成長、飢餓(starvation)

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Effect of Growth on the Levels of Free Histidine and Amino Acids in White Muscle of Milkfish (*Chanos chanos*)

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Accumulation patterns of free amino acids (FAAs) in white muscle of milkfish (*Chanos chanos*) during the period of 8-month growth were investigated. Histidine, taurine, and glycine were the predominant FAAs. An increase in histidine was observed during growth. The level present in the 1-month-reared fish (mean weight = 58 g) was about 5 times higher than that in the initial fish (1.4 g). After 8 months of growth, milkfish contained 59 μmol/g, which was responsible for 72% of the total FAAs. There was a positive correlation between the histidine content and fish body weight. In contrast, taurine decreased with increasing rearing time. The glycine level was not correlated well with fish size. The total relative amounts of histidine, taurine, and glycine remained about the same, although the individual contributions varied considerably in the FAA pool during the period of cultivation.

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Table 1. Body Weight (Grams),[a] Body Length (Centimeters),[a] and Proximate Composition (Percent)[b] in White Muscle of Milkfish during the Period of 8-Month Growth

month	weight	length	moisture	crude fat	crude protein	ash
0	1.39 ± 0.24	4.72 ± 0.37	80.78 ± 1.49[a]	1.56 ± 0.10[c]	16.31 ± 0.91[b]	1.29 ± 0.07[a]
1.0	57.53 ± 4.66	14.60 ± 0.58	75.03 ± 1.09[b]	2.45 ± 0.18[b]	20.89 ± 0.67[a]	1.28 ± 0.08[a]
2.5	194.44 ± 37.14	22.72 ± 1.18	74.99 ± 0.72[b]	2.83 ± 0.27[ab]	19.81 ± 1.53[a]	1.25 ± 0.09[a]
4.5	422.36 ± 50.69	28.58 ± 1.20	74.38 ± 0.78[b]	3.21 ± 0.33[a]	20.98 ± 0.71[a]	1.22 ± 0.11[b]
6.5	477.82 ± 70.62	30.32 ± 1.21	74.10 ± 0.64[b]	3.40 ± 0.24[a]	19.94 ± 0.87[a]	1.25 ± 0.07[ab]
8.0	587.32 ± 85.26	32.38 ± 0.37	74.63 ± 0.66[b]	3.43 ± 0.14[a]	21.04 ± 0.66[a]	1.21 ± 0.08[b]

[a] Expressed as mean ± standard deviation (n = 12). [b] Expressed as mean ± standard deviation (n = 6). Means followed by the same letter within each column are not significantly different at P = 0.05.

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Table 2. Free Amino Acids (Micromoles per Gram of Wet Weight)[a] in White Muscle of Milkfish during the Period of 8-Month Growth

	month					
	0	1.0	2.5	4.5	6.5	8.0
phosphoserine	0.25 ± 0.01[a]	0.08 ± 0.01[b]	0.07 ± 0.02[b]	0.07 ± 0.01[b]	0.05 ± 0.00[c]	0.05 ± 0.01[c]
taurine	8.45 ± 1.99[bc]	15.81 ± 1.10[a]	12.84 ± 1.60[b]	7.54 ± 1.93[c]	6.37 ± 2.75[c]	2.80 ± 0.83[d]
aspartic acid	1.81 ± 0.23[a]	0.19 ± 0.07[b]	0.19 ± 0.06[b]	0.23 ± 0.08[b]	0.20 ± 0.22[b]	0.06 ± 0.02[b]
threonine	1.72 ± 0.17[a]	0.74 ± 0.09[c]	0.56 ± 0.07[cd]	0.49 ± 0.11[d]	0.60 ± 0.28[cd]	0.98 ± 0.24[b]
serine	2.64 ± 0.25[a]	1.61 ± 0.29[b]	0.94 ± 0.15[cd]	1.09 ± 0.31[c]	0.63 ± 0.13[e]	0.74 ± 0.16[de]
asparagine	0.82 ± 0.08[a]	0.35 ± 0.05[bc]	0.44 ± 0.15[b]	0.40 ± 0.09[bc]	0.27 ± 0.18[c]	0.36 ± 0.03[bc]
glutamic acid	6.27 ± 1.05[a]	2.88 ± 0.64[b]	1.63 ± 0.10[c]	1.07 ± 0.15[c]	1.10 ± 0.40[c]	1.41 ± 0.82[c]
glutamine	0.92 ± 0.06[a]	0.98 ± 0.11[a]	0.42 ± 0.10[b]	0.39 ± 0.10[b]	0.51 ± 0.11[b]	0.48 ± 0.21[b]
proline	3.46 ± 0.96[a]	3.00 ± 0.67[ab]	2.18 ± 2.03[bc]	1.24 ± 0.41[cd]	1.18 ± 0.29[cd]	0.83 ± 0.14[d]
glycine	6.92 ± 1.80[a]	4.16 ± 1.08[b]	2.95 ± 0.75[b]	3.52 ± 1.44[b]	8.39 ± 2.27[a]	7.88 ± 1.91[a]
alanine	6.53 ± 0.90[a]	1.83 ± 0.09[c]	2.11 ± 0.50[c]	1.64 ± 0.13[c]	1.58 ± 0.50[c]	3.77 ± 1.54[b]
valine	1.69 ± 0.60[a]	0.76 ± 0.18[b]	0.65 ± 0.10[bc]	0.40 ± 0.15[cd]	0.46 ± 0.06[bcd]	0.27 ± 0.13[d]
methionine	0.84 ± 0.13[a]	0.19 ± 0.11[b]	0.12 ± 0.07[bc]	0.08 ± 0.04[c]	0.10 ± 0.03[c]	0.09 ± 0.02[c]
isoleucine	1.49 ± 0.10[a]	0.36 ± 0.07[b]	0.28 ± 0.08[c]	0.17 ± 0.03[d]	0.17 ± 0.03[d]	0.13 ± 0.03[d]
leucine	2.84 ± 0.21[a]	0.71 ± 0.08[b]	0.48 ± 0.13[c]	0.31 ± 0.09[d]	0.27 ± 0.04[d]	0.21 ± 0.03[d]
tyrosine	1.10 ± 0.17[a]	0.27 ± 0.02[b]	0.22 ± 0.06[bc]	0.17 ± 0.03[c]	0.13 ± 0.05[c]	0.12 ± 0.02[c]
phenylalanine	1.20 ± 0.15[a]	0.30 ± 0.03[b]	0.19 ± 0.06[c]	0.13 ± 0.04[cd]	0.10 ± 0.03[d]	0.06 ± 0.03[d]
β-alanine	0.24 ± 0.05[a]	0.05 ± 0.06[c]	0.13 ± 0.05[b]	0.06 ± 0.02[c]	0.06 ± 0.01[c]	0.02 ± 0.02[c]
ornithine	0.32 ± 0.02[b]	1.16 ± 0.12[a]	0.40 ± 0.13[b]	0.21 ± 0.07[c]	0.12 ± 0.01[cd]	0.09 ± 0.05[d]
lysine	5.13 ± 0.29[a]	1.87 ± 0.16[cd]	1.78 ± 0.45[cd]	1.41 ± 0.41[d]	2.76 ± 1.82[bc]	3.09 ± 0.66[b]
histidine	7.16 ± 1.54[e]	37.38 ± 3.15[d]	40.41 ± 6.15[cd]	46.17 ± 3.76[bc]	47.90 ± 2.68[b]	59.19 ± 8.73[a]
arginine	2.12 ± 0.29[a]	2.25 ± 0.14[a]	0.75 ± 0.30[b]	0.94 ± 0.38[b]	0.30 ± 0.08[c]	0.23 ± 0.05[c]
total	63.23 ± 7.49[d]	76.76 ± 4.38[ab]	69.74 ± 4.38[bcd]	67.74 ± 3.79[cd]	73.24 ± 4.39[bc]	82.68 ± 9.42[a]

[a]Expressed as mean ± standard deviation (n = 6). Means followed by the same letter within each row are not significantly different at P = 0.05.

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Effect of starvation on free histidine and amino acids in white muscle of milkfish *Chanos chanos*

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Table 1
Changes in body weight, body length, condition factor and hepatosomatic index of milkfish during 60 days of starvation*

Day	Weight (g)	Length (cm)	Condition factor	HSI (%)
0	46.7 ± 3.2[b]	14.6 ± 0.3[b]	15.0 ± 0.2[a]	1.9 ± 0.1[a]
10	42.9 ± 1.4[bc]	14.3 ± 0.4[b]	14.5 ± 1.2[ab]	1.2 ± 0.1[c]
25	40.2 ± 1.9[cd]	14.3 ± 0.3[b]	13.7 ± 0.9[c]	1.0 ± 0.2[d]
40	35.1 ± 2.2[d]	14.2 ± 0.2[b]	12.2 ± 0.8[d]	0.8 ± 0.1[c]
60	27.6 ± 4.1[c]	14.2 ± 0.2[b]	9.5 ± 1.2[e]	0.7 ± 0.1[e]
Control	198.4 ± 25.2[a]	24.0 ± 1.2[a]	14.4 ± 1.0[b]	1.6 ± 0.5[b]

*Data are means ± S.D. (n = 12). Means followed by the same letter within each column are not significantly different at $P > 0.05$. Condition factor = weight/length^3 × 10^3, HSI, hepatosomatic index = liver weight/body weight × 100%; Control, fish fed on a diet for 60 days.

Table 2
Changes in proximate composition (%) in white muscle of milkfish during 60 days of starvation*

Day	Moisture	Protein	Crude fat	Ash
0	76.0 ± 0.8^{b}	20.1 ± 0.5^{a}	2.6 ± 0.2^{b}	1.2 ± 0.1
10	77.0 ± 0.6^{b}	20.0 ± 0.6^{a}	2.4 ± 0.1^{b}	1.2 ± 0.1
25	77.6 ± 0.9^{b}	19.3 ± 0.4^{ab}	1.8 ± 0.1^{c}	1.3 ± 0.0
40	79.5 ± 0.7^{a}	18.7 ± 0.6^{bc}	1.7 ± 0.2^{c}	1.2 ± 0.1
60	79.8 ± 0.6^{a}	18.0 ± 0.6^{c}	1.2 ± 0.1^{d}	1.2 ± 0.1
Control	74.6 ± 0.7^{c}	20.1 ± 0.6^{a}	3.2 ± 0.3^{a}	1.2 ± 0.1

*Data are means ± S.D. ($n = 6$). Means followed by the same letter within each column are not significantly different at $P > 0.05$. Control, refers to Table 1.

