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Cholesterol content of Indian fish and shellfish

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Abstract

Ninety-seven samples of fish and 17 samples of shellfish from tropical waters were analysed for fat, nonsaponifiable matter (NSM) and cholesterol contents. Significant differences were noted in the cholesterol contents of the various families of fish analysed. However, the variation in the content of cholesterol was found to be not significant within the families. Higher contents of cholesterol were observed in shellfish than in fish. No correlation existed between the fat content of the fish/shellfish and the levels of cholesterol or NSM.

Keywords: Cholesterol; Fish; Shellfish; Nutrition labelling

1. Introduction

Consumer awareness regarding the nutritional quality of food is increasing. In developed nations, Nutrition Labelling is becoming compulsory, which makes it mandatory to label all marketed processed food products with their nutrient contents to enable the consumer to maintain a healthy food regime (Sehat & Niedwetzki, 1998). The Nutrition Labelling and Education Act (NLEA) of 1990 in the USA has formulated, for the first time, labels with information on nutrient contents of processed foods. The Association of Official Analytical Chemists (AOAC) International formed a task force for defining the methods for nutrient labelling analysis (Sullivan & Carpenter, 1993). According to this task force, fat is defined as the sum of fatty acids expressed as triglycerides. Contents of vitamins and cholesterol are to be indicated in the label, separately. As dietary cholesterol is known to affect serum cholesterol (Ammu, Sankar & Devadasan, 1996; Nair, Devadasan & Antony, 1985; Nair & Gopakumar, 1981; Sanchez-Muniz, Higon, Cava & Viejo, 1991), information on the daily dietary intake of cholesterol can be quite important, especially to those with cardiovascular problems. A nutrition label has mandatory and optional dietary components. Both fat and cholesterol are included as mandatory components. In this context, the information on the cholesterol content of Indian food fish assumes significance. Marine products have become a major export item from India, accounting for 3.4% of the total exports. The overseas markets may insist on nutrition labelling data for these products. Although the composition of almost all Indian food fish is known, data on their cholesterol contents are inadequate. An attempt is made here, for the first time, to quantify cholesterol in common food fish and shell fish of Indian waters in order to obtain a database for nutrition labelling.

2. Materials and methods

Ninety-seven samples of fish and 17 samples of shell fish were analysed for their fat, non-saponifiable matter (NSM) and cholesterol contents. Only the edible portion of fish and shellfish was used for analysis. Muscle from four to five fish was minced together and representative samples of 30 g in duplicate were taken for analysis. Prawn was used in the peeled and undeveined condition. Antartic krill samples were collected during the FIKEX 1995–96 expedition of the Research vessel FORV Sagarsampada. Other samples were collected during Cruise 153 of FORV Sagarsampada, from local markets and aquaculture farms. Lipid content was determined by extraction with chloroform methanol mixture (Bligh & Dyer, 1959), NSM by the method of AOAC (1990) and cholesterol by the ferric chloride method as described by Rudel and Morris (1973). Cholesterol standard was procured from Sigma Chemicals. Other chemicals were of analytical grade from BDH. Statistical analysis for cholesterol content between

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Table 1
Content of cholesterol, NSM and fat (a) in fish, (b) in shellfish

