Proximate composition and nutritive value of Shrimp scad, *Alepes djedaba* (Forsskal, 1775) off Cochin coast

[*]Sajana N, [#]S. Bijoy Nandan

[*]Research scholar, [#]Professor, Dept. of Marine Biology, Microbiology and Biochemistry. Cochin University of Science and Technology, Kochi. Kerala, India.

[*]sajanasidheeq@gmail.com, [#]bijoynandan@yahoo.co.in

Abstract - The proximate composition, amino acid profiles, fatty acid profiles and mineral contents of *Alepes djedaba* was determined in this study. The fish muscles contained high moisture content and the average value for moisture was 78.2 ± 1.73 in males and 79.2 ± 1.74 in females. The fish was a lean fish as they contain very low fat (<2%) but rich in proteins (20.96% in males and 20.36% in females). They were rich in all essential and non essential amino acids. Good proportion of ω-3 poly unsaturated fatty acids were recorded, especially Eicosapentaenoic acids (4.53% in males and 5.38% in females) and Docosahexaenoic acids (4.8% in males and 6.52% in females). The EPA: DHA ratio was 0.93% in males and 0.82 % in females and has a high n3/ n6 fatty acid ratio of 4.2% and 6.2% .The abundant minerals in the muscles were potassium (16.6% in males and 12.95% in females) and phosphorus (23.86% in males and 8.39% in females). The Na/ K value was very low. The trace elements such as zinc (0.14% in males and 0.04%in females) and iron (0.92% in males and 0.35% in females) were found to be in good quantity.

Key words: Alepes djedaba, Proximate composition, Fatty acid profiles, Mineral content

I. INTRODUCTION

Fishes form an essential part of human diet in almost all countries of the world and they are one of the cheapest sources of so many nutrients. Understanding the biochemical composition is very important to determine its nutritive value. Proteins, lipids, moisture and ash form the basic chemical composition of fishes; which create the nutritional value, sensory characteristics and the functional aspects of its flesh. These four basic constituents are together referred as proximate composition and that may vary from species to species based on their age, sex, environment and season [1], [2].

Fishes are good sources of high quality proteins which in turn made up of all essential amino acids; provide required quantity of protein to human diet. Marine fishes possess high concentration of long chain ω-3 poly unsaturated fatty acids in their muscles [3]. Among these Eicosapentaenoic acids (EPA) and Docosahexaenoic acids (DHA) are typically found in the fish muscles and they have so many health benefits. They lower the risk of coronary heart diseases, Hypertrigliceridaemia, rheumatoid arthritis and exhibit anti-inflammatory action [4], [5], [6], [7]. They are also vital for brain development particularly for the early development of vision and cognitive functions [8]. Previous studies also proved that they are effectively used in the prevention and treatment of various diseases such as hyper tension, osteoporosis, eczema, psoriasis, cancer, and asthma [9]. Many of the mineral elements are inevitable to all living organisms as they take part in so many metabolic processes and hence the estimation of its presence in the fish muscles is of considerable importance.

Alepes djedaba is a commercially important carangid fish commonly occurring along south west coast of India. They are commonly consumed by the local people and have got a good demand due to its affordable prize and good taste. Hence it is necessary to evaluate its nutritional value as a dietary component. No previous reports were available on the nutritional aspects of these promising fishery resources. So the current study aimed to evaluate its nutritional quality by estimating proximate composition, amino acid profile, fatty acid composition and mineral contents of *A. djedaba* collected from Cochin, south west coast of India.

II. MATERIALS AND METHODS

The fresh fish samples were collected from commercial landing centers at Cochin, Kerala and were transported to the laboratory in iced condition. The fishes were cleaned and excess water on body surface was removed with blotting paper. After recording the length, weight, sex and stage of maturity, a portion of fish muscle was removed and stored at -20^0 C for further analysis. Proximate composition

 DOI : 10.18231/2454-9150.2019.0316

was estimated by following AOAC methods [10]. The moisture content was analysed by drying about 5 g of fish muscles in hot air oven at 105^0 C. After drying, cool the sample and weighed. The percentage of moisture was calculated by the formula.

Moisture (%) = $\frac{W1-W2}{w1} \times 100$, where W1 = Weight (g) of sample before drying and W2 = Weight (g) of sample after drying

The ash content was estimated by overnight ignition of the fish muscles in a Muffle furnace at 550^0 C. The percentage of ash was calculated by the following formula.

