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Changes in Extractive Components and Glycogen in the Edible Meat of Hard Clam *Meretrix lusoria* During Storage at Different Temperatures

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The changes in extractive components and glycogen in hard clam meat during storage at 0, 5, 10, 20 and 30°C were investigated. The initial levels of ATP-related compounds, glycogen, succinic acid and free amino acids in hard clam were 3.34±0.19 μmol/g, 1201±52 mg/100 g, 9.44±2.55 μmol/g, and 1226±106 mg/100 g, respectively. ATP in all samples decreased markedly during storage, while the accumulation of ADP, AMP, inosine, and hypoxanthine varied depending on the 5 storage temperatures. The decrease in glycogen was common for all the samples. In contrast, succinic acid increased with time of storage, and the increase rate was faster for the samples stored at 5 and 10°C. The changes in levels of free amino acids in hard clam during storage at different temperatures were inconsistent. The samples stored at 5 and 10°C showed a relatively high increase in the amounts of free amino acids, particularly in alanine, taurine, and arginine. The enrichment of free amino acids and succinic acid might potentially improve the flavor quality of hard clam stored at 5 and 10°C.

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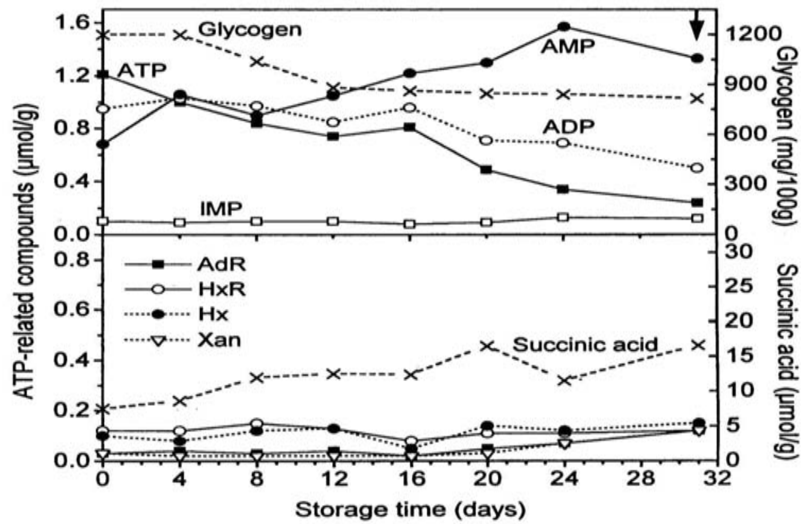

Fig. 1. Changes in ATP-related compounds, glycogen and succinic acid in the edible meat of hard clam during storage at 0°C. Arrow indicates the time of onset of initial decomposition.

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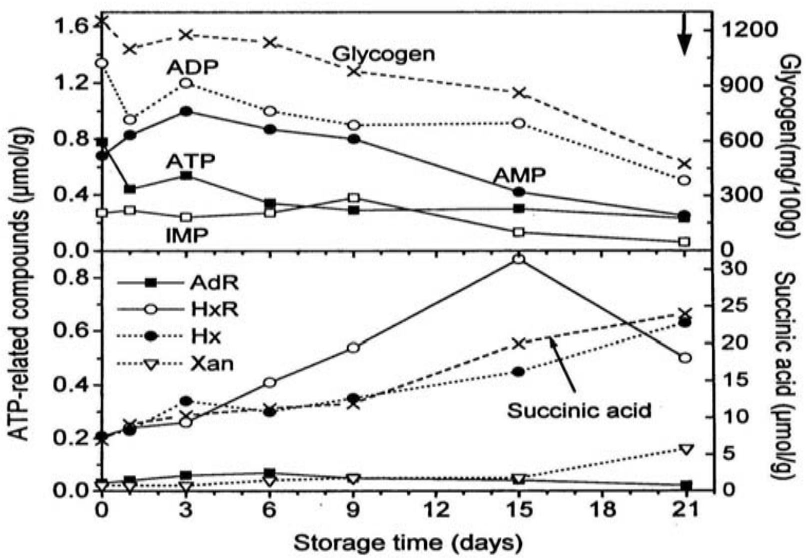

Fig. 2. Changes in ATP-related compounds, glycogen and succinic acid in the edible meat of hard clam during storage at 5°C. Arrow indicates the time of onset of initial decomposition.

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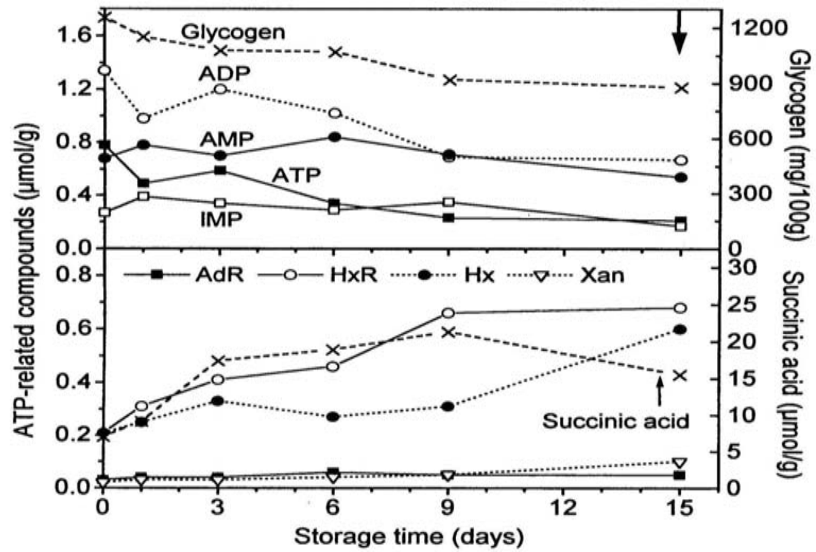

Fig. 3. Changes in ATP-related compounds, glycogen and succinic acid in the edible meat of hard clam during storage at 10°C. Arrow indicates the time of onset of initial decomposition.

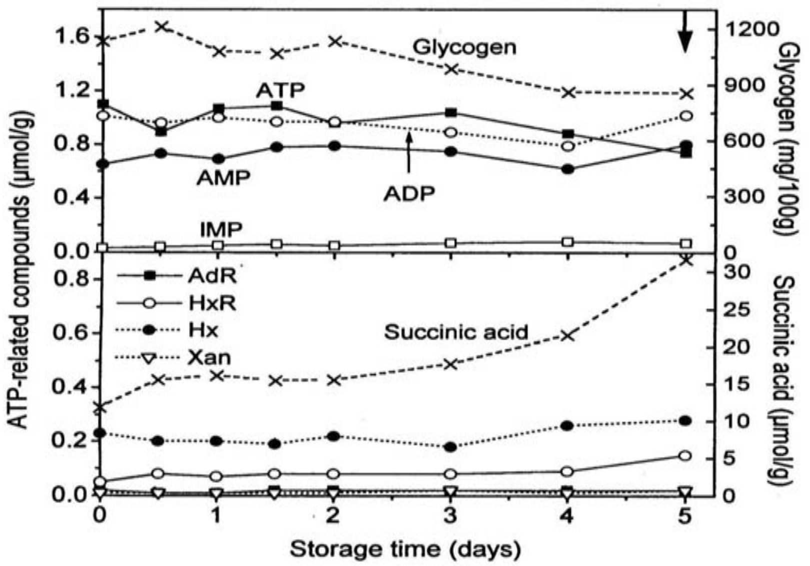

Fig. 4. Changes in ATP-related compounds, glycogen and succinic acid in the edible meat of hard clam during storage at 20°C. Arrow indicates the time of onset of initial decomposition.

