PROXIMATE COMPOSITION OF SOME RED SEA FISHES

By

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SUMMARY

1. The present work deals with the estimation of moisture, protein, fat and ash in the flesh of 25 species belonging to 12 families. Material collected from the neighbourhood of Al-Ghardaqa, Red Sea, during the period of May through October.

2. Moisture content ranged from 72.67 to 79.77%. Highest content was recorded in *Variola louti* and the lowest in *Clupea leiogaster*. Most species have water content more than 75%. Range of difference between maximal and minimal values of water content is mostly from 1 to 3%, is different for different species and is less manifested within the species of the same family than within different species of different families. Standard deviation ranged from 0.2307 to 1.3863.

3. Protein content ranged from 17.99 - 23.22%. Highest protein content is recorded in *Clupea leiogaster* and lowest in *Epinephelus megachi.*. Most species have protein between 18 and 20%. Nine species have this content more than 20%. Standard deviation ranged from 0.1961 to 0.9840.

4. Fat content had range from 0 339 to 2.515% and standard deviation from 0.0648 to 0 4368. 18 species had fat content less than 1% and only 2 species, namely, *Clupea leiogaster* and *Decapterus sanctaehelenae* had fat content over 2%.

5. Among the species examined. surface fishes have high fat content as compared with that of other fishes, except *Lethrinus latifrons*. The 25 species examined are lean.

6. Among moisture, protein, and fat, the last showed the highest degree of variation and ranges of the coefficients of variation are 0.3 - 1.84, 0.85 - 4.67 and 7.52-85.65 respectively.

7. According to Stansby's nomenclature (1962), most of the species examined belong to category A, i.e. having low oil and high protein content, some fishes belong primarily to this group but secondarily to group D, i.e. having low oil and very high protein. Few fishes belong only to group D while some others belong primarily to this group but secondarily to group A. Such a characterization has no relation with the family to which the fish belongs.

8. Ash content ranged between 1.169 to 1.559%. 22 species lied in ash content range between 1.2 to 1.5%. Ash content less than 1.2% or more than 1.5% is recorded in one and two species respectively.

INTRODUCTION

The consumption and production of food in the world are very uneven. Consumption ranges from 2,000 to 3,100 calories per caput per day. Qualitative deficiency is more significant than the quantitive one. In many countries of Asia, Africa and South America; most of the calories are mainly derived from cereals, starch roots, and tubers and minor proportion is derived from milk, eggs, meat or fish.

In the undeveloped countries, it is of great importance to increase the proportion of protein especially that of animal origin. This cannot be fulfilled or can be, but very slowly, by increasing agricultural production. On the other hand, fish is highly nutritious and is particularly valuable source of protein of high quality comparable with that of meat, milk or eggs. By activation of the marine and fresh-water fisheries the vital gap in animal protein supply can be closed. Therefore, the consumption of fish, whereever available in sufficient quantites, can considerably help in correcting the state of malnutrition which is so widely prevalent in the world today. Besides, fish constitutes qualitatively a good source of protein. Fishes are as well a good source of minerals, especially calcium, phosphorus, and iron.

Furthermore, knowledge of the proximate composition of the diet is of great importance for different purposes and to many individuals and specialists. It is, for example, essential for dieticians in institutions concerned with mass feeding. Individuals who are in need of weight control are interested in caloric content of foods.

In medicine, the proximate composition of fish has been in demand by heart specialists after the recent study of the relationship between the type of fat ingested and arteriosclerosis, as well as the need for control of boesity. Many of these specialists recommend the use of generous quantities of fish in their patient's diets, both as means of ingesting polyunsaturated fatty acids which are beneficial in keeping down the cholesterol level of blood, and as a means of obtaining sufficient amounts of protein in the diet without ingesting excessive amounts of fat, which might cause the patients to have over-weight and lean fish fulfill these requirements. Fish may, as well, be prescribed for patients who need sodium restricted diets. On this account, in order that fish may be prescribed as food, good knowledge of proximate composition of fish is essential.

Knowledge of the proximate composition of fish is also important to those people who deal with animal feeds containing fish. In this connection, they are specially interested in the composition of the whole fish.

It is important, besides, to know if amount of fish protein of a given species render the preparation of fish flour and other dried fishery products economically feasible. Knowledge of fat content of fish is also essential for commercial production of oil as well fish preservation.

All the above facts, besides others, point to the importance of having a good idea about the proximate composition of fish species. On the bases of such information, fish can be diverted to the most suitable way of its utilization. In conclusion, consumption of fish deserves to be encouraged in the whole world and particularly in the countries consuming high cereal and low protein diets.

Our knowledge of the biochemical composition of Egyptian fishes is incomplete as few species were subjected to such an investigation before. The present work is therefore undertaken dealing with the composition of 25 species from the Red Sea, belonging to 12 families collected from the Red Sea during May through October from the vicinity of Al-Ghardaqa (Table 1).

METHODS

For the problem under investigation and for the different biochemical assays, each species was represented by eight samples. Each sample is made up of at least four fishes of comparable size and weight. For each sample, length, weight, sex if possible, date and region of capture, and state of gonad were recorded. The parameters for a given fish sample as body length or weight are based on the average for the fishes comprising this sample. Specimens were carefully skinnned and 5-10 gm of the edible portion were separated. Samples taken were subjected to the following estimations :

A. Moisture content :

Water content was determined by drying duplicates of fresh samples of known weight, from 15 - 20 gm, in an oven at 105°C for 24 hours, by which period a constant weight was attained. From the decrease in weight, the moisture content per 100 gm. of fresh flesh was computed.

