Proximate Composition of Certain Red Sea Fishes

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Introduction

Knowledge of the proximate composition of fishes can be used to estimate the food value of fishes and to plan the most appropriate industrial and commercial processing. Early, though long outdated, data on the chemical composition of fishes were given by Priestly (1790), Biot (1807), Morin (1822), Weigelt (1891), and many others.

The first Egyptian fish samples from the Mediterranean Sea were analyzed by Milone (1896) and El-Saby (1934). The only work on the Red Sea fishes was done by Latif and Fouda (1976). They analyzed fish samples from the Al-Ghardaga area, though interpretation of their results was limited and they did not indicate age or sex of the specimens.

Many Red Sea fishes are important commercially so classification by fat and protein content (Stansby, 1962) may be of value. This study covers 19 species (Table 1) belonging to 10 families which were collected from the Red Sea between Ras Shukier, in the north, to Qoseir, in the south, during two seasons, winter and summer, in 1980.

ABSTRACT—Moisture, protein, fat, and ash content of muscle and gonads were determined for 19 species of 10 fish families, inhabiting coral reef areas of the coastal Egyptian Red Sea waters, which were collected in winter and summer 1980. Values of these parameters appear to vary widely depending on a number of factors including age, sex, season, and species. The fish samples were classified into five fat-protein content categories: Low oil-high protein, medium oil-high protein, high oil-low protein, low oil-very high protein, and low oil-low protein.

Table 1.—Scientific and common names of the fishes examined.

Family	Serial no.	Scientific name	Local common name
I. Serranidae	1	*Epinephelus fasciatus*	Koshar Abu-loulow
	2	*Epinephelus areolatus*	Koshar Ads
	3	*Cephalopholis miniatus*	Koshar Nawara
	4	*Variola louti*	Koshar sherif
II. Signidae	5	*Siganus oramin*	Segan
III. Mullidae	6	*Upeneus tragula*	Enpir Assfar
IV. Lethrinidae	7	*Lethrinus genivittatus*	Driny
	8	*L. mahsena*	Mehsenaa
	9	*L. harak*	Pongez
V. Balistidae	10	*Odonus niger*	Shoarom Eswad
	11	*Balistoides viridescens*	Shoarom
VI. Labridae	12	*Thalassoma lunare*	Mallass
	13	*Cheilinus trilobatus*	Mallass Abu-Sabiba
	14	*Coris angulata*	Mallass Gorap
VII. Acanthuridae	15	*Ctenochaetus strigosus*	Kahma
VIII. Lutjanidae	16	*Lutjanus fulviflamma*	Hebria Om-nokta
IX. Hemirhamphidae	17	*Hemirhamphus marginatus*	Gambaror
X. Sparidae	18	*Acanthopagrus bifasciatus*	Rabaag
	19	*Chrysophrys haffara*	Haffara

Methods

Fishes were collected, tightly sealed in plastic bags, and deep frozen (−20°C) until examination. Date and location of collection were recorded for each specimen. Subsequently, the fishes were identified, and the length, weight, sex, and age were determined. The skin was removed from the flesh. The entire muscle portion of each fish was cut from the vertebral column, and bones were removed. The entire muscle portion, and also the gonad (ovary or testis), of each fish sample was homogenized in a Waring blender[1]. The homogenated sample was used for all the analyses. At least four fish of a species were sampled to represent each parameter (length, weight, age, and sex). The mean values of the proximate composition of the four fish samples were calculated to represent each

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[1]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

parameter. Age was determined by otolith examination.

