2011 2nd International Conference on Biotechnology and Food Science
IPCBEE vol.7 (2011) © (2011) IACSIT Press, Singapore

Effect of Pre-cooling on Muscle Yield of Mud Crab, *Scylla serrata,* During Emersion Storage

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***Abstract*— Live mud crab was pre-cooled with different temperatures during emersion storage at room temperature (27±1ºC). The treatments were done pre-cooling at 5°C for 5-15 min and pre-cooling at 10°C for 5-15 min. The effect of pre-cooling could decrease stress response and delayed loss of muscle yield. The pre-cooling with dipping at 5ºC for 5 min extended the 100% survival rate and high remained muscle yield more than other treatments, the percentage of muscle yield after 7 days lost to 18.13±2.65%. In addition, the relationship of muscle yield was also correlated with total body weight in pre-cooling at 5°C for 5 min (R^2=0.8343). The result indicated that the pre-cooling method may be useful for the handling process and transport of mud crabs.**

Keywords -mud crab; pre-cooling; emersion storage; muscle yield

I. INTRODUCTION

Mud crab, *Scylla serrata*, (Forskal) is one of the most important edible shell-fish. The production of mud crab in Thailand is mostly from aquaculture in eastern and southern of Thailand such as Trad, Chantaburi, Ranong, and Surat Thani. They are sold primarily in the live state, although some are sold as frozen and cooked products. Live mud crabs reach very high prices, where they are regarded as a luxury food.

During the process of live cultured mud crabs for market, there are a number of conditions to which they are subjected. In some circumstances, post-harvest handing conditions can have a negative impact on the crabs and may induce stress responses that may lead to reduced quality and survival of live crabs. The method of chilled packing has been shown to minimize respiratory requirements, anaerobiosis and to extend the duration of shipping [9]. Improved handling can reduce physiological changes of animals that lead to delay loss of quality. Taylor and Whiteley (1989) showed that reducing O_2 consumption of prawns by cooling which makes them less susceptible to stress. Samet et al., (1996) reported that using long pre-cooling periods will prolong the survival of prawns during transport. According to this report, the pre-cooling method could decrease stress response and delayed loss of biochemical changes of mud crabs. The best condition of pre-cooling process was the dipping mud crab in 5ºC seawater for 5 min [8].

The present study, therefore, investigated the changes in the muscle yield of mud crab reflected by using pre-cooling before storage, which will be useful to processor, exporter, and nutritionalist in assessment of their quality.

II. MATERIALS AND METHODS

A. Animals

Adult intermolt *Scylla serrata* (male) with an average body weight of 150 g (145 -155 g) and an average carapace width of 9 cm (range 8-10 cm) were obtained from commercial farms in Chantaburi province, Thailand. The crabs were transported to and maintained in the laboratory of the Department of Food Science and Technology, Rambhai Bharni Rajabhat University. All crabs were acclimated for one week prior to experimentation in polypropylene tanks with aerated seawater, mean salinity of 33±2 ppt, mean temperature of 27±1°C under natural light-dark condition. During this period, the crabs were fed every day with chopped mussel tissue, and the seawater was changed every few days.

B. Experimental design and Muscle sample preparation

The experimental live crabs were divided into seven groups with three replications in each group. They were exposed to seven different methods of pre-cooling process: (1) non pre-cooling (control), (2) pre-cooling at 5°C for 5 min, (3) pre-cooling at 5°C for 10 min, (4) pre-cooling at 5°C for 15 min, (5) pre-cooling at 10°C for 5 min, (6) pre-cooling at 10°C for 10 min, and (7) pre-cooling at 10°C for 15 min. Each crab was accommodated in a styrofoam case (20 x 33 x 18 cm) and stored at 27±1°C for 7 days. Crabs were removed everyday and muscle samples were analyzed.

For the effect of condition based on the previous experiment for relationship between muscle yield and total body weight, live crabs at optimum sixty crabs were packed into a 20 x 33 x 18 cm styrofoam cases and stored in room temperature at 27±1ºC for 48 hr. The relationship between total body weight and muscle yield were determined by linear regression.

C. Analyses

Before cooking, the total body weight of crab were recorded. Crab was placed in a freezer at -10°C for 1 hr and then was cooked with stream at 100°C for 8 min. All muscles were separated from the exoskeleton and weighed. The muscle yield was calculated according to Chiou and Huang (2003) as follows:

$$\text{Muscle yield (\%)} = \frac{\text{(muscle weight)}}{\text{(total body weight)}} \times 100\%$$

$$\text{Muscle loss (\%)} = \frac{\text{(weight loss of muscle yield)}}{\text{(initial weight of muscle yield)}} \times 100\%$$

Statistical analysis was performed using the Analysis of Variance (ANOVA) followed by Duncan's Multiple Range Test ($p < 0.05$)