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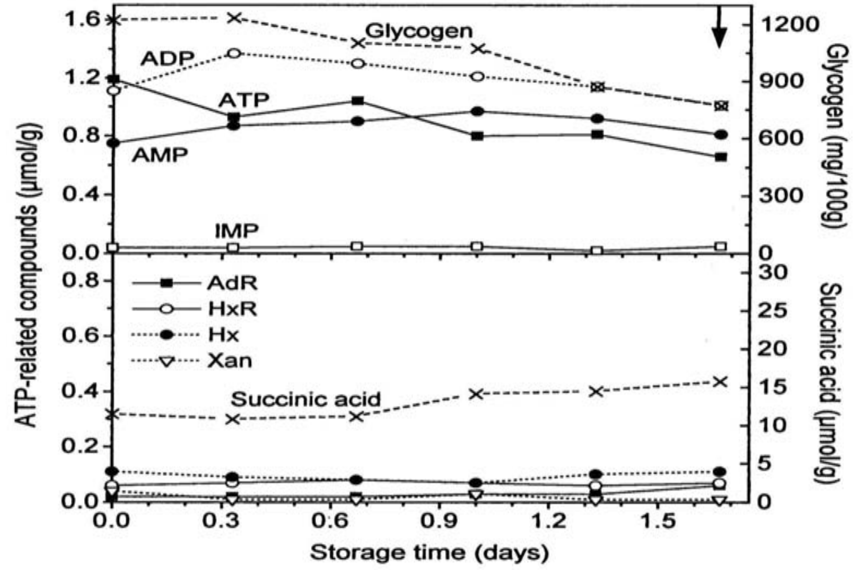

Fig. 5. Changes in ATP-related compounds, glycogen and succinic acid in the edible meat of hard clam during storage at 30°C. Arrow indicates the time of onset of initial decomposition.

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Table 1. Changes in free amino acids (mg/100 g) in the edible meat of hard clam during storage at different temperatures

Amino acids	0°C storage (days)								5°C storage (days)						
	0	4	8	12	16	20	24	32	0	1	3	6	9	15	21
Phosphoserine	7	9	7	8	6	6	6	6	7	6	7	8	10	9	9
Taurine	596	542	500	490	497	476	431	406	547	529	565	660	648	658	498
Aspartic acid	34	31	31	29	32	28	24	19	19	21	22	25	33	29	21
Threonine	15	15	14	15	13	15	13	13	12	10	13	14	20	17	13
Serine	9	7	7	7	6	7	6	5	8	7	8	8	10	8	5
Glutamic acid	162	121	110	100	111	97	79	69	132	120	127	136	141	137	103
Glutamine	9	3	4	3	4	3	2	2	16	15	16	14	25	19	14
Proline	11	9	11	12	10	10	11	11	5	7	8	9	14	11	11
Glycine	57	52	50	50	50	49	43	33	32	34	35	44	48	47	34
Alanine	177	175	180	177	183	178	161	155	129	139	153	193	220	234	187
Valine	17	17	17	18	17	18	17	17	11	12	15	17	25	22	21
Cystine	2	1	1	1	1	1	1	1	1	1	2	2	2	1	1
Methionine	6	4	6	7	6	6	6	7	7	8	8	10	14	10	14
Isoleucine	9	9	10	11	10	10	10	11	10	13	17	14	24	19	19
Leucine	13	13	15	16	15	15	15	16	13	14	18	20	32	27	25
Tyrosine	12	10	13	14	13	13	13	13	11	12	15	16	24	21	21
Phenylalanine	8	9	10	10	14	10	8	8	10	10	13	14	21	18	18
β-Alanine	5	4	4	4	4	4	5	5	1	2	2	2	3	3	3
Ornithine	8	7	8	7	7	7	7	6	8	8	10	10	13	12	23
Lysine	28	25	25	26	24	25	25	23	23	23	26	26	37	28	24
Histidine	8	7	7	8	7	8	7	7	5	5	6	7	9	10	7
Arginine	116	98	94	87	96	93	82	74	80	80	87	98	107	108	58
Total	1309	1168	1124	1110	1126	1079	972	907	1087	1076	1173	1347	1480	1448	1129

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Amino acids	10°C storage (days)						20°C storage (days)								30°C storage (days)					
	0	1	3	6	9	15	0	0.5	1	1.5	2	3	4	5	0	0.3	0.7	1	1.3	1.7
Phosphoserine	7	8	9	9	10	10	9	10	8	9	9	8	8	10	7	7	7	7	7	8
Taurine	547	622	635	681	677	605	652	661	652	653	655	659	629	651	445	457	442	453	439	430
Aspartic acid	19	23	27	33	37	33	22	28	27	28	29	30	28	30	21	21	19	18	20	19
Threonine	12	12	14	15	19	12	7	9	8	10	9	9	9	10	6	7	7	7	7	7
Serine	8	8	8	8	8	5	5	6	5	6	6	5	5	5	6	6	6	5	5	5
Glutamic acid	132	143	132	140	142	131	150	139	133	134	129	120	112	114	111	118	98	100	96	92
Glutamine	16	16	14	31	30	15	5	4	4	4	5	5	5	5	6	5	3	2	2	3
Proline	5	8	10	11	13	5	7	8	9	8	8	8	8	10	7	7	8	9	9	9
Glycine	32	40	42	47	49	54	60	64	62	71	63	68	69	73	79	88	80	88	86	87
Alanine	129	164	194	248	274	296	206	246	253	272	289	289	299	350	320	338	344	371	390	387
Valine	11	13	16	18	24	18	10	11	11	13	12	12	12	15	12	13	16	14	16	16
Cystine	1	1	2	1	2	1	1	1	1	1	1	1	1	1	trace	trace	trace	1	1	1
Methionine	7	7	7	11	12	18	4	3	4	4	5	4	4	6	3	3	3	3	4	5
Isoleucine	10	11	14	16	21	14	5	6	6	8	7	7	8	10	6	7	7	8	9	9
Leucine	13	15	19	22	29	22	7	8	9	11	11	10	11	15	8	9	10	11	12	13
Tyrosine	11	13	15	18	22	16	6	7	7	9	9	9	9	10	6	6	7	7	7	8
Phenylalanine	10	12	14	16	19	13	4	5	5	8	9	6	7	10	4	5	6	6	6	6
β-Alanine	1	2	2	2	3	3	3	3	3	3	3	3	3	4	6	7	6	7	7	7
Ornithine	8	9	10	11	11	12	6	6	6	6	6	6	6	7	3	4	3	4	4	5
Lysine	23	24	25	26	29	21	12	11	11	12	11	11	12	13	9	10	10	11	12	12
Histidine	5	6	7	9	10	10	4	5	5	6	6	7	7	8	3	3	4	4	4	5
Arginine	80	97	95	110	115	95	89	89	92	92	95	92	90	99	66	70	67	70	70	65
Total	1087	1254	1311	1483	1556	1469	1274	1330	1321	1368	1377	1369	1342	1456	1134	1191	1153	1206	1213	1199

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Original Article

Extractive component changes in the foot muscle of live small abalone during storage

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ABSTRACT: Changes in the freshness indices and extractive components in the foot muscle of live small abalone *Haliotis diversicolor* during storage at 5°C, 15°C, and 25°C were investigated. The pH values declined with storage time. Volatile basic nitrogen and the *K*-value increased gradually with storage time at 15°C and 25°C, but changes were small at 5°C. The onset of initial decomposition of samples was observed after 3.5 days at 5°C, after 2.5 days at 15°C, and after one day at 25°C. Adenosine triphosphate and adenosine diphosphate degraded rapidly within the early days of storage. In contrast, levels of adenosine monophosphate increased and exhibited prolonged accumulation throughout the storage period. The total amount of free amino acids increased markedly during storage. The dominant free amino acids, such as taurine, glutamic acid, glycine, alanine, and arginine, also increased after storage.