Ash (%) = $\frac{weight\ of\ fish\ muscle\ after\ dryig}{weight\ of\ fish\ muscle\ before\ dryig} \times 100$

The total nitrogen was determined from the homogenised sample by micro Kjeldahl method [10] and the value was multiplied by the conversion factor (6.25) to get the crude protein of the sample. The crude fat was extracted by petroleum ether with the help of soxhlet apparatus [10]. The percentage of fat in the fish muscles was calculated by the following formula.

Fat (%) = $\frac{weight\ of\ fat}{weight\ of\ \ sample} \times 100$

All the values were expressed in gm per 100 gm wet weight of fish sample.

For analysing the amino acid constituents of the fish muscles the proteins were hydrolysed to amino acids by treating with 6N HCl. These amino acids were analyzed by HPLC equipped with an ion exchange column [11]. After extracting the fat, fatty acid methyl esters (FAMEs) were prepared by trasmethylation with boron trifluoride (BF3) in methanol [12]. The fatty acid profiles were analysed by Gas Liquid Chromatography (GLC) and expressed as percentage to total fat extracted. Mineral content of the fish muscles were estimated by ICP-AES (Atomic Absorption Spectrophotometer) after digesting it with a mixture of concentrated nitric acid and per chloric acid.

Triplicate samples were analysed for each chemical parameters and mean values were calculated. Analysis of variance was employed to find out significant variations in the proximate composition between sexes and different maturity stages. All the statistical analysis was done by SPSS 16.0 (Statistical Package for Social Sciences) [13].

III. RESULT AND DISCUSSION

PROXIMATE COMPOSITION

Fishes are generally recognized as healthy food by virtue of its richness in nutrients such as proteins, fat, essential amino acids, trace elements, minerals and PUFAs. The proximate composition of male and female *A. djedaba* was estimated separately and presented in the table 1. The moisture was the major component in fish muscles with an average value of 78.2% and 79.2% in males and females respectively. Similar results were reported by [14] and [15] and they found that moisture was very high for the species, but [16] reported low moisture content. Proteins form the second major biochemical constituents and expressed as 20.96% in males and 20.36% in females. Generally the protein content of most of the species lies in the range of 16-21% [17], [18].

The present study revealed that the fish muscles provided with low lipid (1.17% in males and 1.29% in females). Previous workers reported that the fat content was inversely proportional to moisture [19], [20]; the present result was corroborated with this report that muscles of *A. djedaba* contained high moisture but the lipid content was very low. The ash content was expressed as 1.17% and 1.3% in males and females respectively and this is in tune with the observation that the average ash content of the fish muscles ranges between 0.5- 1.8% [21]. These results are in agreement with the analysis of chemical composition of the *A. djedaba* caught from Arabian Gulf coast [17]; in contrast they reported a lower fat content than the present study. According to [22] the lipid content of a lean starved fatty fish can be as low as 0.5% and may get a high value of 20% or above for well fed fatty fishes. It can be inferred from the present analysis that *A. djedaba* is a lean fish with high protein content.

The biochemical composition of a fish species is closely related to food intake, migration and other sexual changes during breeding periods [23]. The present study also showed that the proximate composition of the fish muscles varied during the various stages of maturity. The spent fishes of both sexes possessed high protein content, 22.24% and 20.7% for males and females respectively than immature and mature fishes (Table 2). The value of proteins can be expressed in the order spent > immature > mature. Whereas higher lipid content was reported for immature fishes of both sexes (1.48% and 1.73%) and the least was reported for spent fishes (0.83% and 0.82%). These variations in the protein and fat contents were highly significant ($P < 0.001$). But slight variations were shown in the moisture and ash content which was not significant. The moisture content ranged between 77.5% to 78.45 % in males and 77.75% to 80.3% in females. The ash content contributed 1.16% to 1.18% in males and 1.26% to 1.27% in females. Moisture and ash were comparatively stable during maturation while lipid and protein concentration varies with maturity.

