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RESEARCH ARTICLE

Nutritional Properties of Crab (*Potamon potamios* Olivier, 1804) in the Lake of Eğirdir (Turkey)

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ABSTRACT

Some of the nutritional properties of freshwater crab (*Potamon potamios*), captured from the Lake of Egirdir, Turkey, were investigated in relation to season and sex. In the laboratory, crab meat and crab shells were seperated. All crab meat and dried crab shell analyses were conducted separately. According to proximate composition analysis, there were no significant differences in the moisture, protein, fat and ash contents in terms of seasons. But there were significant ($P<0.05$) changes between male and female crab meats in terms of protein values. It was found that freshwater crab meat was a good protein source. Mineral matter analysis was carried out with ICP-OES instrument after drying of crab samples in lyoflizator. Of the crab meat, the highest contents of calcium, sodium and potassium were 17.87±1.356 (winter ♀), 11.88±0.62 (summer ♀) and 11.70±0.50 mg/g (summer ♂), while these values for crab shell were 197.50±7.836 (summer ♂), 3.96±0.583 (winter ♂) and 6.26±0.222 mg/g (summer ♂), respectively. Chitin and Chitosan analysis were performed from shells with demineralization, deproteinisation, decoloration and deacetylation. Female freshwater crab samples had the highest chitin (7.80±0.835%) and chitosan (5.86±0,536%) contents in the summer and spring, respectively.

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INTRODUCTION

Crabs are the basic components of the ecosystem and they are consumed as food in many countries. Generally, it is the marine type that is consumed. It is economically important in countries such as China, France, Indonesia, Japan, Philippines, Spain, Thailand and United States. Crab species in the world not only is a direct source of food, but also it is used as food additive and fertilizer, especially crab processing residues are used as feed additive (Gülle, 2005).

According to the Institute of the State Statistics records 2008 (in Turkey), the amount of production was about 57.453 tons of other seafood products except for fish and only 25 tons of this amount belonged to marine crab species (TUIK, 2008). Marine invertebrates are used as food all over the world. Meat quality and economic value of edible crabs in terms of organisms found in western countries is of quite high price (Özcan and Akyurt, 2006).

Potamon potamios (Olivier, 1804), a species of family Potamidae, is distributed in the Sinai, the Jordan River system, the Litani River, mainland Greece, the southeastern Aegean islands, and southern Anatolia (Brandis *et al*., 2000). Population size of *P. potamios* varies from 12,848.74 (June) to 23,857.64 kg (July) according to the data of CPUE in the Lake of Egirdir (Isparta-Turkey) (Bolat *et al*., 2010). However, this population has not been economically evaluated in Turkey. The amount of freshwater crab stock in Turkey has not been estimated, but fresh water crab is known to be present almost all over the geographical regions of Turkey.

Freshwater crab is an important protein source and large amounts of potamid and parathelphusid is consumed in Thailand. It has been stated that potamid is important in the diet of rural areas and it is also consumed by the natives of South America to improve the health, treat dyspepsia and to heal physical injuries (Yeo *et al*., 2008).

There are a number of studies about biological, ecological features and population of freshwater crabs so far (Brandis *et al.*, 2000), but very few studies have been conducted on the nutritional properties. The aim of this study was to demonstrate the nutritive value and thereby to encourage utilization of *Potamon potamios* species in Turkey.

MATERIALS AND METHODS

Freshwater crabs (*Potamon potamios,* Olivier 1804) were captured from April 2009 to April 2010 at 5 stations chosen randomly and 150 traps (Fyke-net) were set at each station. Following the capture, they were transferred to the laboratory alive. The weight, carapace width and length of crabs were measured and mean values were determined. Meat from the body and claw portions of crabs was separated manually, combined, homogenized, and then stored at -18ºC until analyzed for proximate composition, mineral analysis and chitin-chitosan contents. Crab meats were analyzed as fresh; shells were left at ambient temperature to dry. All assays were conducted on duplicate samples of the homogenates.