KEY WORDS: **extractive component, freshness index, small abalone, storage.**

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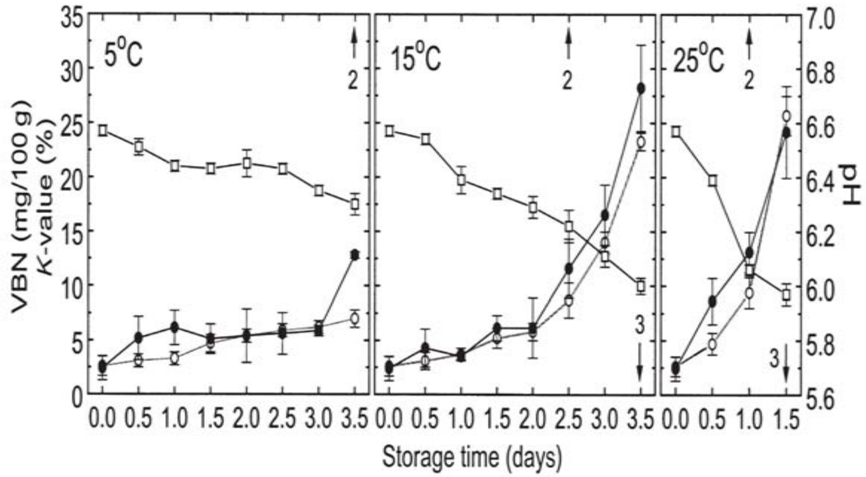

Fig. 1 Changes in levels of (□) pH, (○) volatile basic nitrogen (VBN), and (●) *K*-value in the foot muscle of small abalone during storage at 5°C, 15°C, and 25°C. Data are the mean ± SD of triplicate experiments. Arrows indicate the time of onset of initial decomposition (2) and advanced decomposition (3).

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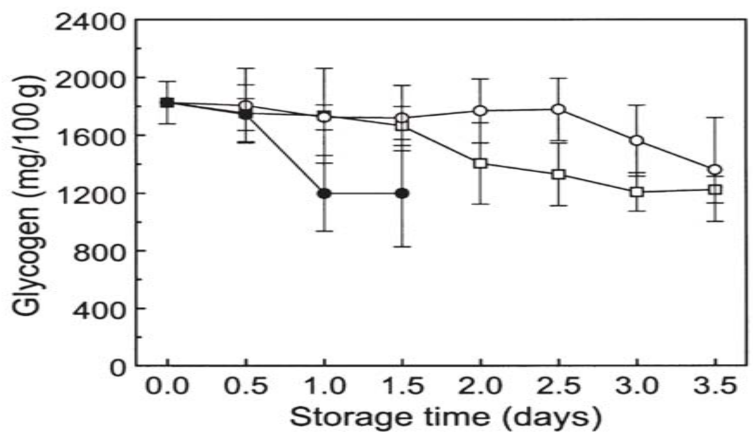

Fig. 2 Changes in the levels of glycogen in the foot muscle of small abalone during storage at (□) 5°C, (○) 15°C, and (●) 25°C. Data are the mean ± SD of triplicate experiments.

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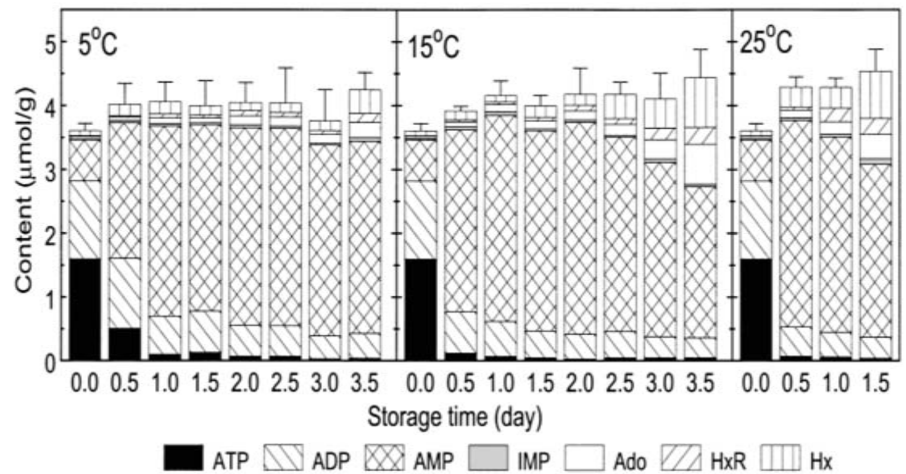

Fig. 3 Changes in the level of adenosine triphosphate (ATP) and its related compounds in the foot muscle of small abalone during storage at 5°C, 15°C, and 25°C. Data are the mean ± SD of triplicate experiments. Bars at the top of each column indicate the SD of the total content. ADP, adenosine diphosphate; AMP, adenosine monophosphate; IMP, inosine monophosphate; HxR, inosine; Ado, adenosine; Hx, hypoxanthine.