Table 3
Changes in free amino acids (μmole/g of wet weight) in white muscle of milkfish during 60-days of starvation*

	Day					Control
	0	10	25	40	60	
Phosphoserine	0.1 ± 0.0	0.1 ± 0.0	0.1 ± 0.0	0.1 ± 0.0	0.1 ± 0.0	0.1 ± 0.0
Taurine	22.7 ± 1.1^{a}	21.7 ± 0.4^{a}	22.8 ± 2.5^{a}	24.1 ± 4.8^{a}	23.9 ± 4.6^{a}	12.8 ± 2.8^{b}
Aspartic acid	0.3 ± 0.1^{bc}	0.2 ± 0.1^{c}	0.3 ± 0.1^{bc}	0.4 ± 0.1^{ab}	0.4 ± 0.1^{a}	0.2 ± 0.1^{cd}
Threonine	0.5 ± 0.2^{bc}	0.6 ± 0.2^{b}	0.8 ± 0.1^{a}	0.8 ± 0.2^{a}	0.9 ± 0.2^{a}	0.3 ± 0.1^{c}
Serine	0.6 ± 0.1^{bc}	0.5 ± 0.1^{c}	0.6 ± 0.2^{bc}	0.6 ± 0.2^{ab}	0.7 ± 0.3^{a}	0.5 ± 0.1^{bc}
Asparagine	1.3 ± 0.4^{a}	0.8 ± 0.4^{b}	0.7 ± 0.3^{b}	0.6 ± 0.1^{b}	0.5 ± 0.2^{b}	0.1 ± 0.2^{c}
Glutamic acid	1.0 ± 0.2^{bc}	0.8 ± 0.1^{c}	1.0 ± 0.3^{bc}	0.8 ± 0.5^{c}	1.3 ± 0.4^{a}	1.1 ± 0.4^{bc}
Glutamine	1.2 ± 0.2^{a}	1.0 ± 0.1^{b}	0.9 ± 0.1^{cd}	0.7 ± 0.1^{de}	0.6 ± 0.1^{e}	1.0 ± 0.1^{bc}
Proline	1.8 ± 1.5^{ab}	1.6 ± 1.1^{abc}	0.7 ± 0.0	0.6 ± 0.1^{c}	0.8 ± 0.1^{bc}	2.6 ± 1.0^{a}
Glycine	6.8 ± 0.9^{b}	6.7 ± 1.6^{b}	7.3 ± 0.9^{b}	7.5 ± 1.5^{b}	7.8 ± 1.3^{b}	12.0 ± 1.6^{a}
Alanine	2.3 ± 0.8^{a}	1.9 ± 0.5^{ab}	2.5 ± 0.7^{a}	2.6 ± 0.6^{a}	2.3 ± 0.7^{a}	1.4 ± 0.4^{b}
Valine	0.5 ± 0.1^{ab}	0.6 ± 0.0^{a}	0.6 ± 0.1^{a}	0.6 ± 0.1^{a}	0.6 ± 0.2^{a}	0.4 ± 0.1^{b}
Methionine	0.1 ± 0.0^{ab}	0.1 ± 0.0^{ab}	0.1 ± 0.1^{a}	0.1 ± 0.0^{a}	0.1 ± 0.1^{a}	0.0 ± 0.0^{b}
Isoleucine	0.1 ± 0.1^{ab}	0.2 ± 0.1^{ab}	0.3 ± 0.1^{a}	0.2 ± 0.1^{ab}	0.3 ± 0.1^{a}	0.1 ± 0.0^{c}
Leucine	0.2 ± 0.1^{bc}	0.3 ± 0.1^{ab}	0.4 ± 0.2^{ab}	0.4 ± 0.1^{ab}	0.4 ± 0.3^{a}	0.1 ± 0.0^{c}
Tyrosine	0.2 ± 0.1	0.2 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.2 ± 0.1	0.1 ± 0.1
Phenylalanine	0.1 ± 0.0^{bc}	0.1 ± 0.1^{ab}	0.1 ± 0.1^{bc}	0.1 ± 0.1^{bc}	0.1 ± 0.1	0.0 ± 0.0
β-Alanine	0.1 ± 0.0	0.1 ± 0.0	0.1 ± 0.0	0.1 ± 0.0	0.1 ± 0.0	0.1 ± 0.0
Ornithine	0.4 ± 0.4^{a}	0.3 ± 0.3^{ab}	0.1 ± 0.0^{b}	0.1 ± 0.0^{b}	0.1 ± 0.0^{b}	0.5 ± 0.3^{a}
Lysine	2.1 ± 0.7^{b}	2.5 ± 0.8^{ab}	2.5 ± 0.4^{ab}	2.4 ± 0.8^{ab}	2.0 ± 0.7^{b}	3.5 ± 1.4^{a}
Histidine	31.1 ± 3.1^{ab}	30.1 ± 3.3^{b}	26.6 ± 2.9^{bc}	16.8 ± 6.6^{c}	16.3 ± 4.9^{c}	35.5 ± 3.0^{a}
Arginine	0.6 ± 0.4^{b}	0.6 ± 0.3^{b}	0.5 ± 0.1^{b}	0.4 ± 0.1^{b}	0.5 ± 0.2^{b}	1.1 ± 1.7^{a}
Total	74.0 ± 3.5^{a}	70.7 ± 7.0^{a}	68.8 ± 3.6^{a}	60.2 ± 10.4^{b}	60.1 ± 6.1^{b}	72.3 ± 4.6^{a}

*Data are means ± S.D. ($n = 6$). Means followed by the same letter within each row are not significantly different at $P > 0.05$. Control refers to Table 1.

餌料、季節性變動

魚介類的體成分在不同季節，尤其產卵期的前後，常有相當明顯的變動。

- 生理狀態：授精、產卵、成熟度、飢餓等
- 棲息環境：運動、水溫、餌料來源等

當令期、時令期、盛產期、『旬』

風味、美味性

FISHERIES SCIENCE 2002; **68**: 388–394

Original Article

Comparison of taste components in cooked meats of small abalone fed different diets

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ABSTRACT: Differences in taste preference and the levels of extractive components and glycogen were compared between cooked meats of small abalone *Haliotis diversicolor* fed either gracilar (G-small abalone) or an artificial diet (A-small abalone). Using sensory tests, taste preference of cooked meats was significantly higher for A-small abalone than for G-small abalone. Results of clustering analysis and principal component analysis of chemical data also revealed that the two cooked meats differed from each other in terms of their measured constituent compositions irrespective of sampling periods. Compared with G-small abalone, A-small abalone meats were lower in taurine and arginine, but higher in glycine (Gly), glutamic acid (Glu), alanine, serine, proline, adenosine monophosphate (AMP), and glycogen. It is concluded that the discrepancy in the levels of taste-active components of abalone, such as Gly, Glu, and AMP, is likely to be responsible for the differences in taste preference between G- and A-small abalone cooked meats.

KEY WORDS: **abalone, amino acid, artificial diet, extractive component, *Haliotis diversicolor*, taste.**

Table 2 Results of paired comparison test for taste of the cooked meats of G- and A-small abalone

Date of sampling	No. panelists (G)	(A)	Level of significance
Sep. 10 1997	14	26	$P<0.10$
Jan. 13 1998	12	28	$P<0.05$
Mar. 18 1998	11	29	$P<0.01$
May 8 1998	4	36	$P<0.001$
July 21 1998	11	29	$P<0.01$
Sep. 9 1998	11	29	$P<0.01$

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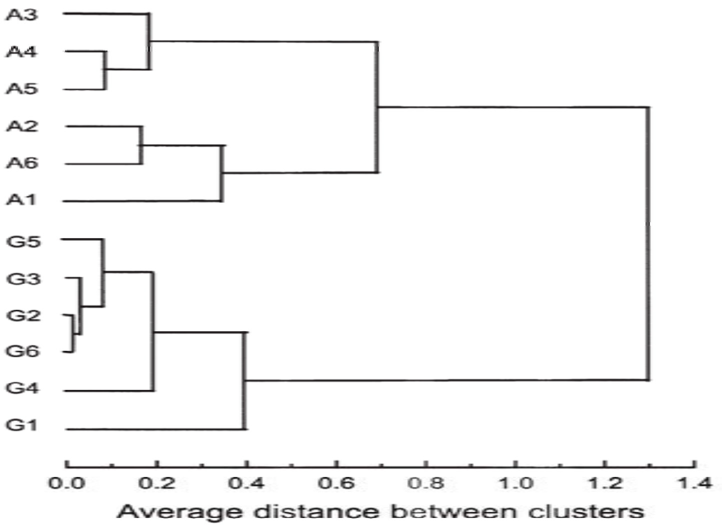

Fig. 1 Cluster analysis of all chemical data of the G- and A-small abalone meat samples. G, G-small abalone; A, A-small abalone; 1–6, sampling dates from September 1997 to September 1998.

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Levels of chemical constituents (mg/100 g) in the cooked meats of (G) G- and (A) A-small abalone

	1997 Sep. 10		1998 Jan. 13		Mar. 18		May 8		Jul. 21		Sep. 9	
	(G)	(A)	(G)	(A)	(G)	(A)	(G)	(A)	(G)	(A)	(G)	(A)
Taurine	1578^{a}	1148^{b}	1333^{a}	963^{b}	1351^{a}	1213^{a}	1322^{a}	1074^{b}	1531^{a}	1152^{b}	1263^{a}	1211^{a}
Serine	36^{b}	53^{a}	33^{b}	53^{a}	40^{b}	55^{a}	36^{b}	58^{a}	27^{b}	57^{a}	28^{b}	40^{a}
Glutamic acid	96^{b}	125^{a}	50^{b}	75^{a}	33^{b}	59^{a}	25^{b}	73^{a}	56^{b}	100^{a}	49^{a}	60^{a}
Proline	29^{b}	61^{a}	29^{b}	83^{a}	38^{b}	111^{a}	25^{b}	94^{a}	21^{b}	55^{a}	18^{a}	23^{a}
Glycine	129^{b}	294^{a}	370^{b}	455^{a}	334^{b}	393^{a}	266^{b}	403^{a}	187^{b}	358^{a}	186^{b}	307^{a}
Alanine	48^{b}	76^{a}	40^{b}	58^{a}	21^{b}	45^{a}	17^{b}	72^{a}	50^{b}	98^{a}	41^{a}	49^{a}
Arginine	585^{a}	506^{b}	446^{a}	376^{b}	549^{a}	469^{b}	511^{a}	493^{a}	605^{a}	480^{b}	467^{a}	501^{a}
Total FAA	2649^{a}	2481^{a}	2485^{a}	2319^{a}	2547^{a}	2575^{a}	2367^{a}	2550^{a}	2653^{a}	2560^{a}	2192^{a}	2392^{a}
ADP	27^{b}	53^{a}	45^{a}	39^{a}	29^{a}	33^{a}	43^{b}	62^{a}	99^{a}	96^{a}	43^{a}	46^{a}
AMP	90^{b}	126^{a}	100^{a}	118^{a}	160^{a}	177^{a}	122^{b}	162^{a}	111^{a}	131^{a}	68^{a}	73^{a}
Total ARC	124^{b}	193^{a}	150^{a}	162^{a}	197^{a}	216^{a}	171^{b}	231^{a}	217^{a}	236^{a}	122^{a}	130^{a}
Glycinebetaine	426^{a}	422^{a}	413^{a}	380^{a}	388^{b}	476^{a}	353^{a}	383^{a}	429^{a}	460^{a}	382^{a}	428^{a}
Glycogen	571^{b}	4167^{a}	2066^{b}	5638^{a}	2121^{b}	7818^{a}	1408^{b}	7313^{a}	2173^{b}	7028^{a}	1993^{b}	5125^{a}
Total	3769^{b}	7264^{a}	5114^{b}	8499^{a}	5253^{b}	11085^{a}	4299^{b}	10473^{a}	5471^{b}	10280^{a}	4689^{b}	8075^{a}

^{a,b}Means in the rows from the same sampling date with different superscript differ significantly ($p < 0.05$).

