# THE CHEMICAL COMPOSITION OF THE CRAYFISH (*Astacus leptodactylus*) IN POND YENICE

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## Abstract

The changes in the compositions of crude protein, fat and fatty acid in the muscle tissues of male and female samples of *Astacus leptodactylus* acquired by hunting in the dates between November 2007 and June 2008 which is the breeding season for the crayfish from Pond Yenice which is used for irrigation in Çanakkale province, Turkey, are examined in the study. Whereas the amount of crude protein in male samples is around 11.78-15.68%, it is identified that the amount is around 13.09-17.59% with the female samples. Fat changes from 3.29-4.95% for the male samples, 3.67-5.82% with the female samples. It is observed that there is a continuous increase in the compositions of crude protein and fat generally through the beginning and the end of the sampling period. The amounts of EPA, DHA and AA show change according to the breeding season and season.

**Keywords:** *Astacus leptodactylus*, Fatty acids, Crude protein, Lipid, Seasonal change.

## Introduction

The crayfish (*A. leptodactylus*), a member of the Astacidae family, is widely seen in our inland waters. Generally, they live in various habitats such as streams, rivers, ponds and lakes (Lowery &Köksal, 1988). Having more than 500 species over the world, the crayfish is represented only by two subspecies (*A. leptodactylus leptodactylus* and *A. leptodactylus salinus)* of *A. leptodactylus* species (Geldiay & Kocataş, 1970). They exist naturally in many lakes, reservoirs and rivers. Crayfish is one of the species of the crustacean species which has a high economic value.

The *A. leptodactylus* species is reported in the inland waters of Turkey in Kayseri, Bursa and İstanbul for the first time (Bott, 1950). While the crayfish were represented only by *A. leptodactylus* until recent time in our country, the existence of *Austropotamobius torrentium* (Shrank, 1803), a new species in the northern Thrace, is proven (Harlıoğlu &Güner, 2006). There are about 500 lakes in various sizes in the Marmara region and these lakes and ponds are unrestrainedly filled with crayfish in different times. One of the water resources that are filled with crayfish is Pond Yenice (Berber, Yıldız, Ateş, Bulut, Mendeş, (2010)) (Çanakkale, Yenice Central Irrigation Pond).

Its most significant natural habitat is lakes and ponds and they began to be seen widely in the lakes and ponds of the Marmara region after the 2000's (Harlıoğlu, 2004; Berber et al. 2010). Reaching 5000 tons in the 1980's nationwide in Turkey, the crayfish production decreased substantially due to a mycosis, the crayfish plague (*Aphanomyces astaci*) after the date (Bolat, 2001).

Like in other aquaculture products productions, the breeding season and breeding physiology are quite significant in crayfish production as well. Healthy and genetically durable offspring are needed to increase the amount of production in the lakes and ponds. The quality of the brood stock should stand out in order to acquire individuals with high life forces. The availability of quality offspring is based on body biochemical compositions of the brood stock. The composition of fatty acid in the muscle and egg tissues of the brood stock individuals is an important parameter for quality as well. Fatty acid levels of EPA, DHA and AA in the muscle and egg content are especially important for the offspring quality (Bulut, 2003). The fatty acids; DYA, MUFA and PUFA are individually important for the offspring and brood stock quality and should be evaluated one by one (Bulut, 2003).

The effect of the fatty acid content on the offspring quality is studied in the research. The seasonal fatty acid change in the muscle tissue of the brood stock is identified.

## Material and Methods

### Research Field and Material

This research is performed in the Center Irrigation Pond in Yenice District, Çanakkale Province between the dates July 2007-June 2008. 1842 *A. leptodactylus salinus* crayfish caught from the pond are used as material in the test. Literature is used in determining the type of crayfish (Bott, 1950; Holthius, 1961; Geldiay & Kocataş, 1970; Köksal, 1988)

### The Hunting Gears Used

A single-entry fyke net with two venters is used to catch the crayfish samples from the pond. The fyke net used have 5 frames and a stretch net is put between two fyke nets. The cell width of the fyke net is 34 mm.

### Identification of Physical and Chemical Features of the Water Samples

The warmth, oxygen, pH, salinity and conductivity features of the pond water is evaluated using YSI Probe (556 MPS) and its calcium and magnesium contents are analyzed in inductively-matched plasma-atomic emission spectrometry, in Çanakkale Onsekiz Mart University, Science and Technology Application and Research Center.