Table 1 *Continued*

Amino acids	15°C storage (days) 0.5	1.0	1.5	2.0	2.5	3.0	3.5	25°C storage (days) 0.5	1.0	1.5
Phosphoserine	5 ± 1	7 ± 1	7 ± 1	7 ± 1	10 ± 1	9 ± 1	12 ± 1	7 ± 0	9 ± 0	11 ± 1
Taurine	1141 ± 82	1213 ± 115	1262 ± 24	1311 ± 54	1484 ± 65	1310 ± 30	1377 ± 34	1294 ± 67	1315 ± 195	1420 ± 74
Aspartic acid	4 ± 1	3 ± 1	3 ± 1	2 ± 0	2 ± 1	1 ± 0	1 ± 0	2 ± 0	3 ± 1	2 ± 1
Threonine	13 ± 3	14 ± 2	15 ± 3	16 ± 5	16 ± 3	13 ± 3	14 ± 3	16 ± 4	14 ± 4	19 ± 2
Serine	23 ± 7	28 ± 7	24 ± 3	31 ± 10	34 ± 5	29 ± 2	23 ± 2	27 ± 5	27 ± 7	30 ± 9
Glutamic acid	35 ± 6	47 ± 3	52 ± 14	54 ± 17	65 ± 17	54 ± 16	51 ± 14	51 ± 11	52 ± 20	55 ± 14
Glutamine	16 ± 11	16 ± 9	18 ± 11	14 ± 11	14 ± 6	13 ± 8	13 ± 10	16 ± 11	12 ± 8	13 ± 7
α-AAA	6 ± 1	8 ± 2	8 ± 2	7 ± 2	9 ± 1	7 ± 1	7 ± 1	9 ± 1	8 ± 0	7 ± 2
Proline	15 ± 4	15 ± 2	18 ± 5	19 ± 7	20 ± 3	18 ± 5	19 ± 2	20 ± 9	16 ± 2	22 ± 4
Glycine	245 ± 43	248 ± 18	300 ± 67	275 ± 66	294 ± 96	275 ± 90	298 ± 51	282 ± 60	280 ± 74	339 ± 77
Alanine	29 ± 7	39 ± 5	43 ± 10	42 ± 7	52 ± 5	47 ± 8	48 ± 6	41 ± 6	41 ± 10	49 ± 4
Citrulline	3 ± 2	4 ± 1	4 ± 1	2 ± 2	4 ± 2	4 ± 1	9 ± 5	3 ± 1	3 ± 2	6 ± 2
α-ABA	2 ± 1	3 ± 1	3 ± 1	2 ± 1	3 ± 0	3 ± 0	2 ± 2	2 ± 1	3 ± 0	3 ± 1
Valine	6 ± 2	7 ± 1	8 ± 3	8 ± 3	9 ± 1	8 ± 1	9 ± 4	8 ± 1	8 ± 2	10 ± 1
Methionine	3 ± 1	3 ± 2	3 ± 2	3 ± 2	2 ± 1	2 ± 1	3 ± 1	4 ± 2	3 ± 2	3 ± 1
Cysthionine	4 ± 1	4 ± 3	4 ± 1	3 ± 1	5 ± 3	5 ± 0	5 ± 1	5 ± 0	5 ± 1	5 ± 2
Isoleucine	5 ± 1	6 ± 1	6 ± 2	7 ± 2	7 ± 1	7 ± 1	7 ± 2	6 ± 1	7 ± 1	8 ± 1
Leucine	7 ± 2	9 ± 2	8 ± 2	9 ± 3	10 ± 0	9 ± 1	9 ± 1	8 ± 3	9 ± 2	11 ± 0
Tyrosine	11 ± 2	13 ± 1	14 ± 3	13 ± 3	15 ± 3	11 ± 2	13 ± 2	12 ± 2	13 ± 2	15 ± 2
Phenylalanine	6 ± 3	8 ± 3	8 ± 2	8 ± 2	9 ± 2	7 ± 2	8 ± 1	9 ± 3	8 ± 2	11 ± 3
β-Alanine	1 ± 0	2 ± 1	2 ± 1	2 ± 0	3 ± 1	3 ± 1	4 ± 1	3 ± 0	3 ± 1	4 ± 1
β-AiBA	2 ± 0	2 ± 1	2 ± 0	2 ± 1	2 ± 1	2 ± 1	3 ± 0	2 ± 0	3 ± 1	3 ± 1
γ-ABA	0 ± 0	0 ± 0	0 ± 0	1 ± 0	1 ± 0	1 ± 0	1 ± 0	0 ± 0	1 ± 0	1 ± 0
Ethanoamine	1 ± 1	1 ± 0	1 ± 1	1 ± 1	1 ± 1	0 ± 0	1 ± 0	1 ± 1	1 ± 1	1 ± 1
Ornithine	4 ± 3	3 ± 1	6 ± 4	4 ± 3	7 ± 4	6 ± 3	23 ± 18	3 ± 1	4 ± 1	10 ± 2
Lysine	15 ± 5	19 ± 7	19 ± 4	20 ± 6	21 ± 5	20 ± 3	19 ± 3	18 ± 6	18 ± 3	19 ± 3
Histidine	10 ± 3	13 ± 6	13 ± 4	13 ± 3	15 ± 3	14 ± 4	13 ± 3	14 ± 3	13 ± 5	15 ± 1
Arginine	380 ± 64	443 ± 77	448 ± 12	462 ± 46	530 ± 15	474 ± 23	458 ± 21	467 ± 52	482 ± 42	529 ± 51
Total	1995 ± 218	2176 ± 208	2297 ± 150	2339 ± 56	2646 ± 170	2350 ± 68	2449 ± 41	2330 ± 176	2364 ± 313	2622 ± 155

α-AAA, α-amino adipic acid; α-ABA, α-amino-*n*-butyric acid; β-AiBA, β-amino-isobutyric acid; γ-ABA, γ-amino-*n*-butyric acid.
Data are the mean ± SD of triplicate experiments.

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Biochemical changes in the abdominal muscle of mud crab *Scylla serrata* during storage

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ABSTRACT: Changes in levels of pH, volatile basic nitrogen (VBN), *K*-value, glycogen, adenosine triphosphate (ATP) and its related compounds (ARC), and free amino acids (FAA) in the abdominal muscle of live mud crabs stored at 10°C and 25°C were investigated. Levels of pH, VBN, and *K*-value did not increase until 2 days of storage, whereas the energy charge and glycogen levels declined rapidly during the early period of storage. The onset of initial decomposition of the mud crab muscle was observed after storage at 10°C for 6 days and 25°C for 3 days. The initial ATP concentration was high but decreased by 76–80% on day 2 of storage. The total nucleotide contents in the 2-day-stored samples accounted for 82–83% of the total ARC. The value decreased to 50% after storage at 10°C for 4 days. Glycine, arginine, glutamine, alanine and proline were the major FAA. Total amounts of FAA and taste-active amino acids including glycine, arginine, alanine and glutamic acid had no apparent change during storage at 10°C, while an increase of 14–38% was found prior to the initial decomposition stage at 25°C. In both storages, ornithine, citrulline and ammonia increased markedly in the stage of initial decomposition.

KEY WORDS: **adenosine triphosphate, free amino acid, freshness, glycogen, mud crab, storage.**

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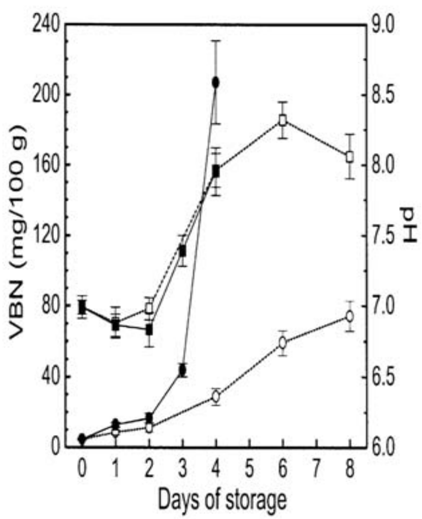

Fig. 1 Changes of pH (□) and volatile basic nitrogen (VBN) (○) in the abdominal muscle of mud crab stored at 10°C (dotted lines) and 25°C (solid lines). Data are mean ± SD ($n = 3$).

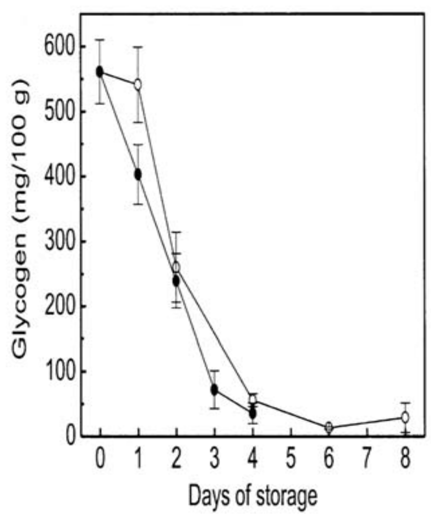

Fig. 3 Changes of glycogen in the abdominal muscle of mud crab stored at (○) 10°C and (●) 25°C. Data are mean ± SD ($n = 3$).

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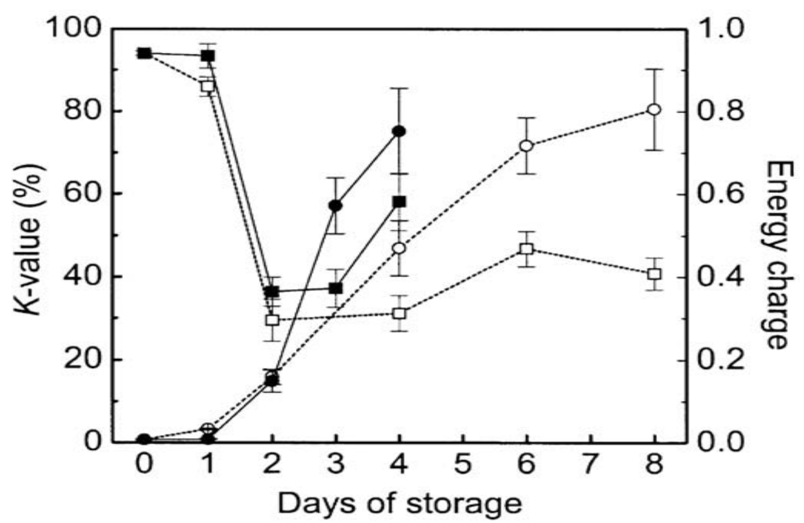

Fig. 2 Changes of *K*-value (○) and energy charge (□) in the abdominal muscle of mud crab stored at 10°C (dotted lines) and 25°C (solid lines). Data are mean ± SD ($n = 3$).

