International Journal of
Science Inventions Today
www.ijsit.com
ISSN 2319-5436
Research Article

PROXIMATE COMPOSITION OF CLUPEIDAE AND ENGRAULIDAE INHABITING THENGAITHITTU ESTUARY PUDUCHERRY- SOUTH EAST COAST OF INDIA

N. Vijayakumar*, D. Sakthivel and V. Anandhan

Department of Zoology,KanchiMamunivar Centre for Post - Graduate Studies (Autonomous),Lawspet, Puducherry - 605 008.

ABSTRACT

Estuarine fish are commercially valuable species and easy to cultivate in coastal areas. The biochemical composition is the yard stick to measure and assess the nutritional quality of food sources. Consumption of marine and estuarine fish provides an inexpensive source of protein with a high biological value, essential mineral and vitamins. Clupeidae (*Sardinellalongiceps*, *S. gibbosa*, *Nematalosanasus*, *Ilishamelastoma*) and Engraulidae (*Stolephorusindicus*, *S. commersonni*, *Thryssamystax* and *T. malabarica*) are dominant in Thengaithittu estuary are examined for proximate composition for their nutritional value. The average moisture content ranged from 67 to 73% and the majority of the fishes had protein contents between 14 to 21%. *T. mystax* and *S. commersonni* had high protein content 21.3% and 19.2%. Lipid content varied widely from 2.4 to 6.3% with *S. longiceps* had high lipid content (6.3%). Ash content varied from 1.42% to 4.9% and carbohydrate from 0.8% in *S. commersonni* to 4.82% in *N. nasus*.

Keywords: estuary, finfish, proximate, protein, carbohydrate, lipids

INTRODUCTION

Fish is a major source of food for human nutrition providing an important amount of dietary protein and lipid diet in many countries. Fish flesh is easily digestible because it contains long muscle fibres. Furthermore, it has been linked to health benefits, such as the prevention of cardiovascular diseases and some types of cancer, including colon, breast and prostate [1,2]. Polyunsaturated fatty acids (PUFA) is also reported that n-3 PUFA have been recognized as important substances with beneficial properties for the improvement of visual function [3] and also for the prevention of atherosclerosis and thrombosis development [4]. Fish meal is the main dietary protein source in aquaculture feeds [5]. Several studies deal with the proximate composition of biochemical components of many commercially important fishes [6-10]. Variation of biochemical composition of fish flesh may also occur within same species depending upon the fishing ground, fishing season, age and sex of the individual and reproductive status. The spawning cycle and food supply are the main factors responsible for this variation [11]. Fish has long been an important source of food for people all over the world. The importance of fish as a source of high quality, balanced and easily digestible protein, essential amino acid and nutraceuticals like Polyunsaturated Fatty Acid is well understood and it has historically been more readily available to the poor, especially in the rural areas of many developing countries like India.

India has a rich estuarine and other brackish water resources along the west and east coasts formed by the Ganges, Mahanadhi, Brahmaputra, Godavari, Krishna, Cauvery, Narmadha and Tapati rivers and smaller coastal rivers along the west coast, mainly in kerala, Karnataka and Goa. The various estuarine systems of India has 2.7 million ha combined area with an estimated yield of 45-75 kg/ha [12]. Estuarine fish provide high quality protein with all the dietary essential amino acids for maintenance and growth of the human body [13]. As the world population is growing, the per capita consumption of seafood is also increasing rapidly. Because of health consciousness, the modern day man is interested in taking seafood more in view of its nutritional superiority than all other sources of food accessible to him. There remains no considerable study on selective estuarine fishes with regard to their nutritive value. Though estuarine fishes are being consumed in inland and other country, in India there is no evidence to support the estuarine fishes as edible. Hence, the present work was planned to study the proximate composition of estuarine fishes from two families namely Clupeidae and Engraulidae were dominant in Thengaithittu estuary for estimating their major proximate components such as total protein, carbohydrate, lipid, moisture and ash content.

