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Seasonal amino acid profiles and mineral contents of green tiger shrimp (*Penaeus semisulcatus* De Haan, 1844) and speckled shrimp (*Metapenaeus monoceros* Fabricus, 1789) from the Eastern Mediterranean

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Abstract

The amino acid and mineral contents of green tiger shrimp (*Penaeus semisulcatus*) and speckled shrimp (*Metapenaeus monoceros*) from the North Eastern Mediterranean were determined for each season of the year. For both species, the highest protein values were recorded during the summer ($p < 0.05$). The most abundant amino acids were, in decreasing order, glutamic acid, aspartic acid, arginine, lysine, leucine, glycine and alanine. The ratio of essential to nonessential amino acids (mean value) for green tiger shrimp and speckled shrimp were 0.60 and 0.59, respectively. Mineral contents of the two species varied with season ($p < 0.05$), except for the Ca content in green tiger shrimp.

Keywords: Shrimp; Amino acids; Mineral content; Seasonal changes

1. Introduction

Speckled shrimp (*Metapenaeus monoceros*) and green tiger shrimp (*Penaeus semisulcatus*) are the most valuable species caught off the Eastern coast of Turkey and are widely appreciated by Turkish consumers. They are valuable natural food sources by being rich especially in protein and minerals, and contain well-balanced essential amino acids.

In order to avoid nutritional disorders and to set diet formulations, it is of great importance to know the quantity and quality of the nutritional composition of foods. In the studies on shrimp species, proximate compositions (Karakoltsidis, Zotos, & Constantinides, 1995), fatty acid profiles and cholesterol contents (Luzia, Sampaio, Castellucci, & Torres, 2003) and total carotenoid contents (Yanar, Çelik, & Yanar, 2004) of shrimps were reported to change seasonally. However, nothing is known of seasonal amino acid and mineral contents of these penaeid species. Therefore, this study has been carried out to determine the mineral contents and amino acid profiles of green tiger shrimp (*P. semisulcatus*) and speckled shrimp (*M. monoceros*) during four seasons.

2. Materials and methods

The shrimps were caught off Karataş, the Eastern Mediterranean coast of Turkey during January, April, July and October of 2001. Immediately after catching, they were stored on ice in an insulated box and transferred

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to the laboratory. The mean lengths and mean weights of the shrimps were 18.93 ± 0.07 cm and 63.93 ± 0.71 g for green tiger shrimp and 12.67 ± 0.04 cm and 16.49 ± 0.15 g for speckled shrimp, respectively. Shrimp samples were deheaded, peeled and divided. Only the edible portion was used for analysis. Three lots of each species were analysed in duplicate for each season.

Ash and moisture contents were determined as described by AOAC (1984) and crude protein content was calculated by converting the nitrogen content determined by Kjeldahl's method (6.25 × N) (AOAC, 1984).

For mineral analysis, shrimp samples were wet-digested with HNO_3/HCO_4 (AOAC, 1996). The elements, calcium, magnesium, sodium, potassium and iron were determined using a Perkin–Elmer AA 700 atomic absorption spectrophotometer (Perkin–Elmer Corporation, Norwalk, CT).

For amino acid analysis, samples were hydrolysed in 6 M HCl at 110 °C for 24 h (AOAC, 1984) in an evacuated sealed ampoule. Excess acid from the hydrolysate was removed by flash evaporation under reduced pressure. The analysis was carried out using an Eppendorf Biotronic LC 3000 Amino Acid Analyzer (Eppendorf-Biotronic, Hamburg, Germany), according to standard program.

Analysis of variance was used to evaluate harvesting season upon the mineral content and the amino acid profile of the shrimp samples.

3. Results and discussion

Table 1 shows protein, moisture and ash contents of the shrimps. The protein content varied between 20.44% and 21.70% in green tiger shrimp and between 21.06% and 22.46% in speckled shrimp; the highest values were obtained during the summer period in both species ($p < 0.05$). However, in the studies on red and pink shrimp species, the protein content did not change between winter and summer (Rosa & Nunes, 2003). For both species, the highest moisture content was found in winter ($p < 0.05$). While the seasonal ash contents were similar in speckled shrimp, green tiger shrimp had a higher ash content in autumn (1.65%) compared to other seasons ($p < 0.05$).