No. family	Species	Common name	Length (average) (cm)	Weight (g)	Month	Cholesterol (mg%)	NSM (g%)	Fat (g%)
(a) Fish								
1 Acanthuridae	*Acanthurus xanthopterus* (Valenciennes, 1835)	Yellow fin surgeon fish			October	33.8	0.05	0.99
2 Ariidae	*Arius jella* (Day,1877)	Black fin sea catfish	25	300	July	58.3		1.6
3 Ariidae	*Arius jella* (Day,1877)	Black fin sea catfish	32	315	March	56.9	0.09	0.72
4 Ariommidae	*Ariomma indicus* (Day, 1870)	Indian drift fish				59.9	0.25	2.4
5 Belonidae	*Strongylura strongylura* (Van Hasselt, 1823)	Spot tail needle fish	35	145	Februray	55	0.07	0.86
6 Bothidae	*Pseudorhombus* sp	Flounder	15	40	March	64.7	0.13	0.3
7 Bothidae	*Pseudorhombus* sp	Flounder	14	29.5	March	51.9	0.11	0.55
8 Carangidae	*Megalaspis cordyla* (Linnaeus, 1758)	Torpedo scad	21	100	Februray	59.1	0.11	1.6
9 Carangidae	*Megalaspis cordyla* (Linnaeus, 1758)	Torpedo scad (with skin)	21	100	Februray	62.3	0.15	1.88
10 Carangidae	*Trachynotus ovatus*	Pompano	19	193		55	0.1	1.04
11 Carangidae	*Caranx carangus* (Bloch, 1793)	Black tailed trevally	14	968	October	52.6	0.28	7.11
12 Carangidae	Scomberoides tol (Cuvier, 1832)	Needle scaled queen fish			March	48.1	0.12	1.02
13 Carangidae	Trachynotus ovatus	Pompano	20	220	October	47.4	0.08	1.94
14 Carangidae	*Megalaspis cordyla* (Linnaeus, 1758)	Torpedo scad	20	120	March	50.9	0.08	0.64
15 Carangidae	*Parastromateus niger* (Bloch, 1975)	Black pomfret	23	250	March	60.2	0.11	1.09
16 Carangidae	*Decapterus russelli* (Ruppell, 1830)	Indian scad	18	49	March	67.6	0.12.	1.34
17 Carangidae	*Scomberoides tol* (Cuvier, 1832)	Needle scaled queen fish	36	285	March	55.1	0.09	0.88
18 Carangidae	*Megalaspis cordyla* (Linnaeus, 1758)	Torpedo scad	37	424	March	55.1	0.11	1.01
19 Carangidae	*Carangoides malabaricus* (Bloch & Schneider, 1801)	Malabar trevelly	16	75	March	55.9	0.16	1.61
20 Carangidae	*Carangoides malabaricus* (Bloth & Schneider, 1801)	Malabar trevelly				47.6	0.14	1.16
21 Carangidae	*Caranx carangus* (Bloch, 1793)	Black tailed trevally	20	99	March	67.3	0.13	1.01
22 Carangidae	*Caranx para* (Cuvier, 1832)	Banded scad	15	32	March	73.7	0.13	1.73
23 Carangidae	*Atropus atropus female* (Schneider, 1801)	Cleft belly trevally	23	181	March	64.6	0.15	3.41
24 Carangidae	*Atropus atropus* (Schneider, 1801)	Cleft belly trevally	18	91	March	57.1	0.09	1.52
25 Chanidae	*Chanos chanos* (Forsskal, 1775)	Milk fish	35	300	December	33.6	0.05	0.98
26 Chirocentrida	*Chirocentrus dorab*	Silver bar			October	39.6	0.06	2.42
27 Chirocentrida	*Chirocentrus nudus* (Swainson, 1839)	White fin wolf herring	49	94.32	March	46	0.2	–
28 Chirocentrida	*Chirocentrus nudus* (Swainson, 1839)	Wolf herring	45	364	March	39.4	0.1	1.56
29 Cichlidae	*Oreochromis mossambica*	Tilapia female	16	65	December	41.8	0.06	0.51
30 Cichlidae	*Etroplus maculatus* (Bloch, 1785)	Orange chromicle	7	7.5	December	5.12	0.07	0.71
31 Clupeidae	*Opisthoptertus tardoor* (Cuvier, 1829)	Tardoore	15	30	July	68.6	0.11	4.9
32 Clupeidae	*Opisthoptertus tardoor* (Cuvier, 1829)	Tardoore	16	44	October	62.2	0.36	6.3
33 Clupeidae	*Opisthoptertus tardoor* (Cuvier, 1829)	Tardoore	24	110	March	53.7	0.11	1.46

(continued)

