise, just as disgusting? I'm not very impressed with the flavour or the texture of this sample but it did look good!
Time 5	**MAP whole redclaw**	**Vacuum packed whole redclaw**	**Air stored whole redclaw**
	not a lot of flavour the overall rating is low, this sample had less flavour, and a texture likened only to the chewing of whale blubber low overall quality due to flavour and texture	very hard to extract from shell intact not great looking smelling or tasting texture let it down, too soft...	I'm down grading it because of the messy appearance - the flavour is great flavour good, texture and odour bring it down a bit

Time 8	**MAP redclaw tails**	**Vacuum packed redclaw tails**	**Air stored redclaw tails**
	very soft shell quite bland and ordinary; not something I'd come back for again dry and stringy, bit musty and lacking total crustacean flavour	crustacean flavour a bit weak not as nice as first sample a very bright red shell on this sample which was also quite soft; I think it may be a new shell flavour OK but bad texture	texture ain't too bad, but it does taste musty
	MAP whole redclaw	**Vacuum packed whole redclaw**	**Air stored whole redclaw**
	weird smell, flavour and too dry and chalky promised so much, and ended with the taste of cardboard..... not nice as far as texture is concerned	cotton wool soaked in water from over boiled cabbages alimentary tract full, very hard to remove from shell, fell apart attempting... flesh not staying together overcooked??	bit washy on the overall flavour??
Time 12	**MAP redclaw tails**	**Vacuum packed redclaw tails**	**Air stored redclaw tails**
	way too dry not as good as 360 *(vacuum tails)*	flavour was terrible	soft and a bit watery in flavour
	MAP whole redclaw	**Vacuum packed whole redclaw**	**Air stored whole redclaw**
	bit dry	wouldn't come back for that one if I had a few before	a bit tasteless and doesn't look at all appealing bitter cabbage looks poor mediocre for flavour
Time 15	**MAP redclaw tails**	**MAP whole redclaw**	**Vacuum packed whole redclaw**
	aspartame taste the very strong ammonia smell was the main factor which dragged my overall quality score down no off flavours just few typical ones	looked terrible on outside but not too objective a flavour but the texture was terrible	where did all the flavour go? YUK to the texture worst of all we have tasted so far

Appearance comments for trial 2.

Time 0	**Map redclaw tails**	**Air stored redclaw tails**
	not very dry just a little firm not dripping or anything like that, but moist to look at, intact and a clean white....	looks soft and a little gaping no free moisture visible
	MAP whole redclaw	**Air stored whole redclaw**
	looks good came out of shell easily with good clean appearance to it. bright orange colour no visibly free moisture yet has the appearance of being moist, intact and firm looking with a nice clean intestinal chute, also easy to remove shell	very crumbly; fell apart when cut firm no free moisture and more drier then moist, but not dry?? shell VERY weak, collapsed easy, too easy I crushed the tail, meat difficult to remove from shell, slippery and shell and meat externals VERY RED, apparent pre moult, second shell forming, meat soft cuticle fragmenting- premoult some flesh stuck to shell and some fell apart
Time 5	**MAP redclaw tails**	**Air stored redclaw tails**
	looks fibrous moist as in it doesn't look as dry as 372 *(air whole)* did, but it ain't dripping water or anything like that	some darkening of ventral shell surfaces - black spot? no visible free moisture, feel apart when shelling, but no gaping in main bit?
	MAP whole redclaw	**Air stored whole redclaw**
	premoult looks dry and tough hard to get shell off moister then the last two, but not dripping...shell was soft, but easy to peel	clean tender shiney moist and intact, very clean looking white looks good! flesh very pink, almost orange throughout
Time 8	**MAP redclaw tails**	**Air stored redclaw tails**
	seems to be separating from shell - as if its shrunk can't see segments looks compacted together moister then previous orange tinge	stringy - very hard to get shell off very wet, difficult to separate from shell, very bright external flesh, second shell development, definite pre-moult stages, intact but squishy looks good
	MAP whole redclaw	**Air stored whole redclaw**
	flesh is stained form shell so doesn't look fresh any more, shell quite soft and easy to remove, looks firm and dryish pinky to an orange tint, pronounced around carapace end of tail section, apparent throughout, clean intestinal tract, well purged paler coloured back than other samples	fell to bits darkening on ventral surface of shell hard to peel shell really strong looks moist clean white and wet, very minimal gaping sample fell apart sample completely disintegrated on opening - a pile of mush back not smooth and even colour; looks old and worn out

Time 12	**MAP redclaw tails**	**Air stored redclaw tails**
	chalky fibrous compacted shell, very dirty came out of shell easily but back of flesh starting to look a little rough; colour still good	very slight orange/red colouration/tinge shiny loose only slight gaping but back of flesh starting to look poor and spotty
	MAP whole redclaw	
	dry firm compacted some staining around gut line beige around the head end, sample very small and shrivelled looking came out of shell fairly easily and back of flesh a little rough looking	
	MAP redclaw tails	**MAP whole redclaw**
Time 15	looks pushed together firm and dry very ragged around the head end of the meat	bit shrunken from the shell looks a little dry not as bad as 470 *(MAP tails)* brown autolytic staining in gut adjacent to the cephalothorax soft shell, flesh comes apart on peeling looks good
Time 19	**MAP redclaw tails**	
	very flexible shell pronounced autolysis it is quite intact, the segments even are barely visible, its like its shrunk stringy and dry flesh pink to orange colour; very compact; also makes funny squishing noise when trying to peel - froth and bubbles also shell very soft and porous not soft and moist looking; gaping not severe this sample nearly has a red tinge it is so pink	
	MAP redclaw tails	
Time 22	shrunken or shrivelled in appearance looks fibrous and compacted animal in process of shedding - shell soft and thin skin came away from flesh as peeled	

