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Proximate composition and energetic value of selected marine fish and shellfish from the West coast of Peninsular Malaysia

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Abstract: This study was conducted to determine the proximate composition and energetic value of selected marine fish and shellfish from the West Coast of Peninsular Malaysia. This study has included 20 species of fish (10 pelagic fish and 10 demersal fish) and 4 species of shellfish. For pelagic fish, Longtail shad (terubuk) was found to contain significantly lower moisture (59.31+0.00%), but significantly higher fat content (23.15+0.00%) compared to other fish species. For demersal fish, moisture and ash contents ranged between 74-82%, and 0.9-2.1%, respectively. Long-tailed butterfly ray contained the highest protein (22.22+1.24%) compared to other fish studied. The highest fat content of demersal fish was in Moonfish at 6.89+2.76%. For shellfish, prawn contained the highest protein (19.12+1.44%). The fat content of shellfish ranged between 1-2%. Oyster contained significantly higher carbohydrate at 6.45+0.00%, compared to other shellfish. Longtail shad contained the highest energetic value of 13.34 kJ g-1 of all samples. These values are useful references for consumers in order to choose fish and shellfish based on their nutritional contents.

Keywords: protein, fat content, carbohydrate, energetic value, marine fish, shellfish

Introduction

Fish and shellfish are important source of protein and income for people in Southeastern Asia (Agusa, 2007). They are also increasingly marketed for their health benefits to consumers (Schmidt, 2006). Generally, marine fish can be divided into pelagic and demersal fish. Pelagic fish are those fish associated with the surface or middle depth of body water (Fisheries Research Institute, 2004). Marine pelagic fish can be divided further into coastal fish and oceanic fish depending on the continental shelf they inhabit (McLintock, 2007). Generally, the pelagic fish feeds on planktons (Fisheries Research Institute, 2004). Meanwhile, demersal fish are those fish sinking to or lying on the bottom of sea, feeding on benthic organisms (Fisheries Research Institute, 2004).

Both of these types of marine fish are being consumed by consumers. Statistic obtained in the year 2000, showed that the per capita food supply from fish and fishery products was 58 kg per person in Malaysia (World Resources Institute, 2003). In the year 2007, the fisheries sector which comprised of marine capture fisheries and aquaculture, produced 1,654,217.98 tonnes of food fish with a value of RM6,467.40 million. This recorded an increase in production by 4.17% and in value by 3.65% as compared to the year of 2006. In the year 2007, the fisheries sector contributed 1.2% to the Gross Domestic Product (GDP) (Department of Fisheries Malaysia, 2007). Besides that, Malaysian Adult Nutrition Survey (MANS) of 2008, also reported high prevalence of daily consumption of marine fish among rural and urban adults at 51% and 34%, respectively (Norimah et al., 2008). This shows that, fisheries production and consumption in Malaysia is very huge.

However, according to Osman et al. (2001), generally Malaysians simply consider fishes from different types are of the same nutritional value. The selection process is usually made based on the availability, freshness, flavour and other physical factors. They do not pay attention on the variability of the nutrient composition of the different fish species. Therefore, in order to make the consumers more attentive on the nutritional content of fish and shellfish, information on nutrient values of Malaysian fish and shellfish must be made available.

In the present study, attempt was made to provide

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information on the proximate values of 24 marine fish and shellfish species. This information is useful to help consumers in choosing fish and shellfish based on their nutrient values, besides to complement information in Malaysian Food Composition database (Tee et al., 1997).

Materials and methods

Sampling method

There were 20 species of marine fish and 4 species of shellfish selected as samples of the study. Table 1 lists the samples with their common and scientific names, type, and range of weight and length. The targeted species were commercial fish and shellfish available to consumers in Malaysia. Selection of fishes also was based on work by Osman et al. (2001) where half of the fish samples were those preferred by consumers.

In this study, fish and shellfish samples were collected by stratified random sampling procedure. This approach is the most suitable method for generating food composition database (Greenfield and Southgate, 2003). The samples were collected from 10 fish landing areas located along the West Coast of Peninsular Malaysia, which were identified with the help of Lembaga Kemajuan Ikan Malaysia (LKIM). West Coast of Peninsular Malaysia was chosen based on logistic reason. The locations are marked as L1 to L10 (Figure 1). This approach was used to ensure that the samples would be well representative of the marine fish and shellfish from West Coast of Peninsular Malaysia. Within each samples collection sites (stratum), the samples were collected randomly according to the species.

