THE FOOD CENTRE
of Western Australia (Inc)

The Improvement in the Quality of Meat from Frozen Trawl Caught Blue Crabs

CJ Hughes and RN Stevens

THE FOOD CENTRE
of Western Australia (Inc)

FISHERIES
RESEARCH &
DEVELOPMENT
CORPORATION

Project 92/125.34

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ACKNOWLEDGEMENTS

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- Dorre Island Fishing Company, for allowing the Principal Investigator access to his Prawn Trawling operation in Shark Bay.

- Ricciardi Seafoods for their co-operation and the provision of processing and frozen storage facilities.

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- The Western Australian Fishing Industry Council (WAFIC) for the assistance given during this investigation.

- Fishing Industry and Fisheries Department personnel for their participation in the Focus Groups.

- The National Seafood Centre (NSC) and WAFIC for making the project possible.

1.0 TABLE OF FIGURES

2.0 NON-TECHNICAL SUMMARY

92/125.34 The Improvement in the Quality of Meat from Frozen Trawl Caught Blue Crabs.

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OBJECTIVES:

1 To develop improved quality frozen 500g and 1kg packs of frozen green and frozen cooked blue crab meat.

2 To test the packs for Total Volatile Bases, coliform and Total Bacterial Counts and presence/absence of Listeria Sp. to ascertain shelf life of the products.

3 To investigate different freezing techniques, and their effect on shelf life and eating quality.

4 To conduct market trials on the products to discern consumer acceptability.

5 To produce as an attachment to the scientific report, appropriate copy and text for use in an industry "How to produce..." booklet, which would describe product specifications and methods of production, including guidelines to assist individual processors to develop their own Hazard Analysis Critical Control Point (HACCP) plans.

SUMMARY

This study was undertaken to improve the quality of frozen crab meat. Frequently, frozen crab meat is of poor texture and has lost flavour. The technological aim of the project was to improve the quality of frozen crab meat by examining a range of different on-board handling and freezing combinations. The quality of the meat obtained from these crabs was determined by carrying out focus group discussions and microbiological tests as an indicator of shelf life. The removal of the meat from whole damaged crabs will help to improve their landed value, as well as improving the financial return to the fishing industry, while producing a quality frozen product for use in the food service industry and retail outlets.

The project demonstrated that trawling *per se* is not an indicator of poor quality in blue crabs, but the subsequent handling of these trawled crabs does impact on their quality. Evidence obtained from the focus groups demonstrated that a simple improvement in the immediate on-board handling of trawled crabs creates a significant improvement in the organoleptic quality of the meat.

If handled correctly, trawled crabs may be stored whole, for up to three months, without serious deterioration in meat quality. Using these frozen crabs, an additional 3-5 months frozen storage of packaged raw crab meat is also possible, provided that the trawling, on-board handling, freezing and meat extraction techniques are carried out using good hygienic handling techniques, Good Manufacturing Practices and temperature control.

The most successful on-board handling and freezing combination produced high ratings in the organoleptic assessment, and was also estimated to attract the highest value ($27.80/kg) of all samples considered by the focus groups.

The microbial results from the crab meat extracted from trawled crabs were well within the ideal limits set for the raw crab meat. However, it should be noted that although ice-slurrying improved the organoleptic quality of the meat, the microbial levels increased quite significantly in the cryogenically frozen samples after 3 months frozen storage. The reason for this increase is unknown and a further study into cryogenic freezing techniques is recommended.

The blast frozen crab meat from the crabs that had been ice-slurried on-board, consistently had lower microbial levels than from the other trawl caught crabs, (except in the fifth month of storage where microbial levels increased). This again demonstrates the importance of improving the immediate on-board handling of the catch.

To assist fishermen and processors, an "Industry Guide" has been produced and is appended to this document. The guide includes example product specifications as well as HACCP guidelines for the handling and processing of Blue Crab Meat.

CONCLUSION

- Improvement in the immediate on-board handling of trawled crabs significantly improves the eating quality of the crab meat.
- Meat extracted from damaged whole crabs can be utilised to produce quality frozen blue crab meat.
- Blast frozen crab meat from crabs that had been ice-slurried on-board, was of a higher quality than that from crabs that were not ice slurried prior to freezing.
- Frozen crab meat can be successfully stored frozen for up to 5 months.

3.0 ABBREVIATIONS AND GLOSSARY OF TERMS

ANZFA	Australia New Zealand Food Authority The organisation under the Federal Department of Health that is responsible for Australian and New Zealand Food Standards.
ANZFA Food Standards Code	The composition and labelling of food is regulated by the ANZFA Food Standards Code. The Food Standards Code ensures Australia has nationally consistent food laws, although each State and Territory is responsible for ensuring food law.
cfu	colony forming units.
Clostridium botulinum	A bacterium capable of causing severe food poisoning including death. Ubiquitous in soils and waters.
GMP	Good Manufacturing Practices A set of procedures necessary for ensuring that safe, clean and wholesome products are produced. These include: Personal Hygiene, Hygienic Processing, Cleaning & Sanitation and Pest Control.
HACCP	Hazard Analysis Critical Control Point A system which identifies, evaluates and controls hazards which are significant for food safety.
HACCP Plan	A document prepared in accordance with the principles of HACCP, to ensure control of hazards which are significant for food safety in the segment of the food chain under consideration. It includes the HACCP audit table, flowcharts, raw materials and product specifications and other supporting information. *(Codex)*
Hazard	A biological, chemical or physical agent in, or property of, food with the potential to cause an adverse health effect. *(Codex)*
Listeria monocytogenes	A bacterium capable of causing severe food poisoning including death in some cases. It is widely distributed in nature, in soil, vegetation and water.
ND	Not detected
SPC	Standard Plate Count
TVB	Total Volatile Bases

4.0 BACKGROUND

Improvements in the post harvest handling and marketing for blue crabs (*Portunus pelagicus*) (Stevens, 1995) have led to the establishment of export markets.

The standards for export are both high and rigid. It is inevitable, therefore, that a number of crabs will be rejected for export. Crabs are a by-catch of prawn trawling in Shark Bay WA, and these crabs are unfit for export. (P. Catalano, pers. comm.) The trawl caught crabs also depress the Australian market price for blue crabs, due both to their volume and quality, and tendency to be damaged or poorly handled on-board the trawlers.

A major problem for users of local crab meat is the unreliability of both supply and quality of frozen crab meat. The former can be resolved by using the bulk catch from Shark Bay, and the latter is the subject of this research. Frequently, frozen crab meat is of poor texture and lacks flavour. This project sought to obviate those deficiencies by testing improved freezing techniques.

There is an opportunity to improve the value of both export reject and trawl caught crabs by removing the meat from the shells and freezing for further value-adding. The NSC funded project (92/125.17) showed that good recoveries of meat were possible from blue crabs.

Data supplied by the WA Department of Fisheries, and collated by the Western Australian Fishing Industry Council (WAFIC) show that there has been a doubling of the blue crab catch since 1992, to 300 tonnes per annum. The fishery is managed by input controls and there are no catch quotas for crabs in Western Australia.

5.0 NEED

Periodic over-supplies of whole damaged crabs onto the domestic market cause price crashes. The conversion of these whole damaged crabs into crab meat would therefore help to alleviate this problem. By removing meat, the landed value of the crabs would be improved. The current market price (Sydney) for frozen meat is $26.50 per kg. Preliminary investigations have discovered a latent demand for fresh and frozen crab meat in two forms, in 500g to 1kg packs for food service and seafood retail outlets.

6.0 OBJECTIVES

1. To develop improved quality frozen 500g and 1kg packs of frozen green and frozen cooked blue crab meat.

2. To test the packs for Total Volatile Bases, coliform and Total Bacterial Counts and presence/absence of Listeria Sp. to ascertain shelf life of the products.

3. To investigate different freezing techniques, and their effect on shelf life and eating quality.

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7.0 METHODS

7.1 Literature Review

All available literature resources were reviewed using standard research techniques.

7.2 Existing Product Evaluation

Retail outlets around the Perth Metropolitan area were searched for crab meat products. Potential packaging options were also investigated.

7.3 Product Development

7.3.1 Selection of crabs

The crabs selected for use in this project were trawl caught in Shark Bay and frozen on-board the vessel. All crabs that were caught in the trawl nets were examined for size and gender. Undersized and female crabs were returned alive to the water.

Two methods of on-board handling were investigated:

(A) Trawled crabs were selected at random from each shot and set aside from the prawn sorting table. These crabs were then boxed and frozen at the end of the night's fishing (ie they were on deck for between one and eight hours).

(B) Trawled crabs were selected at random from each shot and placed immediately into an ice slurry. These crabs were boxed and frozen at the end of the night's fishing (ie the crabs were in the ice slurry for between one and eight hours). The ice slurry was continually replenished.

All boxed crabs were frozen on-board to a temperature of -48°C. Upon returning to Carnarvon, the frozen crabs were placed in frozen storage at the Dorre Island Fishing Company and subsequently transported, via frozen transport, and stored at -40°C at Ricciardi Seafoods, Fremantle, WA.

7.3.2 Preparation of crab meat

All crabs caught in Shark Bay had been in frozen storage for approximately 3 months at the time of processing, to extract the meat. Approximately 10 frozen crabs at a time were randomly selected, and were placed on ice to allow them to partially thaw. Each crab was then picked by hand to extract the meat from the body, claws and legs. Good Manufacturing Practices were followed at all times, and the recovery rates for the crab meat were noted for each batch.

The meat was then vacuum packed, as soon as possible, in 100g packs using:

(1) semi permeable vacuum bags, and
(2) tray packs using a soft vacuum.

Freshly caught crabs (ex Cockburn Sound) were also sampled and were used as a control. These crabs had been caught by pot, comatosed at sea, but not killed in an ice slurry. The crabs were caught between three and eight hours prior to processing.

Two freezing techniques were examined, whereby the 100g packs were either blast frozen or cryogenically frozen.

NB A schematic diagram of the batch cryogenic freezer can be found in Appendix 1.

7.3.3 Shelf Life Study

An examination of the frozen shelf life of the crab meat packs was carried out. Microbiological tests were performed on the defrosted raw crab meat by Microserve Laboratory Pty Ltd. The results were then compared with a pre-determined microbiological specification to assess the safety and quality of the crab meat products.

Each handling/freezing combination was examined for Standard Plate Count (SPC), coliforms and the presence/absence of *Listeria monocytogenes*. Samples were tested after one month, three months, and five months frozen storage. No appropriate chemical tests could be found, that would adequately give an indication of shelf life.

7.3.4 Focus Groups

In order to investigate the potential of the crab meat product in the Western Australian market, three focus group discussions were carried out using target consumers as well as Fishing Industry personnel.

The crab meat samples were cooked in a microwave oven, without the use of any seasoning, to enable an accurate evaluation of the product to be carried out.

Each focus group was conducted in order to gauge consumer reaction to the new products. In particular, the discussions focused on the odour, flavour, texture, presentation and appearance of the crab meat. Each participant was asked to sample the cooked crab meat and respond to a series of questions (a blank questionnaire can be found in Appendix 2).

Each focus group was recorded so that an accurate summary of all the comments could be made.

8.0 RESULTS

8.1 Literature Review

Relevant literature relating to the extraction of crab meat was obtained. This included NSC Project 92/125.17 "Improvements in Post Harvest Handling and Marketing Strategy for Blue Crabs". A variety of other published papers were found that related to the examination of frozen crab meat by Scanning Electron Microscopes. All literature consulted for this project can be found in section 13.0 References.

8.2 Existing Product Evaluation

The majority of crab meat products found on the market were imported canned varieties. Frozen crab meat products that were found, included those where a prototype crab picking machine had been used. There are currently two such prototype machines being developed in Western Australia.

