PAPER

COMPARISON OF FATTY ACID PROFILES OF MALE AND FEMALE GIANT RED SHRIMPS (*ARISTAEOMORPHA FOLIACEA* RISSO, 1827) OBTAINED FROM MEDITERRANEAN SEA

İ.A. OLGUNOGLU*, E. ARTAR and M. GÖÇER
Department of Aquaculture and Fisheries Program,
Kahta Vocational Training School, Adıyaman University, Turkey
*Corresponding author: Tel. 90 416 725 81 80,
email: ilkanali@yahoo.com

ABSTRACT

This study was carried out to detect the concentration of fatty acid in female and male specimens of commercially important giant red shrimp (*Aristaeomorpha foliacea*) obtained from (including 20 male shrimps and also 20 female shrimp) Mediterranean Sea. In fatty acid composition, the saturated fatty acid fraction was dominant, followed by polyunsaturated fatty acid and monounsaturated fatty acid for both sexes. The analyses indicated that PUFAs, and the MUFAs content were higher in female shrimp than in those of males and they were statistically significant differences in fatty acid profile between females and males ($p<0.05$).

- Keywords: *Aristaeomorpha foliacea*, fatty acids, giant red shrimp, Mediterranean Sea -

INTRODUCTION

The giant red shrimp (*Aristaeomorpha foliacea* RISSO, 1827) belongs to the family Aristeidae, which includes other important species such as the blue and red shrimps (*Aristeus antennatus* RISSO, 1816) and the scarlet shrimp (*Plesiopenaeus edwarsianus* JOHNSON, 1868) (RAGONESE *et al.*, 1997). *A. foliacea* is widely distributed in the eastern and western Atlantic, Indian Ocean and western Pacific, in the waters of Japan, Australia, New Zealand and in the Mediterranean Sea. In the Mediterranean Sea, the species inhabits muddy bottoms of the continental slope approximately between 100 and 1200 m depth. This species plays an important role in the overall biomass of the Mediterranean Sea and represent an important commercial resource among the other shrimp species since 1959 (D'ONGHIA *et al.*, 1998; DESANTIS *et al.*, 2003; FERNANDEZ *et al.*, 2011). Due to its economic relevance, recently there are many studies on this species from Mediterranean Sea and there has been a considerable amount of research on nutritional value of various species of shrimp. However there is not any data on the nutritional and fatty acids composition of *A. foliacea.*

Seafoods are important source of nutrients in the human diet. Crustaceans such as shrimps have high nutritive value, are low in fat, especially saturated fatty acids; contain high amount of polyunsaturated fatty acids (omega-3 and omega 6) (OKSUZ *et al.*, 2009; TAG EL-DIN *et al.*, 2009; TURAN *et al.*, 2011; SHALINI *et al.*, 2013). These fatty acids could not be synthesised by the human body and must be obtained through the diet are crucial for normal brain structure and function (ALASALVAR *et al.*, 2002; RICHARDSON, 2003). In addition to this, these fatty acids have great importance to humans for prevention of coronary artery diseases, diabetes, hypertension and cancer (VISENTAINER *et al.*, 2007; CENGIZ *et al.*, 2012). The levels of these fatty acids are low in many modern diets, particularly those in which highly processed foods predominate. The omega-3 polyunsaturated fatty acids (PUFAs) that the human needs (EPA and DHA) are found in appreciable quantities only in oily fish, seafood, aquatic invertebrates and algae (RICHARDSON, 2003; GÖKCE *et al.*, 2011). Therefore, this study was carried out to determine the nutritive value and fatty acid content of giant red shrimp collected from the Mediterranean Sea of Turkey.

MATERIALS AND METHODS

Collection and preparation of samples

The samples were caught by bottom trawlers between 450 and 500 m of depth, during in 2013 from Mediterranean Sea of Turkey (36° 22' 707"N-24° 25' 941" E /36° 14' 919" N- 34° 19' 163" E).

