How to Cite:
Govindarajan, E., Sivamani, G., Veerabathiran, R., Pandian, A., & Mariappan, R. (2022). Peroximate composition and different types of amino acids analysis of economically important finfishes – Sardinella fimbriata, Scomberomorus guttatus in Nagapattinam Coast, Tamil Nadu, India. *International Journal of Health Sciences*, *6*(S5), 10642–10654.
https://doi.org/10.53730/ijhs.v6nS5.10860

Peroximate composition and different types of amino acids analysis of economically important finfishes – *Sardinella fimbriata, Scomberomorus guttatus* in Nagapattinam Coast, Tamil Nadu, India

Elangovan Govindarajan
PG & Research Department of Zoology, A.V.V.M. Sri Pushpam College (An Autonomous Institution Affiliated to Bharathidasan University), Poondi, Thanjavur 613503, Tamil Nadu, India.

Ganesan Sivamani
PG & Research Department of Zoology, A.V.V.M. Sri Pushpam College (An Autonomous Institution Affiliated to Bharathidasan University), Poondi, Thanjavur 613503, Tamil Nadu, India.
Email: ganesanmolbio@gmail.com

Ramakrishnan Veerabathiran
Faculty of Allied Health Sciences, Chettinad Academy of Research and Education, Chettinad Hospital and Research Institute, Kelambakkam 603 103, Tamil Nadu, India.
Email: rkgenes2@gmail.com

Arjun Pandian
Department of Biotechnology, PRIST Deemed University, Thanjavur 613 403, Tamil Nadu, India.
Email: arjungri@gmail.com

Ramasamy Mariappan
PG & Research Department of Zoology, A.V.V.M. Sri Pushpam College (An Autonomous Institution Affiliated to Bharathidasan University), Poondi, Thanjavur 613503, Tamil Nadu, India.
Corresponding author email: pmr.spc@gmail.com

***Abstract*---**The current study was undertaken to investigate the composition of peroximate in relative to season, types of sexes, and size groups in edible tissues of finfishes of *Sardinella fimbriata* and *Scomberomorus guttatus* in Nagapattinam coast, Tamil Nadu, India. *S.*

Manuscript submitted: 9 March 2022, Manuscript revised: 18 May 2022, Accepted for publication: 27 June 2022

fimbriata, indeterminates are 4-10 cm, male and females are 11-19, in *S. guttatus* the indeterminates are 4-12 cm, male and females are 13-24. Variations in proximate composition noticed in *S. fimbriata* are depicted. Moisture content ranged between 70.35 and 76.79%. Both the size groups of indeterminates (8-10 and 4-7 cm) exhibited elevated values during pre-monsoon (76.34 followed by 76.11%) and small values during post-monsoon (4-7 and 8-10 cm; 72.44 followed by 72.36%). Variations in proximate composition noticed in *S. guttatus* are depicted, the moisture content ranged between 70.08 and 77.88%. Both the size groups indeterminates (4-7 and 8-10 cm) exhibited elevated values during monsoon (77.88 followed by 77.05%) and minute values during summer (8-10 and 4-7 cm; 74.33 followed by 74.29%). The amino acid pleased of *S. fimbriata* was (91.78%), results of current study shows that the necessary amino acids (EAA) percentage was more (49.25%) than that of supplementary amino acid (NEAA, 42.76%). The highest amount EAA obtained on lycine (11.64%) followed by leucine (6.54%). Total amino acid content of *S. guttatus* was obtained (93.98%), results of current revision showed that the essential amino acids (EAA) percentage was extra (51.85%) than that of non-essential amino acid (NEAA, 43.88%). Topmost amount of EAA obtained on lycine (10.87%) followed by arginine (7.87%). It can be concluded that the finfishes was a plankton feeder and status of the stock was in over fishing condition, consuming finfishes economically important for human consumption.

***Keywords*---**Arginine, Finfishes, Important amino acids, Lycine, Peroximate.

Introduction

The nutrients act as very important role on the development, growth in physical, and maintenance of regular body functions, physical activity and health. Nutrition is a essential prerequisite to maintain life. The nutrients necessity is obtained throughout a sensible alternative and amalgamation of a diversity of foods (Ramakrishnan and Venkat Rao, 1995). An impartial diet should supply around 60-70% in the total amount of calories from carbohydrates, rather starch, about 10-12% in proteins and 20-25% in fats. In accumulation, other nutrients such as nutritional fiber, phytochemicals and antioxidants encourage constructive health reimbursements (Ramakrishnan and Venkat Rao, 1995). A most important nutrition related problem in India is constant beneath nourishment connected with small fat ingestion (FAO/WHO, 1992).