The meat quality obtained from these extraction processes varied, and was dependent upon the nature of the extraction. In general, the crab meat packs consisted of a mixture of medium to large size "chunks" as well as a large proportion of small pieces and fragments. With both machines, small fragments of shell were detected in the picked crab meat. The crab meat was packaged in vacuum bags.

8.3 Product Development

8.3.1 Selection of Crabs

Several boxes of trawled crabs were obtained. Approximately one third of these contained crabs that had been ice slurried on-board prior to packing and freezing. The remainder were those crabs that had been set aside in the sorting table before packing and freezing on-board. In both of the crab handling techniques, the crabs may have been between 1 and 8 hours out of the water when frozen. The tub containing the ice slurried crabs was continually topped up with fresh ice to minimise any deterioration in the quality of the crab meat. (See Reference 4)

All boxes of frozen crabs were then transported to Ricciardi Seafoods, Fremantle, WA, and held in frozen storage until required.

8.3.2 Preparation of Crab Meat

At the time of preparation of the crab meat, the whole crabs had spent approximately 3 months in frozen storage. A number of 100g packs of hand picked crab meat were produced from each of the handling and freezing treatments.

Similar packs of hand picked crab meat from freshly caught crabs were also produced. These crabs were caught in Cockburn Sound, and were processed on the day of capture. They were not ice slurried. They had therefore been out of the water for between 3 and 8 hours, and hence were comparable to the trawled crabs.

The six handling/freezing combinations are outlined in Table 1.

Table 1 Handling and Freezing Combinations for the Crab Meat Packs

A	Fresh crabs picked and blast frozen
B	Fresh crabs picked and cryogenically frozen
C	Crabs frozen on-board, defrosted, picked and blast frozen
D	Crabs frozen on-board, defrosted, picked and cryogenically frozen
E	Crabs ice slurried/frozen on-board, defrosted, picked and blast frozen (-24°C)
F	Crabs ice slurried/frozen on-board, defrosted, picked and cryogenically frozen (-29.4°C surface temperature)
CONTROL	Fresh crabs, picked and chilled (5°C)

In general, the average recovery rate for the frozen crab meat was 37% (range 37-41%) and 36% from fresh crabs. The dimensions of the 100 gram vacuum packs of crab meat were 18 x 16.5 x 0.3 cm thick. These dimensions, and in particular the thickness of the pack, had a direct influence on the speed of cryogenic freezing. Thinner packs require a shorter freezing time.

A number of samples of crab meat were tray packed using a soft vacuum. These samples were used purely for a visual evaluation during the focus groups. The purpose of producing tray packs of crab meat was to examine the variation in presentation, as well as the feasibility of producing such a pack for retail sale.

All packs of crab meat could be presented as a cooked product where the crab meat could be extracted directly from cooked crabs or alternatively, the meat could be extracted from green crabs, then cooked. In view of the nature of the product and the potential for cross contamination from the handling of cooked whole crabs, the latter option would be the preferable process.

8.3.3 Shelf Life Study

The microbiological profile of the crab meat samples was used as an indicator of frozen shelf life. The ideal microbial limits that were selected as the parameters for the shelf life, are as follows:

Total Plate Count	< 1,000,000 cfu/g
coliform	< 1000 cfu/g
Listeria monocytogenes	minimise

As there are no current microbial standards for raw crab meat, these limits were based on the use of Good Manufacturing Practices and good handling techniques. Microserve Laboratory was consulted when selecting the ideal microbial limits for the raw product.

The microbiological results are displayed in Tables 2 and 3 and Figures 8.1 to 8.7. In each of the graphs, the microbial counts were plotted against the ideal standard limits.

It should be noted that the microbiological results for the ice-slurried crabs were significantly higher than for the other handling techniques. The exact reason for this is unknown. However, it is feasible to say that the sea water/frozen sea water contributed by causing microbial contamination. It may also be possible that as the crabs had been drowned, the meat may have absorbed some of the sea water hence increasing the microbial load. The time the crabs spend in the ice slurry should be minimised to approximately 1 hour, after which time they should be packed and frozen, or placed on ice until they are packed.

One hypothesis, is that the speed of cryogenic freezing actually prevents ice crystal formation within the bacterial cells. Thus the survival of bacteria may be higher in a cryogenically frozen sample than in those that are blast frozen, where ice crystal formation within the cells would cause them to rupture upon thawing.

Further work is recommended to investigate the microbiological quality of ice-slurried crabs.

It was anticipated that there would be a suitable chemical indicator for shelf life, such as a TVB (Total Volatile Bases) test. However, although this test could have been carried out, a “freshness” level for crabs could not be found in the literature. The TVB test as a chemical indicator of shelf life was deemed inappropriate, as there is no current standard with which to compare the test results.

The microbiological quality of pre-cooked frozen crab meat has been legislated in Standard S2 of the ANZFA Food Standard Code (1992). All packs of cooked frozen crab meat produced for retail sale or the food service market must therefore comply with this Standard. Details of the microbiological quality and processing techniques for cooked and packaged crab meat are described in the Industry Guide.

An investigation into the use of Scanning Electron Microscopy to access ice crystal damage to the myofibrils in the crab meat, was carried out. It was hoped that this technique would also provide an indication of shelf life, particularly from an organoleptic perspective. The technique was

found to be extremely difficult to master. Further studies into this technique would be required in order to obtain some useful information, particularly in the area of sample preparation. The literature has indicated that it may be beneficial to freeze-dry the samples before examination, so that the spaces that are occupied by the ice crystals will still be obvious.

Table 2 Microbiological Results for Hand Picked Green Crab Meat after 1, 3 & 5 Months Frozen Storage.

SAMPLE	SPC cfu/g			Coliforms cfu/g			*Listeria monocytogenes*		
	1 month frozen storage	*3 months frozen storage*	*5 months frozen storage*	*1 month frozen storage*	*3 months frozen storage*	*5 months frozen storage*	*1 month frozen storage*	*3 months frozen storage*	*5 months frozen storage*
A Fresh Blast Frozen	41,000	20,000	26,000	< 10	< 10	< 10	ND	ND	ND
	50,000	29,000	26,000	< 10	< 10	< 10	ND	ND	ND
B Fresh Cryogenically Frozen	30,000	22,000	28,000	< 10	< 10	< 10	ND	ND	ND
	23,000	14,000	15,000	< 10	< 10	< 10	ND	ND	ND
C Frozen on-board/ Blast Frozen	120,000	7,100	6,900	< 20	< 10	< 10	ND	ND	ND
	180,000	10,000	2,800	< 10	< 10	< 10	ND	ND	ND
D Frozen on-board/ Cryogenically Frozen	170,000	8,800	5,800	30	< 10	< 10	ND	ND	ND
	260,000	7,900	11,000	30	< 10	< 10	ND	ND	ND
E Ice-slurried/ Frozen/ Blast Frozen	59,000	30,000	75,000	< 10	< 10	< 10	ND	ND	ND
	110,000	28,000	140,000	< 10	< 10	< 10	ND	ND	ND
F Ice-slurried/ Frozen/ Cryogenically Frozen	1,500,000	250,000	6,600,000	230	< 10	140	ND	ND	ND
	150,000	9,800,000	20,000,000	40	< 10	37	ND	ND	ND

ND - Not detected

NOTE: For each sample the duplicate results are given.

Table 3 Microbiological Results for Fresh Hand Picked Crab Meat.

SAMPLE	SPC cfu/g	Coliforms cfu/g	*Listeria monocytogenes*
Fresh Control	17,000 15,000 13,000 11,000	< 10	ND

ND - Not detected

Figure 8.1

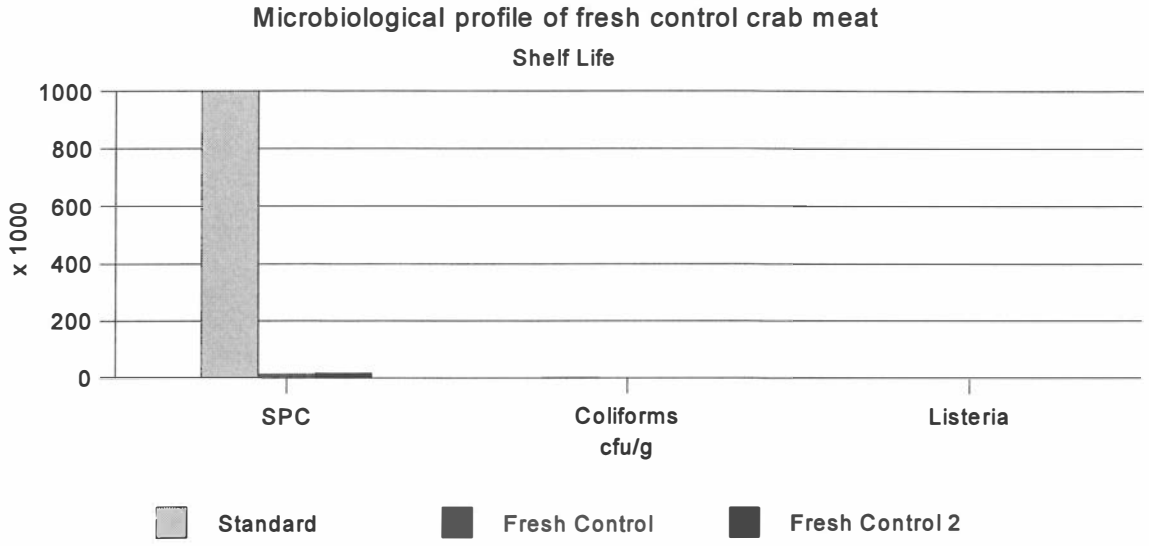
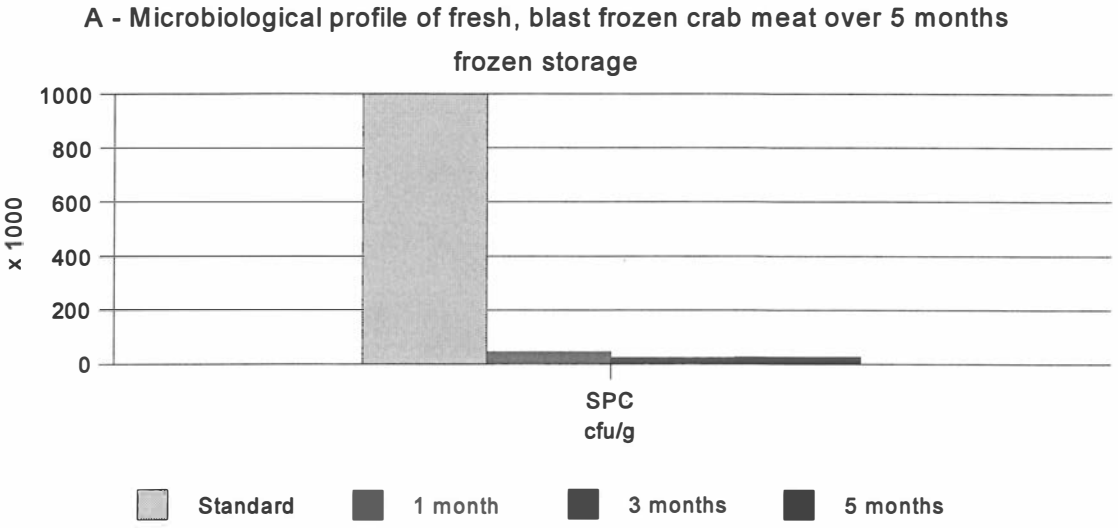


Figure 8.2


A - Microbiological profile of fresh, blast frozen crab meat over 5 months frozen storage
1000
800
600
400
200
0
x 1000
SPC
cfu/g
Standard
1 month
3 months
5 months

