

IMPROVING POST HARVEST HANDLING TO ADD VALUE TO FARMED MUSSELS

Report Prepared By

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IMPROVING POST HARVEST HANDLING TO ADD VALUE TO FARMED MUSSELS

**FRDC Project 2002/418
Funded by Seafood Services Australia and Australian mussels farmers**

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Disclaimer

This report has been prepared by the author for Seafood Services Australia.

It is based on primary research and information gathered by the writer from published works and personal interviews.

I believe the report to be accurate but it contains some evaluation of future events and accept no responsibility for the information herein, so readers should make their own enquiries to satisfy themselves on all matters.

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NON TECHNICAL SUMMARY

The post harvest handling of farmed blue mussels, from the sea farm through to the retail store and restaurant was examined in 2003 in a national study funded by Seafood Services Australia and the Australian mussel farming industry.

The Objectives of the study were to:(a) Identify the key quality and marketing parameters for chilled mussels and prepare product specifications for “premium” and “standard” mussels (b) Develop a Code Of Practice which takes account of product labelling, uniform size grading, shell fouling and cleanliness, condition index and any mandatory food safety requirements for the guidance of all industry sectors and (c) prepare a product Trade Users Guide for wholesalers, retailers and restaurateurs.

The project was designed to reduce the volume of poor quality mussels going to market and thereby help raise overall prices for producers and to reduce the wastage experienced by the industry and consumers with poor quality mussels.

Desk research was also carried out to explore the basis of the advice commonly given by cookery writers to discard mussels which do not open after cooking. This warning has led to the waste of many mussels and generated much confusion amongst many trade users and consumers. Cooking tests were undertaken to examine the validity of this advice and to develop a simple method for assessing the “meat content” or Mussel Condition Index.

OUTCOMES ACHIEVED

Trade interviews clearly indicated that the primary factor driving demand for live mussels is the meat content of the shellfish. Other quality/marketing factors of importance in determining demand and prices were (in descending order): (a) Cleanliness of the shell (b) Size and size grading being true to label and (c)Packaging.

Criteria were established for each of these key factors in developing a product quality specifications table to underpin the Post-Harvest Code of Practice, attached. Three quality grades (basic, regular and premium) and three size grades (cocktail, standard and large) were identified through product research and industry consultation and defined in the product specifications sheet and the size grade table in the Code.

Other noteworthy results, incorporated in the Code, were the industry agreement on overpacking of mussels by at least 5% by weight and the development of a new cheap rapid method for estimating Mussel Condition Index (MCI).

This new method is particularly simple to use and the grower evaluates the mussels just as the chef or consumer does i.e. after cooking. Furthermore by only measuring the cooked meat and shell weight—taking no account of the seawater held inside the two shells of the bivalve — the MCI remains essentially the same when calculated on the harvest day or several days later. The methodology is therefore a substantial improvement on earlier MCI tests.

The term basic is used for product which meets food safety requirements but has a low meat content and little or no sorting regarding quality parameters. The term regular was adopted (in lieu of the word standard) for the common quality grade, which offers

at least 28% meat content. The premium quality grade offers the highest quality: a very clean shell and at least 39% meat content.

A one page leaflet, on water proof paper, to guide trade users such as restaurateurs, retailers and wholesalers on good handling and storage practices and to inform them on the farmers' new developments in size and quality grading was published and made available free of charge. This highlights the need for better temperature control, one of the key factors determining shelf life and consumer satisfaction.

The leaflet was purposely designed as one page for wholesalers and the reverse side for retailers and restaurateurs so that the key points are easily noted when the leaflet is fixed to a cool room wall and serve as a constant reminder of good practices for all personnel. The Code was published with colour illustrations and distributed to all licensed farmers and both the Code and a detailed illustrated version of the Trade Users Guide have been posted on the Seafood Services Australia web site.

The common advice that mussels which do not open after cooking should be thrown out has been found to be based on a long standing fear that the unopen ones were dead before cooking and therefore unsafe to eat. This warning is puzzling given that all or almost all of those unopen ones have experienced more cooking time and heat treatment than those removed from the cooking utensil earlier once they opened—and invariably found to be adequately cooked if opened with a knife.

Mussels are molluscs which live intertidally or under water and close their shells tightly when exposed to unfavourable conditions such as heat or removal from the sea. Our observations had been that with continued exposure to heat, as in cooking, the muscle holding the mussel shells closed weakens and then the shells open up when the muscle breaks off from one of the two shells. Moreover we noted that a very small number of these mussels (average 1.9%) removed early, after they opened up, have not had sufficient heat treatment to cook them adequately and perhaps insufficient cooking to destroy any possible pathogens.

All or almost all dead mussels will have shells open that do not close when tapped. Furthermore any dead mussels which are closed before cooking are just as likely to open up with cooking as the live mussels in the cook batch. Also, live (closed) mussels are just as likely to have pathogens, if present, as are dead closed mussels in any batch.

We concluded that farmed mussels still unopen after cooking are no more dangerous than the open ones and that the traditional warning on unopen mussels is unfounded and has led to a waste of sound mussels. Therefore in the Trade Users Guide leaflet, and in the website version, cooks are advised to carefully examine mussels *before* cooking to detect and avoid cooking dead or doubtful mussels, which are more likely to impart unpleasant flavours rather than make consumers ill.

This R & D project has produced information and publications which can be used by mussel farmers in generic product promotion to stimulate interest and demand for the better grades of mussels and otherwise maximise the benefits from the project. If farmers remain inactive on industry or product promotion then much of the potential benefits of this project will be lost.

1. INTRODUCTION

1.1 Background

The Australian mussel industry has grown only modestly in the past decade because market development and industry income has been constrained by the limited financial resources and the inconsistent approach to product handling and quality management by many farmers.

Some of the farmed mussels grown each year are not harvested and sold because concerned growers with good mussels cannot compete satisfactorily with the cheaper ungraded or poorer quality mussels that are marketed by some growers at times.

The mussel industry had a national meeting in Melbourne in March 2000 — when it was anticipating large increases in output over the next five years— with the support of the Fisheries R & D Corporation, to develop an R & D Strategy and to promote collaboration and communication within the industry. The underlying aim of this meeting was to facilitate a more coordinated, sustainable and profitable growth for the farming industry.

One of the outcomes of this meeting was agreement by farmers to contribute towards the funding of a researcher to develop a national Code of Practice for the post harvest handling of mussels, including the development of product specifications.

It was recognised at this meeting that it would first be necessary to examine the key quality parameters such as size grading so that some consensus could be reached in the selection of product specifications which would be used as the foundation stone for the Post Harvest Code of Practice.

This Code of Practice and a complementary Trade Users Guide were to serve as the primary tools to assist in raising the volume of high quality mussels produced and sold and thereby enhance the aggregate value of farmed mussel production in Australia.

Consultant Nick Ruello was an invited participant at this meeting in Melbourne and was encouraged to prepare a research and development application, as the principal investigator, for submission to the Fisheries R & D Corporation's Seafood Services Australia.

1.2 Need For The Project

There was a number of mussel growers with little knowledge on size grading and grading of mussels in relation to a condition index or “meat content” so that only “good mussels” with a satisfactory quality and shelf life were forwarded to market.

There was a need to identify the key quality and marketing parameters and then develop product specifications for a premium and a “standard” grade mussels as a prerequisite for the development of a Code of Practice on post harvest handling to guide growers, packers and marketers. The Code needed to cover handling, grading, packing, storage and transport of mussels to maximise quality and safety, shelf life and value of the mussel harvest for the benefit of the seafood industry as well as the consumer.

Adoption of the practices recommended in the Code would reduce the amount of poor quality mussels going to market and thereby help raise overall prices for producers and also reduce the wastage experienced by industry and consumers with poor quality mussels.

Wholesalers, retailers and restaurateurs need a users guide with reliable information on how to handle and store mussels to maximise quality and consumer benefit because many of these trade users are experiencing difficulties in maintaining high quality and shelf life of the product they buy.

2. OBJECTIVES

The project objectives were to : (a) Identify the key quality and marketing parameters for chilled mussels and prepare product specifications for “premium” and “standard” mussels.

(b) Develop a Code Of Practice which takes account of product labelling, uniform size grading, shell fouling and cleanliness, condition index and any food safety requirements of government for the guidance of all industry sectors.