B. Protein content :

As is mostly the case, the total protein was calculated by multiplying the total nitrogen (T.N.) by 6.25. Total nitrogen was estimated by applying the macro-Kjeldahl method.

C. Fat content :

The fat content was determined after extraction of fat from dried samples by ethyl ether and on heating in a soxhlet appartus.

D. Ash content :

The ash content was determined by igniting individual dried samples of known weight in silica crucible at 550°C for about 10 hours. Few drops of nitric acid was used to get rid of any traces of carbon. After cooling in a dessicator, the ash was weighed, and hence its magnitude per 100 gm. of fresh flesh could be calculated.

RESULTS

1. Percentage of different components

Data available for the different components, viz., moisture, protein, fat and ash are given in table 2. From this table, it is clear that moisture shows the highest content and in most species comprises more than 75% of the fresh flesh. Protein, but much lower, comes next and its percentage ranges from about 18% to about 23%. Among the 25 species examined, the fat content is low and ranges from about 0.4% to about 2.5% Ash content is in most cases more than that of fat and is not less than 1% and more than 1.6% (Table 2).

TABLE 1. **Scientific and verancular names of the 25 fish species examined.**

Family	Scientific name (species)	Vernacular name
1. Serranidae	1. *Epinephelus faciatus* (Forskal)	Koshar Abu-loulou
	2. *Epinephelus areolatus* (Forskal)	Koshar Ads
	3. *Epinephelus summana* (Forskal)	Koshar Kharnaa
	4. *Epinephelus megachi* (Richardson)	Koshar Tina
	5. *Cephalopholis argus*	Koshar
	6. *Epinephelus diacanthus* (Valenciennes)	Koshar Abu-nawara
	7. *Variola louti* (Forskal)	Koshar Sherif
2. Lethrinidae	8. *Lethrinus mahsena* (Forskal)	Mehseny
	9. *Lethrinus nebulosus* (Forskal)	Sho'our
	10. *Lethrinus bungus* (Forskal)	Bonkos
	11. *Lethrinus latifrons* (Rupp).	Drainy
3. Sphyraenidae	12. *Sphyraena kenie* (Klunz).	Kaneya
4. Plectropomidae	13. *Plectropomus maculatus* (Bloch)	Nagel
5. Scombridae	14. *Restrelliger kanagurta* (C. & V.)	Kuscombry
	15. *Scomber japonicus* (Linnaeus)	Shakk-el-zor
6. Carangidae	16. *Decapterus sanctaehelenae* (Cuvier)	Shakhoura
7. Lutianidae	17. *Lutianus argentimaculatus* (Forskal)	Shahfala
	18. *Lutianus bohar* (Forskal)	Bohar
	19. *Lutianus fulviflamma* (Forskal)	Hebria Om-nokta
	20. *Lutianus kasmira* (Forskal)	Herbia Mekattata
8. Scaridae	21. *Scarus harid* (Forskal)	Bayadeya
9. Acanthuridae	22. *Teuthis stellata* (Forskal)	Sigan
10. Plectorhyncidae	23. *Gatrin gaterinus* (Forskal)	Gatrin
11. Sparidae	24. *Chrysophrys haffara* (Forskal).	Haffar
12. Clupeidae	25. *Clupea leiogaster* (C. & V.)	Moza

TABLE 3 : **Maximum, minimum, average values and standard deviation of moisture content,**

Species	Moisture content				
	Maximum %	Minimum %	Diff. between max. and Min.	Average %	σ
1. Koshar Abu-loulou . . .	80.19	78.24	1.95	79.31	0.6272
2. Koshar Ads	79.18	77.57	1.61	78.70	0.7863
3. Koshar Kharnaa . . .	79.37	78.32	1.05	79.01	0.3592
4. Koshar tina	79.30	77.70	1.60	78.50	0.4979
5. Koshar	79.80	78.67	1.13	79.32	0.3707
6. Koshar Abu-nawara . .	79.97	78.81	1.16	79.17	0.4089
7. Koshar Sherif	82.23	78.42	3.81	79.77	0.4600
8. Mehseny	80.12	77.38	2.74	78.70	0.8009
9. Sho'our	77.91	76.47	1.44	77.38	0.4194
10. Bonkos	79.09	77.54	1.55	78.43	0.7750
11. Drainy	77.16	74.75	2.41	75.29	0.6916
12. Keneya	78.28	73.99	4.29	75.25	1.3863
13. Nagel	78.92	76.33	2.59	77.93	0.7918
14. Kuscombry	75.03	73.01	2.02	73.95	0.6366
15. Shakk-el-zor	75.09	73.21	1.88	74.41	0.5546
16. Shakhoura	76.21	74.10	2.11	75.10	0.7209
17. Shahfala	79.14	77.68	1.46	78.55	0.2796
18. Bohar	80.82	78.45	2.77	79.04	0.7427
19. Hebria-om-nokta . . .	75.07	77.79	1.28	78.25	0.3930
20. Hebria Mekattata . .	79.52	77.35	2.17	78.60	0.6270
21. Bayadeya	80.56	76.25	4.31	78.65	1.1563
22. Sigan	79.43	76.34	3.09	77.87	1.0620
23. Gatrin	78.19	78.00	0.19	78.10	0.2307
24. Haffar	77.95	75.95	2.00	76.93	0.5954
25. Moza	73.41	71.77	1.64	72.67	0.5135

