STUDIES ON HANDLING AND DEPURATION OF GREEN BAY MUSSEL, *Perna veridis*

By

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ABSTRACT

This paper covers two phases of study: phase I deals on how to prolong the life of mussels out of water using different methods such as banana leaves, wet cheese-cloth, ice, and dipping in seawater. It was found possible to keep mussels alive out of water for more than four days at temperatures of $14^{o} \pm 2^{o}C$ with the use of ice with no considerable loss in flavor qualities and nutritive values.

Phase II deals on the home depuration of mussels by using clean seawater, 3% iodized salt solution, 3% coarse salt solution and tapwater. It was found that this method is effective in reducing the microbial load of mussels.

INTRODUCTION

The green mussel *(Perna veridis)* locally known as *tahong* is gaining popularity as a food item not only because of its delicious meat but also because of its high protein and mineral content. However, considering the perishable quality of mussel, there is a need to improve the handling techniques during the transporting and marketing processes.

In Manila, mussels from the Visayas, where they are abundant, are packed in sacks and transported by boats. This poses some problems regarding the large mortality rate in transporting.

Another problem confronting this industry is pollution. Mussels in their natural environment may carry a bacterial load because of their feeding and living habits, the season, the temperature and the quality of waters in which they grow. Before they are consumed, they must be rid of bacteria.

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One way of cleansing mussels of these bacteria is by a process called depuration. This is carried out by soaking the shellfish in water that is free from pathogenic or enteric bacteria and to allow enough time for water to be pumped through the cavity of the mussels.

In the Philippines, unlike in other countries, there is no law prohibiting the sale of mussels which have not undergone depuration. It is therefore necessary to look into proper ways of cleansing mussels in order to safeguard public health.

REVIEW OF LITERATURE

Considering the perishable quality of mussels, the harvest must reach the consumer before the day is over because mussels stay alive for only 24 hours (Obusan & Urbano, 1968).

There are many studies undertaken on mussels but most of them deal with the biology, methods of culture and utilization aspects. A few studies abroad have considered means of prolonging shelf-life so as to make transporting and marketing easy and profitable.

Boyd and Wilson (1978) have found the possibility of increasing the time for mussels (*Perna canaliculus*) to remain alive out of water ranging from three days at ambient temperatures to over two weeks with the use of ice and specially-designed cardboard boxes.

PHASE 1. HANDLING OF MUSSELS

EXPERIMENTAL PROCEDURE

A. *Raw Materials*

All mussels used in the study were cultured in Bacoor Bay thru the staking method. The byssus was retained in all the samples.

In Phase I of this study the experiment was conducted immediately upon harvest at the culture site.

B. *Methodology*

1. Ways of Keeping Mussels Alive During Transport

Mussels immediately after harvest were washed in clean seawater and sorted according to size. Sizes for the study ranged from 5.2 to 6.9 cm. The cleaned mussels were divided into five lots, each consisting of 100 pieces:

Lot A – Mussels packed in bamboo baskets and covered with fresh banana leaves on top and at the bottom. The leaves were not changed throughout the duration of the study.

Lot B – Mussels packed in a perforated polyethylene bag and stored in a styropore box containing ice at a ratio of 1:4 (ice to mussel by weight).

Lot C – Mussels were placed in a bamboo basket and covered with wet cloth on top and at the bottom. The cloth was always maintained wet with tapwater throughout the experiment;

Lot D – Mussels were packed in a plastic sack measuring 10 x 12 inches. Every 12 hours for 30 to 40 mins., the lot was dipped in seawater kept in a tank inside the room where the experiments were conducted.

Lot E – This lot which served as the control was placed on a tray and exposed without any treatment.

The mussels stored in a styropore boxes did not come in direct contact with the ice. This was made possible by a wire screen platform placed over the ice as shown in Figure 1, below. The screen rests on supports on four corners so that it is above, and does not touch, the ice. Through a hole on one side of the box about the level of the wire screen, a thermometer is inserted to measure the temperature inside the styropore box. Icing was done every six hours.

All five lots were stored at room temperature (30° ± 2°C).