(c) Prepare a product Trade Users Guide for wholesalers, retailers and restaurateurs.

3 METHODS

The farmers' state representatives participating in the Mussels Meeting in Melbourne 2000 served as an industry reference team to identify the key quality and safety parameters for consideration in this project and provided suggestions for critical limits for each parameter.

The principal investigator visited mussel farmers working in Port Phillip Bay and Port Arthur to gain an up to date picture of how mussels are handled there. He then consulted with other growers in the mussel producing states on regional variations and any particular points or issues of importance to them. Industry meetings were also held at Queenscliff and at Hobart with interested mussel farmers in order to gain maximum input from growers.

Mussel wholesalers, retailers and restaurateurs, 20 in all, were consulted for their input on key parameters, and particular issues of interest to them.

Steam cooking tests were undertaken to develop a simple method for assessing the "meat content" or Mussel Condition Index and to examine how mussels close and then open in cooking to assess the relevancy of the common cookery advice to discard mussels which do not open after cooking.

A draft Code Of Practice was then prepared by the consultant after consideration of the industry input and the requirements of the various state Shellfish Quality Assurance Programs. The first draft was circulated to the mussel association in each state for comment. A draft Trade Users Guide for mussel wholesalers, retailers and restaurateurs was also prepared and then submitted for comment by participating parties.

These draft documents were amended as needed in the light of comment received and resubmitted to the reference group for examination and then endorsement. Simon Bennison (Aquaculture Council Western Australia Executive Officer) and Tony Onley (Queensland Department of Primary Industry Marketing Officer) were also consulted on the layout and extension planning of these documents.

Although not part of the original project plan, desk research was carried out to explore the origins of the advice commonly given by cookery writers to discard mussels which do not open after cooking. This warning has led to the waste of many mussels and generated much confusion amongst many trade users and consumers who have safely consumed these unopen mussels. This advice ignores the natural biological response of mussels to close when they are exposed to harsh conditions (such as cooking temperatures) and focuses consumer attention on mussels after cooking when it is arguably more appropriate to have consumers examine the mussels more carefully before cooking.

Growers were kept informed on progress on the project, and regularly consulted, particularly on the planned arrangements for release of the documents, via email communication and telephone.

The Code and Trade Users Guide leaflet were officially released to the seafood industry and the food media at the Heritage restaurant in Sydney where a presentation on the program, the Code and the Guide were given by the principal investigator. The Code and the Guide were subsequently released in Perth, Port Lincoln, Melbourne and Hobart in November with personal presentations by Mr. Ruello in Perth and in Port Lincoln.

The Code and a more detailed version of the Trade Users Guide were made available to Seafood Service Australia for attachment to its web site.

4. RESULTS AND DISCUSSION

4.1 Quality Grading, Specifications And The Code Of Practice

Discussion with mussel retailers and restaurateurs indicated that the primary factor driving demand for live mussels is the meat content of the shellfish. Other quality/marketing factors of importance in determining demand and prices were (in descending order):

- Cleanliness of the shell
- Size and size grading being true to label
- Packaging.

All of these factors identified as important to commercial trade in mussels were dealt with at length in developing the product quality specifications (Table 1) for the industry's Post-harvest Code of Practice, which is attached as Appendix 1, and not repeated in detail here.

Other results of note which were incorporated in the Code were the industry agreement on overpacking of mussels by at least 5% by weight (Section 4.2 in the Code) and the development of a new rapid method for estimating Mussel Condition Index (MCI) or meat content.

This new method, entailing the steaming of just 20 mussels, is easy and cheap and the grower evaluates the mussels just as the chef or consumer does ie after cooking. Furthermore by only measuring the cooked meat and shell weight—taking no account of the seawater held inside the two shells of the bivalve—the MCI remains essentially the same when calculated on the harvest day or several days later.

This methodology is a substantial improvement on contemporary industry practices and earlier MCI tests for mussels compared by Davenport J & X Chen in 1987 and is described in full in Section 2.1 of the attached Code.

Three quality grades—basic, regular and premium—and three size grades—cocktail, standard and large—were identified through industry consultation and research and defined in the product specifications sheet and shown below.

Mussel Size Grades (based on mussel length)	
Cocktail	55-80 mm
Standard	65-80 mm
Large	80+ mm

The term basic describes product which meets food safety requirements, has a low meat content but has had little or no sorting regarding quality parameters. The term regular was adopted (in lieu of the word standard) for the common quality grade, which offers at least 28% meat content. The premium quality grade offers the highest quality: a very clean shell and at least 39% meat content.

The mussel size grades adopted in the Code were adapted from those developed by TASEA, the Tasmanian shellfish marketing company. The Cocktail, Standard and Large size grades herein correspond to TASEA's Cocktail/Standard, Standard and Large respectively.

Growers and consumers will increasingly have the choice of clearly specified sizes and quality grades, subject to seasonal conditions and availability, as well as the traditional ungraded mussels as more and more growers move to producing the higher quality grades of mussels. This will facilitate trade and reduce a lot of the uncertainty that prevails today in the sale and purchase of mussels.

4.2 Trade Users Guide

Mussel growers at the Melbourne industry meeting in 2000 identified the need for a simple trade users guide on handling mussels to complement their own Code Of Practice and assist in getting better mussels to consumers.

Research on the distribution of mussels identified that there was a widespread lack of knowledge on good handling practices and particularly the need for temperature control of mussels from farm to retail sale.

A Trade Users Guide was therefore published on an A4 sheet of water proof paper to guide trade users such as restaurateurs, retailers and wholesalers on good handling and storage practices and to inform them on the farmers' new developments in size and quality grading.

The leaflet was purposely designed as one page for wholesalers and the reverse side for retailers and restaurateurs so that the key points on temperature control are easily noted when the leaflet is fixed to a cool room wall or hung from the ceiling. This is made easy by the two holes punched at its head. When attached to a cool room wall or ceiling it can serve as a constant reminder on good practices for all personnel.

This leaflet questions the common advice about discarding mussels which do not open after cooking and emphasises a need to check and wash mussels before cooking—to remove any dead or doubtful mussels—as well as the traditional check of mussels after cooking. This subject and our recommendations are all discussed at length in the following pages.

The leaflet has been distributed free of charge by farmers and various government and industry stakeholders to seafood wholesalers, retailers and restaurateurs. It is attached here as Appendix 2.

A detailed version of the Guide leaflet, complete with the industry's quality specifications table and various illustrations, has been made available on the Seafood Services Australia website www.seafoodservices.com.au for those trade users wanting more information. It is attached here as Appendix 3. The farmers Code Of Practice is also available on the SSA website free of charge.

4.3 Discarding Of Unopened Mussels

The principal investigator had been cooking mussels and noting the opening/non opening of cooked mussels several years before the commencement of this R& D project but took the opportunity to investigate steam cooking (the common cooking practice) and the history of this widespread advice to discard unopen mussels. This warning is puzzling given that mussels are molluscs which live intertidally or under water and close their shells tightly when exposed to unfavourable conditions such as heat or removal from the sea.

Our observations on cooking had been that live mussels at first close the two shells and then with continued exposure to heat in cooking, the adductor muscle holding the mussel shells closed detaches from one of the two shells, in most cases. But some mussels in almost all batches cooked remained closed, some even after excessive cooking.

Our observations and quantitative data are summarised here but detailed data are in Appendix 4. We noted unopen mussels on 90% of occasions, with cook batch size ranging from 20 to 111 mussels, with an average of 11.5% unopen; the maximum observed was 53% unopen in a cook batch of 66 mussels (Table 1, Appendix 4). We invariably found the unopen mussels to be adequately cooked when opened with a knife—a total of 76 such unopen mussels from five cooking batches were all found to be adequately cooked (Table 2, Appendix 4).

Table 1 shows considerable variation in the percentage of mussels which do not open but a rigorous study of the importance of the various factors determining this, such as harvesting and post harvest handling history, were beyond the scope of this study.

In other tests when unopen mussels were given an extra cook time of 90 seconds, which would then render them as overcooked by cookery writers, as many as 13.2%% still remained closed (Table 3, Appendix 4).

The typical recipe advice is to remove mussels once they open up with cooking with an implication that the mussels that do not open are somehow unsafe to eat. Yet all or most of those that do not open have experienced more cooking time and heat treatment than those removed from the cooking utensil earlier once they opened.