養殖虱目魚普通肉含氮萃取物成分之季節變化

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摘　　要

為瞭解本省養殖虱目魚含氮萃取物成分含量之季節變化，自民國 81 年6月至 82 年4月間每二個月採樣，取其普通肉分析。一般成分組成之季節變動小，但主要含氮萃取物成分包括組胺酸、牛磺酸、麩胺酸、離胺酸、甘胺酸及丙胺酸等游離胺基酸 (FAA)、肌苷酸 (inosinic acid) 與肌酸 (creatine) 之季節性變化則有顯著差異 ($p<0.05$)。游離胺基酸總量 (878～1,129 mg/100 g) 以 12 月份為最高，各主要胺基酸則分別在 12 至 4 月份間較高。核苷酸及相關化合物總量 (10～12 μmole/g) 在 10 及 8 月份最高，2 月份最低；肌酸含量 (345～494 mg/100 g) 則以 2～6 月份最高而 10 月份最低。虱目魚呈味成分之組成特徵與青甘鰺等紅肉魚類似，肌苷酸雖因季節而有所變動，但含量比一般魚肉高，推測多季生產虱目魚之 FAA 含量較豐富而呈味性較佳。

關鍵詞：虱目魚，萃取物成分，呈味成分，游離胺基酸，核苷酸，肌酸，季節變化。

邱思魁、游昭玲、蕭泉源，1995，養殖虱目魚普通肉含氮萃取物成分之季節變化。食品科學，22(4): 387-394。

國立台灣海洋大學食品科學系：水產化學授課資料04- 萃取物成分補充文獻- 邱思魁1060503

表一　虱目魚之體重、體長及其普通肉之一般成分
Table 1. Body weight, body length and proximate composition* of milkfish

Date of sampling	No. of sample	Body weight (g)	Body length (cm)	Proximate composition(%) Moisture	Proiten	Fat	Ash
'92 Jun. 16	12	497.2±51.7	30.2±0.7	73.0	24.1	2.3	1.3
Aug. 22	12	524.5±28.0	30.7±0.7	74.3	22.0	1.0	1.4
Oct. 27	8	473.2±34.6	29.4±0.8	74.4	22.3	0.7	1.3
Dec. 2	12	470.4±41.3	29.4±1.3	73.3	22.7	1.2	1.4
'93 Feb. 28	12	453.0±41.8	29.0±1.5	74.8	22.6	1.6	1.3
Apr. 26	12	364.4±16.5	27.1±1.2	73.8	22.9	1.7	1.9

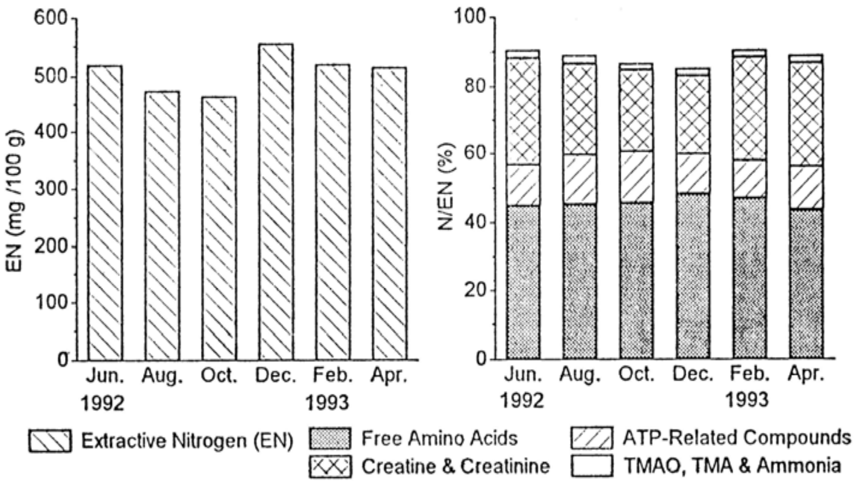
* Ordinary muscles.

表三　虱目魚普通肉核苷酸相關化合物及其餘成分含量之季節變化
Table 3. Seasonal variation of the contents of ATP-related compounds and other constituents in the muscle extracts of milkfish

	'92 Jun.	Aug.	Oct.	Dec.	'93 Feb.	Apr.
ATP-Related Compounds (μmole/g)						
ATP	0.12±0.01*	0.07±0004	0.06±0.01	0.06±0.01	0.10±0.01	0.12±0.02
ADP	0.20±0.04	0.16±0.01	0.13±0.02	0.17±0.03	0.08±0.02	0.12±0.02
AMP	0.09±0.02	0.17±0.06	0.16±0.01	0.10±0.04	0.14±0.01	0.28±0.10
IMP	9.33±0.37	10.43±0.53	11.17±0.73	10.33±0.52	8.79±0.22	9.80±0.28
Inosine	1.19±0.10	1.04±0.33	0.51±0.07	0.66±0.04	0.81±0.05	0.78±0.08
Hypoxanthine	0.16±0.04	0.15±0.04	0.25±0.07	0.8±0.01	0.17±0.04	0.20±0.03
Total	11.07±0.49^{b}	12.02±0.27^{a}	12.29+074^{a}	11.38±0.49^{b}	10.08±0.22^{c}	11.30±0.21^{b}
Other Constituents (mg/100 g)						
Creatine	494.4±18.9^{a}	389.3±12.2^{b}	344.8±16.9^{c}	392.7±12.1^{b}	486.1±31.3^{a}	483.4±23.4^{a}
Creatinine	8.4±1.2	6.3±0.8	3.4±1.7	8.2±3.5	4.3±1.3	3.7±0.3
TMAO	5.5±0.8	5.0±0.3	2.3±1.7	9.6±2.1	5.9±2.1	7.7±0.9
TMA	1.5±0.2	1.3±0.1	1.0±0.4	2.0±0.2	1.6±0.1	1.2±0.2

* Mean±standard deviation of four determinaions.
a–c Means with the same superscript letterin a row did not vary significantly from each other ($p>0.05$).

國立台灣海洋大學食品科學系：水產化學授課資料04- 萃取物成分補充文獻- 邱思魁1060503



圖一　虱目魚普通肉萃取物氮之季節變化及其中氮的分佈
Fig. 1. Seasonal variation of extractive nitrogen (EN) and the distribution of nitrogen in the muscle extracts of milkfish.

國立台灣海洋大學食品科學系：水產化學授課資料04- 萃取物成分補充文獻- 邱思魁1060503

表二　虱目魚普通肉游離胺基酸含量之季節變化
Table 2. Seasonal variation of the content of free amino acids in the muscle extracts of milkfish

(mg/100 g)

Amino acid	'92 Jun.	Aug.	Oct.	Dec.	'93 Feb.	Apr.
Phosphoserine	1.0±0.1*	0.8±0.5	0.4±0.1	0.7±0.1	0.6±0.2	0.6±0.1
Taurine	104.5±16.7^{b}	97.1±18.5^{b}	67.6±13.1^{c}	77.8±9.1^{c}	96.4±35.9^{bc}	142.1±18.9^{a}
Aspartic acid	2.9±1.0	0.9±0.6	2.2±0.9	1.3±0.6	2.0±1.3	0.6±0.3
Hydroxylproline	10.5±2.3	12.0±6.2	7.4±1.2	2.3±0.7	0.9±0.2	0.5±0.1
Threonine	6.7±0.3	4.1±1.2	4.8±0.8	12.7±0.8	7.0±0.4	5.1±1.5
Serine	11.7±2.9	5.8±1.5	5.8±1.2	5.6±0.5	11.7±6.5	4.9±1.0
Glutamic acid	28.1±3.6^{b}	23.8±6.4^{b}	7.2±2.1^{c}	23.5±5.0^{b}	27.5±3.8^{b}	35.6±4.4^{a}
Glutamine	11.2±1.8	5.8±2.7	18.9±8.9	10.6±6.8	5.2±2.4	15.2±7.4
Proline	9.9±1.4	10.7±1.3	7.8±1.3	8.2±1.0	8.4±3.1	5.7±1.9
Glycine	20.1±3.7^{c}	26.4±2.3^{bc}	27.9±6.4^{bc}	59.8±11.7^{a}	52.2±6.9^{a}	31.1±6.5^{b}
Alanine	18.8±2.6^{bc}	10.9±2.7^{c}	24.5±5.3^{b}	39.2±1.4^{a}	24.4±10.8^{b}	22.7±2.2^{b}
Valine	4.4±0.4	2.0±0.6	1.7±0.3	6.2±1.0	6.8±0.6	3.0±0.4
Methionine	2.6±0.2	1.5±0.4	1.2±0.2	2.2±0.1	2.4±0.5	2.1±0.3
Isoleucine	3.0±0.2	0.8±0.4	1.3±0.3	3.1±0.8	2.8±0.4	2.6±1.2
Leucine	4.5±0.5	1.8±0.6	2.1±0.6	5.1±1.2	5.2±0.8	3.1±0.5
Tyrosine	4.4±1.0	3.2±0.4	2.8±0.6	3.5±0.4	3.6±0.8	1.8±0.6
Phenylalanine	1.6±0.2	1.0±0.4	0.4±0.1	1.8±0.5	2.3±0.8	1.1±0.3
β-Alanine	1.1±0.3	1.0±0.1	0.1±0.1	0.7±0.2	0.9±0.2	0.6±0.1
Ornithine	3.0±0.7	4.0±1.3	3.0±1.9	1.0±0.3	7.7±8.1	1.3±0.4
Lysine	22.8±3.4^{b}	16.4±5.6^{c}	15.8±3.0^{c}	27.5±6.9^{b}	36.0±5.4^{a}	35.8±7.6^{a}
Histidine	710.7±55.7^{b}	669.1±62.9^{b}	670.7±61.5^{b}	829.4±90.3^{a}	734.2±63.3^{b}	665.1±36.6^{b}
3-Methylhistidine	2.5±0.6	3.5±0.7	2.2±0.6	2.5±0.8	1.7±0.3	2.5±0.5
Arginine	11.6±2.9	9.8±1.0	3.3±0.4	4.3±0.4	6.0±1.0	3.4±0.8
Total	997.4±61.7^{b}	912.0±90.0^{c}	878.5±83.5^{c}	1,128.5±78.9^{a}	1,046.0±46.4^{ab}	986.4±24.7^{bc}
Ammonia	11.7±2.8	11.8±1.6	9.3±0.8	11.0±0.6	10.7±0.6	10.3±0.5

* Mean±standard deviation of four determinations.
a–c Means with the same superscript letter in a row did not vary significantly from each other ($p>0.05$).

