CENTRE FOR **FOOD TECHNOLOGY**

A REPORT ON THE ESTABLISHMENT OF COMMERCIAL PRODUCTION OF MODIFIED ATMOSPHERE PACKAGED SCALLOPS

By

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EXECUTIVE SUMMARY

The aim of the project was to establish commercial production and market acceptance of modified atmosphere packaged scallops. This report contains the quality data obtained from raw material evaluation and the shelf–life trial. The results of a market trial has been compiled by Fishmac staff.

The microbiological quality of scallops from the supply boats was assessed. A total plate count of less than 10,000 (log count 10^4) cfu/g for the raw material was required before the scallop could be packed into individual trays, vacuum skin packed using gas permeable film. The packs were placed into a master carton and flushed with 100% carbon dioxide and sealed. The shelf life of the scallops was determined by testing for a number of microbiological and sensory criteria. When the shelf life had been determined scallops were packed in MAP and sent to buyers for appraisal. Feedback was requested from these individuals about the quality of the product.

A high bacterial load present in product from some supply vessels indicated that a quality assurance program and additional steps in the processing operation are required to ensure consistently low bacterial counts. The scallops packaged for the marketing trial had very high counts which could not be identified until several days after packaging. Because of this the packs were not exported to overseas buyers. Fishmac is currently trialing a food grade chemical treatment that will assure suitable bacteriological quality of the raw material. When this process becomes part of normal production the quality of all the scallops processed by this factory will be suitable for MAP.

The feasibility of using “frozen at sea” scallops in modified atmosphere packs (MAP) has been proven. The shelf-life extension achieved was similar to that observed when fresh unfrozen scallops were used in MAP. The extended shelf life gained through the application of MAP will allow this company to export fresh chilled scallops to any country in the world.

INTRODUCTION

It has been known for some time that packaging seafood in a modified atmosphere which contains a high proportion of carbon dioxide can inhibit the growth of bacteria that cause spoilage. Modified atmosphere packaging is widely used overseas in Europe and the UK but the Australian seafood industry has not shown an interest in this technology until recently. Consumers have become familiar with this type of packaging as other industries apply this technology, so that seafood packed under these conditions will also be accepted.

Experiments were initiated by the Centre for Food Technology to assist FishMac with the establishment of commercial production of modified atmosphere packaged scallop. The main work involved a shelf life study of scallop stored frozen on board the capture vessel and thawed and processed on shore.

The bulk of Queensland scallops presently being produced are now frozen-at-sea. Experiments conducted by the Centre on MAP scallops previously have concentrated on fresh, never frozen, scallops.

The handling and storage conditions the scallops would be exposed to helped determined the type of packaging to apply. As the amount of cold storage space outside of the customer area is limited for retailers the exposure of the product to MAP was only required during shipment. When the product had been received the packs would be removed from the bulk barrier bags and placed on the shelf. Scallops are very moist and can easily slide around within a loose pack. This results in the smearing of the inner surface of a pack’s laminate preventing a customer from viewing the product. These

conditions indicated a vacuum skin pack covered with a permeable membrane would more acceptable to buyers. These packs could then be placed into a barrier bag, which could then be evacuated and gas flushed before sealing.

METHODS

The microbiological quality of scallops from a number of supply boats was assessed for total count and anaerobic count. This component continued while the other phases were initiated.

The vacuum skin packer was installed in factory to operate in conjunction with a gas flusher. The equipment was set up in the wet processing area of the factory and a number of vacuum skin packs produced. These were then transported to another factory containing an evacuating and gas flushing machine manufactured by Oakham Pty Ltd (NZ). A number of parameters were modified to obtain the best vacuum and flushing conditions. The gas used for this contained 60% carbon dioxide and 40% nitrogen.

A portable gas analyser was used to test the atmosphere within the barrier bags. Gas analysis identified a mixture of 3% oxygen, 58% carbon dioxide and 37% nitrogen. These gas flushing machines are designed for rapid production and do not achieve the low oxygen levels possible using sealed chamber units. This level of oxygen was sufficient for these experiments. Some researchers of MAP suggest that some oxygen should remain to provide some inhibition of anaerobes while others insist on total absence of oxygen. At this stage all of the conditions were now suitable to progress to the storage trial.

Scallops from a recently unloaded vessel were thawed, shucked and vacuum skin packed in trays covered with the permeable film at the factory within 2 hours. These were then transported chilled to the plant containing the MAP machine. Barrier bags were placed into FishMac's 5kg sized frozen scallop cartons containing a horizontal divider. Two trays of scallops were placed on both levels of the carton. The opening of the barrier bag was then placed into the mount of the MAP machine. The vacuum was applied for 5 seconds, a gas containing 100% carbon dioxide flushed into the barrier bag for 5 seconds, and then the bag was heat-sealed.

Data loggers were placed in two of the cartons to record temperatures during transport to the laboratory and cold storage under modified atmosphere. A 1 kg control sample was placed in an open plastic bag and stored open to the air. The shelf life trial was conducted at the Centre for Food Technology laboratory during refrigerated storage in air or MAP at 4°C.