A very small number of the mussels removed early, opening up after only a minute steaming time, had not had sufficient heat treatment to cook them adequately and perhaps insufficient cooking to destroy any possible pathogens. In a close examination of five cooked batches we noted an average of 1.9% of open mussels earlier deemed as cooked when they were in the cooking utensil were in fact inadequately cooked (Table 4, Appendix 4). i.e. undercooked as indicated by the uncoagulated nature of some of the “meat” and its adherence to the perimeter of the shell (See Figure 1).



Figure 1. Undercooked mussels. The “meat” is not all coagulated and detached from the entire margin of the shell, in both mussels it is still attached to the margins of part of the shell in the upper margin of this picture.

An examination of seafood cookery books (Australian and others) in our personal library and a nearby municipal library indicated that consumers were “frightened of being poisoned “ from eating mussels as early as the 1880’s in the United Kingdom according to Cassells Dictionary (in Jane Grigson, 1993). But the now common advice to discard unopen mussels came to prominence in the mid 1970’s with the remark “Throw away any mussels that refuse to open” by Jane Grigson —the well known English writer—in her best selling book *Fish Cookery* published in 1973 and again in 1975.

Interestingly, two of the most influential food/cookery books of the 1960’s *Larousse Gastronomique* (Montagne 1965) and Elizabeth David’s *Italian Food* (1966) did not give any such warning in their discussion or recipes on mussels; nor did seven seafood cookery books published in the early 1970’s which we have examined. Grigson’s advice came at the end of a discussion on preparing and cooking mussels but gave no clear indication why the unopen mussels should be thrown away.

In all, this warning was given in two of the 15 seafood cookery books (13%) published in the 1970's and five of the 16 (31%) published in the 1980's that we consulted. By 1990 such advice was being repeated without question, or an explicit explanation why, and all of the 11 books published from 1990 to 2002 we have examined do so too. This view now seems entrenched with food writers and cookery teachers.

Our enquiry posted on the National Shellfisheries Association's (an international association of scientists and industry members) website Forum (on www.shellfish.org) asking for information on the historical origins of this advice attracted 78 viewers over a 3 month period ending 31 December 2002 but no replies. The same enquiry posted on the seafood users group at the University of California Davis—used by food scientists, government regulatory authorities and industry personnel—elicited one response only while an email enquiry on the NSW TAFE cookery teachers' internal network elicited two responses.

The common thought amongst respondents was the fear of a dead mussel in a batch, particularly one full of mud, which might harbour some type of harmful bacteria, remaining closed after cooking. Further correspondence with these respondents revealed that the fear was based on outdated information on wild mussels (including product dredged from mud banks) without an understanding of modern aquaculture practices, the gaping of dead mussels or a knowledge of how mussels respond to heat in cooking.

Thus their fear was not based on fact or first hand knowledge. We regard this fear as unfounded, with Australian farmed mussels in particular, because of the following observations.

All or almost all dead mussels will have shells open and not closed — any rigor mortis is apparently very quick, especially when mussels are cooked. Furthermore any dead mussels which are closed before they are cooked are just as likely to open up with cooking as do the live mussels in the cook batch; dead *vis a vis* live mussels have no special properties holding the two shells closed. Also, live (closed) mussels are just as likely to harbour pathogens as are dead closed mussels in any batch, *if* the growing waters were polluted.

The mussels still unopen after cooking are therefore no more dangerous than the open ones, and as indicated above are arguably safer to eat given their greater exposure to heat.

Hence we see this now entrenched advice as unfounded. Therefore in the Trade Users Guide leaflet, and in the website version, cooks and consumers are advised to carefully examine mussels *before* cooking to detect and avoid cooking dead or doubtful mussels, which are more likely to impart unpleasant flavours rather than make consumers ill.

Nevertheless they are also reminded that some mussels do not open up even after excessive cooking and that these do not have to be discarded but rather they can be opened up (with a knife) and cooked a little more if they wish to do so.

It is noteworthy that several cookery writers who have had books published over a long time span advised readers to discard unopened mussels in books published in the 1990's while no such advice was given in their earlier publications in the 1980's. Personal discussions with two such writers, of national fame in Australia, revealed that the warning given in their latest publication does not represent their view but came from their young research assistants who did much of the work in preparing the latest book.

Further discussion with other food writers and cookery teachers leads us to conclude that this now widespread advisory note on mussels (and clams) is a case of writers and teachers repeating without question what appears to be good advice—albeit well meaning but unfounded. The contemporary situation is an outcome of a growing precautionary approach on public advice that has developed because of increasing food safety scares, class action compensation claims and a fear of litigation.

Water pollution is not new but Jane Grigson's 1975 somewhat confusing discussion on wild and sterilized mussels, quoted below, not only reflected the contemporary fear about water pollution and bivalve molluscs but gave unwarranted credibility to the view that mussels which do not open after cooking are unsafe to eat.

“There is a word of warning. Don't let enthusiasm drive out common sense. Mussels are abundant around Britain. No need to set up mussel farms here with line after line of wooden stakes to entice them to our shores; in fact they need to be weeded out and transplanted, so that they can grow to their full size. This makes them a tempting prospect if you are on holidays at the seaside. Unfortunately sewage is as abundant as mussels, at least in many places, which means they can be quite unfit, even dangerous to eat. Mussels on sale at fishmongers have spent a suitable period in sterilized seawater cleansing tanks. This makes them safe. Cases of poisoning from mussels occur so rarely that they make the headlines when they do—which has the sad result of putting people off this most abundant form of delicious and cheap protein.”

5. BENEFITS AND ADOPTION

The greatest immediate benefit of this project has been the national acceptance of uniform practices and terminology on size grades and quality grades, a product specifications sheet and a standard method for assessing Mussel Condition Index or meat content to underpin the quality grading scheme.

The establishment of this industry wide framework for grading and labelling product allows for greater product and market diversification. This development offers consumers and trade buyers a greater choice of product size, quality and packaging. It also reduces the level of uncertainty on size and quality that has prevailed in the past.

Seafood wholesalers, retailers and restaurateurs will benefit from better handling practices on farm and consumers will quickly benefit from better quality mussels and the enhanced shelf life which will come from better handling by everyone in the marketing chain from retailer back to the farmer. Tangible results are not evident yet because the Code and the Trade Users Guide have only been available to most people over the past couple of months.

The forecasted economic benefits to accrue from increased consumer and trade confidence and a subsequent increase in demand and prices will come in 2004 and later years as farmers are able to alter their output and enhance mussel size and quality and sell larger and better quality mussels. Farmers unable to grow larger or better mussels too will benefit simply by adopting the national grading and labelling terminology.

Tasmanian farmers working through TASEA and Spring Bay Seafood have already adopted the new grading scheme as company practice and will quickly be able to turn out large high quality mussels this year. Farmers in Victoria, NSW, South Australia and Western Australia suffered from unusual oceanographic conditions in the spring of 2003 and are experiencing a shortfall of larger mussels and so are unlikely to produce substantial volumes of large high quality mussels before the second half of 2004.

Although the economic benefits are not measurable yet the strong interest in the grading of mussels and the strong demand for premium quality mussels augers well for the mussel industry. Together they suggest that the forecasted improvement of about 20% or more than \$1 million in aggregate national value over the next few years will be realised.

6. FURTHER DEVELOPMENT

The Australian mussel farming industry has the opportunity to raise consumer and trade awareness of Australian blue mussels, and aggregate demand, on the back of the new improved handling, grading and labelling practices adopted as a result of this R & D project with further media publicity.

Media publicity on the release of the Code and Trade Users Guide was limited to the media personalities who attended the formal release in Sydney in October 2003, at the request of farmers around Australia, because of the shortage of mussels around the country at the end of 2003. This limited media attendance nevertheless generated a lot of free publicity at a time when industry was unable to capitalise on it.

The publication and release of a new consumer oriented leaflet on handling and cooking Australian blue mussels, and related mussel tastings, offers another cost effective means of increasing awareness, demand — especially for better quality mussels — and hence aggregate returns to industry.

Farmers in Western Australia and Victoria have expressed an interest in producing an information-recipe leaflet and the principal investigator has encouraged them to try and work together to produce a national or generic leaflet or produce their own leaflet in a positive manner without unduly emphasising state of origin.