The samples were only collected from in-shore fishing vessels; which were below than 40 GRT (Gross Registered Ton) in size and licensed to fish in water zones less than 12 nautical miles from shore based on the Fisheries Comprehensive Licensing Policy (FCLP). These fishing vessels included those operated in Zone A (0-5 miles from shore), which generally worked on traditional fishing gears; and Zone B (5-12 miles from shore), which worked on traditional, as well as commercial gears namely trawlers and purse seiners. These fishing vessels generally went in-shore for less than 3 days per session for fishing activities. This was to ensure samples were still fresh during landings and caught within the period of 0 to 36 hours (Department of Fisheries Malaysia, 2007).

The collected samples were immediately dipped in ice, kept and transported in polystyrene boxes to sustain freshness. Upon arrival to laboratory, fish and shellfish were individually measured for their total body weight and length. Only fish and shellfish with weight and length within the narrow range of the collected samples for each species were included as primary samples. The fish samples were beheaded, gutted, washed and filleted. Meanwhile, for shellfish samples, heads, shells, tails, and legs were removed. Later, the primary samples were packed in sealed plastic bags and kept frozen at -20˚C.

Primary sample of each species used was between 100 to 400 g. The primary sample of each species was used to prepare a composite sample. The composite samples of the same species from L1 to L4 were mixed and marked as Composite 1, L5 to L7 as Composite 2, and L8 to L10 as Composite 3. The composite samples were divided into two; for proximate analysis, and lipid content analysis. For each analysis, the values of each composite 1, 2 and 3 were combined to get a single representative mean of the proximate content for each species. All values were based on wet weight and expressed as mean + s.d. (standard deviation).

Moisture content analysis

Moisture content of fish fillets and shellfish were determined according to method described by AOAC 1990 with slight modifications by Tee et al. (1996). The samples were dried in moisture dish in an oven (UM400 Memmert, Germany) at 105˚C until constant weights were obtained.

Ash content analysis

Ash content of fish fillets and shellfish were determined according to method described by AOAC 1990 with slight modifications by Tee et al. (1996). Pre-dried samples obtained from moisture content analysis were ashed in furnace (Barnstead, Iowa, USA) at 550˚C overnight.

Crude protein analysis

Crude protein content of fish fillets and shellfish were determined according to method described by AOAC 1990 with slight modifications recommended by Kjeltec 2200 (Foss Analytical, 2003). Briefly, one gram of sample was weighed into digestion tubes. Two Kjeltabs Cu 3.5 (catalyst salts) were added into each tube. About 12 ml of concentrated sulphuric acid (H2SO4) was carefully added into the tube and then shaken gently. Digestion procedure was performed using pre-heated (420˚C) digestion block of Kjeltec 2200 (Foss Analytical, Hoganas, Sweden) for 60 minutes until clear blue/green solution was obtained. Digested samples were cooled for 10-20 minutes. Distillation procedure was then performed using distillation unit of Kjeltec 2200. Distillate was titrated with 0.2N hydrochloric acid (HCl) until blue