σ = Standard deviation

(*c*) *Individual variation :*

Individuals of the same species vary in their water content. As is clear from table 3, the difference between the maximum and minimum values of water content varies in the different species. Thus the widest range in the moisture content is seen in Keneya and Bayadeya where differences between maximal and minimal values of water content are 4.29 and 4.31 respectively. Koshar sherif and sigan come next as the differences between maximal and minimal values of water content is 3.81 and 3.09 respectively. On the whole, the difference between maximal and minimal values of moisture content is more than 1% and less than 2% in twelve species. Besides, eight specis have this difference more than 2% and less than 3%. Difference between maximal and minimal values less than 1% was found in only one species, between 3 and 4% in two species and in two species only this difference was more than 5%.

B. **Protein**

(*a*) *Variation among different species:*

In the 25 species studied the protein content ranged from 17.99 to 23.22 gm/100 gm. tissue (table 2). Most of the species fall within the range of 18 - 20% protein. Among the species examined, *Lethrinus nebulosus, Lethrinus latifrons, Rastrelliger kanagurta, Sphyraena kenie, Scomber japonicus, Decapterus sanctae-helenae, Teuthis stellata, Chrysophrys haffara and Clupea leiogaster* have a protein content over 20%. The lowest protein content was recorded in *Epinephalus megachi,* while the highest was found in *Clupea leiogaster*. The difference between the highst and lowest protein content is 5.23%. The ratio of the highest protein content of *Clupea leiogaster to* the lowest value found in *Epinephelus megachi* is 1.29 : 1.0.

(*b*) *Variation within the same family :*

Among the members of family Serranidae here exmined, the protein content on the average ranged from 17.99 to 18.97%. Thus, the range of difference, is less than one. The protein content of the four lethrinids, Mehseny, Sho'our, Bonkos and Drainy ranged from 19.3 to 20.48. The range of difference is only 1.18.

For the four examined lutianids, the range in protein content is from 18.4 to 19.55, and the range of difference is 1.19%. Thus, these ranges of differences in the protein content of serranids, lethrinids and lutianids are small as compared with the range of difference of 3.7 recorded among the 25 species exmined. In turn, for the differferent families here mentioned such ranges may be apt to change if more species are examined.

(*c*) *Individual variation :*

There is a variation in the protein content between different individuals of the same species. In most fishes here examined, the difference between maximal and minimal values is less than 2% and this reveals that there is a narrow range of variation among the different individuals of the same species (table 4). Only 4 species have this difference about 1, 16 species have this difference more than 2 and less than 3, and lastly only 1 species has this difference more than 3.

TABLE 4. **Maximum, minimum, average values and standard deviation of protein content**

Species	Protein content				
	Maximum %	Minimum %	Diff. between max and Min.	Average %	σ
1. Koshar Abu-loulou .	19.62	18.44	1.18	18.79	0.3987
2. Koshar Ads	19.70	18.41	1.29	18.92	0.5152
3. Koshar Kharnaa . .	19.10	18.44	1.66	18.71	0.2128
4. Koshar Tina	18.87	17.36	1.51	17.99	0.5648
5. Koshar	19 35	18.50	0.85	18.83	0.2472
6. Koshar Abu-nawara.	19.13	18.24	0.89	18.59	0.3207
7. Koshar Sherif . . .	19.16	17.66	1.50	18.30	0.4853
8. Mehsny	20.06	18.29	1.77	19.30	0.6148
9. Sho'our	21.45	20.17	1.28	20.61	0.3806
10. Bonkos	20.41	18.28	2.13	19.33	0.6934
11. Drainy.	21.41	20.26	1.15	20.48	0.3548
12. Keneya	22.05	19.33	2.68	21.41	0.9840
13. Nagel	20.08	19.30	1.50	19.92	0.4109
14. Kuscombry.	24.08	22.26	1.82	23.20	0.5537
15. Shakk-el-zor	23.19	22.12	1.07	22 65	0.3204
16. Shakhoura	21.40	20.12	1.28	20.83	0.4646
17. Shahfala	18.95	17.77	1.18	18.65	0.4061
18. Bohar	18.90	17.58	1.32	18.40	0.4167
19. Hebria Om-nokta .	20.24	17.33	2.89	19.59	0.8666
20. Hebria Mekattata. .	20.32	18.45	1.87	19.34	0.5034
21. Bayadeya	20.48	17.84	2.64	19.27	0.7501
22. Sigan	20.95	18.98	1.97	20.07	0.7485
23. Gatrin	20.29	19.69	0.60	19.95	0.1691
24. Haffar	21.25	19.65	1.60	20.65	0.5114
25. Moza	24.35	21.16	3.18	23.22	1.0349

σ=Standard deviation

The standard deviation for the values of protein content estimated for the different individuals of the same species is mostly low and this points to the fact that although the protein content is variable in the different individuals yet these values are nearly comparable. In general, the standard deviation of protein content of different individuals is found less than 0.5 in 3 species and more than 0.5 and less than 1 in 11 species, and in only one species (Moza) the standard deviation is more than one.