Moisture content was measured with automatic moisture analyzer (AND MX-50). Protein contents were determined (Velp UDK 142) according to Kjeldahl method (N x 6.25), as previously described (AOAC, 2000). Crude fat and crude ash contents were determined according to standard procedures (Lovell, 1981). Analysis of calcium, copper, ferrous, magnesium, phosphorus, zinc, sodium and potassium were conducted on crab shell and crab meat according to sex and season. Following the seperation, 0.5 g meat freezed at –80°C and then placed at lyoflizator (up to –55°C) for drying. For mineral determination, the samples were digested in HNO_3/H_2O_2 and measured using ICP-OES instrument (Perkin-Elmer 5300 DV model) following the method described by Dolan and Cabar (2002).

Dried shells were used for chitin and chitosan analysis. Dried shells were grounded using a TETRA mill (Model HD-702 Istanbul-Turkey) with a 2 mm mesh screen and sieved with 40 mesh (0.425 mm) sieve (No *et al.,* 2003). The isolation of chitin–chitosan from the crab shells was carried out with 3 repetitive analyses. Chitin–chitosan analyses were performed in accordance with the modified method of Bolat *et al*. (2010). Chitosan was derived from shells with demineralization, deproteinisation, decoloration and deacetylation.

Statistical analyses were performed using SPSS 16.0 (Trial version) (Groups were analyzed by one way analysis of variance (ANOVA) and post hoc multiple contrast & $P<0.05$ was considered statistically significant.

RESULTS

The lowest length, weight and carapace width values in female and male crabs were determined during winter season. Male crabs were bigger than females in terms of biometric values (Table 1). Moisture contents were the highest in male crabs during spring season. Crude protein values decreased in spring season in both the sex (Table 2). The lowest fat value was obtained from autumn male crabs. Ash values increased in winter season in male crabs.

Calcium, phosphorus and magnesium contents of freshwater crab shell were higher than those found in crab meat (Tables 3 and 4). Ferrous, zinc, sodium and potassium values for freshwater crab meat were higher than those found in crab shell. Copper was not detected in crab shell. Chitin and chitosan contents of freshwater crab were found as 7.42±0.593% (in autumn male) and 7.80±0.835% (in summer female), 5.25±0.425% (in winter female) and 5.86±0.536% (in spring female), respectively (Table 5).

DISCUSSION

In this study, all examples were captured on the pre-selected seasons to determine the most appropriate season for utilization. Reproductive behavior and population size was found less in June, because they were less active before reproductive period. Highest length, weight and carapace width values in female and male crabs were found during autumn season (Table 1). This situation may be due to nutritional status. Crabs find plenty of food in mid summer and autumn; therefore, they grow well during the season.

The chemical composition analysis of crab meat revealed variable moisture contents ranging from 76.76±0.49 to 81.03±0.16% according to the season and there was non significant ($P>0.05$) difference between sexes except during spring (Table 2). The results of moisture analysis of European green crab ranged from 79.1±0.4 to 82.30±0.5% (Naczk *et al.,* 2004). Skonberg and Perkins (2002) found 79.0±0.7% moisture in *Carcinus maenus* crab. These values are close to the findings of present study.

The highest fat value (1.08±0.026%) of female freshwater crab was found in autumn, while the highest fat value (1.05±0.633%) of male crab was found in summer in the present study. In these seasons, crabs are in search of the food after reproduction time and find plenty of prey. Therefore, the fat contents may be increased. Türeli *et al*. (2000) measured Blue crab's (*Callinactes sapidus*) and sand crab's (*Portunus pelagicus*) breast meat fat contents and found them to be 1.51±0.01 and 1.53±0.01%, respectively.