Fish is accepted universally as a rich source of nutrition for millions. It is considered as a remedy to set right nutritional deficiencies. Fish utilization is therefore mounting quickly in many countries. Aquaculture finfish has been recommended as a vector for introduce non inhabitant, and potentially enveloping species, moreover through unintentional escapes of non aboriginal farmed fish or through acting as a vector for drawback mountaineering species. Fisheries for demersal finfish species are several of the major, the majority inexpensively

significant fisheries in the earth. Although escaped farmed fish are consideration to have elevated transience in the undomesticated (Fleming et al., 2000), numerous studies recommend that fish undeveloped introductions might put together in uncultivated ecosystems. Composition of proximate, amino acid profile and mineral composition of suitable for eating muscle tissue in 17 marine fish fishes (hilsa, seer, pomfret black, anchovy, Jew fish, conger eel, giant perch, mackerel, mullet, pomfret trevally, white, Bombay duck, lesser sardine, threadfins, pink perch, shark and catfish) were analyzed through Chandrasekhar and Deosthale (1993).

The study on amino acid showed the relative concentration of major amino acids to be homogenous in fish, the lysine to be unique and all other amino acids to differ slightly in their presence (Braekkan and Boge, 1962). The amino acid profile also varied in different regions of fishes. Fatty acid of muscle composition has been recorded for *Merluccius capensis, M. paradoxus* (Wessels and Spark, 1973) and *M. australis* (Vlieg and Body, 1988). Krajnovic-Ozretic et al. (1994) experimental elevated attentiveness of extremely unsaturated fatty acids (n-3) in white and liver muscle of natural sea bass compared to their farmed counterparts. Fatty acids and lipids of two pelagic cottoid fishes (*Comephorus* spp.) were studied by Kozlova and Khotimchenko (2000). Senthilkumar (2001) studied the systematic, biochemical and toxinology of Tetraodontid fishes occurring along Nagapattinam and adjacent coastal waters. Composition of fatty acid cultured and natural sea bass (*Dicentrarchus labrax*) was noticed by Alasalvar et al. (2002). The mineral nutrition of fish has been moderately well investigated and several of the achievements have been decorated in the reviews of Watanabe et al. (1989), Hilton (1989), Lall (1989) and Steffens (1989). Alasalvar et al. (2002) investigated the differences connecting cultured and wild sea bass (*Dicentrarchus labrax*) in trace mineral composition. Solar dried sardines of different character were examined for nutrient contented and for digestibility of nutrient and N balance in sheep (Early et al., 2001).

Based several parameters and economically important *Sardinella fimbriata, Scomberomorus guttatus* selected for the intermediates, male and female selected based on different sizes, proximate composition – moisture content in relative to different seasons, sex and size groups with the view of assessed in amino acid profiles and their percentage contributions.

Materials and Methods

Collection and preparation of samples

The finfishes were collected frequently throughout 4 seasons; monsoon, pre monsoon, post monsoon and summer) in Nagapattinam coastal for a phases of one year from July 2018 to June 2019. Fishes was examined through observing the eyes brightness, color of gills and texture of the muscles. Identified fishes sexes and grouped into five size groups based on their total length the purpose of identification, publications of Munro (1955) and Fischer and Bianchi (1984), dorsolateral epaxial white muscle portion was taken, about 2 cm behind the head, followed through samples are dried (60°C; 24 h) in an oven, it's were crammed in air tight polyethylene covers and reserved in desiccators. The oven dried samples were delicately powdered and used in further analysis.

