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Nutritional Profiling and Seasonal Variation in the Proximate Composition of Emperor Fish (*Lethrinus lentjan*) from Thoothukudi Coast of Tamil Nadu, India

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Abstract

Seasonal variation in the proximate composition (moisture, protein, fat, carbohydrate and ash) was analysed in emperor fish (*Lethrinus lentjan*). Mineral composition (iron, phosphorus, sodium, potassium and calcium) was also analysed. Moisture, protein, fat, carbohydrate and ash contents were found to range from 74.93–78.20, 14.53–24.40, 0.21–2.76, 0.49–1.07 and 1.24–2.70% respectively. Iron, phosphorus, sodium, calcium and potassium was 4.20, 13.50, 7.20, 156.20 and 17.90 mg% respectively. Fatty acid profile of emperor fish revealed palmitic acid (C16), stearic acid (C18) and myristic acid (C14) to be the major saturated fatty acid and elaidic acid (C18:1n9T) and oleic acid (C18: 1n9C) were the dominant monounsaturated fatty acids. Investigations also revealed that fat content was higher during the monsoon season (October and November).

Keywords: Emperor fish, proximate composition, mineral composition, fatty acids

Introduction

Fish is an important source of nutrients such as proteins, lipids, essential fatty acids, amino acids and some of the principal vitamins. Fish is also a rich source of minerals like zinc, iron, and copper etc. Fish lipids contain high levels of polyunsaturated fatty acids (PUFA) especially EPA (eicosapentaenoic acid, C20:5n3) and DHA (docosahexaenoic acid, C22:6n3). These ω3 PUFAs play a vital role in the development and function of nervous system (brain), photo reception (vision) and the reproductive system (Alasalvar et al., 2002). Fish is also a major source of polyunsaturated fatty acids especially EPA and DHA. Regular consumption of fish can reduce the risk of colon, breast, prostrate cancer and lower the risk of dementia and alzheimers disease and prevent cardiovascular disease (Whelton et al., 2004; Ruxton, 2011; Villegas et al., 2011; Djouse et al., 2012).

Proximate composition of fish which includes protein, fat, minerals, carbohydrates and moisture (Love, 1970) is used to estimate the food value of fishes and also to plan the most appropriate processing methods. Fishes are exposed to considerable environmental changes and composition of feed also changes, which affects the proximate composition (Olsen et al., 1995). Besides, other factors such as age, sex and state of maturity also affect the proximate composition (Bandarra et al., 1997). Further, proteins and lipids are mobilised from muscle and transferred to the gonads in the reproductive tract during spawning season (Shearer, 1994).

In India, several studies have been carried out on the proximate composition of fishes in relation to their reproductive cycle rather than their energy value. However, there are few studies on the nutritive value of Indian fishes. Reports are available on the proximate composition of fishes landed in the West Coast (Gopakumar, 1997) and on few fish species landed in the east coast of India (Ravichandran, Kumaravel & Florence, 2011;

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Mathana et al., 2012; Kumaran et al., 2012). In the east coast, Tuticorin is a major fishing area with an annual landing of 48 510 t in 2008- 2009 contributing to about 12.2% of fish landing from Tamilnadu (Palani kumar et al., 2014). Due to the changes in the climate condition and industrial growth, there could be wide differences in the proximate compositions of the fishes. Hence it becomes essential to document the proximate composition of the fishes periodically in a region. Different Lethrinidae species are sold as emperor sea bream, which belong to the perch-like fishes. Emperor fish (*Lethrinus lentjan*) is a commercially important and commonly available fish in Thoothukudi coast with high demand because of the unique taste and texture of the meat. Therefore, the study was undertaken to create a base line data on seasonal variation in the proximate and mineral composition of the *L. lentjan* landed in Tuticorin coast of India.