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養殖台灣蜆化學成分之季節變化

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摘　　要

本研究探討本省養殖台灣蜆 (*Corbicula fluminea* Muller) 可食部位化學成分之季節變化，民國 84 年 8 月至 85 年 8 月間每二個月自花蓮壽豐養殖區採樣與分析。一般成分的季節變化大，水分含量以 12 至 4 月份明顯較高，但此期間之粗脂肪量較低 ($p<0.05$)，粗蛋白及灰分量則變動不大，採肉率 (11.8 ～ 21.0 %) 及肝醣含量 (1,171 ～ 4,216 mg/100 g) 同樣呈現夏、秋季高而冬、春季低之趨勢。游離胺基酸 (FAA) 總量在 87.8 ～ 147.9 mg/100 g 間，麩胺酸、麩胺醯胺、丙胺酸、鳥胺酸、離胺酸及精胺酸等爲主要胺基酸， FAA 總量與多數 FAA 的含量均以 8 及 10 月份較高，而 12 及 2 月份之 FAA 總量最低 ($p<0.05$)。ATP 相關化合物總量 (2.43 ～ 3.75 μmole/g) 以 2 及 4 月份最高， 12 月份則爲最低值 ($p<0.05$)。萃取物氮量 (151 ～ 187 mg/100 g) 大抵以 2 及 4 月份較高。從以上結果，採肉率、粗脂肪、呈味胺基酸、核苷酸、肝醣等含量以夏秋兩季之蜆明顯較高，推測此季節間生產蜆之風味較佳。

表一　採樣蜆之體重、殼長及採肉率

Table 1. Body weight, shell length and meat yield of freshwater clam

Date of sampling	Body weight (g) (n = 60)	Shell length (cm) (n = 60)	Meat yield (%) (n = 3)
1995 Aug. 29	2.4±0.3	2.0±0.1	19.0±0.7^{b}
1995 Oct. 27	2.5±0.5	2.1±0.2	18.5±0.3^{b}
1995 Dec. 30	3.0±0.4	2.1±0.1	12.0±0.4^{d}
1996 Feb. 28	2.8±0.4	2.2±0.1	15.7±0.1^{c}
1996 Apr. 30	2.6±0.5	2.1±0.1	11.8±0.2^{d}
1996 Jun. 25	2.7±0.5	2.1±0.2	21.0±0.1^{a}
1996 Aug. 26	3.0±0.5	2.3±0.2	21.0±0.4^{a}

$^{a\text{-}d}$ Mean with the same superscript letter in a column did not significantly differ from each other ($p>0.05$).

表二　蜆一般成分及肝醣含量之季節變動

Table 2. Seasonal variation in proximate composition and glycogen of freshwater clam

Date of sampling	Proximate composition (%) Moisture	Protein	Fat	Ash	Glycogen (mg/100g)
1995 Aug. 29	82.2±0.1^{d}	10.5±0.4^{ab}	1.7±0.3^{b}	0.8±0.1^{c}	4,216±182^{a}
1995 Oct. 27	82.7±0.4^{d}	11.1±0.4^{a}	1.6±0.1^{b}	1.1±0.1^{a}	2,533±254^{c}
1995 Dec. 30	88.3±0.2^{a}	8.7±0.1^{c}	0.5±0.0^{d}	1.1±0.1^{ab}	1,171±38^{d}
1996 Feb. 28	85.2±0.1^{b}	10.7±0.6^{ab}	0.9±0.0^{cd}	1.0±0.1^{ab}	2,303±114^{c}
1996 Apr. 30	85.4±0.3^{b}	10.2±0.6^{b}	0.7±0.0^{c}	0.9±0.1^{bc}	2,309±254^{c}
1996 Jun. 25	83.6±0.3^{c}	10.6±0.3^{ab}	1.8±0.1^{b}	1.0±0.1^{ab}	3,284±160^{b}
1996 Aug. 26	82.1±0.8^{d}	10.5±0.3^{ab}	2.4±0.1^{a}	1.0±0.1^{c}	3,588±336^{b}

Mean ± standard deviation (n = 3).

$^{a\text{-}d}$ Mean with the same superscript letter in a column did not significantly differ from each other ($p>0.05$).

表三　蜆游離胺基酸含量 (mg/100 g) 之季節變動

Table 3. Seasonal variation in free amino acids (mg/100 g) in the extract of freshwater clam

Amino acids	1995 Aug.	1995 Oct.	1995 Dec.	1996 Feb.	1996 Apr.	1996 Jun.	1996 Aug.
Phosphoserine	2.9±0.3^{b}	2.4±0.1^{b}	3.0±0.1^{b}	3.0±0.5^{b}	4.3±0.7^{a}	2.9±0.5^{b}	2.8±0.3^{b}
Taurine	2.4±0.7^{c}	2.7±0.0^{bc}	2.4±0.1^{c}	3.1±0.5^{b}	5.3±0.2^{a}	3.1±0.5^{bc}	2.6±0.2^{bc}
Aspartic acid	3.4±0.1^{a}	2.6±0.3^{b}	1.7±0.2^{d}	1.9±0.1^{cd}	2.1±0.3^{b}	2.8±0.2^{b}	3.6±0.3^{a}
Threonine	2.9±0.1^{c}	3.6±0.3^{b}	1.9±0.3^{d}	1.9±0.2^{d}	2.7±0.3^{c}	3.4±0.5^{b}	4.5±0.3^{a}
Serine	4.2±0.1^{a}	3.7±0.3^{ab}	4.3±0.5^{a}	3.6±0.3^{b}	1.8±0.3^{c}	3.2±0.4^{b}	3.8±0.3^{ab}
Asparagine	1.5±0.2^{ab}	0.9±0.3^{d}	1.0±0.2^{bcd}	1.0±0.2^{cd}	1.5±0.3^{a}	1.4±0.2^{abc}	1.6±0.3^{a}
Glutamic acid	13.5±0.1^{b}	12.9±0.7^{bc}	8.8±1.2^{d}	7.9±0.8^{f}	10.3±1.0^{de}	11.5±1.3^{cd}	17.1±1.5^{a}
Glutamine	17.4±0.5^{a}	17.9±0.5^{a}	7.0±1.0^{d}	9.4±0.1^{c}	15.6±0.5^{b}	3.8±0.4^{e}	4.2±0.3^{e}
a-AAA	1.0±0.3^{b}	0.5±0.2^{c}	0.5±0.1^{c}	0.2±0.0^{d}	0.4±0.1^{cd}	0.8±0.1^{b}	1.4±0.2^{a}
Proline	3.0±0.1^{c}	4.5±0.1^{b}	2.2±0.2^{d}	2.3±0.2^{d}	3.0±0.3^{c}	3.6±0.4^{c}	5.5±0.5^{a}
Glycine	2.8±0.2^{b}	3.6±0.4^{a}	2.3±0.4^{b}	2.3±0.4^{b}	2.9±0.5^{b}	2.4±0.2^{b}	3.8±0.2^{a}
Alanine	15.1±0.1^{c}	20.4±0.4^{b}	7.5±1.0^{e}	11.4±0.4^{d}	12.7±1.3^{d}	15.8±1.7^{c}	26.5±0.7^{a}
a-ABA	0.2±0.0^{d}	1.3±0.1^{b}	0.7±0.3^{c}	1.2±0.1^{b}	1.7±0.1^{a}	0.6±0.2^{c}	1.7±0.1^{a}
Valine	3.4±0.1^{ab}	5.0±0.2^{b}	2.9±0.3^{f}	3.1±0.2^{ef}	3.7±0.3^{cd}	4.0±0.3^{c}	5.6±0.2^{a}
Cystine	0.2±0.0^{d}	1.3±0.1^{abc}	1.4±0.1^{abc}	1.1±0.1^{c}	1.9±0.3^{a}	1.2±0.1^{bc}	1.6±0.1^{ab}
Methionine	1.2±0.0^{d}	2.0±0.1^{b}	1.7±0.2^{c}	1.6±0.1^{c}	0.5±0.2^{e}	1.8±0.1^{c}	2.7±0.1^{a}
Isoleucine	2.3±0.1^{cd}	3.1±0.2^{b}	1.6±0.2^{f}	1.8±0.2^{ef}	2.1±0.2^{de}	2.5±0.2^{c}	4.6±0.2^{a}
Leucine	3.3±0.1^{c}	4.6±0.3^{b}	2.1±0.3^{e}	2.5±0.2^{de}	2.7±0.2^{d}	3.4±0.3^{c}	6.2±0.4^{a}
Tyrosine	2.4±0.1^{bc}	2.9±0.2^{b}	1.7±0.3^{e}	1.7±0.2^{de}	2.4±0.7^{bcd}	2.2±0.2^{cde}	3.9±0.3^{a}
Phenylalanine	1.6±0.0^{bcd}	2.1±0.1^{b}	1.1±0.2^{e}	1.3±0.2^{de}	1.7±0.6^{bc}	1.8±0.1^{bc}	3.3±0.6^{a}
b-Alanine	1.8±0.3^{bc}	2.5±0.4^{ab}	1.4±0.5^{c}	1.3±0.5^{c}	2.0±0.9^{bc}	1.4±0.1^{c}	3.2±0.2^{a}
b-AiBA	0.2±0.0^{d}	0.4±0.0^{b}	0.3±0.0^{bc}	0.2±0.0^{d}	0.3±0.1^{cd}	0.3±0.1^{bc}	0.9±0.1^{a}
γ-ABA	0.2±0.1^{c}	0.5±0.1^{ab}	0.4±0.1^{bc}	0.4±0.1^{bc}	0.3±0.1^{c}	0.3±0.1^{c}	0.6±0.1^{a}
Tryptophan	1.6±0.0^{a}	1.4±0.1^{b}	1.0±0.1^{c}	0.6±0.2^{de}	0.7±0.1^{d}	0.5±0.1^{de}	0.5±0.2^{e}
Ethanolamine	4.5±0.8^{b}	3.4±0.2^{c}	6.3±0.8^{a}	4.6±0.4^{b}	3.2±0.4^{c}	2.6±0.2^{c}	3.0±0.5^{c}
Ornithine	9.4±2.1^{ab}	11.7±3.5^{ab}	8.9±3.4^{ab}	7.3±2.9^{b}	15.3±6.4^{a}	5.6±0.3^{b}	10.1±0.4^{ab}
Lysine	7.2±0.1^{bc}	7.6±0.4^{b}	4.3±0.7^{e}	4.2±0.3^{e}	5.3±0.7^{d}	6.5±0.7^{c}	8.7±0.3^{a}
Histidine	1.8±0.3^{a}	1.7±0.1^{ab}	0.9±0.1^{c}	0.9±0.1^{c}	1.4±0.1^{b}	1.0±0.2^{c}	1.9±0.1^{a}
Arginine	11.4±0.1^{ab}	10.5±0.3^{abc}	8.7±0.8^{c}	10.2±0.8^{bc}	10.5±0.5^{abc}	12.1±2.2^{a}	11.6±0.6^{ab}
Total	122.9±3.4^{bc}	137.8±7.1^{ab}	87.8±12.5^{e}	92.0±8.9^{e}	118.6±12.8^{cd}	102.2±10.0^{de}	147.9±7.8^{a}
Ammonia	3.4±0.2^{cd}	4.0±0.1^{ab}	3.2±0.2^{d}	3.2±0.2^{cd}	3.7±0.3^{bc}	3.1±0.3^{d}	4.5±0.6^{a}

