



International Journal of **Biological Chemistry**

ISSN 1819-155X



Academic
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Total Lipid and Cholesterol Content in the Flesh of the Five Important Commercial Fishes from Waters Around Jaffna Peninsula, Sri Lanka

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ABSTRACT

The present investigation was carried out to understand the total lipid and cholesterol content of flesh of five commercially important adult fishes such as *Siganus lineatus*, *Gerres oblongus*, *Scoliodon laticaudus*, *Scomberoides lysan* and *Hemirhamphus marginatus* collected from waters around Jaffna peninsula. People living in Jaffna peninsula consume fish as the main source of nutrition in their diet. However they have no definite knowledge, pertaining to which species can be intake with their food without harming their health condition. Therefore studies on the nutritional value of marine food fish is a prime theme of research for fish consuming people. In the northern province of Sri Lanka, no study on lipid and cholesterol content of fish has been done so far and therefore the present investigation was initiated. Total lipid in the flesh of five different fishes was extracted and the cholesterol content was estimated in the present study. Mean total lipid and cholesterol content of five commercially important fishes ranged from 2.63 to 4.41% and 54.2 to 104.5 mg/100 g, respectively. Values obtained for total lipid and cholesterol content of five different fishes were found to be good indication of nutritional values. Highest total lipid content was found in muscle tissue of *Gerres oblongus* lowest was in *Hemirhamphus marginatus*. However, highest cholesterol content was recorded for *Scoliodon laticaudus* and the lowest for *Scomberoides lysan*. Analysis of Variance (ANOVA) for total lipid and cholesterol content of five different adult fishes showed that there is significant difference ($p < 0.05$) between fishes.

Key words: Lipid, cholesterol, *Siganus lineatus*, *Gerres oblongus*, *Scoliodon laticaudus*, *Scomberoides lysan*, *Hemirhamphus marginatus*

INTRODUCTION

Lipids are the predominant source of energy for fish. The mechanisms by which fish allocate energy from lipids for metabolism, development, growth and reproduction are critical for understanding key life-history strategies and transitions (Leaver *et al.*, 2008). Lipids are the major source of nutrition in marine fishes (Sargent, 1976; Sargent *et al.*, 1989). They are considered an efficient biochemical means of concentrating large amounts of stored energy at small space. The cells of white fat tissue, called adipocytes, are responsible for lipid synthesis, release and storage in

the organism (Szkudelski *et al.*, 2009). The major storage sites of fish are mesenteric fat, muscle and Liver (Sheridan, 1988).

The fat content in fish muscle is highly variable. It depends on species, age, spawning season, fish diet, and muscle type (Gehring *et al.*, 2009). Qualitative studies on the composition of fish flesh have been investigated frequently (Love, 1970). The live weight of majority of fish usually consists roughly of lipid 2-12% (Love, 1980; Weatherley and Gill, 1987). The seasonal storage and utilization of lipid reserves are important in the metabolic activities and overall life histories of many animals including fish (Love, 1970; Shulman, 1974). Constancy in tissue or organ function is reflected in the composition and structure of polar lipids, while neutral lipids vary widely as a result of a balance between dietary intake, anabolism and catabolism (Sargent and Henderson, 1986). There are several classes of lipids, all having similar and specific characteristics due to the presence of major hydrocarbon portion in their molecule.

Lipids can be used as an assay of physiological condition and may reflect resources availability, metabolic activity or recent stress (Fraser, 1989). Lipids are important fuel for marine organisms especially for those living in high latitudes (Clarke, 1983). When maternal diets are deficient, insufficient transfer of lipids to developing ovaries may reduce fecundity and the viability of the progeny (Watanabe, 1985; Luquet and Watanabe, 1986; Heming and Buddington, 1988). The role of lipids in reproduction may be just as critical, supplying energy for activities such as egg development, nest building, courtship, or protection of young (Meffe and Snelson, 1993). Slobodkin (1962) and Calow (1977) noted that fat deposition may actually detract from reproduction, particularly when fat deposition and reproduction are concurrent.