The Victorian Department of Primary Industries has also expressed an interest in participating in a mussel industry promotional function in Melbourne or Port Arlington and the release of a consumer oriented leaflet in 2004.

A Code Of Practice is a “living document” and not set in concrete. The quality grades and product specifications are new but not static and so should be reviewed and upgraded as harvesting, processing or marketing practices change or new technology and systems are adopted.

The Mussel Condition Index (meat content criteria for premium, regular and basic grade) in particular, needs to be reviewed by the grower’s association in each state in the first quarter of 2005, in the light of practical experience in the marketplace, after a full year of operation. These criteria and the Code should be re-endorsed or changed according to feedback from members, customers and consumers.

7. PLANNED OUTCOMES

As indicated earlier, all of the planned publications have been completed and released and are now available free to all Australian stakeholders via a variety of printed and electronic media.

The Research & Development results have been well received by industry and are being adopted throughout the country at different speeds according to the supply situation and market distribution arrangements in each state.

The consumer has yet to notice much change in retail outlets or restaurants because of the low profile or passive manner in which news has been released and the limited change in industry so far because of time lags in producing large mussels. Nevertheless feedback to date from farmers and media is very positive and most states are planning to have promotional and/or media functions later this year when the supply situation is favourable.

Farmers should therefore be more active in promoting the new practices in industry and the availability of defined quality grades to their customers and to consumers.

Our conclusion that the hitherto common advice to discard unopened mussel is unfounded and unnecessary in regard to Australian farmed mussels (if not all mussels) helps reduce some of the uncertainty or fear surrounding this bivalve mollusc. It has already generated positive feedback from food writers, retailers and restaurateurs because the Trade Users Guide and related publicity recommend the cook check mussels *before and after* cooking which means consumers and restaurateurs can stop throwing out good mussels.

This forecasted reduction in wastage makes mussels a more affordable seafood and represents an unplanned outcome of this R & D project of benefit to industry and consumers.

8. CONCLUSIONS

The adoption of the Code's uniform size and quality grading practises and terminology around the country provides a sound base for market promotion and further product development but it is really just the first step on the path to industry growth and maturity for Australian mussel farmers

The actual industry development and benefits which may accrue from this project will depend on how quickly and widely the farmers and their trading partners utilise the grading and handling practises, product specifications and terminology outlined in the Code and the Trade Users Guide.

The farmers should take the lead and stimulate interest and demand for the better grades of mussels. If they remain inactive or passive on industry and product promotion then much of the potential benefits of this R & D project will be lost.

It is the principal investigator's considered belief that the mussel industry can use the improved handling practices and mussel quality as a springboard to far greater national consumption of Australian blue mussels if it is prepared to invest in generic promotion.

This project has demonstrated that mussels are less dangerous than previously thought and the Trade Users Guide provides reliable information on how to enhance shelf life and advises the commercial or domestic cook on how to check mussels before and after cooking in order to get a tasty dish.

After all, Australian farmed mussels are a safe, versatile, delicious and inexpensive shellfish, with a positive public image but which have yet to be cooked at home by many Australians according to consumer research in Sydney and Perth by Ruello & Associates in 1999 and 2000.

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10. ACKNOWLEDGMENTS

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11. APPENDICES

APPENDIX 1 Post Harvest Code of Practice



SEAFOOD SERVICES
AUSTRALIA

Blue Mussels

Post-Harvest Code of Practice



Prepared by

Ruello & Associates Pty Ltd

September 2003

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BLUE MUSSEL CODE OF PRACTICE

1. INTRODUCTION

This Code of Practice is a set of guidelines developed by Ruello & Associates Pty Ltd in conjunction with a steering committee of mussel growers' representatives. The Code is intended to guide farmers in the harvesting, packing and distribution of fresh whole blue mussels (live and chilled) so that they can consistently deliver safe, high quality product to their customers and gain some uniformity in trade practices around the country.

It has been developed with funding from Seafood Services Australia as part of an overall Research & Development project initiated to improve post harvesting handling and add value to the mussel growing industry of Australia.

The value of the Australian mussel industry has been constrained in recent years because of the high variability in the quality and grading of mussels and the sale of mussels in 10kg or larger lots after little grading for size or quality.

The intention of this R & D project is to facilitate the adoption of uniform quality and size grading practices for live mussels around the country. *The introduction of three new specified quality grades : Premium, Regular and Basic quality (defined in Table 1 on page 8) provides customers a choice of quality grades and sizes of whole mussels.* It also offers growers the opportunity to increase their income by selling the mussels which meet the Premium quality specifications for a price premium.

The quality gradings and product specifications proposed in this Code of Practice are voluntary and for guidance only, and do not prevent growers from selling mussels meeting even tighter specifications to their customers.

While the aim of the project is to improve mussel quality and safety, growers utilising the recommended grades and product specifications may continue to pack mussels of two size categories or quality grades in one container if they choose as long as there is a clear indication of this on the pack. Likewise growers may continue to distribute mussels in bulk without any grading at all as *ungraded*.

This Code describes the *principles and general procedures* proposed for achieving best practices for the harvesting and distribution of live blue mussels for human consumption, and covers:

- The handling and storage of mussels at sea
- Product specifications and grading
- Packing and labeling
- Transport and distribution.

This Code does not deal with farm management or the growing of mussels. All mussels are grown in Australia in compliance with the Shellfish Quality Assurance Program (SQAP) in their state, which governs farm management and food safety of bivalve molluscs. Farm management and issues relating to ecological or responsible farming practices have been detailed in the South Australian Mussel Growers Association Code of Practice of 2001 and in the Tasmanian Shellfish Code of Practice 2001 for operational practices in live shellfish.

1.1 A Code of Practice

This Code of Practice focuses on post-harvest handling. It is not a detailed prescriptive manual setting out exactly how each task should be carried out because there is usually more than one way to safely and efficiently undertake any particular activity.

It describes principles and general practices. Each grower has different facilities and staffing and therefore selects the most appropriate manner and/or equipment to undertake each individual task, while respecting all state and national food and food processing plant hygiene standards.

Although the Code is not designed as a training manual it nevertheless contains much useful information that can be used as reference material for induction training of new staff.

The mussel growing industry is still a small one and new technology is emerging rapidly as the volume of production increases, therefore best post harvest practices will undoubtedly change too.

A Code of Practice is a "living document", hence the grades and specifications are not static, and will be reviewed and upgraded as harvesting and processing practices, distribution systems, regulatory standards or new technology evolve.

The mussel condition index (MCI) described in this Code is the first attempt to guide growers and mussel resellers as to the condition of the mussels. The meat content proposed for each quality grade in the accompanying specifications sheet (Table 1) is therefore most likely to change as the MCI is put to commercial use and the mussel market develops further.

1.2 General Aims And Principles behind this Code

Bivalve shellfish such as mussels and oysters are often considered a high risk seafood because of the animal's ability to bioaccumulate potentially pathogenic (harmful) microorganisms from the surrounding waters and the fact that they are often consumed raw or after only light cooking.

Poor handling and inappropriate storage conditions of these shellfish may therefore allow the proliferation of spoilage bacteria inside the shellfish or the contamination of the shellfish with toxic substances or potentially pathogenic microorganisms.

This Code deals with mussels as a whole bivalve mollusc which leaves the growing area in a live condition but which is then cooled with ice or mechanical refrigeration to maximise safety and quality. The subsequent passage of time along the marketing chain and loss of liquid usually leads to the death of some of the shellfish and so the mussels are then best treated as fresh seafood by buyers and kept refrigerated or chilled to maximise safety and shelf life. Any mussels which die in transit while under refrigeration remain safe to eat (after cooking) if they are maintained at temperatures less than 5°C. Nevertheless packers should advise their customers of the need to refrigerate mussels.

Farm management should therefore provide or arrange for:

- all the necessary processing plant and equipment to produce a clean and safe working environment.
- introductory training on personal hygiene and the hygienic handling of foods for all staff before they commence duty.
- adequate staff, clean ice or chilling facilities and containers to process the anticipated daily volume in a safe manner.
- the swift and careful harvesting of mussels to minimise damage and stress to the living shellfish.
- the packing of mussels into clean containers clearly labeled with all statutory requirements and any additional requirements of the customers.
- the maintenance of detailed records on the growing, packing and distribution of product to facilitate effective and efficient product trace-back and recall if necessary.
- the distribution to wholesalers, agents, retailers and restaurateurs of information (e.g. Trade Users Mussel Guide) on the commercial handling of mussels to maintain quality after they take delivery.