The MAP packs were opened after two and four days of storage at 4°C and kept in air for an accumulated period of 16 days. The packs were opened then scored for visual appearance and odour, the pH measured and assessed for microbiological quality. The microbiological tests included total plate count, psychrotrophic count (4°C), anaerobic plate count and count of hydrogen disulphide producing bacteria (H_2S producers). A shelf life was then determined using this data.

A second production run was conducted which supplied samples for a marketing evaluation by Hong Kong and domestic buyers. Scallops were packed on 15 September into 200g trays and 4 trays were placed into horizontally divided waxed cartons lined with a barrier bag. The barrier bag was evacuated, flushed with 100% carbon dioxide and heat sealed. The cartons were then placed into polystyrene boxes with cool packs for transportation. As another type of packaging machine (a developmental model supplied by Sealed Air Australia) had become available another batch of scallops was packed in MAP lidded trays which were flushed with a mixture of 60% carbon dioxide and 40% nitrogen. These were also placed into polystyrene boxes with cool packs for transportation.

Both types of packs were sent to regular customers of FISHMAC Pty Ltd and to Airport Fine Foods in Brisbane. Instructions were forwarded with the packs stating the expected shelf life, the recommended storage conditions and a possible wholesale price.

Microbiological Evaluation

Three batches of scallop samples were tested for their microbiological properties. These trials included the observation of the (a) raw materials, (b) the storage under aerobic and MAP conditions and (c) the aerobic storage following MAP treatment. A storage temperature of 4°C was used throughout for these trials. The material used were fresh scallops received directly from the processing plant on the arrival of the fishing boats or the samples were transported to the laboratory and tested within 24 hours. The total bacterial counts of some frozen scallops were also evaluated.

Sample preparation

The test sample was prepared by aseptically subsampling 10 g from 3 pieces of scallop and transferring it into sterile stomacher bag. The subsample was diluted 1:10 with 0.1% peptone diluent. The mixture was then homogenised for 60 seconds using a Colworth Stomacher 400.

Total bacterial count

The total bacterial count (TPC) were carried out by the surface spread method (Australian Standard, 1991b) using nutrient agar. The plates were incubated at 25°C for 3 to 4 days

Anaerobic count

Anaerobic counts were done by the surface spread method (Australian Standard, 1991b) using reinforced Clostridial agar (Oxoid). The plates were incubated anaerobically at 30°C for 10 days in an anaerobic jar charged with hydrogen and carbon dioxide gases using Gas-Pak Plus sachets (Beckton Dickinson).

A new method was used to determine anaerobic counts was done by the surface spread method (Australian Standard, 1991b) using a modified Differential Clostridial Media (**DRCM**) with the addition of polymyxin B sulphate. The plates were incubated anaerobically at 30°C for 10 days in an anaerobic jar charged with hydrogen and carbon dioxide gases using Gas-Pak Plus (Beckton Dickinson). This media is selective for gram +ve anaerobic rods and cocci. A further step was pasteurisation of a sample to grow the heat activated spores of anaerobic gram +ve spore formers on this media (**Pasteurised DRCM**).

H_2S positive bacterial count

Total count for hydrogen disulphide (**H_2S**) producing organisms was estimated by the pour plate method (Australian Standard, 1991a) using iron agar of 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.

Demerit Assessment

The appearance of the product in the packs before and after opening incorporating colour, parasite presence and flesh appearance, the odour and the drip present in the pack were rated using the demerit point system. A number of descriptive parameters were scored on sheets designed specifically for each product. Copies are present in Appendix 1. The accumulated scores were calculated and these and the individual parameter scores were analysed for significant difference using analysis of variance.

RESULTS AND DISCUSSION

A number of samples were appraised for total count to ensure the appropriate microbiological quality could be produced for MAP. The following table contains the initial microbiological count of freshly processed scallops.

Table 1. Total plate count of freshly thawed and shucked scallops.

Vessel Name	Sample Date	Total Count (log cfu/g)	Psychrotrophic count (log cfu/g)
Unknown vessel name	13/1/99	3.72	3.57
Unknown vessel name	13/1/99	3.51	3.20
Unknown vessel name	13/1/99	3.79	3.70
Unknown vessel name	13/1/99	3.74	3.51
Unknown vessel name	20/1/99	4.51	4.66
Bowen	18/5/99	3.63	1.98
Bowen	18/5/99	4.61	3.55
Plendirrack	18/5/99	4.74	3.10
Shane	29/6/99	4.05	2.84
Startruk	29/6/99	4.01	3.27
Bonnie-Ellen	10/9/99	3.41	1.88
Craiglyn-Anne 1 day in 60% CO_2	15/9/99	5.05	2.68

While these samples were obtained from processed scallops supplied by a limited number of vessels, the initial total counts obtained during January indicated that it was possible to progress with the MAP packaging without any changes to the processing environment. As sampling progressed a number of vessels could be identified which could not supply the quality that was required for this type of packaging and were excluded as sources for packaging experiments. Scallops supplied by these vessels should be avoided for this process until improvements in quality can be achieved.

Shelf life trial

The temperature present within the master packs during transport to the laboratory can be seen in Appendix 2.

The oxygen content of the four master packs tested before opening ranged from 1.8% to 3.4%. The carbon dioxide was at 89.1% after 2 days MAP and after 4 days MAP the concentrations ranged from 2% to 3.2% and 83.6% to 89.5% respectively. The microbial counts and physical measurements are present in Table 2 and the demerit scores recorded can be seen in Table 3.

