STUDIES ON THE TASTE QUALITY OF HANASAKI CRAB

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1. DEVELOPMENT OF INDEX FOR FRESHNESS AND LIVELINESS OF HANASAKI CRAB

1.1. Objectives

The index for freshness of fisheries products commonly used are the K-value, to measure change after death of fisheries products, or the volatile basic nitrogen (VBN). However, as an alive Hanasaki Crab is usually boiled before distribution and thus K-value or VBN cannot be used as freshness/liveliness indices for Hanasaki Crab, the Energy Charge, used as an index for freshness or activeness of living organisms, was tested for possible use as freshness/liveliness index for Hanasaki Crab.

1.2. Materials and Methods

The materials for analyses were live Hanasaki Crabs landed in August to September 2004. The leg meat, the one as soon as obtaining and the other after preserved under constant condition, was sampled and frozen. The nucleotides relating substances were analyzed, after extraction by 10% perchloric acid, neutralization, and freezing processes. The analyses were requested to Prof. ABE Hiroyoshi, Laboratory of Fisheries Chemistry, Department of Aquatic Bioscience, Graduate School of Agricultural and Life Sciences, University of Tokyo.

1.3. Results and Discussions

The results of measurements on nucleotides relating substances and energy charge (EC) of Hanasaki Crab are shown in **table 1** and **table 2.** The sample just after arrival at market and stocking in the cooled seawater at 5°C over one night indicated EC values of 0.82–0.90, and indicated quite good energy conditions. For the sample two days after since transported and arrived to Tokyo, the first sample transported showed EC of 0.81 and no significant drop of value, but decreasing tendency for ATP content; however the second sample showed EC value decreased to 0.49–0.68, and judged as muscle energy condition clearly worsened. Further for the sample kept 3 days in cold storage after transportation, which is barely living, ATP was almost exhausted and EC dropped to 0.20. However, the differences of EC by sex or size were not observed at all.

Table 1

Results of measurements on nucleotides relating substances and energy charge (EC)

Test section	Arrival at Market *Hanasaki Market	After 1-night rearing *in artificial seawater	2-days after transportation *below 10°C
Obtained date	2004/8/23	2004/8/24	2004/8/26
Sex (sample number)	♂ (n=3)	♂ (n=3)	♂ (n=3)
Av. Body weight g	1.005	946	–
ATP μmol/g	3.80	3.44	2.83
ADP μmol/g	0.97	0.66	0.78
AMP μmol/g	0.19	0.32	0.35
IMP μmol/g	0	0	0.02
HxR μmol/g	1.63	1.43	1.56
Hx μmol/g	1.43	1.15	0.57
EC	0.86±0.03	0.85±0.03	0.81±0.002
K-value	38.2±4.3	36.7±2.4	35.2±3.3

Table 2

Results of measurements on nucleotides relating substances and energy charge (EC)

Test section	After 1-night rearing *in artificial seawater		2-days after transportation *below 10°C		3 days kept in cold storage
Obtained date	2004/9/17		2004/9/21		2004/9/24
Sex (sample number)	♂ (n=9)	♀ (n=3)	♂ (n=9)	♀ (n=3)	♂ (n=3)
Av. Body weight g	933	949	862	937	957
ATP μmol/g	4.32	3.32	1.81	2.33	0.07
ADP μmol/g	0.88	1.11	1.39	1.22	0.33
AMP μmol/g	0.22	0.29	1.02	0.92	0.82
IMP μmol/g	0	0	0	0	1.13
HxR μmol/g	1.65	1.75	1.77	1.94	1.29
Hx μmol/g	0.16	0.85	0.73	0	0.41
EC	0.88±0.03	0.82±0.05	0.60±0.18	0.65±0.15	0.20±0.11
K-value	25.0	34.9	37.6	30.4	41.8

** Samples were obtained from Habomai Market on 2004/9/19.*

From above results, EC is thought to be effective for judging liveliness of Hanasaki Crab after landing, while decrease of EC was not observed for first time transport experiment, it will be necessary to measure the contents of phosphoarginine and investigate its relation with EC.

Secondly, the K-value used generally for judgment of freshness at initial phase after death of fishes was measured as high as 21.6–38.2 before transportation and also high as 25.7–55.9 after transportation and no significant difference was not observed.

As though reason is not clear, the contents of inosine (HxR) is high in Hanasaki even in alive conditions, and this value had not changed after transportation. Hypoxanthine (Hx) had also shown considerably high value. From these results, the K-value is thought to be already high in living conditions. The cause of high HxR is needed to be examined.

Inosinic acid is not detected for almost samples, but the increase up to 1.13 μ mol/l was detected only for the almost dying sample of 3-days cool storage after transportation, along with decrease of ATP. In crabs and shrimps, the decomposition of ATP after death is recognized to take both of IMP path and adenosine path, but, as the increase in AMP was not observed, the adenosine path is thought to be the main path, while the IMP path is also thought to be exist.

From these results, it is concluded that, for the judgment of freshness/liveliness of Hanasaki crab, the EC is effective with small standard deviations.

2. GEOGRAPHICAL AND SEASONAL CHANGES IN TASTE COMPONENTS IN HANASAKI CRAB

2.1. Objectives

Through the past studies on taste effective components of sea foods, the taste effective components of crabs and shrimps have been made clear. 1, 2, 3) On the Hanasaki Crab, which has a position of representative specialty of the Nemuro region, there is a report on analyses of taste components but no past report on the seasonal or geographical differences. Thus, in order to recognize geographic and seasonal characteristics of taste of Hanasaki Crab, the analyses of taste components such as free amino acids etc. were performed, together with analyses using taste sensing facility developed for objective assessment of taste instead of usual sensory test.

2.2. Materials and Methods

The samples analyzed were the live Hanasaki crabs caught in the waters off Habomai and Ochi-ichi from August to September 2005 and the live Hanasaki crabs landed as imported marine products to Hanasaki Port from September to October. As soon as after obtained leg meats were collected from these samples and frozen immediately, together with moisture and salinity measurements, after extraction by 10% perchloric acid, neutralization, and freezing processes, frozen specimens were sent to Prof. ABE Hiroyoshi, Laboratory of Fisheries Chemistry, Department of Aquatic Bioscience, Graduate School of Agricultural and Life Sciences, University of Tokyo, for analyses of nucleotides relating substances. The part of the frozen samples was properly diluted and taste items were analyzed and measured using Taste sensing system SA402 (hereafter abbreviates as 'Taste Sensor') at Intelligent Sensor Technology, Inc.

2.3. Results of tests and Discussions

2.3.1. Seasonal and geographic difference in free amino acids and nucleotides relating substances

The average value of total free amino acids for the Hanasaki Crabs obtained from August to October was, about 2,500–3,000 mg/100g for male, and about 2,300–2,900 mg/100g for female, and for both sexes, the abundant components were glycine, arginine, taurine, and next, proline, glutamine, those account for 70–80% of total amino acids.

The nucleotide relating substances were almost made up by ATP and ADP, and K-value was low value of 3.0 for both sexes. As the values of Energy Charge (EC), the index for judging energy status within cells, were higher values larger than 0.8 for almost samples, and thus, the samples were considered to be in good liveliness.

The results of analyses of live male Hanasaki Crab on glycine, alanine, proline, glutamic acid, and arginine, those reported as taste effective components for crabs

and shrimps, averaged by obtaining time and by obtaining water, were about 500–600 mg/100g for glycine, about 600 mg/100g for arginine, about 300–400 mg/100g for proline, about 60–100 mg/100g for alanine, about 50 mg/100g for glutamic acid, and total of these amino acids was about 1,500–1,600 mg/100g (**fig. 1**).