Moisture Content

Moisture (water) content was determined by the method in FAO (1981). Labelled moisture dishes, with a layer of acid-washed sand in the bottom, were left to dry overnight in an oven at 105°C. Then they were removed, dried, and cooled in a desiccator for 30 minutes. The dishes were weighed accurately using an analytical balance ($W1$). Triplicate representative samples of flesh and gonads (5-10 g) were then placed into the dishes and reweighed ($W2$). Then they were left overnight in an oven at 105°C, and reweighed ($W3$) after 30 minutes of cooling in a desiccator. The percentage of moisture was calculated as follows:

$$\text{Percent moisture} = \frac{(W2 - W3) \times 100}{(W2 - W1)} .$$

Protein Content

Total protein was determined using the Walker and Youngson (1975) method, which is based on the Snow (1950) and Dyer et al. (1950) procedures. Duplicate portions of the homogenate were dissolved by heating in 0.2N NaOH containing 0.5 percent w/v KI at 100°C for 10 minutes; Biuret reagent was then added. After 10 minutes at 37°C the optical density was measured at 545 nm against a reagent blank using a Perkin-Elmer spectrophotometer model 550S. Standard solutions of bovine serum albumin were similarly treated.

Snow (1950) proved that this Biuret method gives results within 2 percent of the micro-Kjeldahl values. Walker and Youngson (1975) compared the results of Biuret method with two other methods: First with the estimation from the nitrogen values (i.e., the nitrogen values multiplied by the conversion factor of 6.25); second, with that calculated from the addition of the weights of the individual amino acids. They found that the total protein content expressed as a function of nitrogen values was about 4 percent higher than the values of Biuret method, which in turn were about 4 percent lower than the values of the total weights of the amino acids.

Fat Content

Fat was extracted into ethyl ether from the dried samples in a standard soxhlet apparatus for 36 hours; the ethyl ether was evaporated to dryness in a rotary evaporator, and the fat was determined gravimetrically (Latif and Fouda, 1976).

Mineral (Ash) Content

Duplicate samples (5-10 g) were ashed in a muffle furnace for 6 hours at 550° C. The weight of the residual ash, expressed as a percentage of the wet sample weight, was taken as the total inorganic residue (mineral content).

Results and Discussion

The reliability of the methods for assessing moisture, protein, fat, and ash were assessed by taking seven replicate samples from the same specimen: *Odonus niger*, 3 years old, total length 37 cm, weight 430 g. The standard deviations for the estimates of water, protein, fat, and ash were calculated. The variability (S.D.) in the estimates of protein, fat, water, and ash content of replicate samples from the same specimen, were ±0.851, ±0.213, ±1.856, and ±0.298 percent, respectively.

Age Variation

The moisture, protein, fat, and ash content results sometimes showed unaccountable fluctuations even between specimens of the same species, age, and sex and from the same catch. Thus, it is useful for the interpretation of the results to calculate them as average values for each species and then for each family.

The mean and standard deviation values and ranges of moisture, protein, fat, and ash content in the muscles of all age groups of fishes of different species and families are given in Table 2 as percent of wet weight. The mean values of the proximate composition in Table 2 of a given species express the average values of four fish of each male and female of the four age groups studied (1st-, 2nd-, 3rd-, and 4th-year age groups). Average moisture values for all year-groups ranged from 81.12 percent for *Odonus niger* to 73.62 percent for *Chrysophrys haffara*, and standard deviation ranged from ±2.33 for *Upeneus tragula* to ±0.41 for *Hemirhamphus marginatus*.

Average protein values ranged from 23.13 percent for *Chrysophrys haffara* to 16.61 percent for *Odonus niger*, and the standard deviation ranged from ±1.84 for *Upeneus tragula* to ±0.12 for *Cheilinus trilobatus*. Average fat content ranged from 1.74 percent for *Thalassoma lunare* to 0.75 percent for *Acanthopagrus bifasciatus*, and standard deviation values ranged from ±0.79 for *Variola louti* to ±0.07 for *Epinephelus areolatus*. Average ash content ranged between 2.11 percent for *Chrysophrys haffara* to 0.91 percent for *Lethrinus harak*, and the standard deviation ranged from ±0.71 for *Epinephelus fasciatus* to ±0.02 for *Acanthopagrus lifasciatus*.

Figure 1 shows the relationship between age and the moisture, protein, fat, and ash content in the muscle of *Variola louti*. Muscle moisture content varied inversely with the amount of fat (i.e., when moisture was highest, fat content was lowest and vice versa). Generally, there was an increase in fat and less water content in flesh with increasing size (i.e., increasing age). The fluctuations of water, fat, protein, and ash values with age of the fishes may be due in part to migration and spawning (Zaitsev et al., 1969; Waters, 1982).