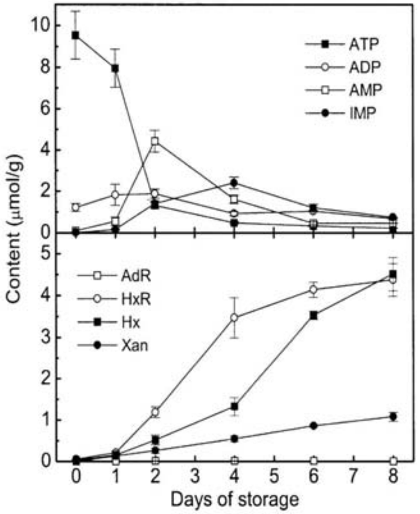

Fig. 4 Changes of adenosine triphosphate and its related compounds in the abdominal muscle of mud crab stored at 10°C. Data are mean ± SD ($n = 3$). ATP, adenosine triphosphate; ADP, adenosine diphosphate; AMP, adenosine monophosphate; IMP, inosine monophosphate; AdR, adenosine; HxR, inosine; Hx, hypoxanthine; Xan, xanthine.

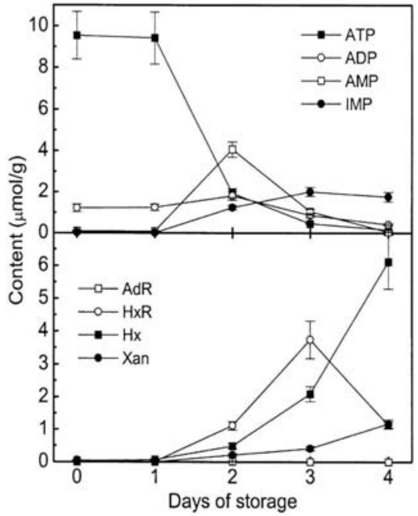

Fig. 5 Changes of adenosine triphosphate and its related compounds in the abdominal muscle of mud crab stored at 25°C. Data are mean ± SD ($n = 3$). ATP, adenosine triphosphate; ADP, adenosine diphosphate; AMP, adenosine monophosphate; IMP, inosine monophosphate; AdR, adenosine; HxR, inosine; Hx, hypoxanthine; Xan, xanthine.

Table 1 Changes of free amino acids (mg/100 g) in the abdominal muscle of mud crab during storage at 10°C and 25°C

Amino acids	Before storage	Days at 10°C					Days at 25°C			
		1	2	4	6	8	1	2	3	4
Phosphoserine	1 ± 1	1 ± 1	1 ± 1	3 ± 1	3 ± 1	4 ± 1	1 ± 0	3 ± 0	6 ± 0	7 ± 1
Taurine	83 ± 20	90 ± 9	134 ± 17	114 ± 18	150 ± 25	195 ± 23	176 ± 21	121 ± 17	168 ± 20	155 ± 22
Aspartic acid	21 ± 5	6 ± 2	5 ± 1	6 ± 1	9 ± 0	5 ± 1	14 ± 1	11 ± 2	13 ± 0	9 ± 2
Threonine	14 ± 2	11 ± 1	16 ± 1	27 ± 2	35 ± 3	52 ± 7	19 ± 0	21 ± 1	43 ± 2	46 ± 2
Serine	8 ± 1	8 ± 1	11 ± 0	22 ± 1	23 ± 2	25 ± 3	13 ± 0	15 ± 1	24 ± 1	5 ± 1
Glutamic acid	56 ± 16	29 ± 10	18 ± 2	28 ± 5	31 ± 4	37 ± 6	80 ± 15	31 ± 4	54 ± 12	166 ± 13
Glutamine	220 ± 27	191 ± 21	212 ± 34	254 ± 29	253 ± 19	243 ± 32	280 ± 39	255 ± 21	260 ± 25	124 ± 14
Sarcosine	0 ± 1	2 ± 0	4 ± 2	2 ± 0	6 ± 2	5 ± 2	3 ± 1	3 ± 0	7 ± 2	4 ± 1
α-AAA	3 ± 2	3 ± 1	4 ± 2	3 ± 0	4 ± 0	4 ± 1	4 ± 1	5 ± 0	8 ± 1	9 ± 2
Proline	177 ± 24	184 ± 19	225 ± 31	187 ± 21	202 ± 24	250 ± 37	245 ± 23	259 ± 36	271 ± 20	125 ± 20
Glycine	555 ± 78	603 ± 49	483 ± 41	448 ± 46	641 ± 64	528 ± 79	596 ± 40	763 ± 52	755 ± 36	573 ± 67
Alanine	202 ± 30	180 ± 17	192 ± 16	231 ± 22	301 ± 29	388 ± 99	268 ± 28	313 ± 49	380 ± 35	480 ± 57
Citrulline	2 ± 2	2 ± 1	9 ± 2	6 ± 5	25 ± 2	16 ± 0	5 ± 0	8 ± 2	12 ± 2	32 ± 5
α-ABA	6 ± 4	5 ± 1	0 ± 0	4 ± 4	0 ± 0	2 ± 3	6 ± 2	9 ± 1	10 ± 1	24 ± 2
Valine	23 ± 4	22 ± 6	29 ± 5	31 ± 14	54 ± 4	46 ± 21	29 ± 3	27 ± 2	45 ± 27	108 ± 26
Cystine	0 ± 0	0 ± 0	4 ± 4	8 ± 3	6 ± 5	4 ± 5	6 ± 2	10 ± 0	9 ± 2	0 ± 0
Methionine	14 ± 1	11 ± 3	19 ± 1	22 ± 4	37 ± 4	43 ± 6	21 ± 4	18 ± 1	40 ± 6	69 ± 13
Isoleucine	10 ± 1	6 ± 1	15 ± 1	24 ± 4	35 ± 3	46 ± 5	17 ± 1	15 ± 1	45 ± 10	88 ± 15
Leucine	21 ± 2	19 ± 2	35 ± 3	53 ± 5	73 ± 7	88 ± 11	35 ± 1	37 ± 3	97 ± 14	149 ± 17
Tyrosine	18 ± 3	15 ± 2	27 ± 4	40 ± 6	53 ± 7	51 ± 6	39 ± 3	28 ± 6	56 ± 6	38 ± 3
Phenylalanine	15 ± 2	14 ± 1	21 ± 4	33 ± 5	43 ± 6	47 ± 6	22 ± 1	22 ± 3	55 ± 7	95 ± 15
β-Alanine	2 ± 1	2 ± 2	3 ± 1	2 ± 0	2 ± 1	3 ± 0	3 ± 1	1 ± 0	2 ± 0	2 ± 0
β-AiBA	6 ± 4	4 ± 4	6 ± 2	2 ± 1	3 ± 3	5 ± 2	5 ± 4	2 ± 0	5 ± 0	5 ± 0
γ-ABA	1 ± 0	2 ± 2	3 ± 1	2 ± 0	4 ± 1	5 ± 0	4 ± 4	4 ± 1	5 ± 0	4 ± 0
Tryptophan	7 ± 2	10 ± 3	10 ± 3	20 ± 2	19 ± 3	24 ± 0	9 ± 6	9 ± 2	16 ± 2	22 ± 5
Ethanoamine	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	1 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0
Ornithine	2 ± 0	2 ± 0	4 ± 0	11 ± 2	44 ± 3	91 ± 15	2 ± 0	3 ± 0	22 ± 3	93 ± 21
Lysine	28 ± 3	23 ± 3	45 ± 14	71 ± 14	78 ± 16	106 ± 16	41 ± 8	47 ± 14	94 ± 14	72 ± 9
Histidine	13 ± 2	14 ± 2	15 ± 1	18 ± 1	28 ± 2	28 ± 4	18 ± 3	18 ± 1	32 ± 2	42 ± 8
Arginine	508 ± 49	568 ± 67	609 ± 65	578 ± 38	567 ± 42	440 ± 58	534 ± 48	723 ± 59	764 ± 85	308 ± 24
Total	2018 ± 240	2026 ± 204	2159 ± 183	2250 ± 156	2731 ± 203	2781 ± 365	2495 ± 135	2780 ± 200	3294 ± 269	2850 ± 129
Ammonia	6 ± 2	6 ± 2	7 ± 1	15 ± 4	19 ± 9	17 ± 4	7 ± 1	9 ± 1	14 ± 3	38 ± 6

α-AAA, α-amino adipic acid; α-ABA, α-amino-*n*-butyric acid; β-AiBA, β-amino-isobutyric acid; γ-ABA, γ-amino-*n*-butyric acid.
Data are mean ± SD ($n = 3$).