2. QUALITY AND MARKETING FACTORS

The primary factor driving demand for live mussels is the meat content of the shellfish. Other factors of importance in determining demand and prices are (in descending order) :

- cleanliness of the shell
- size and size grading being true to label
- packaging.

There is strong demand for mussels delivered in convenient size containers or packaging, which have a high meat content and no bitter taste, clean shell and true to label regarding size grade.

All of these factors are important to commercial trade in live mussels and are dealt with at length in this Code. This Code also discusses the commercial matter of “overpacking” to compensate for weight loss due to drainage of water from the shells as this is a matter which is dealt with in a variable and often unsatisfactory manner by some parties.

2.1 Mussel Condition And Condition Index (MCI)

The meat content of mussels varies throughout the year as the shellfish’s gonad condition changes with the seasons but lightweight or “empty” shellfish are unacceptable to most users. Mussels with a bitter taste are also unacceptable to consumers.

More than a third of the mussel users contacted in this study indicated a willingness to buy a premium grade mussel which offered a particularly high meat content and approximately half of these persons said they would pay extra for such a premium grade mussel with ample meat. Thus about 20% of current customers are prepared to pay more for a premium grade mussel.

A number of methods are used by growers, processors and researchers here and around the world to measure mussel meat condition.

An improved method for evaluating the MCI proposed in this Code entails steaming open and weighing 20 mussels. This new method is particularly quick and simple to use and the grower evaluates the mussel just as the chef or consumer does i.e. after cooking. Furthermore by only measuring the cooked meat and shell weight — taking no account of the seawater held inside the two shells of the bivalves —the MCI index is much the same when calculated on the day of harvest or several days later (full methodology below).

Mussel Condition Index (MCI) Assessment

Select at random and test 20 mussels from each growing area per day. When mussels from more than one harvest area are to be commingled for packing then the results for each sample should be combined and average values taken for the pack. When the harvest is from one growing area only and totals more than 300 kg two samples should be taken and the average MCI figure calculated.

If the mussels have a heavy beard or byssus cut it off with scissors before cooking.

Equipment needed:

Battery or electronic digital scales capable of weighing to the nearest gram

A large base frying pan or boiler with a tight fitting lid

Paper toweling or tea towel

A pair of kitchen tongs

Plastic wrap (e.g. Glad wrap)

Notebook and pen. See accompanying photograph for equipment.

Place mussels into the cooking utensil and add water at room temperature to a height of approximately 1cm. Turn heat onto full.

Remove the lid on the mussels once steam is escaping vigorously from the lid. Remove any cooked mussels and up-end onto the toweling to drain. Do not overcook mussels, they are done when flesh has shrunk away from the entire margin of the shell and has a rubbery feel rather than a jelly texture.

Turn the heat down to a simmer and continue to remove mussels as they cook. Remove the cooking utensil (with mussels) from the heat about a minute after the first few mussels have been cooked to avoid overcooking. Overcooking the mussels will reduce the meat weight and therefore the MCI.

Open all mussels and remove the mussel meat and drain on toweling (leave any remaining byssus attached to the meat), put the empty shells aside to drain too. Weigh the meats and then weigh the shells (you may need to wrap the shells in plastic wrap to contain them on the scales). Record these figures and harvest information in your notebook.

Add up the meat weight and shell weight then weigh the mussel meat and the shells together. Check this combined weight against the total weight added up earlier before you dispose of the shells or meat.

Calculate the condition index by multiplying the meat weight by 100 and dividing this number by the combined weight of the shells and cooked meat.

$$\text{e.g. } \frac{68 \text{ gram of meat} \times 100}{177 \text{ gram of meat and shells}} = 38.4\%$$



Photograph of MCI assessment equipment



Premium grade mussels (from left to right, female and male)

Table 1. Product specifications sheet for fresh blue mussels.

Product feature	Basic Quality grade	Regular Quality grade	Premium Quality grade
Size grading	No warranty on size grading	No more than 8 out of grade per 5kg for large size grade and no more than 12 for the standard size category.	No more than 4 out of grade per 5kg for large size category and no more than 6 for the standard size category.
Mussel (meat) Condition Index	No warranty on Mussel (meat) Condition Index	Average MCI 28.0-39.0%	Average MCI more than 39.0%. No more than 10% of mussels with less than 30% meat content
Shell cleanliness	Heavy fouling acceptable	Majority of mussels (>50%) are clean of heavy fouling	Most mussels (>90%) are clean of heavy fouling
Temperature Control	Mussels may not have been chilled by grower or packer.	Mussels have been chilled by grower or packer to less than 10°C before shipment.	Mussels have been chilled by grower or packer to less than 10°C before shipment.
Flavour	No bitter flavour present	No bitter flavour present	No bitter flavour present
Harvest date and other label information	Date of harvest and all necessary (government) information shown on all packs.	Date of harvest and all necessary (government) information shown on all packs.	Date of harvest and all necessary (government) information shown on all packs.
Crabs & Parasites	Not examined for pea crab or internal parasites	Practically free of pea crab and internal parasites	Practically free of pea crab, no obvious impact of internal parasites per 5 kg
Packing weight	Overpack by minimum of 5%	Overpack by minimum of 5%, more for distant transport	Overpack by minimum of 5%, more for distant transport

Research tests on Australian blue mussels indicate that the best mussels will have a MCI of about 50% while those in poor condition will have a MCI of less than 25%. Premium grade mussels are therefore defined as those with a MCI greater than 39.0% (Table 1).

Mussels should be assessed for presence of any bitter taste prior to sale. This can easily be undertaken by eating the mussel meat, after the MCI has been determined, to ensure that mussels with bitter taste are not sold for human consumption.

2.2 Size And Size Grading

Most mussel buyers and consumers have a preference for a particular size category mussels to meet their needs. Therefore the mussel industry can meet these varying needs by offering size graded mussels as well as ungraded packs.

A “small” mussel is the norm in Western Australia however most mussel buyers in eastern Australian states have become accustomed to “medium” or “large” size mussel but many buyers are unaware of the size grading systems in use by several packing companies around the country.

The mussel size grades and terminology proposed in this Code and the specifications sheet have been adapted from those developed by TASEA, the Tasmanian shellfish marketing company. Three size grades are proposed in this Code : Cocktail, Standard and Large which correspond to TASEA’s Cocktail /Standard, Standard and Large.

Mussels should be graded by eye according to the size categories and tolerances shown in the specifications table. Two size categories can be packed into one container and labeled accordingly.

There is widespread agreement amongst growers around the country that mussels under 55 mm length should not be offered for sale for human consumption unless it is at the buyers request.

Size grades for blue mussels (based on mussel length)

Cocktail: 55-80 mm

Standard: 65-80 mm

Large: 80 + mm

2.3 Shell Cleanliness

Shell cleanliness is of importance to restaurants and consumers because mussels with a heavy fouling cover of animals or algae are unsightly. This biological fouling can also release unwanted materials into the cooking utensil which can detract from the cooked meal of mussels.

A heavy covering of fouling organisms also leads to unwanted odours inside the storage containers since the organisms die off (and fall into the liquid at the bottom of liner bags) and a possible shortening of shelf life of the mussels. This is particularly so with shelled animals such as tube worms, oysters, overcatch mussels and barnacles.

Mussels for sale as the Regular and Premium grade (Table 1) are to be examined to ensure they meet the prescribed specifications for these grades. When the majority of the product has a heavy fouling it can be sold as basic quality grade.

2.4 Commensal Crabs And Internal Parasites

The pea crab occasionally seen inside mussels is a commensal i.e. it lives with the mussel but is not a threat to the mussels nor is it a significant hazard to human health.

Mussel tissues can sometimes be affected with a microscopic parasite which are typically only evident to trained observers and not a hazard to consumers.

Premium grade mussels are to be examined (during the assessment of meat content) to ensure that the pea crab is not present in significant numbers within the mussel sample and that there is no unsightly impact of any internal parasite.

3. HANDLING AT SEA

Mussels live underwater in a reduced light environment with fairly stable cool temperatures. In handling mussels it is advisable to keep them cool, avoiding fluctuating temperatures, heat, sunlight (and other bright lights) and wind which will accelerate drying out and death.