My results agree with those of Vinogradov (1953) who recorded a minimum moisture content of 75 percent for the family Sparidae. Some of my data also agrees with those of Latif and Fouda (1976) who found a moisture content for *Lethrinus mohsena* of 78.7 percent, compared with my average of 78.86 percent. Figure 1 also shows that the smaller the amount of ash, the less the

Table 2.—Moisture, protein, fat, and ash content (mean, standard deviation, and range) in the muscle of all age groups of fishes studied (as percent of wet weight).

	Moisture			Protein			Fat			Ash		
Family and species	Mean	S.D.	Range	Mean	S.D.	Range	Mean	S.D.	Range	Mean	S.D.	Range
I. Serranidae (all species)	77.64	0.86	74.33-79.70	19.83	1.20	17.72-21.72	1.15	0.14	0.43-2.30	1.58	0.34	1.01-2.28
1. *Epinephelus fasciatus*	77.77	1.42	76.36-79.20	19.91	1.12	19.01-20.60	1.23	0.61	0.84-1.92	1.47	0.71	1.01-2.28
2. *Epinephelus areolatus*	77.27	1.21	76.12-78.53	20.50	1.10	19.35-21.55	1.07	0.07	1.00-1.14	1.17	0.03	1.14-1.20
3. *Cephalopholis miniatus*	78.76	0.96	77.78-79.70	18.28	0.65	17.72-19.00	1.00	0.16	0.82-1.11	1.96	0.17	1.77-2.10
4. *Variola louti*	76.75	1.68	74.33-78.00	20.31	0.95	19.60-21.72	1.31	0.79	0.43-2.30	1.71	0.06	1.66-1.79
II. Siganidae	77.45	0.96	76.39-78.28	20.12	1.12	19.05-21.38	0.98	0.13	0.84-1.10	1.39	0.31	1.04-1.6
5. *Siganus oramin*	77.45	0.96	76.39-78.28	20.12	1.12	19.05-21.38	0.98	0.13	0.84-1.10	1.39	0.31	1.04-1.6
III. Mullidae	77.48	2.33	74.79-78.92	20.23	1.84	19.14-22.36	1.02	0.12	0.93-1.10	1.27	0.32	1.08-1.64
6. *Upeneus tragula*	77.48	2.33	74.79-78.92	20.23	1.84	19.14-22.36	1.02	0.12	0.93-1.10	1.27	0.32	1.08-1.64
IV. Lethrinidae (all species)	78.06	1.84	75.22-80.47	20.02	2.18	17.62-23.63	1.12	0.18	0.81-1.52	1.06	0.15	0.74-1.37
7. *Lethrinus genivittatus*	75.93	0.96	75.22-77.02	22.53	0.96	21.93-23.63	1.22	0.30	0.93-1.52	1.20	0.17	1.03-1.37
8. *Lethrinus mahsena*	79.06	0.69	78.53-79.84	18.66	0.91	17.62-19.42	1.22	0.19	1.04-1.41	1.08	0.07	1.01-1.14
9. *Lethrinus harak*	79.18	1.19	78.12-80.47	18.87	0.86	18.03-19.75	0.91	0.10	0.81-1.00	0.91	0.24	0.74-1.19
V. Balistidae (all species)	79.73	1.97	77.69-83.01	17.63	1.44	15.13-19.02	1.28	0.49	0.74-2.09	1.55	0.28	1.10-2.29
10. *Odonus niger*	81.12	1.91	79.20-83.01	16.61	1.49	15.13-18.10	0.93	0.21	0.74-1.15	1.35	0.25	1.10-1.60
11. *Balistoides viridescens*	78.34	0.66	77.69-79.21	18.20	0.64	17.53-19.02	1.63	0.36	1.25-2.09	1.75	0.59	1.21-2.29
VI. Labridae (all species)	78.26	1.24	76.69-80.20	18.92	0.99	18.23-20.15	1.23	0.24	0.86-1.82	1.57	0.51	0.82-2.26
12. *Thalassoma lunare*	77.50	0.71	76.99-78.00	18.65	0.59	18.23-19.07	1.74	0.11	1.66-1.82	2.09	0.25	1.9 -2.26
13. *Cheilinus trilobatus*	79.69	0.74	79.15-80.20	18.08	0.12	18.00-18.16	1.19	0.47	0.86-1.52	1.08	0.18	0.95-1.21
14. *Coris angulata*	77.58	0.77	76.69-78.07	20.02	0.15	19.85-20.15	1.23	0.24	1.03-1.50	1.54	0.64	0.82-2.03
VII. Acanthuridae	76.45		76.45	20.04		20.04	1.57		1.57	1.88		1.88
15. *Ctenochaetus strigosus*	76.45		76.45	20.04		20.04	1.57		1.57	1.88		1.88
VIII. Lutjanidae	77.37		77.37	20.00		20.00	1.22		1.22	1.58		1.58
16. *Lutjanus fulviflamma*	77.37		77.37	20.00		20.00	1.22		1.22	1.58		1.58
IX. Hemirhamphidae	75.79	0.41	75.50-76.04	21.81	0.75	21.3 -22.32	1.27	0.13	1.17-1.36	1.11	0.19	0.97-1.24
17 *Hemirhamphus marginatus*	75.79	0.41	75.50-76.07	21.81	0.72	21.3 -22.23	1.27	0.13	1.17-1.36	1.11	0.19	0.97-1.24
X. Sparidae (all species)	76.12	3.54	73.21-79.03	21.26	2.65	19.11-23.54	0.95	0.28	0.66-1.28	1.68	0.61	1.23-2.23
18. *Acanthopagrus bifasciatus*	78.62	0.59	78.20-79.03	19.38	0.37	19.11-19.64	0.75	0.13	0.66-0.84	1.25	0.08	1.23-1.26
19. *Chrysophrys haffara*	73.62	0.59	73.21-74.03	23.13	0.58	22.72-23.54	1.15	0.18	1.02-1.28	2.11	0.18	1.98-2.23