Table 1—*contd*

34 Clupeidae	*Dussumieria acuta* (Valenciennes, 1847)	Rainbow sardine	17	41	March	50.4	0.13	0.94
35 Clupeidae	*Sardinella melanura* (Cuvier, 1829)	Blacktip sardinella	16	49	March	52.7	0.09	1.8
36 Clupeidae	*Dussumieria hasselti*	Oil sardine	16	25	June	86.5	0.25	4.34
37 Cynoglossida	*Cynoglossus dubius* (Day 1873)	Carrot tongue sole	33	213	March	39.2	0.07	0.47
38 Cynoglossida	*Cynoglossus sp*	Flounder	19	38	March	48.3	0.1	0.24
39 Cyprinidae	*Cirrhinal mrigata* (Hamilton & Buchanan, 1802)	Mrigal				36	0.06	–
40 Cyprinidae	*Labeo rohita* (Hamilton and Buchanan, 1802)	Rohu	Adult			36.2	0.07	–
41 Elopidae	*Elops machnata* (Forsskal, 1775)	Lady fish	52	900	December	32.9	0.05	0.47
42 Engraulidae	*Tryssa dusumeiri* (Valenciennes, 1848)	Dussumier's thryssa	15	30	Februray	54.6	0.26	3.15
43 Ephippidae	*E phippus Orbis* (Bloch, 1787)	Spade fish	11	42	March	82.7	0.26	3.19
44 Gerridae	*Gerres filamentoses* (Cuvier, 1829)	Whipfin silver biddy	15	84		53.8	0.09	2.35
45 Gerridae	*Gerres filamentoses* (Cuvier, 1829)	Whipfin silver biddy	18	84	October	45.9	0.09	2.2
46 Haemulidae	*Pomadasys furcatum*	Grunter	19	100	February	61	0.22	4.63
47 Haemulidae	*Pomadasys kaakan* (Cuvier, 1830)	Javelin grunter			March	53.7	0.13	0.67
48 Haemulidae	*Pomadasys* sp	Grunter	15	63	March	63.8	0.12	0.93
49 Hemiramphid	*Hemiramphus lutkei*	Needle fish			October	52.5	0.12	1.74
50 Lactaridae	*Lactarius lactarius* (Bloch & Schneider, 1801)	False trevally	14	40	July	97.4	0.38	6
51 Leiognathidae	*Leiognathus equulus* (Bloch, 1787)	Pugnose ponyfish			May	90.6	0.15	–
52 Leiognathidae	*Leiognathus splendens* (Cuvier, 129)	Splendid ponyfish			May	107	0.14	1.1
53 Leiognathidae	*Leiognathus bindus* (Valenciennes, 1835)	Orange fin pony fish	8	7	March	88.2	0.31	1.85
54 Lethrinidae	*Lethrinus cinerius*		44	1200	October	148	0.37	3.26
55 Lutjanidae	*Lutjanus gibbus* (Forsskal, 1775)	Humpback red snapper	31	850	March	95.5	0.24	7.7
56 Lutjannidae	*Pristipomoides filamentoses* (Valenciennes, 1835)	Blue spotted job fish			October	80.6	0.2	5.03
57 Megalopidae	*Megalops cyprinoides* (Broussonet, 1782)	Oxeye tarpon	18-	69	December	46.2	0.07	0.62
58 Mugilidae	*Vaiamugil cunnesius* (Valenciennes, 1835)	Long arm mullet				62.9	0.25	2.24
59 Mullidae	*Upenus vittatus* (Forsskal, 1775)	Striped goatfish	15	50	March	48.7	0.15	1.01
60 Mullidae	*Upenus vittatus* (Forsskal, 1775)	Goat fish				43.1	0.1	0.89
61 Myliobatidae	*Myliobatis nieuhofli*	Eagle ray	27	1040	March	56	0.09	0.67
62 Nemipteridae	*Nemipterus bleekeri* (Day, 1875)	Pink perch	22	119	March	63.4	0.12	0.8
63 Nemipteridae	*Nemipterus japonicus* (Bloch, 1791)	Pink perch	21	130	March	56.4	0.09	0.83
64 Nemipteridae	*Parascolopsis eriomma*	Rosy monacle bream	27	375	February	46.5	0.1	1.56
65 Polynemidae	Eleutheronema tetradactylus	Four finger thread fin	33	500	Februray	63.7	0.1	0.85
66 Polynemidae	*Polynemus sextarius* (Bloch and Schneider, 1801)	Blackspot threadfin	15	43	March	68.5	0.11	1.08
67 Priacanthidae	*Priacanthus* sp	Bull eye	18	75	March	53.1	0.1	0.52
68 Psettodidae	*Psettodes erumei* (Schneider, 1801)	Indian tiny turbot	33	587	March	41.6	0.07	0.54
69 Scianidae	*Nibea maculata* (Schneider, 1801)	Blotched croaker	23	150	January	38.8	0.12	1.56
70 Scianidae	*Johnius carutta* (Bloch, 1793)	Karut croaker	18	65	October	74	0.08	1.2