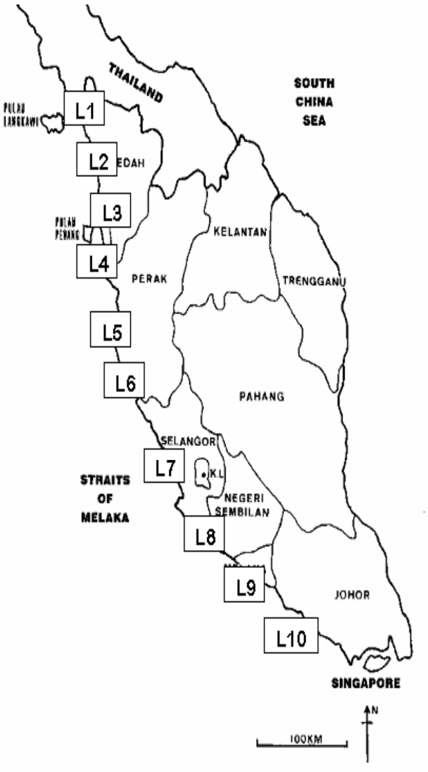

Figure 1. Samples collection sites

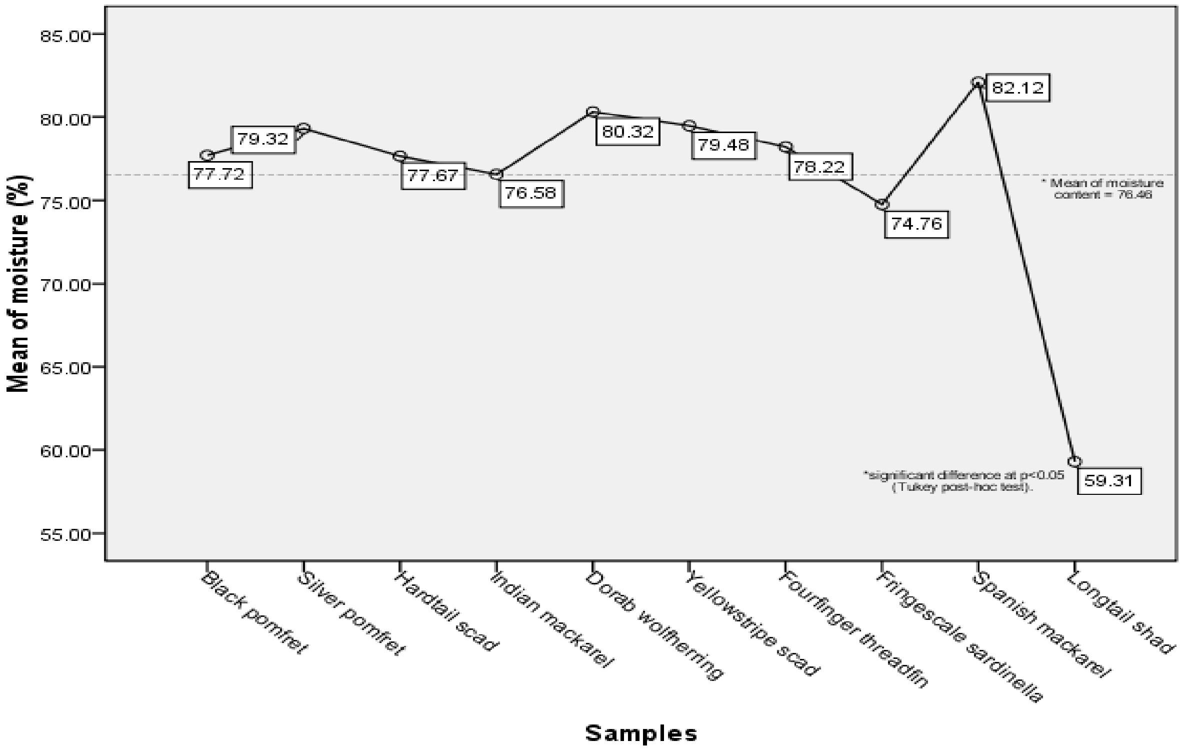

Figure 2: Moisture content of pelagic fish

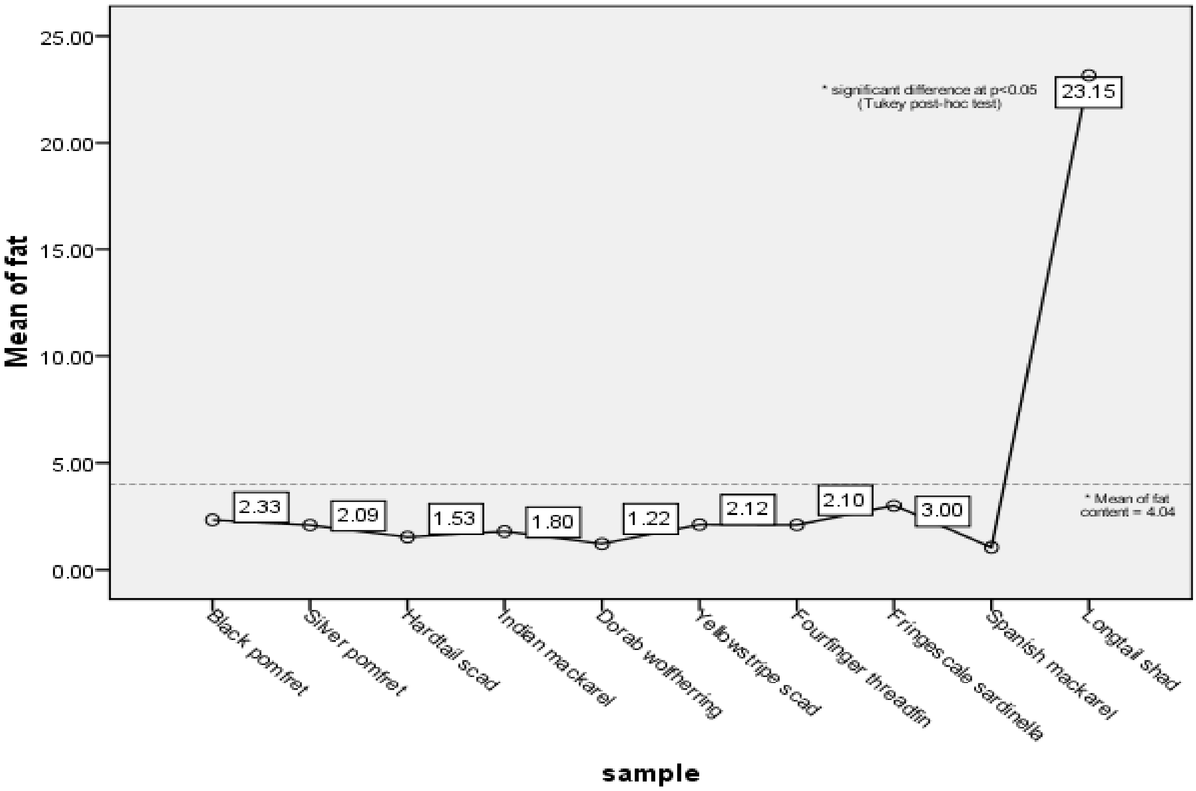

Figure 3: Fat content of pelagic fish

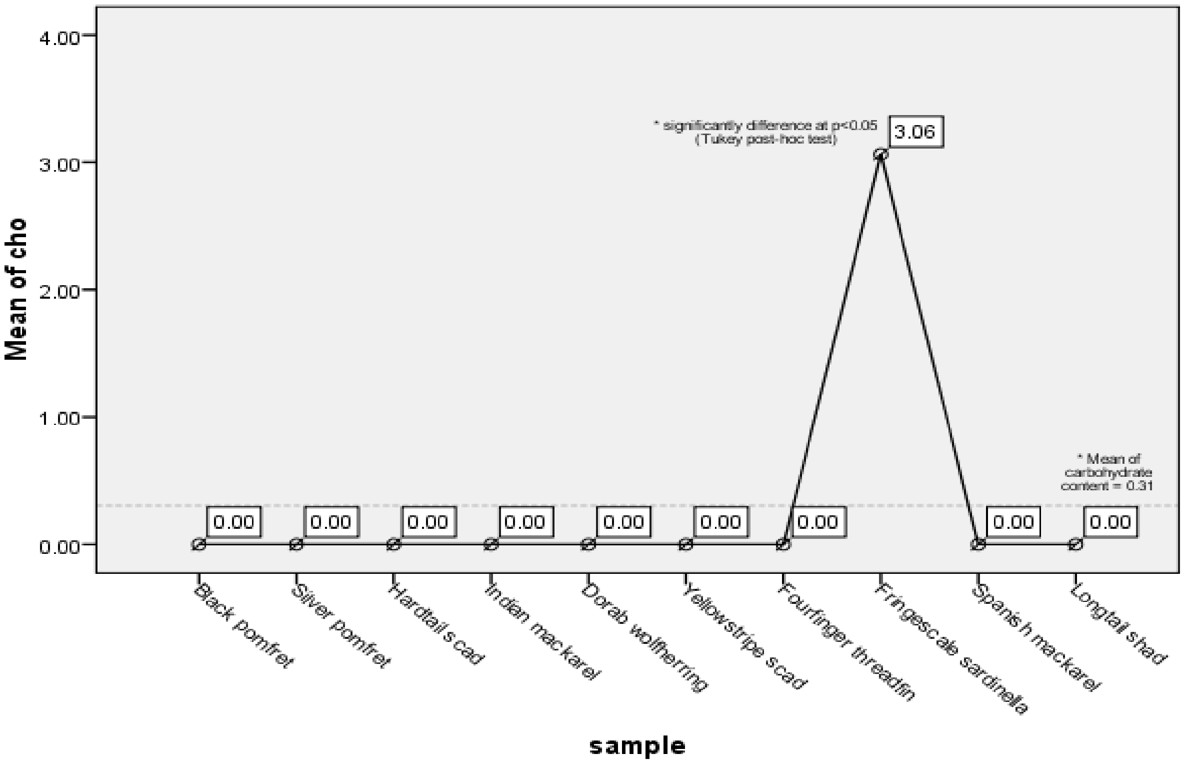

Figure 4: Carbohydrate content of pelagic fish

Table 1. List of samples with narrow range of weight and length

Local name	**Common name**	**Scientific name**	**Type**	**Weight (g) (min – max)**	**Length (cm) (min – max)**
Bawal hitam	Black pomfret	*Parastromaueus niger*	Pelagic	780-1040	33-42
Bawal putih	Silver pomfret	*Pampus argentus*	Pelagic	100-200	15-25
Cencaru	Hardtail scad	*Megalapsis cordyla*	Pelagic	100-250	21-28
Parang	Dorab wolfherring	*Chirocentrus dorab*	Pelagic	200-900	40-71
Kembung	Indian mackarel	*Rastrelliger kanagurta*	Pelagic	50-100	14-20
Selar kuning	Yellowstripe scad	*Selaroides leptolepis*	Pelagic	50-100	16-20
Senangin	Fourfinger threadfin	*Eleutheronema tetradactylum*	Pelagic	150-300	27-32
Tamban	Fringescale sardinella	*Clupea fimbriata*	Pelagic	20-40	13-17
Tenggiri papan	Spanish Mackarel	*Scromberomorus guttatus*	Pelagic	200-450	30-42
Terubuk	Longtail shad	*Hilsa macrura*	Pelagic	900 - 950	40-45
Kerapu	Sixbar grouper	*Epinephulus sexfasciatus*	Demersal	480-750	33-36
Kerisi	Japanese threadfin bream	*Nemipterus japonicus*	Demersal	100-230	18-25
Kurau	Indian threadfin	*Polynemus indicus*	Demersal	350-1450	36-59
Merah	Malabar red snapper	*Lutjanus argentimeculatus*	Demersal	580-760	28-37
Nyior-nyior	Moonfish	*Trachinotus blochii*	Demersal	400-1400	31-47
Jenahak	Golden snapper	*Lutjanus johnii*	Demersal	490-510	30-35
Pari	Long-tailed butterfly ray	*Gymnura spp.*	Demersal	1300-1700	32-36