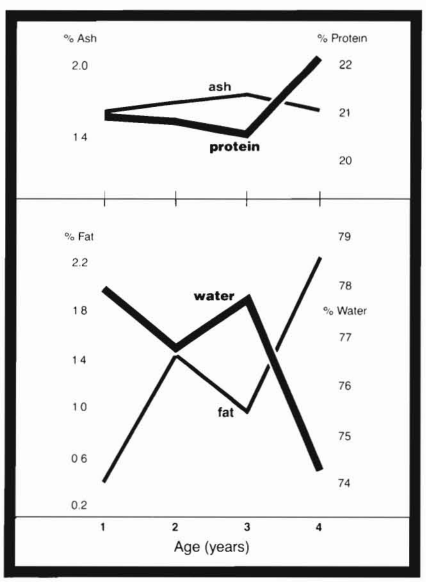

Figure 1.—Age and proximate composition of *Variola louti* muscle.

Table 3.—Sex differences in the proximate composition of fish muscle and gonads (as percent of wet weight).

Species Habitat Capture date	Sex	Organ	Mean fish length (cm)[1]	Age (years)	Mean proximate composition (%)[2]			
					Water	Protein	Fat	Ash
Siganus oramin	M	Muscle	15.5	1	73.88	23.64	1.18	1.40
Qoseir	F	Muscle	15.5	1	78.80	19.68	0.66	0.92
25 Aug. 1980	M	Muscle	17	2	75.4	22.80	1.02	
	F	Muscle	19	2	77.37	19.95	1.00	1.66
Lethrinus genivittatus	M	Muscle	16.8	1	76.31	21.82	0.92	0.96
Safaga	M	Testes	16.8	1	73.36	22.84	0.98	2.75
30 May 1980	M	Muscle	18	1	75.30	22.04	1.12	1.48
	M	Testes	18	1	73.37	23.56	1.05	2.01
	F	Muscle	17	1	77.40	20.63	0.94	1.03
	F	Ovaries	17	1	72.45	23.75	1.10	2.70
Lethrinus harak	M	Muscle	13	1	75.95	21.85	0.92	1.26
Safaga	F	Muscle	13	1	78.20	19.60	0.88	1.28
30 May 1980	M	Muscle	21	2	79.15	18.52	0.93	1.30
	F	Muscle	21.5	2	80.06	18.01	0.91	1.04
	M	Muscle	27.0	3	79.40	19.00	0.82	0.82
	F	Muscle	29.0	3	81.50	17.05	0.80	0.65
Balistoides viridescens	M	Muscle	39.6	3	78.80	18.80	1.66	1.48
Safaga	M	Testes	39.6	3	72.48	23.77	1.21	2.60
4 Feb. 1980	F	Muscle	40.0	3	78.85	17.53	1.46	2.20
	F	Ovaries	40.0	3	70.60	25.07	1.63	2.69