Immediately, after collection, shrimps were stored in a container, preserved in crushed ice and transferred to the laboratory, where the heads, shells and intestines were separated and placed in labeled polyethylene bags respectively and stored at -20°C until processing for analysis. For each season, 20 female and 20 male samples of *A. foliacea* were obtained by random sub-sampling.

Fatty acid analysis

The samples were transported with dry ice to the Accredited Industrial Services Laboratory of Turkey/Istanbul. The methyl esters of fatty acids of samples were prepared according to IUPAC Methods II. D. 19 (1979). The analyses were carried out by using a Perkin Elmer Autosystem. XL Gas Chromotography and Flame Ionization Detector (FID) equipment and a Supelco 2330 fused silica capillary column (30 m x 0.25 mm x 0.20 μm film thickness) for determining the fatty acid composition.

Data analysis

For data analysis independent samples t-test was used to identify significant differences in fatty acid concentration. Statistical significance was defined at $p<0.05$. The mean values were obtained from 3 experiments and reported as means±SD (DINÇER and AYDIN, 2014).

RESULTS AND CONCLUSIONS

Table 1 shows mean weights (g) of female and male species of shrimp (*Aristaeomorpha foliacea*) obtained from Mediterranean Sea.

Table 1 - The Nutritional value and mean weights (g) of female and male shrimps.

Parameter	Female	Male
Weight (g)	29.96^{a}±6.53	12.26^{b}±2.07
Protein (%)	15.72^{a}±1.02	18.0^{b}±0.80
Lipid (%)	0.72^{a}±0.11	0.51^{b}±0.13

Different letters (a,b) in the same row represent significant statistical differences ($p<0.05$).

The mean weight for female shrimps was found to be higher than the mean weights for male shrimps. Similar results were reported by YILMAZ and YILMAZ (2007) for *Penaeus semisulcatus* collected from Mediterranean Sea of Turkey and also by TURKMEN (2012) and CEVIK *et al.* (2008) for *Penaeus kerathurus* and *Parapenaeus longirostris* respectively. Our findings are consistent with prior research. The levels of protein and lipid vary depending upon season, age, maturity, sex, water temperature, spawning cycle and availability of food, types of diet and

feeding system of organism (OKSUZ *et al.*, 2009; TURAN *et al.*, 2011; ROSLI *et al.*, 2012).

In a study on *Crangon crangon* protein and lipid content were 18.47 and 0.95% respectively (TURAN *et al.*, 2011). SAGLIK and IMRE (1997) determined total lipid as 0.93% for *Parapenaeus longirostris* and 0.58% for *Penaeus semisulcatus*. YANAR *et al.* (2011) found that protein and lipid of *Penaeus semisulcatus* ranged between 22.76-23.53% and 0.76-1.44% respectively. FATIMA *et al.* (2012) reported that lipid in the muscle tissue of *Fenneropenaeus penicillatus* varied from 0.92 to 1.0% and of *F. merguiensis* from 0.87 to 0.98%. Protein and lipid were also reported as 20% and 1.1% for *Parapenaeus longirostris* and 14.2% and 2.6% for *Plesionika martia* by OKSUZ *et al.* (2009). DINCER and AYDIN (2014) determined that protein and lipid of *Metapenaeus affinis* ranged between 18.4-19.1% and 1.07-1.30% respectively. In the present study the content of protein and lipid were identified as slightly lower than those reported previously for some shrimp 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. In the study, the protein content for male shrimps was found to be higher than the protein content for female shrimps whereas the lipid content was found to be lower in male shrimp ($p<0.05$). Similar results were reported by DINCER and AYDIN (2014) for female and male species of *Metapenaeus affinis*.

The ratios of PUFA/SFA and *n*-6/*n*-3 and the fatty acid compositions of the investigated shrimp are presented in Table 2.