Odour comments from trial 2

Time 0	**MAP redclaw tails**	**Air stored redclaw tails**
	quite pungent odour when first peeled cabbagy metallic odour lite on the muddy, the other I'd put as 'a bit mullety'; not an off fish odour, but a fishy odour in the mullety range???oily??	quite strong odour when first opened cabbagy a little old socky?? not much odour
	MAP whole redclaw	**Air stored whole redclaw**
	metallic slight hint of mud, and a little on the vegetable side of things also weedy /vegetable	had to mash it up to extract meat; may have dissipated odour vegemite yeasty cabbage odour not really anything to pick, cloudy and weak, bit of fish and bit of crustacean weedy/cabbagy
Time 5	**MAP redclaw tails**	**Air stored redclaw tails**
	cabbage easy on the muddy, and the other is a slight vegie taint also a bit of a MEATY taint, beefish like?	vegetable throw a bit of cabbagy in there too cabbagy
	MAP whole redclaw	**Air stored whole redclaw**
	very cabbagy slight cabbagy	very mild aroma rubber a meaty kind of odour, crustacean still normal redclaw
Time 8	**MAP redclaw tails**	**Air stored redclaw tails**
	rubber pretty plain moist onions a musty sulphury meaty odour, crustacean definitely, but not all that bright and clean; not shocking	meaty cabbagy vegetable VERY meaty odour, almost beefy like in odour, not very redclawy at all, consider moult stage.... I could almost say a VERY strong lobster taint, as in VERY MEATY? or strong farmed prawn meaty?? muddy/weedy
	MAP whole redclaw	**Air stored whole redclaw**
	vegetable old muddy fishy odour present, not the cleanest smelling , would favour as old and maybe avoid, personally... cabbagy	rubber watered down crustacean cabbagy clean musty plastic?? not usual but hard to describe

Time 12	**MAP redclaw tails**	**Air stored redclaw tails**
	vegetably/cabbagy overboiled cabbage or slightly asparagus cabbagy weedy smell slightly ammoniacal	vegetable slightly sour odour smelt metallic
	MAP whole redclaw	
	boiled cabbage vegemite eggy kind of OLD smell old and unpleasant	
Time 15	**MAP redclaw tails**	**MAP whole redclaw**
	its like I got swamped by the last one, the crustacean odour is very low protein eggy sweet strong	flavour is a bit weak green smell like grass
Time 19	**MAP redclaw tails**	
	yuk... very slight ammoniacal odour which dissipated after peeling quite quickly; shell was very soft but stuck to the flesh so couldn't peel easily sweet – acidic totally un-nice	
Time 22	**MAP redclaw tails**	
	meaty/acidic smells like really old overboiled cabbage strong stalish type odour	

Flavour comments made for trial 2.

Time 0	**MAP redclaw tails**	**Air stored redclaw tails**
	strong initial sweet crustacean flavour but disappeared fast metallic taint as in it tastes very bright (edge and under tongue?) ??, and that mullety kind of flavour to go with the odour is there, an oily kind of meaty taste??? not off though, sweet and a little higher in the salt taste, slight veggie taint and easy on the mud bland slightly metallic aftertaste	slight vegetable aftertaste just bit of the old watery taint the aftertaste lingers

Time 0	**MAP whole redclaw**	**Air stored whole redclaw**
	quite clean flavour yeasty vegetable heading towards bitterness almost say it had a creamy sort of taint that one would find in a nice mac nut, just softly of the side of the tongue, crustacean flavour not overly bright, yet nice and present? almost a parsnip flavour	very slightly bitter cardboard creamy taint avocado/mac nut creamy taint on side of tongue?? no real crustacean flavour, bland weak washy sweet seafoody taste is about it
Time 5	**MAP redclaw tails**	**Air stored redclaw tails**
	peppery and bitter, almost a CO2/carbony type taste/aftertaste, not just on the tongue, but throughout the mouth as if a very non redclaw type taste totally bland	cabbage cabbagy flavour way lower then the anticipated odour, cardboardy and a bit of vegetable, stalish /blandish?
	MAP whole redclaw	**Air stored whole redclaw**
	quite strong flavour initially bitter flavour was redclaw like, but so dry and cottonwoolly that large amount of mastication was required to free up and detect the actually flavour, initial impression was of CARDBOARD, but the flavour was there when it come, and PEPPERY	a really creamy/nutty taint, bright crustacean flavour, touch of peppery and cabbage sort of nothing flavour meaty type flavour
Time 8	**MAP redclaw tails**	**Air stored redclaw tails**
	pleasant aftertaste peppery around edges and aftertaste, not overly though, tastes like a rather nice redclaw? fishy metallic aftertaste	cabbagy considering its a fresh water beast, I'd have to say that the 'other' and aftertaste was very beefy like, strong/solid taste, not overly un pleasant, but not a typical redclaw? watery washed out flavour meaty flavour just sort of nothing!!
	– **MAP whole redclaw**	**Air stored whole redclaw**
	fish protein flavour like white flesh fish steamed muddy flavour, maybe just very cloudy?, slight ammoniacal / carbony type of after taint, edges of tongue/roof of mouth types?? flavour almost 'gritty/powdery'?? crustacean a bit low, clouded	aftertaste is peppery metallic aftertaste and other the same, clean though? bland
Time 12	**MAP redclaw tails**	**Air stored redclaw tails**
	slight old butter taste burnt meat flavour is 'other' this sample has hardly any flavour again a dirty sort of taste and aftertaste not pleasant	unusual bitter flavour very little flavour other - in the sense of nothing at all - only a little foul tasting, silagey not nice at all

Time 12	– **MAP whole redclaw**	
	brothy meaty flavour meaty eggy type flavour, metallic aftertaste old green vegetable taste and after taste nutty like	
Time 15	**MAP redclaw tails**	**MAP whole redclaw**
	the roast beefy flavour is pronounced- but its hard to tell where this stops and the 'regular' flavour starts funny flavour a little like freshwater fish not exactly off - but NOT pleasant at all, would be disgusted if purchased	almost buttery flavour quite strong crustacean taste not sweet at all I got fairly distinct egg and radish type flavours in this sample taste like very old stale green peas odd
Time 19	**MAP redclaw tails**	
	smelt worse than it tastes, but pretty sad all around... bitter and baked meaty/sulphury not fresh	
Time 22	**MAP redclaw tails**	
	meaty aftertaste took a while generally sweaty old flavour not at all pleasant -objectionable	

Texture comments made for trial 2.