AMINO ACID PROFILE

Estimating the content of nutritionally indispensable amino acids in food proteins is necessary to evaluate its nutritional quality [24]. Fishes are considered as a valuable source for high quality animal protein in human diet. About sixteen amino acids were extracted from the muscles of *A. djedaba* during the present study, among them eight were essential amino acids (EAA) and the remaining were non essential amino acids (NEAA). All these EAA are important for the proper functioning of cells and organs and should be supplemented through the diet [25]. Glutamic acid was the

 DOI : 10.18231/2454-9150.2019.0316

most abundant amino acids in both sexes (Table 3) which constituted about 17.05% and 18.84% in male and female fishes respectively. Similar abundance of glutamic acid was reported by various authors for fishes like mackerel [26], red salmon [27], *Catla catla*, *Labeo rohita*, *Clarias batrachus*, *Heteropneustes fossilis* and *Cirrhinus mrigala* [28] .

Glutamic acids are considered as conditionally essential amino acids (CEAA) as they play a key role in amino acid metabolism and necessary for the synthesis of glutathione [29]. The fish meat was also rich in aspartic acid (10.56% in males and 12.29% in females), lysine (10.86% in males and 11.44% in females) and leucine (9.06% in males and 9.91% in females). All other EAA were present in good proportion except methionine (2.89% and 3.34%). Aspartic acid can act as precursor for important EAAs like methionine, threonine, isoleucine and lysine [28]. Lysine is essential for growth and its lack may lead to immunodeficiency; leucine is the only dietary amino acid required to stimulate muscle protein synthesis [30]. Among NEAA cystine (1.17% and 1.24%) and tyrosine (1.2% and 1.01%) were represented in least quantity. Amino acids like Arginine, cystine, leucine, methionine, tryptophan, tyrosine, aspartic acid, glutamic acid, glycine, proline etc were also classified as functional amino acids (FAA) by considering its regulatory effect on various metabolic path ways to improve health, survival, growth, development, reproduction and lactation [29].

Table 1: Proximate composition in the muscles of *A. djedaba* (gm 100 gm^{-1} wet tissue or %)

Sex	Protein	Lipid	Moisture	Ash
Male	20.96 ± 1.05	1.17 ± 0.3	78.2 ± 1.73	1.17 ± 0.1
Female	20.36 ± 0.44	1.29 ± 0.41	79.2 ± 1.74	1.3 ± 0.14

Table 2: Proximate composition in the muscles of *A. djedaba* (gm 100 gm^{-1} wet tissue or %) during various maturity stages

Male				
Stage	**Protein**	**Fat**	**Moisture**	**Ash**
Immature	20.82 ± 0.08	1.48 ± 0.03	78.42 ± 2.19	1. 17 ± 0.13
Mature	19.83 ± 0.15	1.23 ± 0.03	78.45 ± 1.19	1.18 ± 0.09
Spent	22.24 ± 0.21	0.83 ± 0.02	77.5 ± 1.93	1.16 ± 0.13
Female				
Immature	20.55 ± 0.05	1.73 ± 0.01	80.3 ± 1.8	1.27 ± 0.06
Mature	19.83 ± 0.35	1.31 ± 0.08	77.75 ± 0.9	1.27 ± 0.23
Spent	20.7 ± 0.13	0.82 ± 0.03	79.24 ± 1.29	1.26 ± 0.09

FATTY ACID COMPOSITION

The extracted fish oil contained three types of fatty acids saturated fatty acids (SFA), mono unsaturated fatty acids (MUFA) , poly unsaturated fatty acids (PUFA) and their proportions in the fish muscles is represented in the table 4. Among these PUFA cannot be synthesised in our body, must be obtained through the diet and the present study reported a good proportion of PUFAs (19.3% in males and 26.8% in females). SFA was found to be dominant in both sexes (60% and 50.8%) and MUFA was the second dominant proportion in males (20.8%) while in females PUFA (26.8%) formed the second dominant fatty acid. The principal fatty acid content of SFA was palmitic acid (18.72% and 15.41% for males and females respectively) followed by Stearic acids (9.38% and 7.45%) and myristic acid (4.37% and 3.05%). Among the MUFA palmitoleic acid (5.42% and 5.8% in males and females respectively) and oleic acid (5.93% and 5.96%) constituted almost in equal proportion (Table 5). A similar predominance of palmitic acid was reported in round scad *Decapterus punctatus* [31] followed by oleic acid and stearic acid. Reference [32] also reported a high concentration of palmitic acid on three scad species collected from southern Philippines; stearic acid forms the second most abundant fatty acid.

