# HANDLING AND PROCESSING OF RAFT-FARMED MUSSELS

by

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*Abstract*

This paper describes the handling and processing of farmed mussels with special reference to keeping mussels alive out of water and to the freezing of shucked mussels.

It was possible to increase the time mussels remain alive out of water from 3 days at ambient temperatures to over 2 weeks with the use of ice and specially designed cardboard boxes.

Unless adequately blanched, mussels develop strong off-flavours within 2 weeks of frozen storage. Off-flavour development can be prevented by using adequate heat treatment; overheating results in a considerable loss of weight and toughening of the meats.

The shelf-life of blanched, frozen and glazed mussel meats is greater than 9 months at $-30^{o}C$.

## INTRODUCTION

Farming the green-lipped mussel, *Perna canaliculus,* is a rapidly growing industry in New zealand. The expected crop from the main growing area in the Malborough Sounds for the 1977/78 season is 500 t, rising to 5 000 t in five years' time.

For many years, small quantities of this mussel have been collected by bottom dredging. Although the flavour of the dredged mussel is similar to the farmed product, its texture is very tough and rubbery and parts of it, such as the adductor muscle, are so tough as to be inedible. The farmed mussel, however, probably because of its fast growth rate, has a much softer texture and its quality is such that it is able to compete with other shellfish such as oysters and scallops.

Mussels on growing raft
↓
Harvested and transported to processing factory

| | |
|---|---|
| ↙ Transported alive in shell to retailer | ↘ Steamed open |
| ↓ Sold as live mussels | ↓ Packed and frozen |
| | ↓ Sold as frozen cooked mussels |

Figure 1. The main outlets for formed mussels

The industry has two main outlets for the product (Fig. 1). Much of the present production is sold fresh in the shell; the live mussels (shellstock) are packed into sacks or cartons and sent direct to the retailer. Increasing quantities are now being steamed open and frozen in catering and retail packs. This paper looks at the handling and processing requirements for maintaining the quality of mussels destined for both of these markets.

METHOD

*Handling shellstock*

A taste panel score sheet has been prepared to assess the freshness of mussels (see Appendix); the mussels are scored for odour, texture and flavour on a scale from 5 for very fresh mussels to 0 when almost inedible. This score sheet was used to determine the rate of spoilage of shellstock under the following conditions:

(i) packed in ice
(ii) held in air at ambient temperatures (15-18°C)
(iii) held in a chillroom at temperatures between 5 and 7°C and relative humidity greater than 95 percent
(iv) held under melting ice at temperatures between 2 and 3°C after the method described by Rama and Metamoros (1973).

Six mussels from each treatment were taken every 24 h, steamed open and submitted to the taste panel for evaluation.

*Steaming open shellstock*

Fresh mussels weighing between 45 and 55 g were opened by heating with live steam at atmospheric pressure for periods of 2, 3, 5, 7, 9 and 10 minutes. The weight loss of the mussel meat during cooking was expressed as follows:

$$\frac{\text{whole mussel} - (\text{shell} + \text{cooked meat})}{\text{whole mussel} - \text{shell}} \times \frac{100}{1} = \%\ \text{weight loss}$$

Organoleptic quality was measured using the taste panel score sheet given in the Appendix; aerobic bacterial counts of the cooked meats were made on nutrient agar incubated at 25°C. In addition, samples were also frozen and stored at −20°C without protective packaging. After 1 and 2 months storage these samples were heated over a water bath in a covered casserole dish and evaluated organoleptically.

*Frozen storage*

Fresh mussels which had been steamed open for 5 min were frozen, glazed in ice water and stored at −20 and −29°C. After 1, 3 and 10 months, the quality was determined as above.

RESULTS AND DISCUSSION

*Handling shellstock*

The loss of flavour of mussel shellstock after removal from the water is shown in Fig. 2. Mussels that had been packed in ice dried very quickly and showed the most rapid loss of flavour. If the quality level acceptable for processing is established at grade 3, the point at which definite off-flavours begin to appear, then iced mussels have a shelf-life of only 2 days.