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黃鰭鮪魚肉於低溫貯藏中鮮度與官能品質的變化

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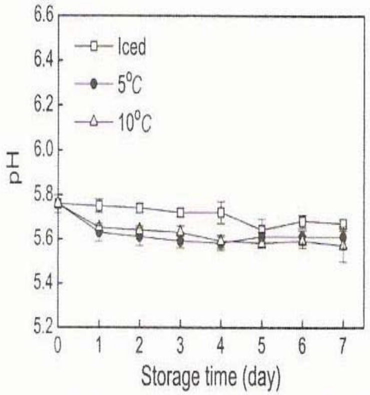
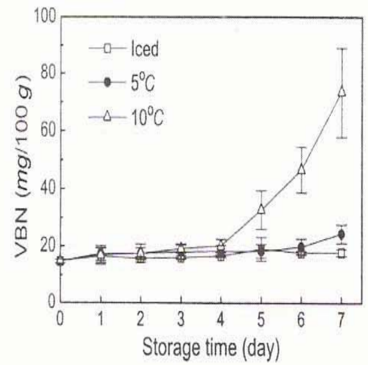
（接受刊載日期：中華民國九十四年五月一日）

本研究探討黃鰭鮪魚肉在冰藏、5℃及 10℃貯藏七天鮮度與官能品質之變化。貯藏中 pH 值及游離胺基酸的變化小，惟 10℃貯藏六天後組胺酸含量有減少之趨勢，揮發性鹽基態氮僅 10℃貯藏五天後始明顯增加。各溫度貯藏下，總生菌數及 K 值均隨時間的延長而增加，在 5℃及 10℃貯藏分別於第六及五天的總生菌數超過 10^5 之生食標準；顏色變化以紅色度下降明顯。食用生魚片之接受性試驗，結果顯示顏色、質地、氣味、滋味及整體接受性之評分值均隨時間的延長而降低；由各官能屬性之線性迴歸計算，在各貯藏溫度下達最低可接受的時間均較之由總生菌數變化所判定為短，尤以滋味的貯藏期限最短，其次為氣味。各溫度貯藏中的 K 值和氣味、整體接受性評分值之間的線性相關性高，歸納出 K 值 34.5%可視為黃鰭鮪生魚片官能品質仍可接受之臨界值。

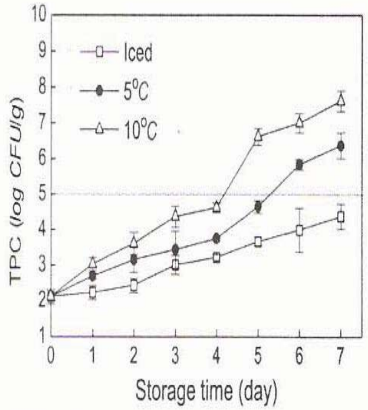
關鍵字：鮪魚，生魚片，貯藏，鮮度，官能性質。



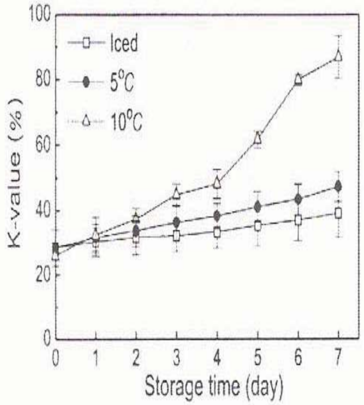
圖一　黃鰭鮪魚肉在不同溫度貯藏中的 pH 值變化
Fig. 1. Changes in pH value of yellowfin tuna muscle during storage at different temperatures.



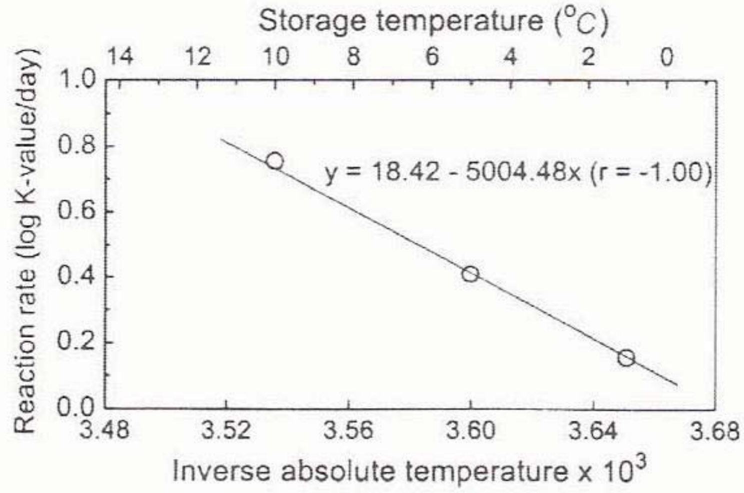
圖二　黃鰭鮪魚肉在不同溫度貯藏中的揮發性鹽基態氮含量變化
Fig. 2. Changes in volatile basic nitrogen (VBN) of yellowfin tuna muscle during storage at different temperatures.



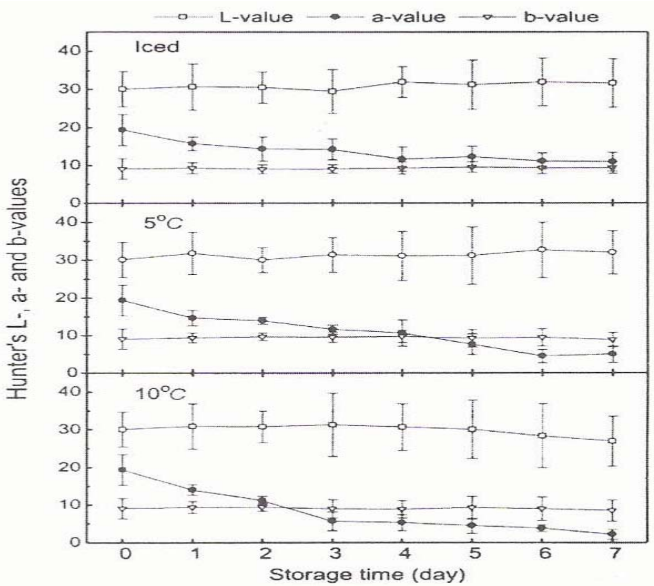
圖三　黃鰭鮪魚肉在不同溫度貯藏中的總生菌數變化
Fig. 3. Changes of total plate count (TPC) in yellowfin tuna muscle during storage at different temperatures.