Table 2. Mean microbiological counts (log cfu/g), pH and drip loss in scallops stored at 4°C in MAP, air or a combination of both for up to 16 days.

Total storage days followed in brackets by the number of days under the different atmospheric conditions	Total count	Psychrotrophic count	H_2S producer count	Anaerobic count	Pasteurised (60°C) anaerobic count	Pasteurised (80°C) anaerobic count	Clostridial count	pH	Drip loss (%)
0d fresh	3.30^{def}	3.2^{defg}	0	2.28^{ef}	0	0	0	6.10^{abcd}	0.4^{e}
2d (2d MAP)	3.24^{def}	2.95^{efg}	0	2.58^{def}	0	0	0	5.85^{g}	3.8^{cd}
2d (2d Air)	3.27^{def}	3.18^{defg}	0	2.93^{de}	0	0	0	5.91^{fg}	m
4d (4d MAP)	2.59^{f}	2.68^{fg}	0	1.37^{f}	0	0	0	5.87^{g}	6.25^{abc}
4d (2d MAP 2d Air)	3.04^{ef}	3.16^{defg}	0	2.77^{de}	0	0	0	5.88^{g}	7.2^{a}
4d (4d Air)	2.98^{ef}	2.88^{fg}	0	3.04^{cde}	0	0	0	5.95^{efg}	m
7d (4d MAP 3d Air)	2.76^{f}	2.66^{fg}	0	2.14^{ef}	0	0	0	6.11^{abc}	5.7^{abc}
7d (2d MAP 5d Air)	2.94^{ef}	2.73^{fg}	0	2.57^{def}	0	0	0	6.03^{cde}	5.55^{abc}
7d (7d Air)	4.11^{cd}	3.95^{bcdef}	0	2.94^{de}	0	0	0	6.18^{a}	2.6^{de}
9d (4d MAP 5d Air)	2.83^{ef}	2.77^{fg}	0	2.15^{ef}	0	0	0	6.16^{ab}	5.65^{abc}
9d (2d MAP 7d Air)	3.36^{def}	3.33^{cdef}	0	2.93^{de}	0	0	0	6.11^{abc}	6.5^{ab}
9d (9d Air)	4.64^{c}	2.67^{fg}	0	2.94^{de}	0	0	0	6.08^{abcd}	m
11d (4d MAP 7d Air)	3.72^{cde}	4.83^{b}	0	4.29^{abc}	0	0	0	5.96^{efg}	5.7^{abc}
11d (2d MAP 9d Air)	4.33^{c}	4.27^{bcde}	0	3.75^{bcd}	0	0	0	6.08^{abcd}	7.28^{a}
11d (11d Air)	7.85^{a}	7.76^{a}	0	5.51^{a}	0	0	0	6.16^{ab}	4.1^{bcd}
14d (4d MAP 10d Air)	3.22^{def}	3.71^{bcdef}	0	1.84^{ef}	0	0	0	6.02^{cdef}	6.2^{abc}
14d (2d MAP 12d Air)	4.32^{c}	4.43^{bcd}	0	2.59^{def}	0	0	0	6.10^{abcd}	6.05^{abc}
14d (14d Air)	6.64^{b}	7.78^{a}	0	4.7^{ab}	0	0	0	6.00^{cdef}	m
16d (4d MAP 12d Air)	2.46^{f}	1.96^{g}	0	2.17^{ef}	0	0	0	6.00^{def}	5.9^{abc}
16d (2d MAP 14d Air)	4.63^{c}	4.64^{bc}	0	3.14^{cde}	0	0	0	5.95^{efg}	5.1^{abcd}
16d (16d Air)	6.44^{b}	8.34^{a}	0	4.38^{abc}	0	0	0	6.05^{bcde}	m

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

m means the sample was not able to be taken

Table 3. Demerit scores of scallops stored at 4°C in MAP, air or a combination of both for up to 16 days.