The fatty acids analyzed were grouped as saturated fatty acids (SFAs), monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs). In the present study, in both groups, SFA was the highest followed by PUFA and MUFA. These results were in agreement with that obtained by TURAN *et al.* (2011) who reported highest levels of SFA followed by PUFA and MUFA for brown shrimp (*Crangon crangon*) from Sinop Region, Black Sea. Similar results were also reported by OURAJI *et al.* (2011) for wild Indian white shrimps (*Fenneropenaeus indicus*); by OKSUZ *et al.* (2009) for rose shrimp (*Parapenaeus longirostris*) and red shrimp (*Plesionika martia*); by YANAR *et al.* (2011) for *Penaeus semisulcatus*; by FATIMA *et al.* (2012) for *Fenneropenaeus merguiensis* and *F. penicillatus* and by DINCER and AYDIN (2014) for *Metapenaeus affinis*. According to the results, C16:0 (Palmitic acid) and C18:0 (Stearic acid) were the main saturated fatty acids in both shrimp species. In both sexes, the predominant monounsaturated fatty acids were found as C18:1 (Oleic acid). The principal acids in PUFA group were eicosapentaenoic acid (C20:5, EPA), docosahexaenoic acid (C22:6, DHA) and linoleic acid (C18:2) for female and male shrimp species. These results agree with studies on fatty acids found in other shrimp species (OKSUZ *et al.*, 2009; TAG EL-DIN *et al.*, 2009; SAGLIK and IMRE 1997; OURAJI *et al.*, 2011; TURAN *et al.*, 2011; YANAR *et al.*, 2011; FATIMA *et al.*, 2012). In the present study, the rate of SFAs, PUFAs and MUFAs were determined as 43.69%, 29.33% and 24.37% for female shrimps and as 47.15%, 25.41% and 17.34% for male shrimps respectively. However, different percentage compositions of fatty acids obtained from various species and subspecies of sea and freshwater shrimps were also reported by several Authors. These differences among species might be associated with the different characteristics of the shrimp species (KARUPPASAMY *et al.*, 2013). In a study, TURAN *et al.* (2011) reported SFA, MUFA and PUFA rates in brown-color shrimp at 33.04, 22.17 and 29% respectively. OKSUZ *et al.* (2009) reported the MUFA rate in *P. longirostris* and *P. martia* at 26.09% and 34.47% respectively. OURAJI (2011) reported the rate of SFA in wild white Indian shrimp and its cultured specimen at 32.88 and 33.79% respectively. EMAMI *et al.* (2014) reported that the rate of SFA in *Penaeus vannamei* at 37.26%, in *Penaeus semisulcatus* at 49.12% and the rate of MUFA in *P. vannamei* at 24.9%, in *P. semisulcatus* at 33.76% and the PUFA in *P. Vannamei* at 37.84%, in *P. semisulcatus* at 16.9% respec-

Table 2 - Fatty acid composition of female (F) and male (M) shrimps.

Parameters	Female (%)	Male (%)
C6:0	1.23^{a}±0.03	2.70^{b}±0.01
C8:0	0.11±0.01	n.d
C14:0	3.43^{a}±0.03	2.16^{b}±0.10
C16:0	27.59^{a}±1.20	27.29^{a}±0.60
C18:0	11.10^{a}±0.04	14.37^{b}±0.75
C24:0	0.23^{a}±0.04	0.63^{b}±0.03
∑SFA	43.69^{a}	47.15^{b}
C16:1	2.69^{a}±0.20	1.66^{b}±0.23
C18:1	21.68^{a}±0.70	15.68^{b}±1.00
∑MUFA	24.37^{a}	17.34^{b}
C18:2*n*6	6.26^{a}±0.02	4.41^{b}±0.60
C20:3*n*3	0.11±0.01	n.d
C20:5*n*3(EPA)	13.36^{a}±0.50	11.47^{b}±0.60
C22:6*n*3(DHA)	9.60^{a}±0.50	9.53^{a}±0.05
∑PUFA	29.33^{a}	25.41^{b}
PUFA/SFA	0.67	0.54
∑*n*3	23.07	21.00
∑*n*6	6.26	4.41
*n*6/*n*3	0.27	0.21
Unidentified	2.61	10.1

n.d.: below detection limit; Data are expressed as mean±SD of triplicate measurements.
Different letters (a,b) in the same row represent significant statistical differences ($p<0.05$).