Fish oil is enriched with long chain PUFAs such as EPA and DHA that increases the value of fish oils when compared to vegetable oils. Intake of sufficient quantity of EPA and DHA would be vital to maintain a healthy life. According to [33] a total intake of 1200 mg/day of EPA plus DHA was recommended through the diet and a considerable portion of it comes from fish or marine sources. As per the report of [34] American Heart Association (AHA) recommended 1 g EPA + DHA / day for cardio vascular disease patients and 2-4 g EPA + DHA/ day for patients with hypertriglyceridemia. *A. djedaba* contained a good quantity EPA (4.43% in males and 5.38% in females) and DHA (4.8% in males and 6.52% in females), and EPA plus DHA value was found to be 9.23 % in males and 11.9% in females (Table 5). The DHA level is slightly higher than the EPA and these results agrees with the earlier observation [35] that in all marine fishes except in sardine DHA was found to be higher than EPA. The EPA: DHA ratio has certain therapeutic significance and was calculated as 0.93% in males and 0.82 % in females. But [32] recorded a high DHA concentration than EPA and the EPA: DHA ratio was very low compared to present study.

The n3/ n6 fatty acid ratio is considered as a good index for comparing the nutritional value of fish oils [36] and dictates its anti inflammatory effects [37]. The present analysis reported relatively high n3/ n6 fatty acid ratio of 4.2% and 6.2% in males and females respectively. An increase in the human dietary n3/n6 ratio is a necessary requirement of the diet that helps to prevent coronary heart diseases and

 DOI : 10.18231/2454-9150.2019.0316

reduces the risk of cancer [38]. Fatty acids such as linoleic acid, linolenic acid and arachidonic acid can be considered as essential fatty acids as they are not synthesised in our body. Arachidonic acid was represented a good proportion (1.11%) in the muscles of male fishes. Previous reports suggested that the fatty acid composition of fish lipids may vary from species to species, during different seasons, these variations may be attributed to the fluctuations in the amount and quality of available food and gonad development [3], [36], [39], [40].

IV. MINERAL ELEMENTS

Marine fishes are enriched with all the mineral elements. Macro elements such as calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), phosphorus (P) and micro elements such as zinc (Zn), iron (Fe), manganese (Mn) and copper (Cu) were estimated in the present study and expressed as percentage of dry weight (g/100g or percentage) (Table 6). Potassium (16.595% in males and 12.95% in females) and Phosphorus (23.858% in males and 8.39% in females) were the most abundant elements in the fish muscles and a good quantity of Ca, Na and Mg were also recorded. The present study revealed that heavy metals such as Zn, Cu and Mn which can act as an indicators of water pollution, were represented only in meagre quantity in the fish muscles. Previous work on *Pseudotolithus typus* and *P. elongatus* also reported a high concentration of K while Na content was low [41]. They also suggested that the Na/K value for a good fish meal should be less than one that is good for health especially in preventing cardio vascular diseases [41]. The present work reported a low Na/ K value for *A. djedaba* (0.27 in male fishes and 0.13 in female fishes).

Zinc which is an essential mineral required for proper growth development and functioning of immune system was found to be higher in *Alepes djedaba* as compared to that of fresh water fishes [42], [43], [44]. Iron is an essential micronutrient for synthesis of haemoglobin and its content in muscles of *A. djedaba* was found to be higher when compared with the iron content of certain fresh water and marine fishes [44], [45], [46]. All the elements estimated in the present study were found to be in higher proportion in male fishes than in females. Previous studies proved that the mineral composition of a fish mainly depends on the species and the food intake [47], [48], [49]. All these macro and micro elements are essential for human health and either excess or deficiencies may lead to disturbances in biochemical functions of animals including humans [50], [51].