Materials and Methods

Fresh fish of *L. lentjan* were procured from the Thoothukudi landing centre in the second week of every month for one year from June 2013 to May 2014. The fish were placed in sterile polythene bags, kept in ice and brought to the laboratory within 30 min. In the laboratory, fish were washed thoroughly with distilled water and length (cm) and weight (g) data were recorded. Fishes were then dissected to remove fins, gills, viscera and skin and the muscle portion was collected for analysis. Moisture content was determined by the hot air oven method (AOAC, 1995). Nitrogen content was determined by the Kjeldhal method (AOAC, 1995) using KEL PLUS – Elite ExVA – digestion and distillation apparatus and the protein content was calculated by multiplying the nitrogen content with a factor of 6.25. The crude fat was determined by Soxhlet method (AOAC, 1995) using petroleum ether (60 - 80°C) as solvent in a SOCS PLUS-SCS 08R system. Ash content was determined in a muffle furnace at 500-550°C for 16 h (AOAC, 1995). Carbohydrate was estimated using anthrone reagent (Seifter et al., 1950). The gross energy (GE) value of fish was calculated by modified method of Ali et al, (2013) using following formula:

GE (kcal 100 g^{-1}) = % protein (g) x 4.1 + % fat (g) x 9.3 + % carbohydrate (g) x 4.1

Mineral composition was determined by standard methods (AOAC, 1995) and expressed as mg 100 g^{-1} sample. Sodium, potassium and calcium were determined using a Flame Photometer (Deep Vision, Chennai) and expressed as mg 100 g^{-1} sample.

Approximately five emperor fish weighing around 130-160 g collected in the month of May 2014 were used to analyse the fatty acid composition by gas chromatography. For the determination of fatty acid composition total lipid was extracted from fish using chloroform and methanol (Folch et al., 1957), methylation of fatty acids by BF3-methanol and subsequent analysis of fatty acids methyl esters by capillary gas chromatography. Fatty acid profile was analysed using gas chromatography (Clarus 580, Perkin Elmer, USA) with a flame ionization detector and capillary column. The oven temperature was set for 50°C at 3 min, then raised to 150°C for 5 min and finally raised to 250°C. The injector and the detector temperatures were set at 220 and 280°C respectively. The sample volume was 1 μl. The carrier gas was controlled at 16 psi. The split was 1:10. Fatty acid was identified by comparing the retention times of FAME with a standard component FAME mixture (Supelco, USA). Peaks were determined by comparison of their retention times with FAME standards (Supelco) and individual fatty acids were expressed as percentage of total fatty acids. Two replicates GC analysis was performed and the results were expressed in GC area % as a mean value±standard error.

The statistical package, SPSS (version 16, Chicago, IL) was used for data analysis. The results were expressed as mean±standard error (n=3) and one way ANOVA was performed to compare the results of different months. Significant difference in the seasonal variation of proximate composition was determined by Tukey's HSD test ($p<0.05$).

Results and Discussion

Length and weight of fishes collected from June 2013 to May 2014 are given in Table 1. The length of the fish ranged from 20.50 to 29.33 cm and weight ranged from 130 to 360 g. Moisture content of the samples varied from 74.93 to 78.20%. According to Younis et al. (2011) higher moisture content of 79.58% was reported in emperor fish caught from Saudi Arabia. Ali et al. (2013) also reported high moisture content in emperor fish from Oman. The moisture content of *L. lentjan* from Thoothukudi was about 77.63% (Palani Kumar et al., 2014). The moisture content of fish can vary greatly (Younis et

Table 1. Seasonal variation in length, weight and proximate composition of *Lethrinus lentjan*