### Chemical Analysis

In this study, 255 male (mean weight=29.96 g) and 291 female (mean weight=31.04 g) are used for the chemical analysis. All analyses were performed in triplicate. Analyses of crude protein, moisture and ash in crayfish were performed according to standard procedures (AOAC, 2000). Dry matter content of samples was determined by drying at 105 $^{o}C$ until a constant weight was obtained. Ash content was measured by incineration in a muffle furnace at 525 $^{o}C$ for 12 h. Crude protein (N*6.25) was analyzed by the Kjedahl method after acid digestion using the Gerhardt system. Total lipids in the crayfish were extracted according to the procedure of Floch, Lee & Sloane-Stanley (1957) with chloroform/methanol (2:1 v/v). The fatty acids in the total lipid were esterified into methyl esters by saponification with 0.5 N methanolic NaOH and Trans esterified with 14% boron trifluoride-methanol (AOAC, 2000). Fatty Acid Methyl Esters (FAME) were analyzed using a flame ionization gas chromatograph (Shimadzu GC-2014) equipped with an Omega wax 250 capillary column (30 mg/l X 0.25 mm internal diameter), a Flame Ionization Detector (FID) and a split injection system with nitrogen carrier gas. Injector port and detector temperatures were maintained at 250 $^{o}C$ and 260 $^{o}C$, respectively. The column temperature program was held at 140 $^{o}C$ for 5 min and then elevated at a rate of 3 $^{o}C$/ min to 200 $^{o}C$. Total run time was 60 min per sample. Fatty acids were identified by comparing their retention times of the standard fatty acid standards (Sigma-Aldrich Co, USA).

## Statistical analysis

All data were subjected to one way analysis of variance (ANOVA) and Duncan multiple range test using Stat graphics 7.0 version for Windows (Manugistics Incorporated, Rockville, MD, USA). The results were treated statistically significant at the P<0.05 level.

## Results

The physico-chemical water parameter findings acquired from Pond Yenice are displayed in Table 1. The highest temperature detected in the pond during the field work is 26.8°C in August; the lowest is 5.7°C in December 2007. The dissolved oxygen values are determined to be under 8mg/1 in the dates July, September and October 2007; determined to be above 10mg/1 in the dates December 2007, February, March and June 2008. Apart from these, the pH is 5.5 and the following values displayed a change between these ranges: conductivity 229.1-387.1 µS, Ca 21.06-38.27 mg/l, Mg 6.91-10.47 mg/l. The saltiness (S) levels are determined to be 0.2 ppt except for the dates July-August 2007 (0.1 ppt).

**Table 1.**The physico-chemical water parameter findings acquired from Pond Yenice

| Tarih | T (°C) | ÇO (mg/l) | pH | EC (µS) | Ca (mg/l) | Mg (mg/l) | S (ppt) |
|---|---|---|---|---|---|---|---|
| **July,2007** | 28.9 | 7.65 | 9.03 | 279 | 36.16 | 9.85 | 0.1 |
| **August,2007** | 26.8 | 8.25 | 8.95 | 301.2 | 37.46 | 10.47 | 0.1 |
| **September,2007** | 22.1 | 7.9 | 8.8 | 330.2 | 31.33 | 9.21 | 0.2 |
| **October,2007** | 18.2 | 7.6 | 8.75 | 387.1 | 24 | 8.41 | 0.2 |
| **November,2007** | 8.3 | 8.72 | 7.14 | 229.1 | 23.08 | 8.11 | 0.2 |
| **December2007** | 5.7 | 11.8 | 8.68 | 269.5 | 36.43 | 9.77 | 0.2 |
| **January,2008** | 8.2 | 8.5 | 8.34 | 320.1 | 21.06 | 8.91 | 0.2 |
| **February,2008** | 9.1 | 10.2 | 7.86 | 344.6 | 24.43 | 8.02 | 0.2 |
| **March,2008** | 9.6 | 12.85 | 9.03 | 382.3 | 38.27 | 7.88 | 0.2 |
| **April,2008** | 13.9 | 9.53 | 6.11 | 311.6 | 23.85 | 6.91 | 0.2 |
| **May,2008** | 15.9 | 9.02 | 5.5 | 265.8 | 34.31 | 7.44 | 0.2 |
| **June,2008** | 22.4 | 10.69 | 6.85 | 234.5 | 36.5 | 8.11 | 0.2 |

The changes in the crude protein and fat compositions in the muscle tissues of the male and female individuals of *A. leptodactylus* species acquired from Pond Yenice are displayed in Table 2. While the lowest amount of crude protein (respectively 11.78 – 13.09 units) of both male and female individuals is observed in the samples taken in November, the highest amount (respectively 15.68 – 17.59 units) in both individuals is determined in the samples taken in June. While the monthly difference in the samples taken from male individuals in May and June are seen significant, it is determined that this difference is significant for the females in the months April, May and June (P<0.05). While the monthly change in the fat compositions of male individuals are seen significant only in June, the fat changes are significant for the female individuals in November, April and June (P<0.05). In the study, the interaction between male and female individuals is evaluated.