For mussels held at ambient temperatures (15-18°C), the first mortality occurred after 4 days. Noticeable loss in flavour occurred after only 2 days and the minimum quality grade of 3 was reached after 3 days. It is commonly believed that providing mussels are alive they are of premium quality. This is clearly not the case.

Chilling the mussels to between 5 and 7°C extended the time before flavour losses were detectable to three and a half days; they became unacceptable after five days. Mussels held under ice at temperatures between 2 and 3°C showed the largest increase in shelf life. When chilling by this method was delayed for 24 h after harvest, the quality remained above grade 3 for eight and a half days and the first mortality was observed after nine days. When chilled 4 h after harvest, the mussels remained alive and above grade 3 for fourteen days.

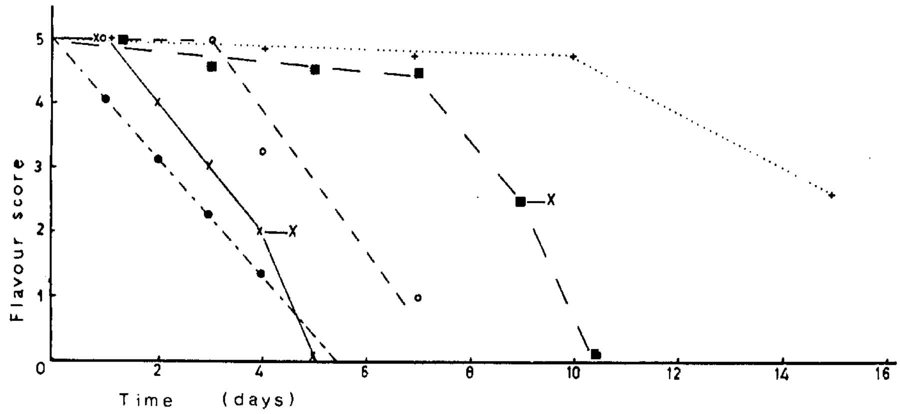


Figure 2 - Flavour changes in mussels held under storage conditions:

- Held in ice
- Held out of water at ambient (15 to 18° C)
- Held in high-humidity chiller (5 to 7° C)
- Held at ambient for 24 h then under ice (2 to 3° C)
- Held under a ceiling of ice 4 h after harvest
- Time of first mortality

*Steaming open shellstock*

Changes in percentage weight loss, bacterial numbers and textural quality with steaming time are shown in Fig. 3. The percentage weight loss of the mussel meats during steaming was 25 percent after the first 3 min with a gradual increase of 34 percent after 7 min. The rate of loss increased further when the cooking times were extended beyond 7 min. During the first 3 min of steaming there was 95 percent reduction in bacterial numbers. Extending steaming times to 10 min produced little further improvement.

Mussels require some heat treatment to prevent rapid loss of quality during frozen storage. Overcooking results in excessive weight loss and adverse textural changes. For the size of mussel used in these experiments, a steaming time close to 5 min appears to be the optimum.