Time 0	**MAP redclaw tails**	**Air stored redclaw tails**
	good firm and springy on the first few chews, in a good way, it had plenty of body and didn't mush up as the others had, a bit more prawn like in texture than the mush of the previous 2 samples dry	falls apart very quickly on the chew, no real resilience to it?????? very good
	MAP whole redclaw	**Air stored whole redclaw**
	firm and crisp each segment apparent lite on the floury texture, not overly firm or resilient to the chew, falls apart very quickly, as if frozen product kind of cell damaged things.. soft, too soft	spongy SLOPPY, very sloppy, flavour tissues?? moist though slimy feel on surface (external) not powdery mushy but definitely soft this sample was completely different to the others, it just fell out of the shell and fell into pieces

Time 5	**MAP redclaw tails**	**Air stored redclaw tails**
	tough and dry more cotton woolly???, VERY DRY, firmish, and springy, but falls into mushy, not tough still an unpleasant after taint very slightly rubbery	not very firm segmented cardboardy in texture, not that much body, frozen like flesh?? and VERY DRY
	MAP whole redclaw	**Air stored whole redclaw**
	dry tough very firm too dry fair bit off chewing required to find the flavour, but not actually tough, more dried out??	dry tough sticks to the teeth casually, nice crisp texture, not mushy or tough.... a nice one.... normal fresh animal
Time 8	**MAP redclaw tails**	**Air stored redclaw tails**
	bit too dry all texture similar to a fresh claw, bar the mushy, failures in structural integrity develop rapidly very dry and firm; possibly overcooked?; worst texture out of all the samples	dry and cotton woolly bit woolly, resistant to breakdown, but not tough wet cotton wool like very soft lot of free water in mouth on chewing
	MAP whole redclaw	**Air stored whole redclaw**
	dry and compacted no feel of segments in the mouth lost it's resilience rapidly, firm on chewing; went to chew structure less mushy, didn't melt away though, it stayed with you, as if frozen or long storage? very dry good	chalky is not excessive, but sample lacks resilience good first few crunchy, then pulps, not mushy,,,,,, moist and juicy mushy soft sludgy - no body awful
Time 12	**MAP redclaw tails**	**Air stored redclaw tails**
	not as bad as last one but still too dry and compacted can't feel the segments which gives good texture slightly rubbery	tender moist fleshy, quite good really not bad texture bit too soft soft
	MAP whole redclaw	
	very dry becomes a mushy lump which has to be chewed for ages to swallow that's why tough scale not as moist not nice	
Time 15	**MAP redclaw tails**	**MAP whole redclaw**
	too dry no segments dry very firm - slightly dry	dry and cotton wool tough as had to chew for quite a while but to break up fibrousness not segments dense dry and firm

Time 19	**MAP redclaw tails**	
	not very moist upon chewing, dry? something has happened to the skin between the meat and shell its gone hard and brittle feels like eating plastic sheet dry	
Time 22	**MAP redclaw tails**	
	dry really dry and stringy not valid due to growth state of animal	

General comments made for trial 2.

Time 0	**MAP redclaw tails**	**Air stored redclaw tails**
	good a little firmer than *125 (air tails)* a good clean tasting product with body to chew on, the texture is good but aftertaste drags it down	dry with not a lot of flavour good - little too soft not off but not all that fresh or strong in the flavour or texture department, not really all that redclawy in the aroma department either
	MAP whole redclaw	**Air stored whole redclaw**
	marred by flavour which is v strong vegetable like raw cabbage; aftertaste lingers taste of cabbage flavour good and odour not bad, just no real body to speak of?	sample had very little flavour, and very mushy to eat flavour was strong but not clean crisp sweet crustacean flavours weren't that bad, just no texture and blandish..... pre-moult texture is good but other flavours are distracting
Time 5	**MAP redclaw tails**	**Air stored redclaw tails**
	dry texture put me off it colour from shell stained flesh makes it look old BlaHHH.... not too nice, a gaseous/carbony after taste persists, not all that high in the flavour? different to other samples	lack of flavour crustacean and sweet odours OK, texture flavour and moisture less than yum, as if frozen and dried out a little
	MAP whole redclaw	**Air stored whole redclaw**
	too dry and not enough crunch spring to texture flavour quite cabbagy but very crustacean too peppery after still here, and so is the flesh, hard to get rid off, cottony quality lower due to poor texture - tough and chewy	the cleanest flavour and odours I'd say??

Time 8	**MAP redclaw tails**	**Air stored redclaw tails**
	strong flavour but a little too dry aftertaste has become cardboardy almost that nutty aftertaste there, the creamy mac nut type one??	too dry and had muddy cabbage flavour all things considered, not bad, clean flavours that were there, but beefy/meaty moult?? personally I quite liked the stronger flavour of this sample but I was disappointed by the lack of body/texture
	MAP whole redclaw	**Air stored whole redclaw**
	funny flavour really tasted like eating fish instead of redclaw slightly metallic flavour odour and flavour bring it down more so then the texture, but not flash	bit dirty flavour overall and some degree of cabbage but not much clean, not many not claw attributes.. maybe made by previous moult.? flavour ok very poor texture sample fell apart on peeling poor sample
Time 12	**MAP redclaw tails**	**Air stored redclaw tails**
	odour was troubling, but taste was okay aftertaste quite odd and unpleasant	slight baked meat taste afterwards slight slippery feel to flesh just after peeling
	– **MAP whole redclaw**	
	texture is terrible, crustacean flavour still quite strong but this is totally detracted from by texture	
Time 15	**MAP redclaw tails**	**MAP whole redclaw**
	a bit like the other one. I'd still eat it and it lacks negative characters, but it is a bit sad shell very hard to get off colour run through flesh funny taste peppery slightly lacking in taste and dry borderline on edible	bit dry and tasteless, but no real negatives came away from shell cleanly didn't have a sticky feel on fingers
Time 19	**MAP redclaw tails**	
	odour is poor, flavour is so so and texture is drier, but appearance is okay, if a bit on the dry side. far too dry and almost totally lacking in any flavour no sweetness at all not pleasant	
Time 22	**MAP redclaw tails**	
	didn't look much, but otherwise ok has really strong vegetable flavour now need another sample to give valid assessment of condition at this stage of trial	

APPENDIX 8 FREEZING AND PACKAGING OF RECLAW.

Figure 8. Humane killing and blackspot treatment of redclaw.

Figure 9. Treating redclaw with chlorine dioxide.

Figure 10. Packing redclaw into freezing tray.

Figure 11. Placing ice within redclaw freezer tray to speed freezing.