C. Fat

(a) *Variation among different species :*

The average values of the fat content for the 25 species studied ranged from 0.339% to 2.515% as shown in table 2. The difference between the highest and lowest fat content was thus 2.176%. Of the species examined, 18 species had fat content less than 1%,5 had fat content from 1-2% and only 2 species, namely *Clupea leiogaster* and *Decapterus scanctaehelenae* had this content over 2%. In other words, our Red Sea species here examined have a low content of fat. On the whole, the ratio of the highest value of fat content found in *Clupea leiogaster* to the lowest value found in *Epinephlus faciatus* was 7.42 : 1. This ratio is considerably high when compared with that shown in both moisture and protein contents where these ratios were 1.09 : 1 and 1.29 : 1 respectively. This points to the fact that variation of the fat content is great as compared with that manifested by either protein or moisture.

(b) *Variation within the same family.*

Among the serranids examined, fat content ranged from 0.339 to 1.098 gm/100 gm tissue with range of difference of 0.729. For the four lethrinid species, fat content ranged from 0.535% to 1.377%. In the lutianids here examined the range of fat content was found between 0.629 and 0.224%. It is thus quite clear that ranges of fat content of different families are different. Such ranges here revealed are wider in the lithrinids than in serranidss and are the narrowest for the lutianids. In general, these ranges are still narrower among the different members of one family than those recorded for the 25 species here examined.

(c) *Individual variation :*

Individuals of the same species vary in their fat content. This variation is relatively more significant than that exhibited by either protein or moisture· This is clearly shown on comparing the ratio between their maximum and minimal values with that of the fat content. Thus, in *Epinephelus faciatus* while fat content has an average of 0.339%, it ranged from 0.128 to 0.540%. In another serranid, *Epinephelus areolaus*, fat content has an average of 1.068% and ranges from 0.404 to 1.665%. In *Clupea leiogaster*. the average fat content is 2·515% and it ranges from 2.215 to 2·815%

TABLE 5. **Maximum, minimum, averaga values and standard deviatio of fat content.**

Species	Fat content				
	Mxaimum %	Minimum %	Diff. between Max. & Min.	Average %	σ-
1. Koshar Abu-loulou .	0.540	0.128	0.412	0.339	0.1442
2. Koshar Ads	1.665	0.404	1.261	1.068	0.3849
3. Koshar Kharnaa . .	0.794	0.578	0.216	0.686	0.0824
4. Koshar Tina	0.924	0.586	0.338	0.787	0.1403
5. Koshar	0.813	0.458	0.355	0.678	0.1493
6. Koshar Abu-nawara.	1.115	0.571	0.544	0.856	0.1847
7. Koshar Sherif . . .	0.816	0.505	0.311	0.682	0.1209
8. Mehseny	1.012	0.208	0.804	0.608	0.3609
9. Sho'our	0.729	0.559	0.170	0.654	0.0648
10. Bonkos	0.648	0.239	0.409	0.535	0.1378
11. Drainy.	1.547	1.035	0.512	1.377	0.1929
12. Kenya	2.223	1.024	1.199	1.974	0.4206
13. Nagel	1.421	0.368	1.053	0.679	0.4368
14. Kuscombry.	1.493	1.083	0.410	1.288	0.1410
15. Shakk-el-zor	1.625	1.317	0.308	1.472	0.1208
16. Shakhoura	3.082	2.125	0.957	2.504	0.3703
17. Shahfala	1.032	0.674	0.358	0.853	0.1380
18. Bohar	1.442	0.223	1.219	0.839	0.3602
19. Hebria Om-nokta .	1.457	0.314	1.143	0.644	0.3749
20. Hebria Mekattata. .	0.907	0.414	0.493	0.629	0.2002
21. Bayadeya	0.672	0.234	0.538	0.453	0.1729
22. Sigan	1.142	0.125	1.017	0.494	0.4231
23. Gatrin	0.780	0.508	0.272	0.644	0.1015
24. Haffar	1.323	0.742	0.581	0.989	0.1729
25. Moza	2.815	2.215	0.600	2.515	0.1892

σ=Standard Deviation

(Table 5). In general, according to the range of difference of fat content of different individuals, the studied 25 species can be classified into 3 groups : (a) less than 0.5%, (b) between 0.5% to less than 1% and, (c) more than 1%.. Twelve species belonged to the first group, seven to the second and six species to the third.

The standard deviation for the fat content (table 5) is in fact low but is in turn considerable in comparison with the actual values of fat content of the different individuals. Thus, in *Epinephelus faciatus,* the ratios of the standard deviation to the maximal and minimal values are about 1 : 4 and 1 : 1 respectively, Among 6 fishes, viz., Koshar Abu-loulou, Mehseny, Nagel, Bohar, Herbria Omnokta and Sigan, the values of standard deviation are higher than the minimal values of fat content recorded for the different individuals of the concerned species.

In general, the degree of variation is rather different and the individual variability in fat content of the different species is not the same.

D. Ash

As shown in table 2, ash content for the 25 species ranged from 1.169 to 1.559%. Among the examined fishes, 22 species have an ash content between 1·2 and 1.5%. Ash content is less than 1.2% in only one species and more than 1.5% in 2 species. The ratio of the highest value of ash content of Sigan to the lowest value of Koshar is 1.3 : 1.

In general, there is a variation in ash content between the different species belonging to th same or different families, but in turn this variation is much less manifested than that of moisture, protein or fat.