III. RESULTS AND DISCUSSION

The effects of pre-cooling temperature and holding duration of time resulted in a decrease of muscle yield. At all treatments, the muscle yield lost as the duration of emersion storage and pre-cooling temperature were increased. At 5ºC of pre-cooling, the loss of muscle yield was less than at 10ºC of pre-cooling and non pre-cooling, which that longer pre-cooling periods resulted in loss of muscle yield higher than short duration of holding at low temperature (Table 1). The greatest loss of muscle yield was occurred in mud crabs at non pre-cooling treatment to 30.11±2.53% on the seventh days storage, which a level significantly difference from pre-cooling 5ºC 5 min and pre-cooling 10ºC 5 min with averaged 18.13±2.65 and 26.31±2.01% on 7 days storage, respectively. However, pre-cooling at 5ºC for 10-15 min and pre-cooling at 10ºC for 15 min, death of crabs also found approximately 100% on 3 days storage. Where as at pre-cooling 10ºC for 10 min, crab died approximately 100% on 4 days storage.

The correlation between muscle yield and total body weight was shown in Fig. 1. A significant positive correlation between muscle yield and total body weight was found in pre-cooling with 5ºC for 5 min and 10ºC for 5 min (R^2=0.8343 and R^2=0.7851), and control storage (R^2=0.5258), respectively. Whereas pre-cooling with 5ºC for 10-15 min and 10ºC for 10-15 min, the proportion of muscle yield and total body weight showed weak correlation with R^2=6906, R^2=0.6384, R^2=0.5258 and R^2=3643, respectively.

Loss of muscle yield may result from high metabolic rate of crabs during emersion storage and reactions that lead to chemical changes of proteins and lead to an increase in drip loss [6]; [7], glycogen loss and lactate accumulation. It has been reported that body weight losses of prawns occurred after 18 hr of air exposure; and the prawns died when there was approximately 16% loss of the initial body weight. Samet et al., (1996) described that may result from a reduction of haemolymph volume as well as a slight decrease of the muscular water content. The increase in the viscosity of the haemolymph may cause problems on circulation and oxygen delivery which result in death. Similar results have been reported by Samet et al., (1996) which found that using long pre-cooling periods will prolong the survival of prawns during transport. Morris and Oliver (1999) who measured lactate concentration in muscle of lobster, *J. edwardsii.* Before chilling, the lactate concentration was 3.9 mmol/kg. In non-chilled and chilled lobster (lobster was dipped in 5°C seawater for 2 min before packaged), the concentration had increased to 9.76 mmol/kg and decreased to 0.90 mmol/kg after 10 hr emersion storage, respectively. Thus, this result indicated that the pre-cooling process could reduce accumulation of lactate and glycogen during emersion period by reducing O_2 demand and thereby delaying the onset of anaerobiosis. Moreover, The difference in yield loss may result from the unacceptably high metabolic rate of the crabs when they are directly transferred to different temperature from the optimum temperature. The elevated metabolic rate will probably lead to depletion of tissue glycogen concentration [5] and a move premature exhaustion of tissues. Paterson, Goodrick, and Grauf (1993), who suggested that the beneficial effect of cooling in the reduced activity of the animals during packaging and in the reduced metabolic rate during live transport. Paterson (1993) indicated that the main effects of chilling procedure was related to the temperature-induced anaesthesia which allowed the animals to be handled without signs of stress. However, the result of pre-cooling with 5ºC for 5 min was positive relationship more than those of other storage. Thus, a linear regression model can be utilized to determine the muscle yield of live mud crab, especially a linear regression model of fresh mud crab at initial storage.

TABLE 1 PERCENTAGES LOSS OF MUSCLE YIELD (MEANS ± SD) OF MUD CRAB DURING EMERSION STORAGE AT ROOM TEMPERATURE (27±1°C)

Process	Storage time (days)						
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Non pre-cooling	0.00	^{a}4.20±2.31	^{a}8.18±3.06	^{a}10.54±3.45	^{a}15.67±2.45	^{a}20.12±3.67	^{a}26.87±2.78	^{a}30.11±2.53
Pre-cooling 5ºC								
5 min	0.00	^{b}2.11±3.10	^{c}4.30±2.59	^{c}6.54±3.51	^{b}10.86±2.74	^{b}12.59±3.30	^{b}13.74±2.42	^{b}18.13±2.65
10 min	0.00	^{b}2.13±3.05	^{b}4.51±2.31	-	-	-	-	-
15 min	0.00	^{b}2.20±2.76	^{b}4.59±3.11	-	-	-	-	-
Pre-cooling 10ºC								
5 min	0.00	^{b}2.21±2.43	^{b}4.55±2.10	^{b}7.08±2.67	^{b}11.20±3.26	^{b}15.11±2.69	^{c}20.23±3.01	^{c}26.31±2.01
10 min	0.00	^{b}2.25±3.11	^{b}4.60±2.42	^{b}7.12±3.10	-	-	-	-
15 min	0.00	^{b}2.26±2.50	^{b}4.63±2.02	-	-	-	-	-