Figure 12. Filling redclaw freezer tray with water.

Figure 13. Placing trays containing redclaw in plate freezer.

Table 46. Mean pH and demerit scores in fresh and frozen uncooked whole redclaw stored for up to 179 days.

Storage time (weeks)	Pack conditions	Farm	pH	Colour of shell	Presence of blackspot	Flesh appearance	Flesh colour*	Staining	Odour	Total demerit points
0	Fresh	Biloela	7.16^{cd}	0^{c}	0	0^{b}	0^{c}	0^{c}	0^{c}	0^{c}
0	Fresh	Calliope	7.06^{d}	0^{c}	0	0^{b}	0^{c}	0^{c}	0^{c}	0^{c}
2	Fresh	Biloela	7.42^{bc}	0.2^{abc}	0	0.03^{b}	0.22^{abc}	0^{c}	0^{c}	0.45^{c}
2	Fresh	Calliope	7.45^{bc}	0.33^{abc}	0	0.03^{b}	0.1^{c}	0.43^{a}	0^{c}	0.9^{abc}
2	Frozen	Biloela	6.96^{de}	0.48^{ab}	0	0.18^{ab}	0.23^{abc}	0^{c}	0^{c}	0.89^{abc}
2	Frozen	Calliope	7.17^{cd}	0.11^{bc}	0	0.2^{ab}	0.22^{abc}	0^{c}	0.09^{bc}	0.62^{bc}
7	Fresh	Biloela	7.58^{ab}	0^{c}	0	0^{b}	0.09^{c}	0^{c}	0^{c}	0.09^{c}
7	Fresh	Calliope	7.69^{a}	0^{c}	0	0^{b}	0^{c}	0^{c}	0^{c}	0^{c}
7	Frozen	Biloela	7.03^{de}	0.41^{abc}	0	0.43^{a}	0.58^{a}	0^{c}	0.11^{abc}	1.53^{ab}
7	Frozen	Calliope	7.13^{cd}	0.6^{a}	0	0.19^{ab}	0.51^{ab}	0.24^{ab}	0.24^{ab}	1.78^{a}
12	Fresh	Biloela	7.48^{bc}	0^{c}	0	0^{b}	0.3^{abc}	0.08^{c}	0^{c}	0.38^{c}
12	Fresh	Calliope	7.49^{abc}	0^{c}	0	0^{b}	0^{c}	0^{c}	0^{c}	0^{c}
12	Frozen	Biloela	7.28^{cd}	0.07^{bc}	0	0^{b}	0.53^{ab}	0^{c}	0^{c}	0.6^{bc}
12	Frozen	Calliope	6.83^{e}	0.3^{abc}	0	0.18^{ab}	0.17^{bc}	0.05^{c}	0.32^{a}	1.027^{abc}
LSD			**0.21**	**0.43**	**-**	**0.29**	**0.38**	**0.27**	**0.21**	**1.04**

^{abcde} Different letters signify significant differences between treatments (P<0.01). When ***** was present for the parameter, different letters signify significant differences between treatments (P<0.05).

Table 47. Microbiological counts (log cfu/g) of fresh and frozen uncooked whole redclaw stored for up to 179 days.

Storage time (weeks)	Pack conditions	Farm	Total	Psychrotroph	H_2S producer
0	Fresh	Biloela	2.16^{d}	1^{cd}	1^{cd}
0	Fresh	Calliope	3.48^{abcd}	2.66^{abc}	3^{abc}
2	Fresh	Biloela	4.11^{abc}	2.47^{abc}	3.19^{abc}
2	Fresh	Calliope	5.29^{a}	4.04^{a}	3.09^{abc}
2	Frozen	Biloela	2.34^{cd}	0.25^{d}	0^{d}
2	Frozen	Calliope	2.93^{bcd}	1.63^{bcd}	1.97^{abcd}
7	Fresh	Biloela	4.97^{a}	2.47^{abc}	4.33^{a}
7	Fresh	Calliope	4.72^{ab}	4.05^{a}	3.27^{abc}
7	Frozen	Biloela	3.63^{abcd}	0.25^{d}	2.39^{abcd}
7	Frozen	Calliope	5.24^{a}	1.63^{bcd}	2.86^{abc}
12	Fresh	Biloela	5.24^{a}	3.57^{ab}	4.19^{a}
12	Fresh	Calliope	5.11^{a}	2.97^{abc}	4.10^{ab}
12	Frozen	Biloela	3.65^{abcd}	2.22^{abcd}	2.07^{abcd}
12	Frozen	Calliope	2.99^{bcd}	0.95^{cd}	1.61^{bcd}
LSD			**1.9**	**2.1**	**2.53**

^{abcde} Different letters signify significant differences between treatments (P<0.01).

Table 48. Percentage of panellists selecting appearance descriptors.

Attribute	White				Cream				Beige				Grey				Green			
Time (weeks)	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**
Fresh	91	79	69	79	18	25	31	21	0	8	4	8	0	0	4	0	0	0	0	0
Frozen	n/a	88	81	75	n/a	13	23	13	n/a	0	0	8	n/a	0	4	4	n/a	0	0	0

Attribute	Pink Tinge				Yellow				Visible black spot				Dry			
Time (weeks)	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**
Fresh	0	8	23	8	0	0	4	4	0	0	0	0	0	13	23	17
Frozen	n/a	4	12	25	n/a	0	0	0	n/a	0	0	0	n/a	8	27	38

Attribute	Moist				Intact				Gaping				Other			
Time (weeks)	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**
Fresh	86	75	69	71	91	96	77	100	5	4	20	0	18	17	12	21
Frozen	n/a	79	65	50	n/a	88	77	71	n/a	17	15	29	n/a	8	12	4

Table 49 (a)–(c). Mean scores for the odour attributes.

(a) Crustacean odour *(not significant P>0.05)*

Treatment	Day 0	2 weeks	7 weeks	12 weeks
Fresh	65.2	67.3	58.0	60.7
Frozen	n/a	63.5	61.3	61.5
LSD	*5.83*			

(b) Fishy odour

Treatment	Day 0	2 weeks	7 weeks	12 weeks
Fresh	1.1 ^{ab}	1.2 ^{ab}	3.0 ^{d}	2.3 ^{cd}
Frozen	n/a	1.0 ^{a}	1.5 ^{abc}	2.2 ^{bcd}
LSD	*1.06*			

^{abc} Means followed by a common letter are not significantly different (P>0.05).