Sebelah/Lidah	Large-scale tongue sole	*Cynoglossus arel*	Demersal	50-100	24-32
Sembilang	Gray eel-catfish	*Plotosus spp.*	Demersal	350-600	40-50
Siakap	Giant seaperch	*Lates calcarifer*	Demersal	700-1000	38-42
Sotong	Cuttlefish	*Sepia officinalis*	Shellfish	20-45	12-18
Udang putih	Prawn	*Metapenaeus affinis*	Shellfish	10-20	12-17
Kerang	Cockles	*Anadara granosa*	Shellfish	10-20	2-5
Tiram	Oyster	*Ostrea spp.*	Shellfish	100-300	14-48

end point achieved. Volume of acid required in the titration was recorded. Blank was prepared with the exclusion of sample. The percentage of protein content was calculated according to equation below.

$$\% \text{ Nitrogen } (\%N) = \frac{(T-B) \times N \times 14.007 \times 100}{\text{Weight of sample (mg)}}$$

% Protein = N x F

Where:
T = Titration volume for sample (ml)
B = Titration volume for blank (ml)
N = Normality of acid to 4 decimal places
F = Conversion factor for nitrogen to protein (6.25)

Fat content analysis

Fat extraction was done following the method of Bligh and Dyer (1959), with slight modifications by Kinsella et al. (1977). Representative samples of fish fillets (30 g) were homogenized in Waring blender for 2 min with a mixture of methanol (60 ml) and chloroform (30 ml). Chloroform (30 ml) was added to the mixture and after mixing for an additional 30 secs, distilled water (30 ml) was added. The homogenate was stirred with a glass rod and filtered through Whatman No. 1 filter paper on a Buchner funnel with slight suction. The filtrate was transferred to a separatory funnel. The lower clear phase was drained into a 250 ml round-bottom flask and concentrated with a rotary evaporator at 40˚ C. The fat extract was stored at -20˚C.