The fundamental principles to follow in each operation are :

Keep mussels cool, shaded, and out of the wind.

3.1 Shellfish Harvesting And Labelling

Mussels are only to be harvested from licensed areas which are open to harvest in accordance with the local SQAP.

Shellfish from different harvest areas should not be mixed according to the Shellfish Quality Assurance Programs (SQAP). If mussels are to be harvested from more than one lease during the day then containers are tagged immediately to ensure that all the catch can be clearly labeled as prescribed in the SQAP to lease origin and date of harvest.

3.2 Cleaning And Sorting

Mussels should be tumbled and washed to remove fouling organisms and overcatch and to wash away mud, algae and other material. A number of mechanical devices are available to facilitate this process. The cleaning operation is to be undertaken in open approved areas or with the use of potable water.

The removal of dead, broken, cracked or other suspect mussels is an important first step in assuring customers that they are getting safe mussels with a satisfactory shelf life. Dead or broken mussels will soon spoil, especially in warm weather and release unpleasant liquid and smells which can contaminate a case of mussels.

Harvesting should be avoided at times when water or air temperatures or wind conditions are too high for good practices.

Store the mussels in clean covered containers to keep them out of sunlight and wind and to prevent contamination from bird droppings. Second hand sacks should not be used to store the cleaned mussels. A clean wet sack or can be placed over the mussels if needed to control warming and dehydration at sea.

3.3 Temperature Control And Cooling Of Mussels

Prescribed temperature levels and cooling requirements vary somewhat from state to state but in general it is desirable to chill the mussels down as soon as possible after harvest to prolong their vitality and shelf life, especially in summer when sea and air temperature are both high.

The Australian Shellfish Quality Assurance Program requires that bivalve molluscs such as mussels are stored under effective temperature control at or below 10°C within 24 hours of harvest.

Ice can be used at sea to commence chilling but it is best to have a porous sack or towel between the ice and mussels and not have ice in direct contact with the shellfish. A “shower” or “curtain” of melting ice water over the mussels is recommended but where ice is not feasible wet sacks to control temperature and damage from sunlight and wind are needed.

4. PACKING, TRANSPORT AND DISTRIBUTION

4.1 Road Transport To Packing Depot Or Customers

Care should be taken in transporting the live shellfish to packing premises or customers rapidly so that the mussels do not get contaminated or exposed to wind, sun or heat which may lead to a deterioration in their vitality and quality or render them unsafe.

Where necessary, with long distances or time in transit, then insulated vehicles or refrigeration (mechanical or ice) will have to be used to ensure temperature control (see 4.4 below).

All transport vehicles need to be clean and the mussels stored and covered so that they are not contaminated by other goods on board, vehicle fumes, airborne dust, or animals (domestic or livestock).

4.2 Packing And Packaging

Styrene and cardboard cases are increasingly being seen as a preferred method of distributing seafood for maximum temperature and weight control. A new case readily accepts and retains a self adhesive label and creates a better image for the product than the reusable plastic fish bins which are difficult to clean.

A new styrene or cardboard case is favored by retailers and restaurateurs, and many growers too, because it can be sealed and all parties can easily see if it has been opened and the mussels tampered with or pilfered. This security also means less complaints from retailers or restaurateurs about short weight to the wholesale distributor.

A choice of different sized cases has been identified as one option for increasing farmers' revenue. Many customers are happy to pay more per kilogram for the convenience offered by smaller packs e.g. a 5kg pack rather than 10 kg pack.

Overpacking

Mussels lose seawater from the shell after they have been harvested and it is necessary to "overpack" to ensure that customers receive the weight they order. With air transport it is also necessary to include an absorbent pad inside styrene cases to trap any of this liquid which may escape from the liner bag holding the mussels.

A 5% overpack is widely recognised by growers as a minimum for short transit times (several hours) ; a 7.5% minimum overpack is proposed for more distant transport or overnight shipment by road or air. A 10% overpack is recommended for transit times of more than 36 hours.

Mussels should be weighed on electronic scales with an accuracy of 20 grams or better. The scales should be registered as required with the state authority designated for this purpose and accuracy checked at least yearly.

4.3 Final Quality Check

A final check for any dead mussels should be undertaken immediately prior to sealing the pack.

SQAP regulations stipulate that growers should discard dead, damaged or gaping shellfish. Even though it is extremely difficult to ensure that not a single damaged or dead mussel is packed there is an obligation on packers to make all possible efforts on this. It is therefore advisable to undertake a final check for dead shellfish before sealing the bag or pack. Dead shellfish often have a noticeable smell or rattling sound which can be detected by a trained person.

4.4 Temperature Control In Distribution

Mussels should be packed and distributed with due care to temperature control. For distant transport sufficient ice, gel pack or refrigeration will be necessary to ensure that the mussel temperature remains low and does not rise above the prescribed level.

Mussels which have been cooled before packing need to be maintained below the packing temperature while in transit. The ice volume, gel pack or refrigeration needed will depend on the type of packaging, volume of mussels, transit time and ambient temperatures encountered during distribution.

Mussels which have not been cooled prior to packing and distribution must be cooled to a temperature of 10°C or less within 24 hours of harvest. The labels on this product should advise that the mussels need to be refrigerated on receipt and buyers should be made aware of this condition so that they cool the mussels to ensure safety and maximise shelf life.

4.5 Labelling Of Bags, Plastic Bins And Cases

All bags, plastic bins, styrene or cardboard cases and other containers should have a label or tag firmly affixed which carries all information required by State and Commonwealth laws. This includes the following:

- The name and address of the farm or packer
- Lease /license/permit number
- Harvest date
- Growing area
- Species
- Customers name, address and phone number
- Lot number.

This label information must be in indelible and legible form with minimum letter size of 5 mm, on a durable waterproof tag or label. The harvest date is required for the SQAP but it also helps buyers to manage their stock on a first in first out basis.

It is also advisable to mark the size category and quality grade and to carry instructions to refrigerate the mussels as soon as possible.

5. RECORD KEEPING AND PRODUCT RECALL

5.1 Record Keeping

True and accurate records are to be kept of all mussel sales and movements each day to allow for an efficient product recall of any suspect product if needed.

The information required includes :

- Date of transaction
- Number and weight of mussels in each container
- Growing area
- Lease number
- Harvest date
- Name and address of purchaser.

The records should be sufficiently detailed and reliable so that a single bag or case can be traced back to a specific harvest area for any date. These records should be retained for at least one year from the date of any sale.

5.2 Recall Product

The manager (or relieving manager) of the packing business should be designated to manage a recall of any suspected hazardous mussels. A trace-back and recall of any affected may be required if there is a report of a public health problem with any product.

The manager/relieving manager must have the telephone, fax and mail contact details for all customers. Also the contact details for local State health office must be in an easily accessed file for immediate notification of any potential problem.

Food Standards Australia New Zealand (FSANZ) recently issued a small guide to conducting a food recall and developing food recall plans. Copies of this "Food Industry Recall Protocol" booklet are available *gratis* by contacting FSANZ by phone on 02 62712241 or by email to info@foodstandards.gov.au and it should be kept as part of the company's operating and training resources.

6. PACKING PREMISES AND HYGIENIC HANDLING

6.1 Building

The premises used for grading and packing mussels must comply with local and state regulations but in general terms farm management should provide the necessary buildings and equipment to grade and pack mussels in a safe and hygienic environment.

This is best achieved by having a designated building or room that is:

- completely enclosed with a self closing door, or clear plastic flaps, maintained in good repair and kept in a clean and orderly condition.
- equipped with smooth impervious washable walls and floors and with effective drainage of the floor.
- All product and packaging materials are stored off the floor on shelves, pallets etc so that it is not contaminated by splash.
- fitted with a designated hand washing basin and adequate supplies of water, soap and toweling or hand drying apparatus.
- equipped with adequate lighting to safely process the product.
- arranged with designated space to wash processing equipment.
- equipped with a toilet nearby with its own hand washing facilities (hand basin, toilet paper, soap and hand drying facilities).
- equipped with cleaning and sanitizing compounds and equipment that are approved for use in a food processing facility and stored in a designated safe area at all times when not in use.
- Any toxic substances (such as fuel) are stored in designated safe areas at all times.
- fitted with sufficient covered waste bins designated for non-putrescible waste.
- equipped with sufficient covered waste bins designated for putrescible waste.
- Pests such as rats, mice, birds and insects and domestic animals such as dogs and cats are kept out of the processing area at all times.