Triglycerides are compounds where most of the fat calories are stored. The reserve fats of fish have a mechanical function, maintaining the elasticity of the outer covers and creating a soft lining for the internal organs (Stroganov, 1962). The major lipids that have direct role in buoyancy of marine fish are wax esters, squalene and alkyldiacylglycerols. Triacylglycerols and cholesterol have an indirect role in buoyancy of marine fish. Many fishes in the ocean have oil-filled bones (mostly triacylglycerols) (Phleger, 1998). Phospholipids are the main constituents of biological membranes (Bhouri *et al.*, 2010) and it provides sheaths surrounding the nerve cells (Sargent and Whittle, 1981; Farkas *et al.*, 1988). It plays a central role in the embryonic metabolism.

Fish is a major source of food for human nutrition providing an important amount of dietary protein and lipid diet in many countries (Bouriga *et al.*, 2010). Compared with red meat, fish flesh is easily digestible (Pirestani *et al.*, 2010). Fish and fish oil are the rich source of omega 3- fatty acids. Fish oils have moved into the center stage of fatty acids in nutrition, it helps to prevent brain aging and Alzheimer's disease (Whelan, 2008). Cod liver oil taken for vitamins A and D. Fish oil were used as industrial chemical based on paints and linoleum.

The Jaffna Peninsula is an area in Northern Sri Lanka. Jaffna peninsula is surrounded by sea water but connected to mainland via an isthmus called Elephant pass. Jaffna is situated within ten degrees of latitude to the north of the equator. It is in close proximity to the sub-continent of India and separated from it by the Palk Strait and the Bay of Bengal. In addition to agriculture and livestock, fishery sector is an important industry in Jaffna provides major source of food and income for society. Jaffna district alone contributed 26% of the total fish production and 57% of the total dry fish production of Sri Lanka, in 1983.

The fishes selected in the present study are high consumer demand food fishes found in the Sri Lankan coast having high flesh content and good taste. Among the selected five fishes *Siganus lineatus*, *Gerres oblongus* and *Hemirhamphus marginatus* are relatively cheaper than the other two and therefore people living in coastal regions of Sri Lanka frequently consume these fishes even though they did not have any idea about the nutritional composition of these fishes. *Scoliodon laticaudus* is a delicious food fish in Sri Lanka the whole part of shark can be utilized as food. Shark meat is used for the production of minced fish products such as fish balls, fish cake, fish sausage, fish ham and fish paste and particularly appreciated in other parts of Asia. Sharks fins are also processed and exported to other Asian Countries by Sri Lankans. Shark liver oil is also an important by product of shark. *Scomberoides lysan* is also an important food fish in Sri Lanka mostly exported to other parts of the world as dry fish.

People living in coastal region of Sri Lanka provide these fishes to pregnant women and feeding mothers. However they have no definite knowledge, pertaining to which species can be intake with their food without harming their health condition. Therefore studies on the nutritional value of marine food fish is a prime theme of research and the results obtain in the present study will provide a detailed understanding on prevention of lipid oriented diseases for a healthy life for the fish consuming people.

In the northern province of Sri Lanka, no study on lipid and cholesterol content of fish has been done so far. As such the present investigation was carried out to understand the lipid and cholesterol content of five commercially important fishes from waters around Jaffna peninsula.

MATERIALS AND METHODS

Sampling of fishes: The commercially valued fishes namely *Siganus lineatus*, *Gerres oblongus*, *Scoliodon laticaudus*, *Scomberoides lysan* and *Hemirhamphus marginatus* were selected for the present study. Samples of five commercially valued adult fishes were collected from Point Pedro, Pasaioor and Delft landing centers (Locations of sampling stations are presented in Fig. 1) from March 2010 to July 2010 and brought to laboratory in an ice box. Total body weight was weighed to the nearest 0.1 g and standard length was measured to the nearest 0.1 mm. The fish samples were dissected and the stage of maturation was determined, macroscopically. Only matured adult fishes from the selected species were considered for the present research. Size range of adult fishes and number of observations are provided in Table 1.

Identification of fishes: Collected fishes were brought to the laboratory and species identification was confirmed using the FAO species identification guide (De Bruin *et al.*, 1994).