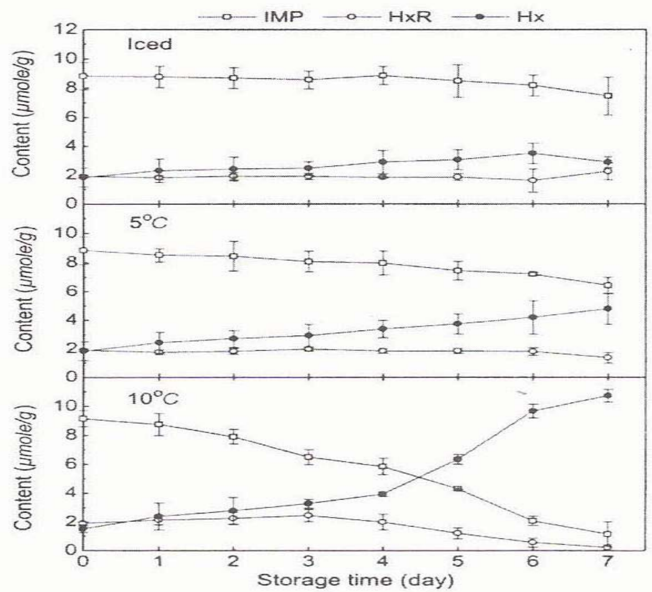
圖四　黃鰭鮪魚肉在不同溫度貯藏中的 K 值變化
Fig. 4. Changes of K-value in yellowfin tuna muscle during storage at different temperatures.



圖五　K 值反應速率與貯藏溫度之 Arrhenius plot
Fig. 5. Arrhenius plot of reaction rate of K-value vs. storage temperature.



圖六　黃鰭鮪魚肉在不同溫度貯藏中的 Hunter's L、a 及 b 值變化
Fig. 6. Changes in Hunter's color trimulus values of yellowfin tuna muscle during storage at different temperatures.



圖七　黃鰭鮪魚肉在不同溫度貯藏中的肌苷酸、肌苷及次黃嘌呤含量變化

表二　在不同溫度貯藏下黃鰭鮪魚肉作為生魚片所預估各官能屬性的貯藏期限

Table 1. The predicted shelf-life based on the sensory attributes of yellowfin tuna sashimi at different temperatures

Sensory attribute	Shelf-life (days)		
	Iced	5℃	10℃
Color	4.92	4.25	1.74
Texture	4.30	4.47	1.43
Odor	4.05	3.50	1.03
Taste	3.52	1.85	0.69
Overall acceptance	4.06	3.06	1.21

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Organoleptic and volatile aroma compounds comparison of wild and cultured gilthead sea bream (*Sparus aurata*): sensory differences and possible chemical basis

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Table 1
Muscle proximate composition of wild (A) and cultured (A) sea bream used for the triangular test and for wild (B) and cultured (B) fish used for the aroma compounds (Mean values ± standard deviation)

	Moisture	Fat	Protein	Ash
Wild (A)	78.11 ± 1.79 b	1.16 ± 1.03 a	20.05 ± 2.32	1.44 ± 0.04
Cultured (A)	71.20 ± 2.52 a	9.8 ± 1.36 b	18.08 ± 0.71	1.37 ± 0.08
Wild (B)	74.51 ± 0.54 b	3.72 ± 0.91 a	20.23 ± 0.52	1.42 ± 0.07
Cultured (B)	69.56 ± 3.20 a	8.93 ± 3.50 b	20.00 ± 0.50	1.38 ± 0.05

Values are average of five fish from each group. Different letters indicate statistically significant difference ($P < 0.05$).

Table 2
Descriptors given for wild and cultured gilthead sea bream

	NR. of panelists
Descriptors for wild fish	
"More pleasant taste", "more delicious"	4
"More firm"	3
"More juicy"	2
"More fresh"	1
"More dark flesh"	1
Descriptors for cultured fish	
"Poorer taste"	4
"More fatty"	2
"More pleasant, aromatic taste"	2
"Smells more fishy"	2
"More white"	1

Table 3
Volatile aroma compounds identified in raw wild and cultured gilthead sea bream

Compound	Wild	Cultured
Alcohols		
1-Butanol	0.328	0.208
1-Penten-3-ol	0.130	0.226
3-Methyl-1-butanol	0.067	0.010
1-Pentanol	0.142	0.134
2-Penten-1-ol	0.057	0.045
1-Hexanol	0.037	0.061
1-Octen-3-ol	0.324	0.062
1-Heptanol	0.044	tr
2-Ethyl-1-hexanol	5.064	2.397
1-Nonanol	0.041	0.016
Total (%)	55.3	42.4
Aldehydes		
2-Methyl-1-butanal	0.487	0.158
3-Methyl-1-butanal	0.210	0.057
Hexanal	0.152	0.068
Octanal	0.077	0.082
Nonanal	0.310	0.180
(*E*,*E*)-2,4-hexadienal	nd	0.329
(*E*,*E*)-2,4-heptadienal	0.261	0.102
Benzaldehyde	0.060	0.041
(*E*)-2-nonenal	0.035	nd
Total (%)	14.1	13.7
Ketones		
2,3-Butanedione	0.035	0.038
2-Propanone	0.414	0.665
2,3-Pentanedione	nd	0.015
2-Heptanone	0.076	tr
2-Octanone	0.162	nd
6-Methyl-5-hepten-2-one	0.431	0.276
2-Nananone	0.033	0.033
2-Decanone	0.290	0.247
(*E*,*E*)-3,5-octadiene-2-one	0.040	0.033
2-Undecanone	0.013	0.018
Total (%)	13.2	14.0
Aromatics		
Toluene	0.078	0.095
Ethylbenzene	0.038	0.035
p-xylene	0.040	0.026
m-xylene	0.041	0.069
o-xylene	0.018	0.039
Propylbenzene	0.060	nd
1-Ethyl-3-methylbenzene	0.171	0.031
1,3,5-Trimethylbenzene	0.165	0.048
Styrene	0.046	0.078
1-Ethyl-2-methylbenzene	0.070	0.098

Table 3 (*continued*)

Compound	Wild	Cultured
Aromatics		
1,2,4-Trimethylbenzene	0.063	0.094
1-Ethyl-2,4-dimethylbenzene	0.075	nd
1,4-Dichlorobenzene	tr	0.057
Napthalene	0.034	0.051
Total (%)	8.0	9.6
Terpenes		
Alpha-pinene	0.037	0.032
Beta-pinene	0.008	nd
3-Carene	0.009	nd
Myrecene	0.025	nd
Limonene	0.043	0.351
Camphor	0.022	nd
b-terpineol	0.015	0.098
Total (%)	1.4	6.4
S-containing compounds		
Dimethyl disulfide	nd	0.014
Dimethyl trisulfide	nd	nd
Total (%)	0	0.2
Miscellaneous compounds		
Trimethylamine	0.101	0.320
Chloroform	0.306	0.226
Total (%)	3.6	7.3
Furans		
2-Ethyl furan	0.232	0.274
Total (%)	2.1	3.7
Acids		
Acetic acid	0.265	0.191
Total (%)	2.3	2.5
TOTAL	100	100

Individual volatile quantities are expressed as peak area ratios. Volatile groups are expressed as total percentage. nd: not detected, tr: found in traces.

Abstract:
These results show a strong organoleptic difference between wild and cultured fish. The test also showed a preference on wild fish, while most common descriptors given for wild fish were "more pleasant taste" (four answers), "more firm texture" (four answers) and for cultured fish were "poorer taste" (four answers). From these answers, a superiority of wild fish is strongly indicated.

The volatile aroma compounds profile of the wild fish was found different than that of the cultured counterparts, containing a higher number of taste-contributing compounds.

Organoleptic differences can be related to proximate analysis, volatile aroma compounds and fatty acid profile differences of the fish muscle.

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Muscle cellularity and flesh quality of wild and farmed sea bass, *Dicentrarchus labrax* L.