(c) Other odour *(not significant (P>0.05))*

Treatment	Day 0	2 weeks	7 weeks	12 weeks
Fresh	6.3	7.5	15.0	12.2
Frozen	n/a	4.7	4.9	5.4
LSD	*3.07*			

Scales used: Crustacean; Fishy not (0) - very (100); Other none (0) - very (100)

Table 50. Percentage of panellists selecting odour descriptors.

Attribute	Ammoniacal				Muddy				Musty				Plastic			
Time point (weeks)	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**
Fresh	14	4	12	8	9	4	23	13	9	4	27	29	0	4	12	13
Frozen	n/a	8	4	0	n/a	8	8	13	n/a	13	8	8	n/a	4	12	13

Attribute	Stale				Sulphury				Sweaty				Other			
Time point (weeks)	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**
Fresh	0	0	4	4	18	17	15	4	14	17	15	8	18	17	31	33
Frozen	n/a	0	8	4	n/a	8	12	0	n/a	8	4	8	n/a	13	31	25

n/a not applicable

Table 51 (a)- (j). Mean scores for the flavour attributes.

(a) Crustacean

Treatment	Day 0	2 weeks	7 weeks	12 weeks
Fresh	65.0 [c]	61.8 [bc]	51.2 [a]	55.8 [ab]
Frozen	n/a	62.7 [bc]	62.1 [bc]	64.4 [c]
LSD	*8.14*			

[abc] Means followed by a common letter are not significantly different (P>0.05).

(b) Salty *(not significant P>0.05)*

Treatment	Day 0	2 weeks	7 weeks	12 weeks
Fresh	6.6	9.7	6.3	8.4
Frozen	n/a	10.4	8.6	11.0
LSD	*3.53*			

(c) Sweet *(not significant P>0.05)*

Treatment	Day 0	2 weeks	7 weeks	12 weeks
Fresh	21.9 [b]	22.4 [b]	17.9 [a]	16.9 [a]
Frozen	n/a	23.4 [b]	19.0 [a]	19.0 [a]
LSD	*2.91*			

(d) Muddy *(not significant P>0.05)*

Treatment	Day 0	2 weeks	7 weeks	12 weeks
Fresh	2.1	3.2	7.9	3.1
Frozen	n/a	1.6	3.3	3.5
LSD	*6.91*			

(e) Cabbagy *(not significant P>0.05)*

Treatment	Day 0	2 weeks	7 weeks	12 weeks
Fresh	4.2	7.3	14.5	8.5
Frozen	n/a	5.2	7.0	8.5
LSD	*7.75*			

(f) Fishy *(not significant P>0.05)*

Treatment	Day 0	2 weeks	7 weeks	12 weeks
Fresh	0.8	0.7	1.1	1.6
Frozen	n/a	0.6	1.2	0.9
LSD	*0.98*			

(g) Stale *(not significant P>0.05)*

Treatment	Day 0	2 weeks	7 weeks	12 weeks
Fresh	0.7	1.9	5.5	2.6
Frozen	n/a	2.5	2.3	3.1
LSD	*2.81*			

(h) Off *(not significant P>0.05)*

Treatment	Day 0	2 weeks	7 weeks	12 weeks
Fresh	0.5	2.0	3.0	1.2
Frozen	n/a	0.6	0.9	0.8
LSD	*1.64*			

(i) Other *(not significant P>0.05)*

Treatment	Day 0	2 weeks	7 weeks	12 weeks
Fresh	7.4	8.2	14.9	14.8
Frozen	n/a	8.0	7.2	8.8
LSD	*8.65*			

(j) Aftertaste *(not significant P>0.05)*

Treatment	Day 0	2 weeks	7 weeks	12 weeks
Fresh	10.7	13.1	21.1	22.5
Frozen	n/a	11.7	14.3	18.1
LSD	*8.57*			

n/a not applicable Scales used: Crustacean; Salty; Sweet; Muddy; Cabbagy; Fishy; Stale; Off: not (0) – very (100), Other; Aftertaste: none (0) – very (100)

Table 52. Percentage of panellists selecting flavour descriptors.

Attribute	Ammoniacal				Bitter				Cardboard				Metallic			
Time point (weeks)	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**
Fresh	0	0	8	4	9	13	23	25	14	8	15	4	9	13	38	29
Frozen	n/a	0	0	4	n/a	13	15	13	n/a	13	12	4	n/a	8	15	17

Attribute	Musty				Peppery				Plastic				Soapy			
Time point (weeks)	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**
Fresh	9	4	31	29	23	21	27	46	0	4	8	8	0	4	4	4
Frozen	n/a	13	19	8	n/a	25	31	29	n/a	4	8	4	n/a	4	4	0

Attribute	Sweaty				Vegetable				Weedy/ herbaceous				Other			
Time point (weeks)	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**
Fresh	0	4	8	0	36	29	46	29	9	17	27	21	27	17	15	17
Frozen	n/a	4	0	8	n/a	46	42	33	n/a	21	23	21	n/a	17	27	25

n/a not applicable

Table 53 (a)-(e). Mean scores for the texture attributes.

(a) Firm *(not significant (P>0.05))*

Treatment	Day 0	2 weeks	7 weeks	12 weeks
Fresh	58.3	56.8	51.5	55.4
Frozen	n/a	59.7	55.8	54.8
LSD	*6.76*			

(b) Springy *(not significant P>0.05)*

Treatment	Day 0	2 weeks	7 weeks	12 weeks
Fresh	25.9	25.0	20.8	23.5
Frozen	n/a	26.5	21.5	22.4
LSD	*7.07*			

(c) Moist *(not significant P>0.05)*

Treatment	Day 0	2 weeks	7 weeks	12 weeks
Fresh	62.3	58.5	54.1	52.2
Frozen	n/a	54.5	54.3	54.3
LSD	*10.94*			

(d) Mushy *(not significant P>0.05)*

Treatment	Day 0	2 weeks	7 weeks	12 weeks
Fresh	5.7	6.8	7.4	4.9
Frozen	n/a	5.1	8.9	6.9
LSD	*8.05*			

(e) Tough *(not significant P>0.05)*

Treatment	Day 0	2 weeks	7 weeks	12 weeks
Fresh	0.8	3.4	3.0	2.2
Frozen	n/a	5.7	5.1	9.1
LSD	*6.57*			

Scales used: Firm soft (0) – firm (100)
Springy; Mushy; Tough not (0) – very (100)
Moist dry (0) – moist (100)

Table 54. Percentage of panellists selecting texture descriptors.

