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The Amino Acid Composition of Blue Swimming Crab (*Portunus Segnis*, Forskal, 1775) from The North Eastern Mediterranean Sea of Turkey

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A B S T R A C T

This study was carried out to detect the content of amino acid in female and male specimens of blue swimming crab (*Portunus segnis*) obtained from (including 12 male crab and also 12 female crab) North Eastern Mediterranean Sea, Turkey. The protein was identified as 17.63% and 18.13% for female and male crab respevtively. Totally 9 essential amino acids were recorded in the present study. Lysine and leucine constituted the highest essential amino acid (EAA) concentrations in *P. segnis*. This species was found to be in good score in terms of the level of EAA and the EAA/Non-EAA ratios when compared with other economical crab species.

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Kuzeydoğu Akdeniz'den elde edilen Yüzücü Mavi Yengeç'in (*Portunus segnis*, Forskal, 1775) Amino Asit Kompozisyonu

M A K A L E B İ L G İ S İ

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Ö Z E T

Bu çalışma Türkiye'de, Kuzeydoğu Akdenizden elde edilen yüzücü mavi yengeçlerin (*Portunus segnis*) erkek dişi bireylerinin (12 erkek, 12 dişi birey) aminoasit içeriklerini tespit etmek üzere yapılmıştır. Protein değerleri, dişi ve erkek yengeçler için sırasıyla %17,63 ve %18,13 olarak tespit edilmiştir. Toplamda 9 esansiyel aminoasit tespit edilmiştir. Lisin ve lösin *P. segnis'teki* en yüksek esansiyel aminoasit (EAA) konsantrasyonlarını oluşturmuştur. Bu türün, diğer ekonomik yengeç türleri ile karşılaştırılmasında EAA ile EAA/Esansiyel olmayan aminoasit oranı açısından daha iyi değerde olduğu saptanmıştır.

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Introduction

Portunus segnis, (Forskal, 1775) known as the blue swimming crab is one of the commercially important species that inhabit a wide range of inshore and continental shelf areas, including sandy, muddy and sea grass habitats, from the intertidal zone to at least 50 m depth (Safaie et al., 2013; Noori et al., 2015). The species is often considered a benthic carnivore and eats mainly sessile mollusk and other invertebrates (Pazooki et al., 2012). It is distributed from eastern Mediterranean to east coast of Africa in the western Indian Ocean and to Pakistan, Red Sea and Persian Gulf (Lai et al., 2010; Pazooki et al., 2012). This species entered to the Mediterranean with Suez Canal. Because of its large size and good flavor, this crab is consumed as food in Turkey and sold for 0.25 to 0.42 Euro at local fish markets in Mersin and Iskenderun Bays (Özcan, 2012). The global capture production of this crab was more than 200 000 tons in 2013 (Noori et al., 2015). In general people eat crabs because of its taste, easy availability and affordability but are often unaware of the health benefits (Soundarapandian et al., 2015).

It is commonly marketed either as refrigerated fresh product, frozen or pasteurized chilled meat and is usually consumed by European and Far East countries (Segner, 1992; Chung and Cadwallader, 1993; Olgunoglu, 2010). Its meat is often recommended for pregnant women (Adeyeye, 2008; Kuley et al., 2008; Elegbede and Fashina, 2013). Because crab meat is highly nutritious and healthy owing to its high protein and amino acid contents (AA) (Gökoglu and Yerlikaya, 2003; Sudhakar et al., 2011).

Food and tissue proteins contain 20 different amino acids including essential (threonine, valine, methionine, isoleucine, leucine, phenylalanine, lysine and histidine) and non essential (aspartic acid, arginine serine, glutamic acid, glutamine, glycine, alanine, tyrosine proline, taurine) of nutritional importance. Amino acids are mainly obtained from proteins in diet therefore a sufficient quantity of dietary protein is required for growth, survival, development, reproduction and maintaining good health throughout life (Kücükgulmez and Celik, 2008; Suvitha et al., 2014).

