Nat. Volatiles & Essent. Oils, 2022; 9(1):1403-1419

NVEO
Natural Volatiles &
Essential Oils

A Comparative Study For The Estimation Of Chemical Composition In The Muscles Of The Carp Arabibarbus Grypus (Heckel, 1843) And Acanthopagrus Arabicus (Iwatsuki,2003) In Karbala Governorate

Doaa.H.H.AL-turfi [1] , Mohammed.W.H.AL-muhanna[2] , [3]kadhim O.M AL- humairi

[1,2]Department of Biology, College of Education for Pure sciences, University of Kerbala, Iraq.

[3] Al-Furat AL- Awsat Technical University, AL- Musaib Technical College, Babylon- Iraq .

Abstract

The current study included conducting a comparative study on two types of bony fish Osteichthyes with similar aquatic environment and different food habits, namely: Arabibarbus grypus (Heckel, 1843), which belongs to the family Cyprinidae, and the fish Acanthopagrus arabicus (Iwatsuki, 2003), which belongs to the family Perciformes; Its purpose is to conduct a comparative study between them on some aspects related to determining locomotor activity as well as determining its nutritional value by estimating the chemical content of fish muscles, which includes: protein content, fat content, moisture content, ash content, and caloric values in two different areas of the body: (R1 and R2), and (50) samples for each type of study fish were collected from Euphrates river (Shatt al-Hindiya) in Karbala governorate and for the period between (September 2021and November 2021) using gill nets and hand-throwing nets with the help of fishermen in the area.

The results of the current study demonstrated a difference in the values of the rates of chemical components in the muscles of the study fish, as the total rates of protein content values in Arabibarbus grypus ranged between (16.72 - 17.52%),while the total rates of protein content rates in Acanthopagrus arabicus were (16.80 - 18.67 %),while The total averages of the values of the fat content of the Arabibarbus grypus ranged between (5.95 - 8.24 %),while the total averages of the values of the fat content of the Acanthopagrus arabicus were (4.65 - 6.21 %), and the total averages of the values of the moisture content of the Arabibarbus grypus ranged between (70.34 - 67.01%),While the values of the total rates of moisture content for Acanthopagrus arabicus were (76.45-72.56%), and the total averages of ash content rates for Arabibarbus grypus ranged between (6.22 - 6.70%), while the total rates of ash content in Acanthopagrus arabicus were (1.36-2.40%).

The results of the current study proved that Arabibarbus grypus fish have higher calories (energy) compared to Acanthopagrus arabicus, the total calorie values of Arabibarbus grypus were (133.56 Kcal/g), while the total calorie values of Acanthopagrus arabicus were (120.76 Kcal/g).

In light of the current results, the study fish was considered among the medium-fat fish due to its proportions of the fat content in its muscles.

Introduction

The fish Arabibarbus grypus (Hekel,1843) which belongs to the family Cyprinidae, and the fish Acanthopagrus arabicus (Iwatsuki,2003) which belongs to the family of sparidae, which is a local Iraqi

fish and is a source of daily consumption in human life; Because it contains high nutritional value as well as health benefits in its muscles (Mansour, 2005) which represents a healthy food for humans (Sidhu, KS.2003). Muscle tissue constitutes (60-80 %) of the fish's body (Johnston, Bower & Macqeen, 2011)

Fish wealth suffers from a constant shortage in numbers with the increase in population numbers, so the importance of aquaculture has emerged, which provides large quantities of fish suitable for human consumption, and aquaculture techniques have developed rapidly and remarkably to achieve Muscle fibers were classified into two main types in most sustainable development (FAO, 2010a). fish: white muscle fibers, which are lateral to the site and deep and occupy most of the muscle tissue, ranging between (80-100%) of the total body mass (Anttila, 2009), and red muscle fibers, which are lateral and superficial, representing a percentage of Few muscle mass of the body ranging from (5-20%) of the total mass (Al-Badri, Al-Darajj, Neshan, and Yesser, 1991)

Kiessling (2006) indicated that there is a third type of muscle, which is the pink or intermediate muscle, which is located between the two previous types.

As for the chemical components of fish muscles from protein,fat,moisture ,minerals, vitamins and polyunsaturated fatty acids all contribute to the formation of muscle and these components can vary according to their function and availability (Shearer, 1994) .

As indicated Al-Aswad (2000) that fish can be divided into three groups according to its fat content, which are:

1-Fatty fish: the percentage of fat in it is more than (10 %)

2-Medium fat fish: the percentage of fat in it is between (2.5-10%)

3-Non-fat fish: the percentage of fat in it is less than (2.5%)

Materials and working methods

(50) samples of the Arabibarbus grypus (Hekel,18843) and (50) samples of the fish Acanthopagrus arabicus (Iwatsuki,2003), were collected from Shatt al-Hindiya (Euphrates River) from different locations within the Shatt area in the same district of al-Hindiya for the period fromthe beginning of September 2021 to the beginning of November 2021), using Gill nets with different dimensions ranging between (5.3 - 5.6 cm) to catch different sizes of fish.

Chemical analyzes were carried out in the Fish Nutrition Laboratory of the Musayyib Technical College / Middle Euphrates University. Meat pieces were taken from the frontal area called (R1) and the back area called (R2), where the percentages of protein, fat, moisture and ash were determined in each muscle sample according to (A.O.A.C, 2005)

statistical analysis

The differences between the averages of the total length of fish and the estimation of the chemical content (protein, fat, moisture and ash) in the studied body areas (R1 and R2) for the two studied species were tested using the T-test at the level of significance (0.05), and the relationships in the variables were also studied to calculate the correlation coefficient. Correlation Coefficient (r), and the regression equations for each relationship were calculated according to the SPSS 16 Statistical Package for Social Sciences 16.

Results

The results of the current study showed that there is a difference in the proportions of the chemical components of the two regions R1 and R2 of the two studied types, represented by the protein and fat content, moisture and ash, as this difference depends on the fish species. Some of the external and internal factors that affect the chemical composition include season, ecological location, nutrition, species, size, sex, reproductive cycle, muscle location in the fish body, and stage of maturity (Mansour, 2018)

The results of the current study showed a clear difference in the percentages of the total protein content in the two studied species and the different groups of studied fish weights, where the values of the total average protein content in carp ranged between (16.72-17.52%), while the values of its rates in shank fish were (16.80-18.67%), as shown in tables (4,3), and it was noted that the values of protein content rates increase with increasing fish weights, and this is indicated by the values of the correlation coefficient (r) that ranged between (0.947 and 0.862) in carp and shank fish, respectively, and this indicates that There is a direct relationship between the average protein content and the average fish weight, the higher the weight of the fish, the higher the protein content in it, as shown in Figures (6) and (7).