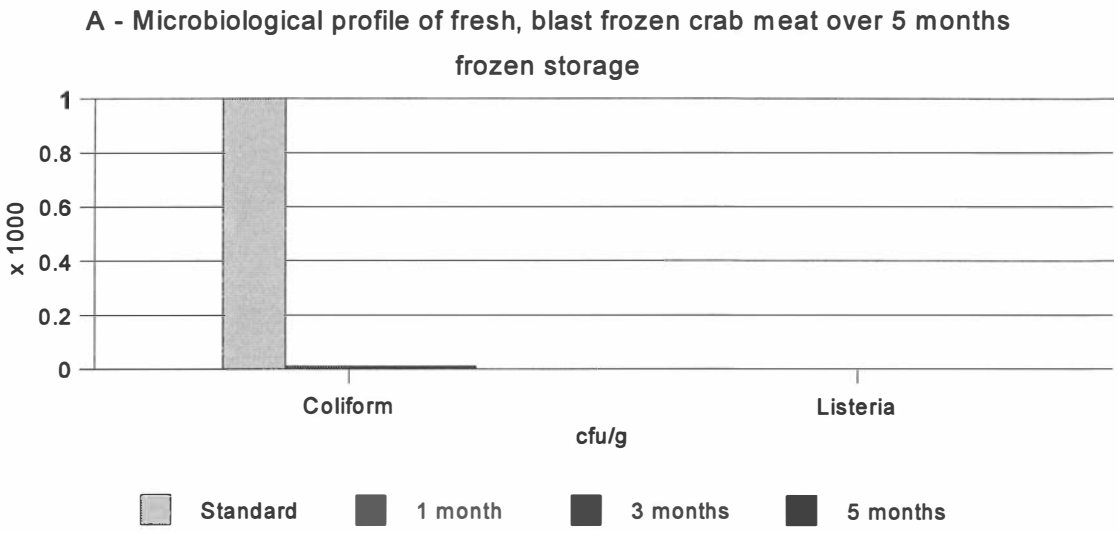
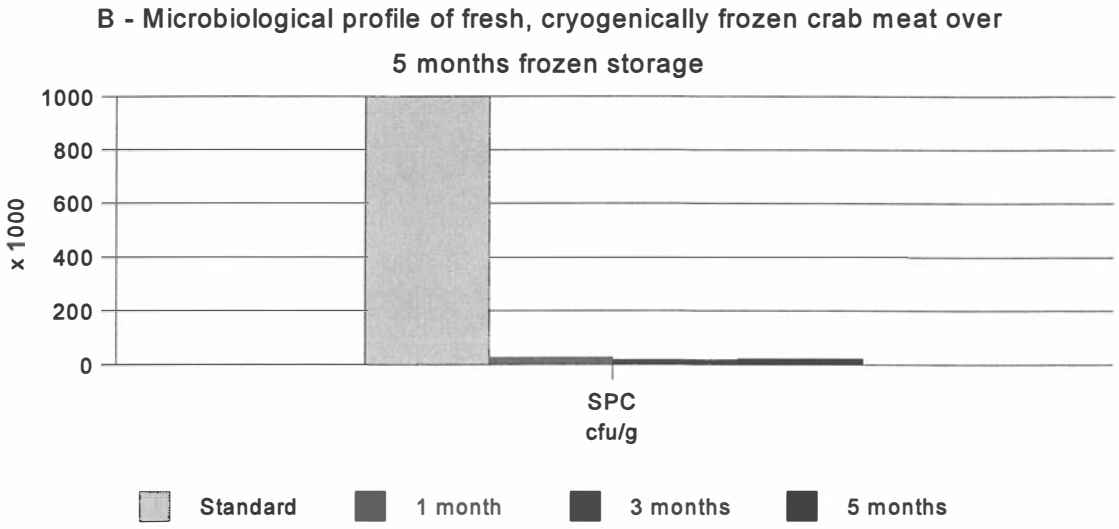

A - Microbiological profile of fresh, blast frozen crab meat over 5 months frozen storage
1
0.8
0.6
0.4
0.2
0
x 1000
Coliform
Listeria
cfu/g
Standard
1 month
3 months
5 months

Figure 8.3


B - Microbiological profile of fresh, cryogenically frozen crab meat over 5 months frozen storage
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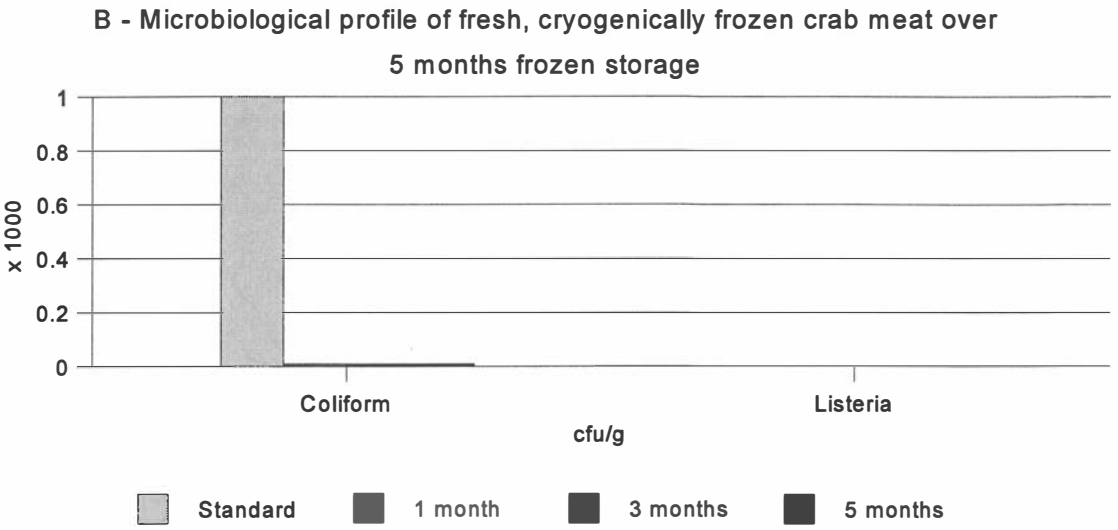
600
400
200
0
x 1000
SPC
cfu/g
Standard
1 month
3 months
5 months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1
0.8
0.6
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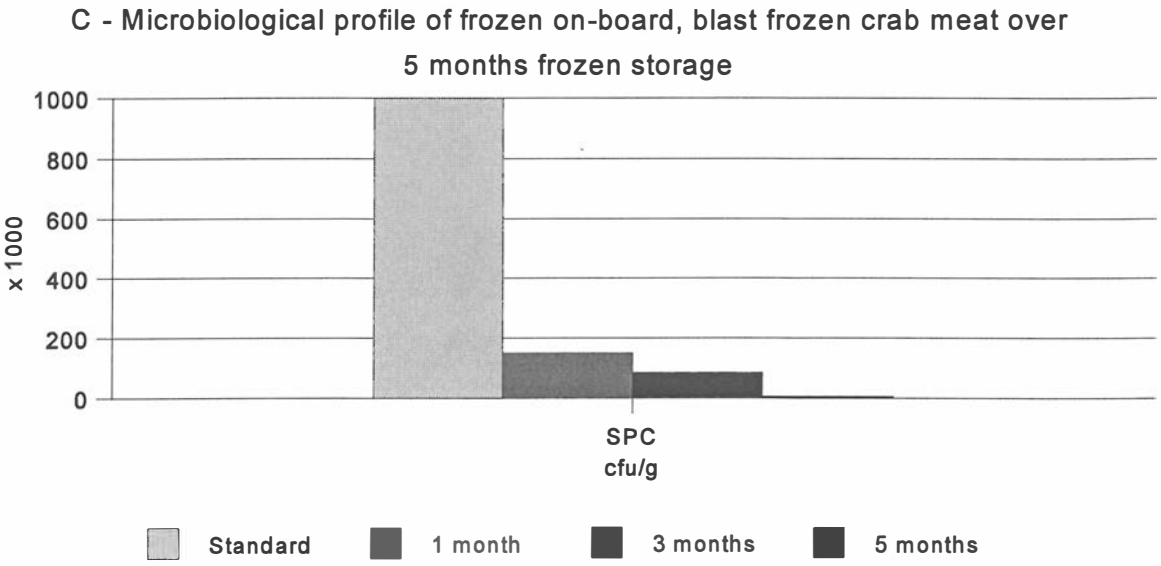
0.2
0
x 1000
Coliform
Listeria
cfu/g
Standard
1 month
3 months
5 months

Figure 8.4


C - Microbiological profile of frozen on-board, blast frozen crab meat over 5 months frozen storage
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800
600
400
200
0
x 1000
SPC
cfu/g
Standard
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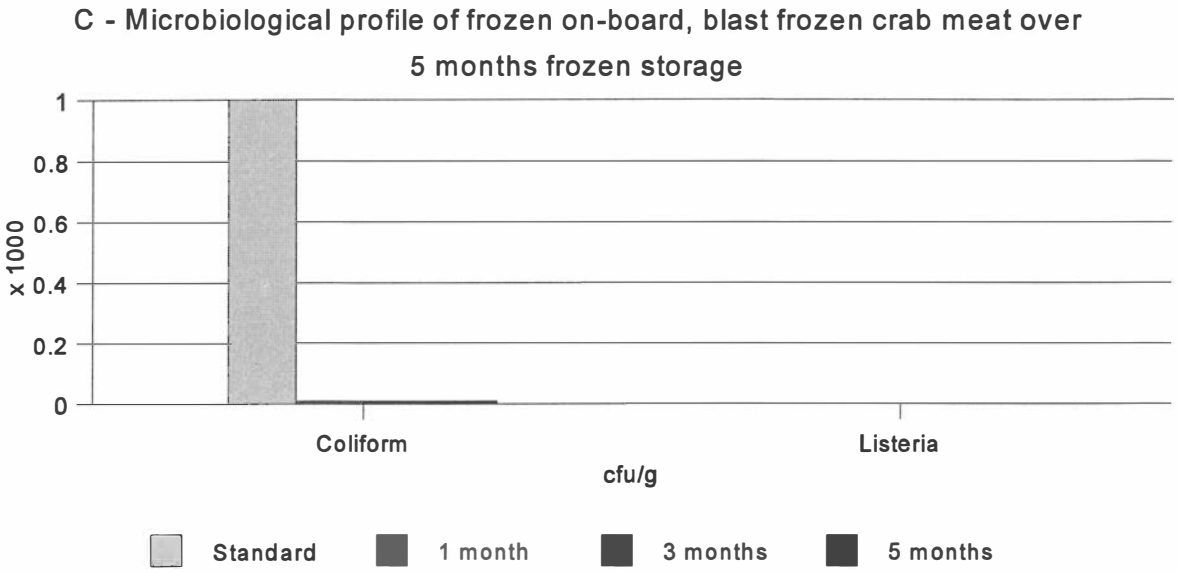
3 months
5 months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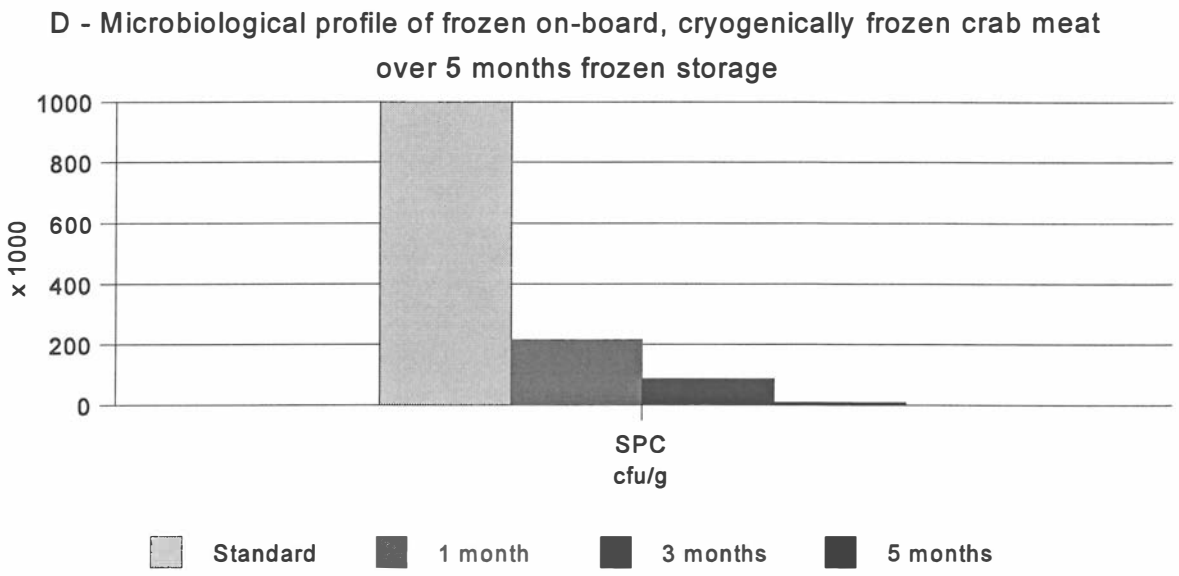
1
0.8
0.6
0.4
0.2
0
x 1000
Coliform
Listeria
cfu/g
Standard
1 month
3 months
5 months