Attribute	Chalky/ floury				Chewy				Crunchy				Fibrous				Flaky			
Time point (weeks)	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**
Fresh	0	4	8	8	14	21	4	8	14	21	19	13	5	8	27	17	0	4	8	8
Frozen	n/a	8	15	13	n/a	33	27	17	n/a	29	19	21	n/a	29	50	38	n/a	0	0	0

Attribute	Gritty				Rubbery				Sticky				Other			
Time point (weeks)	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**	**0**	**2**	**7**	**12**
Fresh	0	0	0	0	9	4	4	0	23	8	4	8	23	29	23	29
Frozen	n/a	0	4	0	n/a	4	0	0	n/a	4	8	17	n/a	13	8	13

n/a not applicable

Table 55. Mean scores for overall quality.

Treatment	Day 0	2 weeks	7 weeks	12 weeks
Fresh	68.4 [d]	62.1 [bcd]	48.4 [a]	54.8 [ab]
Frozen	n/a	64.1 [cd]	54.5 [ab]	58.7 [bc]
LSD	*7.92*			

[abc] Means followed by a common letter are not significantly different (P>0.05). Scale used: Overall quality very poor (0) – very good (100)

List of appearance comments made for frozen redclaw.

TIME 0 - FRESH

- fresh and firm can see segments very white moist looking
- candy pink back; soft looking
- looks excellent
- external surfaces are slimy to the touch
- looked very intact
- firm segments clearly visible
- pale pink on back - good overall
- looks excellent
- clean and white.....VERY DIFFICULT to shell, rock hard shell....

2 WEEKS – FRESH

- moist translucent appearance
- very moist - bubbles of moisture around back canal -oozing water from flesh
- beige meaning a little off white, but not overly so moist to look at
- slightly dry appearance
- one side gaping one side intact
- orange tinge
- very bright white

7 WEEKS – FRESH

- fibrous stringy loose between segments
- intestinal canal not purged
- well purged
- firm
- bubbles of moisture around cut flesh
- very very slight orange tinge

12 WEEKS – FRESH

- moist
- paler orange back; not fresh looking flesh; anal canal not purged
- had a slight yellowish tinge, particularly between the segments
- not purged
- faeces in intestine
- flesh was quite beige/grey
- firm compacted slightly drier than usual colour very bright
- fresh looking and good colour on back
- pinkish/orangeish colour
- very firm while shelling.... well purged; orange flesh too so for my liking?

2 WEEKS – FROZEN

- looks fibrous, bright coloured
- whiter flesh than previous sample
- fell apart a little bit more when taking it out of the shell
- drier firmer look segments well defined
- some gaping closer to body section
- minimal gaping on the inter segmental sections, SLIGHT, very slight opagueness on small amount of sections in body, ie clear is as if raw? but not the rest of the flesh

7 WEEKS – FROZEN

- stringy
- appears drier than first sample (125) *(fresh Biloela)*
- bright clean white
- slight slime on exterior
- flesh was normal but outer skin of redclaw was practically fluorescent!
- bright, firm, moist
- very very slight yellowish tinge

well purged

12 WEEKS FROZEN

- shell dirty orange
- not purged!!!!!
- flesh looks weaker and jot fresh; weak colour also
- intestine contains faeces
- very white flesh - whiter than usual for a redclaw
- actually intact but very gapy between segments
- good even colour on back; nice looking flesh and freshish
- very moist, free moisture evident
- very white flesh

List of odour comments made for frozen redclaw.

TIME 0 - FRESH

- slightly herbaceous green smell
- clean and fresh
- lite on the sulphury but rather heavy in the old sock kind of taint, bit of the old fish might be in the old sock/sweaty taint?? ie not all that fresh an odour?
- was a clean smelling sample - crustacean only
- slightly herbaceous
- fresh shellfish
- lite on the mud and ammonia..... clean odours though

2 WEEKS – FRESH

- dried grass smell and a little like a sauna room slight chlorine type smell
- watery like boiled too much
- a bit on the musty et al side of things, not disgustingly though
- vegetable boiled cabbage odour
- fresh cray smell
- a real metallic odour?, sniff alfoil like??
- I didn't tick the boxes but very slight ammonia/muddy/musty smell - still the overpowering smell was of crustacean

7 WEEKS – FRESH

- cabbagy/weedy
- cabbagy
- cabbagy
- typical redclaw
- wet earth and rainforesty
- OLD SOCK musty, out weighs the crust odour, if the was any??
- yuk

quite a strong muddy smell

- low level of fresh odour
- metallic cabbage grassy odour
- quite musty
- am I supposed to eat this?
- fresh crustacean odour

12 WEEKS – FRESH

- grassy/green odour
- metallic
- peppery and cabbagy
- geosminy, very much so, old water, hesitant to taste the taint is so strong, yet still a redclaw overtone(JUST)
- crustacean
- odour is a bit sad, maybe the ammoniacal

2 WEEKS – FROZEN

- herbaceous slightly
- fresh and clean odour
- very slight on the musty
- was a very slight ammonia smell - but couldn't pick it as definitely ammonia - but something was there that wasn't fishy
- normal fresh redclaw
- muddy/stale/musty, like and old still creek kind of odour, like old water??? and a plasticy taint

7 WEEKS – FROZEN

- fresh and pleasant
- green cabbagy
- sweet/cabbagy
- slight hint of muddy, cabbage, also known as redclaw odour, but not all that strong in the good smells, and a touch of the fish odour
- sweet odour
- lacks the clean fresh smell - something a bit weird about the odour of this one
- vegetably herbaceous
- kind of like stale plastic, no odour of a redclaw
- crustacean
- smelt a little bit like a band-aid - plasticy
- sweet aromatic odour

12 WEEKS – FROZEN

- metallic
- weedy
- watery as if soaked for hours
- peppery
- bit cabbagy, but at least redclaw like
- crustacean
- fresh clean and very pleasant
- cooked cabbage
- sweet
- clean . freshish
- crustacean
- not much smell at all

thing is just the crustacean flavour going
- cheesy and vegetable...like rotting vegetables
- sweet/weedy
- peppery/cabbagy
- a very sickly sweet sort of odour, one I cant place?? maybe really boiled cabbage?? not a nice one either way? some what stale watery geosminy taint
- crustacean

List of flavour comments made for frozen redclaw.