MATERIALS AND METHODS

Fishes samples from two families namely Clupeidae (*Nematalosanasus, Sardinellagibbosa*, *Sardinellalongiceps*and*Ilishamelastoma*) and Engraulidae (*Stolephorusindicus, S.*

commersonii,*Thryssamystax*,*Thryssamalabarica*) are collected during 2009 – 2012, using cast net from the study area Thengaithittu estuary is located in (Lat $11^0$59'N long $79^0$50'E) South region of Puducherry and 162km South from Chennai. Specimens brought immediately to the laboratory for further studies. The estuarine fishes were kept in glass trough in tap water for 24 hours, for emptying and cleaning the gut. The scales were removed and the entire body tissue was dried at 55^0C (constant temperature) for 24 hours in the hot air oven. Then, the dried meat was powdered and the required quantity of powder was taken for the estimation of total protein, carbohydrate, lipid, moisture and ash.

Estimation of total Protein:

The Folin-Ciocalteu Phenol method of [14] was adopted for the estimation of total protein in the tissue.

Estimation of total Carbohydrate:

The estimation of total carbohydrate content, the procedure of [15] using phenol-Sulphuric acid was followed.

Estimation of total Lipid:

The chloroform-methanol extraction procedure of [16] was used for extracting lipid from the various body parts.

Moisture content:

The moisture content of the fish was estimated by drying a known weight (1g) of fish tissue in a hot air oven at 105^0c for 24 hrs. The differences in weight before and after drying are the amount of moisture present and the results are expressed in percentage of wet weight of the tissue[17].

Ash content:

The ash content was estimated by burning oven-dried sample in a muffle furnace at 550^0c [17].