The amino acid profiles of green tiger shrimp and speckled shrimp are presented in Tables 2 and 3, respectively. There were significant seasonal variations in the content of total amino acids (TAA) in both species ($p < 0.05$); the highest values were obtained in summer. The most abundant amino acids in both species were glutamic acid, aspartic acid, arginine, lysine and leucine. These amino acids constituted 50% of the total amino acids. Methionine and histidine were found to be the first and second limiting amino acids.

The ratios of essential amino acids (EAA) to nonessential amino acids (NEAA) in green tiger shrimp and speckled shrimp were 0.60 and 0.59, respectively. Iwasaki and Harada (1985) explained that EAA/NEAA ratio of many fish species is 0.70 on average, whereas this ratio was reported to be 0.59 in crab (*Portunus trituberculatus*) and squid (*Doryteusthis bleekeri*). In both species, just like in many other marine fish species (Iwasaki & Harada, 1985), acidic amino acids were found to be more dominant than basic amino acids.

The present data revealed that both shrimp species were well-balanced with respect to essential amino acids when compared with the FAO reference pattern (FAO/WHO/UNU, 1985).

The mineral contents of green tiger shrimp and speckled shrimp are given in Table 4. Ca, K, P, Na and Fe contents found in both species showed seasonal differences ($p < 0.05$), except the Ca content in green tiger shrimp. The average Ca contents of green tiger shrimp and speckled shrimp were 60.28 mg/100 g and 60.44 mg/100 g, respectively. While these values are found to be higher than those reported by Exler (1987) for penaeid and pandalid shrimps, they are nearly half of Ca content (121 mg/100 g), reported by Karakoltsidis et al. (1995) for *Aristeus antennatus*. The reason for this difference is suspected to stem from species and/or biotope varieties.

The average K contents of green tiger shrimp (218 mg/100 g) and speckled shrimp (223 mg/100 g), were found to be higher than those reported for penaeid and pandalid shrimps (185 mg/100 g) (Exler, 1987), but were found to be rather lower than the value re-

Table 1
Seasonal variation in the proximate compositions (% wet weight)[A] of green tiger shrimp and speckled shrimp

	Green tiger shrimp				Speckled shrimp			
	January	April	July	October	January	April	July	October
Protein	20.58 ± 0.07^{bB}	20.44 ± 0.07^{b}	21.70 ± 0.05^{a}	20.48 ± 0.08^{b}	21.06 ± 0.05^{d*}	21.31 ± 0.03^{c}	22.46 ± 0.04^{a}	21.91 ± 0.05^{b}
Ash	1.63 ± 0.01^{b}	1.56 ± 0.01^{c}	1.55 ± 0.01^{c}	1.65 ± 0.01^{a}	1.62 ± 0.01^{a}	1.59 ± 0.01^{a}	1.61 ± 0.01^{a}	1.60 ± 0.01^{a}
Moisture	75.73 ± 0.02^{a}	75.77 ± 0.02^{a}	75.09 ± 0.07^{b}	74.87 ± 0.27^{b}	75.57 ± 0.02^{a}	75.48 ± 0.02^{b}	74.70 ± 0.03^{d}	74.81 ± 0.02^{c}

[A] Data are expressed as mean ± standard error ($n = 3$).
[B] Different letters for each species within a row denote significant differences ($p < 0.05$).

Table 2
Seasonal variation in the amino acid profile of green tiger shrimp (g/100 g muscle tissue)[A]