Water And Ice

Water of a microbiological clean status, that is *potable water*, is essential for public health safety therefore:

- adequate supply of potable water is available and used throughout the washing of product.
- all ice is made from potable water, whether “in house” or bought in, and stored in hygienic containers at all times,.
- all equipment used for handling and storage of ice is maintained in a clean manner to minimise contamination.

6.2 General Hygiene

Mussels are handled under conditions that ensure that no contamination occurs.

This is best achieved by:

- conducting a pre-operational check of facilities and equipment before processing starts and cleaning any soiled areas or equipment as necessary, before start-up,
- keeping processing facilities and equipment as clean as possible during processing.
- ensuring that the room and equipment are cleaned at the end of the day's processing by staff trained in cleaning procedures.
- keeping chillers and other storage areas clean.
- storing packaging material such as plastic bags, plastic foam, cartons and styrene boxes in a manner that protects them from contaminating product.
- keeping the room and toilets clean of food scraps or drink containers and waste paper.

The FSANZ web site www.foodstandards.gov.au has detailed information on national requirements for food premises and hygienic practices.

7. ACKNOWLEDGMENTS

We would like to thank all the persons who have assisted in the development of this Code.

Our appreciation is also extended to TASEA, the South Australian Mussel Growers Association and the Tasmanian Health Department for making available their Codes and other printed material.

Funding for this R & D project and associated publications was provided by Seafood Services Australia and the Australian mussel farming industry.

APPENDIX 2. Trade Users Guide Leaflet



TRADE USERS GUIDE TO WHOLE BLUE MUSSELS.

This leaflet has been published to guide trade users such as restaurateurs, retailers and wholesalers on good handling and storage practices and to inform you about new developments in size and quality grading of whole Australian blue mussels. A more detailed version of this guide as well as the new Code of Practice adopted by Australian mussel farmers to improve the handling, grading and packing of live blue mussels are available from the website www.seafoodservices.com.au

This Code of Practice defines three new quality grades (basic, regular and premium) and three size grades (cocktail, standard and large) for whole mussels so you now have a choice of clearly specified sizes and quality grades (subject to availability) as well as the traditional ungraded mussels.

All farmed mussels are grown in Australia according to a mandatory Shellfish Quality Assurance Program (SQAP) which regulates the food safety requirements. The farmers' new Code of Practice and this Guide thereby supplement the SQAP and help you to serve consumers with better mussels.

Part A Guide For Seafood Wholesalers

Check for the name and address of the supplier , and date harvested, on all cases and bags. Do not remove the packer's label or tag from the case or sack.

Keep mussels cool, shaded and out of wind. Refrigerate or chill with ice immediately on receipt.

Store mussels in a cool room with temperatures between zero and 5°C—lower temperatures will kill the mussels. It may be necessary to open the lid of a styrene case to accelerate chilling in the cool room if the mussels have warmed up in transit from the packer to you.

Shelf Life And Stock Rotation : Shelf life for good eating quality is limited to a total of about 7 days from harvest date if the mussels are held continuously at a cool room temperature of 0 - 5°C.

Rotate stock in the cool room and sell on a First In First Out (FIFO) basis so customers can enjoy the freshest mussels possible. Mussels more than 5 days from harvest date and held in a cool room will mostly be alive still but have limited shelf life remaining for your trade customers.

Leaflet produced by Ruello & Associates Pty Ltd with R & D funding from Seafood Services Australia and the Australian mussel industry. October 2003.



Part B Handling And Display Guide For Retailers And Restaurateurs

Most of the mussels you bought are alive but a few may have died during the cleaning or distribution process. Treat mussels like other fresh seafood and keep them refrigerated or cool with ice at all times.

Store mussels in a cool room with temperatures between zero and 5°C—lower temperatures or direct contact with ice will kill the mussels.

If you have bought an unopened case, open and drain the water from inside the case so that the mussels do not lie in the now dirty water. This water will get smelly with time even in the cool room and may contaminate the mussel flesh as the mussels open up.

Cover the mussels with a clean wet towel to protect them from drying out while in the cool room. Do not seal the mussels inside a closed styrene case.

Rotate stock and sell on a First In First Out (FIFO) basis so that that customers enjoy the freshest mussels possible. Good eating quality shelf life is about 7 days from harvest date if they are held refrigerated or iced.

For retail or restaurant display. Keep the container of mussels under refrigeration or embedded in ice so that they do not warm up; any in direct contact with a refrigerated counter or ice will die. Some mussels will open up with increasing time but live mussels close again if the shells are tapped or pushed together.

Avoid sunlight and other bright lights and wind or draughts, which will accelerate drying out and death.

For restaurateurs: Care is needed before cooking to ensure that only mussels which are alive or in a safe fresh condition are cooked. Mussels which do not close when tapped may be cooked (if previously held refrigerated or iced) if they have no unpleasant smell or other sign of spoilage. So wash and check mussels before cooking and discard any that are doubtful.

Farmed mussels will not all open up during cooking—some don't open up even after excessive cooking—but you do not have to discard these. Just open them up with a knife and cook a little more if you wish.

APPENDIX 3. Trade Users Guide, Web version

Web Site Version



TRADE USERS GUIDE TO WHOLE BLUE MUSSELS

Developed by Ruello & Associates Pty Ltd

This guide has been produced to advise trade users of fresh Australian blue mussels such as restaurateurs, retailers and wholesalers on good handling and storage practices for whole mussels (live and chilled) so that you can add on to the farmers' quality control program and get greater satisfaction from mussels.

All farmed mussels are grown in Australia according to a Shellfish Quality Assurance Program (SQAP) which governs the food safety requirements of these shellfish. All cases or sacks of mussels should have a label or tag attached by the grower/packer indicating the approved growing areas from which the mussels come and information for trace back to the packer (in case of problems or need for a product recall).

Australian mussel farmers have recently adopted a newly developed national *Code of Practice* for improving the handling, grading and packing of live mussels. This Code of Practice defines three new quality grades (basic, regular and premium) and three size grades (cocktail, standard and large) so you now have a choice of clearly specified sizes and quality grades (subject to availability) as well as the traditional ungraded mussels.

The availability and price of the mussels will, of course, depend on your supplier and seasonal conditions in each growing area. The "meat" content and condition of mussels varies throughout the year as the mussels mature, spawn and lose condition, and then gradually regain weight again.

Mussel condition or meat content is the critical quality factor in the new quality grading scheme and a simple method has been developed to allow everyone to quickly assess this Mussel Condition Index (MCI).

The specifications for the three size and quality grades are shown in the accompanying table and the entire Code, including the MCI assessment method, is available for viewing on www.seafoodservices.com.au



Premium Quality Grade mussels, female and male, left to right.



Premium, Regular and Basic Quality grades; all females about 75 mm in length (Standard size grade).

Part A

Guide For Seafood Wholesalers

Food Safety Check On Receival

Check for the name and address of supplier, and date harvested on all containers. **Do not remove this label or sticker from the case or sack.**

Keep mussels cool, shaded, and out of the wind.

Mussels live underwater in a dark environment with fairly stable cool temperatures. In handling mussels it is advisable to keep them cool, avoiding fluctuating temperatures, heat, sunlight (and other bright light) and wind or draughts, which will accelerate drying out and death.

Although most of the mussels you buy are alive a few may have died during the cleaning or distribution processes and so it is best to treat your mussels as a fresh seafood and **refrigerate or chill with ice immediately on receival.**

This is critical if the mussels have not been chilled by the farmer or packer before delivery to you.

While a SQAP regulation stipulates that growers should discard all dead, damaged or gaping shellfish it takes no account of the human limitations of quality control checks when millions of mussels are being packed each day. Nevertheless, a few dead or cracked mussels may be packed so any mussels that die at ambient (air) temperature may be unsafe to eat and must therefore be discarded.

Storage

Store mussels in a cool room with temperatures between zero and 5°C—lower temperatures will kill the mussels. Ice in direct contact with mussels will also kill them. So if ice is to be used for cooling at any time it is best to place a clean sack or towel between the mussels and the ice to produce a “shower” or “curtain” of melting ice water over the mussels.