In the present study, the lowest protein values (13.94±0.228%) were measured in female crabs during spring while in male crabs (18.35±0.202%) during summer (Table 2). The difference between seasons and sexes in terms of protein value was statistically significant ($P<0.05$) in all seasons. It has been reported that freshwater crab is a good source of protein on different regions of the world (Yeo *et al.,* 2008). Türeli *et al*. (2000) reported that breast meat protein content of *Portunus pelagicus* (sand crab) were 18.83±0.23 and 17.55±0.23% in male and female, respectively. In another study, Naczk *et al*. (2004) found that in Northern Canada the European green crab samples taken from 4 different stations had protein contents of 13-14%. According to the seasons, freshwater crab spring samples (both of sexes) gave close values (Table 2). It was confirmed that soft-shelled crab meat contained 14.31±0.05% of crude protein, 1.67±0.09% of ash, 84.38±0.39% of moisture and 0.18±0.02% of fat (% wet weight) (Benjakul and Sutthipan, 2009).

Table 1: Biometric values of freshwater crab (*Potamon potamios*)

	Weight (g)		Length (cm)		Carapax width (cm)	
Seasons	♀	♂	♀	♂	♀	♂
Spring	30.30±1.59b	35.15±1.80b	3.10± 0.05a	3.34±0.08b	3.91±0.08ba	4.43±0.08b
Summer	27.50±1.23cb	37.90±2.81b	2.78±0.09b	3.41±0.09b	3.66±0.10bc	4.32±0.10b
Autumn	36.50±2.59a	54.20±3.25a	3.25±0.10a	3.84±0.10a	4.19±0.10a	4.89±0.11a
Winter	22.90±2.18c	37.95±3.83b	2.73±0.12b	3.33±0.14b	3.34±0.19c	4.23±0.17b

The average values in the same column with different superscripts differ significantly (P<0.05).

Table 2: Proximate compositions of freshwater crab (*Potamon potamios*) meat (%)

Sex/Season	Moisture	Crude protein	Fat	Ash
Female				
Spring	78.85±0.519aA	13.94±0.228dA	0.67±0.020cA	1.05±0.483bA
Summer	78.56±0.449aA	15.84±0.240bA	0.98±0.003bA	1.04±0.090bA
Autumn	76.76±0.490bA	15.10±0.112cA	1.08±0.026aA	1.08±0.060bA
Winter	79.32±0.175aA	17.25±0.172aA	1.06±0.020aA	1.71±0.031aA
Male				
Spring	81.03±0.160aB	13.96±0.880dB	0.67±0.463bA	0.99±0.472aA
Summer	78.06±0.204cA	18.35±0.202aB	1.05±0.633aA	1.06±0.786aA
Autumn	78.43±0.433bcA	17.26±0.174bB	0.48±0.115cB	1.03±0.036aA
Winter	79.40±0.496bA	16.34±0.233cB	0.56±0.404bcB	1.05±0.578aA

Capital letters indicate statistical difference between the sex in a season while lowercase letters indicate statistical difference (P<0.05) between the seasons in a sex.

The highest ash contents (1.71±0.032%) were found in female (winter) and the lowest (0.99±0.472%) in male (spring) crabs (Table 2). Ash contents differed significantly (P<0.05) between the seasons for female in winter. The cause of high ash contents could be the high calcium in female during winter in crab meat. According to Gökoğlu and Yerlikaya (2003), proximate ash contents of blue crab (*Callinectes sapidus*) and swim crab (*Portunus pelagicus*) caught from the Gulf of Antalya for claw meat and body meat were 1.39±0.019 and 1.89±0.08%, respectively. Although the studies were conducted in different habitats and on different species, the ash content in all crabs was found similar to each other.

The highest calcium contents were found in winter female crab meat samples (17.87±1.356 mg/g) while these values were the highest in spring male crab samples in the present study. There was significant difference (P<0.05) between male and female calcium shells in the spring and their meat in the autumn and summer (Tables 3 and 4). In the shell, the highest calcium, magnesium and phosphorus contents were detected in summer and spring for male (Table 3). The higher Ca content in males is likely due to the sexual dimorphism of crabs, males have bigger claws and harder exoskeletons (composed by calcium phosphate) (Barrento *et al.*, 2009).