(continued)

Table 1—*contd*

No. family	Species	Common name	Length (average) (cm)	Weight (average) (g)	Month	Cholesterol (mg%)	NSM (g%)	Fat (g%)
71 Scianidae	*Johniops sinai* (Cuvier, 1830)	Sin croaker	14	33	May	69.6	0.1	0.6
72 Scianidae	*Johniops sinai* (Cuvier, 1830)	Sin croaker	12	18	May	72.1	0.23	0.8
73 Scianidae	*Johnius elongatus* (Mohan, 1967)	Spindle croaker	16	74	March	65.6	0.11	0.87
74 Scianidae	Otolithus ruber (Schneider, 1801)	Tiger toothed croaker	34	458	March	41.7	0.05	0.81
75 Scianidae	*Johniops sina* (Cuvier, 1830)	Sin croaker	17	80	March	59.7	0.1	0.85
76 Scombridae	*Rastrelliger kanagurta* (cuvier, 1817)	Mackerel	12	15	May	51.4	0.05	6.84
77 Scombridae	*Rastrelliger kanagurta*	Mackerel female	27	259	September	58.4	0.18	7.65
78 Scombridae	*Rastrelliger kanagurta*	Mackerel male	23	127	June	55.6	0.17	5.09
79 Scombridae	*Rastrelliger kanagurta*	Mackerel immature	18	70	June	64.8	0.09	2.08
80 Scombridae	*Rastrelliger kanagurta*	Mackerel female	21	115	October	65.4	0.14	5.17
81 Scombridae	*Elachata nigra*	Kadal varal	46	750	October	59.3	0.1	1.38
82 Scombridae	*Rastrelliger kanagurta*	Mackerel	21	119	March	69.7	0.15	1.94
83 Scombridae	*Elachata nigra*	Kadal varal	44	514	March	65.6	0.1	0.68
84 Serranidae	*Epinephles latifasciatus* (Temminck and Schlegel, 1842)	Banded grouper	27	283	March	41.4	0.08	0.42
85 Sillaginidae	*Sillago sihama* (Forsskal, 1775)	Silver sillago	14	30	March	112	0.12	3.39
86 Sparidae	*Argyrops spinifer* (Forsskal, 1775)	King soldier bream	20	190	March	37.8	0.06	0.43
87 Sphyraenidae	*Sphyraena forsteri* (Cuvier, 1829)	Big eye barracuda	30	125	March	58	0.1	0.61
88 Sphyraenidae	*Sphyraena obtusata* (Cuvier, 1829)	Obtuse barracuda	23	80	March	59.9	0.09	0.84
89 Sphyraenidae	*Sphyraena jello* (Cuvier, 1829)	Barracuda	45	510	March	34.6	0.09	0.53
90 Stromateidae	*Pambus argentius* (Epiphrases, 1788)	Silver pomfret	16	150	March	44	0.1	1.08
91 Synodontidae	*Saurida undosquamosis* (Richardson, 1840)	Brush tooth lizard fish	24	98	March	57.6	0.11	1.22
92 Teraponidae	*Therapon jarbua* (Forsskal, 1775)	Jarbua therapon			October	33.7	0.1	1.94
93 Teraponidae	*Terapon jarbua*	Jarbua therapon				24.6	0.06	0.96
94 Torpedinida	*Narcine sp*	Electric ray	23	1.1	March	72.7	0.1	0.78
95 Trachinidae	*Percis pulchella*	Rosy grub fish	14	35	March	22.2	0.04	0.72
96 Trichiuridae	*Lepturacanthus savala* (Cuvier, 1917)	Savalai hair tail	47	87	March	68	0.1	0.88
97 Uranoscopide	*Chanoscopes* sp	Star gazers	28	399	March	37	0.11	0.87
Fish Egg								
1 Scombridae	*Rastrelliger kanagurta*	Mackerel egg			September	462	1.38	5.71
(b) Shellfish								
Prawn								
1 Penaeidae	*Penaeus indicus* (H.Milne Edwards, 1837)	Indian white shrimp	13	14	February	129	0.17	1.35
2 Penaeidae	*Penaeus indicus*	Indian white shrimp	17	22	February	163	0.18	1.34
3 Penaeidae	*Metapenaeus monoceros* (Fabricius, 1798)	Speckled shrimp	7	2.75	February	144	0.18	0.95
4 Penaeidae	*Metapenaeus monoceros*	Speckled shrimp	9	6.25	February	123	0.17	1.22
5 Penaeidae	*Penaeus monodon* (Fabricius, 1798)	Giant tiger prawn	19	45	February	118	0.25	1.02
6 Penaeidae	*Metapenaeus dobsoni* (Miers, 1878)	Kadal shrimp	9	3.13	February	120	0.23	1.34
7 Penaeidae	*Metapenaeopsis stridulens* (Alcock, 1905)	Fiddler shrimp	8	2.3	March	143	0.23	0.98
Crab								