Composition of Proximate

The composition proximate including moisture contents of the desiccated muscle tissue was estimated; determine the moisture substance (1 g) clean tissue was dried in oven at a invariable temperature (105°C) for 24 hours (AOAC, 1990). The size groups commonly available in the markets i.e. 11-13 cm in the case of *Sardinella fimbriata*, 13-16 cm in *Scomberomorus guttatus* was selected for further entire studies.
Moisture percentage (%) = Wet weight –Dry weight (mg) / Weight of the sample (mg) × 100

Amino acids

The muscle from 10 individuals in each species was pooled and used in the analysis. The samples collected and its oven dried (60°C; 24 h), packed in air tight polyethylene covers and reserved in desiccators. The dried (oven) samples were delicately powdered before estimate the amino acid contour. The samples were hydrolyzed with 6-N HCl (110°C) for 22 h. The amino acids were determined throughout an automatic amino acid analyzer (SHIMADZU High Performance Liquid Chromatography LC 10A). Hydrolyzed samples (20 µl) were injected into column. The eluded amino acids were quantitatively detected through fluorescent detector (FLD 6A) using *o*-phthaldialdehyde reagent. The amino acids were then recognized through contrast their retention time with the typical amino acids run at matching conditions (AOAC, 1990).

Statistical analysis

The arithmetical examination were prejudiced through ANOVA (One-way Analysis of Variance) to determine the remarkable of variation of resources of an collection of administration groups, with the DMRT (Duncan's Multiple Range Test) through resources of SPSS (Statistical Package for the Social Sciences) (Version 16.0) ranged level (5%) package, standards are obtainable as consequence ($P < 0.05$) (Daoud et al., 2011).

Results and Discussions

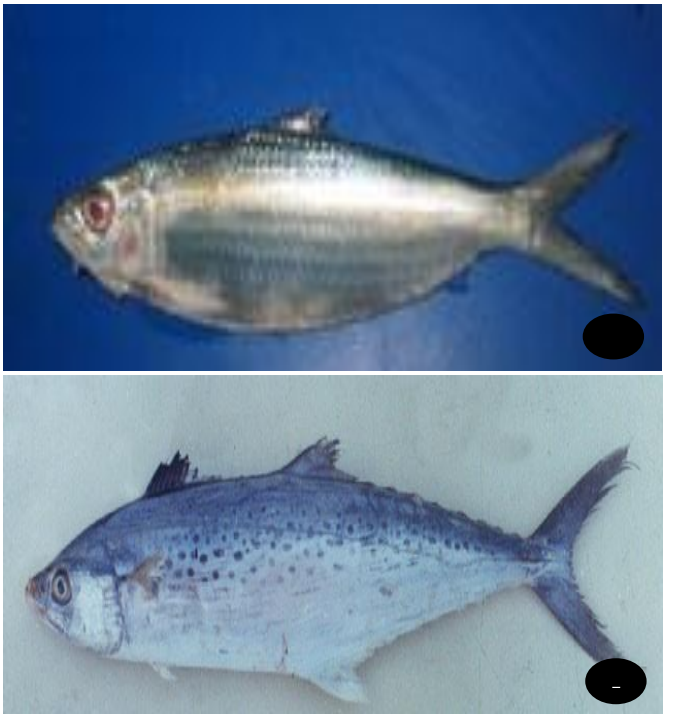
The seasonal variations in proximate composition – moisture contents of finfishes are presented; every assessment in results represents the mean of triplicate samples for each species. It was establish extremely difficult to compare the monthly variations, as all the two species exhibited wide fluctuations in their nutritional composition. For the sake of expediency, regular seasonal values were calculated through summing the monthly values. Different size (cm) groups of indeterminates, males and females of two finfish species collected from Nagapattinam coast, *Sardinella fimbriata*, indeterminates 4-10 cm, male and females 11-19, *Scomberomorus guttatus* indeterminates 4-12 cm, male and females 13-24 (Table 1; Fig. 1).

Table 1. Size groups of indeterminates, males and females of two finfish species collected from Nagapattinam coast

Species	Indeterminates (CM)		Males and Females (CM)					
			Males	Females	Males	Females	Males	Females
Sardinella fimbriata	4-7	8-10	11-13	11-13	14-16	14-16	17-19	17-19
Scomberomorus guttatus	4-8	9-12	13-16	13-16	17-20	17-20	21-24	21-24

Variations in proximate composition - moisture content of *Sardinella fimbriata* and *Scomberomorus guttatus*

Variations in proximate composition noticed in *S. fimbriata* are depicted (Table 2). Moisture content ranged between 70.35 and 76.79%. Both the size groups of indeterminates (8-10 and 4-7 cm) exhibited elevated values during pre-monsoon (76.34 followed by 76.11%, respectively) and small values during post-monsoon (4-7 and 8-10 cm; 72.44 followed by 72.36%, respectively). Amongst different size groups in both male and female sexes, high value was observed and recorded in male during pre-monsoon (11-13 cm: male-76.79%; followed by 14-16 cm; 75.43%) and lowest amount was recorded in male post-monsoon (11-13 cm; 70.45% followed by 17-19 cm; 70.41%). Among female highest amount of moisture content was obtained in pre-monsoon (11-13 cm; 76.38% followed by 14-16 cm; 75.85%), smallest amount of moisture content obtained in post-monsoon (11-13 cm; 72.33% followed by 17-19 cm; 70.35%). Low values were observed in superior size groups while elevated values in slighter size groups (Table 2).