Table 3: Amino acid composition of *A. djedaba*

Sl No.	Essential Amino acids	Male	Female
		EAA %	
1	Phenylalanine	5.05 ± 0.07	4.39 ± 0.05
2	Valine	4.57 ± 0.06	5.08 ± 0.37
3	Threonine	4.32 ± 0.02	5.17 ± 0.11
4	Isoleucine	5.05 ± 0.07	5.42 ± 0.13
5	Methionine	2.89 ± 0.01	3.34 ± 0.04
6	Arginine	6.33 ± 0.04	6.16 ± 0.11
7	Leucine	9.06 ± 0.08	9.91 ± 0.19
8	Lysine	10.86 ± 0.06	11.44 ± 0.32
	Non Essential Amino acids	**NEAA (%)**	
9	Alanine	6.15 ± 0.07	6.45 ± 0.49
10	Aspartic acid	10.56 ± 0.06	12.29 ± 0.45
11	Cystine	1.17 ± 0.09	1.24 ± 0.02
12	Glutamic acid	17.08 ± 0.04	18.84 ± 0.09
13	Glycine	5.16 ± 0.06	4.24 ± 0.05
14	Proline	4.57 ± 0.04	3.96 ± 0.06
15	Serine	4.16 ± 0.22	4.61 ± 0.14
16	Tyrosine	1.2 ± 0.14	1.01 ± 0.01

V. CONCLUSION

There was a lack of information on the biochemical composition and nutritive value of commercially important carangid fish *Alepes djedaba*. In the present study the nutritive value of the species was evaluated. The species is a high protein low fat fish and can act as good source for lean meat which has got high demand due to its dietary significance. They are also rich in many major elements such as potassium, phosphorus, iron, calcium Zinc etc and also have a good quantity of ω-3 poly unsaturated fatty acids. Due to its significantly high n3/ n6 fatty acid ratio and low Na/ K value it may be recommended for a heart friendly diet.

VI. ACKNOWLEDGMENT

The authors are thankful to the Head, Dept. of Marine Biology for the facilities for undertaking the work and the first author is grateful to Ministry of Minority Affairs, University Grants Commission for awarding the Maulana Azad National Fellowship.

Table 4: Fatty acid composition of *A. djedaba* (% of total fatty acids)

Fatty acids	Male	Female
SFA	60	50.8
MUFA	20.8	22.4
PUFA	19.3	26.8

 DOI : 10.18231/2454-9150.2019.0316

Table 5: Fatty acid composition of *A. djedaba* (% of total fat)

Saturated Fatty Acids	**Male**	**Female**
	SFA (%)	
Lauric acid (C12:0)	0.62	0.560
Myristic acid (C14:0)	4.37 ± 3.1	3.05 ± 2.74
Pentadecanoic acid (C15:0)	0.84 ± 0.56	0.63 ± 0.37
Palmitic acid (C16:0)	18.72± 5.81	15.41 ± 13.16
Heptadecanoic acid (C17:0)	1.27 ± 0.84	1.300
Stearic acid(C18:0)	9.38 ± 6.81	7.45 ± 5.82
Behenic acid (C22:0)	0.56 ± 0.43	0.58 ± 0.03
Lignoceric acid(C24:O)	0.25	ND
Monounsaturated fatty Acids	MUFA (%)	
Palmitoleic acid (C16:1 ω7)	5.42 ± 2.98	5.810
Oleic acid (C18:1 ω9)	5.93 ± 0.87	5.96 ± 3.98
Polyunsaturated Fatty Acids	PUFA (%)	
Linoleic acid (C18:2 ω6)	1.17 ± 0.79	1.99 ± 1.12
Linolenic acid(C18:3 ω3)	0.370	0.430
Arachidonic acid(C20:4 ω6)	1.11	ND
Eicosapentaenoic acid (C20:5 ω3)	4.43 ± 1.59	5.380
Docosa hexae noic acid (C22:6 ω3)	4.8 ± 1.24	6.52 ± 7.13
EPA : DHA	0.92	0.83
EPA + DHA	9.23 %	11.9%
n-3/ n-6	4.2 %	6.2 %

Table 6: Mineral content of *A. djedaba* (gm 100 gm^{-1} dry tissue or %)

Minerals	**Male**	**Female**
P	23.858 ± 0.03	8.3895 ± 2.86
Ca	12.9085 ± 12.9	2.3115 ± 0.4
Fe	0.9195 ± 1.11	0.3465 ± 0.1
K	16.595 ± 0.56	12.953 ± 3.7
Na	4.489 ± 0.94	1.686 ± 0.33
Mg	4.96 ± 4.5	1.302 ± 0.21
Cu	0.011 ± 0.006	0.0011 ± 0.001
Mn	0.007 ± 0.007	0.004
Zn	0.139 ± 0.072	0.04 ± 0.05
Na/K	0.27	0.13

REFERENCES

[1] Stansby, Proximate Composition of fish. In: E. Heen and R. Kreuzer (ed) Fish in nutrition, fishing News Books Ltd., London. pp. 55-60, 1962.