**Table 2.** Biochemical composition of muscle tissues of Freshwater crayfish (*A. leptodactylus*)

| | Male | | | | Female | | |
|---|---|---|---|---|---|---|---|
| | **Crude Protein** | **Fat** | **Ash** | | **Crude Protein** | **Fat** | **Ash** |
| **November** | $11.78^{a}$ | $3.29^{a}$ | $0.91^{a}$ | | $13.09^{a}$ | $3.67^{a}$ | 1.03 |
| **January** | $12.06^{a}$ | $4.63^{ab}$ | $1.45^{ab}$ | | $14.23^{a}$ | $4.28^{ab}$ | 1.58 |
| **March** | $13.45^{ab}$ | $4.08^{ab}$ | $1.13^{ab}$ | | $15.35^{ab}$ | $4.00^{ab}$ | 1.74 |
| **April** | $13.86^{ab}$ | $3.78^{ab}$ | $1.33^{ab}$ | | $16.47^{b}$ | $4.72^{b}$ | 1.57 |
| **May** | $14.06^{b}$ | $4.66^{ab}$ | $1.59^{ab}$ | | $17.12^{b}$ | $4.50^{ab}$ | 1.36 |
| **June** | $15.68^{c}$ | $4.95^{b}$ | $1.32^{b}$ | | $17.59^{b}$ | $5.82^{c}$ | 1.25 |

Lower-case letters indicate differences in the same column

The fatty acid changes in the muscle tissues of the male individuals of the crayfish that were acquired in the breeding season are shown in Table 3, the fatty acid changes in the muscle tissues of the female individuals are shown in Table 4. While the C14:0 fatty acid is found significantly high in November (1.16%) and in April (1.32%) in male individuals, this difference is found significant for the female individuals only in November (1.13%) ($P<0.05$). The amount of C15:1 fatty acid is determined to have a remarkable increase in June (2.28%) for the male individuals and in April (2.87%) for the female individuals. While the difference in the C16:0 fatty acid composition in April (16.22%) is observed to be significant only for the male individuals, this difference is not significant for the females ($P<0.05$). While the changes in the C16:1 fatty acid is found significantly high in January (4.28%) for the male individuals and in April (7.34%) for the female individuals ($P<0.05$).

**Table 3.** Variation in fatty acid compositions of muscle tissues of male Freshwater crayfish *(A. leptodactylus)* (%)

| | Male | | | | | |
|---|---|---|---|---|---|---|
| **Fatty Acids** | **November** | **January** | **March** | **April** | **May** | **June** |
| C14:0 (Myristic) | $1.16^{b}$ | $0.78^{ab}$ | $0.52^{a}$ | $1.32^{b}$ | $0.54^{a}$ | $0.63^{a}$ |
| C14:1 (Myritoleic) | 0.16 | 0.21 | 0.18 | 0.19 | 0.19 | 0.19 |
| C15:0 (Pentadecanoic) | 0.53 | 0.77 | 0.81 | 0.83 | 0.36 | 0.63 |
| C15:1 (cis-10-Pentadecenoic) | $1.23^{a}$ | $1.73^{a}$ | $1.72^{ab}$ | $1.50^{ab}$ | $1.64^{ab}$ | $2.28^{b}$ |
| C16:0 (Palmitic) | $15.97^{ab}$ | $14.57^{ab}$ | $14.22^{ab}$ | $16.22^{b}$ | $13.65^{a}$ | $15.61^{ab}$ |
| C16:1 (Palmitoleic) | $2.62^{a}$ | $4.28^{b}$ | $3.57^{ab}$ | $3.95^{ab}$ | $3.81^{ab}$ | $3.47^{ab}$ |
| C17:0 (Heptadecanoic) | 0.87 | 0.79 | 0.75 | 0.87 | 0.83 | 0.83 |
| C17:1 (cis-10-Heptadecenoic) | 1.08 | 0.91 | 1.29 | 1.01 | 0.85 | 1.03 |
| C18:0 (Stearic) | 7.93 | 6.14 | 5.81 | 7.02 | 8.23 | 6.83 |
| C18:1n9c (Oleic) | $18.30^{ab}$ | $18.22^{ab}$ | $17.45^{ab}$ | $19.43^{ab}$ | $26.30^{b}$ | $15.85^{a}$ |
| C18:1n7 | 4.29 | 5.04 | 4.27 | 4.45 | 5.16 | 4.00 |
| C18:2n6 | 7.03 | 5.63 | 6.35 | 5.08 | 6.25 | 6.44 |
| C18:3n6 (g-Linoleic) | 0.30 | 0.31 | 0.26 | 0.30 | 0.41 | 0.26 |
| C18:3n3 (a-Linoleic) | 0.96 | 0.82 | 0.84 | 0.70 | 0.60 | 0.70 |
| C18:4n-3 | 0.19 | 0.26 | 0.36 | 0.19 | 0.23 | 0.25 |
| C20:0 (Arachidic) | 0.41 | 0.51 | 0.23 | 0.58 | 0.55 | 0.26 |
| C20:1n9 (cis-11-Eicosenoic) | 1.34 | 1.13 | 0.47 | 1.81 | 0.42 | 1.06 |
| C20:2 (cis-11,14-Eicosadienoic) | 1.45 | 1.98 | 2.15 | 2.07 | 1.23 | 2.01 |
| C20:3n3 (cis-11,14,17-Eicosatrienoic) | $7.09^{ab}$ | $8.22^{b}$ | $9.20^{b}$ | $9.50^{b}$ | $5.87^{a}$ | $9.13^{b}$ |
| C20:4n6 (Arachidonic) | 0.30 | 0.35 | 0.56 | 0.28 | 0.41 | 0.48 |
| C20:5n3 (cis-5,8,11,14,17-Eicosapentaenoic) | 18.40 | 17.28 | 18.10 | 13.52 | 12.26 | 19.42 |
| C22:0 (Behenic) | 0.27 | 0.50 | 0.44 | 0.32 | 0.68 | 0.35 |
| C22:1n9 (Erucic) | 0.25 | 0.22 | 0.24 | 0.20 | 0.23 | 0.19 |
| C22:2 (cis-13,16-Docosadienoic) | $1.78^{ab}$ | $1.13^{a}$ | $0.77^{a}$ | $1.50^{ab}$ | $4.16^{b}$ | $1.25^{a}$ |
| C23:0 (Tricosanoic) | 0.19 | 0.31 | 0.33 | 0.35 | 0.48 | 0.55 |
| C22:5n3 | $0.75^{ab}$ | $0.88^{ab}$ | $1.18^{b}$ | $0.75^{ab}$ | $0.53^{a}$ | $0.79^{ab}$ |
| C22:6n3 (cis-4,7,10,13,1619-Docosahexaenoic) | $4.70^{a}$ | $7.01^{b}$ | $7.86^{b}$ | $5.85^{ab}$ | $4.43^{a}$ | $5.44^{ab}$ |