Total storage days followed in brackets by the number of days under the different atmospheric conditions	Colour score	Colour mixture score	Presence of parasites score	Flesh appearance score	Drip loss score	Odour score	Total demerit score
0d fresh	1.25^{a}	0.5^{a}	0.63^{a}	0.25^{fghi}	0.75^{cde}	0^{h}	3.38^{ghij}
2d (2d MAP)	0.5^{ab}	0.25^{ab}	0^{b}	0^{i}	0.25^{e}	0^{h}	1^{k}
2d (2d Air)	0.63^{ab}	0^{ab}	0.25^{ab}	0^{i}	0.75^{cde}	0^{h}	1.63^{jk}
4d (4d MAP)	0.81^{abc}	0.25^{ab}	0.19^{ab}	0.32^{efghi}	0.44^{de}	1^{defg}	3^{hijk}
4d (2d MAP 2d Air)	0.51^{abcd}	0.12^{abc}	0.4^{ab}	0.1^{hi}	0.5^{de}	0.5^{fgh}	2.14^{ijk}
4d (4d Air)	0.88^{abcd}	1^{abc}	0.25^{ab}	0.2^{ghi}	1^{bcd}	0.5^{fgh}	3.83^{fghi}
7d (4d MAP 3d Air)	1.13^{abcd}	0.38^{bcd}	0^{b}	0.75^{cde}	0.73^{cde}	0.88^{efg}	3.86^{fghi}
7d (2d MAP 5d Air)	0.94^{bcd}	1^{bcd}	0.06^{b}	0.2^{ghi}	0.56^{cde}	1.05^{def}	3.82^{fghi}
7d (7d Air)	1.25^{bcde}	1.5^{bcde}	0.5^{ab}	0.5^{defgh}	1.5^{ab}	1^{defg}	6.25^{bcde}
9d (4d MAP 5d Air)	1.13^{bcde}	0.95^{bcde}	0^{b}	0.54^{cdefgh}	0.63^{cde}	0.99^{def}	4.23^{efghi}
9d (2d MAP 7d Air)	1.2^{bcdef}	0.98^{bcde}	0^{b}	0.6^{cdefg}	1.05^{bcd}	0.88^{efg}	4.7^{defgh}
9d (9d Air)	1.8^{bcdef}	1.5^{bcde}	0^{b}	1^{bc}	0.75^{cde}	1.6^{bcd}	6.65^{cd}
11d (4d MAP 7d Air)	1.35^{bcde}	1.15^{bcde}	0^{b}	0.82^{bcd}	0.94^{bcd}	1.38^{cde}	5.63^{bcdef}
11d (2d MAP 9d Air)	1.5^{bcdef}	1.38^{bcde}	0^{b}	1.25^{b}	1.19^{abc}	1.61^{bcd}	6.93^{bc}
11d (11d Air)	1.75^{bcde}	1^{bcde}	0.25^{ab}	0.6^{cdefg}	1.75^{a}	2.1^{ab}	7.45^{b}
14d (4d MAP 10d Air)	1.45^{cdef}	1.38^{cde}	0^{b}	1^{bc}	0.85^{bcde}	0.5^{fgh}	5.18^{cdefg}
14d (2d MAP 12d Air)	1.25^{cdef}	0.45^{cde}	0.25^{ab}	0.65^{cdefg}	0.5^{de}	0.4^{gh}	3.5^{fghij}
14d (14d Air)	1.63^{def}	1.5^{de}	0^{b}	0.7^{cdef}	1.75^{a}	2^{abc}	7.58^{b}
16d (4d MAP 12d Air)	1.5^{ef}	0.94^{de}	0.13^{ab}	0.5^{defgh}	0.94^{bcd}	1.15^{de}	5.15^{cdefg}
16d (2d MAP 14d Air)	1.58^{f}	1.13^{de}	0.25^{ab}	1.25^{b}	1.06^{bcd}	1.31^{de}	6.58^{bcd}
16d (16d Air)	2.25^{f}	2.25^{e}	0.5^{ab}	1.75^{a}	1.5^{ab}	2.58^{a}	10.83^{a}

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

Previous trials with seafood have found that the microbial count will remain static for many days when stored in MAP. Eventually there will be some growth and deterioration of the product but the time before the product becomes unacceptable is usually double that a product lasts in air. When seafood exposed to the air after a short period in MAP the growth of bacteria and deterioration then progresses at the same rate as the product that had only been kept in air.

Tables 2 and 3 show that the initial quality of the scallops packed for the storage trial was excellent. The total microbial count was low and no H_2S producers or Clostridial species were present at any storage time. While this quality has led to the best possible shelf life, it is unrealistic to believe that this initial count will always be achieved under commercial conditions. The high counts present in scallops obtained from some supply vessels (Table 1) indicates that high initial counts can occur in the raw material and reinforces the need for screening of suppliers.

Previous research, with fresh scallops that had never been frozen, identified initial log counts ranging from 3.58 to 4.36 cfu/g for scallops obtained from the same supplier. On most occasions H_2S producers were present leading to higher demerit scores for odour.

During MAP and subsequent air storage frozen-at-sea scallops had lower total counts than scallops that had never been frozen. The act of freezing does lead to reduced microbial loads in thawed products and can remove or inhibit some types of bacteria.

Appendix 3 shows the total microbial log counts for frozen-at-sea scallops during storage. This graph also contains previously compiled data for comparison. MAP storage resulted in significantly lower counts. The total microbial count of frozen scallops stored only in air started to increase in numbers after four days. The counts increased consistently until they became unacceptable (>1,000,000 cfu/g) on the 11th day of storage. The counts, from scallops stored in MAP prior to air storage, dropped initially after degassing and then increased till day 11 but they were still below the rejectable level after 16 days storage. Frozen-at-sea scallops from a previous study, stored for 6 days in MAP and 10 days in air, had unacceptable counts by this time. This past trial started with higher initial counts and H_2S producers were present. Scallops that had never been frozen, after similar MAP treatment, did have shorter shelf life than that observed for frozen scallops.

The psychrotrophic counts were slightly lower than the total microbial counts except towards the end of 4°C storage. Usually after storage at this temperature the total count would be expected to be lower. Growth of this group during air storage was not as rapid when there was prior MAP storage. The anaerobic counts remained low until the end of storage. Storage in MAP for four days led to significantly lower counts for this group. The scallops stored only in air had higher counts than those kept in MAP and air for the same duration. There were no spore forming species present in any of these samples ensuring a very safe product for consumers.