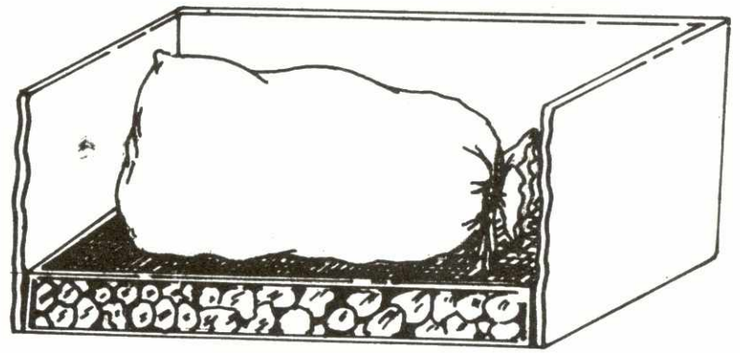

Fig. 1. Cross section of the styropore box used for storing mussel in ice.

Dead mussels were counted and removed every 12 hours until the 60th hour. A mussel was considered dead if it was open and would not close when pressed.

The percentage of mortality was computed using the following formula:

$$\% \text{ mortality} = \frac{\text{number of dead mussels}}{\text{original number of mussels}} \times 100$$

2. *Chilling as a Means of Keeping Mussels Alive*

In order to determine the appropriate temperature at which mussels may be stored to keep them alive, experiments using different proportions of ice were conducted.

Mussels were washed in tap water, sorted and divided into five lots, each containing 100 pieces. The sizes of the mussels ranged from 5.3 to 7.2 cm.

Except for Lot A, mussels were packed in perforated polyethylene bags and stored with ice in styropore boxes as shown in Figure 1.

Lot A – Mussels which served as the control were placed in an open box without any treatment.

Lot B – Mussels with ice at a ratio of 1:2 (Ice to mussel by weight);

Lot C – Mussels with ice at a ratio of 1:4;

Lot D – Mussels with ice at a ratio of 1:4 with rice husks sprinkled on the ice;

Lot E – Mussels were packed and stored in ice at a ratio of 1:6 proportionately.

All lots were kept at room temperature ($30^\circ \pm 2^\circ$C). The temperature for each lot was recorded twice a day. Re-icing was done every 4 to 5 hours. Dead mussels as mentioned earlier, were counted and removed every 12 hours until the 96th hour. The percentage of mortality was taken.

3. *Effects of Packaging Materials in Keeping Mussels Alive*

Perforated polyethylene bags and plastic sacks were used in this study to determine their effectiveness as packaging materials as these are stored in ice.

Mussels were washed and sorted into four lots, each containing 100 pieces. The sizes of the mussels ranged from 5.5 to 7.0 centimeters.

Lot A – Mussels were divided separately into 2 and packed in two perforated polyethylene bags and stored in a styropore box with ice at a ratio of 1:4. The mussels were counted after the 48th and 72nd hours. A second trial was done.

Lot B – Mussels were divided into two and packed separately in two plastic sacks measuring 10 x 12 inches, stored in a styropore box with ice in the same ratio as Lot A and counted after 48 and 72 hours. A second trial was done.

Re-icing was done every 4 to 5 hours. The temperatures of the styropore boxes were maintained at $14^\circ \pm 2^\circ$C.

Before packing, a few mussels were segregated for chemical analysis for fat (Soxhlet method), protein (Kjeldahl method), NaCl content (Volhard method), and moisture content (O'haus moisture tester)

At the end of the study, the same analyses were undertaken on the samples to find out if there was any loss in the nutritive content after prolonged storage.

Using the 9-point Hedonic scale, sensory evaluations for flavour were undertaken by a taste panel composed of seven members. The samples were steamed for 15 minutes. Evaluation was done on the first and fourth day of storage to find out if there was considerable loss in the flavour qualities of the mussels.

RESULTS AND DISCUSSIONS

1. *Survival of Mussels Using Different Methods of Keeping them Alive*

Table 1 shows the percentage survival of mussels using different methods of keeping them alive out of water i.e., covered with wet cloth, covered with banana leaves, dipped in seawater and the use of ice. Mussels which did not receive any treatment had the first mortality occurring after 12 hours; those covered with banana leaves and wet cheesecloth, after 24 hours; and those dipped in seawater, after 36 hours. No mortality was noted until after 48 hours for mussels packed in ice at a ratio of 1:4. This lot had the least mortality than other methods even after 60 hours. This study indicates that the use of ice in that proportion very effectively keeps mussels alive out of water for as long as four days.

2. *Effect of Chilling Mussels*

The life of mussel is prolonged when stored at low temperature up to

Table 1. Percentage survival of mussels using different methods of prolonging shelf life.