Figure 8.5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200
0
x 1000
SPC
cfu/g
Standard
1 month
3 months
5 months

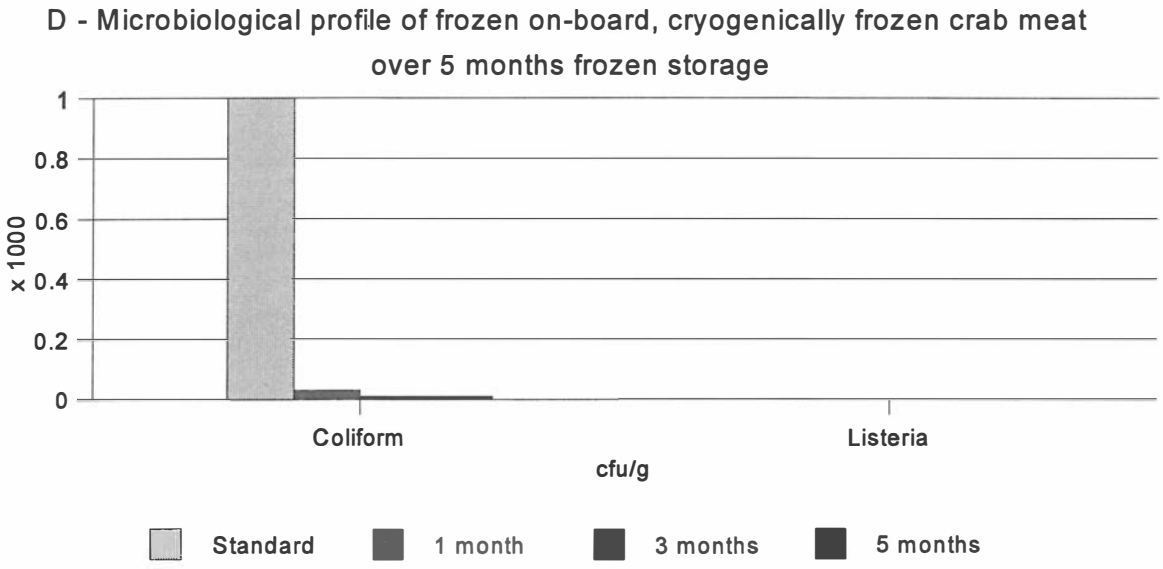
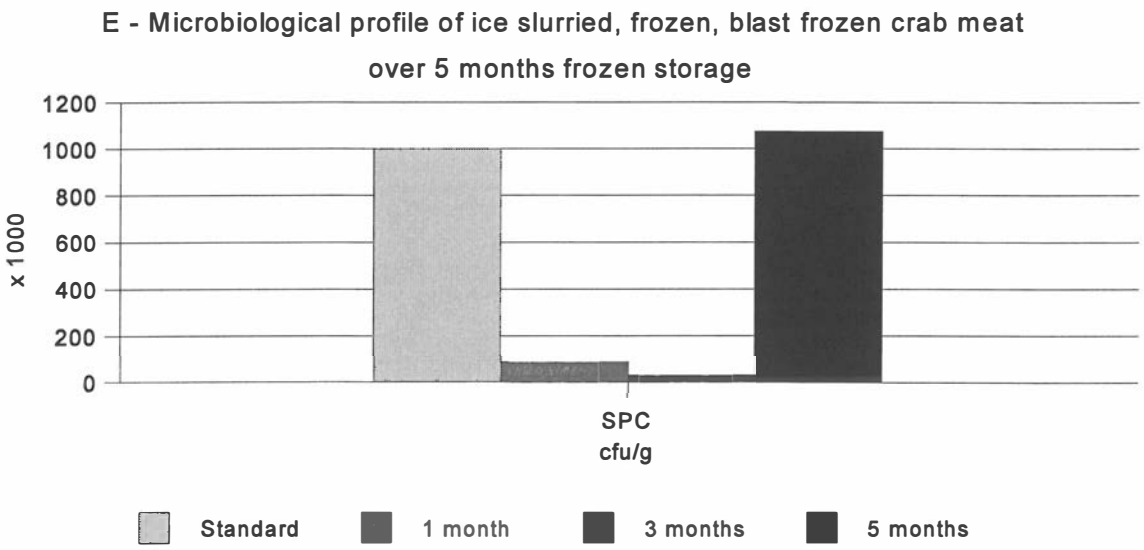

D - Microbiological profile of frozen on-board, cryogenically frozen crab meat over 5 months frozen storage
1
0.8
0.6
0.4
0.2
0
x 1000
Coliform
Listeria
cfu/g
Standard
1 month
3 months
5 months

Figure 8.6


E - Microbiological profile of ice slurried, frozen, blast frozen crab meat over 5 months frozen storage
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1000
800
600
400
200
0
x 1000
SPC
cfu/g
Standard
1 month
3 months
5 months

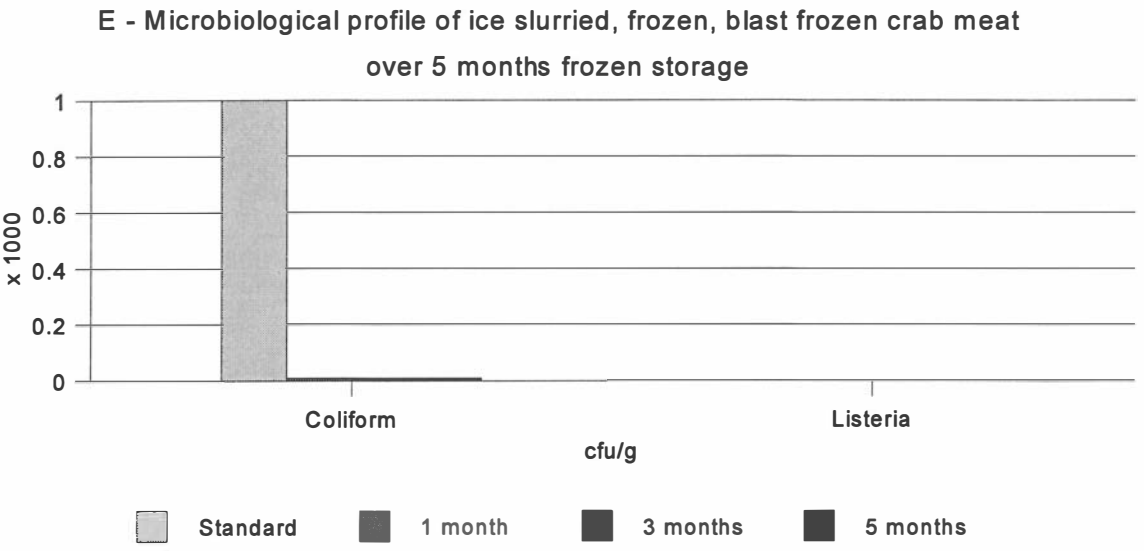
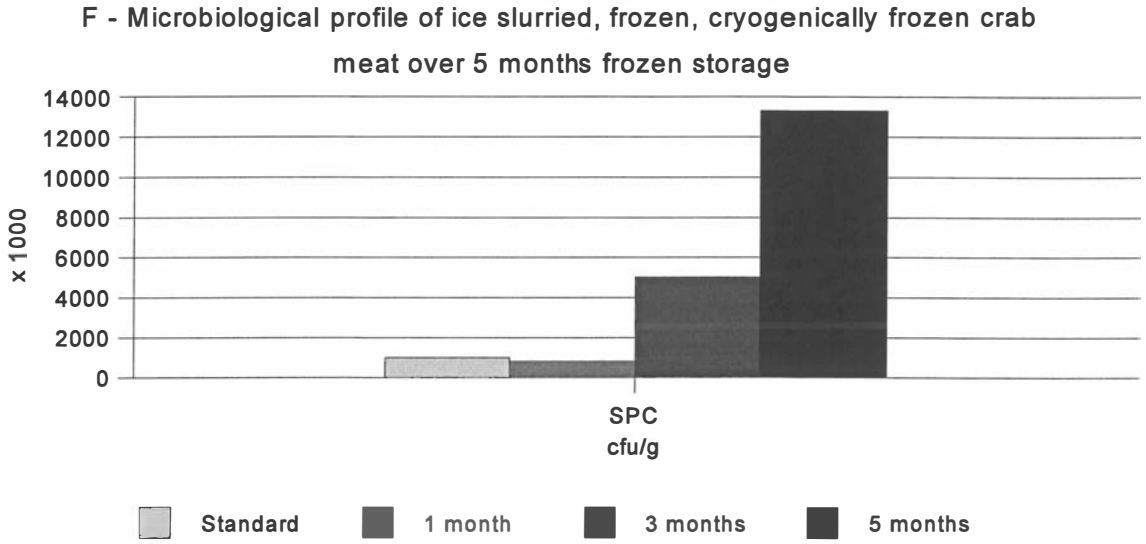

E - Microbiological profile of ice slurried, frozen, blast frozen crab meat over 5 months frozen storage
1
0.8
0.6
0.4
0.2
0
x 1000
Coliform
Listeria
cfu/g
Standard
1 month
3 months
5 months

Figure 8.7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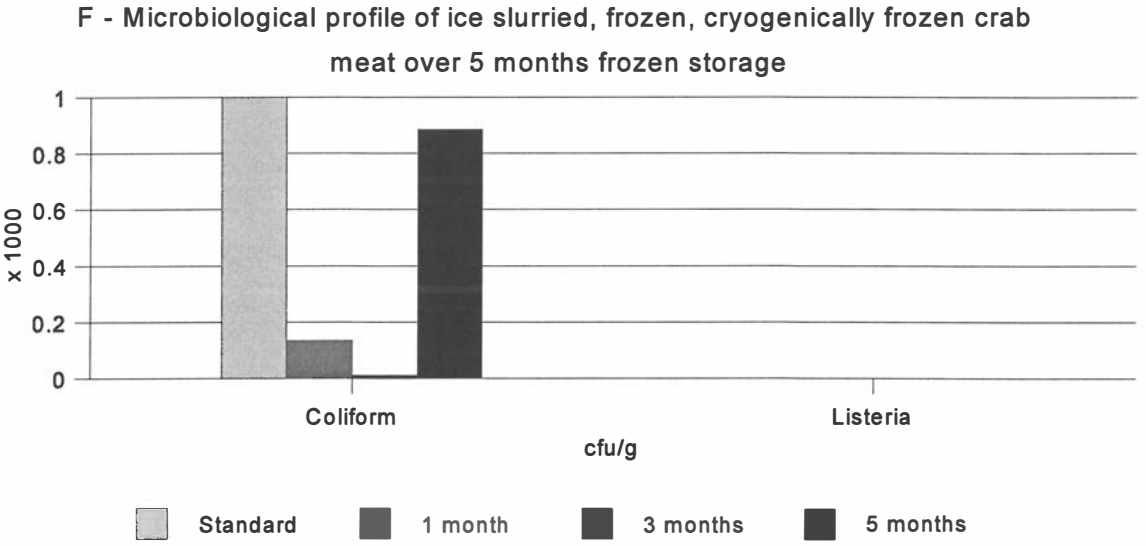
10000
8000
6000
4000
2000
0
x 1000
SPC
cfu/g
Standard
1 month
3 months
5 months


F - Microbiological profile of ice slurried, frozen, cryogenically frozen crab meat over 5 months frozen storage
1
0.8
0.6
0.4
0.2
0
x 1000
Coliform
Listeria
cfu/g
Standard
1 month
3 months
5 months

8.3.4 Focus Groups

Three (3) focus groups were carried out, each comprised of 6-10 people. The first two groups comprised consumers who were Aquaculture Science Students, the third was made up of consumers who worked in the seafood industry.

