Quality and Storage Stability of Frozen Geoduck (*Panope japonica A. Adams*)

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To obtain a basic data of Korean geoduck(*Panope japonica A. Adams*) for fast food manufacturing, contents of proteinous compounds, nucleic acid and related compounds were analysed, and monthly changes of proximate compositions and freshness changes during frozen storage have been studied. The edible portions were 29.92% in 3 years old samples and 38.04% in 5 years old ones, respectively. The moisture and protein content showed the highest level from March to April and those of lipid and glycogen showed the highest level in July. Taurine, glycine, alanine and glutamic acid were the major free amino acid in 5 years old samples harvested in July and taurine content showed the highest level among free amino acids. Glutamic acid was the most abundant amino acid among the amino acids of protein hydrolyzate in 5 years old sample(96.6*mg*/16*g*-N). Leucine and lysine were revealed as relatively higher content(8.35 and 7.70%). From the analytical results on VBN, TMAO, TMA and NH_2-N, blanching at 95℃ for 2 mins was effective to maintain the quality of geoduck during frozen storage. Total creatine content was not changed in blanched geoduck.

Introduction

These days people are interested in not only the conveniences and the nutrients, but also the flavor and the texture of fast foods. But most fast foods have been adapted for European appetite, therefore the processing methods for the fast foods, which are favored for Korean tastes need to be modified and developed.

Shellfish has been used as a traditional food stuff in Korea because it has a particular aroma and delicate taste(Lee *et al.*, 1975a; Lee *et al.*, 1975b; Lee *et al.*, 1980; Lee *et al.*, 1984; Kim *et al.*, 1985). However, the most shellfish was so small and it brought some difficulties in employing processing materials, including smaller edible portion. But Korean geoduck, one kind of large shellfish, showed 8~11.6*cm* in shell size and 80~150*g* of edible portion after 3~5 years growing. Thus it could be expected to be suitable as a basic raw material for fast food, since it adequately meet to Korean taste.

In order to determine the proper harvesting time and to improve the quality of geoduck during frozen storage, the monthly changes of proximate composition of geoduck and the storage stability of geoduck during frozen storage have been investigated.

Materials and Methods

Materials

Korean geoduck was harvested at the Kumjin coast of Okgye at the end of every month through 1991 and 1992. Samples were separated into three groups according to preparation methods. The first group was blanched(95℃, 2 min) muscle. The second group was unblanched whole including the muscle and viscera. The third group was the only muscle prepared from the second group. All samples were stored at -20℃ during the experimental period.

Measurement of chemical analysis

The size and height of geoduck(more than 25 samples) were measured with vernier callipers. Moisture, protein, lipid, ash, trimethylamine(TMA) and trimethylamine oxide(TMAO) contents were determined by the procedures of the AOAC(1984). Glycogen contents were measured by Pomeranz's method(1977). Volatile basic nitrogen(VBN) contents of all samples during the storage were measured by the Conway's micro-diffusion method(Pearson, 1972). NH_2-N form nitrogen(NH_2-N) contents were assessed with the method described by Spies and Chamber(1951).

According to the procedure described by Sato and Fukuyama(1957), the total creatine contents were determined.

Analysis of nucleotides and related compounds (NRC)

NRC were extracted from 10 grams of homogenized samples in 10% perchloric acid solution for 20 mins at 5℃. Then the supernatant was taken after centrifuging at 4,000 rpm for 10 mins. The above procedure was repeated 2 times. After that, the supernatant was controlled at a pH 6.5 with 5N KOH solution. This solution was made up of 100*ml* with neutralized perchloric acid solution. Then it was stored for 30 min at 5℃. After this, it was centrifugated at 10,000 rpm for 10 mins and the supernatant was filtered with a Millipore filtration kit (0.45*μm*). The filtrates became the samples for the HPLC Analysis. The conditions of HPLC instrument(Beckman 110B) are listed in Table 1.