Lower-case letters indicate differences in the same column.

**Table 4.** Variation in fatty acid compositions of muscle tissues of female Freshwater crayfish *(A. leptodactylus)* (%)

| Female | | | | | | |
|---|---|---|---|---|---|---|
| **Fatty Acids** | **November** | **January** | **March** | **April** | **May** | **June** |
| C14:0 (Myristic) | $1.13^{b}$ | $0.84^{a}$ | $0.88^{a}$ | $0.84^{a}$ | $0.53^{a}$ | $0.68^{a}$ |
| C14:1 (Myritoleic) | 0.19 | 0.15 | 0.21 | 0.22 | 0.20 | 0.12 |
| C15:0 (Pentadecanoic) | 0.58 | 0.74 | 0.75 | 0.89 | 0.43 | 0.59 |
| C15:1 (cis-10-Pentadecenoic) | $1.59^{ab}$ | $1.55^{ab}$ | $1.72^{ab}$ | $2.87^{b}$ | $1.33^{a}$ | $1.80^{ab}$ |
| C16:0 (Palmitic) | 15.46 | 13.31 | 14.44 | 17.92 | 13.53 | 15.01 |
| C16:1 (Palmitoleic) | $2.40^{a}$ | $3.28^{a}$ | $3.63^{a}$ | $7.34^{b}$ | $3.49^{a}$ | $3.46^{a}$ |
| C17:0 (Heptadecanoic) | 0.81 | 0.73 | 0.89 | 0.68 | 0.90 | 1.01 |
| C17:1 (cis-10-Heptadecenoic) | 1.00 | 1.12 | 1.02 | 1.05 | 0.99 | 0.97 |
| C18:0 (Stearic) | 7.85 | 7.04 | 7.80 | 6.21 | 8.42 | 8.16 |
| C18:1n9c (Oleic) | $18.18^{ab}$ | $20.39^{ab}$ | $19.10^{ab}$ | $17.13^{a}$ | $24.03^{b}$ | $21.60^{b}$ |
| C18:1n7 | 4.25 | 4.42 | 4.39 | 4.40 | 4.94 | 4.25 |
| C18:2n6 | 7.00 | 5.41 | 5.80 | 7.00 | 6.02 | 5.25 |
| C18:3n6 (g-Linoleic) | 0.30 | 0.30 | 0.39 | 0.30 | 0.43 | 0.30 |
| C18:3n3 (a-Linoleic) | 0.91 | 0.77 | 0.72 | 0.71 | 0.90 | 0.86 |
| C18:4n-3 | 0.19 | 0.22 | 0.25 | 0.27 | 0.22 | 0.26 |
| C20:0 (Arachidic) | 0.51 | 0.55 | 0.26 | 0.48 | 0.59 | 0.57 |
| C20:1n9 (cis-11-Eicosenoic) | $1.30^{ab}$ | $0.93^{ab}$ | $0.52^{a}$ | $0.96^{ab}$ | $1.74^{b}$ | $2.08^{b}$ |
| C20:2 (cis-11,14-Eicosadienoic) | 1.45 | 2.22 | 2.16 | 1.65 | 1.76 | 1.88 |
| C20:3n3 (cis-11,14,17-Eicosatrienoic) | $7.15^{ab}$ | $11.11^{b}$ | $10.50^{b}$ | $5.91^{a}$ | $6.57^{a}$ | $7.28^{ab}$ |
| C20:4n6 (Arachidonic) | 0.30 | 0.36 | 0.51 | 0.41 | 0.31 | 0.37 |
| C20:5n3 (cis-5,8,11,14,17-Eicosapentaenoic) | $18.31^{b}$ | $17.20^{ab}$ | $16.34^{ab}$ | $16.82^{ab}$ | $15.21^{a}$ | $15.24^{a}$ |
| C22:0 (Behenic) | 0.39 | 0.29 | 0.38 | 0.51 | 0.49 | 0.52 |
| C22:1n9 (Erucic) | 0.23 | 0.22 | 0.28 | 0.23 | 0.31 | 0.23 |
| C22:2 (cis-13,16-Docosadienoic) | $1.69^{ab}$ | $0.81^{a}$ | $0.81^{a}$ | $0.85^{a}$ | $1.18^{ab}$ | $2.12^{b}$ |
| C23:0 (Tricosanoic) | 0.29 | 0.49 | 0.49 | 0.28 | 0.58 | 0.36 |
| C22:5n3 | 0.71 | 0.69 | 0.65 | 0.77 | 0.67 | 0.60 |
| C22:6n3 (cis-4,7,10,13,16,19-Docosahexaenoic) | 4.59 | 4.36 | 5.09 | 3.15 | 4.26 | 4.51 |