Counting	Control	Covered w/banana leaf	Covered w/wet cloth	Dipped in sea-water	1:4 (ice to mussel proportion)
Hours	Per cent	Per cent	Per cent	Per cent	Per cent
0	100	100	100	100	100
12	97	100	100	100	100
24	92	98	96	100	100
36	71	80	75	92	100
48	26	50	30	60	100
60	0	7	2	8	86
95	–	–	–	–	40

four or five days of storage. However, the percentage survival varies depending upon the storage temperature attained with the use of varying proportions of ice to mussel. It has been noted that a 1:4 ratio was very effective in prolonging the life of mussel (Table 2). The addition of rice husks to this porportion slightly increases the temperature in the box and helps in preventing lower mortality. There was low percentage of survival in the 1:2 and 1:6 proportions. The low temperature of the former and the high temperature of the latter are conditions unfavorable for the animal to survive. It can be said that at temperatures of 14° ± 2°C, mortality of mussels is greatly reduced.

Table 2. Percentage survival of mussels packed in polyethylene bags and stored in styropore box containing varying proportions of ice.

Counting (hours)	Control (%)	Proportion of Ice to Mussel Used 1:2 (3° ± 2°C) (%)	1:4 (14° ± 2°C) (%)	1:4 w/rice hull (15° ± 2°C) (%)	1:6 (21° ± 2°C) (%)
0	100	100	100	100	100
24	77	100	100	100	93
36	50	90	88	99	90
48	18	85	83	96	85
60	0	59	72	86	53
72		54	64	76	46
84		49	55	65	38
96		26	36	44	22

3. *Effects of Packaging Matetials in Keeping Mussels Alive*

Table 3 shows that chilling mussels packed in a perforated polyethylene bag at a temperature of 14° ± 2°C has a higher percentage survival than those packed in a plastic sack.

Table 3. Comparison of percentage survival of mussels packed in perforated polyethylene bag and plastic sack stored in styropore boxes with ice at a temperature 14° ± 2°C.

Counting Hours	Per cent (%) Survival of Mussels: Packed in Plastic Sack			Packed in Polyethylene Bag		
	Trial I	Trial II	Average	Trial I	Trial II	Average
0	100	100	100	100	100	100
48	81	85	83	88	86	87
72	38	43	41	46	52	49

4. *Nutritive Loss of Ice-Stored Mussels*

Chemical analysis on the protein content of mussels showed minimal loss after four days of storage at chilling temperature (14° ± 2°C). A decrease in the sodium chloride, fat and moisture content of stored mussels was noted; however, the loss may be considered negligible. These losses are due to the absence of food for the mussels while under experimentation (Table 4).

Table 4. Change in the nutritive content of mussels packed in a polyethylene bag after four days of storage at ambient temperature of 14° ± 2°C

Nutrients	Initial (%)	After Four Days of Storage (%)
Protein	12.50	11.56
Fat	2.73	2.67
Sodium Chloride	5.56	5.44
Moisture	78.58	77.50

5. *Sensory Evaluation of Cooked Mussels After Experimentation*

The results of the sensory evaluation of the cooked mussels after having been chilled for one and four days, respectively, using the Hedonic Scale rating for flavour qualities are shown in Table 5. The statistical analysis for flavour scores showed that there is no significant difference in taste between the one and the four day old samples. It can also be said that prolonged storage in ice whether packed in a plastic sack or polythylene bag does not significantly affect the taste of mussel (Table 6).

Table 5. Average sensory scores* for flavor of cooked mussel meats on the 1st and 4th days as stored in temperature of 14° ± 2°C.

Days of Storage	Packed in Plastic Sack	Packed in Polyethylene Bag
1	8.0	8.0
2	8.0	7.5
4	7.5	7.5

*Numerical scoring code:

9 – like extremely
8 – like very much
7 – like moderately
6 – like slightly
5 – neither like nor dislike
4 – dislike slightly
3 – dislike moderately
2 – dislike very much
1 – dislike extremely

Tabl 6. ANOVA chart for sensory scores for flavor of cooked mussel meats on the 1st & 4th days when stored in temperature of 14° ± 2°C.

Source Variance	df	SS	MS	Fc	Ftab
Samples	1	.04	.04	2.0	7.71*
Storage days	2	.25	.12	6.0	6.94
Error	4	.09	.02		
TOTAL	7	.38			

*Fc < Ftab for both samples and storage days.