Proximate composition	June' 13	July	August	September	October	November	December	January' 14	February	March	April	May
Length	22.00±0.57	21.00±0.57	24.00±0.57	24.03±0.29	23.00±0.57	20.50±0.28	26.53±0.86	27.03±0.57	29.06±0.58	28.00±0.57	28.36±0.31	29.33±0.33
Weight	180.33±1.45	155.33±0.88	240.33±0.88	172.00±1.15	360.00±0.57	130.00±0.57	231.00±0.57	274.00±0.57	304.66±0.33	249.66±0.88	325.00±0.57	331.00±0.57
Moisture	77.56 ± 0.23^{ef}	76.09 ± 0.05^{cd}	77.28 ± 0.11^{e}	76.32 ± 0.12^{cd}	77.86 ± 0.08^{ef}	75.24 ± 0.21^{ab}	76.25 ± 0.03^{cd}	75.75 ± 0.12^{bc}	74.93 ± 0.03^{a}	77.29 ± 0.28^{e}	76.50 ± 0.28^{d}	78.20 ± 0.05^{f}
Protein	18.56 ± 0.03^{e}	16.15 ± 0.02^{b}	18.3 ± 0.00^{d}	17.07 ± 0.01^{c}	14.53 ± 0.03^{a}	22.55 ± 0.02^{j}	20.52 ± 0.02^{f}	21.8 ± 0.02^{h}	24.4 ± 0.00^{k}	21.34 ± 0.00^{g}	18.37 ± 0.06^{d}	22.15 ± 0.02^{i}
Fat	1.04 ± 0.01^{e}	1.54 ± 0.01^{f}	0.42 ± 0.01^{b}	1.42 ± 0.01^{f}	2.69 ± 0.00^{h}	2.76 ± 0.01^{h}	1.9 ± 0.01^{g}	1.97 ± 0.00^{g}	0.57 ± 0.00^{c}	0.21 ± 0.09^{a}	0.96 ± 0.00^{e}	0.73 ± 0.01^{d}
Carbohydrate	0.64 ± 0.02^{bcd}	0.71 ± 0.00^{de}	0.59 ± 0.00^{b}	0.60 ± 0.00^{bc}	0.66 ± 0.00^{cd}	0.92 ± 0.01^{h}	0.69 ± 0.00^{de}	1.07 ± 0.01^{i}	0.75 ± 0.01^{ef}	0.85 ± 0.01^{g}	0.82 ± 0.01^{fg}	0.49 ± 0.00^{a}
Ash	1.25 ± 0.02^{a}	2.48 ± 0.01^{f}	2.05 ± 0.02^{d}	1.24 ± 0.02^{a}	1.78 ± 0.01^{c}	2.7 ± 0.02^{g}	2.7 ± 0.05^{g}	1.84 ± 0.02^{c}	2.3 ± 0.05^{e}	1.93 ± 0.02^{cd}	1.86 ± 0.03^{c}	1.54 ± 0.02^{b}

Results are mean ± standard error, values within a row with different superscript letters are significantly different ($p<0.05$) in Tukey HSD test.

al., 2011) and a number of factors which include species, season, age, feeding and environmental condition also affect the moisture content and nutrient composition of fishes (Shearer, 1994).

Lipids are the primary energy storage material in fish. Thus the lipid content of a fish indicates the surplus energy available for future maintenance, growth and reproduction (Adams, 1999, Tocher, 2003). The fat content of the samples varied from 0.21 to 2.76%. According to classification based on their fat content, *L. lentjan* is a lean fish or low fat fish. The fat content of the sample was higher in October (2.69%) and November (2.76%). Earlier studies by Younis et al. (2011) and (Palani Kumar et al., 2014) for *L. lentjan* showed that the fat content was very low (0.45%) similar to previous study showed greater variation in fat content (0.21 to 2.76%) of *L. lentjan* compared to other parameters which could be due to variation in age, maturity within the species and also season (Ozogul et al., 2007). The fat content in fish is inversely proportional to the moisture content (Nurnadia et al., 2011) which is also in accordance with the findings of the present study. The present study also revealed that fat content was higher during the monsoon season (October and November). Similar observation has been observed in earlier studies (Bandara et al., 1997; Som & Radhakrishnan, 2013).