When analyzing the results statistically to clarify the differences recorded between the percentages of total rates of protein content calculated for the groups of studied fish weights, no significant differences ($p<0.05$) were observed for both types studied as shown in Table (5).

The results of the current study showed that the percentages of protein content in Arabibarbus grypus differ according to the different body regions studied (R2, R1) and to different total weights, as the protein content ranged between (16.98-18.02%) and (16.47-17.03%) in the studied body areas (R1, R2) respectively, while in Acanthopagrus arabicus fish, the percentage of protein in the anterior region was (R1) (17.51-19.21%), while the percentage of protein in (R2) ranged between (16.09-18.13%), as shown in the two tables (2.1), When analyzing the results statistically to clarify the differences recorded between the proportions of protein content calculated in the areas of the body studied (R1, R2), no significant differences ($P<0.05$) were observed for both types studied as shown in Table (6).

The results of the current study of calculating the percentages of the total average of the fat content showed that there is a clear difference in the percentages of the fat content in the two studied species and for the different groups of fish weights studied. The values of the total rates of fat content in Arabibarbus grypus ranged between (5.95-8.24%), while the average values were The total of Acanthopagrus arabicus fish (4.65 -6.21%) as shown in tables (4,3), and it was noted that the values of fat content rates increase with increasing fish weights, and this was indicated by the values of the correlation coefficient (r) that was between (0.969 and 0.954) for Arabibarbus grypus and Acanthopagrus arabicus fish, respectively. This indicates that there is a direct relationship between the rate of fat content and the average weight of fish, that is, the higher the fish

In weight, the fat content increased as shown in Figures (8) and (9). When the results were analyzed statistically to clarify the differences recorded for the percentages of the total rates of fat content calculated for the total weights of the studied fish, significant differences ($p<0.05$) were observed for both types studied, as shown in the table. (5).

The results of the current study showed a clear difference in the percentages of fat content of Arabibarbus grypus and Acanthopagrus arabicus in the studied body regions (R1 and R2), the fat content in (R2) greater than (R1) for both studied species, as the percentage of fat content ranged in the frontal region (R1) (5.93-8.21%), while it was in the posterior region (R2) (5.98-8.27%), and this means the different values of fat content according to the regions of the body studied, while in Acanthopagrus arabicus fish, the percentage of fat content in the frontal region (R1) ranged between(4.35-6.03%), while the percentage of fat in (R2) was (4.96-6.39%) as shown in the two tables (2,1) and when the results were analyzed statistically to clarify the differences recorded between the percentages of fat content calculated in the areas of the body studied (R1) and (R2) Significant differences ($p<0.05$) were observed for both studied species, as shown in Table (6).

The results of the current study showed a clear difference in the percentages of the total average moisture content in the two studied species of different groups of studied fish weights, and it was noted that the total average moisture in the Acanthopagrus arabicus is higher than in the Arabibarbus grypus, in the Arabibarbus grypus it ranged between (70.34-67.01 %), while the values of the total rates were The moisture in Acanthopagrus arabicus fish was (76.45- 72.56%) as shown in Tables (4,3), and it was noted that the moisture levels decrease with the increase in the average fish weights, and this was shown by the values of the correlation coefficient (r) that was between (0.988 and 0.973) for the Arabibarbus grypus and Acanthopagrus arabicus fish. Respectively, and this indicates an inverse relationship between the average moisture content and the average fish weights, that is, the higher the fish weight, the lower the moisture content, as shown in Figures (10) and (11). For total fish weights studied, significant differences ($P<0.05$) were observed in both studied species, as shown in Table (5).

The results of the current study showed that the percentages of moisture content differed clearly in the bodily areas (R2,R1) of the two studied species, where the moisture content in the Arabibarbus grypus in the frontal area (R1) ranged between (70.96-68.02%), while the moisture content in (R2) (69.72-66.01%), while in the Acanthopagrus arabicus, the moisture content in the frontal area (R1) ranged between (76.98-73.07%), while the moisture content in (R2) was (75.93-72.05%), as shown in the two tables (2 ,1), and when analyzing the results statistically to clarify the differences recorded between the percentages of moisture content in the studied body areas (R1) and (R2), significant differences ($P<0.05$) were observed for both types, as shown in Table (6).

The results of the current study of calculating the percentages of the total average for the ash content showed a clear difference in the percentages of the total rates in the two studied species

And for the different groups of fish weights studied, where the values of the total rates of ash content in the Arabibarbus grypus ranged between (6.22-6.70%), while the values of the total rates of the Acanthopagrus arabicus fish were (1.36-2.40%) as shown in the two tables (4,3), and it was noted that the values of The ash content increases with the increase in the average fish weights, and this is indicated by the values of the correlation coefficient (r) that were (0.894 and 0.88) in the Arabibarbus grypus and the Acanthopagrus arabicus respectively, and this indicates a direct relationship between the average ash content and the fish weight rate, i.e. the higher the fish weight. The ash content increased in them, as shown in Figures (12) and (13), and when the results were statistically analyzed to clarify the differences recorded for the percentages of the total rates of ash content calculated for the totals of the studied weights, significant differences were noted ($P<0.05$) for both types, as shown in the table (5).

The results of the current study showed that the percentages of ash content in Arabibarbus grypus showed a clear difference between the studied body regions (R1 and R2), as the percentage of ash content in (R1) ranged between (6.61-7.21%), while the percentage of ash content in (R2) was (5.84-6.20%), while in Acanthopagrus arabicus fish, the percentage of ash in the anterior region (R1) ranged between (1.46-2.85%), while the percentage of ash content in (R2) was (1.26-1.96%), as shown in the two tables (2, 1), and when analyzing the results statistically to clarify the differences recorded between the percentages of ash content in the areas of the body studied (R1 and R2), significant differences ($P<0.05$) were observed for both types studied as shown in Table (6).

The results of the current study of calculating calories showed a clear difference in the ratios of the total rates in the two studied species. The calories were for the protein content of Arabibarbus grypus (68.40Kcal/g), while the calories were for the fat content (Kcal/g 65.16), The total calories for the protein and fat content were (Kcal/g 133.56), and the calories for the protein content of Acanthopagrus arabicus fish were (71.08 Kcal/g), while the calories were for the fat content (Kcal/g 49.68),while the total calories for

the protein and fat content were (Kcal/g 120.76), as shown in Table (7).