Lower-case letters indicate differences in the same column.

The difference in the C18:1n9c fatty acid is significant in May (24.03%) and June (21.60%) for the female individuals, while it is significant only in May (26.30%) for the male individuals ($P<0.05$). While the difference in the C20:1n9 fatty acid compositions are significant in May (1.74%) and in June (2.08%) only for the female individuals, this difference is not significant for the males ($P<0.05$). The difference in the C20:3n3 fatty acid compositions is significant in January (8.22%), March (9.20%) and June (9.13%), the difference is determined significant in January (11.11%) and in March (10.50%) for the females compared to other months ($P<0.05$). The difference in the C20:5n3 fatty acid amount is significant in November (18.31%) only for the females, this difference is not significant for the males ($P<0.05$). The difference in the C22:2 fatty acid is found significantly high in May (4.16%) for the males and in June (2.12%) for the females ($P<0.05$). The difference in the C22:5n3 and C22:6n3 fatty acid compositions is significant in respectively March (1.18%), January (7.01%), March (7.86%) for the male individuals, this difference is not found significant in the female individuals. It is seen that the monthly difference between the other fatty acids researched is insignificant for both male and female individuals ($P<0.05$).

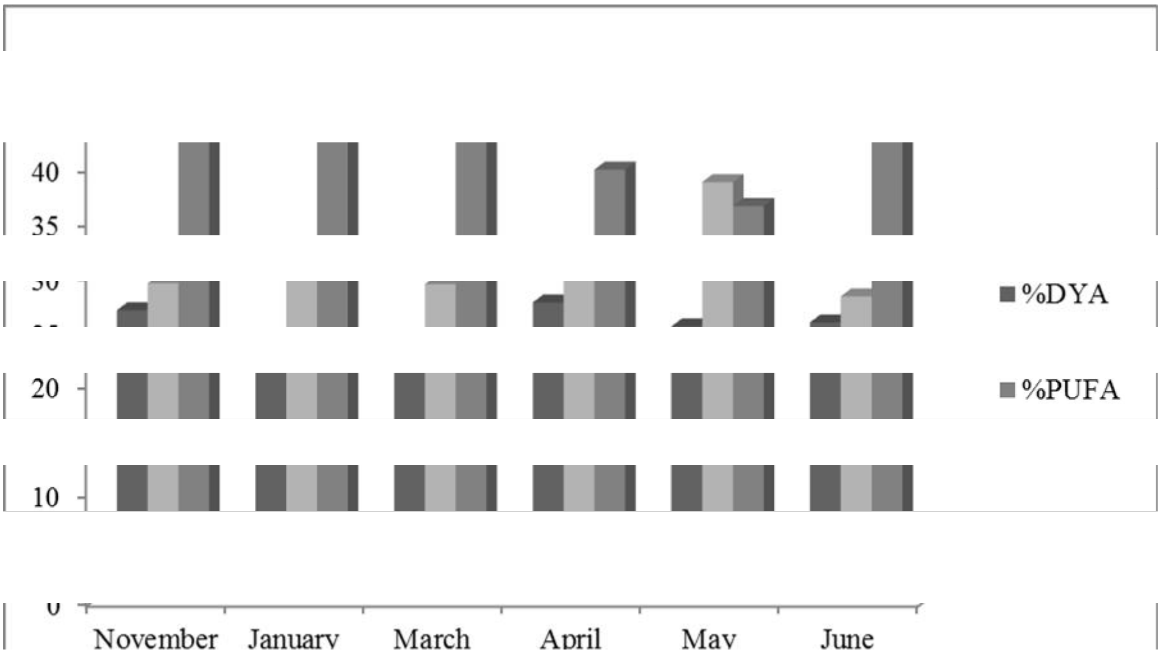


**Figure 1.** The values of DYA%, MUFA% and PUFA% for the male individuals.

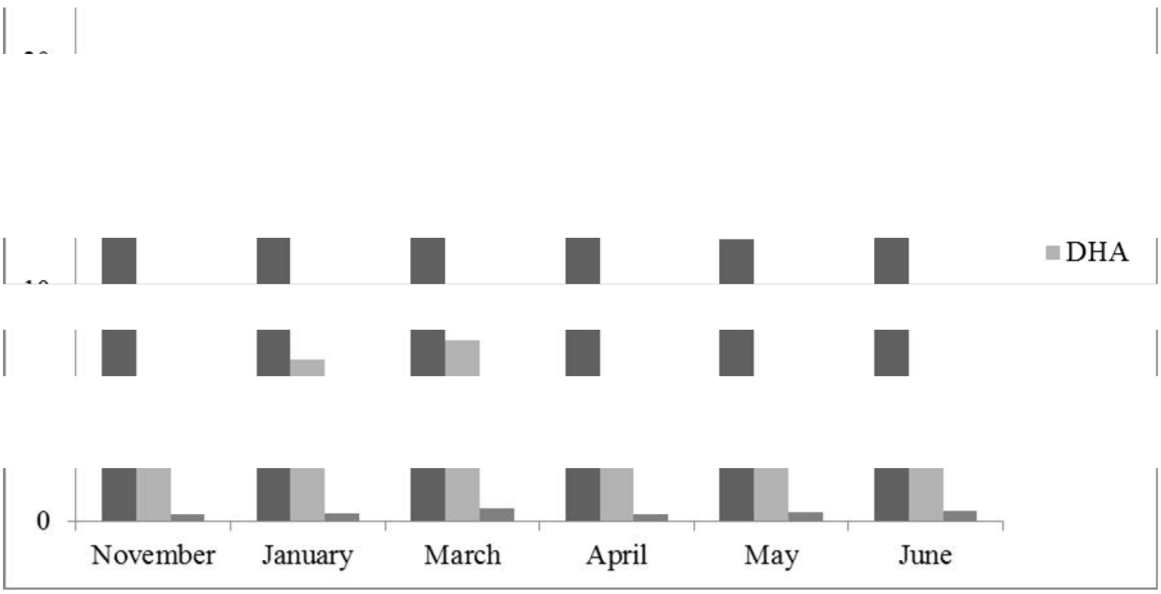


**Figure 2.** The values of EPA, DHA and AA for the male individuals.

For the male individuals, the values of DYA%, MUFA% and PUFA% in Figure 1, the values of EPA, DHA and AA are shown in Figure 2. For the female individuals, the values of DYA%, MUFA% and PUFA% in Figure 3, the values of EPA, DHA and AA are shown in Figure 4.