2: Degree of variation in Moisture, Protein and fat

For comparing the variation in the contents of water, protein and fat, the computed values of the coefficient of variation (CV) are shown in table 6. Thus, this coefficient differs among the different biochemical constituents within the same species and among different species. Thus, for moisture, the highest values are found in Keneya minimal values are recorded in Moza, Shakk-el-zor, sho'our and Kuscombry and are 7.52, 8.18, 9.91, 10.95 respectively.

For the different biochemical constituents, fat shows the highest CV, protein comes next and moisture content showed the least coefficient of variation. On the whole, the difference between the coefficients is much greater between fat and protein than that between moisture and protein. These findings, on the whole, point to the fact that fat showed the highest degree of variation among the components here examined.

Different species behave differently in connection with the magnitude of the CV for the different components. Thus, while some fishes, e.g. Sigan, showed considerably high CV for moisture and fat, but this is not the case with protein.

Moza, another example, showed a high CV with protein but low CV with fat. Koshar and Koshar Karnaa showed low CV for moisture and protein. On the whole, it is difficult to compare this coefficient for the different species and for different constituents in one species. It was attempted to classify fishes into four groups according to the CV of the present biochemical components.

As seen in table 7, some fishes e.g. Koshar Abu-loulou, Koshar Ads, and Hebria Mekatatta, may belong to CV of the 2nd group in case of moisture but of the 3rd group in case of protein and fat. Sho'our, Drainy, and Shakk-el-Zor show CV of 2nd group with moisture and protein but of first group in case of fat. Koshar Kharnaa belongs to first group in case of moisture and fat and belongs to group 2 in case of protein. Sigan is the only species belonging to the fourth group for each of fat, protein and moisture. Other observations can be deduced.

3. Correlation between Moisture, Protein and Fat

For examining the relationships between the different constituents, and namely, moisture, protein and fat, the correlation coefficient was computed for moisture and fat, moisture and protein, and, this latter and fat (table 8).

TABLE 7.—**Different fishes classified into groups according to the coefficient of variation for moisture, protein and fat.**

Group		Moisture	Protein	Fat.
	range of coeff. of variation	Less than 0.5	< 1	< 15
I	Fishes	1. Koshar Kharnaa 2. Koshar 3. Shahfala 4. Gatrin	1. Gatrin	1. Koshar Kharnaa 2. Shak-el-zor 3. Kuscombry 4. Sho'our 5. Drainy 6. Moza
	range of coeff. of variation	0.5 — < 1	1 — < 2	15 -- < 30
II	Fishes	1. Koshar abu-loulou 2. Koshar ads 3. Koshar tina 4. Koshar abu-nawara 5. Koshar Sherif 6. Hebria om-nokta 7. Hebria mekattata 8. Shak-el-zor 9. Sho-our 10. Bonkos 11. Draing 12. Kuscomary	1. Koshar kharnaa 2. Koshar 3. Koshar abu-nawara 4. Sho'our 5. Drainy 6. Shak-el-zor	1. Koshar tina 2. Koshar abu nawara 3. Koshar 4. Koshar Sherif 5. Bonkos 6. Kerleya 7. Shakhoura 8. Shahfala 9 Gatrin 10 Haffar

		13. Shakhoura 14. Bohar 15. Haffar 16. Moza		
	range of coeff. of variation.	1 —< 1.5	2 < 3	30 —< 45
III	Fishes	1. Mehseny 2. Nagel 3. Bayadeya	1. Koshar abu-loulou 2. Koshar ads 3. Koshar sherif 4. Habria mekattata 5. Shakhoura 6. Nagel 7. Kuscombry 8. Shahfala 9. Bohar 10. Moza	1. Koshar abu-loulou 2. Koshar ads 3. Bohar 4. Hebria mekattata 5. Bayadeya
	range of coeff. of variation	> 1.5	> 3	> 45
IV	Fishes	1. Keneya 2. Sigan	1. Koshar tina 2. Mehseny 3. Bonkos 4. Keneya 5. Hebria om-nokta 6. Bayadeya 7. Sigan 8. Moza	1. Mehseny 2. Nagel 3. Hebria om-nokta 4. Sigan

TABLE 8. **Correlation coefficient for the different biochemical components (moisture, protein and fat).**

Fishes	Moisture & fat	Moisture & Protein	Protein & fat
1. Koshar Abu-loulou	— 0.92	— 0.91	+ 0.78
2. Koshar Ads	— 0.96	— 0.87	+ 0.68
3. Koshar Kharnaa	— 0.78	+ 0.59	— 0.11
4. Koshar Tina	— 0.74	— 0.85	+ 0.86
5. Koshar	— 0.80	— 0.91	+ 0.33
6. Koshar Abu-nzwara	— 0.90	— 0.79	+ 0.08
7. Koshar Sherif	— 0.74	— 0.95	+ 0.84
8. Mehseny	— 0.85	— 0.86	+ 0.51
9. Sho'our	— 0.70	— 0.91	+ 0.88
10. Bonkos	— 0.59	— 0.92	+ 0.41
11. Drainy	— 0.34	— 0.38	+ 0.23
12. Keneya	— 0.93	— 0.93	+ 0.87
13. Nagel	— 0.91	— 0.90	+ 0.64
14. Kuscombry	— 0.46	— 0.88	+ 0.73
15. Shakk-el-zor	— 0.82	— 0.94	+ 0.83
16. Shakhoura	— 0.73	— 0.93	+ 0.58
17. Shahfala	— 0.68	— 0.91	+ 0.24
18. Bohar	— 0.89	— 0.89	+ 0.66
19. Hebria Om-nokta	+ 0.02	— 0.42	— 0.75
20. Hebria Mekattata	— 0.84	— 0.85	+ 0.07
21. Bayadeya	— 0.86	— 0.88	+ 0.14
22. Sigan	— 0.83	— 0.95	+ 0.44
23. Gatrin	— 0.78	— 0.64	+ 0.36
24. Haffar	— 0.76	— 0.90	+ 0.50
25. Moza	— 0.88	— 0.74	+ 0.42

From the table it could be concluded that :

(*a*) A negative relationship exists between the fat and water content of fish flesh

(*b*) The water-protein relation is mostly negative

(*c*) No relation exists between protein and fat.