Amino acids	January	April	July	October
Threonine[C]	0.75 ± 0.01[aB]	0.79 ± 0.01[a]	0.75 ± 0.01[a]	0.74 ± 0.02[a]
Valine[C]	0.94 ± 0.02[a]	0.92 ± 0.01[a]	0.96 ± 0.03[a]	0.86 ± 0.02[b]
Methionine[C]	0.46 ± 0.01[c]	0.51 ± 0.01[b]	0.55 ± 0.02[ab]	0.56 ± 0.01[a]
soleucine[C]	0.87 ± 0.01[b]	0.94 ± 0.01[a]	0.91 ± 0.01[a]	0.83 ± 0.01[c]
Leucine[C]	1.46 ± 0.01[b]	1.59 ± 0.01[a]	1.55 ± 0.01[a]	1.37 ± 0.02[c]
Phenylalanine[C]	0.82 ± 0.01[b]	0.78 ± 0.01[c]	0.78 ± 0.01[c]	0.89 ± 0.01[a]
Lysine[C]	1.70 ± 0.01[b]	1.77 ± 0.02[a]	1.75 ± 0.02[a]	1.64 ± 0.02[c]
Histidine	0.37 ± 0.01[b]	0.42 ± 0.01[a]	0.33 ± 0.01[c]	0.30 ± 0.01[c]
Arginine	1.75 ± 0.01[a]	1.73 ± 0.01[a]	1.75 ± 0.04[a]	1.70 ± 0.01[a]
Aspartic acid	1.98 ± 0.01[a]	1.93 ± 0.02[b]	2.00 ± 0.02[a]	1.80 ± 0.01[c]
Serine	0.91 ± 0.01[b]	0.91 ± 0.01[b]	1.12 ± 0.01[a]	0.89 ± 0.01[b]
Glutamic acid	3.07 ± 0.05[b]	3.27 ± 0.03[a]	3.32 ± 0.02[a]	3.06 ± 0.07[b]
Glycine	1.26 ± 0.02[b]	0.94 ± 0.02[c]	1.33 ± 0.01[a]	1.33 ± 0.01[a]
Alanine	0.98 ± 0.03[a]	1.01 ± 0.02[a]	1.03 ± 0.02[a]	0.97 ± 0.01[a]
Tyrosine	0.70 ± 0.01[a]	0.66 ± 0.02[ab]	0.60 ± 0.01[c]	0.65 ± 0.02[b]
Proline	0.67 ± 0.01[b]	0.70 ± 0.01[b]	0.95 ± 0.01[a]	0.71 ± 0.04[b]
TAA	18.68 ± 0.05[b]	18.86 ± 0.04[b]	19.67 ± 0.05[a]	18.26 ± 0.06[c]
EAA[C]/NEAA[D]	0.60 ± 0.00[b]	0.63 ± 0.00[a]	0.58 ± 0.01[c]	0.60 ± 0.00[b]

[A] Data are expressed as mean ± standard error ($n = 3$).
[B] Different letters within a row denote significant differences ($p < 0.05$).
[C] Essential amino acids.
[D] Non-essential amino acids.

Table 3
Seasonal variation in the amino acid profile of speckled shrimp (g/100 g muscle tissue)[A]

Amino acids	January	April	July	October
Threonine[C]	0.83 ± 0.01[aB]	0.82 ± 0.03[a]	0.85 ± 0.01[a]	0.88 ± 0.03[a]
Valine[C]	0.96 ± 0.01[a]	0.87 ± 0.03[b]	0.97 ± 0.01[a]	0.97 ± 0.01[a]
Methionine[C]	0.57 ± 0.02[a]	0.43 ± 0.01[b]	0.56 ± 0.01[a]	0.58 ± 0.01[a]
soleucine[C]	0.76 ± 0.02[d]	0.88 ± 0.02[c]	1.05 ± 0.02[a]	0.94 ± 0.02[b]
Leucine[C]	1.56 ± 0.01[b]	1.66 ± 0.02[a]	1.66 ± 0.01[a]	1.65 ± 0.02[a]
Phenylalanine[C]	0.88 ± 0.01[a]	0.71 ± 0.02[c]	0.78 ± 0.02[b]	0.86 ± 0.02[a]
Lysine[C]	1.72 ± 0.02[b]	1.59 ± 0.01[c]	1.75 ± 0.01[ab]	1.76 ± 0.01[a]
Histidine	0.37 ± 0.01[a]	0.32 ± 0.01[b]	0.33 ± 0.01[b]	0.40 ± 0.01[a]
Arginine	1.85 ± 0.03[a]	1.87 ± 0.02[a]	1.73 ± 0.01[b]	1.69 ± 0.01[b]
Aspartic acid	2.18 ± 0.01[b]	2.22 ± 0.03[b]	2.34 ± 0.01[a]	2.33 ± 0.05[a]
Serine	0.86 ± 0.01[b]	0.87 ± 0.01[b]	0.97 ± 0.01[a]	0.84 ± 0.02[b]
Glutamic acid	3.26 ± 0.03[b]	3.27 ± 0.02[b]	3.41 ± 0.02[a]	3.01 ± 0.04[c]
Glycine	1.16 ± 0.01[b]	1.33 ± 0.02[a]	1.36 ± 0.01[a]	1.16 ± 0.01[b]
Alanine	1.16 ± 0.01[b]	1.06 ± 0.02[c]	1.27 ± 0.02[a]	1.29 ± 0.02[a]
Tyrosine	0.73 ± 0.01[a]	0.72 ± 0.02[a]	0.64 ± 0.01[b]	0.74 ± 0.04[a]
Proline	0.74 ± 0.02[b]	0.67 ± 0.02[c]	0.89 ± 0.01[a]	0.85 ± 0.01[a]
TAA	19.58 ± 0.05[bc]	19.24 ± 0.03[c]	20.53 ± 0.06[a]	19.92 ± 0.02[b]
EAA/NEAA	0.59 ± 0.01[b]	0.57 ± 0.01[c]	0.59 ± 0.01[b]	0.62 ± 0.00[a]