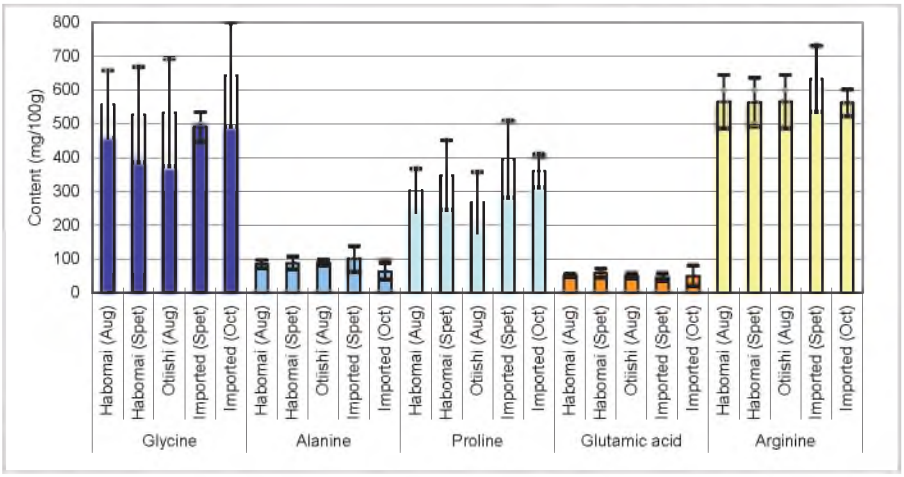


Fig. 1. *The results of analyses on major free amino acids of Hanasaki Crab (♂)*

As though number of sample were small, the statistical tests on difference in averages (t-test) were performed, and the results showed no clear difference between the live crabs caught in the water off Nemuro Peninsula and the live crabs imported, and between obtaining timing and size classes.

Next, the results of analyses of live female Hanasaki Crab on glycine, alanine, proline, glutamic acid, and arginine, those reported as taste effective components for crabs and shrimps, averaged by obtaining time and by obtaining water, were similar to those for male as, about 450–650 mg/100g for glycine, about 69 mg/100g for alanine, about 250–400 mg/100g for proline, about 40 mg/100g for glutamic acid, about 550 mg/100g for arginine, and total of these amino acids was about 1,350–1,650 mg/100g (**fig. 2**).

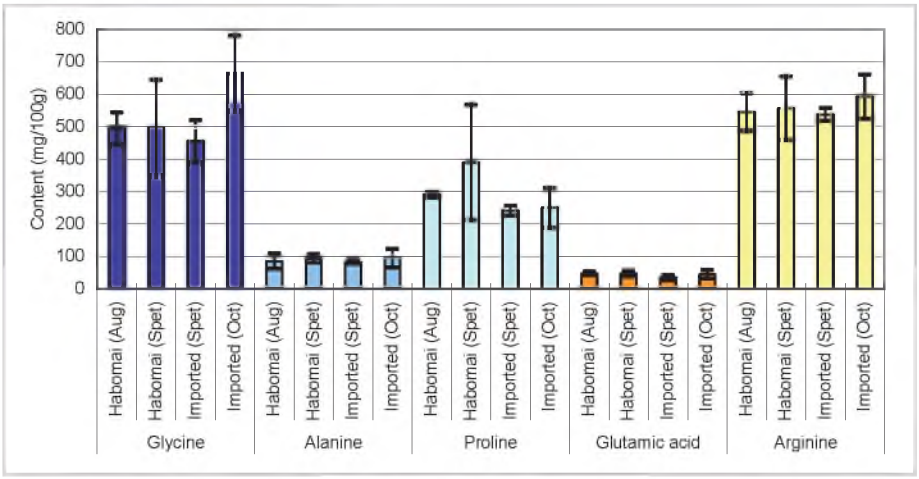


Fig. 2. *The results of analyses on major free amino acids of Hanasaki Crab (♀)*

The high values are indicated by imported live Hanasaki Crabs in October for glycine, and by sample obtained from the water off Habomai for proline, but it is not considered as significant difference among obtaining times and waters, because the test on difference of average indicated comparatively large range of values.

As a part of samples obtained in August had obviously soft carapace and plenty of water content, and considered molted not so long before, the difference in amino acids were compared between crabs of different water content, by differentiate male crab samples into the crabs with lower water content (water content smaller than 80%) and the crabs with higher water content (water content larger than 84%) (**table 3**). The samples with larger water content showed low values for almost amino acids; in addition to arginine that is considered as a taste effective component for crabs and shrimps, glutamine, valine, methionine, and threonine were thought to be different. The difference in water content and amino acids contents were also compared for female samples obtained in September and October, but no clear difference like male was not observed.

Table 3

The results of analyses of live Hanasaki Crab (♂) sampled in August

Harvested Area		Water off Habomai and Ochi-ishi	
Sex (number of samples)		♂ (n=4)	♂ (n=3)
Water content (Ave.) %		78.2	85.9
Salt content (Ave.) %		0.5	1.3
Free amino acids (mg/100 g)	taurine	410	386
	aspartic acid	10	9
	asparagine	35	9
	threonine	69	22
	serine	44	24
	glutamic acid	53	47
	glutamine	285	109
	proline	353	215
	glycine	589	544
	alanine	87	92
	valine	79	37
	methionine	72	25
	isoleucine	67	30
	leucine	134	64
	phenylalanine	62	23
	lysine	83	43
	histidine	30	12
	arginine	633	436
	Total free amino acids	3.285	2.224

From the results above, the amounts of major amino acids considered to contribute to the taste of Hanasaki crab, were almost similar values for the live Hanasaki Crabs those were harvested from the water off Nemuro Peninsula and for

the live imported ones, in comparing averages within limited period from August to October. As though, there found values having relatively wider range, it is considered to be caused by individual differences from difference in elapsed time after molting and so on.

2.3.2. Seasonal and geographic difference in tasted using Taste Sensor

The Taste Sensor is a facility to identify tastes and to measure its strength, from the pattern of difference in electric potentials among multiple sensors with artificial lipid membrane of different characteristics. At present, the basic tastes of bitterness, sourness, umami taste, excepting sweetness, and other tastes are reported to be able to analyze.

As the analyzed values by Taste Sensor are converted to the values corresponding to the density change of about 20%, which can be identified as difference of taste by human sense, the values under unit scale of 1.0 are in the level not to be able to be identified by human tasting.

The results of analyses by Taste Sensor on the live male Hanasaki Crab harvested from the water off Habomai and the live male imported Hanasaki Crab are shown in **table 4,** where the significant test on the difference of average was performed, as though the number of analyzed sample were small and measurements has considerable range in some taste items. The results indicate that the sample harvested from the water off Habomai has tendency of lower (corresponding to about 0.8-fold concentration) bitterness (first taste), and the analyzed values of umami after taste and sourness also show low values, but, judging from the ranges of values, it can be considered there is no evident difference. Referring to the results of analyses on free amino acids and nucleotide relating substances, the samples from the water off Habomai shows slightly higher tendency in AMP values, but no clear difference in other components.