Previous studies of this species of scallop identified higher pH levels. This difference however does not indicate any loss of quality due to storage and processing. While the pH did drop initially for all treatments and then later increased, there was no significant difference between the treatments. The range of values obtained over the trial was between 5.85 and 6.16. This amount of

difference in pH was observed during previous research work. Major increases of scallop pH have been previously recorded after 18 days storage in air.

The colour scores of frozen scallops increased progressively during storage regardless of treatment. After 16 days the colour had become dull while the proportion that were grey in colour was between 40 and 60%. There were few parasites present within the scallops and in nearly all cases these were translucent in colour. Only one individual parasite had turned orange after MAP storage. This condition had been more prevalent during work with fresh scallops and would have a big impact on the acceptability of the product to consumers.

The scallops did not develop any large cracks or splits during storage. The cracks that were present were rated as moderate after 16 days. The scallops stored only in air were significantly worse at this time. There was a progressive increase in drip loss score from the start of storage but the scores never became visually excessive, even though there had been no phosphate treatment. This was due to the absorbent pad present in the packs. Storage in MAP does lead to an increase in drip loss. The actual amount of drip loss was much larger than that observed in scallops that had not been frozen and may become an important commercial aspect for this product.

Marketing trial

There was some urgency apparent when the final marketing trial was initiated. After a long delay due to bad weather and limited availability of raw material scallops finally became available for packaging of samples for the marketing trial in September. Due to the long delays, the imminent departure from the company of the production manager and past history of the high quality of product produced by this company it was decided to proceed with the packaging of MAP scallops without obtaining a total microbial count of the raw material. Table 4 contains the microbial counts obtained after packing and after several days storage for both types of packs.

Table 4. Mean counts (log cfu/g) of spoilage bacteria in scallops stored at 4°C in MAP or a combination of MAP and air for up to 20 days.

Pack type and storage time in days	Date of sample	Total Plate Log Count (cfu/g)	Psychrotrophic Log Count (cfu/g)
Air, day of pack	15/9/99	5.05	2.68
VSP 9d MAP	24/9/99	4.26	3.21
VSP 9d MAP 3d air	27/9/99	4.16	2.56
VSP 9d MAP 3d air at Airport Fine Foods	27/9/99	5.05	5.10
Lidded pack 20d MAP at Airport Fine Foods	5/10/99	7.44	7.52

The initial count for the scallops was too high to attain any real extension of shelf life. As can happen in even the best processing environment, the quality of the raw material can unexpectedly be inferior. It is for this reason that processors need to be able to determine the bacterial loads of raw material on the same day that it is delivered. This technology is still not available in the near future and alternatives are very limited in their application. This was the reason for screening the boats

supplying scallops to this processor at the start of this project. The processor is aware that even product coming from boats with the best possible handling practices can sometimes produce contaminated product because of the environment scallops live under and the nature of the harvest conditions.

It was unfortunate that this condition occurred with the product supplied for this final trial. Excessively high initial microbial counts were obtained for these scallops but the counts were not available until after the scallops had been packed and shipped to regular scallop buyers. The time delay in obtaining these counts was the reason that the trial was initiated and packs were produced. With the transport times the product would be exposed to, the product would be delivered and appraised by the client before any numeration of the bacterial flora was available. When the counts became available the packs sent to the buyers were not appraised.

The report from this market shipment, produced by FISHMAC, is present in Appendix 4. The samples sent to Airport Fine Foods were all returned by the recommended use-by date unsold. Management provided a number of reasons for the lack of interest in this product. Staff employed at the International airport shop were unfamiliar with MAP products so that they were not able to inform potential customers of the advantages of MAP.

Feedback from potential retail customers was that they would not pay the price of $16 for the 200g pack or $37 for the 350g pack when they could buy frozen 500g blocks of scallops at a much cheaper price. The customers visiting this shop were probably unfamiliar with the Queensland scallop to know it's worth, as the wholesale price for this species when frozen has been above $43 per kilogram on a number of occasions. The shop had added 100% to the wholesale price suggested by Fishmac placing this product in the luxury commodity range.

CONCLUSIONS

The application of MAP to frozen-at-sea scallops can be successful if the initial count is kept below 10,000 cfu/g. Previous trials with frozen scallops resulted in a similar shelf life to the 16 days at 4°C after MAP treatment identified by this investigation under the same conditions.

As stated in the company report the type of packaging machine and packaging style is still being investigated by the company so that the potential for the commercial production of this product is still high.

RECOMMENDATIONS

- The marketing of MAP saucer scallops should be conducted in those countries which regularly import this species and are familiar with this species.

- The processor may need to consider implementation of additional processes and/or a chemical treatment to ensure raw material quality is suited to modified atmosphere packaging. There may have to be some chemical treatment added to the processing line.

- The researcher is prepared to package scallops in modified atmosphere for any future marketing trial.

Appendix 1
Score Sheets For Demerit Assessment

SCALLOPS STORED AT 4°C IN MAP

SAMPLE A

TIME IN CO2 PACK TIME IN AIR DATE SAMPLED

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

Mixture of grey to white <20% 40 60 80 >80%
0 1 2 3 4

PARASITES None / Slight / Excessive
0 1 2

Type Transluscent/Orange
0 1

FLESH APPEARANCE Entire/Slight cracks/Moderate/Almost split
0 1 2 3

DRIP None / Slight / Excessive
0 1 2

ODOUR No off odours/Neutral/Slight/Excess Off odour
0 1 2 3

Description .....