[2] R.M. Love, *The Chemical Biology of fishes*. Academic press 1 London, UK. 1970.

[3] R.G. Ackman, "Characteristic of the fatty acid composition and biochemistry of some fresh-water fish oils and lipids in comparison with marine oils and lipids." *Comp. Biochem. Physiol*., vol 22, pp 907–922, 1967.

[4] P.C. Calder," n-3 polyunsaturated fatty acids, inflamation and immunity: pouring oil on troubled water or another fishy tale?" *Nutri. Res*., vol 21, 2001.

[5] K.S. Sidhu, "Health benefits and potential risks related to consumption of fish or fish oils". *Reg. Tox. Pharma*., vol 38, pp 336-34, 2003.

[6] M.B. Cavington, "Omega-3 fatty acids". *Amer. Fam. Phys*., vol 70, pp133-140, 2004.

[7] S.K Kim and E. Mendis, 'Bioactive compounds from marine processing by products a review". *Food res. Int*., vol 39, pp 383-393, 2006.

[8] E.E. Birch, S. Garfield, D.R. Hoffman, R. Uauy, and D.G. Birch, "A randomized controlled trial of early dietary supply of long-chain polyunsaturated fatty acids and mental development in term infants". *Devel. Med. Child Neuro*., vol 42, pp 174-181, 2000.

[9] J.L. Guil-Guerrero, E. Venegas-Venegas, M.A. Rincon-Cervera, and M.D. Sua´ rez, "Fatty acid profiles of livers from selected marine fish species". *J. Food Comp. Anal.*, vol 24, pp 217-222, 2011.

[10] AOAC, Official Method of Analysis, Association of Official Analytical Chemists, Gaithersburg, Md, USA, 17th edition, 2000.

[11] Y. Ishida, T. Fujita and K. Arai, "New detection and separation method for amino acid by high performance liquid chromatography". *J Chromatogr.*, vol 204, pp 143–148, 1981.

[12] L. D. Metcalfe, A.A. Schmitz and J.R. Petha, "Rapid preparation of fatty acid esters from lipids from gas chromatographic analysis". *Anal. Chem*., vol 38, pp 514, 1966.

[13] Biswas. *Manual of methods in fish biology*. South Asian Pvt Ltd. New Delhi, 1993.

[14] M.Z. El- Faer, T.N. Rawdah, K.M. Attar and M. Arab, "Mineral and proximate composition of some commercially important fishes of the Arabian Gulf". *Food. Chem*., vol 45, pp 95-98, 1992.

[15] E. M. Younis, A.A, Abdel-Warith, A. Ali, N. A Al-Asgah and A.S. El-Shayia, "Chemical composition and mineral contents of six commercial fish species from the Arabian Gulf coast of Saudi Arabia". *J. Anim. Vet. Adv*., vol 10 (23) pp 3053-3059, 2011.

[16] E.H. Ewaidah, "Cholesterol fat and food energy content of selected raw and cooked commercial fish species from the Arabian Gulf". *Ecol. Food Nutri*., vol 30, pp 283-292, 1993.

[17] J. Murray, and J. Burt, "The composition of fish". Aberdeen, Scotland: Torry Research Station, 1969.

[18] H.H. Huss, "Quality and quality changes in fresh fish". Rome, Italy: Food and Agriculture Organization, 1995.

[19] A. A. Nurnadia, A .Azrina, I .Amin, "Proximate composition and energetic value of selected marine fish and shellfish from West coast of Peninsular Malaysia". *Int. Food Res. J*., vol 18, pp 137-148, 2011.

[20] J.U. Paul and N.A. Vivian, "The Biochemical Composition of Three Exotic Fish Delicacies: *Scomber scombrus*, (Linnaeus, 1758), *Trachurus trachurus trachurus* (Linnaeus, 1758), and *Sardina pilchard* (Walbaum, 1792) Frozen and imported into Nigeria". *Pak. J. Nutr.*, vol 10, pp 1158-1162, 2011.