[1]Average length of four fish samples.
[2]Average proximate composition of four fish samples.

moisture content (i.e., the amount of mineral substances in the flesh of fishes was directly correlated with the amount of moisture).

Variation by Sex

Table 3 presents the proximate composition of muscle and gonads of fishes of each sex collected from the same habitat at the same time. The flesh of males contains less moisture and more protein and fat than that of females. Also, the ovaries contained more protein and fat than the testes, though the ovaries had less water than the testes and even less than the flesh itself. Zaitsev et al. (1969), Hinard (1931), Giménez (1934), and many others have given similar data. The results of this study of ash content of the flesh and genital organs of male and female fishes were not consistent; the data show no regularity. Generally, the mineral content in the different tissues of the fishes showed marked fluctuations.

Table 4.—Seasonal variations in the proximate composition of flesh of some Red Sea fishes (as percent of wet weight) harvested in 1980.

Species	Habitat	Month	Mean fish length (cm)[1]	Mean fish weight (g)[2]	Age (years)	Mean proximate composition (%)[3]			
						Water	Protein	Fat	Ash
Upeneus tragula	Qoseir	Jan.	17.8	2	61	78.83	19.21	0.99	1.19
	Safage	May	19.0	2	66	74.79	22.36	1.16	1.64
Lethrinus genivittatus	Hurgada	Feb.	13.5	1	16	75.61	22.21	1.16	0.98
	Ras-Shuker	Feb.	15	1	44	73.12	23.41	1.87	1.60
	Safaga	May	17	1	60	77.40	20.63	0.94	1.03
	Safaga	May	16.8	1	56	76.31	21.82	0.92	0.96
	Ras-Shuker	Feb.	17	2	72	72.60	23.63	2.11	1.72
	Safaga	May	18.5	2	75	77.83	20.22	0.93	1.02
Lethrinus harak	Hurgada	Feb.	17	1	66	78.77	19.05	0.95	1.26
	Safaga	May	16	1	53	79.57	18.51	0.88	0.97
	Ras-El-Zeit	Feb.	23	2	189	77.59	19.83	1.20	1.38
	Safaga	May	21.5	2	188	80.06	18.01	0.91	1.04
	Safaga	May	29	3	300	81.50	17.05	0.78	0.65
	Safaga	Feb.	27	3	242	79.40	19.00	0.84	0.82
Siganus oramin	Qoseir	Jan.	15.5	1	60	78.80	19.68	0.66	0.92
	Qoseir	Aug.	15.5	1	68	73.88	23.64	1.18	1.40
	Qoseir	Jan.	17	2	75	77.37	19.95	1.00	1.66
	Qoseir	Aug.	19	2	80	75.40	22.80	1.02	1.40

[1]Average length of four fish samples.
[2]Average weight of the four fish samples.
[3]Average proximate composition of the four fish samples.

Seasonal Variation

The proximate composition of the flesh of some fishes collected during winter and summer shows a seasonal change (Table 4). Protein and fat content peaked in early summer after dropping to a low in winter for *Siganus oramin* and *Upeneus tragula*; water content showed an opposite trend. *Lethrinus genivittatus* and *L. harak*, on the other hand, showed minimum fat and protein content in summer and maximum levels in winter.