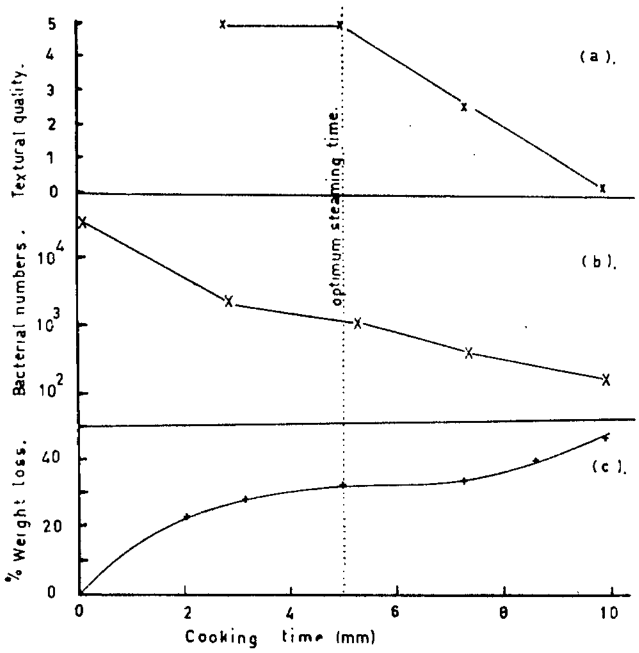


Figure 3 – Changes in textural quality, bacterial numbers, and percentage weight loss with steaming time

*Frozen storage*

Table 1 shows the effect of cooking time on organoleptic quality after 1 and 2 months' frozen storage at −20°C. The uncooked mussels and those cooked for only 3.5 min showed a rapid loss in odour and flavour compared with those cooked for 5.5 min. The mussels cooked for 9.5 min showed an initial quality loss due to overcooking but the scores remained almost constant over the 2 months' storage period.

The loss of quality during frozen storage at −20 and −29°C is shown in Table 2. At −29°C the lower limit of acceptability for odour and flavour is reached after only 3 months' frozen storage; at −25°C this level is reached after 10 months. Banks and House (1958) recommended a storage life of 9 months at −29°C. Commercial storage times of 6 months or longer are often required; this can be achieved only by storage at the lower temperature.

*Table 1*

Quality changes of mussels steamed for various lengths of time during storage at −20°C

| Steaming time (min) | 0 | | 3.5 | | 5.5 | | 9.5 | |
|---|---|---|---|---|---|---|---|---|
| Storage time (months) | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| Odour | 0 | 0 | 2 | 1 | 4 | 3.5 | 3 | 3 |
| Texture | 3.7 | a/ | 4.5 | 4 | 4.5 | 4 | 3.5 | 3.5 |
| Flavour | 2 | a/ | 3 | 2 | 4.5 | 4.5 | 3.3 | 3.2 |

a/ Panel unwilling to taste

*Table 2*

Loss of quality during frozen storage of mussels

| Time (months) | 1 | | 3 | | 10 | |
|---|---|---|---|---|---|---|
| Temperature (°C) | −20 | −29 | −20 | −29 | −20 | −29 |
| Odour | 4 | 4.5 | 3 | 4 | 0 | 3 |
| Texture | 4 | 4 | 4 | 4 | a/ | 3.5 |
| Flavour | 4.5 | 5 | 3 | 4 | a/ | 3 |

a/ Panel unwilling to taste

## CONCLUSIONS

(1) Shellstock held for longer than 24 h out of water should be chilled as soon as possible after harvest by being held under ice.

(2) Carefully controlled cooking times are required to maintain texture and to prevent excessive weight and flavour losses during frozen storage. Uncooked mussels cannot be held in frozen storage.

(3) Frozen storage of mussels for longer than 3 months should be at $-29^{o}C$.

## ACKNOWLEDGEMENT

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## *Appendix*

### *Mussel score sheet*

Cooked odour

*Score*

5 Fresh mussel, salt water, little odour

4 Mild, buttery, milky, thick smell

3 Slightly sweaty, old socks

2 Rubbery, strong sweaty smells

1 Bland, rubbery pumpkin

0 Faecal, vomit, nauseating

Cooked texture

*Score*

5 Soft and juicy

3 Drier, juice runs out on chewing

0 Tough and rubbery

Cooked flavour

*Score*

5 Characteristic mussel flavour, sweet

4 Slight fishy, briney sweet

3 Strong briney, sea-water after-taste, scallop

2 Strong mussels, slightly sweaty

1 Strong mussels, sour after-taste, cabbagy

0 Difficult to taste, nauseating