TIME 0 – FRESH

- flavour remained for fair time, slightly cabbagy flavour but not too bad
- no aftertaste - fresh and clean flavour
- bit on the musty flavour, oldish, but not off or stale, more an old watery ??,,,,, aftertaste a bit metallicy, and a touch peppery throughout
- tastes a bit washed out
- the aftertaste was quite peppery - not crustacean like
- buttery metallic crustacean flavour
- watery and soft
- peppery, metallic, cardboard for the 'other' and the aftertaste.... rest kind of cleanish redclaw, if a bit watery?
- watery
- 'other' is starchy/potato
- very slight stale/cardboard type flavours

2 WEEKS – FRESH

- brown cardboard taste
- slightly watery washed out flavour
- metallicy aftertaste
- 'other' is a starchy flavour. the salt level seems high
- the aftertaste was quite strong and very salty
- slight cabbage flavour
- fresh and sweet
- a flavour that I can only describe as the smell of wet rainforest (herbaceousy)
- no real flavours at all, blandish, like overly boiled, slight cabbagy, metallic and a hint maybe of BLAND??? moist and nice, just bland
- 'other' flavour is both peppery and starchy
- was generally low in flavour - main aftertaste was salty

2 WEEKS – FROZEN

- slight cardboard flavour but overall very nice
- quite bland
- slight on the must and the pepper
- 'other' is a acidy, peppery, roast beefy type flavour
- aftertaste was quite salty
- heading towards bitter - strong vegetable flavour
- no complaints what so ever -beautiful
- little of the old sock/musty flavour, peppery and some load of plastic taint present, bit of cabbagy, and really faint on the crustacean flavour, watery almost, if not for the other flavours
- flavour was starchy/'old', a cardboardy, old oil type of flavour, yet not 'off'
- aftertaste was a little bit old fishy - maybe more stale - but only very slight

7 WEEKS – FROZEN

- very nice
- slightly cabbagy
- watery washed out almost not present
- quite the MEATY taste, almost mullety???? bit of peppery cabbage and a metallic over tone and after palette
- crustacean
- the other odour is starchy
- clean fresh
- very slight mushroomy type flavour
- WATER... no real flavour, say for the watery plastic cabbagy taint??
- the metallic/bitter aftertaste, otherwise, the 'other' flavour is big in the weedy and so forth

7 WEEKS – FRESH

- wet grass, cardboard flavour
- wet earth and rainforesty type flavours and aftertaste (aftertaste also dominated by ammonia & bitter)
- definitely and OLD sock, musty, old water taint STRONG; metallicy after taint STRONG and very cabbagy taint down the back of the throat, YUKKY
- mouldy
- the peppery flavour is sharp in this, the crustacean flavour is swamped by others, I spat it out, yuk
- lower fresh notes
- sulphury type of taste
- not a lot of flavour but not off either
- very washed out watery flavour
- very slightly sour
- not really all that flavoursome, quite peppery/metallicy/cabbagy
- I spat that one out too
- had lower fresh notes - was slightly stale - basically you could tell it wasn't 100% fresh

12 WEEKS – FRESH

- very slight perfume flavour right at very beginning of chewing
- not nice at all - almost off putting
- very strong bitterness and fairly strong metallic flavours and aftertaste.
- not very much flavour at all, more a metallicy peppery taint, and strong in the old water flavour, not as an aftertaste though???
- peppery aftertaste
- aftertaste was plasticy and stale - not at all a sweet redclaw but was quite salty for a redclaw - still salty on aftertaste too
- something else there like processed cheese
- very bland lack of typical flavours
- odd not at all like redclaw but still ok
- bitter aftertaste seemed to intensify over a fair period of time
- basically NO flavours?? bar a bit of peppery cabbagy metal, and that was faint, easy on the old water flavour too?? no moisture?
- crustacean
- aftertaste sharp and tongue tingling
- didn't have a lot of flavour at all - mainly a salty aftertaste
- pretty good but not quite as good as 028 *(frozen Biloela)*

12 WEEKS – FROZEN

- aspirin flavour very watery when first bitten
- odd; not like fresh redclaw
- a touch of peppery plastic with a peppery metallic aftertaint with a bit of beefy in there??
- slight mustiness
- aftertaste mostly peppery
- aftertaste was very sweet-uncharacteristic for a redclaw
- very fresh and sweet
- tasted fake sweet, like too concentrated but quite dry
- good fresh taste
- very moist/watery, flavour a tad of that beefy/meaty taint, sweet and redclaw like though
- crustacean
- aftertaste includes the usual old peppery, roast beefy note,
- has a very strange flavour that I cant pinpoint - almost acidic - a bit metallic maybe but sharp/bitey at the same time
- very good flavour and a lot of it

List of texture comments made for frozen redclaw.

TIME 0 – FRESH

- better cooked than 223 *(fresh Calliope)* but much smaller sample
- soft and palatable - yum
- extremely moist and soft; a lot like wet silastic/silicone rubber (but not sticky) would feel in the mouth (I think)
- moist VERY.... firm on first chew??.... mushy maybe cause it is so moist, water expressed on chew.... sticky to teeth, basically a very moist if not a little mushy texture
- not as crunchy as I'd expect
- seems a little undercooked but texture is great, segments clearly definable very moist
- melt in the mouth - lovely and soft and fresh
- this sample was like a very moist soft but chewy rubber (probably a bit like wet silastic\silicone rubber), but it was OK
- nice texture
- was firm and springy initially but then broke down and became mushy easily

2 WEEKS – FRESH

- slimy mouthfeel
- bit too watery but segments apparent
- extremely soft
- fairly jelly like
- sticky to the teeth, but basically SLOOPY moist gooey clawy stuff
- was quite easy to chew - wasn't mushy but wasn't firm - still had texture on chewing
- slightly watery
- extremely soft - like melt in the mouth
- firm, uniform and gelatinous like
- very soft, no body, falls right apart to a fleshy stuff?