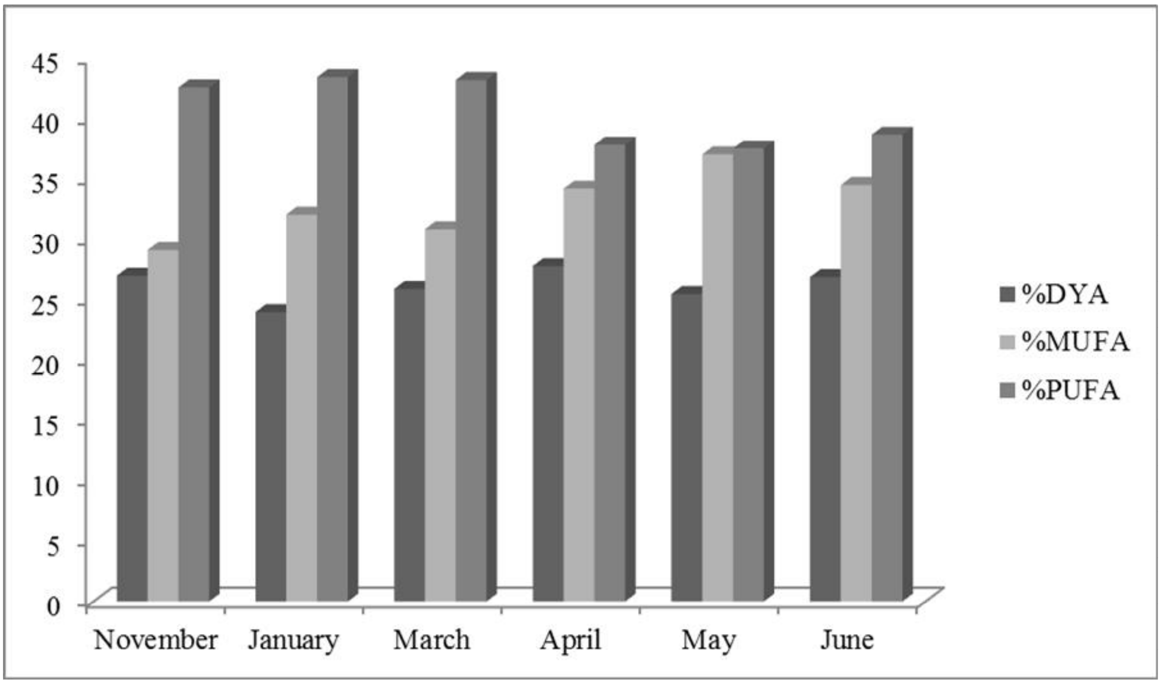


**Figure 3.** The values of DYA%, MUFA% and PUFA% for the female individuals.

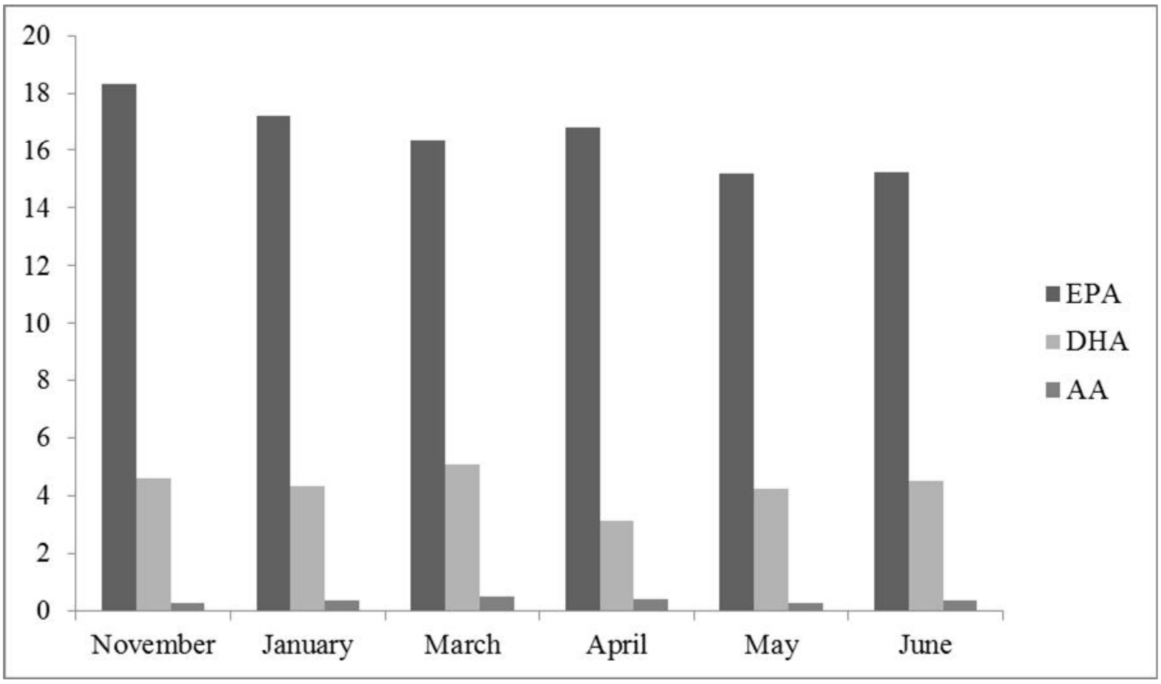


**Figure 4.** The values of EPA, DHA and AA for the female individuals.

## Discussion

The levels of fat and protein determine the adaptation character and strategy of a living being (Vonk, 1960). The levels of fat and protein are effected by many biotic (maturation, breeding and bait suitability) and abiotic (photoperiod, warmth, pH and dissolved oxygen) factors (Vonk, 1960).

The crude protein and fat contents in the muscle tissue have constantly increased in the test during the time of research. The cause for this increase that appeared over time could be the seasonal changes seen in the bait diversity in pond Yenice. While filament green algae (Cladophora) and plant wastes become dominant in fall and winter, maggots and fishes are also seen alongside with algae and plant wastes in spring and summer (Türel & Berber, 2013). Therefore, it might be assumed that plant wastes and Cladophora in fall and winter and maggots and fishes in the following period might have been consumed. The nutrition acquired through these resources is sent to the muscle that works as storage for the fats and protein through blood and to hepatopancreas after being digested (Vonk, 1960).