tively. The results obtained in this study showed slightly similarity to the findings of the mentioned researchers. This difference may be due to geographical variation, seasonal conditions and different types of diet and feeding system. Fatty acid content is also influenced by species, maturity period, size and age of shrimp. The indices of PUFA/SFA and n-6/n-3 ratios were widely used to evaluate the nutritional value of fat for human consumption. According to some nutritional recommendations the PUFA/SFA ratio in human diets should be above 0.45 and, within the PUFA, the n-6/n-3 ratio should not exceed 4.0 (ALFAIA *et al.*, 2010. In the present study the PUFA/SFA and n-6/n-3 ratios of *A. foliacea* (for both female and male shrimps) were within the range reported for human diets. It could be demonstrated that the giant red shrimp (*A. foliacea)* is a desirable item in human diet when the levels of n3/n6 and PUFA/SFA ratios were considered.

Comparison of fatty acid composition between two sexes

The fatty acid compositions of female shrimp species found to be 43.69% saturated (SFAs), 29.33% polyunsaturated acids (PUFAs) and 24.37% monounsaturated (MUFAs) whereas the fatty acid compositions of male shrimp consist of 47.15% saturated (SFAs), 25.41% polyunsaturated acids (PUFAs) and 17.34% monounsaturated (MUFAs). Among these the highest concentrations of SFAs (47.15%) were detected in male shrimp species while the highest concentrations of PUFAs (29.33%) and MUFAs (24.37%) were detected in female shrimp. There is a significant difference between the SFA, PUFA and MUFA profiles in both sexes ($p<0.05$). Similar results were reported for female and male species of *Metapenaeus affinis* by DINCER and AYDIN (2014) and by ESKANDARI *et al.* (2014) for female and male species of *M. affinis*. Based on results, the amount of palmitic acid (C16:0) for female shrimp (27.59%) was almost the same as in male shrimp species (27.29%) ($p>0.05$), while the amount of oleic acid (C18:1) (21.68%) was higher than those in male shrimp (15.68%) ($p<0.05$). The present study also showed that the amount of docosahexaenoic acid (C22:6, DHA) of female shrimp (9.60%) are almost the same as in male shrimp species (9.53%) ($p>0.05$) whereas the levels of eicosapentaenoic acid (C20:5, EPA) and linoleic acid (C18:2) were higher than those in male shrimp ($p<0.05$). In a study, DINCER and AYDIN (2014) reported that the EPA content of male *Metapenaeus affinis* was lower than female *M. affinis*. The ratio of PUFA to SFA (0.54) and *n*-6 to *n*-3 (0.21) for the male shrimp was found to be lower than those in female shrimp. Although both shrimps were subjected to the same sea water and climate conditions, there were naturally some differences between them, in terms of their size, sex and quantity of lipid.

In conclusion, from a nutritional point of view, both male and female giant red shrimps demonstrated acceptable quality; in particular, the female giant red shrimps had the highest levels of PUFAs, and the MUFAs content. Both sexes are low in fat and are considered to belong to a low fat class group. Further investigations are required to obtain more information about this species.

ACKNOWLEDGMENTS

The authors are grateful to Assist. Prof. Dr. Yusuf Kenan BAYHAN for providing the shrimp samples for the study.

REFERENCES

Alfaia C.M.M., Alves S.P., Lopes A.F., Fernandes M.J.E., Costa A.S.H., Fontes C.M.G.A., Castro M.L.F., Bessa R.J.B. and Prates J.A.M. 2010. Effect of cooking methods on fatty acids, conjugated isomers of linoleic acid and nutritional quality of beef intramuscular fat. Meat Sci. 84: 769.