SAMPLE B

TIME IN CO2 PACK TIME IN AIR DATE SAMPLED

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

Mixture of grey to white <20% 40 60 80 >80%
0 1 2 3 4

PARASITES None / Slight / Excessive
0 1 2

Type Transluscent/Orange
0 1

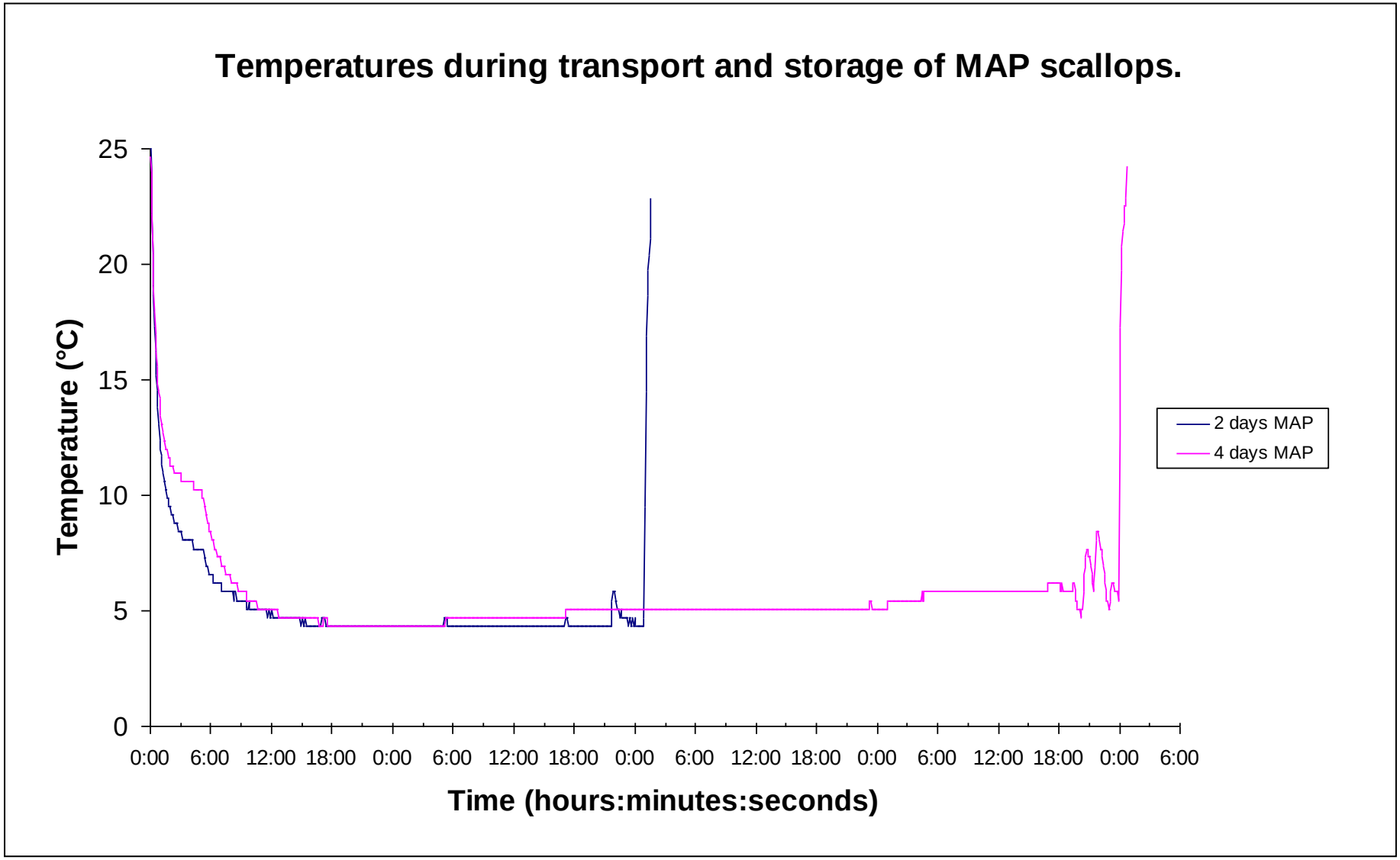
FLESH APPEARANCE Entire/Slight cracks/Moderate/Almost split
0 1 2 3