Discussion

Fish and its products are an essential food source for humans; Because it contains the main components represented by high proportions of proteins and fats and small amounts of vitamins and minerals (Awda, 2012), the muscle tissue in fish is mainly composed of two types of muscles: red muscles and white muscles, where the red muscles form a thin layer located under the skin Directly and extending from the back of the head to the tail area parallel to the lateral line on both sides of the fish, and occupying a small percentage of the body mass (Kiessling et al., 2006).

Al-Shatti (2006) indicated when studying some fish species that there is an inverse relationship between the percentage of protein and the percentage of fat in the body regions, and these results are consistent with the results of the current study, which proved that the percentage of protein content is higher than the percentage of fat content in the muscles of the fishes of the current study, and showed that The percentage of protein in the anterior region (R1) is higher compared to that in the rear region (R2), where the percentage of protein in (R1) ranged between (16.98-18.02%), while in (R2) it was (16.47-17.03%) in Arabibarbus grypus, while in Acanthopagrus arabicus, the percentage of protein content in the frontal region (R1) ranged between (17.51-19.21%), while in the posterior region (R2) the protein content ranged between (16.09-18.13%), and this discrepancy may be due to the difference in the percentage of white and red muscle fibers in The anterior andposterior regions of the fish's body (Delemos et al., 2014).

The results of the current study showed that there is a clear difference in the percentages of fat content, as the percentage of fat content in the posterior region (R2) is higher compared to its percentage in the anterior region (R1), where (R2) ranged between (8.27-5.98%), while in(R1) it was (5.93 -8.21%),in Arabibarbus grypus As for the Acanthopagrus arabicus, the percentage of fat content in the posterior region (R2) was higher compared to its percentage in the anterior region (R1), where (R2) ranged between (4.96 - 6.39%), while in (R1) it was (4.35 - 6.03%), and this difference in These fish depend on the type of food, their nature, their behavior, or the nature of the area in which they live, whether it is cold, hot, or temperate (Al-Muhanna, 2015).

The results of the current study showed that there is a direct relationship between the percentage of fat content and the weight of the fish in the areas of the body studied. The higher the weight of the fish, the higher the percentage of fat content, especially in the back area (R2); Because of the increase in the percentage of red muscle fibers, this showed that the movement and orientation of fish in the aquatic environment depends on the posterior region (caudal peduncle).

The fish of the current study is considered among the medium fat fish according to the classification indicated by (Al-Aswad, 2000) depending on its fat content. The percentage of the total fat content in Arabibarbus grypus ranged between (5.95-8.24%), while in Acanthopagrus arabicus it was (4.65-6.21%).

The results of the current study showed an increase in the values of the total rates of moisture content for both species studied with a clear difference between them. The moisture percentage in the Acanthopagrus arabicus was higher than that of the Arabibarbus grypus, where the percentages of the total rates of moisture in the front and back areas of the Acanthopagrus arabicus ranged between (76.45 - 72.56%), and the percentage of the averages The total moisture in Arabibarbus grypus fish in both regions ranged between (70.34 - 67.01%), and this is consistent with what was reached (Glucas and ward; 1996 Al-Aswad, 2000; Abd Al-Nabi, 2003).

The results of the current study showed an inverse relationship between moisture content and fat content. The higher the moisture content, the lower the fat content, and vice versa for the two studied types, and this is consistent with the study (Awda, 2012; Al-Mhanna, 2015, Al-Baldawi, 2019).

The results of the current study showed a clear difference in the values of the total rates of ash between Arabibarbus grypus and Acanthopagrus arabicus fish, where the percentage of ash was higher in Arabibarbus grypus than in Acanthopagrus arabicus as it ranged between (6.22 - 6.70%) in carp, while the percentage was lower in Acanthopagrus arabicus where it ranged between (1.36 - 2.40%), and this difference may be due to the nature of nutrition, food quality, age, and weight (Al-Khafaji et.al, 2008; Jan et al., 2012; Mohamed, 2013)

The results of the current study showed that Arabibarbus grypus fish have higher calories (energy) than Acanthopagrus arabicus fish, it reached in Arabibarbus grypus (Kcal /g 167.05), while the calories of Acanthopagrus arabicus fish reached (Kcal /g 133.18), and these values are a reflection of protein contents And fat that reflects the amount and proportions of muscle (Bosch, 2012 ; Martines et al., 2017; Mansour, 2018), and this difference in calorie values reflects significant differences in the protein and fat content of the two studied types, and this is consistent with the study of (Mansour and AL-Muhanna, 2019; Arim et al., 2007), which indicated that there are differences in caloric (energy) values in the fish's body, and these differences are due to seasonal changes that are related to food habits, reproductive cycle and storage of energy reserves (AL-Muhanna et al., 2019)…

Table (1): shows the proportions of chemical composition in my area (R2, R1) of carp muscles *A. grypus*

standard error..... ±

Total length group (mm)	number of fish	Average fish weight (g)	Chemical content rates in the (R1) region				R2) Chemical content rates in region the(			
			protein percentage %	fat percentage %	Moisture percentage %	Ash percentage %	Protein percentage %	fat percentage %	Moisture percentage %	Ash percentage %
150-199	10	226.13 ± 1.94	16.98 ± 0.05	5.93 ± 0.03	70.96 ± 0.04	6.61 ± 0.01	16.47 ± 0.04	5.98 ± 0.05	69.72 ± 0.01	5.84 ± 0.02
200-224	10	373.49 ± 1.73	17.21 ± 0.02	6.67 ± 0.01	69.54 ± 0.06	6.73 ± 0.05	16.52 ± 0.01	6.92 ± 0.03	69.46 ± 0.04	5.98 ± 0.05
225-249	10	401.91 ± 1.88	17.52 ± 0.01	7.23 ± 0.05	69.02 ± 0.01	7.05 ± 0.02	16.72 ± 0.02	7.17 ± 0.04	68.89 ± 0.03	6.06 ± 0.01
250-274	10	546.26 ± 1.63	17.81 ± 0.04	8.01 ± 0.03	68.53 ± 0.04	7.10 ± 0.03	16.83 ± 0.03	8.09 ± 0.01	67.16 ± 0.02	6.11 ± 0.04
275-300	10	643.13 ± 1.65	18.02 ± 0.02	8.21 ± 0.04	68.02 ± 0.05	7.21 ± 0.04	17.03 ± 0.02	8.27 ± 0.03	66.01 ± 0.02	6.20 ± 0.03

Table No. (2) shows the chemical composition ratios in the areas (R2, R1) of the muscles of the shank fish A. arabicus.