a-AAA, a-Aminoadipic acid; a-ABA, a-aminobutric acid; a-AiBA, b-amino-isobutyric acid; γ-ABA, γ-aminobutric acid.

Mean ± standard deviation (n = 3).

$^{a\text{-}f}$ Means with the same superscript letter in a row did not significantly differ from each other ($p>0.05$).

表四　蜆 ATP 相關化合物含量 (μmole/g) 之季節變動

Table 4. Seasonal variation in ATP-related compounds (μmole/g) in the extract of freshwater clam

	1995			1996			
	Aug.	Oct.	Dec.	Feb.	Apr.	Jun.	Aug.
ATP	0.44 ± 0.14^{ab}	0.27 ± 0.09^{c}	0.28 ± 0.09^{bc}	0.44 ± 0.05^{ab}	0.46 ± 0.06^{a}	0.34 ± 0.05^{abc}	0.38 ± 0.14^{abc}
ADP	0.69 ± 0.09^{bc}	0.56 ± 0.08^{cd}	0.56 ± 0.08^{d}	0.58 ± 0.08^{cd}	0.70 ± 0.05^{bc}	0.91 ± 0.19^{a}	0.83 ± 0.08^{ab}
AMP	0.58 ± 0.05^{c}	0.45 ± 0.12^{d}	0.33 ± 0.01^{d}	0.41 ± 0.07^{d}	0.60 ± 0.05^{c}	0.73 ± 0.10^{b}	0.95 ± 0.02^{a}
IMP	0.48 ± 0.10^{bc}	0.81 ± 0.08^{a}	0.49 ± 0.02^{bc}	0.54 ± 0.06^{b}	0.43 ± 0.01^{c}	0.20 ± 0.02^{e}	0.30 ± 0.06^{d}
Adenosine	0.03 ± 0.01^{a}	0.04 ± 0.01^{a}	0.02 ± 0.00^{b}	0.03 ± 0.01^{a}	0.04 ± 0.01^{a}	0.04 ± 0.00^{a}	0.05 ± 0.01^{a}
Inosine	0.10 ± 0.02^{c}	0.16 ± 0.06^{b}	0.10 ± 0.02^{c}	0.18 ± 0.05^{b}	0.24 ± 0.02^{a}	0.07 ± 0.02^{c}	0.06 ± 0.01^{c}
Hypoxanthine	0.59 ± 0.04^{cd}	0.49 ± 0.06^{d}	0.63 ± 0.02^{cd}	1.41 ± 0.20^{a}	1.14 ± 0.09^{b}	0.75 ± 0.13^{c}	0.48 ± 0.06^{d}
Xanthine	0.05 ± 0.00^{d}	0.06 ± 0.01^{d}	0.13 ± 0.02^{c}	0.13 ± 0.01^{c}	0.14 ± 0.01^{c}	0.28 ± 0.00^{b}	0.31 ± 0.01^{a}
Total	2.97 ± 0.02^{c}	2.83 ± 0.07^{c}	2.43 ± 0.03^{d}	3.72 ± 0.15^{a}	3.75 ± 0.21^{a}	3.31 ± 0.19^{b}	3.36 ± 0.04^{b}

Mean ± standard deviation (n = 3).

a-e Means with the same superscript letter in a row did not significantly differ from each other ($p>0.05$).

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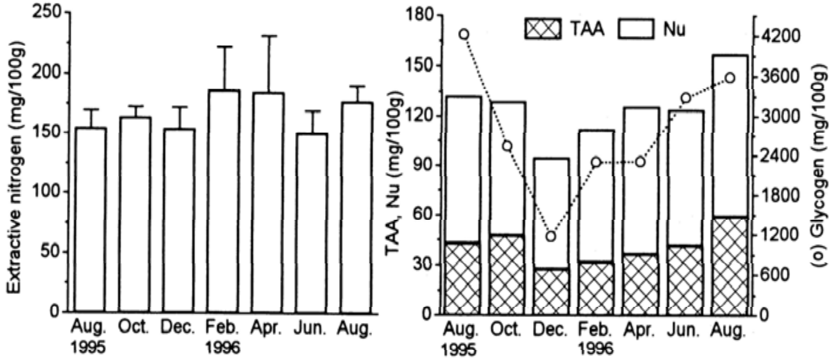

圖一　蜆萃取物氮與呈味成分含量之季節變動

Fig. 1. Seasonal variation in extractive nitrogen and taste components of freshwater clam.
TAA, taste amino acids (glutamic acid + alanine + glycine + arginine);
Nu, nucleotides (ATP + ADP + AMP + IMP).

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Food Science (December, 1996) 23(6): 779–787

養殖文蛤化學成分之季節變化

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摘　要

爲瞭解本省不同季節生產養殖文蛤之化學成分，民國 82 年 11 月至 83 年 11 月間每二個月自雲林臺西養殖戶採樣與分析。一般成分之變動小，採肉率 (11.3～16.7%) 以 5 及 7 月份較高，肝醣含量 (1,103～1,432 mg/100 g) 以 7 月份較高。游離胺基酸 (FAA) 總量在 913～1,299 mg/100 g 間，以牛磺酸含量最多，另包括丙胺酸、麩胺酸、精胺酸及甘胺酸等五種主要 FAA 卽佔總量之 84～91%，且和 FAA 總量均以 7 及 9 月份高於其他月份。核苷酸及相關化合物總量 (3.74～4.57 μmole/g) 在 5 及 7 月份較高，有機酸 (234～504 mg/100 g) 中以琥珀酸量較多，蘋果酸及檸檬酸其次，在夏及秋季生產之文蛤有機酸總量及琥珀酸較高。萃取物氮量大抵呈現由春季往冬季逐漸上升之趨勢，從以上結果顯示夏、秋季生產文蛤之肝醣、呈味胺基酸、琥珀酸等含量較豐富，推測此季節生產之文蛤風味可能較佳。

關鍵詞：文蛤，萃取物成分，肝醣，游離胺基酸，核苷酸，有機酸，季節變化。

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表一　採樣文蛤之體重、殼長及採肉率

Table 1. Body weight, shell length and meat yield of the examined hard clam

Date of sampling	Body weight (g)	Shell length (cm)	Meat yield (%)
1993 Nov. 26	17.2±4.0	4.1±0.4	12.2
1994 Jan. 27	15.0±2.6	4.0±0.2	11.8
1994 Mar. 26	15.6±2.8	4.2±0.3	13.9
1994 May 27	14.2±3.3	4.2±0.3	16.7
1994 Jul. 26	14.0±2.8	4.1±0.4	15.0
1994 Sep. 29	12.9±2.5	3.9±0.3	11.3
1994 Nov. 11	12.5±2.2	3.9±0.2	13.0

表二　文蛤之一般成分及肝醣含量之季節變動

Table 2. Seasonal variation in proximate composition and glycogen content of hard clam

Date of sampling	Proximate composition (%)				Glycogen (mg/100 g)
	Moisture	Protein	Fat	Ash	
1993 Nov. 26	83.0	12.6	0.3	2.0	1,103
1994 Jan. 27	80.3	11.1	0.7	2.4	1,275
1994 Mar. 26	82.0	11.3	0.2	2.5	1.192
1994 May 27	81.4	11.0	0.2	2.2	1,145
1994 Jul. 26	81.3	10.5	0.5	2.3	1,432
1994 Sep. 29	81.4	10.5	3.9	2.4	1,222
1994 Nov. 11	81.6	12.3	0.7	2.5	1,132

表三　文蛤游離胺基酸含量之季節變動

Table 3. Seasonal variation in the content of free amino acids in the meat extract of hard clam

(mg/100 g)

Amino acids	1993	1994					
	Nov.	Jan.	Mar.	May	Jul.	Sep.	Nov.
Phosphoserine	7	7	7	8	8	9	9
Taurine	512	533	638	395	460	652	469
Aspartic acid	19	23	29	30	32	22	19
Threonine	6	9	8	4	6	7	9
Serine	4	7	4	4	6	5	7
Glutamic acid	108	131	132	138	159	150	105
Glutamine	3	5	4	4	4	5	3
Sarcosine	2	3	2	0	0	5	2
α-Amino adipic acid	9	9	5	4	8	11	13
Proline	5	6	7	6	6	7	9
Glycine	22	37	26	59	87	60	52
Alanine	85	121	106	136	274	206	205
α-Amino-n-butyric acid	2	4	3	2	3	4	3
Valine	8	14	9	8	8	10	13
Cystine	4	6	1	0	0	1	1
Methionine	0	6	3	4	1	4	4
Cystathionine	1	3	2	0	0	1	1
Isoleucine	5	8	4	4	4	5	8
Leucine	6	11	6	7	6	7	12
Tyrosine	5	8	6	6	6	6	9
Phenylalanine	3	5	5	5	4	4	7
β-Alanine	2	2	3	3	3	3	4
β-Amino-n-butyric acid	0	0	1	0	3	1	1
Ornithine	6	6	8	7	4	6	5
Lysine	13	19	18	18	20	12	15
Histidine	3	5	5	4	4	4	2
Arginine	74	89	94	80	74	89	71
Total	913	1,069	1,132	936	1,189	1,299	1,059
Ammonia	6	6	4	6	7	7	8