Total lipid analysis: Total lipids in tissue sample were extracted according to the method of Bligh and Dyer (1959), that is modified method of Folch *et al.* (1957). One hundred gram muscle tissue was cut from the fresh fish, rinsed with distilled water and dried to constant weight in a drying oven (60°C, 24 h). Dried samples were minced in a glass blender, homogenized with chloroform: methanol mixture (2:1 V/V), mixed in a vortex mix in 2800 rpm and filtered. The extract was shaken and equilibrated with ¼ of its volume of a saline solution. The extracted lipids were



Fig. 1: Sampling sites (A, B and C) of fishes from waters around Jaffna peninsula (A) Point Pedro (B) Delft (C) Passaiyoor

Table 1: Size range and number of observations of fishes examined

Fishes analyzed	Size range (standard length in cm)	No. of fish examined	Degrees of freedom
<i>Siganus lineatus</i>	22 - 25	24	23
<i>Gerres oblongus</i>	15-18	24	23
<i>Scoliodon palasorrah</i>	50-53	24	23
<i>Hemirhamphus marginatus</i>	40-43	24	23
<i>Scomberoides lysan</i>	42-45	24	23

concentrated by a rotary evaporator (IKA RV 10 basic). Lipids were stored in sealed vials. Extracted lipids were weighed in vials using a micro electronic balance (± 0.001 mg) in order to calculate the total lipid content. The same procedure was repeated with 24 replicates of each fish species and the mean value was computed.

Cholesterol analysis: Cholesterol content of fish was estimated by the Zlatkis *et al.* (1953) method. Extracted lipids were treated with ferric chloride, acetic acid mixture and sulphuric acid and the colour developed was observed. After 20 min absorbance was read at 560 nm in a spectrophotometer (LABOMED, UVD-3000) at the department of Zoology, University of Jaffna. The absorbance readings were plotted in a calibration curve and the relevant cholesterol concentrations were computed. The same procedure was repeated with 24 adult fish samples of each fish and the mean value was computed.

Statistical analysis: The total lipid and cholesterol content obtained for five different adult fishes were first analyzed by one way analysis of variance (ANOVA). When a single factor ANOVA rejects the null hypothesis i.e., when the mean of the samples was significantly different, ANOVA was followed by Post hoc comparison of means: Duncan's multiple range test (DMRT) using STATISTICA software in the computer. The level of statistical significance was set at $p < 0.05$.

RESULTS

Total lipid and cholesterol content: Total lipid and cholesterol content of five different fish species are presented in Table 2, total lipid and cholesterol content of twenty four adult fish samples of five different fishes were subjected in the computation of mean value in the present study. Mean total lipid content ranged from $2.6300 \pm 0.060\%$ (*Hemirhamphus marginatus*) to $4.4117 \pm 0.058\%$ (*Gerres oblongus*) whereas mean cholesterol content ranged from 54.20 ± 1.005 (*Scomberoides lysan*) to 104.05 ± 0.900 mg/100 g (*Scoliodon laticaudus*). Values obtained for total lipid and cholesterol content of five different fishes were found to be good indication of nutritional values. Highest total lipid content was found in muscle tissue of *Gerres oblongus* lowest was in *Hemirhamphus marginatus*. However, highest cholesterol content was recorded for *Scoliodon laticaudus* and the lowest for *Scomberoides lysan*.

Statistical analysis: Analysis of Variance (ANOVA) for total lipid and cholesterol content of five different adult fishes showed that there is significant difference ($p < 0.05$) between treatments. Results of Post hoc-Duncan's test is expressed as superscripts in Table 2. Post hoc-Duncan's Multiple Range Test expressed significant different ($p < 0.05$) between five different fishes at all instances. Box-Whisker plots showing significant difference in total lipid content and cholesterol content between five different fishes are shown in Fig. 2 and 3. Significant differences in mean,

Table 2: Mean total lipid and cholesterol content of five fish species from waters around Jaffna peninsula, Sri Lanka. (Values in the column indicate mean \pm Standard deviation)

Scientific names of fishes analyzed	Mean total lipid (%)	Mean cholesterol content (mg/100 g)
<i>Siganus lineatus</i>	3.3667 ± 0.108^a	74.400 ± 0.252^f
<i>Gerres oblongus</i>	4.4117 ± 0.058^b	93.917 ± 0.870^e
<i>Scoliodon laticaudus</i>	3.9150 ± 0.048^c	104.05 ± 0.90^b
<i>Scomberoides lysan</i>	3.5767 ± 0.071^d	54.200 ± 1.005^i
<i>Hemirhamphus marginatus</i>	2.6300 ± 0.060^e	71.267 ± 0.920^j

Value in the same column with different superscript letters (a-e) (f-j) within a same nutritional component are significantly different ($p < 0.05$)