 DOI : 10.18231/2454-9150.2019.0316

[21] V. Sidwell, "Chemical and nutritional composition of finfishes, whales, crustaceans, mollusks, and their products". Washington, DC: National Oceanic and Atmospheric Administration. 1981.

[22] W. Johnston, "Freezing and refrigerated storage in fisheries". Rome, Italy: Food and Agriculture Organization, 1994.

[23] Kor, "Quality and Quantity Changes in Fresh fish-4. Chemical composition. FAO fish Utilization and Marketing Services". Viale delle, 00100. Rome, Italy. http://www.fao.org/docep/v7180e05.htm, 1995

[24] V. R. Young, and P. L. Pellett, "Background paper 5: amino acid composition in relation to protein nutritional quality of meat and poultry products". *Amer. J. Clinic. Nutri*., vol 40: (3), pp 737–742, 1984.

[25] A. Kucukgulmez, and M. Celik, "Aminoacid composition of blue crab (*Callinectes sapidus*) from the North Eastern Mediterranean". *J. Appl. Bio.Scie*., vol 2 pp 39-42. 2008.

[26] H. Hou, B. Li, and X. Zhao, "Enzymatic hydrolysis of defatted mackerel protein with low bitter taste". *J. Ocea. Uni. China* , vol 10(1), pp 85–92, 2011.

[27] S. Sathivel, S. Smiley, W. Prinyawiwatkul, and P. J. Bechtel, "Functional and nutritional properties of red salmon (Oncorhynchus nerka) enzymatic hydrolysates". *J. Food Sci*., vol 70(6), pp C401–C406, 2005.

[28] B. Mohanty, A. Mahanty, S. Ganguly, T.V. Sankar, K. Chakraborty, A. Rangasamy, B. Paul, D. Sarma, M. Suseela, K.K. Asha, B. Behera, Md. Aftabuddin, D. Debnath, P. Vijayagopal, N. Sridhar, M.S. Akhtar, N. Sahi, T. Mitra, S. Banerjee, P. Paria, D. Das, P. Das, K.K. Vijayan, P.T. Laxmanan and A.P. Sharma, " Amino acid compositions of 27 food fishes and their importance in clinical nutrition". *J. Amino*., Article ID 269797. pp 7. 2014.

[29] G. Wu, "Functional amino acids in nutrition and health". *Amino Acids*, vol 45(3), pp 407–411. 2013.

[30] M. R. Etzel, "Manufacture and use of dairy protein fractions". *J. Nutri.*, vol 134(4), pp 996S–1002S. 2004.

[31] M.B. Hale,. "Proximate chemical composition and fatty acids of three small coastal pelagic species". Marne fishery review, vol 46(1), pp 19-21. 1983

[32] E.B Metillo and A.A. Aspiras-Eya, "Fatty acids in six small pelagic fish species and their crustacean prey from the Mindanao sea, southern Philippines". *Trop. Life. Sci. Res*., vol 25(1), pp 105-115, 2014.

[33] V. Loukas, C. Dimizas, V.J. Sinanoglou and S. Miniadis-Meimaroglou," EPA, DHA, cholesterol and phospholipid content in *Pagrus pagrus* (cultured and wild), *Trachinus draco* and *Trigla lyra* from Mediterranean Sea". *Chemistry and Physics of Lipids.*, vol 163, pp 292-299. 2010.

[34] A.H. Lichtenstein, L.J .Appel, M .Brands, M .Carnethon, S. Daniels, H.A. Franch, B. Franklin, P. Kris-Etherton, W.S. Harris, B . Howard, N. Karanja, M. Lefevre, L. Rudel, F. Sacks, L. Van Horn, M. Winston and J. Wylie-Rosett, "Diet and lifestyle recommendations revision 2006: A scientific statement from the American Heart Association Nutrition". Committee. *Circulation.*,vol 114, pp 82-96. 2006.

[35] L.E. Gutierrez and R.C.M. da Silva," Fatty acid composition of commercially important fish from Brazil". *Scie. Agric.Piracicaba*., vol 50(3), pp 478-483. 1993.

[36] E. Satar, I. E. Uysal, E. Ünlü, M. Başhan and A. Satar, "The effects of seasonal variation on the fatty acid composition of total lipid, phospholipid, and triacylglycerol in the dorsal muscle of *Capoeta trutta* found in the Tigris River (Turkey)". *Turk. J. Biol*., vol 36 , pp 113-123. 2012.