Table 1. Conditions for HPLC analysis of neucleotides and their related compounds

Section	Conditions
Column	μ-Bondapak C_{18}(300*mm*×3.9*mm*)
Mobile phase	1% triethylamine phosphoric acid(pH 6.5)
Flow rate	2.0*ml/min*
Chart speed	0.25*cm/min*
Detector	UV-detector(240nm)
Sampel load	20*μl*

Amino acids analysis

In analysis of free amino acids, samples 5*g* were homogenized after adding 1% picric acid solution. Then the homogenized samples were centrifugated at 4,000 rpm for 15 mins. The supernatant was passed through Dowex 2×8(Cl^- form, 100~200 mesh) resin column and the eluted solution was passed in Amberilite IR-120 resin column(H^+ form, 100~200 mesh). This Amberlite IR-120 resin column was rinsed with 150*ml* of distilled water and then was eluted by using 2N NH_4OH solution. The eluted solution was evaporated with a vacuum evaporator and the dried portion was dissolved with pH 2.2 lithium buffer solution. These solutions were analysed by automatic acmino analysis instruments(Hitachi Model 835; column resin No. 2619 φ2.6×250*mm*).

In amino acids analysis of protein hydrolyzate, the samples were hydrolysed with 6N HCl solution. After the hydrolysed solution evaporated, the dried portion were dissolved with pH 2.2 lithium buffer solution. Finally, as in the free amino acids analysis, this solution was also analysed by the automatic amino acid analysis instrument(Hitachi Model 835; column resin No 2619 φ2.6×150*mm*).

Result and Discussion

Size and edible portion

The physical characteristics of Korean geoduck are listed in Table 2. The average length of the shell after 3 years muturation was 7.6*cm*, and after 5 years was 10.5*cm* respectively. Their average height was 3.8 and 4.5*cm*. The recovery ratios of edible portions after 3 years and 5 years muturation were 29.92% and 38.04%, respectively. These recovery ratios were higher than other shellfish (Lee *et al.,* 1975a; Lee *et al.,* 1975b; Lee *et al.,* 1980).

Table 2. Size and edible portion of geoduck

	growing period	
	3 years	5 years
Length of shell(*cm*)	7.6 ± 1.2[2]	10.5 ± 1.7
Height of shell(*cm*)	3.8 ± 0.8	4.5 ± 1.0
Recovery ratio[1](%)	29.92 ± 3.25	38.04 ± 5.74

1; ratio of edible part to whole body without shell
2; Mean ± standard deviation

Monthly changes of chemical composition

Monthly changes of chemical composition in geoduck are illustrated in Fig. 1. The average moisture content was 80.23%. The highest level of moisture showed in March(83.60%), but then this content began to fall. The protein content of geoduck harvested in April showed the maximum level, at 15.87%, whereas that of July noted in the minimum, at 12.3%. The similar variations between the moisture and protein contents continued through year. The lipid contents of geoduck from March to May showed 0.55~0.69%, these levels were the lowest among lipid contents of any month. That of July was revealed to be 4.06%, which was the highest. These data show the reverse relation between the monthly changes of moisture content and lipid content, as the results of Lee *et al.*(1975) about the monthly changes of chemical composition of oysters. The glycogen content rose steadily from May to July and reached the maximum level of 2.59% on July. The average content of ash showed 1.88%. Many researchers(Let *et al.,* 1975a; 1975b; 1980; 1984; Hujita, 1968) reported that the protein and moisture contents in most shellfish during the period of their genital gland development showed high, but lipid and glycogen contents were low. Therefore it was presummed from the above data, that the spawning season of Korean geoduck might be March or April, therefore, it would be in July or August for the harvesting geoduck.

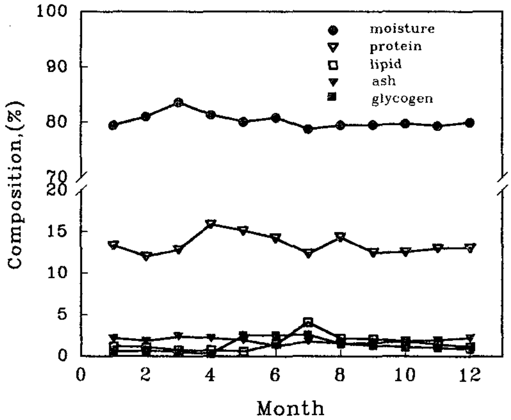

Fig. 1. Monthly variations in proximate composition of geoduck muscle.