A wide variation in the protein content in *L. lentjan* (14.53 to 24.4%) was observed. Younis et al., (2011) reported that the protein content was 18.56% in *L. lentjan* from Arabian Gulf coast of Saudi Arabia and the result was similar (18.48%) to *L. lensus* from Thoothukudi coast (Palani Kumar et al., 2014). Generally reef fishes are low in fat content and are excellent sources of protein (Hanna, 2001; Edirisinghe et al., 2013). The protein content was higher during November to February.

Carbohydrate content in *L. lentjan* also varied remarkably (0.49 – 1.07%). Generally carbohydrate content of fishes is low, due to the fact that glycogen does not contribute much to the reserves of fish tissue. Ash content, which is a measure of the mineral content varied significantly from 1.24 to 2.70%, which could be attributed to the feeding behaviour, environment and migration (Andres et al., 2000; Canli & Atli, 2003). Earlier studies have shown that fishes inhabiting coral reefs show higher values in ash content (Gopakumar, 1997).

Energy value of fish showed significant variation from 79.30 Kcal, being relatively high in the months of November, December, January and February (121.88, 104.62, 112.08 and 108.41 Kcal respectively) corresponding to high protein contents in these months (>20%). Energy value of the fish muscle varies with the type of feed and its digestibility as other factors. Ali et al. (2013) reported an energy value of 86.8 Kcal in emperor fish from Arabian Gulf and 77.97 Kcal in *L. lensus* from Thoothukudi coast (Palani Kumar et al., 2014). Generally variations in fat content would reflect in higher energy values (Judith & Jenny, 1987). However studies by Palani kumar et al. (2014) reported that fishes with high protein (>20%) showed higher calorific values. From the results of the present study it could be inferred that energy value is influenced by both protein and fat content of fish.

Results showed that emperor fish (*L. lentjan*) is a good source of essential minerals (Table 2). Iron content was 4.20 mg%, phosphorus ranges from 13.50 mg%, sodium 7.20 mg%, calcium between 17.90 mg% and potassium ranged from 156.20 mg%. The concentration of minerals in fish species varies depending on age, feeding behaviour, environmental condition and many other factors including time and region of sampling (Zeynali et al ., 2009; Fallah et al., 2010; Burger et al., 2011). The results of the present study are in line with data reported in various previous studies (Kosanovic et al., 2007; Younis et al., 2011, Kumar et al., 2014).

Table 2. Mineral composition of emperor fish (*Lethrinus lentjan*)

S. No.	Minerals	Average
1	Iron (mg%)	4.20±0.05
2	Phosphorus (mg%)	13.50±0.28
3	Sodium (mg%)	7.20±0.05
4	Potassium (mg%)	156.20±0.11
5	Calcium (mg%)	17.90±0.05

Results are mean ± standard error (n=3)

Fatty acid composition of emperor fish (*L. lentjan*) is presented in Table 3. Fatty acid profile of fish muscle reflects the content of dietary lipid sources. However, size, age, reproductive status of fish, environmental condition influence the lipid content and fatty acid composition of fish muscle to a certain extent (Saito et al., 1999). Results showed that among the saturated fatty acids, palmitic acid (C16), stearic acid (C18) and myristic acid (C14) were the dominant ones. Palmitic acid was the most dominant saturated fatty acid constituting 50% of the total SFA. However, earlier studies in many marine fishes have reported palmitic acid to constitute 70% of the total SFA (Prato & Biandolino, 2012). Elaidic acid (C18:1n9T) and oleic acid (C18:1n9C) were the major monounsaturated fatty acid. Oleic acid was the predominant MUFA in the lipids of marine fish accounting for 60-75% of the total MUFA (Ozogul et al., 2007).