Recently, many studies have been done on the nutritional value of seafood which has low saturated fat, high omega-3 polyunsaturated fatty acids (PUFA), and high-quality protein, amino acids and minerals (Gökoglu and Yerlikaya 2003; Celik et al., 2004; Olgunoglu et al., 2011, Ayas and Ozogul, 2012, Pasdaran et al., 2017a, Pasdaran et al., 2017 b, Olgunoglu and Olgunoglu, 2017, Göçer et al., 2018). Among of them, amino acids in diets have been recognized to be special biomolecules. Because these biomolecules both serve as building blocks of proteins and are intermediates in various metabolic pathways. They serve as precursors for synthesis of a wide range of biologically important substances including nucleotides, peptide hormones and neurotransmitters. Moreover, amino acids play important roles in cell signaling and act as regulators of gene expression and protein phosphorylation cascade, nutrient transport and metabolism in animal cells, and innate and cell-mediated immune responses (Mohanty et al., 2014). In the present study the amino acid composition of female and male specimens of blue swimming crab (*Portunus segnis*) caught off the North Eastern Mediterranean Sea (Turkey) were investigated. Many publications are available on the chemical, mineral, fatty acid and amino acid compositions of different crab species (Gökoglu and Yerlikaya 2003; Celik et al., 2004; Cherif et al., 2008; Kuley et al. 2008; Ayas and Özogul 2011a, 2011b; Moronkola et al., 2011; Sudhakar et al. ,2011; Soundarapandıan et al., 2014) in various parts of the world. However, nothing is known of amino acid composition of blue swimming crab meat. Therefore, in view of these facts, the present study was carried out on *P. segnis* in order to assess their proteins and amino acid contents prior to their consumption.

Material and Methods

Collection and Preparation of Samples

The male and female specimen of *P. segnis* was collected by dip net from Mersin Bay in the coast of Northeastern Mediterranean Sea of Turkey in March 2016 (Figure 1).

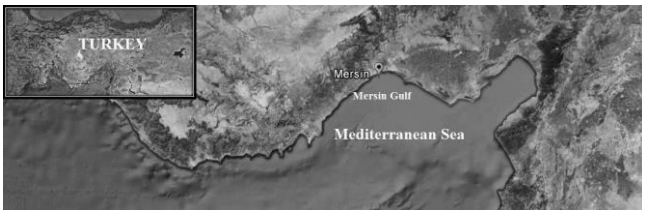

Figure 1 Sampling area in the Northeastern Mediterranean Sea

Immediately after capture, crabs were placed in plastic bags over a layer of ice in a cooler and transported to the laboratory. The carapace meats of each sex group including 12 individuals were taken out by hand and placed in labeled polyethylene bags and stored at -20^{o}C until processing for analysis.

Protein and Amino Acid Analysis

The carapace meat samples of male and female specimens of blue swimming crab were transported with dry ice to the Industrial Services Laboratories of TUBITAK–MAM (The Scientific & Technological Research Council of Turkey – at Marmara Reasearch Centre). Crude protein content was calculated by converting the nitrogen content, determined by Kjeldahl's method (6.25x N) (AOAC, 1995). Amino acid analysis process was performed using a Shimadzu 20 Series UFLC (Ultra Fast Liquid Chromatography) device and a UV detector. The method was adapted from literature and modified by TUBITAK-MAM (Dimova, 2003).

Data Analysis

For data analysis independent samples t-test was used to identify significant differences in protein and amino acid contens. Statistical significance was defined at $P<0.05$. The mean values were obtained from 3 experiments and reported as X±SD (Dinçer and Aydın, 2014).

Results And Discussion

The contents of 16 amino acids (9 esential and 7 non-esential) and the protein of blue swimming crab from North Eastern Mediterranean Sea is shown in Table 1.