Carbohydrate content

Carbohydrate content was calculated based on difference calculation [Carbohydrate =100% - (%moisture+ %ash + %crude protein + %fat)].

Energetic value

The energetic value was determined indirectly-using Rubner's coefficients for aquatic organisms: 9.5 kcal g-1 for lipids, 5.65 kcal g-1 for proteins (Winberg, 1971), and expressed in kJ g-1 wet mass as described by Eder and Lewis (2005).

Statistical analysis

Data collected in this study was analyzed using SPSS (Scientific Package of Social Science) version 17.0. One way ANOVA test was used to compare differences in the means of the moisture content, ash content, crude protein content, carbohydrate content, and fat content of different species of fish and shellfish. This was followed by Tukey post-hoc analysis to determine in more detail how different species of samples differed.

Results and Discussions

Proximate values of pelagic fish

Table 2 depicts results of the mean percentage of moisture, ash, crude protein, fat, carbohydrate contents and energetic values of 10 pelagic fish in this study. Division into pelagic and demersal in this study follows information provided by Fisheries Research Institute (2004). For moisture and fat contents, there were no significant differences in all 10 pelagic fish except for Longtail shad. The moisture content of this fish was significantly lower, while the fat content was significantly higher (Tukey Post-Hoc Test, $p<0.05$) as can be observed clearly in Figure 2 and Figure 3. The fat content of Longtail shad was about 4-10 times higher than other fish with that ranged approximately from only 1% to 3%.