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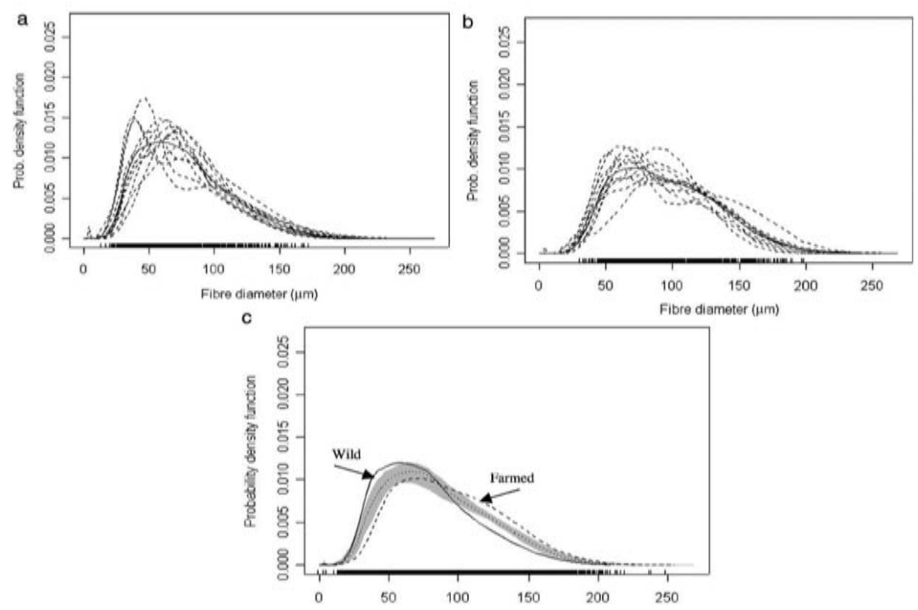

Fig. 2. Probability density functions (PDF) of white muscle fibre diameter (μm) for wild (a) and farmed (b) sea bass. Solid lines represent the average density estimate; dotted lines represent the distribution of muscle fibres of individual fish. (c) Lines represent the average density estimate for each group and shaded area corresponds to the variability band. $P_{K-S}=0.009$.

Table 4
Mean values and standard deviation of saturated, monounsaturated, polyunsaturated, total ω_6 and total ω_3 fatty acids of wild and farmed sea bass flesh, and significance levels between both populations

Parameters	Wild sea bass	Farmed sea bass	Significance
SAFA (mg/100 g fat)	25.66 ± 0.26	27.46 ± 0.25	<0.001
MUFA (mg/100 g fat)	37.61 ± 1.00	41.63 ± 0.29	0.002
PUFA (mg/100 g fat)	36.76 ± 0.91	30.90 ± 0.34	<0.001
Total ω_6 (mg/100 g fat)	14.21 ± 0.79	8.29 ± 0.11	<0.001
Total ω_3 (mg/100 g fat)	28.34 ± 0.66	28.99 ± 0.24	0.414
Ratio ω_3/ω_6	2.11 ± 0.17	3.49 ± 0.04	<0.001
PUFA/SAFA	1.43 ± 0.13	1.12 ± 0.07	<0.001

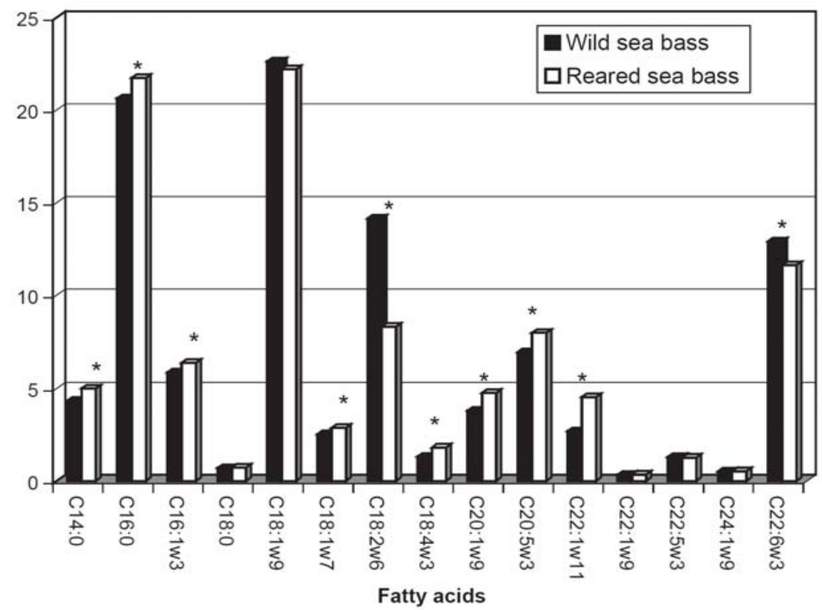

Fig. 3. Fatty acids content in wild and farmed sea bass, expressed as mg/100 g of fat. * indicates $p<0.05$.

Table 1
Mean values and standard deviation of biometric and muscle cellularity parameters in wild and farmed sea bass and significance levels between both populations

	Wild sea bass	Farmed sea bass	Significance
Body length (cm)	32.04 ± 0.48	32.82 ± 0.90	0.425
Body weight (g)	365.53 ± 15.00	360 ± 28.28	0.856
Cross-sectional area of the white muscle (mm^2)	887.29 ± 133.30	886.09 ± 135.74	0.983
Muscle fibre density (number of fibres/mm^2)	187.78 ± 7.42	126.31 ± 5.31	<0.001
White muscle fibres diameter (μm)	83.2 ± 1.65	101.11 ± 2.25	<0.001
Dressing index	90.93 ± 0.59	91.91 ± 0.74	0.305
Condition index	1.11 ± 0.03	1.03 ± 0.09	0.345
Perivisceral fat (g)	4.17 ± 0.43	3.92 ± 0.48	0.701
Hepatosomatic index	2.21 ± 0.15	1.68 ± 0.17	0.05
Gonadosomatic index	0.67 ± 0.17	0.39 ± 0.10	0.187
Digestosomatic index	2.16 ± 0.19	2.20 ± 0.18	0.874

Dressing index: (weight/ total weight) × 100; condition index: (total weight/total length^3) × 100; perivisceral fat: (weight perivisceral fat/total weight) × 100; hepatosomatic index: (weight liver/total weight) × 100; gonadosomatic index: (weight gonad/total weight) × 100; digestosomatic index: (digestive weight/total weight) × 100.

Table 3
Mean values and standard deviation of physico-chemical and textural parameters in flesh of wild and farmed sea bass flesh, and significance levels between both populations

Parameters	Wild sea bass	Farmed sea bass	Significance
Physico-chemical			
Moisture (%)	69.46 ± 1.54	72.63 ± 0.71	0.008
Protein (%)	17.64 ± 0.43	23.37 ± 1.67	0.006
Total fat (%)	9.19 ± 4.94	6.66 ± 1.57	0.119
pH	6.75 ± 0.06	6.44 ± 0.02	<0.001
Hydroxyproline (mg/100 g)	43.46 ± 6.69	32.77 ± 8.12	<0.001
Collagen (%)	0.34 ± 0.055	0.26 ± 0.089	0.004
Collagen/Total protein (%)	1.93 ± 0.31	1.11 ± 0.36	<0.001
Textural parameters			
Springiness (cm)	2.81 ± 0.02	2.07 ± 0.10	<0.001
Hardness (N)	50.57 ± 0.90	48.47 ± 0.60	<0.001
Cohesiveness (ratio)	0.52 ± 0.02	0.34 ± 0.07	<0.001
Chewiness (N cm)	74.43 ± 5.31	36.03 ± 9.98	<0.001
Gumminess (N)	26.44 ± 1.36	16.88 ± 3.57	<0.001