Finfishes selected for present study

a. *Sardinella fimbriata*, b. *Scomberomorus guttatus*

Table 2. Moisture content variations in *Sardinella fimbriata* in relation to sex, size, season and groups (Dry weight % basis)

Species	Indeterminates (CM)		Males and Females (CM)					
			Males	Males	Males	Females	Females	Females
S. fimbriata	4-7	8-10	11-13	14-16	17-19	11-13	14-16	17-19
Monsoon	75.35± 0.16	75.02± 0.15	73.43± 0.47	73.65± 0.32	73.41± 0.32	75.65± 0.32	74.55± 0.55	74.44± 0.76
Pre-monsoon	76.11± 0.55	76.34± 0.54	76.79± 0.54	75.43± 0.76	73.55± 0.74	76.38± 0.54	75.85± 0.76	74.79± 0.43
Post-monsoon	72.44± 0.76	72.36± 0.54	70.45± 0.32	71.36± 0.43	70.41± 0.54	72.33± 0.54	72.85± 0.55	70.35± 0.54
Summer	74.75± 0.76	74.11± 0.76	74.22± 0.74	73.44± 0.54	71.05± 0.87	75.65± 0.87	74.25± 0.54	73.26± 0.54

Table 3. Moisture content variations in *Scomberomorus guttatus* in relation to sex, size, season and groups (Dry Wt % basis)

Species	Indeterminates (CM)		Males and Females (CM)					
			Males	Males	Males	Females	Females	Females
S. fimbriata	4-7	8-10	11-13	14-16	17-19	11-13	14-16	17-19
Monsoon	77.88± 0.54	77.05± 0.55	75.75± 0.55	75.71± 0.55	73.91± 0.55	76.85± 0.54	77.02± 0.54	73.92± 0.54
Pre-monsoon	75.78± 0.54	74.44± 0.32	72.22± 0.54	70.08± 0.54	70.03± 0.87	72.45± 0.54	72.33± 0.43	71.43± 0.54
Post-monsoon	77.77± 0.32	77.63± 0.76	73.85± 0.54	73.81± 0.76	72.95± 0.54	74.87± 0.43	75.01± 0.54	72.91± 0.32
Summer	74.33± 0.54	74.29± 0.55	72.25± 0.76	71.44± 0.43	71.39± 0.76	72.21± 0.76	71.68± 0.54	71.61± 0.54

Variations in proximate composition noticed in *S. guttatus* are depicted (Table 3). Moisture content ranged between 70.08 and 77.88%. Both the size groups indeterminates (4-7 and 8-10 cm) exhibited elevated values during monsoon (77.88 followed by 77.05%, respectively) and minute values during summer (8-10 and 4-7 cm; 74.33 followed by 74.29%, respectively).

Among different size groups in both male and female sexes, high value was recorded in male during monsoon (11-13 cm; male-75.75%; followed by 14-16 cm; 75.71%) and lowly amount was recorded in male pre-monsoon (14-16 cm; 70.08% followed by 17-19 cm; 70.03%). Among female highest amount of moisture content was obtained in monsoon (14-16 cm; 77.02% followed by 11-13 cm; 76.85%), minimum amount of moisture content obtained in summer (14-16 cm; 71.68% followed by 17-19 cm; 71.61%). Low values were observed in bigger size groups while elevated values in minor size groups (Table 3).

Different types of amino acids in *Sardinella fimbriata* and *Scomberomorus guttatus*

Results of the amino acid analyses in the two species are presented in Table 4. Noteworthy differences ($P < 0.05$) between the fishes were experiential in the amino acid composition. Conversely no important difference ($P > 0.05$) was observed in tyrosine content among the finfishes.