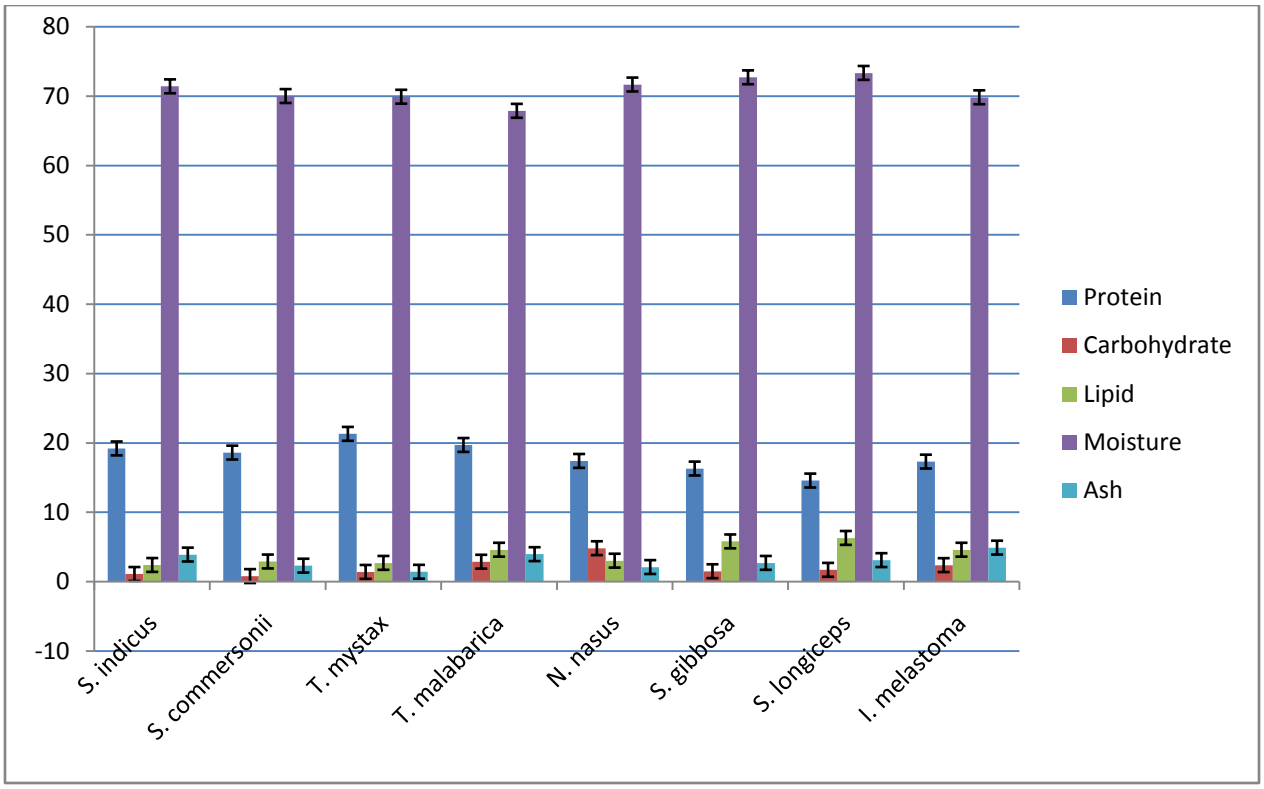
RESULTS

The proximate composition (%) such as protein, carbohydrate and lipid contents of*Stolephorusindicus, S. commersonii, Thryssamystax*, *T. malabarica*,*Nematalosanasus, Sardinellagibbosa*, *S. longiceps*and*Ilishamelastoma*arepresented inTable 1. The results of the present study revealed that the protein composition were high (19.2, 18.6, 21.3, 19.7, 17.4, 16.3, 14.57, & 17.3 %) followed by carbohydrate (1.1, 0.8, 1.4, 2.87, 4.82, 1.5, 1.7, & 2.38 %), lipid (2.4, 2.9, 2.7, 4.6, 3.02, 5.8, 6.3, & 4.6 %) moisture (71.4, 70,

69.9, 67.87, 71.66, 72.7, 73.33, & 69.82 %) and ash (3.9, 2.3, 1.42, 3.96, 2.1, 2.7, 3.1, & 4.9 %). Minimum protein (14.57 %) in *S. longiceps*was recorded and the maximum (21.3 %) was obtained in *T. mystax*. Minimum carbohydrate (0.8 %) in *S. commersonii* was recorded and the maximum (4.82 %) was noticed in *N. nasus*. Minimum lipid (2.4 %) in *S. indicus* was observed and the maximum (6.3 %) was recorded in *S. longiceps*. Minimum moisture (67.87 %) in *T. malabarica* and the maximum (73.33 %) was recorded in *S. longiceps*. Minimum ash (1.42 %) in *T. mystax* was recorded and the maximum (4.9 %) was recorded in *I. melastoma*.

Fishes	Protein	Carbohydrate	Lipid	Moisture	Ash
S. indicus	19.2±0.31	1.1±0.24	2.4±0.04	71.4±0.28	3.9±0.06
S. commersonii	18.6±0.42	0.8±0.9	2.9±0.05	70±0.42	2.3±0.08
T. mystax	21.3±0.08	1.4±0.21	2.7±0.64	69.9±0.3	1.42±0.47
T. malabarica	19.7±1.05	2.87±0.05	4.6±0.14	67.87±1.06	3.96±0.21
N. nasus	17.4±1.08	4.82±0.28	3.02±0.5	71.66±0.01	2.1±0.07
S. gibbosa	16.3±0.56	1.5±0.07	5.8±0.8	72.7±0.69	2.7±0.36
S. longiceps	14.57±0.24	1.7±0.06	6.3±0.6	73.33±0.78	3.1±0.78
I. melastoma	17.3±1.87	2.38±0.64	4.6±031	69.82±1.8	4.9±0.57

Table 1: Proximate composition of Clupeidae and Engraulidae species in percentage (%)



Graph 1: Graphical representation of proximate value (%) of Clupeidae and Engraulidae

DISCUSSION

Changes in Protein content:

The results of the present study revealed that the protein composition were 19.2, 18.6, 21.3, 19.7, 17.4, 16.3, 14.57, & 17.3 % (Table 1) & (Graph 1). The lowest protein content was recorded in *Sardinellalongiceps* 14.57%. Highest protein 21.3% were recorded in anchovies genus namely *Thryssamystax* 21.3%. Similarly [18] obtained a higher value in protein content in same genus namely *T. hamiltoni* 19.43% and [6] also obtained similar value 21.79% in *T. mystax* from Parangepettai waters and [19] recorded higher value in *T. mystax* 18.77% from Ratnagiri coast. [20] recorded protein value ranged between 20.68 to 22.06% in anchovy *Engraulisencrasicolus* from Central Adriatic. [21] discussed protein value ranged between 14.71 to 16.95% in anchovy *Stolephoruscommersonii* from kerala coast. [22] had recorded minimum protein content 7.50% in Bombay duck, *Harpodonnehereus*. Such lower values were not recorded in estuary of east coast in India. Majority of fishes had protein content ranged between 17 to 19%. In Pakistan, protein values of Sardine ranges between 14.11 to 18.78% [23]. [24]reported that the biochemical composition of the Indian Shad, *Ilishamelastoma* (Schneider) was showed a decrease in muscle-protein from 24.5% to 17.5% is in agreement with our present study *I. melstoma* shows similar results

17.3%. Again *Sardinellalongiceps* 14.57% coincides with [19] has protein content 16.50% from Ratnagiri coast. *Nematalosanasus* had protein content 17.4% is accordance with the studies of [25] obtained protein value 17.25%. In present study *S. gibbosa* has protein value 16.3% agreement with [26] they recorded protein value 14.64% wet weight in dark muscle of *S. gibbosa* caught from Thailand. The present study shows anchovies (Engraulidae) families had high protein content when compared to Clupeidae families. Amount of proteins in fish are influenced by the fat and water content. There is inverse relationship exists between the fat and protein contents of the edible part of one and the same fish. Proteins are not only necessary for enzyme and hormonal development [27] but also an important source of energy [28].

Changes in lipid content:

The average lipid content of fishes ranged between 2.4 to 6.3% (Table 1) & (Graph 1). Highest lipid content was recorded in *Sardinellalongiceps*6.3% and lower value 2.4% in *Stolephorusindicus* of anchovies. [23] also recorded high lipid values for sardine from Pakistan ranges from 5.59 to 15.45%. Generally fish species are grouped into four categories based on their fat contents namely lean fish (<2%), low fat (2-4), medium fat (4-8%) and high fat (>8%) [29]. About 50% of fishes were identified as low fat content and 50% are comes under medium fat fishes. Fish species of genus clupeidae shows wide range of lipid content from 3.02 to 6.3%. High fat content were recorded for sardinella spp. ranged from 5.8 to 6.3%. Similar results were obtained by [30] in *Sardinellagibbosa* of 1.9 to 8.4% from Karachi coast. [26] also obtained high value of lipid in *S. gibbosa* 4.77% from Thailand. The average lipid content of Stolephorusspp ranged between 2.4 to 2.9%, but slightly lower values were recorded by [22] for those species in their studies. Different authors reported high variations in fat content in the edible part of anchovy, withranges from 0.94 % to 33.30 % wet weight [31-34] The fish species of the family, clupeidae had medium fat contents ranged between 3.02 and 6.3% including *Sardinellalongiceps*. *Sardinellalongiceps*, being a fatty fish was reported to contain even 11.70% fat [22] and 8.45% [8] in earlier studies and such high values were not obtained in the same species examined in the east coast of India as well as in our study. [35] demonstrated that changes in fat content vary as the sardines drain or replenish their fat reserves in response to the spawning cycle, availability of food and other factors in the sea. Some authors have mentioned that the fat content is inversely proportional to the moisture content [36,37]. In fish species variations in the fat contents are significantly higher than that of other parameters. Reason could be due to the inherent differences in the species, seasonal as well as geographical variations. Variations in age as well as maturity within the same species were also contributed to the differences in the fat contents [38]. Basically fat content affects the flavour and sensory characteristic features of seafood products. So, relatively low fat content (<5%) of the fillet makes anchovy a better choice of raw material, thus not as submissive to lipid deterioration as other small pelagic fish with more pronounced seasonal variations [20].