As shown in Table 2, eight of the pelagic fish were the same species studied by Osman et al. (2001). The fat content of all the eight species were found to be slightly lower than the values obtained by Osman et al. (2001), which also used the same fat extraction method by Bligh and Dyer (1987), with slight modification by Kinsella et al. (1977). The differences in these values could be due to many factors as fat content in fish vary according to seasons, species and geographical variations. Age variation and maturity in the same species may also contribute to the significant differences in the total lipid (Piggot and Tucker, 1990).

According to Ackman (1989), generally fish can be grouped into four categories according to their fat content: lean fish (<2%), low fat (2–4%), medium fat (4–8%), and high fat (>8%). Out of the 10 pelagic fish studied, four species namely Hardtail scad, Indian mackarel, Dorab wolfherring, and Spanish mackarel are lean fish. Another 5 species (Black pomfret, Silver pomfret, Yellowstripe scad, Fourfinger threadfin, and Fringescale sardinella) are categorized as low fat fish. Only Longtail scad is categorized as high fat fish.

Meanwhile, for ash and protein contents, no significant differences were found among the 10 species of pelagic fish. All the pelagic fish were observed to contain no carbohydrate except for Fringescale sardinella with mean value of 3.07 + 0.63%. Figure 4 shows the obvious difference of carbohydrate content of Fringescale sardinella compared to other pelagic fish. However, the carbohydrate content could be considered as insignificant instead, as the values were derived and estimated from the difference of other compounds. After all, the carbohydrate content in fish is generally very low and practically considered zero (Payne et al., 1999; Anthony et al., 2000).

Table 2. Proximate values of pelagic fish

Samples	Local name	Moisture	Ash	Protein	Carbohydrate	Fat	Previous study (Osman *et al*., 2001) Fat content	Energetic value (kJ/g)
		Mean percentage (%)						
Black pomfret	Bawal hitam	77.72 ± 0.91^{a}	1.37 ± 0.28^{a}	19.55 ± 3.42^{a}	0.0 ± 0.00^{a}	2.33 ± 0.11^{a}	2.79 ± 0.20	5.55
Silver pomfret	Bawal putih	79.32 ± 2.75^{a}	1.01 ± 0.26^{a}	18.63 ± 0.75^{a}	0.0 ± 0.00^{a}	2.09 ± 0.93^{a}	2.91 ± 0.11	5.24
Hardtail scad	Cencaru	77.67 ± 1.21^{a}	1.07 ± 0.20^{a}	20.86 ± 2.73^{a}	0.0 ± 0.00^{a}	1.53 ± 0.15^{a}	3.08 ± 0.11	5.54
Indian mackarel	Kembung	76.58 ± 2.27^{a}	1.26 ± 0.11^{a}	20.51 ± 1.93^{a}	0.0 ± 0.00^{a}	1.80 ± 0.62^{a}	4.54 ± 0.28	5.57
Dorab wolfherring	Parang	80.32 ± 6.10^{a}	1.39 ± 0.28^{a}	20.83 ± 2.50^{a}	0.0 ± 0.00^{a}	1.22 ± 0.22^{a}	NA	5.41
Yellowstripe scad	Selar kuning	79.48 ± 2.90^{a}	0.93 ± 0.08^{a}	19.98 ± 2.03^{a}	0.0 ± 0.00^{a}	2.12 ± 0.50^{a}	5.77 ± 0.52	5.57
Fourfinger threadfin	Senangin	78.22 ± 1.06^{a}	1.16 ± 0.08^{a}	20.14 ± 0.94^{a}	0.0 ± 0.00^{a}	2.10 ± 0.25^{a}	2.24 ± 0.20	5.60
Fringescale sardinella	Tamban	74.76 ± 5.85^{a}	1.59 ± 0.30^{a}	19.01 ± 0.52^{a}	3.07 ± 0.63^{b}	3.00 ± 2.40^{a}	3.06 ± 0.06	6.42
Spanish Mackarel	Tenggiri	82.12 ± 5.19^{a}	1.24 ± 0.17^{a}	19.77 ± 4.29^{a}	0.0 ± 0.00^{a}	1.05 ± 0.06^{a}	1.46 ± 0.17	5.09
Longtail shad	Terubuk	59.31 ± 0.00^{b}	1.06 ± 0.00^{a}	17.46 ± 0.00^{a}	0.0 ± 0.00^{a}	23.15 ± 0.00^{b}	NA	13.34