For each focus group, the crab meat was thawed overnight in a refrigerator (5°C) and steamed in a microwave oven for 2 minutes. The samples were served "hot", and each panellist was asked to taste the crab meat and answer questions regarding its characteristics (see Appendix 2 - Blank Focus Group Questionnaire). The samples were numbered and presented to the focus group in a random order to minimise any pre-conceived opinions or bias in the evaluation.

The outcome of the focus groups is summarised in Table 4.

The focus groups demonstrated consumer acceptability for the crab meat products. However, the handling and freezing of the whole crabs had an important impact on the results.

The use of an ice-slurry for the improvement in the eating quality of frozen crab meat was found to be beneficial, even though the microbial counts were significantly higher. The crabs which had been ice-slurried and frozen on-board, thawed, picked and blast frozen (Sample E), had the highest overall ratings for aroma, colour, flavour and texture, and was also expected to obtain the highest price of $27.80 per kg. The importance of ice slurrying for crabs has been previously demonstrated (Reference 4).

The samples with the highest likelihood of purchase (100%) were the fresh crabs, ex Cockburn Sound, that had been picked and cryogenically frozen. This sample was also expected to fetch a reasonable price of $26-30 per kg. These expected prices are comparable to the current market price (Sydney) for frozen crab meat, where the price is in the region of $26.50 per kg. The financial return to the processor, however, would be dependent upon the cost of extracting the meat, for example mechanised versus manual extraction.

Cryogenic freezing of crab meat is a viable option for those processors who already have such a system installed. However, the overall rating of the crab meat samples was generally lower for the cryogenically frozen samples when compared to the blast frozen samples. These results may not, therefore, warrant the purchase and installation of a cryogenic freezing system. Further work in this area is recommended as there are a number of seafood processing plants around Australia already operating with cryogenic freezing tunnels.

Table 4 - Outcomes from Focus Groups

Sample	Rating*				Purchasing %^	Price expected to pay (per kg)#	Comments~
	Aroma	Colour	Texture	Flavour			
A Fresh Blast Frozen	4.3	3.6	3.1	4.3	17	$12.75	*"Texture was soft almost a powdery texture" "Mushy" "The colour is grey/brown in colour - would prefer a white colour" ,"unattractive colour" "Strong aroma - seaweedy", "fishy" "Flavour okay"*
B Fresh Cryogenically Frozen	6.1	6.0	5.6	7.3	100	$26.30	*"Slightly pink in colour - dark in some areas of the meat" "Aroma of meat was good and fresh" "Texture was soft and smooth in some areas and in others firmer - similar to fresh crabs" "Flavour was like that of fresh crabs - good"*
C Frozen on-board/ Blast Frozen	5.2	6.3	5.8	6.1	83	$20.00	*"Aroma is just of fresh smell" "Good Colour - clear and white" "Texture is on the soft side - Mushy","watery" "Nice flavour - strong after taste, ammonia taste"*
D Frozen on-board/ Cryogenically Frozen	5.6	6.0	5.8	6.0	83	$24.60	*"Colour a little grey, and off white" "Tastes like fresh crab", "poor flavour" "Texture looked good - some parts were firm other soft" "Aroma not too fishy, salty or overpowering" "Mushy and soft"*
E Ice-slurried/ Frozen/ Blast Frozen	6.1	6.5	7.0	7.0	83	$27.80	*"Very good overall - tasted like freshly cooked crabs" "Good firm texture" "Texture is excellent" "Colour - white and translucent - good colour" "Flavour is fresh - good aftertaste" "Aroma not overpowering"*
F Ice-slurried/ Frozen/ Cryogenically Frozen	5.3	5.5	5.5	5.5	67	$23.60	*"Texture not consistent - some soft some firm" "Colour is white or close to white" "Aroma good and not too strong - delicate and fresh" "Flavour was strong - maybe a bit too strong - an advantage for cooking"*
Fresh Control	3.8	5.3	7.0	4.5	50	$23.30	*"Aroma smells a little off - very strong and ammoniac" "The colour was slightly grey/brown - prefer white flesh" "Texture was firm and looked good" "Slight after taste in the mouth" "The flavour was strong and not nice at all" "Looked better than it tasted"*

* Rating - scale of 1-10 where 1=awful and 10=fantastic
# Price per kg - average of prices
^ Purchasing - likelihood of product being purchased. Expressed as a percentage
~ Comments - summary of comments in general

9.0 BENEFITS

This project has demonstrated that the method of capture of crabs in Shark Bay in Western Australia, ie by trawl tows of less than thirty minutes duration, does not intrinsically reduce the quality of meat in crabs so caught. This is a significant shift in current attitudes to crab catching methods, in the knowledge that it is the immediate post capture handling of crabs (by any capture method) that affects their quality, particularly after prolonged storage. The beneficiaries are the participants in blue crab fisheries in Shark Bay, with interest for trawl fishermen in Exmouth Gulf, and crab fishermen in other States if they wish to adopt these results. By removing a source of relatively low value crabs from the domestic market, other crab fishermen will benefit from price stability. Further benefits are offered to producers of value-added crab products for the production of high quality crab meat.

10.0 INTELLECTUAL PROPERTY AND VALUABLE INFORMATION

No patents have been proposed for any of the work described in this report. It is hoped, however, that the results will encourage the processing of damaged crabs, in order to prevent them from entering the market and depressing the price of whole crabs. The process would also make better use of a catch that may otherwise be discarded.

The use of ice-slurrying the catch on-board, and its importance for the eating quality of frozen crab meat, has been demonstrated in this research. Further work is again recommended, to establish the effect of ice-slurrying on the microbiological quality of the crab meat.

11.0 FURTHER DEVELOPMENT

A number of issues arising from this project should be considered for future research. It is recommended that the following areas be developed to enable this research to be used effectively in a commercial sense:

1. Improvement in the on-board handling of trawl caught crabs, by the introduction and use of an ice slurry. Minor changes to on-board handling can have a dramatic effect on finished product quality.

2. Further investigation into the microbiological quality of ice-slurried crabs. The study should examine the use of seawater versus freshwater ice slurrying.

3. The development of a suitable crab meat extraction machine that will produce a high quality meat product. Research should include an investigation into the cleaning and sanitation of the machine, to minimise microbial contamination.

4. The development of value added crab meat products such as salads, soups etc to increase the market penetration of locally caught crabs. The importance of hygienic handling practices should be emphasised and demonstrated.

5. Further investigation into the viability of using cryogenic freezing methods for seafood.

12.0 STAFF

- Mrs Cheryl Hughes (Principal Investigator)
- Mr Richard Stevens (Co-Investigator)
- Miss Judy Tam (Laboratory Analyst)

13.0 REFERENCES

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4. Queensland Department of Primary Industries. FIRTA Project 85/29. Investigation of mushiness in crabs. **October 1987.**

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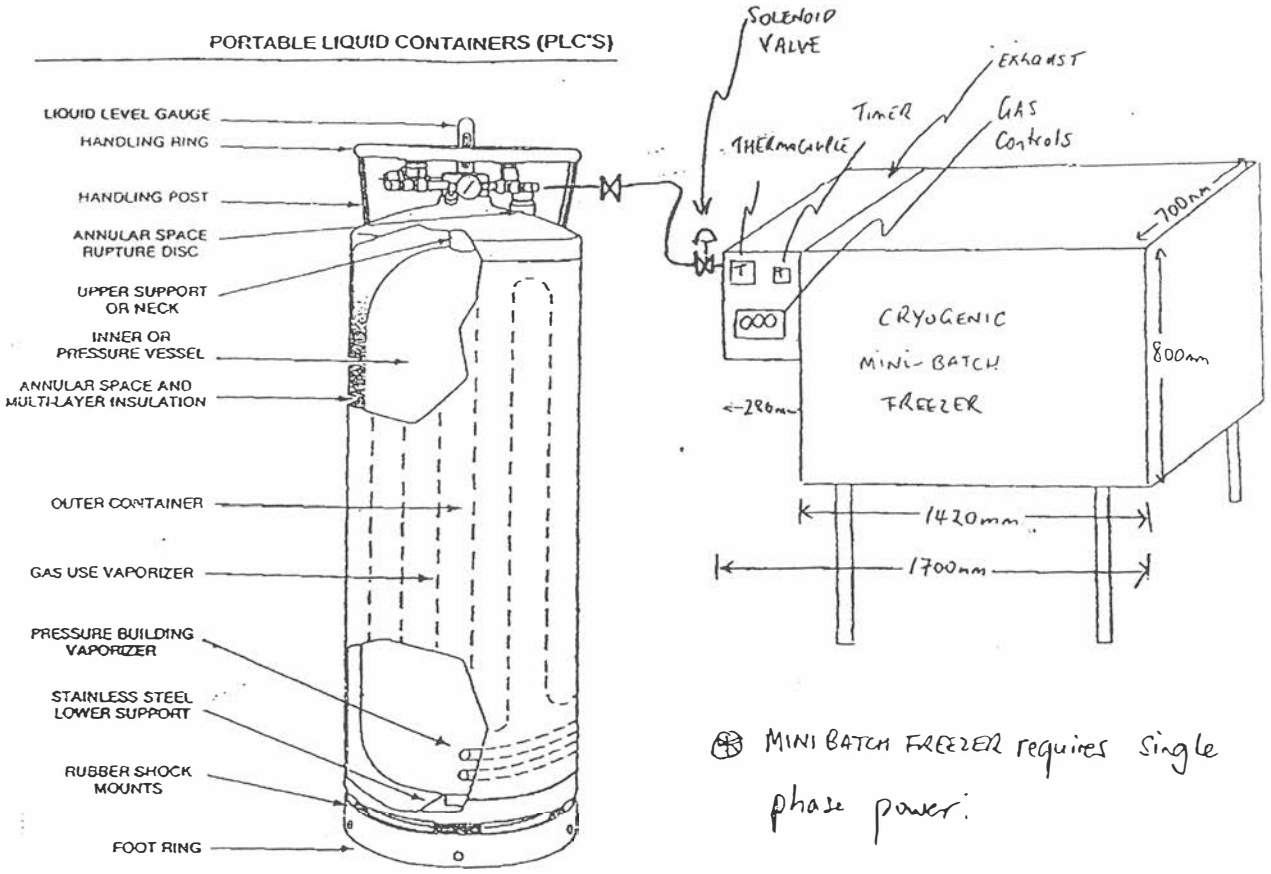
Appendix 1

SCHEMATIC DIAGRAM OF A BATCH CRYOGENIC FREEZER

TRIAL EQUIPMENT



⊛ MINI BATCH FREEZER requires single phase power.