表四　文蛤核苷酸及相關化合物含量之季節變動

Table 4. Seasonal variation in the content of nucleotides and related compounds in the meat extract of hard clam

(μmole/g)

	1993	1994					
	Nov.	Jan.	Mar.	May	Jul.	Sep.	Nov.
ATP	1.05	1.12	1.23	0.99	0.90	0.05	1.14
ADP	0.80	0.97	0.79	0.96	0.59	0.39	1.06
AMP	0.87	0.77	0.85	0.97	2.01	1.74	0.70
IMP	0.17	0.13	0.05	0.17	0.21	0.17	0.03
GMP	0.07	0.08	0.04	0.09	0.16	0.23	0.05
CMP	0.27	0.34	0.34	0.29	0.16	0.29	0.38
UMP	0.12	0.13	0.13	0.29	0.05	0.12	0.13
Adenosine	0.03	0.02	0.05	0.04	0.03	0.05	0.02
Inosine	0.16	0.20	0.10	0.10	0.11	0.14	0.06
Guanosine	0.03	0.03	0.01	0.03	0.03	0.30	0.02
Uridine	0.04	0.05	0.04	0.06	0.10	0.13	0.02
Hypoxanthine	0.29	0.23	0.09	0.25	0.20	0.16	0.17
Xanthine	0.03	0.03	0.02	0.02	0.02	0.10	0.02
Total	3.94	4.08	3.74	4.26	4.57	3.87	3.80

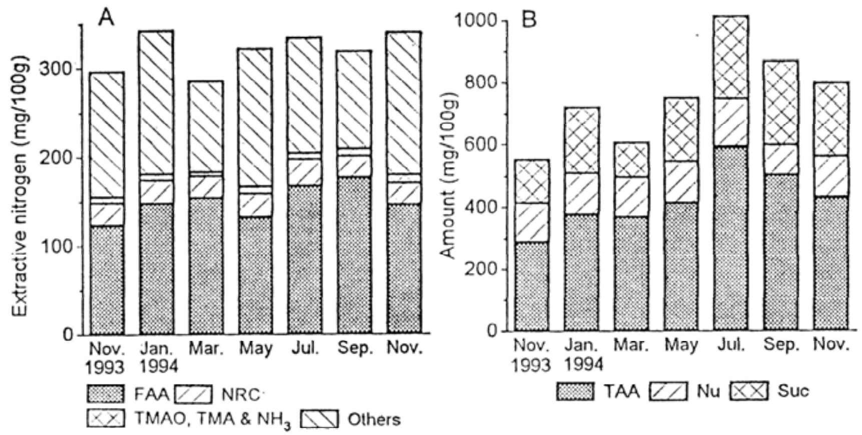
表五　文蛤有機酸、氧化三甲基胺及三甲基胺含量之季節變動

Table 5. Seasonal variation in the content of organic acids, trimethylamine oxide (TMAO) and trimethylamine (TMA) in the meat extract of hard clam

(mg/100 g)

	1993	1994					
	Nov.	Jan.	Mar.	May	Jul.	Sep.	Nov.
α-Ketoglutaric acid	4	3	4	10	10	8	5
Citric acid	53	48	64	44	28	63	38
Succinic acid	140	212	109	204	265	271	235
Lactic acid	8	7	1	3	10	2	9
Malic acid	70	79	56	83	72	149	110
Pyroglutamic acid	—	—	—	—	—	11	2
Total	275	349	234	344	385	504	399
TMAO	6	3	1	9	7	6	5
TMA	2	11	7	5	2	7	12

—, not detected.



圖一　文蛤萃取物氮（A）及呈味成分含量（B）之季節變動

Fig. 1. Seasonal variation in the contents of extractive nitrogen (A) and taste components (B) of hard clam meat.
FAA, free amino acids; NRC, nucleotides and related compounds; Others, unidentified compounds; TAA, taste amino acids (alanine+glutamic acid+arginine+glycine); Nu, nucleotides (ATP+ADP+AMP+IMP+GMP); Suc, succinic acid.

- 養殖虱目魚普通肉含氮萃取物成分之季節變化：虱目魚呈味成分之組成特徵與青甘參等紅肉魚類似，肌苷酸雖因季節而有所變動，但含量比一般魚肉高，推測冬季生產虱目魚之FAA含量較豐富而呈味性較佳。

- 養殖台灣蜆化學成分之季節變化：採肉率、粗脂肪、呈味胺基酸、核苷酸、肝醣等含量以夏秋兩季明顯較高，推測此季節間生產蜆之風味較佳。

- 養殖文蛤化學成分之季節變化：夏、秋季生產文蛤之肝醣、呈味胺基酸、琥珀酸等含量較豐富，推測此季節生產之文蛤風味可能較佳。

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Original Article

Seasonal variations of chemical constituents in the muscle and viscera of small abalone fed different diets

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SUMMARY: The seasonal changes in levels of chemical constituents in the muscle and viscera of small abalone *Haliotis diversicolor* fed gracilar and an artificial diet were investigated. Muscle yields were higher in winter and spring. In October specimens, total adenosine 5′-triphosphate (ATP)-related compounds (ARC), total free amino acids (FAA), and glycogen in both muscle and viscera decreased markedly. The artificial diet fed to small abalone had much higher glycogen in the muscle than those fed on gracilar, and showed a great seasonal change. Total amounts of ARC in the muscles were higher through March to July, while those in the viscera were maximal in January. Taurine, arginine, glycine, glutamic acid, and alanine were the major FAA in both tissues, accounting for 81–94% of the total FAA. Total amounts of FAA in the muscles were higher in the samples collected from winter and early spring than in other seasons. Glycine, glutamic acid, and adenosine monophosphate might be the most important taste components related to the palatability of small abalone. Their total amounts in the muscles of the two specimens were considerably high in December to March. This finding suggested that small abalone produced in winter and early spring might be more palatable.

KEY WORDS: **diet, extractive component, *Haliotis diversicolor*, seasonal variation, small abalone.**

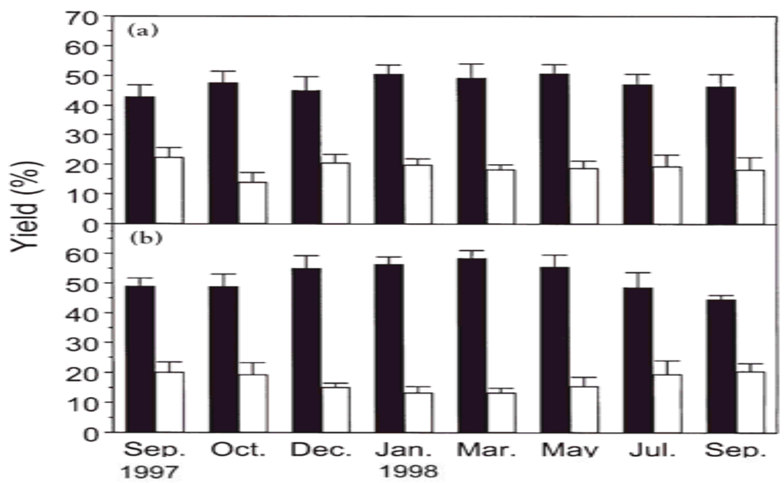

Fig. 1 Seasonal changes in muscle and viscera yields of (a) G-small abalone and (b) A-small abalone. Data are mean and SD of six specimens. (■) muscle; (□) viscera.

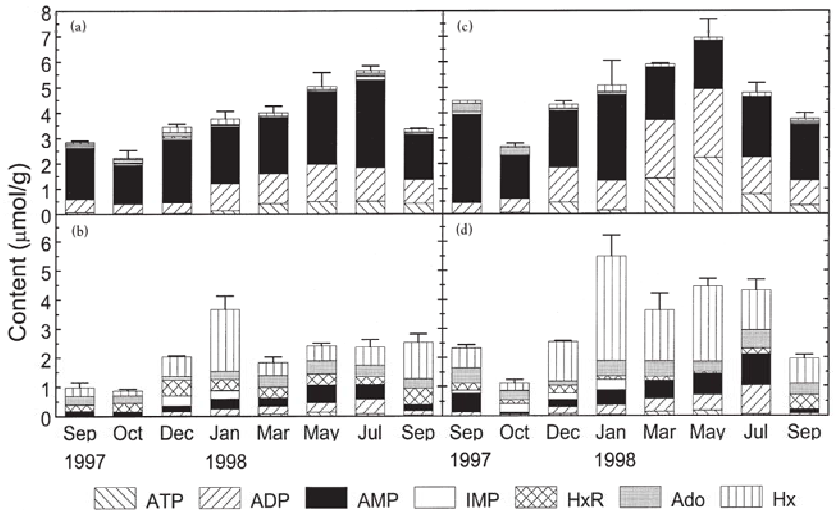

Fig. 3 Seasonal changes in levels of ATP-related compounds in the muscle and viscera of G-small abalone and A-small abalone. Data are mean and SD of two determinations. G-small abalone (a) muscle and (b) viscera. A-small abalone (c) muscle and (d) viscera.

