Processing and Pigment Stability of Cooked and Frozen Cockle, *Fulvia mutica*

Tae-Jin BAE, Sung-Woo KIM, Ok-Soo CHOI*, Hoon-I KANG, Seong-Min PARK and Kui-Shik KIM

Department of Food Science and Technology, Yosu National Fisheries University, Yosu 550-749, Korea

**Department of Women's Liberal Arts, Sunchon Junior Technical College, Sunchon 540-744, Korea*

Processing condition and pigment maintenance of cockle, *Fulvia mutica* were studied. Proximate composition of whole meat was 82.3% moisture, 10.8% crude protein, 0.8% crude lipid, 2.5% carbohydrate and 3.1% crude ash, and that of foot muscle was 80.6%, 12.3%, 0.3%, 2.9% and 3.3%, respectively. When the living cockle was soaked in 2% NaCl solutions, about 90% of silt and mud was removed after 10 hours soaking, and over 92% was removed when the pH was adjusted to 7.5. When the pigment destruction was tested by 40 seconds at 75℃, 80℃, 85℃, 90℃ and 95℃, retention ratios of pigment in cockle were above 95% at all temperature. Soaking in ethanol for 5 minutes resulted in strong adhesion of pigment to meat. Soaking in seasoning liquid containing 10% soy sauce, 5% wasabi, 5% sugar, 2% vinegar, 2% powdered garlic for 3 minutes was effective for instant processing of cooked and frozen cockle after thawing. After 60 days storage at −20℃, the contents of moisture, crude lipid, carbohydrate, ash and salinity were not changed so much, and pH and TBA values increased to 6.6 and 0.3 compared with 6.2 and 0.2, respectively, while pigment absorbance at 226 nm was decreased from 2.7 to 2.3. However, in case of 60 days storage at −45℃, there was no change in these compositions.

Key words : Cockle, *Fulvia mutica*, pigment maintenance, processing condition

Inrtoduction

Cockle is a shellfish which inhabits mainly in mud flat located between Jinhae Bay and Kohung Bay of the southern sea, Korea, and especially reddish brown colored long foot of soft body gives atract public flavor (Yoo, 1979). A haul of cockle has been discontinued for a while as the reduction of production quantity. However, after the construction of the tide embankment, Asan Bay in west sea, it has been mass-produced since 1987 (Park, 1990). Cockle was expected to increase enormously in the process of stabilizing of the ground in the sea area where the tide embankment was constructed, but it has not been examined closely (Kweon, 1992). Because of its sweet taste, cockle has been considered as high-priced product and is mostly exported to Japan after blanching and freezing, and used for making a raw dish.

The annual production of cockle in Korea was 11,226 M/T in 1993 and 6,551 M/T in 1994. However the sum of exportation of blanched and frozen cockle was 2,363 M/T in 1994, which was only 36.1% of the total production (The Fisheries Association of Korea, 1995). It is difficult to export all the product, because cockle looses its quality by discoloration and by losing some amount of reddish brown pigments on long soft body in the process of shedding, blanching, freezing and thawing. So far, reports related with cockle have been mainly concerned about its ecology (Yoshida, 1953; Inoue, 1955a; 1955b; 1955c; Ogushi et al., 1971; 1973; Hotta, 1977; Kim, 1981; Chang and Lee, 1982) and artificial cultivation (Matsuoka et al., 1968; Nishihiro, 1980), but in view of food scientific, a few studies had been done refering to component composition (Kim et al, 1993a; 1993b). There has been no report about investigation of pretreatment and processing of cockle.

Our objectives of the present study were to investigate the method of processing to prevent losing reddish brown pigment on long soft body in the process of shedding, blanching, and freezing treatment and to improve the quality of cockle.

Materials and Methods

Materials

Cockles harvested off the Kyung-Do coast of Yosu city were purchased from October 1995 to May 1996, and immediately delivered to laboratory and then silt and mud was removed from living shell. After shedding and seperating soft body, cockle were stored at −40℃. The size of cockle was 8.2 ± 0.6 cm in length, 4.8 ± 0.3 cm in height, 7.7 ± 0.4 cm in width. And total weight was 105.8 ± 11.2 g and total soft body weight seperated by shedding was 34.4 ± 7.4 g.

Removing silt and mud from samples

In order to remove silt and mud from cockle, a living cockle was soaked in 10 l distilled water whose salt concentrate and pH was adjusted. This was followed by filtering and drying the soaking water and then weighing. The total silt and mud weight were determined by adding the amount of dried silt and mud physically separated from the shell and the amount of silt and mud gained through the above method. From the total silt and mud quantity, excretion percent was calculated as the rate of excretion.