PLC ; HEIGHT = 1·6 m , ⌀ ≈ 500mm

NB; NOT TO SCALE

APPENDIX 2 - Blank Focus Group Questionnaire

FOCUS GROUPS - SEAFOOD

Seafood Sample Code Number: _____

Please rate the sample on a scale of 1-10 for each product attributes, where 1 means that you thought it was awful and 10 means that you thought it was fantastic.

1. Aroma _____
2. Colour _____
3. Texture _____
4. Flavour _____

Comments:

_____

_____

_____

_____

_____

Would you purchase this product? YES/NO

How much would you expect to pay? Price per kg _____

If you would not purchase this product, please give a reason why.

_____

_____

_____

Thank you

Appendix 3

INDUSTRY GUIDE

THE FOOD CENTRE
of Western Australia (Inc)

INDUSTRY GUIDE

HOW TO PRODUCE CRAB MEAT FOR FOODSERVICE AND RETAIL PACKS

THE FOOD CENTRE
of Western Australia (Inc)

WAFIC

FISHERIES
RESEARCH &
DEVELOPMENT
CORPORATION

ACKNOWLEDGMENTS

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This guide was developed following an NSC funded project No. 92/125.34, "The Improvement in the Quality of Meat from Frozen Trawl Caught Blue Crabs", with the assistance of the following organisations:

- Riccardi Seafoods
- Dorre Island Fishing Company
- BOC Gases
- Western Australian Fishing Industry Council

TABLE OF CONTENTS

FOREWORD

This guide has been designed to assist fishermen and seafood processors to produce frozen crab meat products using Good Manufacturing Practices and Safe Food Handling techniques.

Throughout the guide, reference will be made to the HACCP (Hazard Analysis Critical Control Point) system to enable processors to develop and implement their own HACCP plans for the safe production of crab meat products.

CAUTION

This guide is purely ADVISORY and should not be confused with a complete HACCP plan. The information contained in this document complements the WA Health (Food Hygiene) Regulations 1993, the proposed ANZFA National Food Hygiene Regulations, the Food Standards Code and the Codex HACCP Guidelines.

The information given is not necessarily exhaustive or comprehensive. Every processing operation and every factory will have its own characteristics, which may give rise to additional process steps and/or hazards. These should be included alongside the suggestions in this guide.

The Food Centre of Western Australia (Inc) has taken every possible care in compiling, preparing and presenting the information in this 'Industry Guide', but can accept no liability in connection with it.

BACKGROUND

The export and domestic markets for whole Blue Crabs, have increased steadily since 1992 (WAFIC), a direct reflection of the increase in volume of crabs being caught from around the coast of Western Australia.

Most crabs are currently being caught from the Swan River (nets), Cockburn Sound (pots) and Shark Bay (trawled). The number of trawl caught crabs has uncovered a need for improvement in on-board handling techniques, and the resultant improvement in the quality of meat obtained from these crabs. These improvements are the subject of this industry guide.

This guide will outline the appropriate methodology for the on-board handling and processing of Blue Crabs. Recommendations for processing equipment, packaging and presentation of the crab meat, as well as an ideal finished product specification are included. Specific areas where hazards could be introduced are highlighted, to enable an effective HACCP plan to be developed that will consider safety as well as quality hazards.

An industry guide to the correct handling of crabs on-board trawlers has also been developed, and is included in Appendix 1. It is hoped that this guide will be of use to fishermen, by taking it on-board vessels as a reminder of the correct handling procedure for trawl caught crabs.

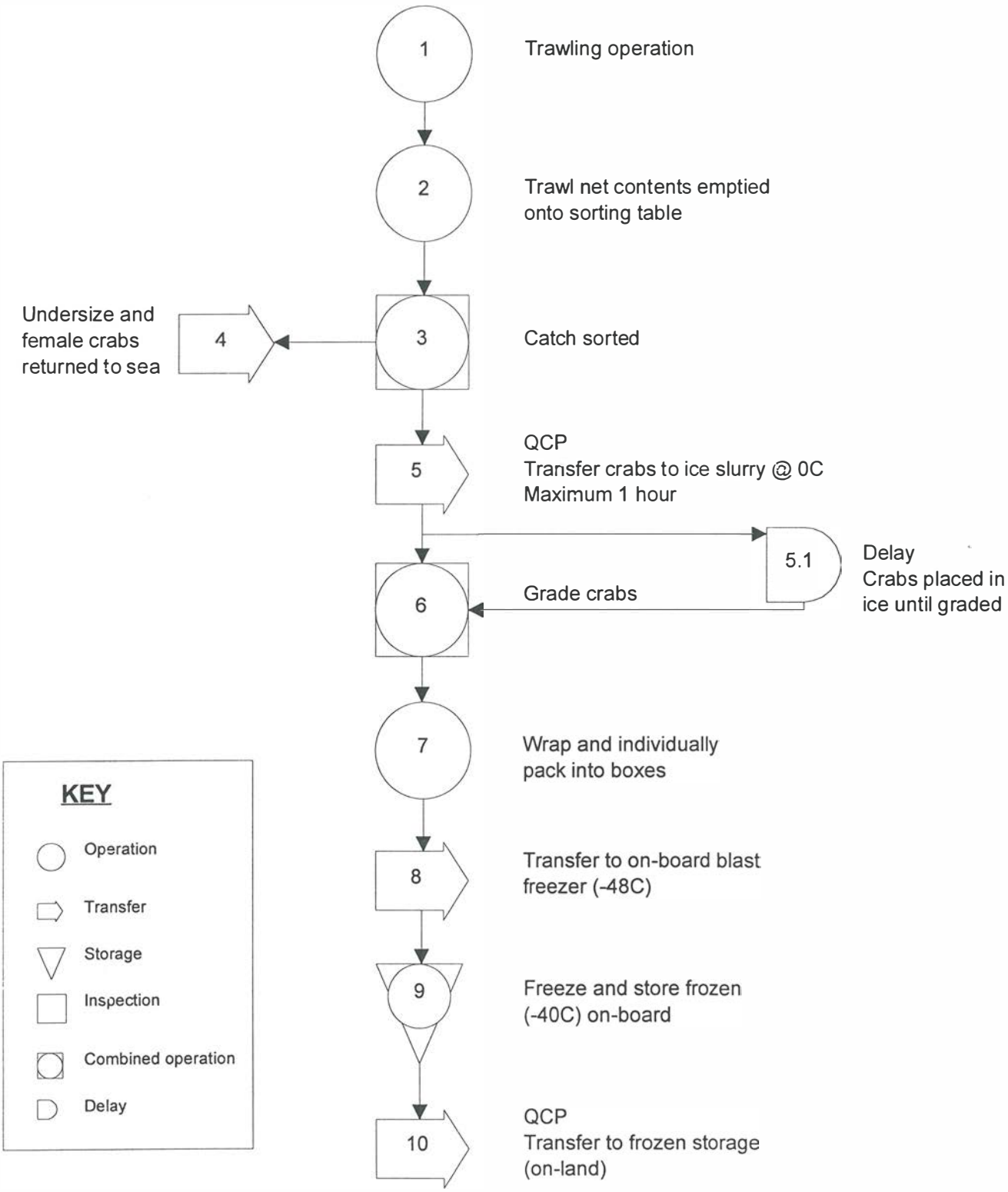
EXAMPLE PRODUCT SPECIFICATION

Product Description	Frozen Raw Crab Meat
Ingredients	Crab Meat
Method of Production	Hand picked/ machine picked meat. Vacuum packed and frozen
Microbial criteria	Standard Plate Count < 1,000,000 cfu/g Coliforms < 1000 cfu/g *Listeria monocytogenes* minimise
Chemical criteria	Not to exceed MRLs (Standard A14 of the ANZFA Food Standards Code)
Physical criteria	Free of all foreign objects
Permissible defects	< 1% shell fragments
Packaging	Vacuum packed in semi permeable vacuum bags or on polystyrene trays using a semi permeable vacuum film
Labelling	KEEP FROZEN (below -18°C) Thaw in refrigerator (5°C) Raw product, cook before use, use within 1 day of thawing
Storage	Frozen, below -18°C
Transport	Frozen, below -18°C
Shelf life	3 months frozen storage (-18°C)
Customer preparation	Thaw and cook before use

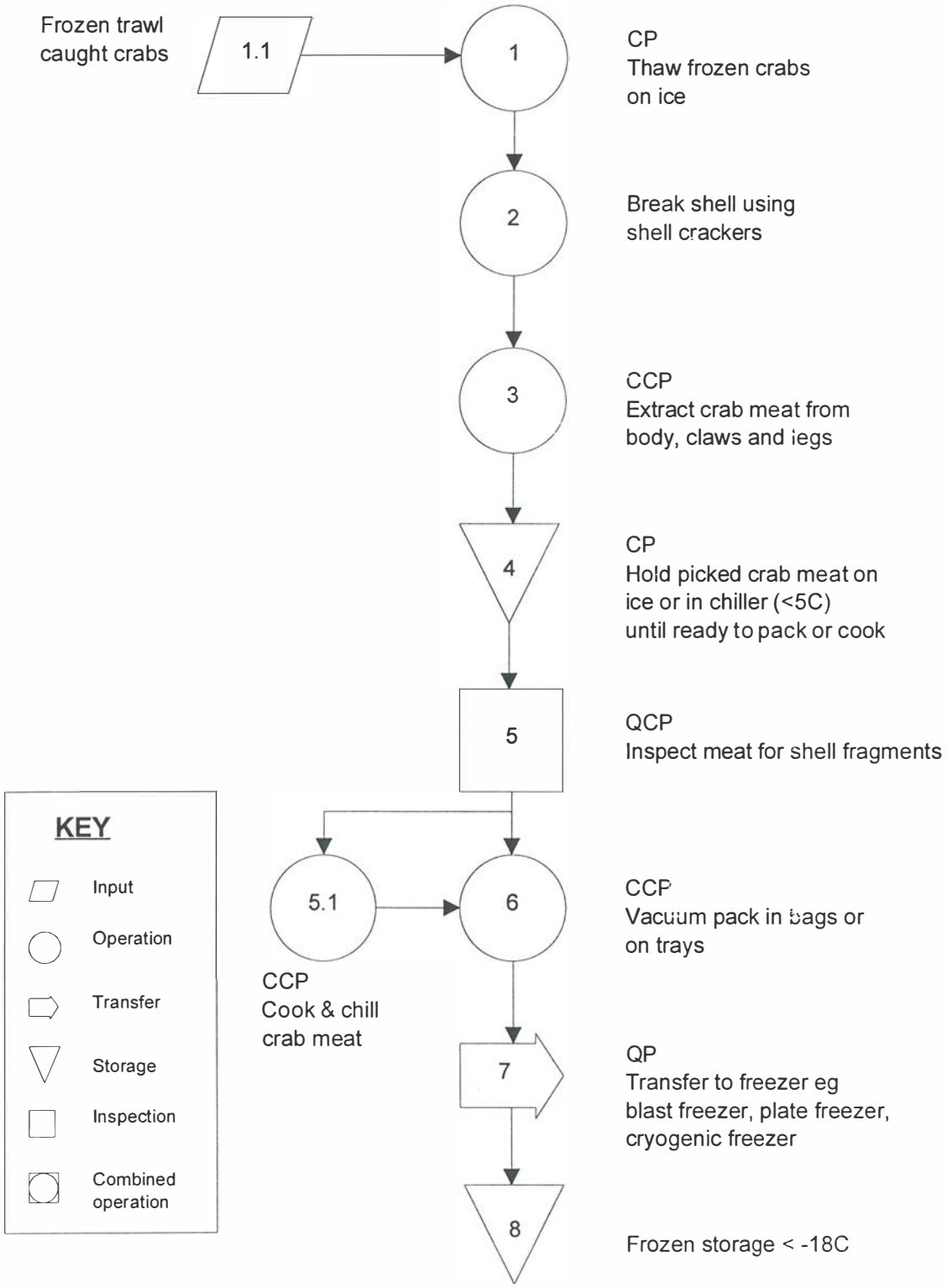
EXAMPLE PRODUCT SPECIFICATION

Product Description	Frozen Cooked Crab Meat
Ingredients	Crab Meat
Method of Production	Hand picked/ machine picked cooked, chilled, vacuum packed and frozen
Microbial criteria **Adopted from Standard S2 of the ANZFA Food Standards Code**	Standard Plate Count < 100,000 cfu/g *Escherichia coli* < 9 *Escherichia coli*/g *Listeria monocytogenes* absent in 25g *Salmonella* absent in 25g coagulase-positive staphylococci < 500 cfu/g
Chemical criteria	Not to exceed MRLs (Standard A14 of the ANZFA Food Standards Code)
Physical criteria	Free of all foreign objects
Permissible defects	< 1% shell fragments
Packaging	Vacuum packed in semi permeable vacuum bags on polystyrene trays using a semi permeable vacuum film
Labelling	KEEP FROZEN (below -18°C) Thaw in refrigerator (5°C),use within 1 day of thawing. Defrost thoroughly before use
Storage	Frozen, below -18°C
Transport	Frozen, below -18°C
Shelf life	3 months frozen storage (-18°C)
Customer preparation	Thaw in a refrigerator and eat within 1 day of thawing