(continued)

Table 1—*contd*

1 Scyllaridae	*Scylla seffata* (Forsskal)	Mud crab	10	180	May	54.8	0.15	0.75
2 Scyllaridae	*Scylla serrata*, claw meat					51.5	0.09	0.64
3 Portunidae	*Portunus sanquinolentus* (Herbst)	Red spot crab	13	110	May	52.4	0.11	0.58
4 Portunidae	*Charibdis cruciata (Herbst)*	Coral crab	10	156	May	56.5	0.11	0.7
5 Portunidae	*Charibdis cruciata*	Coral crab	11	190	March	54.2	0.09	0.76
6 Portunidae	*Portunus pelagicus* (Herbst)	Sand Crab	14	111	May	66.8	0.14	0.68
Antartic krill								
1 Euphausidae	*Euphausia* sp	Antartic krill	Whole			102	0.13	–
2 Euphausidae	*Euphausia* sp	Antartic krill	Tailmeat			33.3	–	–
Cuttle fish								
1 Sepiidae	*Sepia aculeate*	Cuttle fish				162	0.22	1.3
2 Sepiidae	*Sepia aculeata*	Cuttle fish	10	67	March	130	0.24	0.92
Squid								
1 Loliginidae	*Loligo duvauceli* (Orbingy)	Squid	15	52	March	198	0.34	1.4
2 Loliginidae	*Loligo duvauceli* (Orbingy)	Squid				188	0.23	1.33

families was done by the method of ANOVA for unequal numbers of observations.