Changes in carbohydrate content:

Carbohydrate in the tissues exist as glycogen, free sugars and protein bound sugars, which serve as energy reserves for various metabolic processes. They are the major source of energy in animals, rapid depletion of stored carbohydrates primarily in tissue are used for the metabolism. Polysaccharides occur both in free and in bound states along with proteins. The stored glycogen content in tissues is released by anaerobic glycolysis and is utilized to meet the energy requirement when needed [39]. The study thus supports the view that carbohydrate plays an insignificant role as energy reserve in aquatic animals [40]. The results of the present study revealed that the estuarinefinfishes carbohydrate composition was in 1.1, 0.8, 1.4, 2.87, 4.82, 1.5, 1.7, & 2.38 % (Table 1) & (Graph 1). Minimum carbohydrate (0.8 %) in *S. commersonii* was recorded and the maximum (4.82 %) was recorded in *N. nasus*. [13]on finfishes from vellar estuary shows carbohydrate ranges from 2.43 to 4.43%. Carbohydrate content in clupeidae species were ranged between 1.5 to 4.82% and engraulidae between 0.8 to 2.87%. [41] recorded carbohydrate value in *S. longiceps* a fatty fish were 6.41%. *Ilishamelastoma* in the present study had carbohydrate content 2.38% is in agreement with [41] in the same species recorded 2.24% from parangepettai coastal waters. Engraulidae species *S. commersonii*, in the present study has 0.8% carbohydrate value and similar results were obtaind in the same genus namely *S. devisi* shows 0.11% [42]. [6] recorded 0.41% and 0.40% carbohydrate value in *S. commersonii* and *T. mystax* from parangepettai waters. The carbohydrate level varies from species to species mainly due to availability of food and feeding habitat of the species and seasonal distribution. Both carbohydrate and lipids serve as source of energy, but these compounds contain different capacities of energy storage. Each gram of carbohydrates store four calories of energy [43].

Changes in moisture content:

The results of the present study revealed that the estuarine fishes moisture content was 71.4, 70, 69.9, 67.87, 71.66, 72.7, 73.33, & 69.82 % (Table 1) & (Graph 1). Moisture content was within previously reported range in other fishes [44]. Usually, moisture and lipid contents in fish fillets are inversely related and their sum is approximately 80% [45]. A linear relation between water and lipid content was determined for other marine fish species [46]. Moisture content has reported earlier by [22] shows 60-80% of moisture content in marine fishes of Indian coast and the present study also recorded similar values. In the present study *N. nasus* shows 71.44% moisture content has coincides with the findings of [25] they recorded 71.53% in their studies. Anchovy species namely *T. mystax* and *T. malabarica* has recorded 69.9 to 67.87% respectively. *T. hamiltoni* the same genus contains moisture value 77.76% [18]. Similarly *T. vitrirostris* also has moisture content 71.2% reported by [42]. *Stolephoruscommersonii* and *S. indicus* has moisture content ranges from 70 to 71.4% in our studies. [21] reported moisture content in *Stolephoruscommersonii* ranges from 76.47 to 80.65%. *Sardinellagibbosa* shows 72.7% is in accordance with [26] recorded 78.88 to 81.51% moisture content from Thailand waters. Clupeiod fish namely *Ilishamelastoma*and *Sardinellalongiceps* has moisture content 69.82% to 73.33% and similar results were recorded by [41] in *I. melastoma* 69.32% and [19] in *S. longiceps* recorded 78.95%. [22]and [8] also had reported 67.01% and 70.02% moisture content

respectively in oil sardine. Although the water content in many fishes is reported to increase in mature specimens with fall in muscle-protein and fat [40]. The moisture content varies not only from species to species but also from specimen to specimen and between different tissues.