4. Fish categories according to their fat and protein content

Stansby (1962) had classified fishes according to their fat and protein content into five categories as follows :

Category	Oil content %	Protein content %	Type
A	under 5	15 — 20	Low oil — high protein
B	5 — 15	15 — 20	Medium oil — high protein
C	Over 15	under 15	High oil — low protein
D	under 5	over 20	Low oil — very high protein
E	under 5	under 15	Low oil — low protein

On considering our present studied species on the basis of their fat and protein content and according to Stansby's schedule, table 9 can be afforded. It is clear that most of the species examined in the present work lie in the category A, i.e. have low oil and high protein. Some fishes e.g. Mehseny, and Bonkos, belong principally to category A but some individuals of these fishes, as secondary character, belong to category D. Besides, different individuals of some fishes eg. Sho'our, Shakk-el-zor belong to category D. Still, some fishes belong principally to category D and they secondarily belong to category A.

It is not necessary that the different species of the same family belong to one and the same category. Thus, while all the members of family Serranidae belong to category A, the present studied species of both Lethrinidae and Lutianidae behaved differently. From the former, Mehseny and Bonkos primarily belong to category A and secondarily to group D. All the individuals of Drainy and Sho'our belonged as far as the analysis revealed to category D. Among the species of family Lutiandae, Shahfala and Bohar belong to category A while Hebria Mekattata and Hebria om-nokta are primarily of category A and secondarily of category D.

TABLE 9. **Fishes classified into categories according to their content of fat and protein**

Fishes	Fat content range (%)	Protein content range (%)	Category	
			1ry	2ry
1. Koshar Abu-loulou . .	0.128—0.540	18.44—19.62	A	—
2. Koshar Ads	0.404—1.665	18.41—19.70	A	—
3. Koshar Kharnaa . . .	0.578—0.794	18.44—19.11	A	—
4. Koshar Tina	0.586—0.924	17.36—18.87	A	—
5. Koshar	0.458—0.813	18.50—19.35	A	—
6. Koshar Abu-nawara . .	0.571—1.115	18.24—19.13	A	—
7. Koshar Sherif . . .	0.505—0.816	17.66—19.16	A	—
8. Mehseny	0.208—1.012	18.29—20.06	A	D
9. Sho'our.	0.559—0.729	20.17—21.41	D	—
10. Bonkos	0.236—0.648	18.28—20.41	A	D
11. Drainy	1.035—1.547	20.26—21.41	D	—
12. Keneya	1.024—2.223	19.33—22.05	D	A
13. Nagel	0.368—1.421	19.30—20.80	A	D
14. Kuscombry	1.083—1.493	22.26—24.08	D	—
15. Shakk-el-zor.	1.317—1.625	22.12—23.19	D	—
16. Shakhoura	2.125—3.082	20.12—21.40	D	—
17. Shahfala	0.674—1.032	17.77—18.95	A	—
18. Bohar	0.223—1.442	17.58—18.90	A	—
19. Hebria Om-nokta . . .	0.314—1.457	17.33—20.24	A	D
20. Hebria Mekattata . . .	0.414—0.907	18.42—20.32	A	D
21. Bayadeya	0.234—0.672	17.84—20.84	A	D
22. Sigan	0.125—1.142	18.98—20.95	D	A
23. Gatrin	0.508—0.780	19.69—20.29	A	D
24. Haffar	0.742—1.323	19.65—21.25	D	A
25. Moza.	2.215—2.815	21.16—24.34	D	—

DISCUSSION

A knowledge of the chemical composition of fish is of paramount importance to evaluate it as regards nutritive value. For industrial purposes, a knowledge of composition of fish is important in several ways. Information on oil content of certain species and how the oil content varies with season or with the area of capture is needed to evaluate the possibility of its utilization in manufacture of oil. Knowledge of the proximate composition and specially moisture and oil content is important to determine the yield of such products as fish protein concentrate, fish meal, or other fishery products. A knowledge of fatty acids make-up of a fish oil or the amino acid content of a protein is important for several applications. Thus, the presence of high proportion of saturated fatty acids in a fish oil will render it less valuable as a drying oil. Ingestion of polyunsaturated fatty acids, and as fulfilled by fishes, is recommended in keeping down the cholesterol level. The pattern of amino acids in a fishery product will be important in determining whether a resulting meal made from it will be suitable as protein supplement for a stipulated use such as poultry feed.