3. Results and discussion

Ninety-seven samples of fish comprising 43 families, seven samples of prawn from a single family, six samples of crab from two families, two samples of cuttle fish, two samples of squid, Antarctic krill, and mackerel egg were analysed, the results of which are given in Table 1(a) and (b). In fish, the cholesterol content ranged from 22.2 mg% (*Percis pulchella*) to 148 mg% (*Lethrinus cinerius*). However, 55% of the fishes had a cholesterol content between 45 and 65 mg%. In prawns, the range was from 118 to 163 mg%, while in crabs, it was from 51.5 to 66.8 mg%. Squids (188–198 mg%) and cuttle fish-(130 to 162 mg%) showed high cholesterol contents as did mackerel egg (462 mg%). Ackman (1992) reported on the cholesterol contents of 16 species of fish and three species of crustaceans. The range was from 15 to 151% in the case of fish and 71 to 78 mg% in the case of crabs. In the present study, the cholesterol content was higher in shell fish than in fish. Connor and Lin (1982) have reported that the cholesterol contents of fish and shellfish are generally low, with the exception perhaps of shrimp. In the present study, comparatively high concentrations of cholesterol were observed in prawns, squid and cuttlefish, mackerel egg and certain species of fish. Although prawn has a high cholesterol content, defatted prawn powder was found to have a serum cholesterol-lowering property in albino rats (Ammu, Stephen & Devadasan, 1989). In the present study, it was found that the cholesterol content of crab was comparatively low. It is reported that sterols, other than cholesterol, are present in some seafoods (Kritchevsky & Dehoff, 1978). Kritchevsky, Tepper, Dehoff and Holmes (1967) have reported that crab contains 57% cholesterol and 37% brassicasterol. In other seafoods, cholesterol accounts for 90–95% of sterols and hence their estimation using ferric chloride would give a true picture. Thus, the values reported for cholesterol in crabs might have been slightly overestimated. The eggs of mackerel had a very high cholesterol content, similar to hen egg (450 mg%). According to Iwasaki and Harada (1984), the cholesterol content of eggs of 25 species of fish was in the range of 250–650 mg/100 g. The results of statistical analysis for cholesterol content in fish are given in Tables 2 and 3. Significant differences were noted in the cholesterol contents of the families of fish analysed. The coefficient of variation in most of the families was within 15%, which confirms that the cholesterol content was somewhat constant within a family, but differed between families. Thus, cholesterol content would appear to be genetically determined. The families of fish with high cholesterol content were Leiognathidae, Lactaridae, Lethrinidae, Lutjanidae. Sillaginidae and Ephippidae. The families with low cholesterol content were Acanthuridae, Chanidae, Elopidae, Cyprinidae and Teraponidae. In fresh water fish, the cholesterol content was found to be low when compared to their marine counter-parts. Most of the fresh water fish analysed, however, were cultured varieties. Generally, it was seen that smaller specimens of the same species of fish had slightly higher cholesterol levels when compared with the bigger ones. Idler, Tanura and Wainai, (1964) reported that no obvious difference existed in the composition of the muscle of male and female scallops. We have observed some increase in the cholesterol content in the case of female mackerel, but the increase may

Table 2
Average, standard deviation and coefficient of variation of contents of cholesterol, NSM and fat within families