Table 3. Proximate values of demersal fish

Samples	Local name	Moisture	Ash	Protein	Carbohydrate	Fat	Previous study (Osman *et al*., 2001) Fat content	Energetic value (kJ/g)
		Mean percentage (%)						
Golden snapper	Jenahak	80.21 ± 1.02^{ab}	1.11 ± 0.26^{ab}	19.41 ± 2.22^{ab}	0.0 ± 0.00^{a}	1.29 ± 0.41^{a}	NA	5.10
Sixbar grouper	Kerapu	78.69 ± 3.28^{ab}	0.96 ± 0.29^{a}	18.87 ± 1.72^{ab}	0.0 ± 0.00^{a}	3.46 ± 3.46^{ab}	NA	5.84
Japanese threadfin bream	Kerisi	79.39 ± 0.95^{ab}	1.13 ± 0.30^{ab}	18.17 ± 1.36^{ab}	0.0 ± 0.00^{a}	2.70 ± 0.37^{ab}	NA	5.37
Indian threadfin	Kurau	80.13 ± 0.97^{ab}	1.09 ± 0.03^{ab}	19.59 ± 0.29^{ab}	0.0 ± 0.00^{a}	0.85 ± 0.21^{a}	NA	4.97
Malabar red snapper	Merah	78.00 ± 2.76^{ab}	1.46 ± 0.25^{ab}	20.45 ± 1.16^{ab}	0.0 ± 0.00^{a}	1.37 ± 1.10^{a}	NA	5.38
Moonfish	Nyior-nyior	74.61 ± 0.94^{a}	1.16 ± 0.22^{ab}	19.61 ± 1.39^{ab}	0.0 ± 0.00^{a}	6.89 ± 2.76^{b}	NA	7.38
Long-tailed butterfly ray	Pari	78.03 ± 0.67^{ab}	2.08 ± 0.53^{b}	22.22 ± 1.24^{b}	0.0 ± 0.00^{a}	0.93 ± 0.12^{a}	1.95 ± 0.14	5.63
Large-scale tongue sole	Sebelah	80.27 ± 1.13^{ab}	1.42 ± 0.64^{ab}	18.49 ± 1.26^{ab}	$0.0 + 0.00^{a}$	0.70 ± 0.10^{a}	NA	4.65
Gray eel-catfish	Sembilang	81.66 ± 1.47^{b}	0.96 ± 0.21^{a}	16.61 ± 1.33^{a}	0.0 ± 0.00^{a}	3.04 ± 0.59^{ab}	2.79 ± 0.20	5.14
Giant seaperch	Siakap	77.63 ± 1.24^{ab}	0.97 ± 0.01^{a}	19.66 ± 0.35^{ab}	0.0 ± 0.00^{a}	2.68 ± 0.79^{ab}	NA	5.72

Table 4. Homogeneous subsets of moisture content of demersal fish

Tukey HSD

		Subset for alpha = 0.05	
Sample	N	1	2
Gray eel-catfish	2	74.6050	
Japanese threadfin bream	3	77.6300	77.6300
Large-scale tongue sole	2	78.0000	78.0000
Sixbar grouper	2	78.0250	78.0250
Golden snapper	3	78.6900	78.6900
Indian threadfin	2	79.3900	79.3900
Moonfish	2	80.1250	80.1250
Giant seaperch	3	80.2067	80.2067
Malabar red snapper	2	80.2700	80.2700
Long-tailed butterfly ray	3		81.6600
Sig.		.076	.358

Means for groups in homogeneous subsets are displayed.

Table 5. Homogeneous subsets of protein content of demersal fish

Tukey HSD

		Subset for alpha = 0.05	
Sample	N	1	2
Gray eel-catfish	3	16.6100	
Japanese threadfin bream	2	18.1650	18.1650
Large-scale tongue sole	2	18.4900	18.4900
Sixbar grouper	3	18.8700	18.8700
Golden snapper	3	19.4133	19.4133
Indian threadfin	2	19.5850	19.5850
Moonfish	2	19.6050	19.6050
Giant seaperch	3	19.7433	19.7433
Malabar red snapper	2	19.9200	19.9200
Long-tailed butterfly ray	2		22.7650
Sig.		.322	.067

Means for groups in homogeneous subsets are displayed.

Table 6. Proximate values of shellfish

Samples	Local name	Moisture	Ash	Protein	Fat	Carbohydrate	Energetic value (kJ/g)
		Mean percentage (%)					
Cuttlefish	Sotong	83.68 ± 0.80^{a}	0.90 ± 0.17^{a}	13.94 ± 2.42^{a}	1.35 ± 0.28^{a}	0.87 ± 1.04^{a}	4.04
Prawn	Udang	79.47 ± 1.29^{ab}	1.35 ± 0.14^{ab}	19.12 ± 1.44^{b}	1.06 ± 0.10^{a}	0.0 ± 0.00^{a}	4.94
Cockles	Kerang	78.94 ± 2.18^{ab}	1.63 ± 0.34^{ab}	15.99 ± 0.00^{ab}	1.93 ± 1.28^{a}	1.51 ± 0.95^{a}	4.91
Oyster	Tiram	77.73 ± 0.00^{b}	1.27 ± 0.00^{b}	13.31 ± 0.00^{a}	1.24 ± 0.00^{a}	6.45 ± 0.00^{b}	5.17

* Different alphabets in the same row shows significant difference at $p<0.05$ (Tukey post-hoc test).
* All values are based on wet weight basis.
* Carbohydrate (%) was calculated by substracting moisture (%), ash (%), protein (%) and fat (%) from 100%.