Alasalvar C, Taylor K.D.A., Zubcov E., Shahidi F. and Alexis M. 2002. Differentation of cultured and wild sea bass (*Dicentrarchus labrax*): total lipid content, fatty acid and trace mineral composition. Food Chem. 79: 145.

Cengiz E.I., Ünlü E., Bashan M., Satar A. and Uysal E. 2012. Effects of seasonal variations on the fatty acid composition of total lipid, phospholipid and triacylglycerol in the dorsal muscle of Mesopotamian Catfish (*Silurus triostegus*, Heckel, 1843) in Tigris River (Turkey) Turk. J. Fish. Aquat. Sci. 12: 33.

Çevik F., Bayhan Y.K. and Derici O. 2008. Metal concentrations in the muscle of male and female shrimp (*Parapenaeus longirostris*, Lucas, 1846) collected from Marmara Sea and their relationships with season. Asian J. Chem. 20 (3): 2229.

Desantis S., Labate M, Cirillo F., Labate G.M., Maiorano P. and Onghia G.D. 2003. Testicular activity and sperm glycoproteins in giant red shrimp *Aristaeomorpha foliacea*. J. Northw Atl. Fish. Sci. 31: 205.

Dinçer M.T. and Aydın I. 2014. Proximate composition and mineral and fatty acid profiles of male and female jinga shrimps (*Metapenaeus affinis*, H. Milne Edwards, 1837) Turk J. Vet. Anim. Sci. 38: 445.

D'onghia G., Maiorano P., Matarrese A. and Tursi A. 1998. Distribution biology and population dynamics of *Aristaeomorpha foliacea* (Risso, 1827) (Decapoda, Natantia, Aristeidae) in the North-Western Ionian sea (Mediterranean Sea). Crustaceana. 71(5): 518.

Emami S.M., Matinfar A., Kamali A. and Soltani M. 2014. Fatty acid and amino ccid composition of marine (*Penaeus semisulcatus*) and farmed (*Penaeus vannamei*) shrimp species from Bushehr. Iran. J. Appl. Environ. Biol. Sci. 4(4): 262.

Eskandari S., Bitaab M.A., Abtahi B., Ghaffari F., Namin M.M. and Khorjestan S.M. 2014. Determination of fatty acids composition in Persian Gulf shrimp, *Metapenaeus affinis*. J. Paramedical Sci. 5 (2): 212.

Fatima H., Ayub Z., Siddiqui G. and Ali S.A. 2012. Fatty acid composition of two candidate species of aquaculture, *Fenneropenaeus merguiensis* and *F. penicillatus* (Crustacea: Decapoda) in Pakistan. Pakistan J. Zool. 44(4): 969.

Fernàndez M.V., Maltagliati F., Pannacciulli F.G. and Roldàn M.I. 2011. Analysis of genetic variability in *Aristaeomorpha foliacea* (Crustacea, Aristeidae) using DNA-ISSR (Inter Simple Sequence Repeats) markers. C. R. Biologies. 334: 705.

Gökçe M.A., Tasbozan O., Tabakoglu S.S., Çelik M., Ozcan F. and Basusta A. 2011. Proximate composition and fat-

ty acid profile of shabbout (*Barbus grypus*, Heckel, 1843) caught from the Ataturk Dam Lake, Turkey. J. Food Agric. Environ. 9 (2): 148.

I.U.P.A.C. (1979). Standard Methods for analysis of oils, fats and derivatives, 6th Edition (Fifth Edition Method II.D.19) 96-102. Pergamon Pres, Oxford

Karuppasamy P.K., Priyadarshini R.S.S., Ramamoorthy N., Sujatha R., Ganga S., Jayalakshmi T., and Santhanam P. 2013. Comparison of proximate, amino and fatty acid composition of *Penaeus monodon* (Fabricius, 1798), *Fenneropenaeus indicus* (H. Milne Edwards, 1837) and *Aristeus virilis* (Bate, 1881) of Nagapattinam landing centre, Tamil Nadu. J. Mar. Biol. Ass. India 55 (2): 5.