Every living being require an optimum level of temperature in order to survive. When the temperature drops lower than this optimum level and/or rises above it, the metabolic activities of these living beings slow down and thus their energy consumption decreases (BOFC). Such effects of the temperature might possibly be another reason for the increase in the crude protein and fat levels over time. Because the value of optimum temperature for the *A. leptodactylus* species is 4-22 ºC. The average water temperature in fall and winter in Pond Yenice, on the other hand, are determined to be respectively 16.2ºC and 7.6 ºC in the studies by Berber, S. As the water temperatures of both periods are below the optimum value for the survival of the crayfish, the metabolic activities would slow down and accordingly, there will be a decrease in the energy consumption. As a result of accumulation of surplus of protein and fat in the muscle tissue due to such effects of the temperature, such an increase might have happened over time. The water temperatures in spring and summer in the pond are evaluated as respectively 15.3 ºC and 25.3 ºC. Along with the increase in the temperatures, there will be acceleration in the metabolic activities and an increase in the energy consumption. The reason for the increase of protein and fat components might be that the bait diversity improves as the temperature rises and thus the living beings that carry relatively more protein and fat than the algae and plant wastes, such as maggots and fishes, are consumed (Lowery, 1988). There is an increase in the fat content in the seasonal muscle of the crayfish from November to June. This is all related to the nutrition and temperature in the pond and it shows a routine increase and decrease except for the gonad development period.