Styrene or cardboard cases

Remember the styrene or cardboard case is designed to maintain a low temperature in transit by protecting the chilled mussels against warming from air outside; but the insulating properties of styrene also means that the mussels inside the sealed styrene case will cool down slowly in the cool room.

It will be necessary to open the lid of a styrene case to accelerate chilling in the cool room if the mussels have warmed up in transit from the packer to you.

If the mussels are to be held for a couple of days, drain the water from inside the plastic liner bags so that the mussels do not lie in dirty water. This water will have some debris and bacteria draining from the outside of the mussels and will get smelly with time even in the cool room and may contaminate the mussel flesh as the mussels open up with increasing time after harvest.

Sacks And Plastic Fish Bins

Allow water to drain off the mussels, cover with a clean wet towel or clean sack to prevent drying out and then store them in a cool room. Sacks of mussels should be held on a pallet or otherwise kept off the floor.

Shelf Life And Stock Rotation

Shelf life for good eating quality is limited to a total of about 7 days from harvest date if the mussels are held continuously at cool room temperatures of 0-5°C. So stock control is important, especially in summer when higher temperatures prevail.

Rotate stock in the cool room and sell on a First In First Out (FIFO) basis so that customers enjoy the freshest mussels possible. Mussels that are more than 5 days from harvest date and held continuously at refrigeration temperatures, will mostly be alive still but have limited shelf life remaining for your trade customers.

Table 1. Product specifications sheet for fresh blue mussels.

Product feature	Basic Quality grade	Regular Quality grade	Premium Quality grade
Size grading	No warranty on size grading	No more than 8 out of grade per 5kg for large size grade and no more than 12 for the standard size category.	No more than 4 out of grade per 5kg for large size category and no more than 6 for the standard size category.
Mussel (meat) Condition Index	No warranty on Mussel (meat) Condition Index	Average MCI 28.0-39.0%	Average MCI more than 39.0%. No more than 10% of mussels with less than 30% meat content
Shell cleanliness	Heavy fouling acceptable	Majority of mussels (>50%) are clean of heavy fouling	Most mussels (>90%) are clean of heavy fouling
Temperature Control	Mussels may not have been chilled by grower or packer.	Mussels have been chilled by grower or packer to less than 10°C before shipment.	Mussels have been chilled by grower or packer to less than 10°C before shipment.
Flavour	No bitter flavour present	No bitter flavour present	No bitter flavour present
Harvest date and other label information	Date of harvest and all necessary (government) information shown on all packs.	Date of harvest and all necessary (government) information shown on all packs.	Date of harvest and all necessary (government) information shown on all packs.
Crabs & Parasites	Not examined for pea crab or internal parasites	Practically free of pea crab and internal parasites	Practically free of pea crab, no obvious impact of internal parasites per 5 kg
Packing weight	Overpack by minimum of 5%	Overpack by minimum of 5%, more for distant transport	Overpack by minimum of 5%, more for distant transport

Size grades for fresh Australian blue mussels (based on mussel shell length)

Cocktail: 55-80 mm
Standard: 65-80 mm
Large: 80 + mm

Part B

Holding And Display Guide For Retailers And Restaurateurs

Although most of the mussels you receive are alive a few may have died during the cleaning or distribution processes and so it is best to treat your mussels as fresh seafood and keep them refrigerated or cool with ice at all times.

Mussels live underwater in a reduced light environment with fairly stable cool temperatures. In handling and displaying mussels it is advisable to keep them at a temperature between zero and 5°C, avoiding fluctuating temperatures, sunlight and other bright lights and wind or drafts which will accelerate drying out and death. Direct contact with ice will kill mussels.

All mussels are grown in Australia according to the requirements of a Shellfish Quality Assurance Program so when buying a sealed full case check that it has the packing date and details on the packer's address for trace back to the packer in case of problems or need for a product recall. Do not remove this label or sticker from the case.

Refrigerate mussels as soon as possible after receipt, even those in styrene cases. Remember the styrene case is designed to maintain a low temperature in transit by protecting the chilled mussels against warming from air outside; but the insulating properties of styrene also means that the mussels inside the sealed styrene case will cool down slowly in the cool room.

It is advisable to drain the water from inside the styrene case so that the mussels do not lie in the now dirty water. This water will have some debris and bacteria draining from the outside of the mussels and will get smelly with time even in the cool room and may contaminate the mussel flesh as the mussels open up with increasing time out of water. Cover the mussels with a clean wet towel to protect them from drying out while in the cool room.

Shelf Life

Rotate stock and sell on a First In First Out (FIFO) basis so that customers enjoy the freshest mussels possible. Good eating quality shelf life is limited to a total of about 7 days from harvest date if held refrigerated or iced.

For retail or restaurant display. Keep the container of mussels under refrigeration or embedded in ice so that they do not warm up; any in direct contact with a refrigerated counter or ice will die. Keep mussels away from bright light, wind and air conditioning outflow if you wish to keep them alive.

Some of the mussels you have bought will have opened up; this is normal as they have been out of seawater.

For restaurateurs: Care is needed before cooking to ensure that only mussels which are alive or in a safe fresh condition are cooked. Mussels which do not close their shells when they are tapped or pushed together may be cooked (if previously held refrigerated or iced) if they have no unpleasant smell or other sign of spoilage. **So wash and check mussels before cooking** and discard any that are doubtful.

Farmed mussels will not all open up during cooking—some don't open up even after excessive cooking—but you do not have to discard these. You can open these up with a knife and cook a little more if you wish to be extra sure.

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APPENDIX 4. Observations on mussel cooking and opening.

All observations on cooking were done with mussels bought from wholesalers at the Sydney Fish Market as a full unopened styrene case of 5 or 10 kilograms. The handling and temperature history was unknown but all mussels cooked were no more than five days post harvest.

Mussels were steam cooked in a large, lidded frypan or boiler starting with 1 centimetre of water. As the shells opened up and the "meat" looked cooked, i.e. coagulated and shrunken from the shell margins, they were removed from the cooking utensil. The actual steaming time for each individual mussel varied from less than a minute for the early openers in a small batch (<30 mussels) to more than five minutes for some late openers in a large cook batch (>60 mussels).

Table 1. Percentage of mussels cooked which did not open

Date	Percentage Unopen	Number unopen/open
9 Feb 2001	27.9	31/111
	12.5	9/72
	53.0	35/66
28 Dec 2001	16.1	9/56
	25.0	22/88
19 Jul 2002	3.9	6/88
	3.0	2/66
2 Aug 2002	2.1	1/48
	3.3	1/60
28 Aug 2002	1.4	1/72
	3.5	2/57
14 Jan 2003	16.4	11/67
	0	0/62
	16.5	5/77
28 Feb 2003	13.8	4/29
	27.4	14/51
3 March 2003	11.5	6/52
	18.3	11/60
20 March 2003	5.0	1/20
	18.3	11/60
23 March 2003	10.0	2/20
	18.3	11/60
3 Apr 2003	5.0	1/20
	15.0	3/20
	10.	2/20
	10.0	2/20
12 Sep 2003	5	1/20
	0	0/20
	0	0/36
20 Sep 2003	5.0	1/20
	5.0	1/20
30 Oct 2003	5.0	1/20
Average	11.5	

Table 2. Mussels unopen but noted as adequately cooked (and total number cooked)

Date	Number open	Total number cooked
9 Feb 2001	31	111
2 Aug 2002	1	48
	2	60
	2	57
28 Aug 2002	1	72
Total	37	348

Table 3. Percentage of unopen mussels after typical cooking time and after 90 seconds extra cooking time.

Date	Number cooked	% Unopen with typical cooking	% Unopen after extra cooking time
9 Feb 2001	72	12.5	8.3
	66	53.0	30.0
28 Dec 2001	56	16.1	8.9
	88	25.0	13.2

Table 4. Percentage of cooked open mussels subsequently noted as inadequately cooked (undercooked).

Date	Percentage inadequately cooked	Number undercooked/cooked
19 Jul 2002	2.4	2/82
2 Aug 2002	2.1	1/47
	1.7	1/60
	1.8	1/55
28 Aug 2002	1.4	1/71
	1.9 Average	Total 6/325

APPENDIX 5. Intellectual Property

The intellectual property of this project resides with the Fisheries Research & Development Corporation.

APPENDIX 6. Project Staff

The project staff was Nick Ruello and Judith Woods.