In the present study, ferrous content of female crab meat was higher than male crab on almost all seasons with significant variation (P<0.05) in all seasons except spring. Ferrous (Iron) plays a vital role in the enzymatic and respiratory processes of crustaceans (Mohapatra *et al*., 2008).

It has been found that Blue crab (*C. sapidus*) and swim crab (*P. pelagicus*) are rich in minerals especially sodium, potassium, calcium and phosphorus (Gökoğlu and Yerlikaya, 2003). The results showed that crabs are ideal diet foods and consumption of crabs may help to prevent nutrition deficiencies in the future. Barrento *et al*. (2009) studied the influence of season and sex on the contents of minerals and trace elements in Brown crab (*Cancer pagurus*, Linnaeus, 1758). In their study, they found high calcium contents of the female samples in spring and summer. These results are comparable with our findings. According to our findings, freshwater crab shells were rich in calcium. Indeed, Murphy *et al*. (2003) stressed in their study that crab processing residue is a good source of calcium.

The concentration of minerals in the meat of crab species can be influenced by a number of factors such as seasonal and biological differences (species, size, age, sex and sexual maturity), food source and environment (water chemistry, salinity, temperature and contaminants) (Küçükgülmez *et al.,* 2006). The seasonal and sex differences observed are most probably related with the reproductive state and metabolism. The macro and micro element contents of Crustaceans are different and essential elements such as calcium, copper, manganese, zinc and selenium are rich (Kwoczek *et al.*, 2006). Copper content was too little in freshwater crab meat and it was not detected in the shell.

Freshwater crabs are the important source of chitin as the other crustaceans. The crabs can be evaluated as an important source of chitin, as the production of chitin and chitosan is currently based on crab and shrimp shells discarded by the canning industries in some countries (Bolat *et al.,* 2010). It has been observed that chitin contents of male crabs show non-significant changes in all seasons. There was no sexual difference in terms of chitosan contents. Bolat *et al.* (2010) found that chitin content of *Potamon potamios* was 6.830±0.072%. This value is close to our findings. Hertrampf and Piedal-Pascual (2000) reported that *Chionoecetes opilio* contained 10.6% chitin. Chitin value of blue crab is 14% (Tharanathan and Kittur, 2003). In another study, chitin contents of *Pandalus borealis* and *Chinoecetes opilio* were between 17.0 and 32.2% (Shahidi and Synowiecki, 1991). These results are different from our findings. This may be due to the habitat, species and seasonal differences. Nicholas (2003) reported that many factors affect the rate of chitin and chitosan levels in shell and

Table 3: Mineral contents of freshwater crab (*Potamon potamios*) shell (mg/g)

Sex/Season	Ca	Mg	K	Na	P	Fe	Zn
Female							
Spring	188.00±1.23aA	6.02±0.063aA	0.95±0.024cA	3.75±0.025aA	1.09±0.003aA	0.02±0.000bA	0.005±0.001abA
Summer	187.60±0.305aA	5.73±0.497aA	1.11±0.025bA	3.77±0.037aA	1.04±0.007bA	0.02±0.002bA	0.007±0.001aA
Autumn	184.00±1.932aA	5.82±0.108aA	1.45±0.218aA	3.88±0.054aA	1.09±0.007aA	0.02±0.002bA	0.003±0.001bA
Winter	186.90±3.572aA	5.81±0.171aA	1.10±0.310bA	3.85±0.060aA	1.00±0.013cA	0.07±0.012aA	0.003±0.001bA
Male							
Spring	192.70±0.43abB	6.11±0.401abA	0.97±0.008cA	3.87±0.015aB	1.11±0.009cA	0.02±0.001cA	0.004±0.001bA
Summer	197.50±7.836aB	6.26±0.222aA	1.04±0.306bcA	3.72±0.128aA	1.22±0.054aB	0.03±0.004cA	0.004±0.001bB
Autumn	179.20±1.609bA	5.85±0.139abA	1.13±0.056bA	3.39±0.279bB	1.12±0.012cA	0.14±0.016aB	0.008±0.001aB
Winter	185.10±1.106abA	5.75±0.108bA	1.27±0.032aB	3.96±0.583aA	1.14±0.016bcB	0.07±0.006bA	0.003±0.001bA

Capital letters indicate significant difference between the sex in a season while lowercase letters indicate significant difference ($P<0.05$) between the seasons in a sex.