Marine fish have higher levels of PUFA's especially DHA and EPA. The present study showed higher levels of DHA (13%) and EPA (8%). DHA and EPA are the two important PUFA which play a significant role in human health. *L. lentjan* also showed higher level of arachidonic acid (C20:4) (3%) which is a precursor for prostaglandin and thromboxane biosynthesis. The higher poly unsaturated fatty acid composition of marine fishes is due to abundance of PUFA in marine phytoplankton which they consume (Steffens, 1997). In the present study *L. lentjan* has higher levels of ω3 fatty acids (25%). Fish feeds on microorganisms or smaller fish that consume PUFA synthesising microorganism thus acquiring n-3 PUFA (Lunn & Theobald, 2006). The present study also reported higher levels of essential fatty acids such as linoleic (C18: 2n-6) and linolenic acid (C18:3n-3). These fatty acids are of great physiological importance and accumulate in adipose tissues or are converted into long chain

Table 3. Fatty acid profile of emperor fish (*Lethrinus lentjan*)

SFA	Fatty acid	%
	Saturated fatty acid	
C14:0	Myristic acid	5.01±0.005
C16:0	Palmitic acid	21.00±0.005
C17:0	Heptadecanoic acid	2.99±0.005
C18:0	Stearic acid	7.00±0.10
C20:0	Arachidonic acid	1.00±0.00
C24:0	Lignoceric acid	1.00±0.00
Total		38.00
	Mono unsaturated fatty acid	
C14:1	Myristoleic acid	3.00±0.10
C15:1	Cis- 10- pentadecenoic acid	1.00±0.00
C18:1n9T	Elaidic acid	10.00±0.10
C18:1n9C	Oleic acid	4.00±0.10
Total		18.00
	Poly unsaturated fatty acid	
C18:2n6T	Linolelaidic acid	8.00±0.10
C18:2n6C	Linoleic acid	4.00±0.10
C18:3n3	Linolenic acid	11.00±0.10
C20:3n6	Cic-8,11,14-Eicosatrienoic acid	4.00±0.10
C20:3n3	Cis-11, 14, 17-Eicosatrienoic acid	2.99±0.005
C20:4n6	Arachidonic acid	3.01±0.005
C20:5n3	Cis-5,8,11,14,17-Ecosapentaenoic acid	8.00±0.10
C22:6n3	Cis-4,7,10,13,16,19-Docasahexaenoic acid	13.00±0.10
Total		44.00

Results are mean ± standard error (n=2)

unsaturated fatty acids such as arachidonic acid (C20:4n-6), EPA and DHA.

Pigott & Tucker (1990) suggested that the n-3/n-6 rates are a useful indicator for comparing relative nutritional value of fishes with different species. An increase in the human dietary n-3/n-6 fatty acid helps to prevent coronary heart disease by reducing plasma lipids and reduces cancer risk (Simopoulos, 2002). Higher levels of n-6 PUFA in the human diet can lead to many health disorders (Sargent & Tacon, 1999) whereas n-3 PUFA modulates the undesirable effects of n-6 PUFA. In the present study n-3/n-6 PUFA was 1.31. A balanced n-3/n-6 ratio is necessary for preventing high risk of artherosclorosis and LDL levels (Harris, 2009).

In this study, the ratio of n6/n3 was found to be 0.75 for emperor fish. The UK Department of Health recommends an ideal ratio of n6/n3 ratio of 4.0 (HMSO, 1994). Value higher than 4.0 is harmful to health and promotes cardiovascular diseases. In emperor fish PUFA/SFA value was 1.15 (Table 4). Inverse relationships between PUFA/SFA with cardiovascular disease have been reported by Erkkila et al. (2008). In the present study PUFA/SFA was greater than one. The minimum value of PUFA/SFA ratio recommended is 0.45 (HMSO, 1994).

The present study revealed the nutritional significance of emperor fish in human diet. The study also shows that the fish has higher levels of n-3 polyunsaturated fatty acids especially EPA and DHA which play an important role in human nutrition. Further moisture, protein fat, carbohydrate and ash content varied significantly ($p<0.05$) and could not be related to seasons.

Table 4. Sum of various classes of fatty acids and their ratio

Fatty acid	%
Total	100
SFA	38
MUFA	18
PUFA	44
n-3	25
n-6	19
PUFA/SFA	1.15
n-3 / n-6	1.31
EPA/DHA	0.61

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