Table 4

The results of analyses of live Hanasaki Crabs by Taste Sensor

Part of specimen		Meropodite muscle of ambulatory leg		Meropodite muscle of ambulatory leg	
Sex (number of samples)		♂ (n=3)	♂ (n=3)	♀ (n=3)	♀ (n=3)
Obtained date		2005/9/14	2005/9/15	2005/9/14	2005/10/20
Harvested water		Off Habomai	Imported	Off Habomai	Imported
Carapace width (Ave.) mm		116	114	111	106
Body weight (Ave.) g		1.036	993	912	813
Salt content (Ave.) %		0.9	0.8	0.7	0.9
First taste	sourness	0.14±0.58	1.20±0.60	–0.89±0.48	0.83±0.48*
	bitterness	0.03±0.03	1.05±0.04*	0.63±0.80	1.45±0.05*
	umami**	(–0.28±0.25)	(0.19±0.73)	(–0.03±0.25)	(0.27±0.31)
	saltiness	0.16±0.17	0.66±0.63	–0.40±0.43	0.15±0.48
After taste	bitteness	0.05±0.04	0.12±0.07	0.26±0.29	0.33±0.08
	umami body	–0.49±0.42	0.67±1.04	–1.16±0.64	1.82±0.66

** Significant (* P<0.05).*

*** The error of measurement values of umami taste were judged to be large, based on variability of whole samples and statistical test of average measurement errors on each sample, but measurements values are entered for reference.*

The results of analyses on female crabs by Taste Sensor, the imported live Hanasaki Crab shows high values of sour taste (corresponding to about 1.4-fold concentration) and umami body taste (corresponding to about 1.7-fold concentration). Referring to the results of analyses on free amino acids and nucleotide relating substances, the imported female live Hanasaki Crab shows high tendency in glycine (about 1.5-fold) and in taurine (about 1.3-fold), but no clear difference in other components.

Then, dividing samples to the one with higher values of umami body taste, and the other with lower values of umami body taste, ignoring sex, the results of analyses on free amino acids and nucleotide relating substances were compared between these two groups. However, no clear differences were observed and no sufficient results enough for consideration by relating differences among the results of analyses on components as free amino acids or so, to the results of measurements by Taste Sensor, including sourness or bitterness (first taste).

The analyses by Taste Sensor, as a facility developed to measure quantitatively and recognize the subjective and ambiguous sensation of taste, could not give enough results to clarify the seasonal and geographical difference. Therefore, as performing analyses of taste effective components parallel with sensory evaluation, it is necessary, here after, to increase accuracy them as a technology to evaluate taste quality of Hanasaki Crab.

3. DEVELOPMENT OF TECHNIQUE TO IMPROVE TASTE OF HANASAKI CRAB

3.1. Objectives

In order to keep cell volume constant, the invertebrata raise intracellular osmotic pressure by accumulating a part of amino acids as osmolyte, and the sweet tasting amino acids, glycine, alanine, and proline, are reported to be effective osmolyte for crabs and shrimps2, 5). In order to evaluate the efficiency of the short-term acclimation by hypertonic seawater as the technique for taste improvement for Hanasaki Crab, the Hanasaki Crabs acclimated in hypertonic seawater were analyzed on tasted relating components and measured by taste recognizing facility developed to evaluate taste objectively, and the efficiency as a taste improvement technique was examined.

3.2. Materials and Methods

The samples analyzed were live Hanasaki Crabs imported to Hanasaki Port on October to December, 2006. The leg meat specimens from these crabs were sampled, as soon as after obtained, or after acclimated and reared during a given period in the artificial seawater adjusted to given concentration, from live situation, and frozen; then water and salinity contents, free amino acids, and nucleotide relating substances were analyzed, and the taste items were measured and analyzed using the taste recognizing facility SA402 developed by Intelligent Sensor Technology, Inc. (hereafter abbreviated as Taste Sensor).

The rupturing strength of meropodite muscle of ambulatory legs were measured by rheometer (Hudo Kogyo Ltd., NRM-2010J-CW), by using the back of razor's edge as adaptor. The sensory tests on the strength to tastes and preference on Hanasaki Crab was performed with cooperation by staffs of fisheries cooperatives in the city, and students of Department of Aua-bioscience and Industry, Tokyo University of Agriculture.

3.3. Results of Test and Discussions

3.3.1. Survival of live Hanasaki Crabs in the hypertonic seawater

Five individuals of live Hanasaki Crabs (♂♀mixed, average body weight 693g) were received to a 20ℓ tanks with artificial seawater with concentration adjusted to 100–150% seawater, and were acclimated during a given period under aeration. During acclimation, water temperature was kept to 5°C, and the half of tank water was changed every day.

After acclimation of 3 days, the acclimation under 100–110% seawater showed no dead or hypodynamic individuals, while, for the acclimation under 130–150% seawater, all individuals died after 2 days acclimation, and tendency of decrease of survival with increase of seawater concentration (**table 5**). For the acclimation in the seawater concentration higher than 120%, there observed hypodynamic or dead individuals after 1 day acclimation. However, when acclimated 3 days in 110% seawater and then seawater concentration was increased 10% in every 3 days or 5% in every 1 day, no dead individual was observed in 120–150% seawater.

Table 5

The survival rate of Hanasaki Crab during acclimation in seawater

Seawater concentration	Acclimation period (2006/10/30 – 11/12)			
	0-day	1st day	2nd day	3rd day
100% seawater (ca. 33‰)	100%	100%	100%	100%
110% seawater (ca. 36‰)	100%	100%	100%	100%
120% seawater (ca. 40‰)	100%	100%	60%	60%
130% seawater (ca. 43‰)	100%	100%	0%	0%
140% seawater (ca. 46‰)	100%	40%	0%	0%
150% seawater (ca. 50‰)	100%	20%	0%	0%

From these results, Hanasaki Crab can be acclimated to high seawater concentration to a certain degree, by taking time to raise seawater concentration. However, as the test tasting of individuals acclimated in seawater concentration higher than 130%, cooked by boiling or steaming, many individuals had stronger salty taste than commercial product, and the appropriate seawater concentration for acclimation under hypertonic conditions was considered to be below 130% or so.

3.3.2. Test for development of technique for improvement of Hanasaki Crab taste by acclimation in hypertonic seawater

The results of analyses on water content, salt content, free amino acids, and nucleotide relating substances in ambulatory leg muscle of live Hanasaki Crabs, are shown in **table 6,** by comparing the ones acclimated for total 4 days by raising seawater concentration by 5% in every day from 110%, the another ones acclimated for total 7 days, and the ones not acclimated.

Table 6

The results of components analyses of live Hanasaki Crab acclimated in hypertonic seawater

Date obtaining specimens		2006/11/17	2006/11/17	2006/11/17
Sex (number of specimens)		♀ (n=3)	♀ (n=3)	♀ (n=3)
Carapace width (Ave.) mm		104	104	105
Body weigth (Ave.) g		790	804	752
Duration of hypertonic acclimation (acclimation in 125% seawater)		No acclimation	4 days (1 day)	7 days (3 days)
Water content %		78.8±1.6	79.0±2.0	79.8±1.2
Salt content %		0.73±0.16	1.30±0.20*	1.30±0.11**
Free amino acids, Nucleotide relating substances (mg/100 g)	taurine	296±22	355±13*	510±48**
	aspartic acid	5±3	12±4	14±2
	threonine	20±2	20±6	13±2
	serine	36±7	31±7	18±3
	glutamic acid	48±6	38±4	64±28
	proline	173±41	196±120	215±108
	glycine	623±85	689±132	789±121
	alanine	42±39	135±22*	33±6
	valine	44±8	50±12	44±15
	sustine	6±4	11±1	2±2
	methionine	22±3	25±9	22±10
	isoleucine	28±7	40±18	18±8
	leucine	41±10	52±25	24±9
	tyrosine	51±6	61±27	30±17
	phenylalanine	46±3	50±25	16±6
	lysine	54±4	60±36	34±12
	histidine	14±3	23±11	20±10
	arginine	497±48	581±106	585±193
	Total free amino acids	2.047±40	2.430±381	2.452±344
	ATP	106±28	86±12	149±40
	ADP	67±7	64±13	45±5
	AMP	18±18	36±22	10±13
	IMP	2±1	0±0	0±0
	GMP	2±0	2±1	0±0

** Significat ($P<0.05$).*
*** Significat ($P<0.01$).*

For the individuals acclimated in hypertonic seawater, there observed increase tendency for taurine, among free amino acids reported to be effective osmolyte for crabs and shrimps. As though accompanying with individual variability, the average values of proline and glycine are high, and the averages of total amount of free amino acids also indicated about 20% higher values. As for salt contents, the acclimated individuals shows values higher about 0.6%, but no difference is shown in water content.