The total amino acid content of *S. fimbriata* was (91.78%), results of current revision showed that the essential amino acids (EAA) percentage was more (49.25%) than that of non essential amino acid (NEAA, 42.76%). The highest amount EAA obtained on lycine (11.64%) followed by leucine (6.54%), histidine (5.76%) and lowest amount of EAA amino acid obtained on methionine (2.95%). In highest amount of NEAA was notice on glutamic acid contributed the uppermost percentage (14.89%) followed by aspartic acid (9.65%), alanine showed (5.01%) and the lowest amount of NEAA concentration was observed on cystine (1.76%). The levels of isoleucine, methionine, phenylalanine, threonine, valine, cystine, glycine, proline, serine and tyrosine were found to be less than 5% of the total amino acid concentration. Tryptophan was completely denatured during the acid hydrolysis of proteins. So, the tryptophan content was not included in the total EAA composition (Table 4).

Table 4. Amino acid composition (Mean ± S.D.) of muscle proteins in two finfish species collected from Nagapattinam coast (Total amino acids %)

Amino acid	*Sardinella fimbriata*	*Scomberomorus guttatus*
Arginine	5.43 ± 0.16	7.87 ± 0.15
Histidine	5.76 ± 0.47	4.56 ± 0.54
Isoleucine	4.32 ± 0.65	5.76 ± 0.54
Leucine	6.54 ± 0.84	4.42 ± 0.32
Lysine	11.64 ± 0.54	10.87 ± 0.43
Methionine	2.95 ± 0.75	4.75 ± 0.32
Phenylalanine	3.87 ± 0.74	3.65 ± 0.47
Threonine	4.65 ± 0.44	5.84 ± 0.35
Valine	4.67 ± 0.43	4.89 ± 0.34

Σ EAA	**49.25**	**51.85**
Alanine	5.01 ± 0.34	4.72 ± 0.32
Aspartic acid	9.65 ± 0.74	8.84 ± 0.87
Cystine	1.76 ± 0.43	1.83 ± 0.64
Glutamic acid	14.89 ± 0.55	14.98 ± 0.76
Glycine	4.93 ± 0.76	4.93 ± 0.65
Proline	1.98 ± 0.54	2.91 ± 0.43
Serine	3.67 ± 0.76	3.76 ± 0.74
Tyrosine	2.94 ± 0.54	3.75 ± 0.65
Σ NEAA	**42.76**	**43.88**
Σ TAA	**91.78**	**93.98**

The Mean values ± S.D. of examination, calculations for reproduction samples Means in the similar row sharing dissimilar superscripts are considerably different, ($P < 0.05$); standards without letters inside a line are not extensively dissimilar ($P > 0.05$), Essential amino acids - EAA; non-essential amino acids – NEAA; total amino acids - TAA.

The total amino acid contented of *S. guttatus* was obtained (93.98%), results of current revision showed that the percentage of necessary amino acids (EAA) was extra (51.85%) than that of non-essential amino acid (NEAA, 43.88%). Topmost amount of EAA obtained on lycine (10.87%) followed by arginine (7.87%), threonine (5.84%) and lowest amount of EAA amino acid obtained on phenylalanine (3.65%). In NEAA chief amount of amino acid was notice on glutamic acid contributed the uppermost percentage (14.98%) followed by aspartic acid (8.84%), glycine showed (4.93%) and the lowest amount of NEAA concentration was observed on cystine (1.83%), The levels of isoleucine, methionine, phenylalanine, threonine, valine, cystine, glycine, proline, serine and tyrosine were found to be less than 5% of the total amino acid concentration (Table 4).

According to Kudale and Rathod (2015) the moisture is the major component; during the study period on an average it contributed (68.60% & 68.89%) in males and females, in males and females maximum moisture content was observed in males and females, lowest moisture content was observed in 60.16% and 61.7%; varied between 59.71% to 61.06%, and 61.03% to 62.37%. The content of moisture in tilapia was 2.46% minor than that of *S. fimbriata* and *C. gariepinus* (Hemung, 2013). The dampness content is in *S. fimbriata* (78.2%) and in *S. longiceps* (69.8%) (Sheeba et al., 2021). Edirisinghe, et al. (2000) reported the lowly entitlement of moisture (69.4%) in white sardine *S. albella* in Sri Lankan waters. As per Castrillon, et al. (1997), in *Clupeapil chardus* the content of moisture (60.7%) was recorded.