Protein contents of the female and male blue swimming crab have been determined as 17.63% and 18.13% respectively. The contents of total essential amino acids were slightly higher in the male specimen of blue swimming crab (7.730) than the female specimen (7.145). The ratios of essential amino acids to non-essential amino acids for female crab (0.829) were almost the same as in male crab species (0.824). There were no significant differences (P>0.05) in the protein and amino acid contents between the sexes of blue swimming crab. Glutamic acid and aspartic acid had the highest concentrations among their groups and are both non-esential acidic amino acid. Lysine and leucine constituted the highest essential amino acid (EAA) concentrations in *P. segnis.* Lysine is an EAA which is extensively required for optimal growth and its deficiency leads to immunodeficiency. Leucine is the only dietary amino acid that can stimulate muscle protein synthesis and has important therapeutic role in stress conditions like burn, trauma, and sepsis (Mohanty et al., 2014).

Based on results, the crab protein contained high amounts of glutamic acid (2.689g/100g of protein), followed by aspartic acid (1.959 g/100g), lysine (1.515g/100g), glycine (1.441g/100g), leucine (1.365 g/100g) and alanine (1.114 g/100g) in a decreasing order. The levels of protein vary depending upon season, age, maturity, sex, water temperature, spawning cycle and availability of food, types of diet and feeding system of organism (Öksuz et al., 2009; Turan et al., 2011; Rosli et al., 2012). In a study from Mediterranean Sea, Türeli et al. (2002) determined that protein of *Callinectes sapidus* ranged between 12.11-21.96%. Türeli et al. (2000) also reported that protein in *Portunus pelagicus* varied from 17.50% to 18.83%. Protein contents were also reported by Gokoglu and Yerlikaya (2003) as 14.71% for *C. sapidus* and 22.64% for *P. pelagicus*. In an other study on *C. sapidus* from Mersin Bay, protein contents were reported as 22.45% and 21.40% for female and male crap by Ayas and Özogul (2011a) respectively. Ayas and Özogul (2011b) also reported that protein as 23.20% for male speciemen of *P. pelagicus* and 21.93% for female speciemen of *P. pelagicus*. The contents of protein in crabs in this study were consistent with the levels reported in previous studies.

Amino acid contents of *P. segnis* obtained in this study were comparable with several other reports on amino acid profiles of other crap species. The ratio of essential amino acids to nonessential amino acids in breast meat of *C. sapidus* was reported as 0.83 by Kücükgulmez and Celik (2008). The ratio was also reported as 0.66 for warty crab (*Eriphia verrucosa*) by Kaya et al. (2009). Iwasaki and Harada (1985) reported that essential amino acid/nonessential amino acid ratio of many fish species is 0.70 on average whereas this ratio was reported to be 0.56 in crab and squid. Kücükgulmez and Celik (2008) determined total EAA as 7.247 for *C. sapidus*. Soundarapandian et al., (2014) found that EAA of ridged swimming crab (C*harybdis natator*) ranged between 7.483g-7.529g.

Table 1 Protein content and amino acid composition of blue swimming crab tissues (*P. segnis*) (g amino acid / 100 g edible portion)

	Female	Male	Average
Crude Protein (g/100g)	17.63±0.2[a]	18.13±0.3[a]	17.88
EAA			
Arginine (Arg)	0.501±0.02[a]	0.630±0.02 [a]	0.565
Histidine (His)	0.669±0.02 [a]	0.713±0.02 [a]	0.691
Isoleucine (IIe)	0.738±0.03 [a]	0.778±0.02 [a]	0.758
Leucine (leu)	1.269±0.06 [a]	1.365±0.04 [a]	1.317
Lysine (Lys)	1.510±0.02 [a]	1.518±0.01 [a]	1.514
Methionine (Met)	0.498±0.01 [a]	0.558±0.01 [a]	0.528
Phenylalanine (Phe)	0.612±0.01 [a]	0.707±0.02 [a]	0.659
Valine (Val)	0.622±0.02 [a]	0.674±0.02 [a]	0.648
Threonine (Thr)	0.726±0.02 [a]	0.787±0.01 [a]	0.756
Non-A-EAA			
Alanine (Ala)	1.019±0.02 [a]	1.114±0.01 [a]	1.066
Aspartic acid (Asp)	1.690±0.03 [a]	1.959±0.02 [a]	1.824
Glutamic acid (Glu)	2.355±0.03 [a]	2.689±0.04 [a]	2.522
Tyrosine (Tyr)	0.501±0.00 [a]	0.521±0.01 [a]	0.511
Glycine (Gly)	1.433±0.02 [a]	1.441±0.02 [a]	1.437
Serine (Ser)	0.826±0.05 [a]	0.856±0.04 [a]	0.841
Proline (Pro)	0.789±0.01 [a]	0.797±0.03 [a]	0.793
EAA	7.145	7.730	7.437
Non-EAA	8.613	9.377	8.995
EAA/Non-EAA	0.829	0.824	0.826