Waters (1982) and Zaitsev (1969) reported that seasonal variation in chemical composition is due to an alternate accumulation and expenditure of fat and protein. Fish have a minimum fat content after spawning, and a maximum at the end of the feeding season. When fish were in poor condition during migration and spawning, the fat and protein content of their flesh went down and the water content went up; during the feeding period after spawning, the flesh became fatter and its water content decreased. Therefore, *Upeneus tragula* and *Siganus oramin* had maximum fat and protein content by the end of May.

Al-Kholy (1972) reported that *Upeneus tragula* migrated to the Safaga area for intensive feeding in mid-May for 2 weeks; then after another 2 weeks started another migration for spawning. Al-Kholy (1972) also reported that most species of Lethrinidae started their spawning migrations between the end of April and mid-June. So *Lethrinus genivittatus* and *L. harak* had minimum fat and protein content in May due to reproductive activity, including gonad development, migration, and spawning (i.e., expenditure of fat and protein).

Table 5.—Fish species categorized[1] by fat and protein content.

Species	Fat content (range, %)	Protein content (range, %)	Category
1 *Epinephelus fasciatus*	0.84-1.92	19.01-22.18	A-D
2. *Epinephelus areolatus*	1.03-1.10	19.35-21.65	A-D
3. *Cephalopholis miniatus*	0.82-1.11	17.72-19.00	A
4. *Variola louti*	0.43-2.30	19.50-21.72	A-D
5. *Siganus oramin*	0.66-1.18	16.00-23.64	A-D
6. *Upeneus tragula*	0.93-1.16	19.14-22.36	A-D
7 *Lethrinus genivittatus*	0.92-2.11	19.01-23.63	A-D
8. *Lethrinus mahsena*	0.95-1.41	17.62-20.21	A-D
9. *Lethrinus harak*	0.79-1.20	17.05-21.85	A-D
10. *Odonus niger*	0.74-1.15	15.13-18.10	A
11 *Balistoides viridescens*	1.25-2.09	17.53-19.04	A
12. *Thalassoma lunare*	1.66-1.80	18.23-19.07	A
13. *Cheilinus trilobatus*	0.84-1.58	18.02-18.10	A
14. *Coris angulata*	1.03-1.50	19.40-20.98	A-D
15. *Ctenochaetus strigosus*	1.54-1.60	20.00-20.08	A
16. *Lutjanus fulviflamma*	1.16-1.28	22.76-22.83	D
17. *Hemirhamphus marginatus*	1.17-1.36	21.30-22.32	D
18. *Acanthopagrus bifasciatus*	0.66-0.84	19.11-19.64	A
19. *Chrysophrys haffara*	1.02-1.28	22.72-23.54	D

[1]After Stansby (1962).

Fish Categories

The fishes studied were classified by fat and protein content into the five categories of Stansby (1962) (Table 5). Seven species lie in

Category A, the most common type (protein content between 15 and 20 percent and fat content <5 percent). All species in Category A have a fat content <2 percent. Only three species, *Lutjanus* sp., *Hemirhamphus marginatus*, and *Chrysophrys haffara* fall in Category D, and they exhibit a very high protein content (over 20 percent).

Most species, e.g., *Epinephelus areolatus*, *Variola louti*, and *Siganus oramin*, belong primarily to Category A, while the second leading category is D. So, according to Stansby's classification, these Red Sea fishes fall under the Categories A and D, characterized by low fat content (<2.3 percent) and very high protein content (15-23.6 percent). Latif and Fouda (1976) reported similar results.

It is worth mentioning that some plankton feeding fishes caught by purse seining in the Red Sea and also in the Indo-Pacific area have a higher protein content, e.g., *Chrysophrys haffara* (23.13 percent); Marinkovic and Zei (1959) reported similar results. Again, we found that some surface feeding fishes, e.g., *Hemirhamphus marginatus* and *Lutjanus fulviflamma*, have a higher protein content, and a fat content >1.2 percent. This conclusion agrees reasonably well with Van Wyk (1944) that the surface fishes are higher in fat and protein content than deep-water species.

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