7 WEEKS – FRESH

- soft
- texture good
- falls apart rapidly, TOO RAPID... moist though, went cottony
- felt a bit slimy
- soft
- after chewing for a while, just before swallowing it feel like cotton wool in your mouth
- slightly mushy - bland soft texture - lacks initial crunch
- extremely soft but not mushy - like extremely fresh fish almost melt in the mouth type but flavour is lacking

2 WEEKS – FROZEN

- slightly watery
- dry
- crisp clean good redclaw texture
- was chewy but I wouldn't describe it as stringy
- texture dry and stringy needs chewing
- perfect
- a couple of crunchy bits, like the clear bits mentioned in APPEARENCE, other than that, a very moist bit of something sloppy and crustacean, not overly exciting, wet sloppy, somewhat flavourless
- was quite a firm redclaw that was hard to chew - not at all mushy

7 WEEKS – FROZEN

- initially quite firm but on chewing appears mushy and then left with a cotton woolly type residue in the mouth
- very dry and chewy
- very soft but not too mushy, more watery but not rubbery
- very sticky and dry, cottonwoolly, again, very dry, lite on the crustacean flavour but very MEATY?? DRY and metallicy?
- was firm - initially and on chewing
- not overly stringy
- good
- first few chews had crunch, then slop and stingy, still no flavour

12 WEEKS – FROZEN

- turned chalky floury after chewing...too a long time to chew sufficiently to swallow but not rubbery/chewy more tough and cottonwool
- soft and a little slippery; not fresh like
- pleasantly redclaw like, not as firm as it could be?
- seemed to be more watery in mouthfeel than the usual
- was very moist but not mushy - quite fibrous/stringy
- very cottonwoolly like texture
- tough and cottonwoolly
- too dry
- good fresh texture
- VERY moist, moisture readily expelled during mastication

- pulped up rather rapidly, moistish, not much resilience
- its softer, less crunchier and elastic
- was very soft and no spring at all

12 WEEKS – FRESH

- very wet and almost slimy
- jelly like mouthfeel
- slippery feel in mouth - not acceptable in my opinion; I wouldn't be going back for more of these
- slightly slippery???. good texture/spring etc, not as moist as could be
- wasn't exactly mushy but was dry and not firm and so really had no texture
- jelly like texture
- texture was pretty good crisp and springy
- dry texture
- good
- fell apart, but not so much mushy, as no structure, slight stringy, no real moisture present on chew; bland to chew? with a few crunchy bits here and there
- wasn't mushy but there wasn't a lot of texture at all - broke down very easily
- texture was a bit chewier than usual
- a bit pasty but such a good flavour which seems to over ride the slight dry pastiness of the texture

List of other comments made for frozen redclaw.

TIME 0 - FRESH BILOELA

- overall appearance with shell was really good
- I quite liked this sample, but it was a bit too soft and moist
- some of the strange flavours and odours draw the score down, combined with the slimy feeling on peeling, very moist, maybe a tad too so, unless the product is 'aged' ..??
- very good
- I actually quite liked this sample although it does need to be sweeter, firmer and larger to score top marks
- watery taste, but bland on the chewy, aftertastes still here, maybe a tad stronger now?
- texture is good but the potato flavour doesn't appeal

2 WEEKS – FRESH

- reduced score because of overpowering cardboard/cabbage flavour
- boiled rather than steamed??
- flavour not bad, just NO structure during mastication

2 WEEKS – FROZEN

- slight musty taint, little dry at the end of the chew
  all round a good one
- flavour taint very strong again and texture too dry stringy
- not off I suppose?
- very disappointing and un-redclaw like; is it a taint rather than a loss of freshness?

7 WEEKS – FROZEN

- good flavour but texture a bit soft
- slight aspartame flavour
- totally different to previous sample
- dry, flavour low, cottonwoolly, not all that nice or fresh feeling, old freezer burnt stock is my impression?
- peculiar flavour and soft chalky texture - not real good
- good a little watery and bland but no taints or dirty flavours
- very very watery taste and much expressed during chew, kind of like a really over cooked, frozen redclaw, structure, flavour and odour ALL let this one down, hence the

- didn't taste as good as it looked, an off weedy flavour
- okay decent flavour little watery crustacean aftertaste
- maybe a metallicy after taint coming in on the sides of my tongue and edges of mouth??, no body structure at all really, not so much sloppy, just void of any structure

7 WEEKS – FRESH

- flavour was a bit strange real cardboard flavour
- shell hard to crack
- odour and FLAVOUR REALLY let this one down, and old sock reconstituted to a redclaw shape, with the WRONG flavours added, aftertaste of old footy sock very strong, top the point of illness, I would abuse a restaurant for serving me this
- in a restaurant, I'd call the health department!
- not a lot of flavour odour or desirable texture
- flavourless perhaps too fresh?? or has it been frozen and slow thawed??
- washed out kind of flavour, musty and texture failure reminiscent of a re freeze, ie fall apart rapidly under the chew
- it like 125 *(Fresh Biloela)* was awful
- lower quality - inferior text and flavour

12 WEEKS – FRESH

- good
- good texture poor flavour and aftertaste
- not acceptable
- fairly poor flavour but good texture
- texture was good, flavour not so, odour, now that let it RIGHT DOWN
- odour/flavour pulls it down
- some underlying flavours that are not present in the other samples like muddy and cabbagy - not as good flavour wise but the text OK
- strong unusual flavour but still pleasant
- slightly lacked typical crustacean flavour, had high bitterness (especially in the aftertaste); had really good texture
- no flavour at all really, texture strange and not redclaw like, no real moisture, and an initial odour that quite frankly concerns me as to its freshness???
- no flavour, no texture
- pretty good overall - no off flavours or smells score
- taints ruined it for me

12 WEEKS – FROZEN

- texture was tough the flavour non existent
- better than previous but not as good as first
- getting a very meaty/beefy aftertaste coming in, and it is a bit on the meaty side, not sure if I like it??
- seems too moist and the flavour could be better
- one of the best I've ever tasted
- appearance looked poor quality and texture was very poor ie fibrous/stringy
- terrible - lingering taste of dirty dishwater and cooked cabbage after swallowing
- really nice
- texture a bit sloppy
- strange other flavour let the sample down - linger as aftertaste for too long