From above results, Na+, Cl−, or taurine are used as material for osmotic pressure regulation by Hanasaki Crab, in hypertonic seawater of 125% so on, used for acclimation in this time, and glycine, alanine, proline, and glutamine, those are non-essential amino acids and easily synthesized by glycolytic pathway or citric acid cycle, are supposed to be used complementary, and thus the effects of improving sweet-tasting amino acids.

Table 6 shows the results of analyses of water content, salt content, free amino acids, nucleotide relating substances, and measurements by Taste Sensor, on boil-cooked ambulatory leg muscle of live Hanasaki Crabs, of the ones acclimated in hypertonic seawater and of the ones not acclimated.

Table 7 shows the results of analyses of water content, salt content, free amino acids, nucleotide relating substances, and measurements by Taste Sensor, on boil-cooked ambulatory leg muscle of live Hanasaki crabs, of the ones acclimated in hypertonic seawater and of the ones not acclimated.

In comparing the non-acclimated individuals and the individuals acclimated in hypertonic seawater, the acclimated ones show tendencies of lower water contents and higher salt contents. However, in spite of expected improvement effect in sweet-tasting amino acids by the results of analyses on uncooked live crabs, there is no clear difference of free amino acids or nucleotide relating substances is not seen for cooked crabs, and only slightly high value is shown for total amount of free amino acids. On the other hand, in the results of analyses by Taste Sensor, the values of umami body taste (after taste) show considerable differences, and those for the acclimated in hypertonic seawater are remarkably high. The crabs acclimated in hypertonic seawater show a little lower value for umami taste (first taste), and a little higher values for sour taste (first taste), but the differences in values are not so large, and considered within the range of individual differences.

From above results on cooked samples, the effect of acclimation in hypertonic seawater on improvement of sweet-tasting amino acids is not clear, but the effect of improving umami body taste (after taste) is shown to be expected.

Table 8 shows the results of sensory test on the taste of cooked Hanasaki Crabs acclimated in hypertonic seawater, by tasting panel consists from member not well-trained for sensory testing.

Table 7

The results of components analyses and results of measurements by Taste Sensor on live Hanasaki Crab acclimated in hypertonic seawater

Date obtaining specimens			2006/11/17	2006/11/17
Sex (number of specimens)			♀ (9)	♀ (9)
Carapace width (Ave.) mm			104	103
Body weigth (Ave.) g			788 (654–968)	775 (728–829)
Duration of hypertonic acclimation (acclimation in 125% seawater)			No acclimation	4 days (1 day)
Cooking process (seawater concentration at boiling)			20 min. boiling (3%)	20 min. boiling (1.3%)
Water content %			77.9	76.7
Salt content %			0.97	1.14
Free amino acids, Nucleotide relating substances (mg/100 g)	taurine		301±17	299±13
	aspartic acid		6±1	6±1
	threonine		20±4	16±1
	serine		30±7	24±7
	glutamic acid		42±3	35±1
	proline		115±27	156±66
	glycine		624±64	589±38
	alanine		105±23	118±4
	valine		37±4	41±9
	sustine		4±3	5±3
	methionine		18±5	21±6
	isoleucine		22±7	28±6
	leucine		29±13	36±6
	tyrosine		38±12	50±10
	phenylalanine		32±9	41±9
	lysine		46±10	49±10
	histidine		11±2	17±1
	arginine		546±31	573±80
	Total free amino acids		2.026±87	2.104±181
	AMP		65±3	59±4
	IMP		2±0	tr.
	GMP		6±1	7±0
Taste Sensor	First Taste	Salty Taste	–0.07±0.15	–0.72±0.28*
		Umami Taste	0.04±0.25	–1.40±0.24**
		Sour Taste	0.19±0.52	2.50±0.41**
		Bitter Odd Taste	0.02±0.24	–0.68±0.85
	After Taste	Umami Body Taste	–0.43±0.69	8.90±0.30**
		Bitter Taste	0.03±0.11	–0.02±0.35
		Bittern-Type Bitter Taste	0.01±0.08	0.12±0.05

** Significat (P<0.05).*
*** Significat (P<0.01).*

Table 8

The evaluation of taste on Hanasaki Crab acclimated in hypertonic seawater

Section		Points evaluated as favorable	Points evaluated as unfavorable
Boiled cooking n=10	Taste and texture	• Feel strong taste • Moderate salty taste • Feel moderate springiness	• Strong salte taste • Meat is tough and firm • No springiness • Fatty*

** Indicating not fat but thermocoagulated hemolymph, with color of pale orange, adhering to inside of carapace.*

As the results of tasting for boiled Hanasaki Crabs acclimated in the hypertonic seawater, the number of people evaluated the acclimated crabs as for stronger taste and umami, but the degree of favorability was not so large and not considered to be the degree to feel markedly different. As the major reasons in feeling favorable, some member evaluated because feeling strong taste, and, on the contrary, as the reasons in feeling unfavorable, some member evaluated because stronger salty taste, but another member evaluated no clear difference in salty taste and umami taste.

There was a member evaluating "springiness" and "chewiness" to be favorable and the other conversely evaluating these points unfavorable, and among them some member evaluates no clear difference in salty taste and umami taste. These results can be mixture of a simply difference of personal preference, and an effect of individual difference of crabs after cooked.

In the tests of this time, the effect of acclimation in hypertonic seawater was observed in the improvement in the contents of free amino acids, centering in taurine, and in the improvement in the umami body taste (after taste) by Taste Sensor, but, no results to be able to evaluated as clear improvement of taste by sensory testing.

3.3.3. The effect of short term acclimation by hypertonic seawater in improving taste of Hanasaki Crab

From the series of tests stated above, it is confirmed that, through the acclimation of live Hanasaki Crab in hypertonic seawater of 125% concentration, among free amino acids, the concentration of taurine shows tendency to increase5). This time, as a relatively simpler method, the effect of 2 days acclimation in the seawater controlling seawater content to 110% (salinity of 36‰) by adding cooking salt, in improvement of sweet-tasting amino acids and taste, was tested.

The male Hanasaki Crab obtained in July 2007 and female obtained in September 2007 were used as samples, and after boiled under a given conditions, analyses of chemical components and sensory tests were performed.

As the results of male Hanasaki Crab obtained in July 2007, the test section of acclimation by 110% seawater showed slightly higher values, comparing with the control section, but, without statistical significance, for salt, taurine and glycine, and no increasing tendency in sweet-tasting amino acids, reported as osmotic pressure regulating substances (**table 9**).

Table 9

The results of analyses on major components for boiled Hanasaki Crab (♂)

Date obtaining specimens	2007/7/23	
Temporal rearing conditions *water temperature 5°C	110% (36‰) 2 days	100% (33‰) 2 days
Boiling conditions (seawater concentration at boiling)	90°C×28 min. (1.0%)	100°C×14 min. (1.5%)
Number of analyzed specimens	3	3
Body weight (Avg.) g	878	885
Yield rate (after boiling) %	96.2±8.2	91.3±3.8
Salt added (Avg.) %	1.8	1.6
glycine mg/100 g	500±75	421±44
alanine mg/100 g	3±3	4±1
proline mg/100 g	84±49	82±34
glutamic acid mg/100 g	42±9	37±6
taurine mg/100 g	270±10	228±48
glutamine mg/100 g	10±9	19±19
water content %	87.5±0.8	87.6±0.9
juice ratio %	0.39±0.02	0.47±0.06
solid body ratio %	0.50±0.06	0.47±0.05
rupturing strength** g/cm	309±15	248±4

*** Significant (P<0.01) in test on difference in averages.*

As the analyses relating to texture, the section acclimated by 110% seawater showed relatively high value of muscle rupture strength, but no significant differences in water contents, juice ratio, and solid matter ratio.