[37] K.L. Weaver, P. Ivester, J.A. Chilton, M. D. Wilson, P. Pandey and F. H. Chilton, "The content of favorable and unfavourable polyunsaturated fatty acids found in commonly eaten fish". *j Am Diet Assoc.*, vol 108, pp 1178-1185. 2008.

[38] J.E. Kinsella, B .Lokesh, R.A Stone, "Dietary n-3 polyunsaturated fatty acids and amelioration of cardiovascular disease: possible mechanisms". *Am. J. Clin. Nutr*., vol 52, pp 1-28. 1990.

[39] N.M. Bandarra, I. Batista and M.L. Nunes, " Seasonal changes in lipid composition of sardine (*Sardina pilchardus*)". *J Food Sci*., vol 62 pp 40-42. 1997

[40] K. Uysal, M. Bülbül and M . Dönmez, "Changes in some components of the muscle lipids of three freshwater fish species under natural extreme cold and temperate conditions". *Fish Physiol. Biochem*., vol 34, pp 455-463. 2008.

[41] J.M. Njinkoue, I. Gouado , F. Tchoumbougnang , J.H. Yanga Ngueguim, D.T. Ndinteh,C.Y. Fomogne-Fodjo and F.J. Schweigert, "Proximate composition, mineral content and fatty acid profile of two marine fishes from Cameroonian coast: *Pseudotolithus typus* (Bleeker, 1863) and *Pseudotolithus elongatus* (Bowdich, 1825)". *NFS J*., vol 4, pp 27-31. 2016.

[42] M. Gulfraz, T . Ahmad and H. Afal, "Concentration levels of heavy and trace metals in the fish and relevant water from Rawal and Mangla lakes". *J. Biol. Sci.*, vol 1, pp 414–416. 2001.

[43] N. Roos, M.M. Islam and S.H Thilsted. "Small fish is an important dietary source of vitamin A and calcium in rural Bangladesh". *J. Nutr.*, vol 133, pp 4021S–4026S, 2003.

[44] B.P. Mohanty, P. Paria, D. Das, S. Ganguly, P. Mitra, A. Verma, S. Sahoo, A. Mahanty, Md. Aftabuddin, B. K. Behera, T.V. Sankar and A.P Sharma, "Nutrient profile of Giant River – Catfish Sperata seenghala (Sykes)". *Natl. Acad. Sci. Lett*., vol 35(3) pp 155–161, 2012.

[45] K. Gopakumar,"Biochemical composition of Indian food fish". Central Institute of Fisheries Technology (ICAR), Cochin, 1997.

[46] M. Palani kumar, R. A. Annathai , S. R. Jeya and S.A. Shanmugam, "Proximate and Major Mineral Composition of 23 Medium Sized Marine Fin Fishes Landed in the Thoothukudi Coast of India". *J. Nutr .Food Sci*., vol 4(1), pp 259. 2014.

[47] M.I. Gladyshev, I.V. Gribovskaya, E.A. Ivanova, A.V. Moskvicheva , E.Y. Muchkina and S.M. Chuprov, "Metal concentrations in the ecosystem and around recreational and fish-breeding Pond Bugach" . *Water Resour*., vol 28, pp 288-296, 2001.

[48] M.I. Gladyshev, I.V. Gribovskaya, , A.V. Moskvicheva , E.Y. Muchkina S.M. Chuprov and E.A. Ivanova, "Content of metals in compartments of ecosystem of a Siberian pond". *Arch. Environ. Contam. Toxicol*., vol 41, pp 157-162, 2001.

[49] J. Luczyñska, K. Markiewicz and J. Jaworski, " Interspecific differences in the contents of macro- and microelements in the muscles of six fish species from lakes of the Olsztyn Lake District (north-east Poland)". *Pol. J. Food Nutr. Sci*., vol 15/56(1), pp 29-35, 2006.

[50] A. Przybyl and A. Koligot, "The role of mineral components in the animal nutrition. I. Macroelements". *Prz. Ryb*., vol 2, pp 48-52, 1997.

[51] A. Przybyl and A. Koligot, "The role of mineral components in the animal nutrition. I I. Microelements" .*Prz. Ryb*., vol 3, pp 38-42, 1997.

 DOI : 10.18231/2454-9150.2019.0316