The present work represents the first trial to examine the proximate composition of Red Sea fishes caught from the neighbourhood of Al-Ghardaqa,. It entails the estimation of moisture, protein, fat and ash of the flesh of 25 species of food fishes belonging to 12 families. These fishes vary in their behaviour, food and methods of fishing. Thus, these methods may be hook-lining; purse-seining or netting by trammels. By the first are caught the members of families Serranidae, Lethrinidae, Sphyraenidae, Plectropomidae, Lutianidae and Sparidae. By trammel nets are caught the scarids, acanthurids, the sparid, *Chrysophrys haffara,* and sometimes some lethrinids as *Lethrinus nebulosus.* By purse-seining are caught *Clupea leiogaster, Rastrelliger kanagurta, Scomber japonicus, Decaptreus sanctaehelenae.* The sphyrnid, *Sphyraena kenie* is some-times fishes by trolling.

The method of fishing is related to both the behaviour and food habit of fish. Thus, *Rastrelliger kanagurta, Scomber japonicus, Decapterus sanctaehelenae* and *Clupea leiogaster* are pelagic and plankton-feeders (Badawi, 1965 and personal observations). They are light attracted and caught by purse-seining. Light itself attracts planktonic forms which are then followed by the above mentioned species forming aggregations and thence encircled by the purse-seine. Carnivorous flishes, e.g. lutianids, lethrinids, and serranids (Al-Hussaini, 1947, Latif, 1967) that lie towards the bottom roaming for short or wide distances are caught by lining. Herbivorous fishes e.g. *Teuthis stellata* and coral-feeders e.g. *Scarus harid* (Gohar and Latif, 1959) and that dwell-coral reefs, are caught by trammel nets.

According to Jacquot (1961, p. 146), the chemical composition of sea food comes quite close to that of land animals. The principal constituents are water 66—84%, protein 15—24%, lipids 0.1—22%, and mineral substances 0.8—2%. According to Stansby (1962), protein content ranged from 6 to 28%; oil content from 9.2 to 64%, ash 0.4 to 1.5% and moisture from 28 to 90%. Thus, it is generally agreed that moisture is the main component of fish flesh (Almy and Field, 1921; Bolagatos, 1929; Stena and Ganpula, 1944; Devadatta and Varadan, 1949; etc).

Among the 25 species examined, average water content ranged from 72.67% to 79.77%, sixteen species have water content more than 78%. The lowest water content was recorded in *Clupea leiogaster* and the highest in *Variola louti,* having moisture content 72.67% and 79.77% respectively. In general, individual variation was as well recorded. Thus, the ranges of differences vary from one species to another. The highest range of difference is recorded in *Sphyraena kenie* (4.29%) and the lowest in *Cephalopholis argus* (1.16%). On the whole, the range of difference for species belonging to the same family is less than that between different species belonging to different families.

Besides, statistical analysis of the moisture content for different individuals revealed that the standard deviation is rather low, being the highest as 1.3863 for *Sphyraena kenie* and the least is 1.2305 in *Gatrin gatrinus.*

Protein is the next component from the point of view of abundance. Its range is from about 15% to about 26% (Dill, 1921; Bolagatos, 1929, Stena *et al.* 1944 ; etc.) In the present studied species, the protein content ranged from 17.99% to 23.22% and most species lie in the protein range of 18—20%. The lowest protein content was recorded in the serranid, *Epinephalus megachi* and the highest in *Clupea leiogaster.* The difference is not so much on comparing the individuals of the same species or the species belonging to the same family. The standard deviation of the values of protein estimated for different flesh samples is the highest in *Clupea lieogaster* (1.0349) and the lowest in *Gatrin gatrinus* (0.1691). Of the species examined, thirteen fishes have standard deviation less than 0.5 and ten have it between 0.5 and less than one.

Protein content above 20% in found in *Lethrinus latifrons* (20.61%), *Chrysophrys haffara* (20.65%), *Decapterus santaehelenae* (20.83%), *Sphyraena kenie* (21·.41%), *Scomber japonicus* (22.65%) *Rastrelliger kanagurta* (23.20%) and *Clupea leiogaster* (23.22%). These fishes are greatly esteemed as food in the Red Sea district. Besides, the last five species are surface fishes and among them *D. sanctaehlenae, S. japonicus, R. Kanagurta and C. leiogaster* are plankton feeders and caught by purse-seining in the Red Sea and also in the Indo-Pacific territory. It is worth-mentioning that Marinkovic and Zei (1959) expressed the view that plankton feeding fishes appear to show higher protein.

Fat is the third component estimated. In general, the 25 species studied have low fat content as it ranged from 0.339 to 2.215% and eighteen species have fat content less than 1%. The highest content was recorded in *Clupea leiogaster* and the lowest in *Epinephalus faciatus*. The ratio between the highest and lowest fat contents is 7.42 : 1, a ratio which is not recorded for either moisture or protein.

On the whole, the fat content varies from one species to another, whether belonging to the same or different families and within the individuals of the same species. The standard deviation for the fat content recorded varies from one species to another, the highest is found in *Plectropomus maculatus* and the lowest in *Lethrinus nebulosus*. In turn, in some species, the computed values of standard deviation may be higher than the minimal values of fat content of some samples.

According to Jacquot (1961), due to the variation in fat, a distinction is made between species with lean flesh and those with fat tissue. Fatty fishes are exemplified by herring, mackerel, pike, salmon, tuna, etc.; semifatty fishes by barracuda, bass, mullet, perch etc.; and lean fishes by hake, cod, haddock, plaice, smelt, etc. There is no strict line between fatty and lean fishes due to species or individual variation. Thus, salmon contains between 0.35 and 14% lipids depending on season. The present work reveals that the fishes here examined are lean. We do not know how far the fat content increases in the different seasons of the year so that other conditions, e.g. semifatty, can be attained.