The results of taste analyses by Taste Sensor, shown in **table 10,** indicate that the section acclimated in 110% seawater marked higher (1.23 fold) salty taste value and lower (0.77 fold) umami taste value than the control section, but their difference was not significant, and the taste improvement effect was not observed from the results of sensory tests.

Table 10

The results of analyses of boiled Hanasaki Crabs by Taste Sensor

Sections		Acclimation in 110% seawater section	Control section
Sex (Number of specimens) Avg. Body weight g		♂ (n=3) 724	♂ (n=3) 854
First Taste	Salty Taste	1.66	0.51
	Umami Taste	–1.96	–0.51
	Bitter Odd Taste	–2.17	–2.77
After Taste	Umami Body Taste	–1.58	–1.97
	Bitter Taste	–0.17	–0.61

Table 11 shows the results of components analyses on female Hanasaki crab obtained in September 2007. From comparison between the section acclimated in 110% seawater and the control section, the acclimation section shows relatively

lower taurine value, but no increasing tendency in sweet-tasting amino acids. As for texture, both of the tested sections show no significant difference in the values of water content, juice ratio, solid body ratio, and rupturing strength of muscle.

Table 11

The results of analyses of major components of boiled Hanasaki Crab (♀)

Date obtaining specimens	2007/9/4	
Temporal rearing conditions *water temperature 5°C	110% (36‰) 2 days	100% (33‰) 2 days
Boiling conditions (seawater concentration at boiling)	90°C×36 min. (1.5%)	100°C×18 min. (2.5%)
Number of analyzed specimens	3	3
Body weight (Avg.) g	922	949
Yield rate (after boiling) %	104.8±2.4	106.1±0.3
Salt added (Avg.) %	1.2	1.2
glycine mg/100 g	392±136	394±33
alanine mg/100 g	44±26	36±2
proline mg/100 g	178±51	153±47
glutamic acid mg/100 g	41±9	58±6
taurine mg/100 g	335±24**	452±18**
glutamine mg/100 g	46±18	49±11
water content %	77.8±0.4	79.7±3.7
juice ratio %	0.04±0.01	0.08±0.09
solid body ratio %	0.79±0.05	0.78±0.10
rupturing strength** g/cm	295±23	267±43

*** Significant (P<0.01) in test on difference in averages.*

Table 12 shows the results of taste analyses by Taste Sensor. The acclimated section indicates higher (1.42 fold) value of umami body taste, and lower (0.54 fold) value of bitter odd taste. However, the results of sensory tests indicated no effect on improvement of taste.

Table 12

The results of analyses of boiled Hanasaki Crab by Taste Sensor

Sections		Acclimation in 110% seawater section	Control section
Sex (Number of specimens) Avg. Body weight g		♀ (n=3) 920	♀ (n=3) 782
First Taste	Salty Taste	–1.27	–1.12
	Umami Taste	1.22	1.01
	Bitter Odd Taste	–2.69	0.68
After Taste	Umami Body Taste	3.92	1.99
	Bitter Taste	–0.42	0.10

The similar analyses were performed for the Hanasaki Crabs, after 2 days acclimation in 110% seawater, acclimated further in 120% seawater for 2 day, however there observed no remarkable difference other than relatively higher value of salt content and relatively lower values of taurine.

Summarizing above results, the tested method, to acclimate for 2 days in 110% seawater and to boil under given conditions, cannot show any effect in taste improvement to be identified as increase in sweet-tasting amino acids or by sensory tests. As a trial to obtain effect in improvement of sweet-tasting amino acids, the method to increase seawater concentration at acclimation may be considered, however, this may not be a practical method to improve taste of Hanasaki Crab, because, by acclimation with seawater concentration higher than 110%, dead individuals had appeared, and, by gradual increase of seawater concentration that could improve survival rate, but it needs a certain length of acclimation period, and thus, possibility to increase salty taste after boiling became higher.

4. DEVELOPMENT OF TECHNOLOGY OF EVALUATING TASTE OF HANASAKI CRAB

4.1. Objectives

In order to develop the method for objective evaluation of taste specification when eat Hanasaki Crab, the index for evaluating taste specification of Hanasaki Crab was developed through analyses of Hanasaki Crab of different conditions such as harvested time, sex, and so on, together with the sensory test for analyses of taste specifications favorable for consumer.

4.2. Materials and Methods

The analyzed samples were live Hanasaki Crabs caught in the coast of Nemuro Peninsula from June to September 2008, after one night reared in artificial seawater cooled to 5°C, measured their carapace widths, carapace lengths and body weights, and, for good liveliness ones, boiled under a given conditions for analyses. From these samples, the meropodite muscle of ambulatory legs were taken and frozen as specimens, then together with analyses of salt content, water content and glycogen, the contents of free amino acids and nucleotide relating substances were extracted by 10% PCA and analyzed by HPLC. Further, after weight measurements on muscle and juice parts of meropodite of ambulatory legs, the rupturing strength of them are measured by rheometer (Hudo Kogyo Ltd., NRM-2010J-CW), by using the back of razor's edge as adaptor. The sensory tests on the strength to tastes and preference on Hanasaki Crab was performed with cooperation by staffs of fisheries cooperatives in the city.

4.3. Results and Discussions

4.3.1. Method of evaluation on recovery of Hanasaki Crab after molting

The taste specification of Hanasaki crab is supposed to be influenced largely by recovery conditions after molting. The period of molting for adult Hanasaki crabs are considered to be May to July for female and May to October for male). The fishing season of Hanasaki Crab in the water around Nemuro Peninsula is from May to September, and Hanasaki Crabs of different carapace hardness of male and female are landed during fishing season. This is supposed to be caused by co-existence of the individuals on the way of recovering from molting experienced in the early half of the fishing season and the individuals to molt later half of or after fishing season. When forwarding Hanasaki Crab to the market, in order to distinguish the degree of flesh fullness of harvested crabs, fishermen are selecting the hardness of carapace or so, or the ventral color tone as indices, judging from own experiences and feelings, thus no objective method for evaluation was not established.

Therefore, the methods to evaluate the degree of recovery from molting for Hanasaki Crab were examined, through obtaining the crabs caught in the early part of fishing season when crabs with soft carapace are relatively abundant, and the crabs caught later than the middle of fishing season when many hard carapace ones appear.