Changes in ash content:

Ash is the measure of mineral content of any food including fish [47]. The ash content results of the present study of estuarine fishes were 3.9, 2.3, 1.42, 3.96, 2.1, 2.7, 3.1, & 4.9 % (Table 1) & (Graph 1). Highest ash content was recorded in Clupeoid fish namely *Ilishamelastoma* 4.9% and lowest value seen in Engraulidae species *T.mystax* 1.42%. Similarly [18] obtained ash value 1.42% in the same genus but different species namely *T. hamiltoni*. In the present study clupeidae ash content ranges from 2.1 to 4.9% and similar values are recorded in *S. longiceps* 3.94 to 1.77% [48]. *N. nasus* the gizzard shad has 2.1% ash, a reduced value 1.54% were recorded in *N. nasus* from Arabian Gulf by [25]. Stolephorusspp has 2.3 to 3.9% ash in our study. [21] given out the value ranges from 2.40 to 6.63% for the species *S. commersonii* in accordance with our results. [20] recorded value ranges from 1.34 to 1.49% in the same genus but different species of anchovy namely *Engraulisencrasicolus* in central Adriatic. The concentration of trace elements and minerals that contribute for the total ash contents are known to vary in fish depends on their environment, behaviour of feeding, ecosystem and migration even within the same locality [49-51].

CONCLUSION

The present study reveals that biochemical composition varied considerably for all the fishes. The protein content was highest in anchovy species, *Thryssamystax*. Clupeidae species like *Sardinellalongiceps*, *Ilishamelastoma* and *Nematalosanasus* are having high moisture, lipid, ash and carbohydrate contents respectively. From the above observation it is clear that the estuarine fisheswith rich nutritive value can be used for alternate source as an regular sea food which supplies nutrients for the growing children, pregnant women and people suffering from malnutrition.

REFERENCES

1. Marchioli, R (2002). Early protection against sudden death by n-3 polyunsaturated fatty acids after myocardial infarction: Timecourse analysis of the results of GISSI-prevenzione. Circ. 105: 1897-1903.
2. Sidhu, KS (2003). Health benefits and potential risks related to consumption of fish or fish oil. Regul. Toxicol. Pharm. 38: 336-344.
3. Carlson, SE and Werkman, SH (1996). A randomized trial of visual attention of preterm infant fed docosahexaenoic acid until two months. Lipids, 31: 85-90.
4. Calder, PC (2003). New evidence in support of the cardiovascular benefits of long-chain n-3 fatty acids. Ital.Heart J.4: 427-429.

5. Hardy, RW and Masumoto, T (1990). Specification for marine byproducts for aquaculture. Proceedings International conference of Fish Byproducts. Alaska Sea Grant College Program. Anchorage. Ak, pp: 109-120.
6. Ashwinikumar, Sanjeev Kumar, Kannan, D, BabuRao, Thirunavukkarasu, P and Soundrapandiyan, P (2014). Evaluation of Nutrients in Trash Fish, Parangepettai (South East Coast of India). International Journal of Research in Fisheries and Aquaculture, 4(2): 82-85.
7. Palanikumar, M, RubaAnnathai, A, JeyaShakila, R and Shanmugam, SA (2014). Proximate and Major Mineral Composition of 23 Medium Sized Marine Fin Fishes Landed in the Thoothukudi Coast of India. J Nutr Food Sci 4: 259. 1-7.
8. Ravichandran, S, Kumaravel, K and Florence, PE (2011). Nutritive Composition of some Edible Fin Fishes. Int J Zoological Res 7**:** 241-251.
9. Das, S and Sahu, BK (2001). Biochemical composition and calorific content of fishes and shellfishes from Rushikulya Estuary, South Orissa coast of India. Indian J. Fish, 48: 297-302.
10. Nair (1965). Biochemical of some marine fishes. CMFRI, Kochi.
11. Love, RM (1980). The Chemical Biology of Fishes. Brown ME (Edn), Academic press. New York, USA.
12. Jhingran, AG (1991). Development potential and constraints of inland fisheries management in India. IPFC Proceedings, Bogor, Indonesia 24-29 June 1991,FAO Fisheries Report B.No. $85 FAO Rome. pp. 143-161.
13. Shanker, S, Marichamy, G, Saradha, A, Nazar, AR and BadhulHaq, MA (2011). Proximate composition and bioaccumulation of metals in some finfishes and shellfishes of Vellar Estuary (South east coast of India) European Journal of Experimental Biology, 1 (2): 47-55.
14. Lowry, OH, Rosebrough, NJ, Farr, AL and Randall, RJ (1951). Protein measurement with the tolin phenol reagent. J. Biol. Chem, 193: 265-273.
15. Dubois, M ,Giller, KA, Hamilton, JK, Roberts, RA and Smith, F (1956). Colorimetric method for determination of sugars and related substances. Analyt. Chem., 28: 350-356.
16. Floch, J, Lees, M and Sloane-Stanley, GH (1956). A simple method for the isolation and purification of total lipids from animal tissues. J. Biol. Chem., 226: 497-509.
17. AOAC, 2000. Association of Official Analytical Chemists Official Methods of Analysis. (17th ed.). W. Hortuntzed (Ed), Washington.
18. Yesser, AKT (1995). Studies of some aspects of chemical composition of chemical composition of two fish species anchovy, *Thryssahamiltoni*and sea catfish, *Arius thalassinus*. Marina Mesopotamica**,** 10(2): 351-358.