Investigation of blanching and processing fitness

The retention of pigment were measured after cooling the blanched soft body which had been soaked in twentyfold of 3% NaCl solution, and its temperature and soaking time were variously controlled. Although cockles are blanched and frozen for preservation and circulation. In this study, cockle was soaked in flavoring sauce in advance for direct consumption after thawing (Table 1) and frozen, thawed, and sensory evaluation was performed.

Table 1. Compositions of recipe for seasoned foot of cockle (%)

	A	B	C
Soybean sauce	10.0	10.0	10.0
Wasabi	5.0	5.0	5.0
Sugar	5.0	5.0	5.0
Vinegar		2.0	2.0
Powdered garlic			2.0
Powdered red pepper			3.0

Stabilization of pigment

In order to prevent loss or discoloration of pigment in the process of pretreatment such as shedding and washing of cockle or blanching, cockle was immersed in ethanol, BHA, various kinds of organic acid solution, and blanching water and then pigment quantity of cockle was measured.

Measurement of cockle pigment

After the pigment removed from cockle's soft body in distilled water, it was filtered on the glass filter (3 G-4), and then 30 ml of 4% TCA solution was added to the extract to remove protein. Washing with 50 ml distilled water was repeated 3 times, and the extract was filtered on the glass filter, dissolved in 2N NaOH and then absorbance was measured at 226 nm.

Analysis of general compositions

Contents of moisture, carbohydrate, crude protein, crude lipid, and ash were determined using the method of normal pressure heating and drying, semi-micro Kjeldahl, Soxhlet, Somogy, and direct burning, and salinity was determined using the method of Mohr.

Results and Discussion

General compositions of samples

Samples were divided into three parts as whole

Table 2. Proximate compositions and body weight of cockle (%)

Component	Whole	Foot	Etc.
Moisture	82.3	80.6	83.1
Crude protein	10.8	12.3	10.7
Crude lipid	0.8	0.3	1.0
Carbohydrate	2.5	2.9	2.0
Crude ash	3.1	3.3	2.9
Salinity	1.3	1.1	1.4
pH	6.7	6.7	6.8
Weight (g)	54.5 ± 9.6	34.4 ± 7.4	16.7 ± 5.2

meat, soft body tinged with reddish brown color (foot) and the others, to analyze general compositions, and the results are shown in Table 2.

Proximate composition of whole meat were 82.3% moisture, 10.8% crude protein, 0.8% crude lipid, 2.5 % carbohydrate and 3.1% crude ash. And that of foot muscle was 80.6% moisture (which is slightly lower than that of whole meat), 12.3% crude protein (which is slightly higher than that of whole meat), and that of other parts were similiar with whole meat.

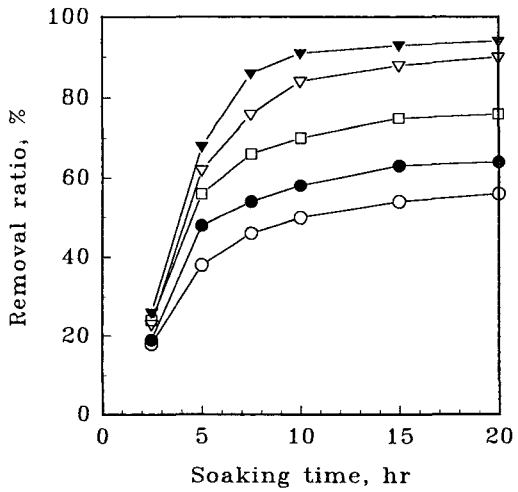

Fig. 1. Influence of salt concentration on the removal of silt and mud in cockle.
○ : Fresh water ● : 1.0% salt soln.
▽ : 1.5% salt soln. ▼ : 2.0% salt soln.
□ : 3.0% salt soln.

Excretion of silt and mud

Cockle usually inhabits at the mud flat in the interior of bay, and it should be immediately shedded and processed after it was hauled. As it hold silt and mud itself, processing of cockle usually have some difficulties. When un-shedded cockle is kept in cold storage for 2 or 3 days, it was still alive, and the pigment of soft body maintained in a good condition even it was shedded. But after shedding, it is difficult to wash silt and mud since the pigment is easily taken off from soft body in short time or when it contacts with water. Therefore, to remove silt and mud of living shell, cockle was soaked for 20 hours in NaCl solution, and the excretion effect of silt and mud are shown in Fig. 1. In case of soaking in 2% NaCl solution, excretion of silt and mud was most effective and the maximum value of 90% at 10 hours. In 3% NaCl solution, of which salt concentration is similiar to the sea, removal ratio of mud after 10 hours, soaking was about 70%. Soaking in 1% NaCl solution and fresh water was less effective as about 50% was removed after 10 hours. The pH of soaking water was adjusted from 7.0 to 9.0, and the results are shown in Fig. 2. The excretion of silt and mud was significant effected by pH. The removal ratio with adjustment of pH 7.5 was above 92% at 10 hours, soaking and marked the maximum value of 96% at 20 hours. At pH 8.0, the removal ratio of mud was slightly lower than that of pH 7.5 but it was still effective as 93% at 20 hours, soaking. Those effective pH range is in accord with that of normal first degree of sea water. But the removal ratio at pH 7.0 was about 70%, and at pH 9.0, it was very low as 60 % at 10 hours, soaking and 70% at 20 hours, soaking.