Totally 17 amino acids were identified in the present study, qualitatively there was no difference in amino acids between species but quantitative difference was noticed. Amino acid composition of the muscle proteins of various fish and shellfish was studied by Nair and Suseela (2000). In their study, lysine was found to be high and tryptophan low. Several researchers (Kulkarni, 1953; Wu et al., 2000; Kitts et al., 2004) studied the amino acid make up of fish and found that

fish and fish products provide protein of the finest nutritive quality, when evaluated on the basis of its content of EAA.

Muscles fish is recognized to surround an outstanding composition of amino acids (Yanes et al., 1976; Venugopal et al., 1996) and is a exceptional resource of physiologically valuable amino acids like histidine, arginine, lysine and taurine (Metzner et al., 2001). The study of amino acid showed that the relative amount of major amino acids is homogenous in fish. Lysine is found to be unique and all other amino acids differed slightly in their presence (Braekkan and Boge, 1962). Anon, (2002b) noticed no significant differences between the levels of amino acids. In contrast to the above, the amino acid composition in the present study exhibited significant variations among the four finfishes.

Sivashanthini (2004) observed that the muscle lipid in *Gerres abbreviatus* declined during monsoon to increase again during post-monsoon and summer months and in G. filamentosus, the muscle lipid was highest during pre-monsoon and it declined significantly during monsoon and postmonsoon to increase again during summer in Nagapattinam waters.

Environmental parameters like temperature, rainfall, thermocline, upwelling, solar periodicity, etc. are known to greatly influence the spawning of pelagic fishes like sardines and mackerels (Jeyaprakash, 2002; Elaiyaraja et al., 2012). Biochemical constituents of fish are subjected to marked continuing changes due to different physiological and supplementary factors such as maturation and spawning (Sathya Shree, 1981; Varadharajan et al., 2009).

The moisture content of muscle in all the size groups of males and females was high during spawning months and very low during post spawning months in all the four species studied presently. Similarly, highest percentage of water was observed in muscle during the spawning season of *Clarius batrachus* (Bano, 1975), *Mugil cephalus* (Das, 1978) and *Osteomugil cunnesius* (Sathya Shree, 1981). Low values of moisture during post spawning seasons have been observed in several other fishes by various authors (Parulekar and Bal, 1969).

Living sequence changes in spawning fish are known to transform fish muscle tissue. Studies with spawning of salmon have shown that protein, lipid and carotenoids are assembling into skin and gonads (Halver, 1989). Lipids encompass simply dry weight (20%) of their ovaries (Tocher and Sargent, 1984) and protein is the standard power foundation for gonadal expansions (Love, 1970; Stansby, 1976).

The sexual adulthood of the fish affects the lipid contented owing to augmented fat consumption of reserves throughout the spawning period. Food accessibility and ecological, temperature, water are also significant factors. Thus, fish will have different levels of lipid contents, based on the cycle of breeding and time of year (Pigott and Tucker, 1987; Beltran et al., 1991). In all the species, high ash values in the muscle coincided with the spawning period and low principles with post spawning months. Similar findings were observed by Sathya Shree (1981) in *Osteomugil cunnesius*. Seasonal changes in ash content have also been reported in other fishes (Das, 1978). The body energy reserves of *Osteomugil cunnesins* and

O. speigleri were depleted during spawning and the rate of recovery after spawning varied considerably in either sex (Sathya Shree, 1981).

In the present study, the maximum calorific values were observed throughout post spawning months and high values throughout pre spawning months. During spawning months, however, the calorific content was low and it was attributed to storage of energy reserves occurring first in the muscle during post spawning months and subsequently getting transferred to gonads.

Conclusion

The information on proximate composition of finfishes has fundamental importance in the application of different technological processes. The present study showed that consumption of *S. fimbriata* and *S. guttatus* during pre-monsoon and post-monsoon is advantageous in Nagapattinam coast, as good amount amino acids found in finfishes. The results of the current study clearly revealed that two species of finfishes studied are containing good quantities of TAA, EAA and NEAA.

Reference

Alasalvar C, Taylor KDA, Zubcov E, Shahidi F and Alexis M. (2002) Differentiation of cultured and wild sea bass (*Dicentrarchus labrax*): Total lipid content, fatty acid and trace mineral composition. Food Chemistry, 79: 145-150.

Anon. (2002b) Fact About Fish. The National Institute of Nutrition and Seafood Research, Norway.

AOAC. (1990) Official methods of analysis, 15th Edn. Association of Official Analytical Chemists.