Amino acid composition and NRC contents

The data described in Table 3 was results from the 5 years old geoduck harvested in July. Taurine was 1,023.5*mg*/100*g*, and this content was the highest of any other amino acids. Among these free amino acids, amounts of glycine, alanine, and glutamic acid were relatively high. Ryu and Lee(1978) reported the results of experiments for taste components in mussel, and they pointed out that taurine and glycine contents were the highest among free amino acids.

In the contents of amino acids of protein hydrolyzate, the major protein amino acids were glutamic acid(96.6*mg*/16*g*-N) and alanine(61.7*mg*/16*g*-N). The total essential amino acid content showed 34.37% of all protein amino acids. This is an relatively high level. Among these amino acids, the relatively higher contents were measured in leucine (8.35%) and lysine(7.70%), while the contents of sulfur-containing amino acids as methionine, cystein and tryptophan showed very low levels(1.9%) or could not be detected(Trp) due to the degradation of those amino acids by acid hydrolysis. Therefore the amount of tryptophan in geoduck needs to be measured by other methods.

Table 3. Contents of free and proteinaceous amino acids in the geoduck(*Panope japonica A. Adams*) muscle

Amino acids	Free amino acids ($mg/100g$)	Proteinaceous amino acids ($mg/16g$ N in dry basis)
Phosphoserine	16.3	-
Taurine	1,023.5	-
Aspartic acid	88.4	50.7
Threonine	43.0	29.2
Serine	32.9	24.8
Glutamic acid	336.7	96.6
Sarcosine	7.3	-
α-Amino apidic acid	7.2	-
Glycine	455.9	35.6
Alanine	398.2	61.7
α-Amino butylic acid	7.2	-
Valine	30.8	28.3
Cysteine	6.7	-
Methionine	9.7	0.1
DL-allocysthathione	4.5	-
Isoleucine	24.5	27.8
Leucine	28.1	44.9
Tyrosine	13.1	10.7
Phenylalanine	5.4	19.5
β-Alanine	3.9	-
β-Amino isobutyric acid	1.3	-
ΓAmino butyric acid	0.4	-
Ethanol amine	0.5	-
NH_3	38.2	7.2
Ornithine	8.2	-
Lysine	17.7	41.4
Histidine	22.1	9.8
3-Methyl histidine	0.9	-
Phosphoserine	16.3	-
Anserine	22.7	-
Carnosine	5.0	-
Arginine	433.4	40.2
Hydroxy proline	4.0	-
Asparagine	54.6	-
Proline	21.3	19.8

The contents of NRC in geoduck harvested in April and July are listed in Table 4. The highest ATP contents(1,821.66$mg/100g$) reached in April, and adenosine were measured in samples harvested in July. In the amounts of GMP that were known to have flavor intensification effect, the amounts in July showed higher than that of April.

Table 4. Contents in nucleic acid and its related compounds of geoduck(*Panope japonica A. Adams*) muscle ($mg/100g$)

Compounds	Harvesting time	
	April	July
ATP	1,821.66	1,280.77
ADP	1,381.09	1,255.61
AMP	1,169.19	1,075.84
GMP	1,050.77	1,116.91
Inosine	929.96	679.16
Hypoxanthine	565.00	458.96

Changes of freshness and flavor components during frozen storage

Fig. 2 shows the changes of VBN content of blanched and fresh muscles, and raw whole(muscle and viscera) in geoduck during frozen storage at -20℃. All samples had the lower levels of VBN 4.0 $mg/100g$ at 7 days frozen storage, but those rose steadily over the storage period. The VBN of raw whole and fresh muscle during storage were increasing continuously, but the increasing of VBN in blanched muscle ended after 55 days storage. This might indicate that the blanching process may inactivate the enzymatic autolysis in geoduck muscle. Therefore, blanching process should be adopted to maintain the freshness of geoduck muscle during long frozen storage.

Fig. 3 and 4 reveal the changes of TMAO and TMA in geoduck during storage at -20℃. As can be seen in these figures, the TMAO contents of all samples at initial storage were 2.4$mg/100g$ for raw whole, 2.8$mg/100g$ for fresh muscle and 0.9$mg/100g$ for blanched muscle, respectively, but those bear to decrease significantly along the frozen period.