Blanching condition and processing fitness

In the general processing of cockle for export, the soft body tinged with deep reddish brown color is seperated after shedding and is shaped into a fixed form, frozen and then exported. In order to get the quality for export, first of all, soft body,s color should be deep black and the size and thickness of meat

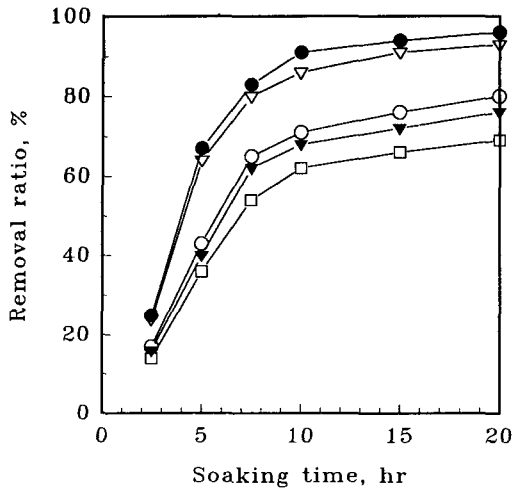

Fig. 2. Influence of pH on the removal of silt and mud in cockle.
○ : pH 7.0, ● : pH 7.5, ▽ : pH 8.0
▼ : pH 8.5, □ : pH 9.0

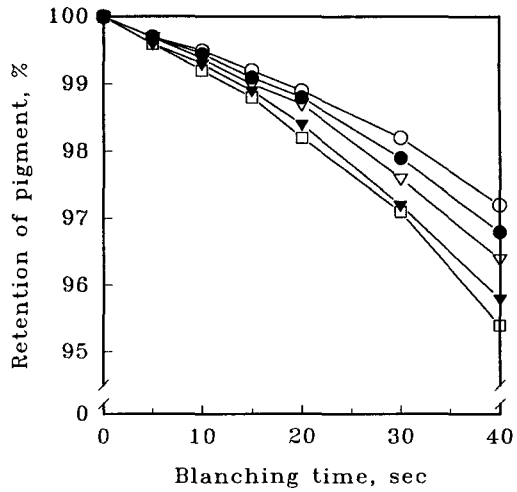

Fig. 3. Influence of blanching time on the retention of pigment separated from cockle.
○ : 75℃, ● : 80℃, ▽ : 85℃
▼ : 90℃, □ : 95℃

parts should be regularly big and thick. The quality of cockle can be easily dimished by loosing the reddish brown colored pigment during the blanching process. So, controlling the blanching time and maintaining the blanching temperature is an important factor in accord with size of soft body, thickness of meat, and character of sample such as season of spawning. In general, blanching process on the spot performed using 200 l blanching water (3% NaCl solution of which temperature is 95℃) per 3 kg of sample for 15 seconds and this process is repeated several times with changing the blanching water. In case of blanching several times with the same blanching water, it is difficult to maintain the temperature and sometimes blanching time is extended at temperature blow 95℃. According to Hotta (1977), when the blanching process was prolonged because of its low temperature of blanching water, meat became tough and was discolored in contrast with the meat blanched for 15 seconds at 95℃, and poor blanched meat was partly putrefied even it was frozen to −10℃.

To investigate changes in pigments of soft body at various blanching temperature, samples were soaked in 3% NaCl solution (about twentyfold quantity of sample), and temperature were adjusted to 75℃, 80℃, 85℃, 90℃, and 95℃. The results are shown in Fig. 3. Retention ratios of pigment in cockle were above 95% at all temperature conditions. On the blanching for 40 seconds, the retention ratio of the pigment was slightly higher at 75℃ than at 95℃, but there was no differences in retention ratios of pigment at all temperature when it was blanched for 15 seconds. Therefore, we supposed that there was no interrelationship between retention of pigment and blanching temperature judging from the fact that low blanching temperature was more effective to maintain the pigment if it is blanched less than 40 seconds, otherewise blanching temperature should be determined by taking in account enzyme activity of cockle meat, manifestation of taste, and toughness of meat.