Total length group (mm)	number of fish	Average fish weight (g)	Chemical content rates in the (R1) region				Chemical content rates in region (R2) the			
			protein percentage %	fat percentage %	Moisture percentage %	Ash percentage %	protein percentage %	fat percentage %	Moisture percentage %	Ash percentage %
150-199	10	127.13 ± 1.66	17.51 ± 0.02	4.35 ± 0.04	76.98 ± 0.02	1.46 ± 0.01	16.09 ± 0.03	4.96 ± 0.05	75.93 ± 0.04	1.26 ± 0.01
200-224	10	269.32 ± 1.73	17.69 ± 0.04	4.93 ± 0.03	75.79 ± 0.05	1.92 ± 0.03	16.15 ± 0.04	5.92 ± 0.01	74.61 ± 0.02	1.53 ± 0.04
225-249	10	311.42 ± 1.91	18.01 ± 0.05	5.13 ± 0.01	74.13 ± 0.04	2.64 ± 0.02	17.83 ± 0.01	6.01 ± 0.02	74.08 ± 0.05	1.72 ± 0.03
250-274	10	425.19 ± 1.52	19.05 ± 0.01	5.28 ± 0.02	73.53 ± 0.05	2.73 ± 0.04	18.03 ± 0.02	6.12 ± 0.03	73.01 ± 0.04	1.81 ± 0.02
275-300	10	513.02 ± 1.44	19.21 ± 0.02	6.03 ± 0.05	73.07 ± 0.01	2.85 ± 0.03	18.13 ± 0.05	6.39 ± 0.03	72.05 ± 0.04	1.96 ± 0.01

standard error..... ±

Table (3): Shows the total rate values of the front and rear areas (R1**,**R2) for protein, fat, moisture and ash content ratios in carp *A. grypus*

totals height	total protein %	total fat %	total moisture%	Total Ash Rate%
1	16.72	5.95	70.34	6.22
2	16.86	6.79	69.50	6.35
3	17.12	7.20	68.95	6.55
4	17.32	8.05	67.84	6.60
5	17.52	8.24	67.01	6.70

totals height	total protein %	total fat %	total moisture%	Total Ash Rate%
1	16.80	4.65	76.45	1.36
2	16.92	5.42	75.20	1.72
3	17.92	5.57	74.10	2.18
4	18.54	5.75	73.27	2.27
5	18.67	6.21	72.56	2.40

Table No. (4): Shows the values of the total averages for the front and back areas (R1, R2)For the proportions of protein, fat, moisture and ash content in A. arabicus shank fish

Table No. (5): shows the differences recorded between the values of protein, fat, moisture and ash content rates in the two studied species.

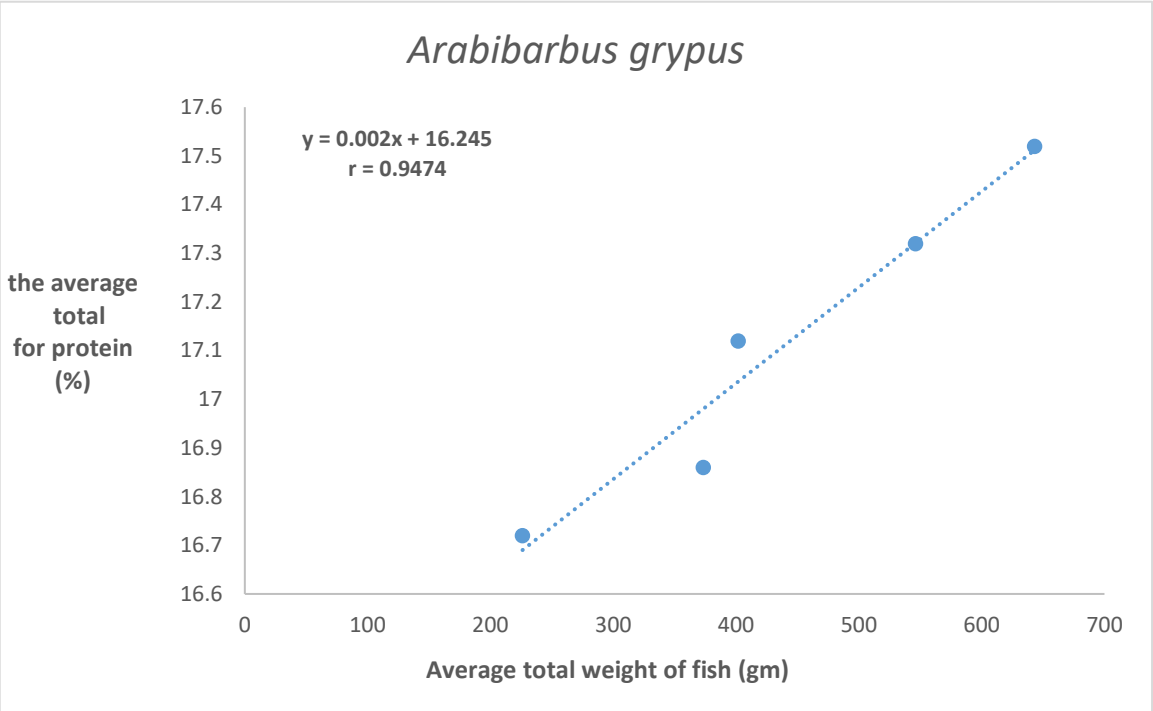
studied trait	Values Calculated T	Values T tabular	morale level 0.05
Average total protein content(%)	1.57	2.50	Non-significant
Average total fat content(%)	3.51	1.85	significant
Average overall moisture content(%)	6.14	2.30	significant
Total average ash content(%)	21.15	1.31	significant

Table No. (6): shows the differences recorded between the values of protein, fat, moisture and ash content rates in the body regions of the two studied species.

studied trait	**Region**	**Values Calculated T**	**Values T tabular**	**morale level 0.05**
Average total protein content(%)	**R1**	**1.96**	**2.57**	Non-significant
	R2	**1.12**	**2.34**	Non-significant
Average total fat (%) content	R1	4.11	1.95	significant
	R2	2.91	1.75	significant
Average overall content(%)moisture	**R1**	**6.16**	**2.61**	significant
	R2	**5.81**	**2.45**	significant
Total average ash (%) content	**R1**	**15.77**	**2.94**	significant
	R2	**32.33**	**3.73**	significant