The crabs used as specimens were obtained in three categories; the individuals with relatively soft carapace considered to be on the way of recovering from molting (Recovery stage 3), the individuals with relatively harder carapace (Recovery stage 4), and the individuals with hard carapace considered to be fully recovered (Recovery stage 5), for male and female, based on the distinguish table (**table 13**), divided in to five stages based on carapace hardness and ventral color tone. The samples of each recovery stages were boiled, and analyzed and measured on various components and items. The results of analyses and measurements are shown in **table 14** and **table 15.**

Table 13

The table for distinguish recovery stages from molting for live Hanasaki Crab

Division	Hardness of carapace etc. (method pressing by fingers)		Ventral color tone (method by visual inspection)	
	Meropodite of ambulatory legs	Others	Whole color tone	Presence of Melano-pigments
1	Very soft	Carapace or so distorted when lifting up	Very strong white	Absent
2	Depressed largery only by pushing lightly with thumb and forefinger	Rood of ambulatory legs depressed by pushing only with forefinger	Same as above	Same as above
3	Depressed by pushing relatively lightly with thumb and forefinger	Rood of ambulatory legs scarcely depressed or feel springiness by pushing with forefinger	Strong white	Same as above
4	Depressed by pushing relatively lightly with thumb and forefinger or feel moderate repulsion	Rood of ambulatory legs scarcely depressed by pushing with forefinger	Slightly strong red	For male, slight darkening on a part of ventral surface (base of ambulatory legs or telson)
5	Depressed by pushing relatively lightly with thumb and forefinger or feel moderate repulsion	Rood of ambulatory legs scarcely depressed by pushing with thumb	Strong red; Male: color tone of whole ventral surface tinged with cream or yellow; Female: strong red tone especially on telson part	Male: clear darkening on ventral surface

Table 14

The boiling procedures of Hanasaki Crab used for analyses

Obtained date	Sex (number of samples)	Recovery stage	Carapace length (Ave.) mm	Carapace width (Ave.) mm	Body weigth (Ave.) g		Yield rate %	Boiling conditions
					Before boiling	After boiling		
2008/6/17	♂ (n=5)	3	93.4	106.8	827	647	79	14 min. heating (salt 1.5%)
	♀ (n=5)	4	100.5	116.1	996	882	89	18 min. heating (salt 2.0%)
2008/7/28	♂ (n=5)	4	96.6	112.7	964	934	97	14 min. heating (salt 2.0%)
	♀ (n=5)	5	99.2	113.3	1.004	1.005	100	18 min. heating (salt 2.5%)
2008/9/1	♂ (n=5)	5	98.2	111.9	1.027	1.018	99	14 min. heating (salt 2.5%)
	♀ (n=5)	5	97.0	112.4	1.001	1.027	102	18 min. heating (salt 2.5%)

Note. *After boiling, crabs were dipped in ice water to take heat, then after 3 min. for male and 5 min. for female, cooled in trash ice.*

Table 15

The results of analyses and measurements on Hanasaki Crab (Meropodite of ambulatory legs)

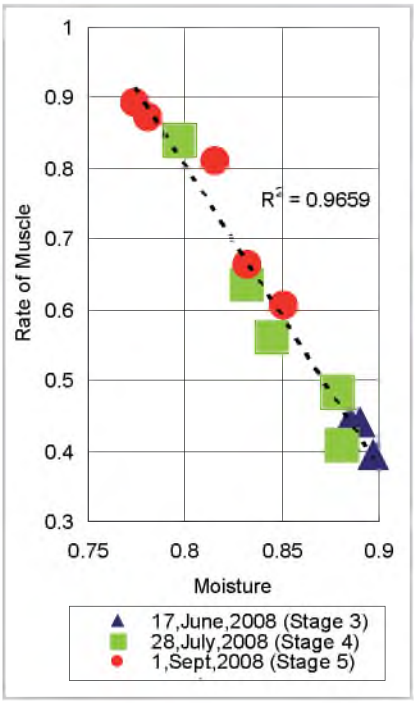
Sex	Recovery sage (obtained date)	Water content %	Composition ratio %			Meropodite of ambulatory legs/Body weigth *3	Rupturing strength g/cm
			juice *1	muscle	others *2		
♂	3 (2008/6/17)	88.7±0.7	44±4	44±3	13±1	0.063±0.007	339±56
	4 (2008/7/28)	84.6±3.5	25±14	59±17	16±3	0.056±0.008	323±56
	5 (2008/9/1)	81.1±3.3	9±8	77±13	14±5	0.060±0.006	359±54
♀	4 (2008/6/17)	86.4±1.7	33±9	47±6	20±3	0.062±0.005	370±46
	5 (2008/7/28)	82.6±2.1	12±12	64±10	24±4	0.059±0.008	279±44
	5 (2008/9/1)	78.8±0.6	3±1	82±4	15±3	0.063±0.005	282±39

**1: Ratio of the weight of the juice separated naturally without pressure to the weight of whole meropodite of ambulatory legs (edible part).*

**2: Ratio of the weight of thermo-coagulating water-soluble protein to the weight of whole meropodite of ambulatory legs (edible part).*

**3: Ratio of the total weight of meropodite of the 1st to 3rd ambulatory legs (edible part) to the body weight (before boiling).*

Comparing among recovery stages, the female and male with harder carapace and stronger ventral surface color tone, indicated lower water content in meropodite of ambulatory legs and higher muscle ratio. Comparing among individuals, as the samples obtained in the last 10-days of July, the middle of fishing season, the values of water content, muscle ratio and juice ratio showed ranges, and the water content, muscle ratio, and juice ratio, for the individuals identified as in same recovery stage, are not necessarily constant and show individual differences (**fig. 3** and **fig. 4**).



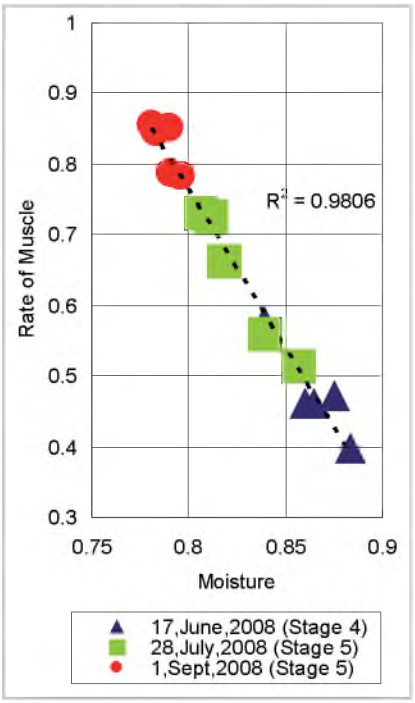


Fig. 3 (left). *The water content and muscle ratio for meropodite of ambulatory legs of male Hanasaki Crab*

Fig. 4 (right). *The water content and muscle ratio for meropodite of ambulatory legs of female Hanasaki Crab*

As for the rupturing strength, there exist large individual differences and no clear correlation to the recovery stage or the muscle ratio was observed, and, thus, the method for measurement of rupture strength other than the method using the back of razor's edge as adaptor, need to be tested.

From above results, as the method for evaluating recovery status after molting for Hanasaki Crab, the conventional empirical method to use carapace hardness or ventral color tone as index cannot make detailed evaluation, and it is considered to be appropriate to use muscle ratio or water contents of meropodite of ambulatory legs, parallel as indices. As for index of the meat fullness, the method to evaluate by muscle ratio is considered to be appropriate, but ratio of the total weigh of meropodite of the 1st to 3rd ambulatory legs (edible part) to the body weight is considered to be inappropriate, because this index did not show any difference by recovery stages and period of catch. For the measurement method for water content or muscle ratio, a method of instantaneous distinguish without damaging samples by nondestructive sensor or so, is expected to be developed.

4.3.2. Method for evaluating taste characteristics of Hanasaki Crab by content analyses

The taste characteristics of Hanasaki Crab are considered to be influenced by not only taste but also other factors of texture or flavor etc. Thus, the results of analyses on components considered to be relating to the taste of Hanasaki crab are shown in **table 16.** Though the taste effective components for Hanasaki Crab were not performed yet, but as the taste effective components for crabs and shrimps, glycine,

alanine, proline for sweet taste, glutamic acid, AMP, IMP, GMP for umami taste, and arginine for whole taste are reported 1, 2, 3). Comparing these components with recovery stages, the crabs with harder carapace and with stronger ventral color tone indicated higher proline and arginine values, for both male and female. The values of glycogen, which is not identified as taste effective component, were higher for the male and female crabs of harder carapace and stronger ventral color tone. The female Hanasaki Crabs identified as recovery stage 5 showed total free amino acid values having range, 898–2,031 mg/100g, but the individuals caught in the middle of fishing season were tending to show lower values. This may indicate that the free amino acids contents are not constant for the individuals identified to belong same recovery stage, as similar to water content, muscle ratio, and juice ration, because of individual differences in recovery conditions after molting.