In the changes of TMA content, the contents in raw whole, fresh and blanched muscle on the first day presented 0.08, 0.12 and 0.06$mg/100g$, and those at 90 days storage reached 3.89, 2.90 and 0.54$mg/100g$ respectively. Particularly, as the storage time lengthened, TMA contents in raw whole and fresh muscle became higher, while that of blanched muscle increased very little. This data showed inverse relation between the variations of TMAO and TMA content. In other research of He-

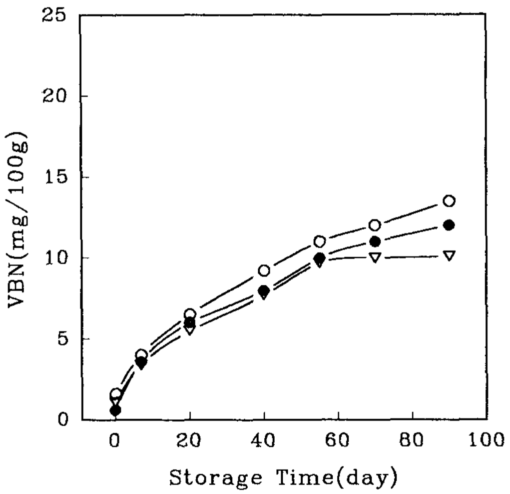

Fig. 2. Changes in volatile basic nitrogen(VBN) content of geoduck during frozen storage at -20℃.
Symbols: ○, fresh muscle and viscera; ●, fresh muscle; ▽, blanched muscle.

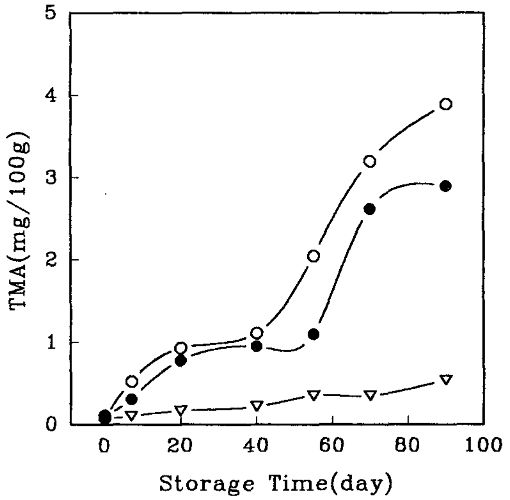

Fig. 4. Changes in trimethylamine content of geoduck during frozen storage at -20℃.
Symbols: refer to the legend of Fig. 2.

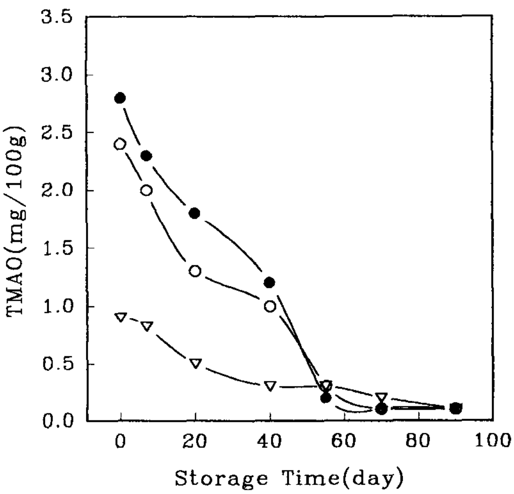

Fig. 3. Changes in trimethylamine oxide content of geoduck during frozen storage at -20℃.
Symbol: refer to the legend of Fig. 2.

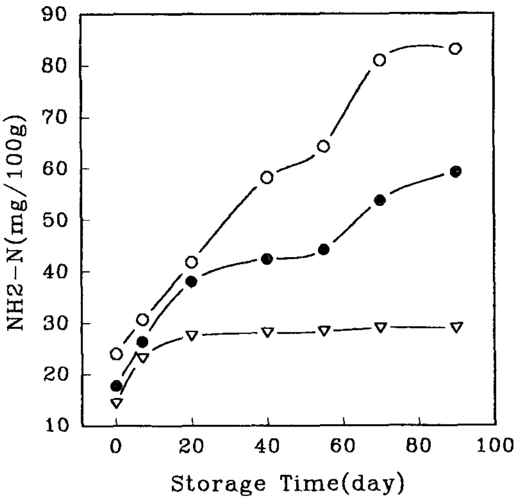

Fig. 5. Changes in NH_2-N content of geoduck during frozen storage at -20℃.
Symbol: refer to the legend of Fig. 2.