Table 1 Seasonal changes in levels of free amino acids (mg/100 g) in the muscle of G-small abalone

Amino acids	Date of sampling							
	1997 Sep. 10	Oct. 1	Dec. 20	1998 Jan. 13	Mar. 18	May 8	Jul. 21	Sep. 9
Phosphoserine	11 (0)	9 (0)*	9 (0)	6 (0)	6 (0)	6 (0)	8 (0)	6 (1)
Taurine	1313 (16)	1425 (43)	1351 (49)	1214 (42)	1218 (111)	1339 (57)	1300 (35)	1321 (96)
Aspartic acid	5 (2)	8 (2)	5 (2)	7 (0)	7 (1)	7 (0)	7 (2)	9 (0)
Threonine	10 (0)	11 (1)	18 (0)	20 (0)	17 (3)	24 (2)	15 (2)	17 (1)
Serine	26 (0)	21 (1)	35 (1)	34 (1)	42 (11)	36 (6)	23 (6)	39 (6)
Glutamic acid	70 (1)	47 (2)	34 (2)	30 (0)	54 (20)	39 (2)	47 (6)	66 (6)
Glutamine	15 (0)	14 (0)	37 (3)	22 (1)	42 (23)	18 (3)	25 (2)	32 (1)
α-AAA	2 (3)	5 (2)	6 (2)	7 (1)	10 (4)	6 (0)	10 (0)	8 (2)
Proline	19 (2)	15 (2)	24 (2)	29 (1)	39 (2)	21 (1)	16 (2)	21 (4)
Glycine	74 (1)	131 (7)	350 (3)	399 (14)	438 (61)	238 (35)	162 (79)	195 (20)
Alanine	45 (0)	41 (1)	37 (1)	31 (0)	50 (22)	23 (1)	41 (3)	47 (4)
Citrulline	6 (1)	8 (0)	6 (1)	5 (0)	6 (0)	1 (0)	1 (1)	0 (0)
α-ABA	3 (2)	0 (0)	3 (1)	2 (0)	2 (1)	4 (2)	2 (0)	6 (0)
Valine	8 (1)	7 (1)	11 (1)	10 (0)	14 (2)	11 (1)	9 (2)	10 (1)
Cystine	0 (0)	1 (1)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Methionine	4 (1)	5 (0)	5 (1)	4 (1)	4 (2)	4 (1)	5 (2)	4 (0)
Cystathionine	3 (3)	1 (1)	5 (0)	8 (0)	7 (1)	5 (0)	1 (0)	4 (1)
Isoleucine	8 (3)	6 (2)	10 (0)	7 (0)	10 (1)	6 (0)	6 (2)	7 (0)
Leucine	11 (2)	10 (1)	12 (0)	9 (0)	15 (4)	11 (0)	12 (1)	11 (2)
Tyrosine	10 (6)	12 (0)	20 (2)	16 (1)	22 (10)	10 (1)	10 (2)	10 (2)
Phenylalanine	4 (0)	4 (1)	7 (1)	8 (0)	13 (5)	6 (1)	6 (1)	7 (0)
β-Alanine	4 (3)	3 (2)	3 (3)	1 (0)	2 (1)	1 (0)	3 (0)	1 (0)
β-AiBA	2 (3)	1 (2)	2 (2)	2 (0)	2 (0)	2 (1)	2 (0)	2 (0)
γ-ABA	0 (0)	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Tryptophan	6 (2)	7 (8)	8 (6)	3 (0)	9 (0)	0 (0)	0 (0)	0 (0)
Ethanol amine	0 (1)	0 (1)	0 (0)	1 (0)	0 (0)	1 (0)	1 (0)	0 (0)
Ornithine	2 (0)	4 (0)	6 (0)	11 (0)	4 (0)	2 (0)	3 (1)	2 (1)
Lysine	9 (0)	9 (0)	18 (0)	16 (0)	21 (3)	17 (1)	14 (3)	18 (2)
Histidine	8 (0)	9 (1)	12 (0)	15 (1)	24 (6)	16 (1)	13 (4)	17 (2)
Arginine	458 (10)	421 (8)	405 (17)	431 (11)	498 (27)	488 (11)	525 (20)	471 (31)
Total	2133 (10)	2236 (67)	2443 (78)	2351 (70)	2576 (22)	2342 (16)	2266 (165)	2332 (122)

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 and SD (in parentheses) of two determinations.

Table 2 Seasonal changes in levels of free amino acids (mg/100 g) in the muscle of A-small abalone

Amino acids	Date of sampling							
	1997 Sep. 10	Oct. 1	Dec. 20	1998 Jan. 13	Mar. 18	May 8	Jul. 21	Sep. 9
Phosphoserine	9 (0)*	7 (0)	7 (0)	9 (1)	6 (0)	7 (1)	7 (0)	6 (0)
Taurine	897 (5)	1045 (5)	1020 (107)	1105 (73)	1150 (114)	986 (35)	1082 (31)	1257 (73)
Aspartic acid	5 (1)	6 (0)	11 (2)	7 (1)	5 (1)	11 (0)	12 (1)	8 (0)
Threonine	10 (0)	16 (1)	11 (1)	15 (1)	15 (4)	11 (1)	18 (1)	15 (1)
Serine	46 (1)	26 (2)	54 (6)	58 (3)	37 (2)	50 (1)	54 (1)	33 (2)
Glutamic acid	110 (2)	46 (1)	59 (8)	79 (2)	50 (5)	67 (1)	109 (0)	71 (4)
Glutamine	23 (1)	29 (1)	75 (13)	66 (1)	35 (10)	55 (3)	52 (3)	43 (0)
α-AAA	3 (2)	6 (2)	7 (1)	4 (2)	6 (0)	7 (0)	10 (0)	7 (3)
Proline	57 (6)	18 (4)	111 (14)	101 (4)	61 (4)	66 (1)	55 (0)	22 (1)
Glycine	224 (5)	278 (7)	484 (41)	448 (24)	362 (28)	335 (41)	329 (32)	257 (14)
Alanine	82 (1)	50 (0)	60 (7)	72 (4)	43 (12)	61 (0)	111 (10)	52 (3)
Citrulline	3 (1)	6 (3)	1 (1)	1 (1)	10 (4)	0 (0)	1 (1)	9 (1)
α-ABA	4 (0)	2 (3)	6 (1)	2 (1)	3 (1)	5 (0)	3 (0)	0 (0)
Valine	9 (1)	11 (1)	20 (1)	23 (2)	11 (1)	15 (0)	15 (0)	15 (1)
Cystine	0 (0)	1 (0)	1 (1)	0 (1)	0 (0)	0 (0)	0 (0)	2 (2)
Methionine	3 (2)	5 (1)	3 (0)	2 (0)	4 (0)	2 (0)	2 (1)	3 (1)
Cystathionine	4 (2)	3 (2)	4 (0)	3 (1)	5 (3)	2 (1)	1 (0)	2 (0)
Isoleucine	8 (2)	9 (1)	14 (4)	14 (0)	8 (0)	10 (0)	10 (0)	3 (0)
Leucine	15 (0)	12 (0)	25 (5)	23 (0)	13 (3)	21 (1)	21 (1)	7 (1)
Tyrosine	21 (1)	15 (0)	48 (8)	31 (1)	19 (3)	22 (0)	19 (1)	8 (0)
Phenylalanine	11 (1)	5 (0)	18 (1)	19 (0)	11 (1)	16 (1)	14 (1)	6 (0)
β-Alanine	9 (1)	4 (2)	4 (1)	2 (0)	1 (1)	3 (0)	10 (1)	2 (0)
β-AiBA	5 (0)	2 (2)	4 (0)	2 (1)	2 (0)	2 (1)	4 (0)	2 (0)
γ-ABA	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Tryptophan	4 (2)	3 (4)	11 (0)	4 (5)	4 (6)	0 (0)	0 (0)	0 (0)
Ethanol amine	1 (2)	0 (1)	0 (0)	0 (0)	0 (1)	1 (0)	1 (0)	0 (0)
Ornithine	2 (0)	7 (0)	3 (1)	4 (0)	14 (0)	4 (0)	7 (2)	7 (0)
Lysine	17 (0)	15 (0)	18 (2)	24 (2)	17 (8)	28 (1)	23 (2)	20 (2)
Histidine	14 (0)	9 (0)	12 (2)	25 (2)	20 (2)	19 (1)	16 (0)	17 (1)
Arginine	412 (9)	395 (10)	387 (50)	375 (17)	454 (27)	405 (20)	432 (2)	449 (19)
Total	2010 (13)	2032 (13)	2476 (278)	2517 (125)	2370 (104)	2212 (108)	2422 (68)	2323 (100)

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 and SD (in parentheses) of two determinations.

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Chemical constituents in the abdominal muscle of cultured mud crab *Scylla serrata* in relation to seasonal variation and maturation

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ABSTRACT: Seasonal changes in levels of chemical constituents in the abdominal muscle of male and female mud crab *Scylla serrata* were investigated. The gonadosomatic index in the female crab was higher in October and August, of which the muscle yield, glycogen, and total amount of adenosine 5′-triphosphate (ATP)-related compounds (ARC) in the October sample were the highest throughout the year, but the total amount of free amino acids (FAA) was the lowest. The total FAA and individual FAA such as glycine, alanine, and arginine increased in the August and November female samples, while that in the male specimens was higher in January, March, and August. The total ARC in both crabs was lower in the samples collected from winter than in other seasons whereas glycinebetaine was higher in winter and early spring. Glutamic acid, glycine, alanine, arginine, glycinebetaine, and adenosine monophosphate might be responsible for the taste of mud crab. Their level together was relatively higher in the August and January male samples, and in the August and November female specimens. However, the correlation between the taste component content and degree of gonad maturation was low.

KEY WORDS: **crab, extractive component, gonad maturation, *Scylla serrata*, seasonal variation.**

Table 1 Seasonal variations of proximate composition and glycogen in the abdominal muscle of male and female mud crabs