No.	Fish	No. of species	Average cholesterol with SD	c.v cholesterol	Average NSM with SD	c.v. NSM	Average fat with SD	c.v Fat
1	Acanthuridae	1	33.81		0.05		0.99	
2	Aiidae	2	57.6 ± 1.02	1.77	0.09		1.16 ± 0.62	53.6
3	Ariommidae	1	59.90		0.25		2.40	
4	Belonidae	1	55.00		0.07		0.86	
5	Bothidae	2	58.3 ± 9.02	15.5	0.12 ± 0.01	9.97	0.43 ± 0.18	42.06
6	Carangidae	17	57.3 ± 15.79	27.5	0.13 ± 0.06	43.8	1.75 ± 1.57	89.56
7	Chanidae	1	33.60		0.05		0.98	
8	Chirocentridae	3	41.64 ± 3.74	8.98	0.12 ± 0.08	62.6	1.99 ± 0.61	30.55
9	Cichlidae	2	46.5 ± 6.66°14.3	0.07 ± 0.01	13.6	0.61 ± 0.14	22.7	
10	Clupeidae	6	62.3 ± 13.66	21.9	0.17 ± 0.11	61.4	329 ± 2.18	66.35
11	Cynoglossidae	2	43.8 ± 6.4	14.6	0.08 ± 0.24	29.2	0.36 ± 0.16	45.81
12	Cyprinidae	2	36.1 ± 0.14	0.39	0.07 ± 0.01	16.7	–	
13	Elopidae	1	32.87		0.05		0.47	
14	Engraulidae	1	54.63		0.26		3.15	
15	Ephippidae	1	82.68		0.26		3.19	
16	Gerridae	2	49.9 ± 7.5°15.1	0.09 ± 0.08	82.6	2.28 ± 1.36	59.74	
17	Haemulidae	3	59.5 ± 5.2	8.75	016 ± 0.05	33.1	2.08 ± 2.21	106.66
18	Hemiramphidae		52.51		0.12		1.74	
19	Lactaridae	1	97.37		0.38		6.00	
20	Leiognathidae	3	95.2 ± 10.12	10.6	0.20 ± 0.09	47.1	1.48 ± 0.53	35.99
21	Lethrinidae	1	147.83		0.37		3.26	
22	Lutjanidae	2	88.0 ± 10.57	12.0	0.22 ± 0.03	11.5	6.37 ± 1.89	29.63
23	Megalopidae	1	46.18		0.07		0.62	
24	Mugilidae	1	62.91		0.25		2.24	
25	Mullidae	2	45.9 ± 3.97	8.64	0.12 ± 0.03	26.7	0.95 ± 0.08	9.09
26	Mytiobatidae	1	56.00		0.09		0.67	
27	Nemipteridae	3	59.92 ± 4.94	8.25	0.11 ± 0.02	15.6	0.82 ± 0.02	2.51
28	Polynemidae	2	66.1 ± 3.44	5.20	0.11 ± 0.01	8.63	0.97 ± 0.16	16.85
29	Priacanthidae	1	53.07		0.10		0.52	
30	Psettodidae	1	41.62		0.07		0.54	
31	Scianidae	7	60.2 ± 12.16	20.2	0.11 ± 0.07	58.3	0.96 ± 0.11	11.28
32	Scombridae	8	61.3 ± 6.12	9.99	0.12 ± 0.05	37.6	3.10 ± 2.54	81.96
33	Serranidae	1	41.40		0.08		0.42	
34	Sillaginidae	1	112.29		0.12		3.39	
35	Sparidae	1	37.77		0.06		0.43	
36	Sphyraenidae	3	50.8 ± 14.09	27.7	0.09 ± 0.004	4.82	0.66 ± 016	24.34
37	Stromateidae	1	43.95		0.10		1.08	
38	Synodontidae	1	57.60		0.11		1.22	
39	Teraponidae	2	29.2 ± 6.39	22.0	0.08 ± 0.03	39.9	1.45 ± 0.69	47.79
40	Torpedinidae	1	72.70		0.10		0.78	
41	Trachinidae	1	22.24		0.04		0.72	
42	Trichiuridae	1	68.04		0.10		0.88	
43	Uranoscopidae	1	37.00		0.11		0.87	

Table 3
ANOVA for cholesterol content between families

Source	SS	df	MSS	F
Total	34023.81	96		
Between family	26312.72	42	626.4933	4.387271 $p < 0.001$
Error	7711.09	54	142.798	

not be due to sexual difference but due to the months of their collection. Idler et al. reported a variation, during different seasons, in the cholesterol content of the muscle, suggesting a relationship between the metabolism and biosynthesis of these sterols.

NSM and fat contents varied from species to species. Surprisingly, the coefficient of variation within families was found to be quite high. The content of fat varies with size of fish and season. (Nair & Nair, 1985; Smith, Hardy, & Young, 1980). The fat content was found to be high in many fish during the month of October. Smith et al. have reported high values for the fat content of mackerel in the months September–November. According to Nair and Nair, the maximum lipid content for sardine oil was during October to December and the minimum was during April to June. In the present study, the contents of NSM and fat were not constant in any of the families. NSM in fish ranged from 0.04%

(*Cynoglossus* sp) to 0.380% (*Lutjanus gibbus*) while fat ranged from 0.24% (*Percis pulchella*) to 7.70% (*Lactarius lactarius*). In prawns NSM varied from 0.165 to 0.246% and fat from 0.95 to 1.35%.

No correlation existed between the content of cholesterol and fat or between NSM and fat as the coefficient of correlation was 0.33 and 0.34, respectively.

4. Conclusion

The high values obtained for cholesterol contents in mackerel eggs indicate that those with heart problems can avoid eating such products. Shell fish and certain families of fish have comparatively high contents of cholesterol, even more than beef (beef = 65 mg%).

From the point of view of keeping cholesterol consumption low, fresh water fish appears to be a better alternative to marine fish.

The current trend is for increased consumption of fish and fishery products and, in this context, data on cholesterol contents of these products will help in the formulation of diets for controlling the intake of cholesterol.

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