FLOW CHART 1: HARVESTING OF BLUE CRABS



FLOW CHART 2: PROCESSING OF CRAB MEAT



INTRODUCTION TO HACCP

The Hazard Analysis Critical Control Point (HACCP) system, is a disciplined approach to Food Safety that is focused on identifying and preventing problems before they occur, rather than rectifying them afterwards.

HACCP relies upon a systematic analysis of the potential food safety hazards introduced into the crab meat from all sources.

Hazards may include microbiological, chemical, or physical hazards. Sources of these hazards vary, but include the raw crab meat, the processing equipment, the staff involved, the processing procedures, handling procedures (particularly of cooked crab meat), storage conditions, and many others.

Microbes, or bacteria, are inherent hazards in all food processing operations that can cause food poisoning, and in the worst case, death.

HACCP is used to:

- Identify all hazards to consumer safety and product quality that could be introduced from all sources.
- Develop Systems and Control Procedures to eliminate those hazards or reduce their risk.
- Set limits for the process, specifically those which are critical for food safety or quality.
- Monitor the process to ensure that food safety is being controlled.
- Review the impact of any changes to the process.

There are 7 HACCP Principles that enable a processor to develop a HACCP plan. These are:

1. Conduct a hazard analysis
2. Determine if the step is a Critical Control Point (CCP)
3. Set Critical Limits for each CCP
4. Develop monitoring procedures for CCP's to ensure that the process is under control
5. Develop Corrective Action Procedures when monitoring indicates there is a problem
6. Verify that the system is working
7. Develop documentation

(Adapted from Codex HACCP Guidelines)

If these principles of HACCP are followed, the HACCP Plan will provide a guide to the process and enable the user to identify the hazards associated with each step, and how those hazards are controlled. The following information is a guide to the typical types of hazard associated with whole crabs, as well as crab meat.

TYPICAL HAZARDS ASSOCIATED WITH WHOLE CRABS & CRAB MEAT

GREEN CRABS

The majority of potential and actual hazards associated with green crabs are those which significantly impact the quality of the crab meat. These hazards are included in the following table.

HAZARD	CAUSE	CONTROL MEASURES
Quality - Poor meat texture, mushiness	Proteolytic enzymes from the hepatopancreas of the crab	Ice slurry catch. Process as quickly as possible.
Quality - strong aftertaste and aroma	Crabs left on deck in the sun or in a warm environment. Ammonium compounds produced as a by-product of protein breakdown.	Ice slurry catch and chill/freeze as soon as possible. Keep crabs at 5°C or below
Microbial - Microbial Growth (leading to a short shelf life)	Crabs left on deck, allowing microbial numbers to increase	Ice Slurry and chill catch as soon as possible (5°C or below)
Microbial - Microbial Growth	Temperature abuse	Minimise delays between meat extraction and chilling/freezing.
Physical - Foreign object contamination	Jewellery, hair, personal effects etc from staff during crab processing	Uniforms, hairnets and no jewellery policy for staff
Physical - Mouth injury to consumer	Shell fragments still remaining in the crab meat	Pass meat over a UV light table to enable visible shell fragments to be removed

COOKED CRABS

Cooked whole crabs, or crab meat, tend to have a larger number of potential and actual hazards associated with them. The reason for this, is the assumption that a pre-cooked product is unlikely to be reheated or will be cooked further by the consumer. Cooked crab meat should therefore be treated as a "high risk", "ready to eat" (RTE) product. The microbiological specification for cooked crab meat is therefore stringent, and is prescribed in the ANZFA Food Standards Code (Standard S2 and D1).

HAZARD	CAUSE	CONTROL MEASURES
Microbial - Pathogens	Inadequate cooking temperature or cross contamination after crab meat has been cooked or whole cooked crabs are picked	Ensure crab meat is cooked to correct temperature and time parameters. Good personal hygiene of all staff. Minimise handling of cooked crab meat.
Microbial - growth	Ineffective chilling process. Temperature abuse	Rapidly chill cooked crab meat to below 5°C Minimise delays. Store cooked crab meat at 5°C or below
Microbial - Pathogens *Clostridium botulinum*	Survival and growth of *Cl. botulinum* due to anaerobic packaging conditions	Use semi-permeable vacuum film. Seek advice from packaging supplier and/or microbiologist
Physical - Foreign object contamination	Jewellery, hair, personal effects etc from staff during crab processing	Uniforms, hairnets and no jewellery policy for staff
Physical - mouth injury to consumer	Shell fragments still remaining in the crab meat	Pass meat over a UV light table before cooking and/or visually inspect cooked meat for shell
Quality - tough chewy meat	Overcooking	Follow appropriate cooking time and temperatures
Quality - Watery or mushy texture	Temperature abuse, inadequate freezing process or product allowed to partially thaw and then refrozen	Correct handling and frozen storage at -18°C or below

MODEL HACCP AUDIT TABLES

Model HACCP Audit Tables for the Harvesting of Blue Crabs and the Processing of Crab Meat are outlined on the following pages.

These tables have been produced to indicate the particular controls, critical limits, monitoring activities and corrective action, that must be established for those steps in the process that have been identified as Critical Control Points (CCP's) or Quality Critical Points (QCP's). For each of these steps, records must be kept and maintained to demonstrate that the hazards, whether actual or potential, are indeed under control during the process.

It is recommended that any processor who intends producing green or cooked crab meat packs, should develop and implement a complete HACCP plan. This will include not only some of the information contained in this Industry Guide, but a full hazard analysis and HACCP Audit Table for each step in the process, as well as a Verification Schedule. For more information regarding HACCP and its application, references for further reading have been included at the end if this guide.

NOTE: Every HACCP plan will be different from that at another location. For example, the HACCP plan will reflect the differences between production methods, plant layout, the nature and design of the products themselves, the skills of the staff, etc.

AUDIT TABLES

MODEL HACCP AUDIT TABLE FOR THE HARVESTING OF BLUE CRABS

STEP	HAZARD	CONTROL MEASURE	CONTROL POINTS *	CRITICAL LIMIT	MONITORING	CORRECTIVE ACTION	RECORDS
5. Transfer crabs to ice slurry	**Quality:** Deterioration. Poor meat texture, mushiness.	Ice slurry catch. Process as quickly as possible.	QCP	Time limits to be set by each processor (see "CL1" below).	**Visual checking on sorting deck that catch is ice slurried**. Monitoring by leading deck hand after each shot has been sorted.	Crabs that have not been ice slurried should be assessed by leading deck hand. Those crabs that have significantly deteriorated, or that have been left on the deck unchilled should also be assessed. Options include cooking on board, freezing immediately or reject.	Label cartons and record details as directed by processor.
	Quality: Deterioration. Strong aftertaste and aroma.	Ice slurry catch as soon as possible.	QCP	Minimise delays - time limits to be set by each processor (see "CL1" below).	**Visual and aroma checks on sorting deck for deterioration of crabs.** Monitoring by leading deck hand whenever crabs are left on deck unchilled.		
	Microbial: Growth	Ice slurry/chill/freeze catch as soon as possible.	CP	(see "CL1" below)			

"CL1" - The time limit that the crabs are left in the ice slurry will be dependent upon the available time between trawl shots. In any case the crabs left in the ice slurry should regularly have the ice replenished. It should also be noted that bacterial numbers can increase on unchilled products, therefore it is important to minimise delays.

* "CONTROL POINTS" - CCP =Critical Control Point, QCP =Quality Control Point, CP =Control Point

NOTE: The steps numbered in the Model HACCP Audit Tables refer to the flowcharts on pages 5 and 6.

MODEL HACCP AUDIT TABLE FOR THE HARVESTING OF BLUE CRABS

STEP	HAZARD	CONTROL MEASURE	CONTROL POINTS *	CRITICAL LIMIT	MONITORING	CORRECTIVE ACTION	RECORDS
10. Transfer to frozen storage on land.	**Quality:** Damage to frozen crabs.	Minimise opportunities whereby frozen cartons can be dropped/damaged.	QCP	No dropped cartons.	**Visual observation at jetty of transfer of cartons**. Monitoring by leading deck hand or frozen storage manager on arrival of trawler.	Advise customer that cartons have been dropped.	Frozen storage inventory log.
	Quality: Deterioration.	Transfer to frozen store as soon as possible to prevent thawing.	QP	No long term delays.	**Visual checks (or by thermometer) of frozen conditions of delivery of external cartons or middle of carton contents**. Monitoring by storage manager upon arrival at frozen storage facility.	Advise storage facility if there has been a delay. Place in deep freeze as soon as possible. **OR** Continue to thaw crabs and process/cook as soon as possible.	

* "CONTROL POINTS" - CCP =Critical Control Point, QCP =Quality Control Point, CP =Control Point

MODEL HACCP AUDIT TABLE FOR THE PROCESSING OF CRAB MEAT

STEP	HAZARD	CONTROL MEASURE	CONTROL POINTS *	CRITICAL LIMIT	MONITORING	CORRECTIVE ACTION	RECORDS
1. Thaw frozen crabs on ice.	**Microbial:** Growth of dangerous microbes.	Maintain product temperature during thawing below 10°C.	CP	Keep temperature of crabs below 10°C.	**Observation of internal temperature of crabs by using thermometer in processing room.** Monitoring by supervisor for each batch.	Place product on hold, supervisor to assess further use of crabs.	Daily production records.
3. Extract meat.	**Microbial:** Growth of dangerous microbes and spoilage microbes.	Maintain product temperature below 10°C at all times.	CCP	Keep meat below 10°C.	**Observation of crab meat temperature by using thermometer in processing room.** Monitoring by supervisor every hour.	Place product on hold, advise supervisor to assess its usage.	