The period between November and June is the breeding season for the *A. leptodactylus* species. Therefore, vitellogenesis, gonad development period and gamete generation, seen in this period depending on the time, might have caused the biochemical structure of the being to change. Because proteins and fats are the structural compounds and energy resources of the embryonic tissues (Vonk, 1960). Hence, the proteins and fats in the storage organs (hepatopancreas and adiposis) are constantly transferred to the gonad (Güner & and Mazlum,( 2010); Harlıoğlu, Cakmak, Köprücü, Aksu, Harlıoğlu,Yonar, Çakmak, Özcan, & Gündoğdu,(2013)). The Gonadosomatic and Hepatosomatic indexes gain importance since there is a constant transfer of protein, fat and energy from the hepatopancreas to the gonad. When the relation between these two is in inverse ratio, it means that the individual reaches maturity and protein, fat and energy are transferred to the gonad (Güner and Mazlum, 2010). In a research performed on the *C. quadricarinatus* species, it is determined that there is an increase in the protein composition in the gonad as a result of transfer of energy from hepatopancreas to the gonad and the oocytes through endocytosis in the gonad (Abdu, Davis, Khalaila & Sagi, 2002). It is obviously seen that vitellogenesis that happens during the hepatopancreas breeding season is the primary source of energy, protein and fat which are essential for the gamete generation and gonad development. If one considers that hepatopancreas fulfills the needs in this period and the increase in the protein and fat amounts in the muscle tissues, one might think that breeding has no effect whatsoever on this increase over time. In this study, the amounts of ash, fat and crude protein decrease in the cold periods and increase in accordance with the increase of nutrition variety with the temperature. However, there is a decrease in the breeding season and during the gonad generation. To increase the survival rate of the offspring acquired at this period, brood stocks should be fed with nutritionally rich food. In a comparison between the male and female brood stocks, the fat and protein levels of the females are determined to be the higher. The reason for this is that the living being always feels the need to store the energy since the gonad generation continues throughout the year for the females. All vertebrates need polyunsaturated fatty acid (PUFA). If this need is not fulfilled, there might be some deficiencies in reproduction, development and growth. Almost all of the vertebrates need linolenic and linolenic fatty acids. The effective form of the PUFA is generally C20 and C22. Metabolic forms are in the form of; linolenic acid, linoleic acid, arachidonic acid and docosahexaenoic acid. The various deviations (linolenic, stearidonic, docosapentanoic acids) of n-3 series fatty acids in the vertebrates occur as a result of the biological activities of docosahexaenoic and eicosapentaenoic fatty acids. This situation is more apparent with the fresh-water living beings (Sargent et al. 1989). In this study, it is determined that the PUFA amount in the muscle is higher compared to HUFA and DYA. This could be a sign that the crayfish species used in this study might have a high performance of growth, development and reproduction. Like in the biochemical composition, the amount of PUFA of female individuals is determined to be higher than the male individuals. This is considered to occur because the females need more PUFA due to the gonad generation. EPA rate for the male individuals from November to June, decreased in April and May and then it stayed around the same level. On the other hand, a decrease from November to June is observed with the females. This could be explained with the breeding season and that the gonad generation period has advanced.

Investigating the DHA rates, it is seen that the male individuals had an increase in January and March, a decrease in May and an increase starting from June. This is considered to be about the temperature and the nutrition regime of the male brood stock. DHA is seen less with the females compared to the males and it decreased to its lowest level in April and then stayed the same. This makes us think that DHA has no direct effect on reproduction. It is seen that the AA amount is at the highest level in March, the minimum level in April and that it rises again. Unlike the males, females have their maximum in March and April and then a decrease and an increase afterwards. It could clearly be seen that the arachidonic acid has no direct effects on reproduction. Bulut, (2003) suggested that EPA, DHA and AA are much more significant in the researches he made about the egg quality and survival rates of some saltwater fish. The fatty acids stated in our study also show seasonal changes according to the breeding season. It is determined that this change is about reproduction. MUFA is at its maximum values in April and May and it stayed as normal in the other months for both males and females. DYA, however, is identified less in the muscle compared to MUFA and PUFA and there is not much seasonal difference between the male and female individuals. Bulut, (2004) in the research he made on the egg quality and biochemical features of sea bass and bream, stated that compared to MUFA and DYA, PUFA is more significant. The results show that PUFA, compared to the other fatty acids, is more significant in terms of reproduction and development for the crayfish as well.

As a result, the biochemical composition of the living beings and contents are great signs of continuity and quality of life. The quality of offspring and brood stocks might be improved using the amounts and rates. This study is quite significant as it forms the structure of future researches.

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