19. SankpalSagar, NaikwadePratap and PatilRaju (2012). Quantification and nutritional value of bycatch of Ratnagiri coast, Maharashtra, India. Asian Journal Of Biology and Biotechnology, 1(108): 1-8.
20. Vida Simat and TanjaBogdanovic (2012). Seasonal changes in proximate composition of anchovy (*Engraulisencrasicolus, L.*) from the central Adriatic. ActaAdriat., 53(1): 125-132.
21. Sankar, TV, Anandan, R, Suseela Mathew, Asha, KK, Lakshmanan, PT, Jones Varkey, Aneesh, P and Mohanty, BP (2013). Chemical composition and nutritional value of Anchovy (*Stolephoruscommersonii*) caught from kerala coast, India. European Journal of Experimental Biology, 3(1): 85-89.
22. Gopakumar, K (1997). Biochemical composition of Indian food fish. Central Institute of Fisheries Technology. Central Institute of Fisheries Technology, Cochin.
23. Munshi, AB, Ali, SA and Shakir, S (2005). Seasonal variations in Biochemical composition of Sardins and Mullet from Pakistani waters. Jour. Chem.Soc.Pak. 27(2): 190-193.
24. Selvaraj, GSD (1984). A note on biochemical composition of the Indian shad *Ilishamelastoma* (Schneider). Indian Journal of Fisheries, 31(1): 162-165.
25. Hantoush, AA, Al-Saad, HT and Abdul-Hussain, FA (1999). Seasonal variations of some biochemical aspects of the muscles of some freshwater and marine fishes from Shatt Al-Arab River and Northwest Arabian Gulf. Marina Mesopotamica**,** 14(2): 427-453.
26. ManatChaijan, SoottawatBenjarkul, WonnopVisessanguan and Cameron Faustman (2004). Characteristics and gel properties of mucles from Sardine (Sardinellagibbosa) and mackerel (Rastrelligerkanagurta) caught in Thailand. Food research International. 01/2004. DOI 10.1016/J.Food. res. 6-12.
27. Wilson, RP (1986). Protein and Aminoacid requirements of fishes. Annual Review of Nutrition, 6: 225-230.
28. Halver, JE and Hardy, RW (2002). Fish Nutrition, 3 rd edition. Academic press, San Diego, CA, USA.
29. Ackman, RG (1989). Nutritional composition of fats in seafood's. Progress in Food and Nutrition Science 13: 161-289.
30. KherunNisa and Asadullah (2008). Seasonal variation in lipid composition of sardine (Sardinellagibbosa) from Karachi coast J.chem.soc. 30 (3): 436-441.
31. FAO (1989). Yield and nutritional value of the commercially more important fish species. FAO Fisheries Technical Paper. No. 309. Torry Research Station, Aberdeen, UK, pp. 1-187.
32. Karacam, H and Boran, M (1996). Quality changes in frozen whole and gutted anchovies during storage at ±18°C. Int. J. Food Sci. Tech., 31: 527-531.
33. Gokoglu, N, Ozden O, Erkan N, Baygar T and Metin, S (1999). Seasonal variation in fat content of anchovy (*Engraulisencrasicolus*). Int. J. Food. Sci. Tech., 34: 401-402.
34. Kaya, Y and TURAN, H (2010). Comparison of protein, lipid and fatty acids composition of anchovy

(*Engraulisencrasicolus*L. 1758) during the commercial catching season. J. Muscle Foods, 21: 474–483.