Table No. (7): shows the calories for the total averages of protein and fat content in the two studied species.

type of fish	% protein	(Kcal/g) calories	fat%	(Kcal/g) calories	total calories (Kcal /g)
A.grypus	21.38	85.54	9.05	81.51	167.05
A.arabicus	17.77	71.08	6.90	62.10	133.18



Shape (6): Shows the linear relationship between the total weight rate of fish (g) and the total rate of protein content (%) in A.grypus

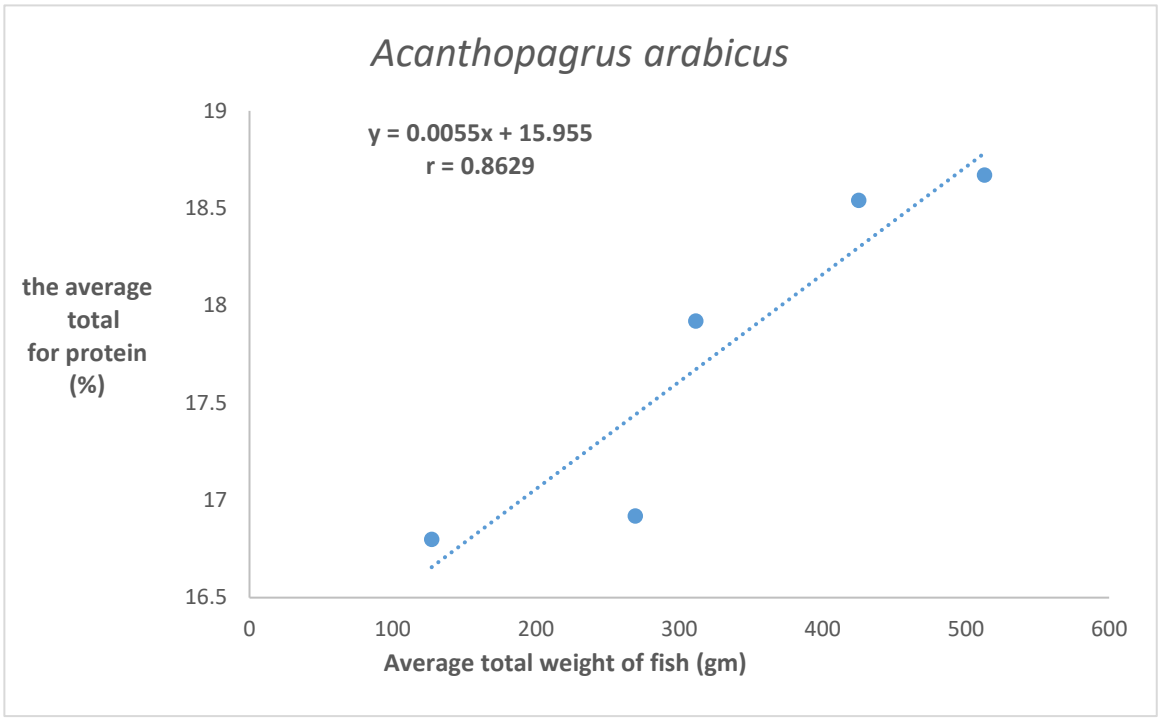


Figure (7) shows the linear relationship between the average total weight of fish (gm) and the total average protein content (%) in A. arabicus.

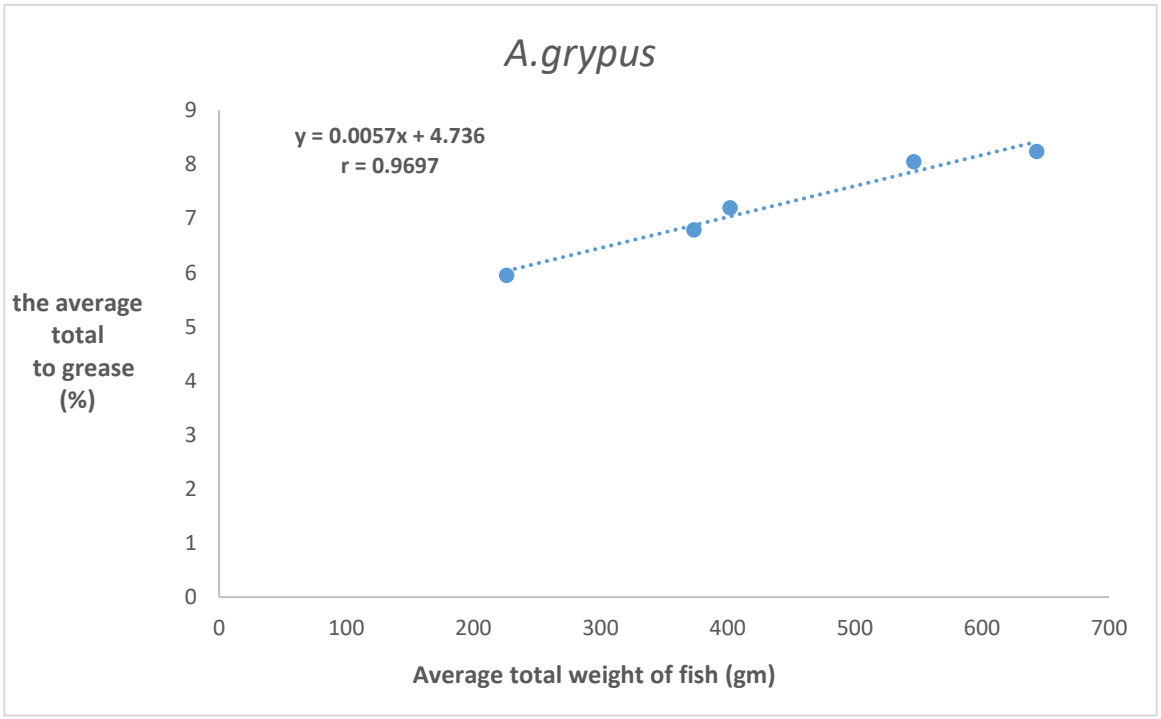


Figure (8): shows the linear relationship between the average total weight of fish (gm) and the total average fat content (%) in A.grypus fish