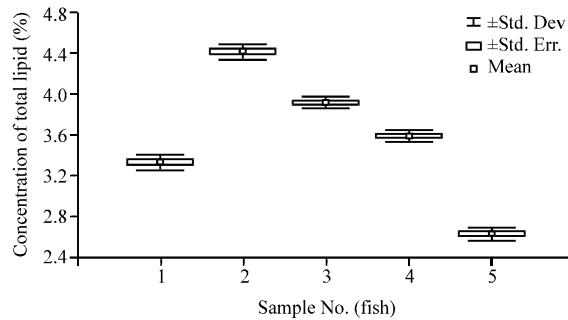


Fig. 2: Box-Whisker plot showing significant difference in total lipid content between five different fishes

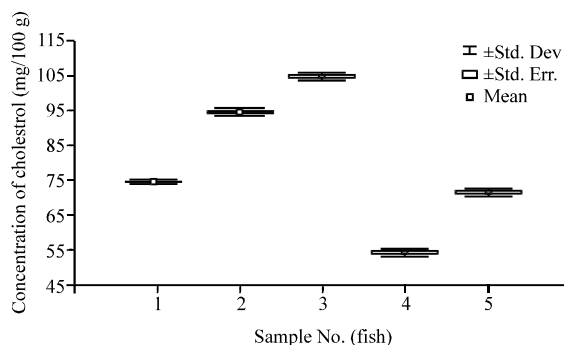


Fig. 3: Box-Whisker plot showing significant difference in cholesterol content between five different fishes

standard error for each mean value and standard deviation for each mean are clearly expressed in Fig. 2 and 3.

DISCUSSION

Very few studies were carried out on the selected tropical fish species from other parts of the world. In a study by Al-Jedah *et al.* (1999), total lipid content of congeners of the three species of fishes studied in the present investigation was presented from the coast of Qatar. The estimated total lipid content for *S. commerson* was 7.46% (Al-Jedah *et al.*, 1999) which is higher than the value estimated for *S. lysan* in the present study. Al-Jedah *et al.* (1999) estimated lowest total lipid content for *G. filamentosus* than the value obtained for *G. oblongus* in the present study. Total lipid content obtained for *S. canaliculatus* from Quatar waters (Al-Jedah *et al.*, 1999) was 3.18% which tally with the present work i.e. for *S. lineatus* in the present study was 3.36%. In another study, Zhao *et al.* (2007) reported a total lipid value of 2.79%±0.15 for adult *Siganus guttatus* from the South China Sea. The recorded value in the South China Sea is lower than the present estimate computed for a congener of the *Siganus* species. The above differences may have been attributed due to different environmental conditions and nutritional status of those fishes in different topographical regions.

Further, Childs and King (1993) classified fish into three categories according to the content of fat, namely the low-fat category with 0.6-3.0% fat, the medium fat category with 3.5-7.0% fat and the high fat category with levels that range from 8.1-15.3% fat. The fish caught from the Northern waters of Sri Lanka tend to fall into the low and medium fat categories, although it should be noted the fat contents may vary between individual fish or groups of fish of the same species caught at different times or under different conditions.

Among the important five fish species from waters around Jaffna peninsula, the richest total lipids were observed in *Gerres oblongus* and the highest cholesterol content was observed in *Scoliodon laticaudus*. Bykov (1996) reported that the fat content for *Scoliodon* sp. varied between 18 to 23%. Bakes and Nichols (1995) studied about the liver oils from the deep-sea sharks *Somniosus pacificus*, *Centroscymnus plunketi*, *Centroscymnus crepidater*, *Etmopterus granulosus*, *Deania calcea* and *Centrophorus scalpratus*. They analyzed lipid, fatty acid and squalene compositions of each shark species and found high squalene content (50-82% of oil) in all species, except *Centroscymnus plunketi* and *Somniosus pacificus* and suggested that the oil from these deep-sea sharks collected in southern Australian waters is suitable for industrial uses.

The nutritive value of *Scomberoides tol* was found to be good and it had 1.6% of lipid and 0.008% of free fatty acid (Patterson and Ranjitha, 2009). Total lipid content of *Siganus fuscescens* showed seasonal variations and were high in winter and low in summer (Osako *et al.*, 2006). No previous study was done on *Hemirhamphus marginatus* and the present investigation is the first record for this species. The present study indicated that all five species of fish studied presently are intuitively good and they could be exploited successfully for food and for preparing various fish by products.

ACKNOWLEDGMENT

Authors are grateful to the authorities of National Research Council for the financial assistance (Research grant No. 07-19).

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