[A] Data are expressed as mean ± standard error ($n = 3$).
[B] Different letters within a row denote significant differences ($p < 0.05$).
[C] Essential amino acids.

ported for *Aristeus antennatus* (347 mg/100 g) (Karakoltsidis et al., 1995).

The average P content of green tiger shrimp (168 mg/100 g) and speckled shrimp (167 mg/100 g) was lower that reported for penaeid and pandalid shrimps (205 mg/100 g) (Exler, 1987) and for unknown shrimp species (240 mg/100 g) (Lall, 1995).

The average Na content of green tiger shrimp (147 mg/100 g) and speckled shrimp (139 mg/100 g), was found to be close to that reported for penaeid and pandalid shrimps by Exler (1987).

The average Fe content were found to be 1.48 mg/100 g for green tiger shrimp and 1.55 mg/100 g for speckled shrimp. These values are higher than those stated for *Aristeus antennatus* (0.9 mg/100 g) (Karakoltsidis et al., 1995) while they are lower than those stated for penaeid and pandalid shrimps (2.4 mg/100 g).

Table 4
Seasonal variation in the mineral contents (mg/100 g muscle tissue)[A] of green tiger shrimp and speckled shrimp

	Green tiger shrimp				Speckled shrimp			
	January	April	July	October	January	April	July	October
Ca	59.5 ± 0.6[aB]	60.3 ± 0.8[a]	60.3 ± 0.9[a]	61.1 ± 1.0[a]	62.4 ± 0.7[a]	60.4 ± 0.8[ba]	59.1 ± 0.6[b]	59.9 ± 0.9[b]
K	214.8 ± 0.9[b]	215.1 ± 0.9[b]	214.1 ± 0.9[b]	226.1 ± 1.2[a]	215.9 ± 0.7[c]	220.0 ± 1.0[b]	218.8 ± 1.2[b]	237.2 ± 0.8[a]
P	158.9 ± 0.7[c]	157.8 ± 1.1[c]	171.3 ± 1.2[b]	183.1 ± 1.0[a]	165.3 ± 0.8[bc]	163.6 ± 1.2[c]	166.6 ± 0.7[b]	171.8 ± 0.8[a]
Na	128.6 ± 0.8[d]	144.4 ± 1.4[c]	160.8 ± 0.8[a]	154.6 ± 1.1[b]	135.9 ± 0.7[c]	123.4 ± 0.9[d]	147.1 ± 1.1[b]	151.1 ± 1.0[a]
Fe	1.51 ± 0.10[ab]	1.58 ± 0.10[a]	1.46 ± 0.01[ab]	1.36 ± 0.10[b]	1.66 ± 0.05[a]	1.55 ± 0.06[ba]	1.63 ± 0.06[a]	1.41 ± 0.04[b]

[A] Data are expressed as mean ± standard error ($n = 3$).
[B] Different letters for each species within a row denote significant differences ($p < 0.05$).

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