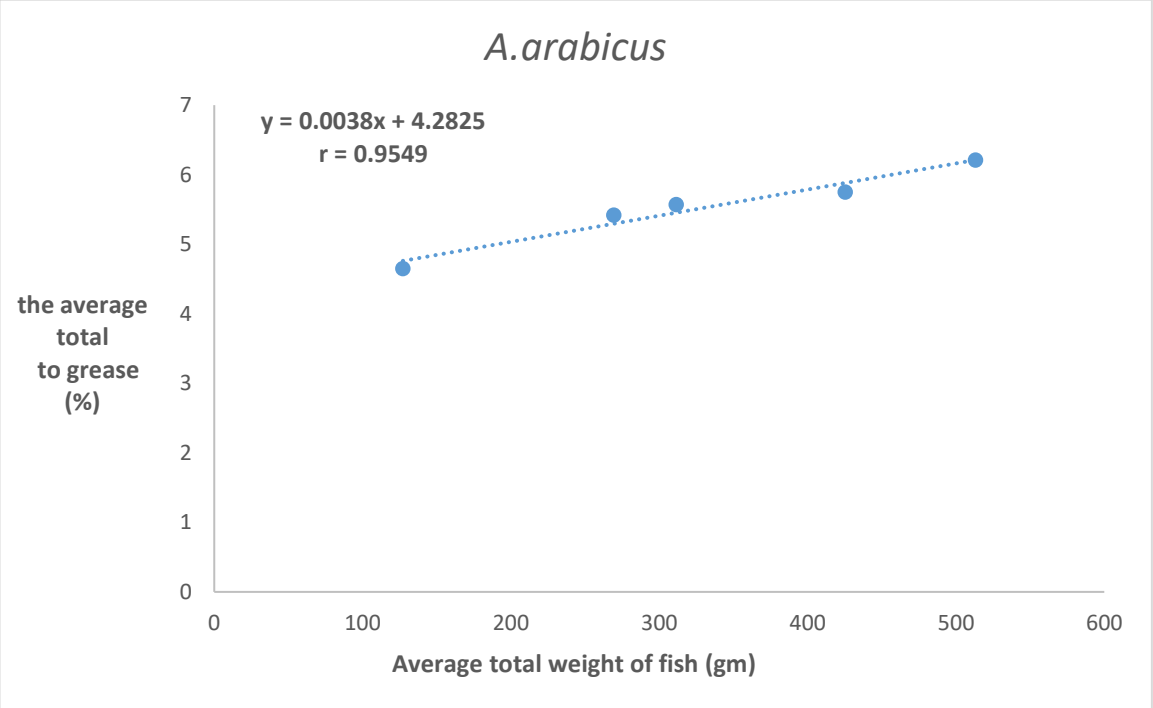
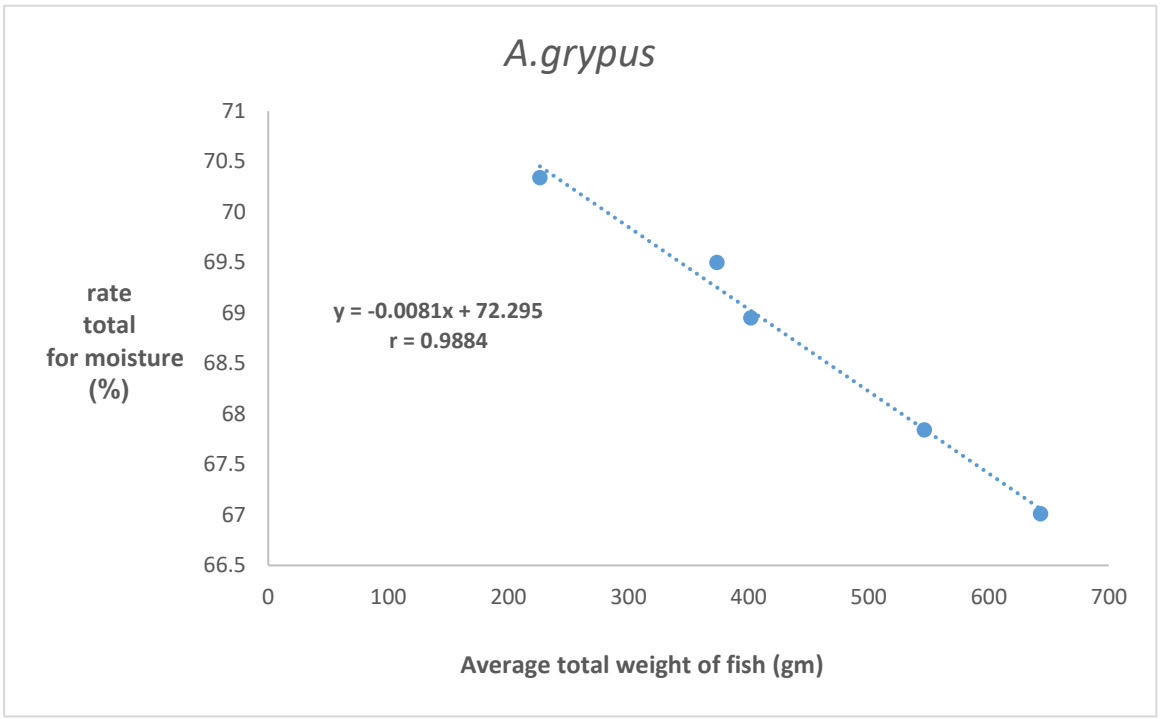
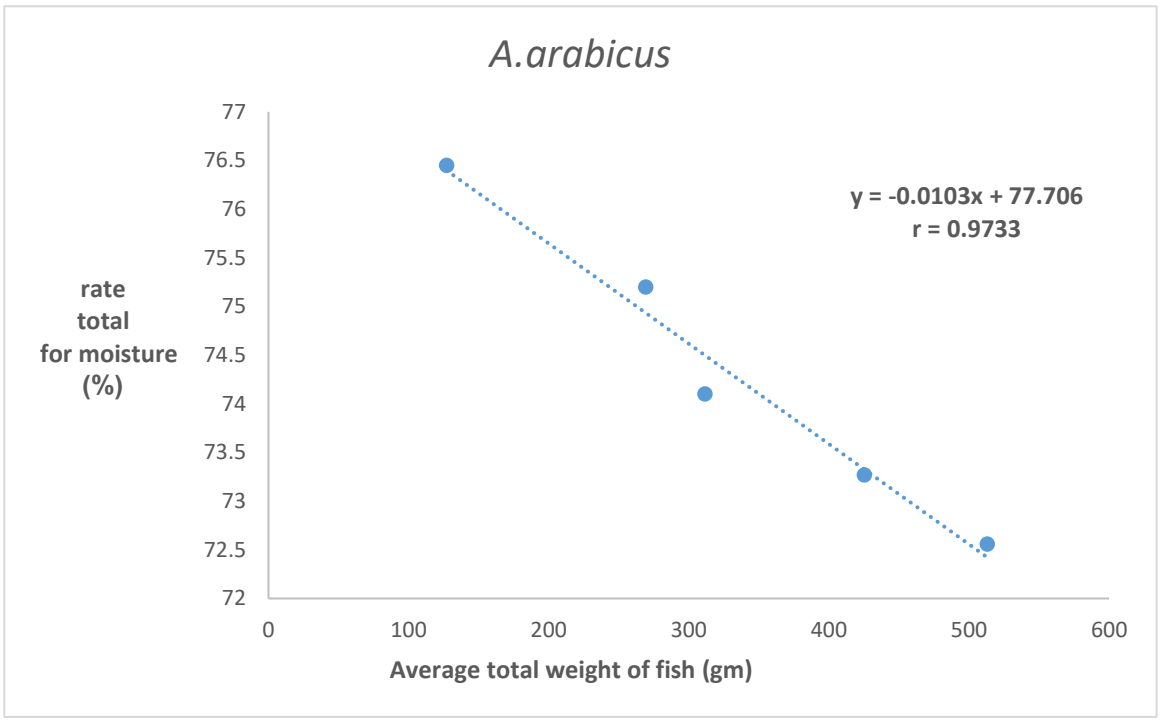