Oksuz A., Ozyilmaz A., Aktas M., Gercek G. and Motte J. 2009. A comparative study on proximate, mineral and fatty acid compositions of deep seawater rose shrimp (*Parapenaeus longirostris*, Lucas, 1846) and red shrimp (*Plesionika martia*, A. Milne-Edwards, 1883). J. Anim. Vet. Adv. 8(1): 183.

Ouraji H., Fereidoni A.E., Shayegan M. and Asil S.M. 2011. Comparison of fatty acid composition between farmed and wild Indian white shrimps, *Fenneropenaeus indicus*. Food Nutr. Sci. 2: 824.

Richardson A. J. 2003. The importance of omega-3 fatty acids for behaviour, cognition and mood Scandinavian. Scandinavian J. Nutr. 47 (2): 92.

Ragonese S., Bertolino F. and Bianchini M.L. 1997. Biometric relationships of the red shrimp, *Aristaeomorpha foliacea*, Risso 1827, in the strait of Sicily (Mediterranean Sea). Sci. Mar. 61(3): 367.

Rosli W.W.I., Rohana A.A.J., Gan S.H., Fadzlina N.H., Rosliza H., Helmy H., Mohd N.S., Mohd I.I., Shaiful B.I., Wan M.W.B. and Kamarul I.M. 2012. Fat content and EPA and DHA levels of selected marine, freshwater fish and shellfish species from the east coast of Peninsular Malaysia. Int. Food Res. J. 19 (3): 815.

Saglık S., and Imre S. 1997. Fatty acid composition and cholesterol content of mussel and shrimp consumed in Turkey. Turk. J. Mar. Sci. 3(3): 179.

Shalini R. Nazar A.R., Badhul Haq M.A. and Shanker S. 2013. Biochemical changes of *Litopenaeus vannamei* and *Fenneropenaeus indicus* in the different stages of WSSV infection. J. Coastal Life Med. 1(1): 19.

Tag El-Din H., Habashy M.M. and Sultan H.M. 2009. Residues of some heavy metals and hormonesin fresh water prawn (*Macrobrachium rosenbergii*) and marine shrimp (*Penaeus semisulcatus*) with reference to the nutritive value. World J. Zoology. 4(3): 205.

Turan H., Kaya Y. and Erdem E. 2011. Proximate Composition, Cholesterol, and Fatty Acid Content of Brown Shrimp (*Crangon crangon* L. 1758) from Sinop Region, Black Sea. J. Aquat. Food Prod. Tech. 20: 100.

Turkmen G. 2012. Seasonal Variation of Heavy Metals in Shrimp *Penaeus kerathurus* (Forskal,1775) from İzmir Bay. J. Anim. Vet. Adv. 11(15): 2839.

Visentainer J.V., Noffs M.D'A., Carvalho Patricia de O., Almeida V. and Vivian D.E. 2007. Lipid Content and Fatty Acid Composition of 15 Marine Fish Species from the Southeast Coast of Brazil. J. Amer. Oil Chem. Soc. 84: 543.

Yanar Y., Göçer M., Yanar M. and Kücükgülmez A. 2011. Differences in nutrıtional composition between cultured and wild green tiger Shrimp (*Penaeus semisulcatus*). Ital. J. Food Sci. 23: 1.

Yılmaz A.B. and Yılmaz L. 2007. Influences of sex and seasons on levels of heavy metals in tissues of green tiger shrimp (*Penaeus semisulcatus* de Hann, 1844). Food Chem. 101: 1664.

Paper Received October 14, 2014 Accepted January 7, 2015