35. Hardy, R and Keay, JN (1972). Seasonal variations in the chemical composition of corn fish mackerel, *Scomberscombrus*(L), with detailed reference to the lipids. Int J Food SciTechnol 7: 125-137.
36. Nurnadia, AA, Azrina, A and Amin, I (2011). Proximate composition and energetic value of selected marine fish and shellfish from West coast of Peninsular Malaysia. Int Food Res J 18: 137-148.
37. Paul, JU and Vivian, NA (2011). The Biochemical Composition of Three Exotic Fish Delicacies: *Scomberscombrus*, (Linnaeus, 1758), *Trachurustrachurustrachurus*(Linnaeus, 1758), and *Sardina pilchard* (Walbaum, 1792) Frozen and imported into Nigeria. Pak J Nutr 10: 1158-1162.
38. Piggot, GM, Tucker, B (1990). Seafood: Effects of Technology on Nutrition. New York, USA.
39. Vijayavel, K, Anbuselvam, C, Balasubramanian, MP, Deepak Samuel, V and Gopalakrishnan, S (2006). Assessement of biochemical components and enzyme activites in the estuarine crab *Scylla tranquebarica* from naphthalene contaminated habitants. Ecotoxicol. 9(5): 469-476.
40. Love, RM (1970). The Chemical Biology of Fishes. 547 pp.
41. Marichamy, G, BadhulHaq, MA, Vignesh, G, Sedhuraman, V and Nazar, AR (2012). Assessment of Proximate and Mineral composition of twenty edible fishes of Parangepettai Coastal waters. International Journal of Pharma and Bio Sciences 3(2): 54-64
42. Bijukumar, A, Deepthi, GR and Padmakumaran Nair (2013). Proximate composition of fish in the Trawl by catch and discards of Kerala, South-West Coast of India. Journal of Aquatic Biology & Fisheries, 1(1&2): 106-116.
43. Louise Tremblay (2014). Lipids vs Carbohydrate for energy storage, Food & Drink > Diet and Nutrition, Live Strong. Com.
44. Gallagher, ML, Harrel, ML and Rulifson, RA (1991). Variation in lipid and fatty acid contents of Atlantic Croaker, Stiped Mullet and Summer Flounder. Transcations of the American Fisheries Society, 120: 614-619.
45. Food and Agriculture Organisation (1999). World production of fish, crustaceans and mollusks by major fishing areas. Fisheries Information Data and Statistics Unit (FIDI), Fisheries Department, FAO Rome. 33pp.
46. Wheeler, SC and Morrissey, MT (2003). Quantification and distribution of lipid, moisture,and fatty acids of West Coast albacore tuna (*Thunnusalalunga*). J. Aquat. Food Prod. Tech. 12: 3–16.
47. Omotosho, OE, Oboh, G and Iweala, EEJ (2011). Comparative effects of local coagulants on the nutritive value, invitro multi enzyme protein digestibility and sensory properties of Wara cheese. Int J Dairy Sci 6: 58-65.
48. Sheril Ann Shaji and Hindumathy, CK (2013). Chemical composition and amino acid profile of *Sardinellalongiceps*collected from Western coastal areas of Kerala, India. Journal of Biology and Earth Sciences. 3,(1): 129-134.
49. Andres S, Ribeyre F, Toureneq, JN and Boudou, A (2000). Interspecific comparison of cadmium and

Zinc contamination in the organs of four fish species along a polymetallic pollution gradient (Lot River,France). Sci Total Environ 284: 11-25.

50. Canli, M and Atli, G (2003). The relationship between heavy metal (Cd,Cr,Cu,Fe,Pb and Zn) levels and size of six Mediterranean fish species. Environmental Pollution 121: 129-136.
51. Abdallah and Maha Ahmed Mohamd (2007). Speciation of trace metals in coastal sediments of El-Max Bay South Mediterranean Sea-west of Alexandria, (Egypt). Environmental Monitoring Assessment 132: 111-123.