PHASE II. METHODS OF MUSSEL DEPURATION

EXPERIMENTAL PROCEDURE

Mussels were purchased in Bacoor, Cavite fish landing, washed with clean seawater and sorted according to size which ranged from 5.0 to 6.5 centimeters and divided into 5 lots, each with 150 pieces.

Lot A – Control (Mussels were placed in a basin without water);
Lot B – Mussels were submerged in tap water;
Lot C – Mussels were submerged in clean seawater;
Lot D – Mussels were submerged in 3% iodized salt solution:
Lot E – Mussels were submerged in 3% coarse salt solution

All lots were kept at room temperature for a period of three days. Cleansing solutions were changed every sampling period, i.e., at 0, 18, 26 and 44 hours of depuration. Rate of mortality was also observed every sampling period.

Microbial analysis for total plate count (TPC) and coliform count (CC) was undertaken just before changing the cleansing solutions.

RESULTS AND DISCUSSIONS

Mussel Depuration

The coliform count of all samples was high which was an indication that the area where the samples were cultured was polluted.

Aside from the TPC, the coliform count was also determined, considering that Coli-organisms are the most possible polluting bacteria present in shellfishes.

Table 7 shows the total plate count (organisms/gm sample) and coliform count (most probable number/gm. sample) of mussels depurated in different cleansing solutions.

Results show that mussels depurated in 3% coarse salt solution proves to be the most effective cleanser after 18 hours. Mussels soaked in 3% iodized salt solution and clean seawater have lower counts after one and two days, respectively. However, there was an increase on the coliform count after 44 hours of depurating in tapwater. This may have been brought about by the deterioration of dead mussels in the container between the 26th and 44th sampling hours.

It was further observed that on the 44th hour of depuration, almost 75% of the samples for each lot was already dead. Depuration until after 26

hours led to a minimal of 3% to 5% mortality on all samples. Mortality was also noted to be lowest for samples depurated in clean seawater throughout the duration of the study.

US Food and Drug Standards for Raw Marine Products requires MPN Coliform to be less than 300 per gram. This standard would, however, vary for each importing country.

SUMMARY AND RECOMMENDATIONS

Proper and careful handling of mussels immediately after harvest is necessary in keeping them alive. Aside from this, it was found possible to increase the time for mussels to remain alive out of water for more than four days at temperature of $14^{\circ} \pm 2^{\circ}C$ with the use of ice with the first mortality occurring on the second day. Storing mussels in styropore box with a 1:4 ice to mussel proportion has been found to be ideal in prolonging their lives up to four days with no considerable loss in flavour qualities. It can be considered that nutritive losses due to prolonged storage is quite minimal.

Based on this study, it is recommended that another study be made on the commercial feasibility of the use of 1:4 ice to mussel proportion which will assure entrepreneurs of better economically viable business transactions; the consuming public, on the other hand, on more and better quality supply of mussels.

These results will benefit those involved in the fishing industry to expand marketing outlets for mussels to places which would require longer time of transporting them. This will also serve as a guide for exporters who may wish to transport live mussels to other countries.

Depurating mussels in clean seawater, 3% iodized salt solution, 3% coarse salt solution and tapwater are effective in reducing the microbial load of mussels.

For home consumption, mussels must be depurated in 3% coarse salt solution (6 tsp in 5 cups of water) for 18 hours or one day.

The method of depuration studied here will be more useful to housewives who may want to make sure their mussels are cleansed of microorganisms. Other ways of depurating mussels as practiced in other countries should further be looked into. This includes depurating mussels in a cleaner sea area or in a depuration plant.

Table 7. Total plate count (organisms/gm. samples) and coliform count (MPN/gm.) of mussels depurated using different cleansing solutions.

SAMPLING PERIODS	CONTROL		CLEANSING SOLUTIONS							
			3% Coarse Salt		3% Iodized Salt		Clean Seawater		Tap Water	
	TPC	CC	TPC	CC	TPC	CC	TPC	CC	TPC	CC
INITIAL (HRS.)	78,000	2,400	78,000	2,400	78,000	2,400	78,000	2,400	78,000	2,400
18 HOURS	TNTC10^4	2,400	53,000	220	37,000	1,600	39,000	1,600	45,000	2,400
26 HOURS	TNTC10^4	2,400	7,200	45	3,000	540	10,000	920	44,000	920
44 HOURS	TNTC10^4	2,400	5,300	39	2,500	180	3,500	280	TNTC	2,400

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