Values are shown as means ± SD. Mean values in the same row having the same superscript are not significantly different (P>0.05)

In the present study EAA/Non-EAA ratios and the total EAA of *P. segnis* were within the range those reported previously for some aquatic organisms. It could be demonstrated that the blue swimming crab (*P. segnis*) is in good score when the level of EAA and the EAA/Non-EAA ratios was considered. In a study on amino acids, the levels of glutamic (2.581g/100g) and aspartic acid (1.596g/100g) were reported to be highest among non-esesntial amino acid in breast meat of *C. sapidus* (Kücükgulmez and Celik, 2008).

Naczk et al., (2004) reported that glutamic acid and aspartic acid were the most abundant non-esesntial amino acids in European green crab (*Carcinus maenas*). Glutamic acid was also repoted to be the most abundant free amino acid in body meat of crab by Jiang et al., (2014).

The results obtained in this study showed similarity to the findings of the mentioned researchers. Kaya et al., (2009) reported that the highest EAA in warty crab (*Eriphia verrucosa*) was leucine (1.762 g/100g) followed by valine (1.106 g/100g) and lysine (1.090g/100g). According to Naczk et al., (2004) arginine is the most abudant EAA in European green crab (*Carcinus maenas*) followed by lysine, and leucine. Kücükgulmez and Celik (2008) reported that the highest EAA in blue crab (*C. sapidus*) was leucine (1.405 g/100g) followed by lysine (1.283g/100g) and arginine (1.034g/100g). Chen et al., (2007) reported that the highest EAA in mitten crab (*Eriocheir sinensis*) was lysine (1.46g/100 g) followed by leucine (1.39 g/100g). The highest content of lysine (2.07g/100g) was also reported in *Chionoecetes opilio* by Martinez et al., (2007). In the present study the order of EAA was identified as slightly differently and the amount of lysine and leucine were found mostly to be higher than those reported previously for some crab species. The main reason for this is thought to be related to variation in seasonal feeding habits (different types of diet and feeding system) and habitats.

WHO recommended lysine and leucine requirements for adults of 30 and 39 mg/kg body weight per day (Table 2).

Table 2 Amino acid requirements of adults

Amino acid	mg/kg per day
Histidine	10
Isoleucine	20
Leucine	39
Lysine	30
Methionine	10
Cystine	4
Methionine+ cystine	15
Phenylalanine + tyrosine	25
Threonine	15
Tryptophan	4
Valine	26

For example, a 70 kg adult will require 2100 and 2730 mg of lysine and leucine per days respectively. In this study, it was found that 100g meat of the blue swimming crab consisted of 1514 mg lysine and 1317 mg leucine, assuming an adult human consumes 100g of blue crab, this can provide a part of the daily amino acid requirement determined by WHO. The same type of calculation can also be hold for the other amino acids.

The results obtained from the study showed that male and female crab meat are an important protein source. The study stressed once again the importance and role of crab consumption in terms of including high amino acid values in both genders in human nutrition. Hence, consuming the meat of blue swimming crab would meet the daily amino acid requirements for the human.

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