DRIP None / Slight / Excessive
0 1 2

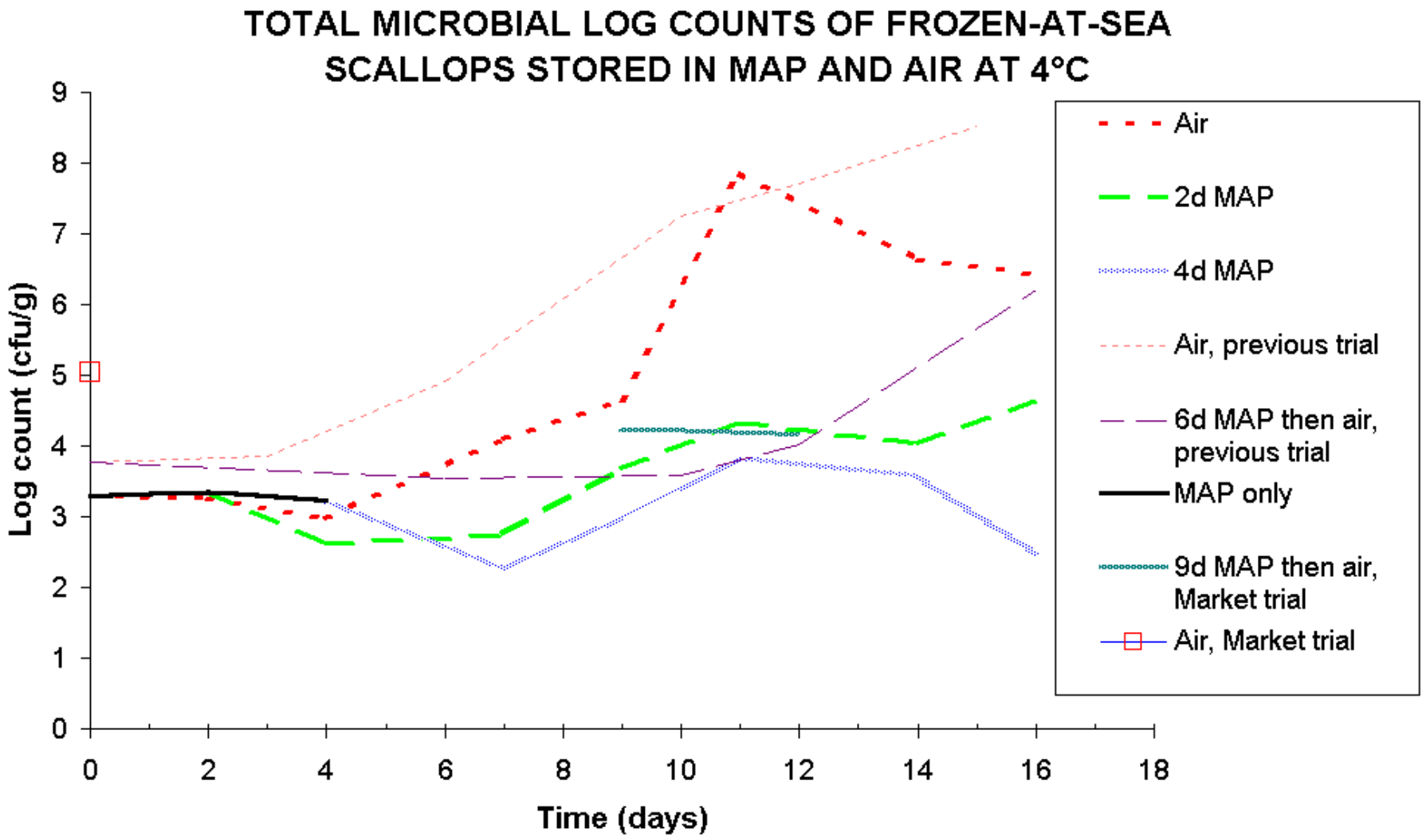
ODOUR No off odours/Neutral/Slight/Excess Off odour
0 1 2 3

Description .....

Appendix 2
Temperatures during transport and storage of MAP scallops


Temperatures during transport and storage of MAP scallops.
Temperature (°C)
25
20
15
10
5
0
0:00 6:00 12:00 18:00 0:00 6:00 12:00 18:00 0:00 6:00 12:00 18:00 0:00 6:00 12:00 18:00 0:00 6:00
Time (hours:minutes:seconds)
2 days MAP
4 days MAP

Appendix 3
Total microbial log counts of frozen-at-sea scallops stored in MAP and air.


TOTAL MICROBIAL LOG COUNTS OF FROZEN-AT-SEA SCALLOPS STORED IN MAP AND AIR AT 4°C
Log count (cfu/g)
Time (days)
0
1
2
3
4
5
6
7
8
9
0
2
4
6
8
10
12
14
16
18
Air
2d MAP
4d MAP
Air, previous trial
6d MAP then air, previous trial
MAP only
9d MAP then air, Market trial
Air, Market trial

APPENDIX 4
MARKETING REPORT PROVIDED BY FISHMAC PTY LTD.

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Seafood
Exporters • Wholesalers • Retailers

Modified Atmosphere Packaging of the Queensland Saucer Scallop (*Amusium balloti*)

Overview

The use of a modified atmosphere to extend the high quality shelf-life of food was demonstrated to Fishmac Pty. Ltd. at the Queensland Department of Primary Industries, Centre for Food Technology. The workshop through the funding of the Fisheries Research and Development Corporation brought together people in processing, retail, government and hospitality.

The research delivered by this workshop and the comments of the participants clearly indicated a bright future for this style of packaging. The modified atmosphere widens the window of time to present a high quality fresh product to existing customers and potentially creates new markets for fresh product world wide. Particularly relevant to this company are markets in the United Kingdom and parts of Europe where there is already a wide acceptance of this style of packaging and potentially the major market for scallop, Hong Kong. Fishmac Pty. Ltd. is attracted to means by which the high quality unadulterated scallop meat produced by it's Bundaberg processing operation can be distinguished from an inferior but similarly packaged product.