^{a,b} different letters in the same column indicate significant differences ($p< 0.05$)

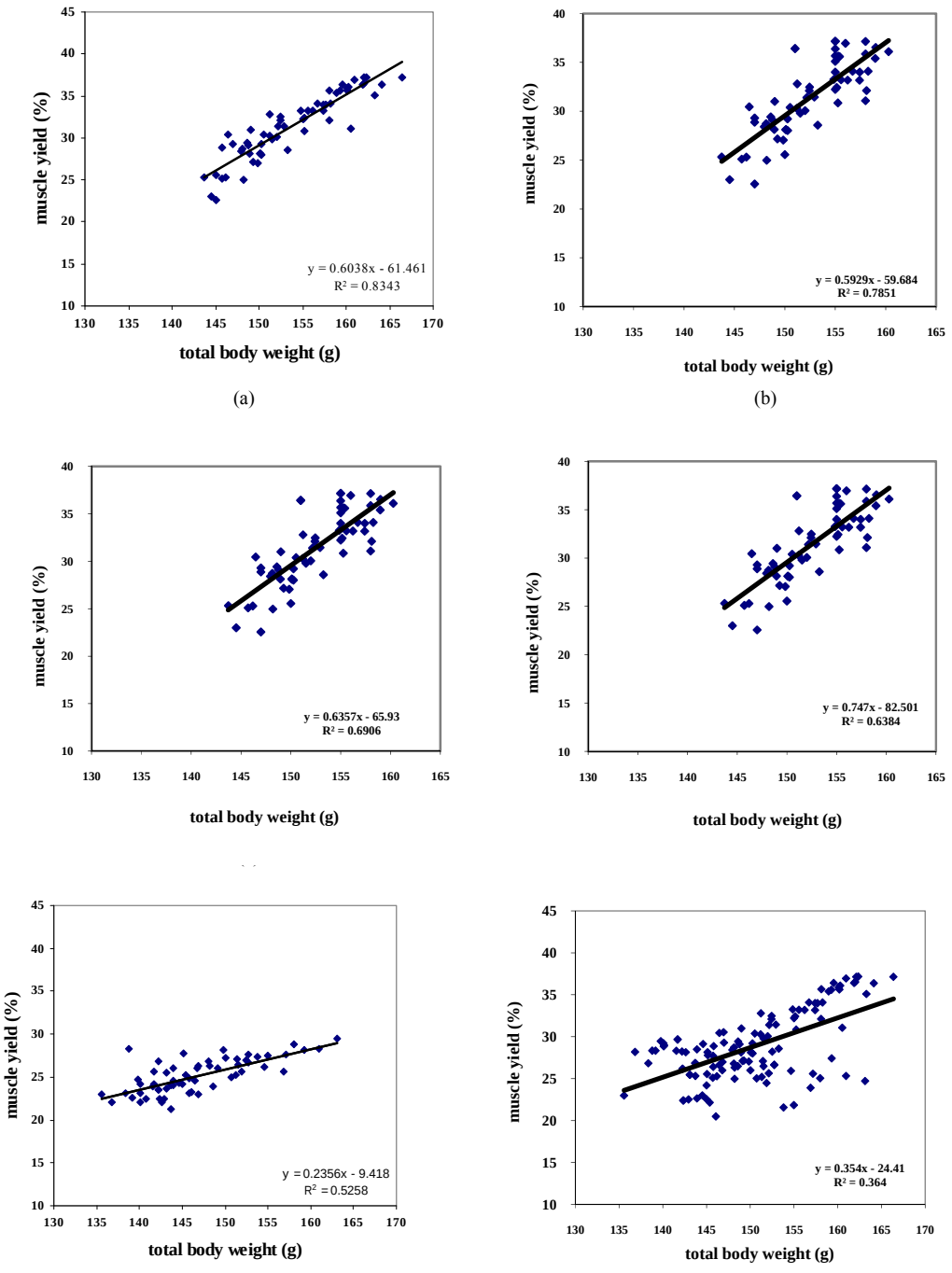

Figure 1 The relationship between muscle yield and total body weight of mud crab

(a) pre-cooling at 5°C for 5 min, (b) pre-cooling at 5°C for 10 min,
(c) pre-cooling at 5°C for 15 min, (d) pre-cooling at 10°C for 5 min,
(e) pre-cooling at 10°C for 10 min, and (f) pre-cooling at 10°C for 15 min.

In conclusion, the present study showed that pre-cooling process had a direct effect on stress of crabs which that lead to an decrease in meat crab. This process seemed to decrease metabolic activity of crabs which resulted in longer survival and reduced changes of physiology and quality of crabs. Which that the best condition of pre-cooling process was the dipping mud crab in 5ºC seawater for 5 min. This condition extended the 100% survival rate and high remained muscle yield more than other treatments. Therefore, this indicates that pre-cooling can be used for the process of preparing live mud crab before transportation in emersion storage conditions.

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