Arip, M., Cembun, .-., & Emilyani, D. (2018). Strategy to improve knowledge, attitude, and skill toward clean and healthy life behaviour. International Journal of Social Sciences and Humanities, 2(3), 125–135. https://doi.org/10.29332/ijssh.v2n3.222

Bano Y. (1975) Seasonal variation in the biochemical composition of *Clarius batrachus* L., Proc Indian Acad Sci. 85: 147-155.

Beltran A, Moral A. and Martin P. (1991) Effect of seasonal factors on polyunsaturated fatty acids in smoked sardine during storage at different temperatures. Lebensim.-Wiss.-Technol., 24: 404-407.

Braekkan OR, (1962) B-Vitamins in fish and shellfish. In: Heen, E. and R. Kreuzer (Eds.), Fish in Nutrition. Fishing News (Books) Ltd., London, pp. 55-60.

Castrillon AM, Navarro P and Alvarez-Pontes E. (1997) Changes in chemical composition and nutritional quality of fried Sardine (*Clupea pilchardus*) produced by frozen storage and' Microware reheating. Journal of Science Food and Agriculture. 75: 125-132.

Chandrasekhar K. and Deosthale YG. (1993) Proximate composition, Amino Acid, Mineral and Trace Element Content of the Edible Muscle of 20 Indian Fish Species. J. Food Comp. Anal. 6(2): 195-200.

Daoud A, Saud A. and Arjun P. (2021) Somatic embryogenesis and in vitro plant regeneration of *Bacopa monnieri* (Linn.) Wettst, a potential medicinal water hyssop plant. Saudi Journal of Biological Sciences, 28: 353-359.

Das H. (1978) Seasonal variation in the chemical composition and calorific

content of *Mugil cephalus* (Linnaeus) from Goa waters, Mahasagar, 11 (3 & 4): 117-134.

Early RJ, Mahgoub O, Lu CD, Ritchie A, Al-Halhali AS. and Annamalai K. (2001) Nutritional evaluation of solar dried sardines as ruminant protein supplement. Small Ruminant Research, 41: 39-49.

Edirisinghe EMRKB, Perera WMK. and Bamunuarachchi A. (2000) Nutritional evaluation of some small coastal fish in Sri Lanka. J Natl Aquat Resour Res Dev Agency, 36(2000): 47-53.

Elaiyaraja C, Sekar V, Rajasekaran R. and Fernando OJ. (2012) Diversity and Seasonal distribution of the turrids (Gastropoda: Turridae) among the four landing centers of Southeast coast of India, Annals of Biological Research, 3(12):5718-5723.

Fischer W, and Bianchi G. (1984) FAO species identification sheets for fishery purposes. Western Indian Ocean (Fishing area, 51). Prepared and printed with the support of the Danish International Development Agency (DANIDA). Rome, Food and Agricultural Organization of the United Nations, Vol. I-VI.

Halver JE. (1989) Fish Nutrition, 2nd edition, Academic Press, San Deigo, CA.

Hemung BO. (2013) Properties of tilapia bone powder and its calcium bioavailability based on transglutaminase assay. Intl J Biosci Biochem Bioinform 3 (4): 306–309.

Jeyaprakash AA. (2002) Long term trends in rainfall, sea level and solar periodicity: A case study for forecast of Malabar sole and oil sardine fishery. J. mar. biol. Ass. India, 44(1&2): 163-175.

Kitts DD, Huynh MD, Hu C, Trites AW. (2004) Seasonal variation in nutrient composition of laskan walleye Pollock. Can J Zool, 82: 1408-1415.

Kozlova TA. and Khotimchenko SV. (2000) Lipids and fatty acids of two pelagic cottoid fishes (*Comephorus* spp.) endemic to Lake Baikal. Comp. Biochem. Physiol., 126B: 477-485.

Krajnovic-Ozretic M, Najdek M. and Ozretic B. (1994) Fatty acids in liver and muscle of farmed and wild sea bass (*Dicentrarchus labrax* L.). Comp. Biochem. Physiol., 109A: 611-617.

Kudale RG. and Rathod JL. 2015. Nutritional value of fringe scale sardine, *Sardinella fimbriata* (Cuv. and Val.) from Karwar waters. International Journal of Fisheries and Aquatic Studies. 3(2): 06-09.

Kulkarni DM. (1953) Some essential amino-acids in *Chirocentrus dorab* and *Meretrix* sp. J. Univ. Bombay, 22A(3): 64-66.