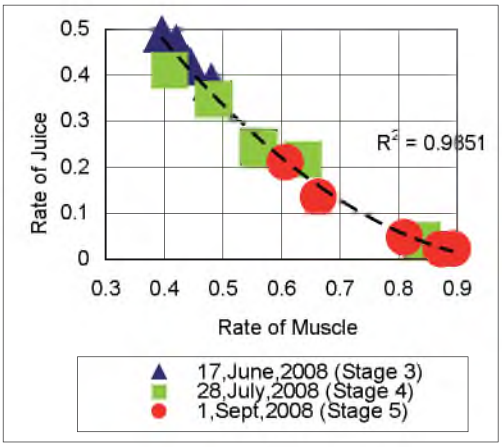
Table 16

The results of components analyses on Hanasaki Crabs (meropodite of ambulatory legs)

Obtained date	2008/6/17	2008/7/28	2008/9/1	2008/6/17	2008/7/28	2008/9/1
Sex (number of samples)	♂ (n=5)	♂ (n=5)	♂ (n=5)	♀ (n=5)	♀ (n=5)	♀ (n=5)
Recovery stage	3	4	5	4	5	5
taurine	174±26	259±42	311±62	194±19	218±35	297±42
aspartic acid	5±1	7±2	5±1	6±1	6±±1	5±1
threonine	4±1	23±17	27±14	14±4	23±12	22±9
serine	12±2	25±11	16±7	15±4	23±5	20±10
glutamic acid	23±4	41±15	47±8	29±3	41±6	41±10
glutamine	14±6	29±12	65±31	19±6	20±6	50±15
proline	1±1	81±104	146±72	12±7	103±61	171±58
glycine	392±53	373±68	311±43	369±51	302±58	297±70
alanine	53±12	71±23	96±21	99±18	88±18	95±26
valine	9±1	35±23	41±11	21±6	34±20	37±9
methionine	3±1	24±21	20±9	10±2	28±13	24±6
isoleucine	4±0	23±21	23±7	13±3	26±13	27±7
leucine	7±1	44±38	49±17	23±6	48±27	46±14
tyrosine	5±2	25±15	58±29	14±3	25±10	52±15
phenylalanine	5±1	22±16	29±13	5±1	6±1	9±2
lysine	6±2	6±2	8±4	13±2	35±14	52±6
histidine	6±4	16±11	16±8	9±6	11±4	19±7
arginine	189±29	320±99	446±105	236±34	318±56	443±92
Total	911±74	1.423±429	1.713±354	1.101±137	1.354±264	1.706±293
AMP	43.7±3.4	54.1±6.7	60.9±14.6	43.2±4.3	53.8±6.7	58.2±14.3
IMP	1.3±0.6	1.6±0.5	0.2±0.2	2.3±0.7	1.8±0.9	0.3±0.3
GMP	3.3±0.5	4.7±0.9	4.2±0.9	4.3±0.7	4.7±1.1	5.7±1.2
Salt (%)	1.5±0.3	1.5±0.3	1.2±0.2	1.5±0.2	1.3±0.1	1.1±0.1
Glycogen (%)	0.06±0.05	0.33±0.37	0.88±0.48	0.15±0.09	0.52±0.27	0.92±0.09

Note. *Values are average value ± standard deviation, units of free amino acids and nucleotide relating substances are mg/100 g.*

As the factors relating to the texture of Hanasaki Crabs, the results of measurements, on juice and muscle weight ratio in meropodite of ambulatory legs, are shown in **figs. 5** and **6.** Comparing among recovery stages, the crabs with harder carapace and stronger ventral color tone showed lower juice ratio and higher muscle ratio of meropodite of ambulatory legs. However, as stated above, the values of muscle ratio and juice ratio indicate ranges and not constant for the individuals identified as same recovery stage, indicating existence of individual differences.



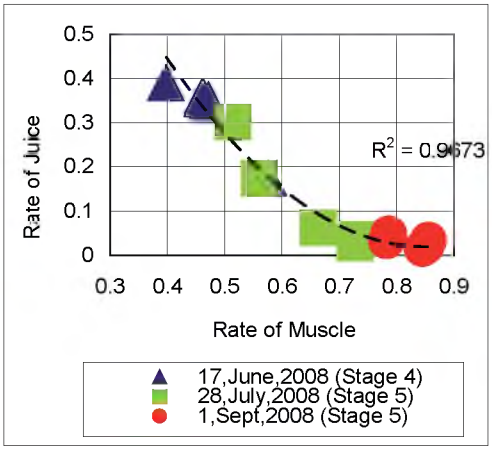


Fig. 5 (left). *The muscle and juice ratio for meropodite of ambulatory legs of male Hanasaki Crab*
Fig. 6 (right). *The muscle and juice ratio for meropodite of ambulatory legs of female Hanasaki Crab*

Paying attention to the muscle ratio and juice ratio, as considering that Hanasaki Crabs can be categorized into high juice/low muscle ratio, low juice/high muscle ratio, and intermediate type individuals, the results of measurements on major components are shown by these categories in **table 17.** For both male and female, the muscle ratio, glycogen and total free amino acids are higher for the individuals of low juice/high muscle type, and the juice ratio and water contents are higher for the individuals of high juice/low muscle type. Among the components reported as effective in taste, on proline, GMT, and arginine, the higher values are shown by the low juice/high muscle type for both male and female, and on alanine, glutamic acid and AMP, the higher values are shown by the low juice/high muscle type. On glycine and IMP, no difference was observed.

Table 17

The results of components analyses on Hanasaki Crabs (meropodite of ambulatory legs)

Sex		♂		♀	
Recovery stage		3–4	4–5	4	5
Obtaining date (sample number)		2008/6/17 (n=4) 2008/7/2 (n=1)	2008/7/28 (n=1) 2008/9/1 (n=3)	2008/6/17 (n=4)	2008/7/28 (n=2) 2008/9/1 (n=5)
Physical properties	Muscle ratio %	42.2±2.1**	85.4±3.6**	44.8±3.4**	79.7±5.5**
	Juice ratio %	44.2±3.5**	3.3±1.5**	36.4±1.8**	3.0±1.1**
Taste effective components	glycine	378±71	373±77	366±58	301±62
	alanine	51±11*	99±23*	100±21	91±24
	proline	3±6**	170±53**	11±7**	164±48**
	glumamic acid	24±5**	52±5**	29±3	41±9
	AMP	43.4±3.0*	65.8±11.9*	42.0±3.7	57.9±12.2
	IMP	1.4±0.7	0.6±0.4	2.5±0.6	0.9±1.1
	GMP	3.3±0.5*	5.0±0.8*	4.0±0.4*	5.4±1.1*
	arginine	192±31**	502±28**	239±39*	421±85*
Others	Salt	1.5±0.3%	1.1±0.1%	1.6±0.1%*	1.1±0.1%*
	Total amino acids	859±134**	1.876±101**	1.115±127*	1.754±391*
	glycogen	0.07±0.05%**	1.06±0.43%**	0.13±0.08%**	0.86±0.16%**
	water	88.7±0.7%**	79.2±1.8%**	87.1±1.0%**	79.4±1.1%**

Note. *Values are average ± standard variation. Significant level (*: $p<0.05$; **: $p<0.01$).*

From results above, as an index for felling of juiciness when we eat Hanasaki Crab, it is considered to be appropriate to use juice ratio, but as an index for feeling of fullness is remained future subject. However, it is found that, as the progress of degree of recovery from molting, the values of specific body components including those reported as taste effective, muscle ratio, or juice ratio etc., increase or decrease.