bard *et al.*(1982), it was reported that two types of enzymes are considered to be responsible for the reduction of TMAO to TMA; namely, endogenous enzymes in fish, and exogenous enzymes produced by bacteria in the course of spoilage. Our results seem to explain the fact that TMAO reductase transforming TMAO into TMA may be inactivated by the blanching process.

The changes of NH_2-N amount in geoduck during storage at -20℃ were expressed in Fig. 5. The NH_2-N contents in raw whole and fresh muscle on the first day were 24.1 and 17.8*mg*/100*g* respectively, at 90 days storage these were increased to 83.1 and 59.3*mg*/100*g*; whereas that of blanched muscle increased from 14.2*mg*/100*g* at initial storage time to 27.5*mg*/100*g* at 20 days storage. However the NH_2-N amount of blanched muscle increased very little after 20 days. These results could be explained by reasoning that the autolysis and proteolysis enzymes in geoduck were deactivated by the blanching process.

In order to assess the effect of the blanching process in geoduck flavor, the changes of total creatine in geoduck were recorded(Fig. 6). There seem to be no certain trends in the changes of total creatine of any of the samples during storage time. It can be assumed that the blanching process had no affect on the creatine amounts in frozen storage.

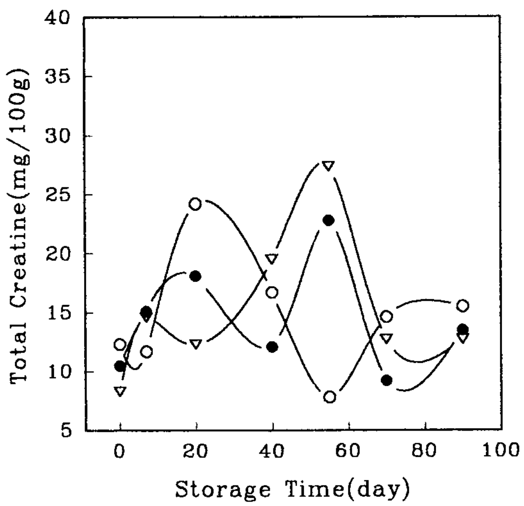

Fig. 6. Changes in total creatine content of geoduck during frozen storage at -20℃.
Symbols: refer to the legend of Fig. 2.

Acknowledgement

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코끼리조개의 월별 조성변화와 가열 전처리가 냉동저장중의 안정성에 미치는 효과

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코끼리조개를 fast foods의 원료로 이용하기 위한 기초자료를 얻기 위하여 물리적 성상, 유리 및 구성 아미노산의 함량, 핵산관련물질, 월별 성분변화 및 냉동기간중의 선도변화를 측정하였다.

3년생과 5년생의 경우 내장을 제거한 가식부의 수율은 각각 29.92, 38.04%이었다. 7월에 채취한 코끼리조개의 유리아미노산중 taurine함량이 가장 높았으며 Gly, Ala 및 Glu 함량도 비교적 높게 나타났다. 구성아미노산에 있어서는 Glu 함량이 가장 높았고 그 다음으로는 Ala이었다. 필수아미노산으로는 Leu과 Lys의 함량이 비교적 높았다. 월별 성분변화에 있어서 수분, 단백질은 3월, 4월에 가장 높았으며 지방과 글리코겐은 7월에 가장 높았다.

핵산관련물질중 5'-GMP의 량은 4월에 채취된 시료보다 7월에 채취된 것에서 더 높게 나타났다. 냉동저장중 VBN, TMA, NH_2-N의 함량변화에 있어서는 95℃에서 2분간 열처리한 시료는 열처리하지 않은 시료에 비하여 증가율이 낮았기 때문에 열처리조작이 선도유지에 효과적이었으며 냉동저장중 총 creatine함량의 변화에 있어서는 열처리 조작의 영향은 나타나지 않았다.