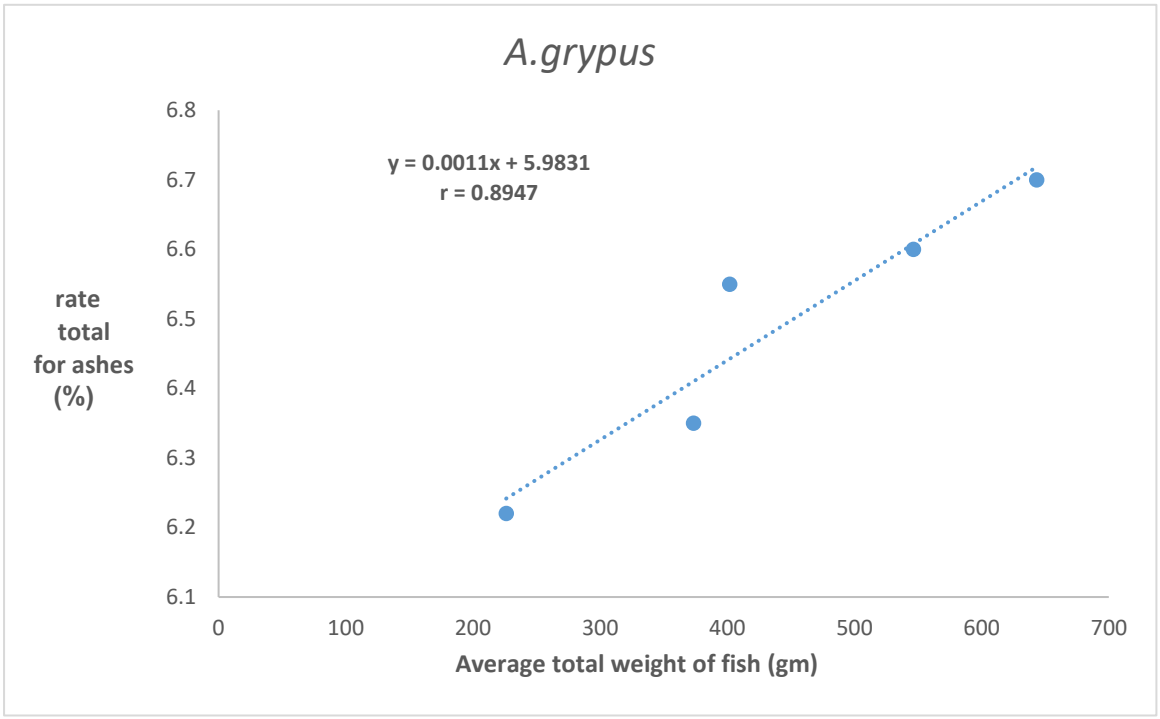
Figure (9) shows the linear relationship between the average total weight of fish (gm) and the total average fat content (%) in A. arabicus



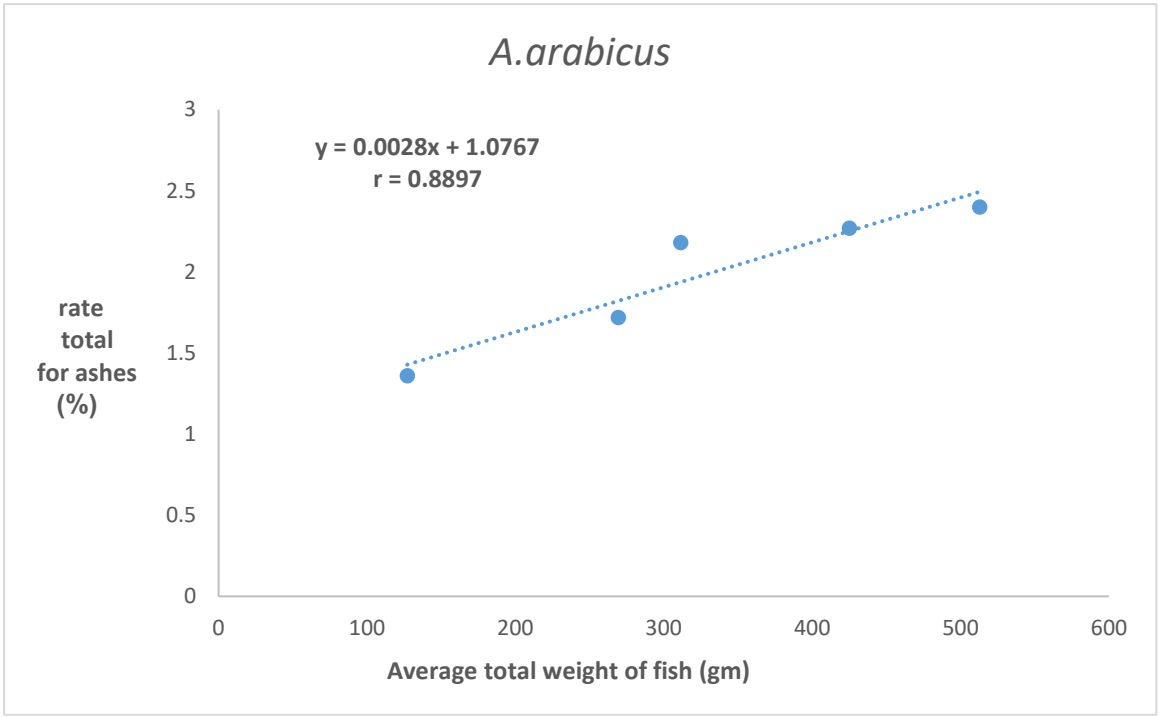
Shape (10): Shows the linear relationship between the total weight rate of fish (g) and the total rate of moisture content (%) in A.grypus