* "CONTROL POINTS" - CCP =Critical Control Point, QCP =Quality Control Point, CP =Control Point

MODEL HACCP AUDIT TABLE FOR THE PROCESSING OF CRAB MEAT

STEP	HAZARD	CONTROL MEASURE	CONTROL POINTS *	CRITICAL LIMIT	MONITORING	CORRECTIVE ACTION	RECORDS
4. Hand picked crab meat <5°C.	**Microbial:** Growth.	Store in chiller <5°C and use as soon as possible.	CP	Chiller temperature <5°C.	**Observation of chiller temperature by visual check of external chiller temperature gauge**. Monitoring by supervisor at start and end of every day.	If temperature gauge above 5°C check temperature of crab meat. If crab meat below 5°C move to chiller running below 5°C. If above 5°C supervisor or manager must assess.	Daily production records.
5. Inspect meat for shell fragments.	**Physical:** Injury to consumers mouth.	Pass green crab meat over UV light table.	QCP	<1% or minimise shell fragments.	**Observation of crab meat by visual checks at UV light table**. Monitoring of all batches by production staff.	Reinspect, cook product and visually inspect for shell fragments that have changed colour.	

* "CONTROL POINTS" - CCP =Critical Control Point, QCP =Quality Control Point, CP =Control Point

MODEL HACCP AUDIT TABLE FOR THE PROCESSING OF CRAB MEAT

STEP	HAZARD	CONTROL MEASURE	CONTROL POINTS *	CRITICAL LIMIT	MONITORING	CORRECTIVE ACTION	RECORDS
5.1 Cook and chill crab meat.	**Microbial:** Survival of dangerous microbes.	Ensure appropriate cooking temperatures and timer are used.	CCP	To be set by processor to eliminate possibility of dangerous microbe survival (see "CL2" below).	**Observation of temperature of cooked meat by using thermometer at steamer/cooker.** Monitoring of each batch by production staff.	If target cooking temperature not reached, keep cooking until temperature and time parameters have been met.	Daily production records.
		Rapid cooling of cooked crab meat to 5°C or below.	CCP	Minimise delays. Cool to 5°C or below. (Length of time for cooling to be set by processor)	**Observation of temperature of cooked meat by using thermometer in chiller**. Monitoring by production staff every half hour.	Advise supervisor to assess product.	
	Microbial: Contamination.	Cover and separate cooked product from raw product. GMP	CCP	All cooked product must be covered and stored separately from raw product.	**Observation of cooked product segregation by visual checks in chiller**. Monitoring by supervisor on daily basis.	If raw and cooked product are found in the same chiller, supervisor to be advised and must assess product safety.	
		Good personal hygiene of staff. Good handling technique. Minimise handling of cooked meat.	CP	All staff to wear clean disposable gloves.			

"CL2" - The cooking temperature and time parameters set by the processor, must be based on the elimination of dangerous microbes, to ensure that none can survive the cooking process.

* "CONTROL POINTS" - CCP =Critical Control Point, QCP =Quality Control Point, CP =Control Point

MODEL HACCP AUDIT TABLE FOR THE PROCESSING OF CRAB MEAT

STEP	HAZARD	CONTROL MEASURE	CONTROL POINTS *	CRITICAL LIMIT	MONITORING	CORRECTIVE ACTION	RECORDS
6. Vacuum pack product.	**Physical:** Foreign object contamination.	Staff uniforms, hairnets, gloves. No jewellery policy.	CP				
	Microbial: Survival and growth of *Clostridium botulinum*.	Ensure that only semi-permeable films/bag used. Good handling technique.	CCP	Semi-permeable bags/film used (see "CL3" below).	**Visual checks of packaging film in store**. Monitoring by storeman on delivery of packaging film.	Reject non-conforming packaging and return to supplier. Advise manager.	Stock inventory /receival log.

"CL3" - With any seafood product there is a likelihood that the dangerous microbe *Clostridium botulinum* may be present. As the microbe does not require air to grow it is important to ensure that all packaging materials do not completely exclude air. For this reason packaging materials and films that are semi-permeable to air must be used.

* "CONTROL POINTS" - CCP =Critical Control Point, QCP =Quality Control Point, CP =Control Point

MODEL HACCP AUDIT TABLE FOR THE PROCESSING OF CRAB MEAT

STEP	HAZARD	CONTROL MEASURE	CONTROL POINTS *	CRITICAL LIMIT	MONITORING	CORRECTIVE ACTION	RECORDS
7. Transfer to freezer.	**Quality:** Temperature abuse.	Transfer crab meat to freezer and freeze as soon as possible.	QP	Minimise time delays between packaging and freezing.			Daily production record.

* "CONTROL POINTS" - CCP =Critical Control Point, QCP =Quality Control Point, CP =Control Point

ABBREVIATIONS AND GLOSSARY OF TERMS:

ANZFA	Australia New Zealand Food Authority The organisation operating under the Federal Department of Health that is responsible for Australian and New Zealand Food Standards.
ANZFA Food Standards Code	The composition and labelling of food is regulated by the Food Standards Code. The Food Standards Code ensures Australia has nationally consistent food laws, although each State and Territory is responsible for ensuring food law.
CCP	Critical Control Point A point, step or procedure at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level. Loss of control may lead to a food safety problem.
cfu	Colony forming unit
Clostridium botulinum	A bacteria capable of causing severe food poisoning including death. Ubiquitous to soil and waters.
Coagulase positive *staphylococci*	A bacteria capable of causing food poisoning. Commonly associated with skin and nasal passages of humans, animals and birds.
Codex	The Codex Alimentarius Commission is a committee of the Food and Agriculture Organisation and World Health Organisation of the United Nations. Their work includes the setting of International Standards in food.
coliforms	They are a group of organisms that commonly inhabit the gut of man and other animals. They include pathogenic strains of *E.coli* and are therefore used as an indicator of contamination in food.
Corrective Action	The actions to be taken when the results of monitoring the critical control point indicates a loss of control. Steps should be taken to correct a process and bring it and the product back under control.
CP	Control Point A point, process or operation that must be controlled to prevent the identified hazard.
Critical Limit	A value which separates acceptability from unacceptability. The tolerance limit that must not be exceeded to ensure that the food is produced safely.

Escherichia coli	A bacteria capable of causing severe food poisoning, even death. A major source is the faeces of infected humans and animals.
GMP	Good Manufacturing Practices This is a general term, covering all actions necessary to ensure safe, clean and wholesome products are produced. These actions include Personal Hygiene, Hygienic Processing, Cleaning & Sanitation and Pest Control.
HACCP	Hazard Analysis Critical Control Point A system which identifies, evaluates and controls hazards which are significant for food safety.
HACCP Audit Table	The plan that lists in one table all the process steps, the control measures, critical limits, monitoring and corrective actions.
HACCP Plan	A document prepared in accordance with the principles of HACCP, to ensure control of hazards which are significant for food safety in the segment of the food chain under consideration. It includes the HACCP audit table, flowcharts, raw materials and product specifications and other supporting information. *(Codex)*
Hazard	A biological, chemical or physical agent in, or property of, food with the potential to cause an adverse health effect. *(Codex)*
Listeria monocytogenes	A bacterium capable of causing severe food poisoning including death in some cases. Widely distributed in nature, particularly soil, vegetation and water.
MRL	The Maximum Residue Limit for pesticides, chemicals etc. This level is the maximum content a food is permitted to contain if it is to be used for human consumption.
Pathogen	A bacteria or microbe that can cause disease or food poisoning.
QP	Quality Point
QCP	Quality Critical Point A point, step or procedure that is critical to the quality of the finished product.
SPC	Standard Plate Count

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THE FOOD CENTRE
of Western Australia (Inc)

Appendix 1

ON-BOARD HANDLING OF CRABS

A Guide for Fishermen

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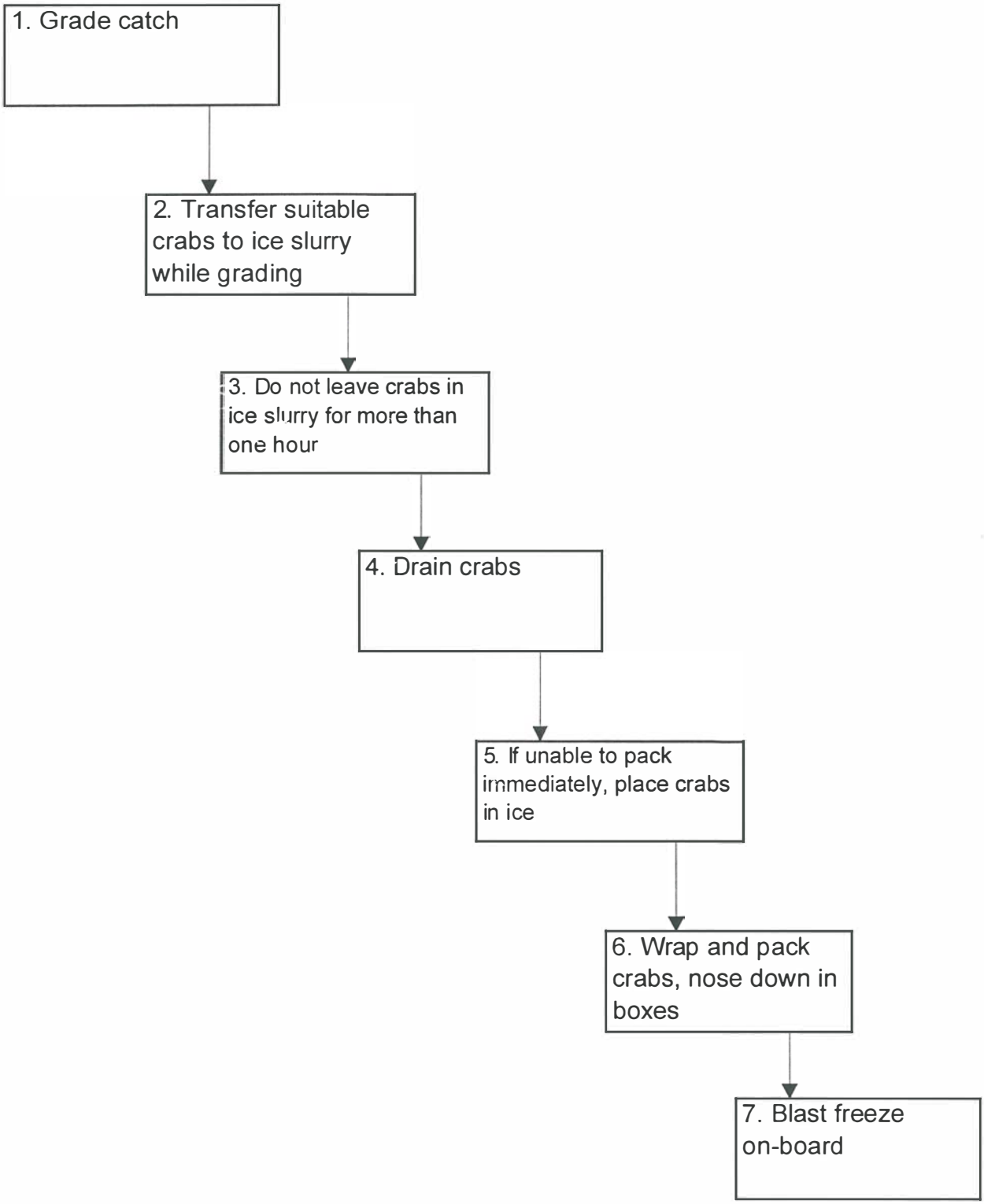

APPENDIX 2 - APPROPRIATE PROCESSING EQUIPMENT AND SERVICES

The following is a list of equipment that may typically be used to produce the crab meat packs. Details of suppliers or contacts have been given where appropriate.

Vacuum Packing Machine Packaging Trays UV Light Box	MBL Ltd 8-10 Asquith Street VICTORIA PARK WA 6100 Ph: 08 9364 3321
Cryogenic Freezer Gas Mix	BOC Gases 509 Hay Street SUBIACO WA 6008 Ph: 08 9273 6798
Vacuum Bags & Films	WR Grace Australia Limited 13 Glassford Road KEWDALE WA 6105 Ph: 08 9353 3433