4.3.3. The method for evaluating taste characteristics of Hanasaki Crab by Analytic Sensory Tests

As a method for evaluating taste characteristics of Hanasaki Crab, besides the method by analyses of components, the sensory tests is also considered to be efficient. Thus, as selecting staffs of fisheries cooperatives in the city, thought to be relatively rich in experience of tasting Hanasaki Crab, as the member of panel for sensory tests, the intensity analyses were performed on the items relating to vision, smell, texture, and taste of Hanasaki Crab, on obtained male and female samples. the intensity of tastes were evaluated among “Very Strong”, “Clearly Strong”, “Not Strong Nor Weak”, “Clearly Weak”, and “Very Weak”, and the results of each evaluation were converted to point of 5, 4, 3, 2, and 1, and expressed by average values (**table 18**).

Table 18

Results of analytic sensory tests on Hanasaki Crab

Obtained date			2008/6/17		2008/7/28		2008/9/1	
Sex			♂	♀	♂	♀	♂	♀
Recovery stage			3	4	4	5	5	5
Taste intensity	Vision	Degree of crab meat fullness	2.4	3.0	3.6	4.1	4.3	4.1
		Degree of juiciness	3.9	3.7	3.6	3.7	3.1	3.2
	Smell	Smell specific to Hanasaki Crab	3.2	3.3	3.6	3.8	3.3	3.5
		Bad smell by bed freshness etc.	1.8	1.9	1.9	2.2	1.9	2.2
	Texture	Texture/ Springiness	2.6	3.1	3.7	4.1	3.8	3.7
		Juiciness	3.7	3.8	3.9	3.7	2.9	3.2
	Tastes/ Flavor	Salty	3.4	3.1	3.4	3.7	3.2	3.0
		Sweet	3.0	3.4	3.1	3.4	3.2	3.4
		Umami/Body	3.2	3.4	3.3	3.7	3.4	3.6
		Bitter odd taste	2.2	2.3	2.4	2.7	2.4	2.5
		Flavor specific to Hanasaki Crab	3.4	3.7	3.4	3.4	3.3	3.4
Number of panel member			16		15		15	

The results of analyses, the Hanasaki Crab, with hard carapace (Recovery stage 5) obtained later than the middle of fishing season, was evaluated by vision as of the strong degree for crab meat fullness. And, for almost specimens, the bad smell by bad freshness was evaluated to be significantly weak. However, on another taste evaluating items, there are no significant differences with recovering stages, time of obtaining, and sex, and the tastes and textures when Hanasaki Crabs were tasted were resulted in evaluation as ordinary not strong nor weak.

Through components analyses and measurements, the Hanasaki Crabs used for sensory tests were confirmed to have large ranges of values in a part of free amino acids reported taste effective in crabs and shrimps, juice ratio and muscle ratio, and thus, it is expected that some degree of difference could be brought by sensory tests, at least in evaluation of texture and tastes. The reason for resulting in no clear difference can be existence of bias in the basis for evaluation of intensity of taste among panel members, in spite of selected among those who have many opportunities to taste Hanasaki Crab usually. In performing sensory tests, the selection of panel member needs special caution, and when the panel members are selected among people who have much opportunity to taste Hanasaki Crab from usual, they may be unable to evaluate textures and tastes exactly. When detailed analytic sensory tests will be performed, the panel members should be selected from the people accumulated training.

4.3.4. The Favorable Taste Characteristics of Hanasaki Crab identified by Preference Type Sensory Tests

In order to analyze and consider the taste characteristics of Hanasaki Crab preferred by consumer, survey by questionnaire was performed against the staff of fisheries cooperatives selected as the panel member for analytic sensory tests. The form of questionnaire is shown in **table 19.**

Table 19

The results of questionnaire on tastiness of Hanasaki Crab (19 valid responses)

Question: In case of boiled Hanasaki Crab, do you think crab of what conditions or time is the best taste crab for your?		
On the conditions of Hanasaki Crab	• Rich juiciness with not so much meat fullness (including 'Crab on the way of recovery after molting') • Good meat fullness • Each is tasty, regardless of degree of recovery from molting	5 3 1
On the time of harvest	• At the time of July–August (including 'Summer') • At the time of September • Others (always tasty)	7 1 1
On the way of boiling and tasting	• Hot from boiling, still hot • Not too cold	11 1

The results of questionnaire indicated that the crabs with good meat fullness are not necessarily preferred by all, but the crabs with high juiciness are preferred by much people. And, the crabs caught in July–August are preferred by relatively larger number of people, and the crabs hot from boiling are preferred by very large number of people.

Next, the results of the preference type sensory tests on Hanasaki Crab by same panel members are shown in **fig. 7.** The degree of preference is evaluated among "Very Fine", "Obviously Fine", "Ordinary", "Obviously Bad" and "Very Bad", and each results are converted to 5, 4, 3, 2 and 1 point(s), and evaluated by average values.

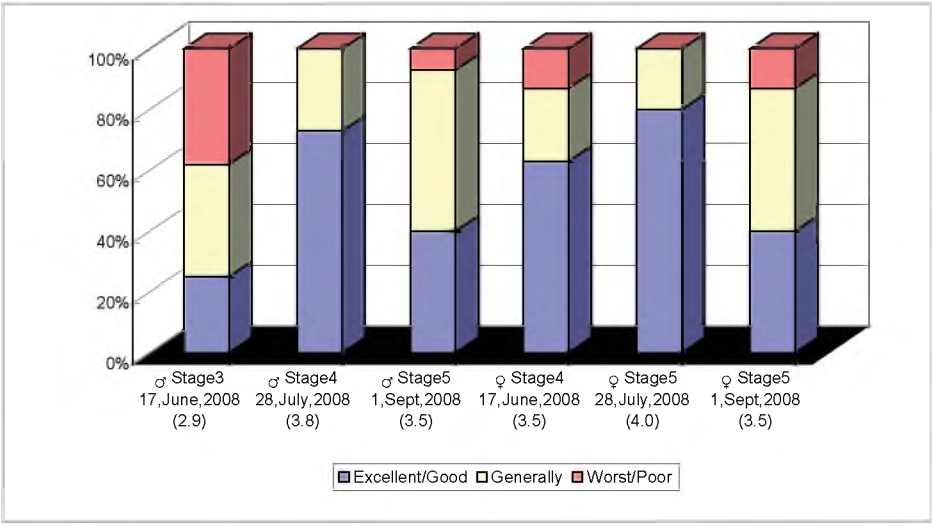


Fig. 7. *The results of preference type sensory tests on Hanasaki Crab*

Judging from the average values, the evaluations for samples obtained in the middle fishing season were relatively higher for both male and female, and the male crabs obtained in the early part of fishing season were evaluated less, however, there are not so much difference among recovery stages or obtaining time or sex. The percentage of answering 'significantly fine', as similar to the results of evaluation by average values, is relatively high for the sample obtained in the middle of fishing season, and there is no answer of 'significantly bad'. Similarly, the percentage of answering 'significantly bad', also similar to the results of average values, is relatively high for the male sample obtained in the early part of fishing season.

From results above, among the samples for sensory test performed this time, the samples obtained in the middle of fishing season got relatively high preference, for both male and female. The fact that the preference for the sample obtained in the later part of fishing season were not so high, while the meat fullness was good and the contents of a part of free amino acids reported to be taste effective were relatively high, is thought to be supporting the result of questionnaire that many people feel the important factor in evaluating tastiness is, not simply the fullness of meat, but the rich juiciness. As though enough results could not be obtained from the analytic type sensory tests, but the results of preference type sensory tests can make use as useful information on tastiness of Hanasaki Crab to be communicated to ordinary consumers, usually having opportunity to taste Hanasaki Crab scarcely.

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