Shape (11): Shows the linear relationship between the total weight rate of fish (g) and the total rate of moisture content (%) in *A.arabicus*



Shape (12): Shows the linear relationship between the total weight rate of fish (g) and the total rate of ash content (%) in A.grypus



Shape (13): Shows the linear relationship between the total weight rate of fish (g) and the total rate of ash content (%) in *A.arabicus*

REFERENCES

A.O.A.C. (1999). Estimation of Moisture content (%) in body muscles of selected fishes Wallago attu and Speratamystus seenhala collected from selected habitats in different seasons (reservoirs) : 90 - 104.

Al-Badri , M . E . H . Al-Darajj , S . A ., Neshan , A . H ., and Yesser , A . K . T . (1991) . Studies on the swimming Musculature of the , Cyprinus carpio (L.) and Liza abu (Heckel , 1843) . l. Fibre types . Marina Mesopotamica ., 6 (1): 155 - 168 .

Anttila , K . (2009) . Swimming Muscles of Wild , Trained and Reared Fish . Aspects of Contraction Machinery and Energy Metabolism . University of Oulu , Finland ., A526, 86 pp .

Bosch A C (2012) Investigation of the chemical composition and nutritional value of smoothhound shark (Mustelus mustelus) meat. M. Sc. Thesis. University of Stellenbosch: 87pp

Delemos , M . V . A . Arantes , T . Q ., Souto , C . N ., Martins , G . P . Araujo , J . G ., and Guimaraes , I . G . (2014) . Effects of Digestible Protein to Energy Ratios on Growth and Carcass Chemical Composition of Siamese Fighting Fish , Betta splendens . Cienc. Agrotec . Lavras ., 1 : 76 – 84 .

FAO, 2010. The Department of Fishery and Aquaculture, Rome . pp. 204 .

Sidhu,k.s .(2003).Health benefits and potential risks related to consumption of fish or fish oil. Regulatory toxicology and pharmacology, 38,336-344.

Johnston ,I.A.,Bower,N.I.,and Macqueen,D.J.(2011).Growth and the regulation of myotomal muscle mass in teleost fish .The Journal of Experimental Biology 214(10):1617-1628.

Kiessling , A . Ruohonen , K ., and Bjornevik , M . (2006) . Muscle Fiber Growth and Quality in Fish . Arch . Tierz ., 49 : 137 - 146 .

shearer KD .(1994) .Factors affecting the proximate composition of cultured fishes with emphasis on salmonids.Aquaculture.119(1):63-88.

Glucas, C.J. and Ward, A.R. (1996). Post-harvest Fisheries Development-A Guide to Handling Preservation Process and Quality, NRI publication, Natural Resources Institute, Kent, UK.

Martines M G, Martins D E G and Pena R S (2017) Chemical composition of different muscle zones in pirarucu (Arapaima gigas). Food Sci. Technol., Campina. 37(4), 651 - 656.

Bosch A C (2012) Investigation of the chemical composition and nutritional value of smoothhound shark (Mustelus mustelus) meat. M. Sc. Thesis. University of Stellenbosch: 87pp

Mansour A J (2018) A comparative study of the chemical composition and nutritional value of muscles in different zones in body of two species of teleosts; Greenback mullet, Planiliza subviridis (Valenneciens, 1836) and abu mullet, Planilizaabu (Heckel, 1843). J. Globalphar. Technol. 10 (10), 347-352.

Mansour , A. J, AL-Muhanna , M.w.h.(2019). STUDY OF SOME HISTOCHEMICAL FEATURES FOR RED MUSCLES SKELETAL IN TWO LOCAL IRAQI FISHES, BUNNI FISH,

MESOPOTAMICHTHYES SHARPEYI (GUNTHER, 1874) AND HIMRI FISH, CARABARBUS LUTEUS (HECKEL, 1843). Biochem. Cell. Arch.. 19(1): 2685-2690 .

AL-Muhanna , M.w.h, Mansour , A. J, AL-Asadi S. A. M. (2019). Estimation of chemical components and caloric values for muscles of some local fish in Karbala province, Iraq. IOP Conf. Series: Materials Science and Engineering 571

Mansour, Aqeel Jamil. (2005). A comparative study of some morphological and histological aspects of some local fish in southern Iraq. Doctoral thesis, College of Education, University of Basra: 145.

Al-Aswad, Majed Ishir. (2000). Meat Science and Technology, Third Edition, Dar Al-Kutub for Printing and Publishing, University of Mosul: 466 pages.

Odeh, Yasser Wasfi. (2012). Comparative anatomical study of phenotypic and histological aspects of gills and muscles of some local fish. Master's thesis, College of Education, University of Basra: 82 pages.

Al-Shatti, Sabah Malik Habib. (2006). A technological, chemical and microbial study on the smoking, pickling and drying of four common marine fish species in Basra. Doctoral thesis, College of Agriculture, University of Basra: 221 pages

Al-Muhanna, Muhammad Wissam, Haider Hassan (2015). A comparative study of gills and some histological characteristics of skeletal muscles in two Iraqi bony fish. Aspius vorax, Liza abu. PhD thesis, University of Karbala. 134 pages.

Al-Baldawi, Ali Naseer. (2019). Anatomical and chemical comparative study of skeletal muscles in two bony fish, Coptodon zillii and Luciobarbus xanthopterus in the Hindiya River. Master’s thesis, College of Education for Pure Sciences, University of Karbala. 105 pages.

Abdel-Nabi, Shamael Abdel-Aali Siwan. (2003). Separation and characterization of some fish proteins using gel filtration chromatography and electrophoresis and study of their functional properties. Master's thesis, College of Agriculture, University of Basra: 70 pages.