Table 4: Mineral contents of freshwater crab (*Potamon potamios*) meat (mg/g)

Sex/Season	Ca	Mg	K	Na	P	Fe	Cu	Zn
Female								
Spring	13.07±0.947bA	1.74±0.33bA	8.93±0.852cA	11.58±0.101bA	0.76±0.001aA	0.031±0.00dA	0.06±0.000aA	0.20±0.001bA
Summer	14.27±0.637bA	1.86±0.008aA	9.66±0.506bA	11.88±0.62aA	0.83±0.029bA	0.05±0.017bA	0.05±0.012cA	0.19±0.000cA
Autumn	9.92±0.299cA	1.71±0.22bA	10.44±0.151aA	9.76±0.135cA	0.82±0.050bA	0.04±0.011cA	0.06±0.003bA	0.23±0.006aA
Winter	17.87±1.356aA	1.82±0.56abA	9.17±0.154cA	11.54±0.170bA	0.95±0.202aA	0.06±0.002aA	0.05±0.000bA	0.18±0.000cA
Male								
Spring	13.53±1.110aA	2.08±0.200aB	11.15±0.945bB	11.59±0.908aA	0.75±0.006cA	0.02±0.003cA	0.06±0.001bA	0.21±0.003aB
Summer	8.97±0.268bB	1.66±0.058cB	11.70±0.500aB	9.53±0.440bB	0.86±0.001bB	0.03±0.003bB	0.07±0.002aB	0.20±0.005bA
Autumn	11.77±0.513abB	1.86±0.098bB	11.48±0.116aB	9.50±0.925bA	0.74±0.006cB	0.03±0.000bcB	0.05±0.002cA	0.21±0.003aA
Winter	11.91±1.786abA	1.67±0.726cA	10.76±0.638cB	11.45±0.576aA	0.90±0.232aA	0.05±0.023aB	0.06±0.001bA	0.20±0.004abB

Capital letters indicate statistical difference between the sex in a season while lowercase letters indicate statistical difference ($P<0.05$) between the seasons in a sex.

Table 5: Chitin-chitosan contents of freshwater crab (*Potamon potamios*) shell (%)

Sex/Season	Chitin	Chitosan
Female		
Spring	7.69±0.554abA	5.86±0.536aA
Summer	7.80±0.835aA	5.70±0.435bA
Autumn	7.43±0.480bB	5.48±0.393cA
Winter	7.65±0.124abA	5.25±0.425dA
Male		
Spring	7.62±0.593aA	5.75±0.424aA
Summer	7.71±0.187aA	5.67±0.055aA
Autumn	7.42±0.593aA	5.48±0.388bA
Winter	7.55±0.113aA	5.36±0.659bA

Capital letters indicate statistical difference between the sex in a season while lowercase letters indicate statistical difference ($P<0.05$) between the seasons in a sex.

chitin contents of crustacean species, such as nutritional status, geographic conditions and season. In boiled and dried freshwater crab shells, Bolat *et al*. (2010) calculated chitosan content and it was 4.651±0.036%. This value is similar to the lowest value in our results, but lower than the others. This is due partly to the different working states. Bolat *et al.* (2010) stressed in a study that the chitosan content of freshwater crab was 4.65% and the chitosan may be extracted from crabs of the Lake of Egirdir between 358.56 and 665.77 Kg depending on the population size and the estimated economic value of chitosan was 484.000-898.000 Euro (1350 Euro/kg chitosan).

Conclusions

The present results have shown that crab meat is a good source of proteins and minerals especially calcium, potassium and sodium, crab shell is rich in calcium. Therefore, these results suggest that crab meat is beneficial for human health and nutrition, and crab meat could be accepted as an alternative dietary supplement of protein and minerals.

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