The current processing method of cockle for export is very simple and consists of taking the soft body, blanching, shaping a fixed form, and freezing. And this is mostly eaten with thick soypaste mixed with red peppers or with flavoring soybean sauce after thawing. However, there are more problems, because pigments of cockle are easily stripped off after thawing. Pigments of living cockle covering the soft body parts are

so stable that it is hardly stripped off physically. However, pigments are easily stripped off when cadaveric rigidity is lost when contacts with fresh water. Moreover, the pigments are easily stripped off when fresh cockle is immediately frozen and thawed. Therefore, we investigated several important factors such as blanching when it is fresh, decreasing the destruction ratio of pigment in the process of thawing, processing instant eatable type of cooked and frozen cockle after thawing.

Table 3 shows the effect of soaking treatment of pigment in cockle shell. Differences in stability of pigment were not found when cockle immersed for 5 minutes in various organic acid and 0.02% BHA solutions after soaking for 15 seconds at 95℃, but soaking in ethanol for 5 minutes had resulted in strong adhesion of pigment to meat although cockle meat was contracted a little. There was no adhesion effect of pigment when blanching water was mixed with organic acid, ethanol and 0.02% BHA at same time.

Table 3. Influence of chemicals on the stability of pigment on the foot in cockle

	Soaked after Blanching	Blanching
15% acetic acid	1.1	1.2
15% citric acid	1.5	1.6
15% tartaric acid	1.4	1.2
Ethanol	4.4	2.6
0.02% BHA	1.7	1.8

values in table : 1;not effective, 3;effective, 5;very effective.
values are significantly different ($p<0.05$)

Table 4. Sensory evaluation of cockle seasoned after blanching for 15 seconds at 95℃

	Color	Taste	Odor	Overall acceptance
A	4.6	3.5	4.0	4.2
B	4.4	3.9	3.4	3.8
C	4.0	4.7	4.4	4.5

values in table : 1;very poor, 3;fair, 5;very good.
values are significantly different ($p<0.05$)

Blanching for 15 seconds at 95℃, soaking in ethanol for 3 minutes to adhere pigments, and soaking in flavoring sauce (its compositions are shown in Table 1) were orderly performed to test sensory evaluation, and the results are shown in Table 4.

In case of sample A, the cockle was soaked in flavoring sauce mixed with 10% soy bean sauce, 5% wasabi and 5% sugar and it gained higher score in color but low score in taste. Sensory evaluation of sample B (in this case, 2% vinegar was added to the former flavoring sauce) showed that it improved taste score but degraded odor score because of the added vinegar compared with sample A. In case of sample C, 2% powered garlic and 3% powered red pepper

Table 5. Changes in chemical compositions, salinity, pigment, pH and TBA value of foot in cockle during storage at −20℃ and −45℃

	Storage Day (−20℃)				Storage Day (−45℃)		
	0	20	40	60	20	40	60
Moisture, %	77.4	77.2	77.3	77.1	77.4	77.2	77.4
Crude protein, %	13.3	13.1	13.0	12.8	13.2	13.2	13.1
Crude lipid, %	0.3	0.3	0.3	0.2	0.3	0.3	0.3
Carbohydrate, %	4.1	4.1	4.0	4.0	4.1	4.1	4.1
Crude ash, %	3.7	3.8	3.8	3.9	3.7	3.8	3.7
Salinity, %	2.8	2.8	2.9	2.9	2.9	2.8	2.9
pH	6.2	6.3	6.4	6.6	6.2	6.2	6.3
Absorbance (226 nm)	2.7	2.7	2.5	2.3	2.7	2.7	2.7
TBA value (531 nm)	0.2	0.2	0.3	0.3	0.2	0.2	0.2

were added to flavoring sauce of sample B and slightly devaluated in color score but gained high score in taste and odor and, it had highest score in overall acceptance. Therefore, further studies (freezing and storing) were performed after soaking in ethanol and in flavoring sauce C for 3 minutes in order to preserve pigment and process instant eatable type of cockle shell.

Changes in components of frozen cockle during storage

Changes in components during storage are shown in Table 5. Right after the flavoring treatment, moisture content of the cockle was 77.4% which was slightly lower than that of soft body itself (80.4%). We assumed that it was because dehydration occurred in the process of blanching and soaking treatment, and contents of protein and carbohydrate were relatively increased during the flavoring treatment and dehydration. No significant changes in contents of moisture, crude lipid, carbohydrate, ash and degree of salt were found during 60 days, storage at −20℃ and −45℃. However, crude protein concentration was slightly decreased from 13.3% to 12.8% during 60 days, storage at −20℃, and pH and TBA value increased from 6.2 to 6.6, 0.2% to 0.3%, respectively. This indicated that enzyme was not completely inactivated by blanching treatment for 15 seconds at 95℃. Also changes in pigment were observed during storage as absorbance measured in 226 nm was decreased from 2.7 to 2.3. However, absorbance of pigment also remained constantly, during 60 days storage at −40℃.

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