Aims

The Centre for Food Technology had demonstrated the potential to apply the packaging technology to the Queensland Saucer Scallop. Fishmac Pty. Ltd. had supported the research, supplying product for testing. The packaging of the product was however performed in laboratory conditions and assessed by trained technicians.
Fishmac Pty. Ltd. therefore sought to determine the application of this packaging to it's existing processing line and to assess market acceptability both in an established high quality fresh market in Australia and in the major frozen product market, Hong Kong.

The trials were dived into two separate sections

(1) Food Safety for Prolonged Anaerobic Storage in a Modified Atmosphere.

Determine the suitability of product for packaging as determined by the presence of potential spoilage organisms.
Steve Slattery, Queensland Department of Primary Industries conducted this trial and reported separately. The same procedure for processing and packaging was undertaken as for the Market assessment.

(2) Market Assessment

Dependent on a suitable outcome for the Food Safety trial (1), a market assessment trial was conducted on product packaged after processing.

The initial market assessment involved three groups. The groups were chosen for their experience with the product at processing and wholesale. Their response would be used as a guide to the determination of packaging and content for specific end user trials.

The groups were:

(A) Fishmac Pty. Ltd staff and process workers.
(B) Fishmac (Sydney). Hong Kong Sales Manager.
(C) A Leading Sydney Wholesaler and Exporter (Japan)

Procedure

Processing of Scallop in Whole Shell.

For the purpose of the trial, scallop shell frozen on board the Fishing Vessel was used. This product has been available on a year round basis and was therefore considered the most suitable for the trial by Fishmac management.

(a) Factory Process

The product was thawed in potable water, shucked, washed and chilled as per the normal process cycle.

(b) Modified Atmosphere Packaging

The chilled product was then placed on an absorbent pad in a plastic tray.
The weight was adjusted to the specified weight.
An intact vacuum packaging machine was then used to seal and evacuate a porous plastic seal to the tray.

The evacuated and sealed tray was then stored in a chilled container and transported to be sealed in a barrier bag.
Four trays were sealed in each barrier bag and the atmosphere evacuated and replaced with 100% carbon dioxide.

(c) Market Assessment

The packaged product was sealed in a styrofoam box and iced prior to air transport. The assessment to be carried out and reported as per the sample sheet attached.

Results

The assessment of Market Trial results are still to be undertaken. The results are incomplete due to:

(1) Scarcity of suitable product within the time frame of the trial .
(2) When product was available the product was determined unsuitable for packaging.

Conclusion

The absence of results is an outcome for this trial.

The absence of product is largely outside the control of the processor. The current poor season has occurred under the influence of the weather pattern associated with El Nino. The fishing vessels usually supplying scallops during this period were restricted by poor sea conditions. The scallop when fished was not caught in any quantity despite the reduction in fishing effort.

The variation in the suitability of scallop meat for modified atmosphere packaging as a fresh product (as determined by the quantity of spoilage organisms present) concludes that a suitable pre-treatment of the meat during processing is necessary. A significantly lower count on the original sample packaged for the microbiological trial indicates there is a potential for sourcing product suitable for packaging without treatment. The limiting factors for this form of control is the difficulty in controlling the handling of product on board the vessel and the need to develop a prompt test suitable for assessing product at the point of unloading from the fishing vessel.

The modified atmosphere packaging trial is continuing with Fishmac Pty. Ltd. able to make an informed choice of a suitable tray sealing machine and packaging style. This feedback was available from packaging samples sent out for the marketing trial.

Modified Atmosphere Packaging Trial

Market Assessment Sheet

Tested By John Broadhurst

Arrival temperature _____

Storage Temperature 2.1°C

	Date		20/9/99	21/9/99	22/9/99	23/9/99	24/9/99	25/9/99	26/9/99	27/9/99	20/9/99	24/9/99
	Sample Number		1	2	3	4	5	6	7	8	350 gram	350 gram
Odour at Unpacking		usual odour	✓	✓							✓	
		neutral										
		off odour			✓	SWEET	ODOUR					✓ SWEET ODOUR
Colour		normal	CLEAR	✓	✓						✓	✓
		unusual										
Drip		none	✓	✓	✓						✓	✓
		slight										
		excessive										
Taste	raw	usual odour	✓	✓							✓	
		neutral										
		off odour										
	cooked	usual odour	✓	✓							✓	
		neutral										
		off odour										
Flavour		normal	✓	✓							✓	
		unusual										
Texture		chewy										
		firm	✓	✓							✓	
		weak										
		gummy										
		soft										

General Comments TRIAL HAD UNSUITABLE $\log 10^5$ TOTAL PLATE COUNT WHEN PACKED. 15/9/99
BOTH THE BARRIER BAG & CO_2 IN HEADSPACE SHOWED OFF ODOUR AT THE SAME DAY

Instruction

Modified Atmosphere Packaging — Store at temperature below 2 degrees

First Carton Remove trays from barrier bag on Monday 20/9/99

sample one tray each day

Second Carton Remove trays from barrier bag on Friday 24/9/99

sample one tray each day