According to Stansby (1962) the cause of the variation in the proximate composition of fish, which is often ascribed to such factors as geographical area or seasons, actually relates primarily to the food ingested, to the metabolic rate and the mobility of fish. As is mentioned above, fat is the most mobile component and liable to great variation (Saha and Guha, 1940; Tekin, 1950; etc.). Comparing the moisture, protein and fat content of the present studied speices we find that the ranges of coefficient of variation are 0.30—1.84, 0·85—4.67, 7.52 — 85.65 respectively. Thus, fat has the the highest coefficient of variation, protein comes next, followed by water. On the whole there is large room of variation in the fat content of the fishes examined.

Furthermore, the highest fat content was recorded in *Clupea leiogaster* (2·515%), *Decapterus sanctaehelenae* (2.405%), *Sphyraena kenei* (1.97%), *Scomber japonicus* (1.42%) ; *Lethrinus latifrons* (1.377%), nad *Rastrelliger kanagurta* (1.288%). These fishes, with the exception of *L. latifrons* are surface fishes and show an activity to a greater degree than that of other species· It may be possible to assume that fat is of importance to meet the energy requirements of these species. Again, fat content did not show a great variation in its content and the coefficient of variation of these five species ranged from 7.52 - 21.28 which is rather low as compared with the coefficient of variation computed for the fat content of *Teuthis stellata, Lethrinus mahsena, Plectropomus maculatus, Lutianus fulviflamma* whose fats coefficient of variation is 85.65, 59.36, 56.80, 58.21, respectively.

Again, the surface fishes above mentioned have as well protein content more than 20% and in both *Rastrelliger kanagurta* and *Clupea leiogaster* up to about 23%. This conclusion agrees reasonably well with the statement of Van Wyk (1944) that the surface fishes were higher in fat and protein content than deep water ones.

Furthermore, fat content of the present species is much lower than that of some fishes examined by Dill (1921), Almy and Field (1921), Belagatos (1929), Chari (1948), and others. Red Sea fishes may be comparable to the Bombay fishes which showed low fat content according to the study of Devadatta and Vardan (1949) and Patakoat *et al.* (1950).

An inverse relation exists between moisture and fat contents in the fishes (Almy and Field, 1921 ; Van Wyk, 1944, etc). Such a conclusion is found tenable in the species studied in the present work. Thus, the correlation coefficient up to-0.96 was recorded in *Epinephelus areolatus*. Apparently, negative correlation also exists between the contents of moisture and protein and correlation coefficient up to- 0.95 was recorded in the scombroid *Rastrelliger kanagurta*. It is worthmentioning that the three fishes, which have protein content more than 22% and namely, *R. kanagurta, Scomber japonicus* and *Clupea leiogaster,* have moisture content less than 75%. This content is higher in the other species. Besides, the values computed for the correlation coefficient of protein and fat are unjustifiable to conclude the type of relation between these two components.

In addition, Stansby (1962) dealing with American fishes has characterized five categories of fishes symbolized by the letters A to E. Most fishes have either low oil (less than 5) and high protein (15-20%) or medium oil (5-15%) and high protein and belong to categories A and B respectively. According to Stansby's classification our Red Sea fishes fall under the categories A and D of which the latter is characterized by low fat and very high protein (more than 20%). Most species belong primarily to group A but secondarily belong to group D. Individuals of some fishes belong principally to group D and secondarily to group A.

Concerning the ash content of fishes, it is in most fishes less than 2% (Devadatta and Varadan, 1949). However, ash content of about 3·5% was still recorded in some fishes (Chari, 1948, and others). In the present studied species, the ash content does not vary greatly among the different species and ranged from 1.169% to 1.559%. Ash range between 1.2% and 1.5% is found in 22 species.

It is generally attempted to study the seasonal variation of some biochemical components, especially fat. Thus, Thompson (1959) concluded that the content of water and fat varied seasonally in accordance with the metorological conditions. Zamboni (1964), contrary to Rios (1962), concluded that there was no relation between fat content and season. Our comment concerning the present studied species is that they all have low oil content during the summer or fall whence the materials were collected.

Furthermore, Van Wyk (1944) postulated that seasonal variation is peculiar to each species. According to Thompson (1966), variation in the fish, such as size, maturity, sex and reproductive cycle of individual species, were considered as possible influences on compositional variation of samples. He, as well, comparing the seasonal variation in the proximate composition in the croaker, spot, and white trout, found that in the first fish the oil content increases to its maximum 3 months prior to spawning, afterwards it decreases and this coicides with the gonadal development. High oil content apparently has no relation with the gonad development in either spot or white trout which show highest oil content 5 or 6 months prior to spawning or 2 months after the end of the spawning season respectively. He accordingly stated "Obviously, it is impossible to make a generalized statement regarding the relation of period of high oil content to the reproductive cycle of fish". From the present work, it appears that the pattern of variation in the oil content differs in the different species which have a comparable season of gonad development or spawning. Thus comparing the four lithrinids here examined and according to some unpublished data from the Institute, we find that *Lethrinus latifrons* has the highest oil content (1.377%) as compared with that of *Lethrinus mahsena* (0.608%) and *Lethrnus bungus* (0.535%) although the three species are sampled during their spawning season which is rather long and comparable in the three species. Besides, *Lethrinus nebulosus* has fat content which is comparable to that of *Lethrinus mahsena* although the former was sampled after its spawning season.

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