Love RM. (1970) The chemical biology of fishes. Academic press, London, Vol. I.

Metzner C, Ulrich-Merzenich G. and Luder W. (2001) Arginine and Taurine-Dietary Factors Preventing Cardiovascular Diseases? Ernahrungs-Umschau, 48: 5188.

Munro ISR. (1955) The marine and freshwater fishes of Ceylon. Dept. of External Affairs, Canberra, 349.

Nair PGV. and Suseela M. (2000) Biochemical composition of fish and shellfish. CIFT technology advisory series. Central Institute of Fisheries Technology, Cochin, p. 14.

Parulekar AH. and Bal DV. (1969) Observation on the seasonal changes in the chemical compostion of *Bregmaceros mcclellandi* (Thomson). J. Univ. Bombay, 38(65): 88-92.

Pigott GM. and Tucker B.W. (1987) Science opens new horizons for marine lipids in human nutrition. Food Rev. Int., 3: 105-138.

Ramakrishnan S. and Venkat Rao S. (1995) Nutritional Biochemistry. T.R. Publications Pvt. Ltd., Madras, p. 246.

Sathya Shree PK. (1981) Biological and biochemical studies in gray mullets (Family: Mugilidae) of Porto Novo, S. India, Ph.D. Theseis, Annamalai University, Parangipettai.

Senthilkumar R. (2001) Systematics, biochemical and toxinology of Tetraodontid fishes (Pisces: Tetraodontiformes) of Southeast coast of India. Ph.D. Thesis, Annamalai University, Tamil Nadu, India.

Sheeba W, Immaculate JK. and Jamila P. (2021) Comparative Studies on the Nutrition of Two Species of Sardine, *Sardinella longiceps* and *Sardinella fimbriata* of South East Coast of India. Food Science & Nutrition Technology, 6(4): 000272.

Sivashanthini K. (2004) Comparative studies on the reproductive biology of gerreids (Pisces: Gerreidae) from Parangipettai waters, Southeast coast of India. Ph.D. Thesis, Annamalai University, Tamil Nadu, India.

Suryasa, I. W., Rodríguez-Gámez, M., & Koldoris, T. (2022). Post-pandemic health and its sustainability: Educational situation. International Journal of Health Sciences, 6(1), i-v. https://doi.org/10.53730/ijhs.v6n1.5949

Tilyakov, H. A., Valiyev, E. Y., Tilyakov, A. B., & Tilyakov, A. B. (2021). A new approach to surgical treatment of victims with pelvic and femoral fracture injuries, taking into account the severity of the condition and the severity of the injury. International Journal of Health & Medical Sciences, 4(3), 338-346. https://doi.org/10.31295/ijhms.v4n3.1763

Tocher DR. and Sargent J.R. (1984) Analyses of lipids and fatty acids in ripe roes of some northwest European marine fish. Lipids, 19: 492-499.

Varadharajan D, Soundarapandian P, and Dinakaran GK. (2009) Vijakumar G. Crab Fishery Resources from Arukkattuthurai to Aiyammpattinam, South East Coast of India. C Res J Biol Sci; 1(3):118-122.

Venugopal V, Chawla SP. and Nair PM. (1996) Spray dried protein powder from threadfin bream: preparation properties and comparison with FPC type-B. J. Muscle Foods, 7: 55.

Vlieg P. and Body DR. (1988) Lipid contents and fatty acid composition of some New Zealand freshwater finfish and marine finfish, shellfish and roes. New Zealand J.Mar. Freshwater Res., 22: 151-162.

Watanabe T, Izquierdo M, Takeuchi J, Satoh S. and Kitajima C. (1989) Competition between eicosapentaenoic and docosahexaenoic acids in essential fatty efficacy in larval red sea bream. Nippon Suisan Gakkaishi, 55: 1635-1640.

Wessels JPH. and Spark A.A. (1973) The fatty acid composition of the lipids from two species of hake. J. Sci. Food Agric., 24: 1359-1370.

Wu Z, Qiu S. and Yang S. 2000. Examination on the biochemical composition of six pelagic fishes in Minnan-Taiwan Bank fishing ground. J. Fish. China, 24 (5): 428-431.

Yanes E, Ballester D. and Monckeberg F. (1976) Enzymatic fish protein hydrolyzate: chemical composition, nutritive value and use as a supplement to cereal protein. J. Food Sci., 41: 1289.