Other than that, the energetic values for all pelagic fish were between the range of 5 kJ g-1 and 6 kJ g-1, except for Longtail shad, with with fairly higher values of 13.34 kJ g-1. This was due to its significantly higher fat content if compared to other fish.

Proximate values of demersal fish

Table 3 shows the proximate, energetic values for demersal fish and fat content data from previous study by Osman et al. (2001). Gray eel-catfish was found to contain the highest level of moisture among the demersal fish studied, with value of 81.66 + 1.47 % compared to other fish that ranged between 75 % and 80 %. However, from in Table 4, it was observed that the moisture content of Gray eel-catfish was not significantly higher than other fish, except for Moonfish (Tukey post-hoc test, $p<0.05$) that contained the least moisture content. Long-tailed butterfly ray was found to have the highest protein content among the studied fish, but not significantly higher than all fish except for Gray eel-catfish (Tukey post-hoc test, $p<0.05$), that contained the least protein content. For other fish species, the protein content ranged between 16 % and 20 %.

Among the 10 demersal fish studied, Moonfish had the highest content of fat at 6.89 + 2.76 %. Meanwhile, Large-scale tongue sole contained the least fat, with percentage of only 0.70 + 0.10%. Other fish contained fat in the range of 0.8 % and 3.5 %. These included two species of demersal fish which were also studied by Osman et al. (2001). Long-tailed butterfly ray was found to contain lower fat content of 0.93 %, compared to 1.95 % in Osman et al. (2001). Meanwhile, Gray eel-catfish was found to contain slightly higher fat content of 3.04 %, compared to 2.79 % in Osman et al. (2001).

From the fat content values, five of the demersal fish studied (Golden snapper, Indian threadfin, Malabar red snapper, Long-tailed butterfly ray, and Large-scale tongue sole) can be categorized as lean fish. The other four species (Sixbar grouper, Japanese threadfin, Gray eel-catfish, and Giant seaperch) can be categorized as low fat fish. Only Moonfish can be categorized as medium fat fish. None of the demersal fish in this study contain carbohydrate. Meanwhile, for energetic value, Moonfish had the highest value of 7.38 kJ g-1 as it contained the highest fat content compared to other fish.

Proximate values of shellfish

Table 6 tabulates the proximate composition and energetic values of 4 shellfish types. Out of the four shellfish, cuttlefish contained the highest level of moisture followed by prawn, cockles and oyster. Prawn contained the highest protein content (19.12 + 1.44 %) than the other 3 shellfish, with mean percentage of 13 % to 16 %. There were no significant differences in the fat content among the four species of shellfish. Oyster contained fairly high amount of carbohydrate, with mean percentage of 6.45 %, which was significantly higher than the other 3 shellfish (Tukey Post-Hoc test, $p<0.05$). On the other hand, cockles and cuttlefish contained only 1.51 + 0.95 % and 0.87 + 1.04 % carbohydrate. Prawn was found to contain no carbohydrate. All four species of shellfish had energetic values that fall within small range of 4 kJ g-1 to 5.17 kJ g-1. This was because their content of protein, fat and carbohydrate did not differ much.

Conclusion

Generally, fish and shellfish are low in fat and carbohydrate contents, but present an excellence source of protein. However, findings of this study have noticed slight differences in the composition of the fish and shellfish from other previous local studies. There were many possible factors such as size, sex, maturity of samples that can affect the differences in proximate composition of marine fish. Sampling procedures also played important role in the differences of the findings. One of possible factors was the representativeness of the samples. Different approach of sampling procedures, which included the method of sample collection, different sample collection sites, and difference in the inclusion criteria of samples with other previous studies, explained the slight difference in the proximate composition values. There was also certain information in previous studies that was insufficient to be used for comparison with the current study. Thus, it is hopeful that details on the sampling procedures and methods of analysis used in this study will be able to provide sufficient information for any comparative purposes in the future. The proximate values obtained from this study would be useful to help the consumers in choosing fish and shellfish based on their nutritional values besides providing an update to food composition database.

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