Date of sampling	Body weight† (g)	Carapace width† (cm)	Proximate composition‡ (%) Moisture	Protein	Fat	Ash	Glycogen‡ (mg/100 g)
Male crab							
19 March 1999	280 ± 57	10.4 ± 0.8	80.8 ± 1.0^{abc}	17.1 ± 0.2^{bcd}	0.3 ± 0.1^{a}	1.7 ± 0.2^{b}	122 ± 19^{e}
6 May 1999	302 ± 49	11.0 ± 0.9	82.0 ± 0.9^{ab}	16.4 ± 0.9^{cd}	0.3 ± 0.0^{ab}	1.7 ± 0.1^{b}	90 ± 34^{e}
12 August 1999	295 ± 59	11.1 ± 0.3	80.7 ± 1.2^{abc}	16.5 ± 1.1^{cd}	0.2 ± 0.0^{c}	2.2 ± 0.2^{a}	194 ± 49^{cd}
25 October 1999	250 ± 53	10.9 ± 0.6	78.8 ± 0.8^{c}	19.1 ± 1.2^{ab}	0.2 ± 0.1^{c}	1.5 ± 0.0^{b}	391 ± 11^{a}
22 November 1999	228 ± 41	10.3 ± 0.3	82.5 ± 1.7^{a}	15.8 ± 1.5^{d}	0.2 ± 0.1^{abc}	1.6 ± 0.2^{b}	247 ± 73^{bc}
7 January 7, 2000	348 ± 45	11.5 ± 0.8	79.8 ± 1.2^{bc}	18.1 ± 0.9^{abc}	0.2 ± 0.0^{bc}	1.6 ± 0.1^{b}	288 ± 33^{b}
6 March 2000	286 ± 50	10.9 ± 0.4	78.6 ± 2.2^{c}	19.2 ± 1.0^{a}	0.2 ± 0.0^{bc}	1.6 ± 0.0^{b}	145 ± 8de
Female crab							
19 March 1999	260 ± 15	10.6 ± 0.3	77.6 ± 1.7^{cd}	19.5 ± 0.6^{ab}	0.5 ± 0.1^{a}	1.8 ± 0.0^{b}	297 ± 111^{c}
6 May 1999	242 ± 20	10.8 ± 0.4	81.3 ± 1.2^{a}	16.4 ± 0.7^{d}	0.3 ± 0.1^{b}	1.8 ± 0.3^{b}	181 ± 63^{c}
12 August 1999	260 ± 36	11.0 ± 0.7	75.8 ± 0.5^{d}	20.9 ± 0.7^{a}	0.4 ± 0.1^{bcd}	1.9 ± 0.0^{a}	485 ± 94^{b}
25October 1999	413 ± 56	12.9 ± 0.6	77.9 ± 1.1^{bc}	18.8 ± 1.0^{bc}	0.4 ± 0.1^{b}	1.5 ± 0.1^{c}	882 ± 122^{a}
22 November 1999	353 ± 43	11.8 ± 0.5	79.6 ± 0.9^{abc}	17.9 ± 0.8^{bcd}	0.3 ± 0.1^{d}	1.5 ± 0.0^{c}	274 ± 83^{c}
7 January 2000	265 ± 37	11.1 ± 0.5	80.2 ± 1.7^{ab}	17.4 ± 1.2^{d}	0.4 ± 0.0^{bc}	1.4 ± 0.1^{c}	302 ± 51^{c}
6 March 2000	307 ± 49	11.3 ± 0.4	78.4 ± 2.1^{bc}	18.9 ± 2.0^{abc}	0.4 ± 0.1^{b}	1.4 ± 0.0^{c}	324 ± 64^{c}

†Mean ± SD ($n = 9$).

‡Mean ± SD ($n = 3$). Means in the same column not sharing the same superscripts are significantly different ($P < 0.05$) among different sampling times.

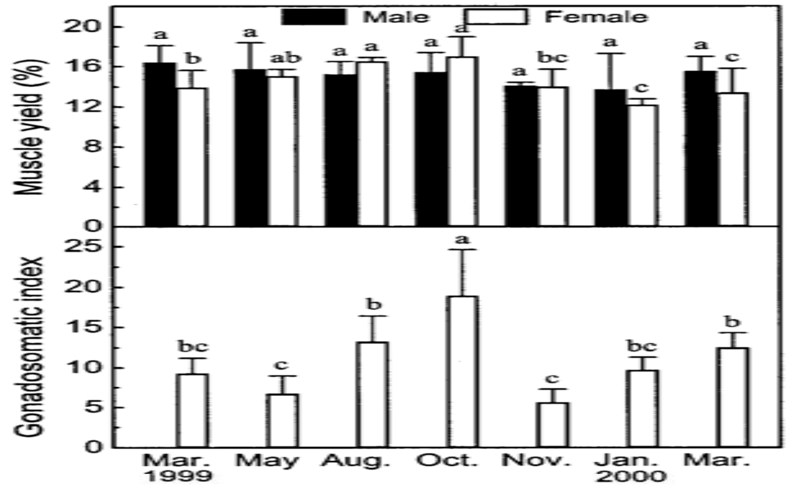

Fig. 1 Seasonal changes in muscle yield and gonadosomatic index of (■) male and (□) female mud crabs. Data are mean and SD ($n = 3$). Different letters indicate significant difference ($P < 0.05$) among different sampling times.

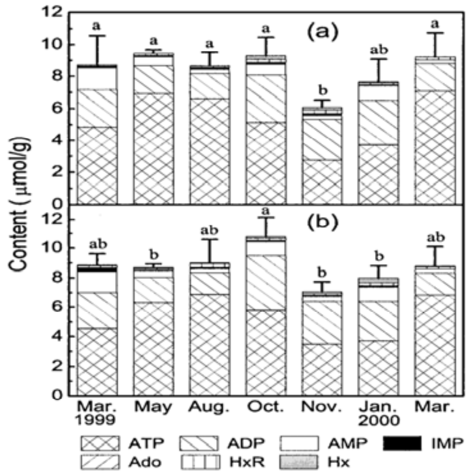

Fig. 2 Seasonal changes in levels of adenosine triphosphate (ATP) and its related compounds in the abdominal muscle of (a) male and (b) female mud crabs. Data are mean and SD ($n = 3$). Bars at the top of each column indicate the SD of the total content. Different letters indicate significant difference ($P < 0.05$) among different sampling times. ADP, adenosine diphosphate; AMP, adenosine monophosphate; IMP, inosine monophosphate; Ado, adenosine; HxR, inosine; Hx, hypoxanthine.

Table 2 Seasonal variations of the major and total free amino acids (mg/100 g) in the abdominal muscle of male and female mud crabs

Amino acids	Date of sampling: 1999, 19 March	6 May	12 August	25 October	22 November	2000, 7 January	6 March
Male crab							
Taurine	97 ± 29^{a}	99 ± 25^{a}	83 ± 5^{a}	97 ± 32^{a}	85 ± 14^{a}	85 ± 13^{a}	88 ± 30^{a}
Glutamic acid	71 ± 4^{ab}	57 ± 10^{bc}	77 ± 7^{a}	74 ± 4^{a}	50 ± 6^{c}	80 ± 22^{a}	52 ± 7^{c}
Glutamine	275 ± 76^{a}	305 ± 7^{a}	244 ± 126^{a}	248 ± 21^{a}	190 ± 47^{a}	291 ± 8^{a}	214 ± 15^{a}
Proline	296 ± 18^{bc}	227 ± 124^{c}	169 ± 33^{c}	345 ± 84^{bc}	327 ± 115^{bc}	472 ± 90^{ab}	542 ± 169^{a}
Glycine	780 ± 44^{b}	742 ± 158^{b}	986 ± 82^{a}	697 ± 10^{b}	726 ± 131^{b}	825 ± 47^{ab}	791 ± 128^{b}
Alanine	237 ± 42^{ab}	191 ± 8^{bc}	259 ± 28^{a}	171 ± 26^{c}	182 ± 32^{b}	273 ± 19^{a}	189 ± 20^{bc}
Arginine	598 ± 73^{a}	615 ± 106^{a}	590 ± 35^{a}	539 ± 24^{a}	547 ± 56^{a}	612 ± 64^{a}	604 ± 53^{a}
Others	328 ± 50^{a}	221 ± 68^{a}	340 ± 138^{a}	231 ± 37^{a}	367 ± 56^{a}	333 ± 55^{a}	320 ± 103^{a}
Total	2682 ± 79^{abc}	2458 ± 221^{bc}	2747 ± 285^{abc}	2401 ± 122^{c}	2474 ± 273^{bc}	2971 ± 92^{a}	2800 ± 179^{ab}
Female crab							
Taurine	165 ± 20^{a}	122 ± 13^{bc}	107 ± 13^{c}	108 ± 9^{c}	116 ± 13^{c}	126 ± 9^{bc}	151 ± 27^{ab}
Glutamic acid	46 ± 1^{b}	73 ± 10^{a}	45 ± 2^{b}	67 ± 8^{ab}	61 ± 12^{ab}	74 ± 10^{a}	63 ± 10^{ab}
Glutamine	289 ± 29^{abc}	367 ± 74^{a}	376 ± 73^{a}	203 ± 39^{c}	312 ± 33^{ab}	256 ± 24^{bc}	256 ± 46^{bc}
Proline	519 ± 134^{abc}	329 ± 37^{d}	361 ± 37^{cd}	418 ± 97^{bcd}	525 ± 47^{abc}	572 ± 138^{ab}	600 ± 119^{a}
Glycine	568 ± 148^{b}	484 ± 26^{b}	862 ± 79^{a}	487 ± 69^{b}	554 ± 46^{b}	571 ± 158^{b}	511 ± 120^{b}
Alanine	226 ± 10^{abc}	183 ± 26^{cd}	278 ± 28^{a}	155 ± 35^{d}	197 ± 28^{bcd}	245 ± 51^{ab}	180 ± 10^{cd}
Arginine	572 ± 30^{b}	534 ± 8^{bc}	658 ± 17^{a}	463 ± 54^{c}	575 ± 23^{b}	477 ± 54^{c}	527 ± 54^{bc}
Others	298 ± 67^{b}	374 ± 93^{ab}	337 ± 23^{b}	234 ± 13^{b}	473 ± 150^{a}	321 ± 56^{b}	270 ± 42^{b}
Total	2683 ± 86^{bc}	2466 ± 68^{c}	3023 ± 203^{a}	2134 ± 246^{d}	2812 ± 203^{ab}	2642 ± 119^{bc}	2560 ± 173^{bc}

Data are mean and SD ($n = 3$). Means in the same row not sharing the same superscripts are significantly different ($P < 0.05$) among different sampling times.

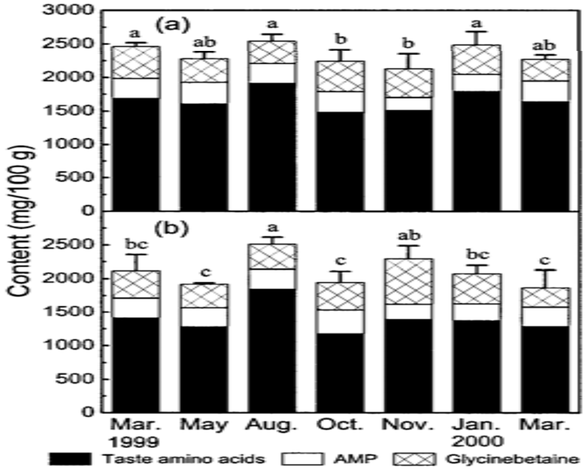

Fig. 4 Seasonal changes in level of taste components in the abdominal muscle of (a) male and (b) female mud crabs. Data are mean and SD ($n=3$). Bars at the top of each column indicate the SD of the total content. Different letters indicate significant difference ($P<0.05$) among different sampling times. Taste amino acids: glutamic acid + glycine + alanine + arginine; AMP (adenosine monophosphate): adenosine triphosphate + adenosine diphosphate + AMP + inosine monophosphate.

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組織部位

- 魚類－背肉、腹肉；普通肉、血合肉之一般組成的差異
- 萃取物氮：魚類－普通肉＞血合肉
  ★游離胺基酸：魚類－普通肉＞血合肉；組胺酸及鵝肌肽的差異更大
  ★肌酸：普通肉＞血合肉
  ★核苷酸成分：普通肉＞血合肉
  ★牛磺酸：血合肉＞＞血合肉