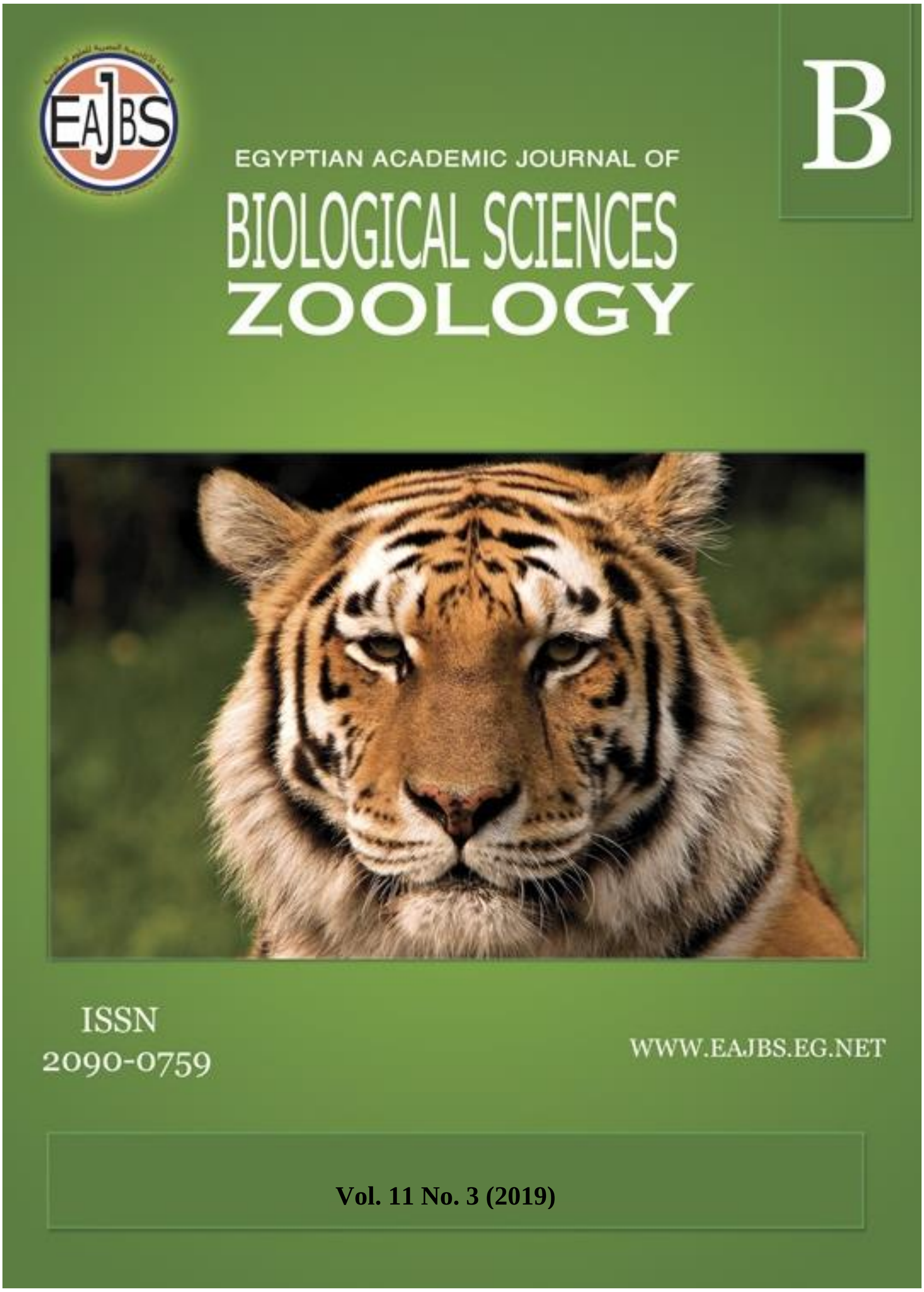

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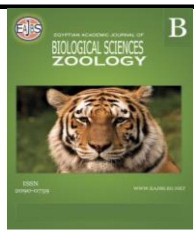

Effect of Food Availability on Some Biochemical Responses in the Target Organs of *Mugil cephalus* Inhabiting Abu-Qir Bay, Alexandria, Egypt

Mohamed Hamed Ghanem
Department of Zoology, Faculty of Science, Al-Azhar University
E.Mail: ghanemhamed@yahoo.com

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ABSTRACT

The present study aimed to determine food and feeding habits of *Mugil cephalus* collected from Abu-Qir Bay, Egypt during the period from July, 2017 to June, 2018 and its effect on the nutritional values (total proteins, total lipids, total carbohydrates) in the target organs (kidney, liver, and muscles) of the commercial fishes, *M. cephalus*.

Results indicated that, the rate of feeding activity of *M. cephalus* was peaked during summer and declined during winter. The maximum value of feeding activity was recorded in the larger fish during summer and autumn and the minimum values occurred in the smaller one during autumn and winter. In the present study, the changes in feeding activity appear to be correlated with water temperature and the availability of food in nature.

The biochemical composition of fish organs is a good indicator of the fish quality and physiological condition. Data declared that the minimum value of total proteins in the kidney and liver was observed in the small size during the summer. Moreover, the percentages of protein contents in the muscles of *M. cephalus* are usually affected by several factors including the type of food, fish size and seasons. It was declined during autumn in the small fish.Results revealed that the maximum average values of total lipids in the kidney and liver of *M. cephalus* were recorded in the large fishes during spring. Whereas, the minimum values were detected in the same size during summer. However, total lipids in the muscles attained its lower value in the small fish during summer and the higher ones in the large size during spring.The present study exhibited the increasing level of total carbohydrates in the kidney of *M. cephalus*, during spring in large size of fishes and the decreasing value occurred in the same group during autumn. On the other hand, total carbohydrates in the liver showed seasonal variations with an increasing level in the large fishes during autumn and the decreasing level occurred in the same group during spring. However, total carbohydrates were peaked in the muscles of the small-sized group during autumn and spring and declined in the large one during spring.Although, the availability of food items during any season due to the optimum condition; it may reflect the lower level of nutritional values attributed to the changes in water quality by the action of pollutants, that may critically influence the growth rate and quality of the fishes which feed on flora and plankton induced by bioaccumulation of metals.Statistical analysis of metabolic parameters in the target organs at different sized groups of *M. cephalus* showed significant differences ($p<0.05$) at one way of ANOVA between the different organs and between different parameters. On the other hand, it was non-significant differences in the interaction between organs and sized group, by using two ways of ANOVA.Such investigation may lead to a better understanding of some biological aspects like food chains, growth rates, productivity, mortality, and nutritional values as well as their trophic levels.

INTRODUCTION

Abu Qir Bay (Fig. 1) is one of the most important fishery ground in Egypt. The total catch landed varied from a maximum value of 1075 tons during the fishing season 1997 to a minimum value of 526 tons during the fishing season 2004 (GAFRD, 2004 and Khalaf-Allah, 2009). The bay has a shoreline of about 50 kms long in East of Alexandria City. The bay is located between Abu Qir headland southwest to Rosetta mouth northeast (Said, 1979 and Khalaf Allah, 2009). It lies between longitudes 30° 4` & 30° 21` East and latitudes 31° 16` & 31° 30` North. Three openings are connected to the bay, the first through Rosetta Nile Branch, the second through a channel to Lake Edku and the third to El-Tabia Pumping Station. The bay is generally shallow; the water depth of the bay fluctuated between 1 meter near the coast to 16 meters at the open sea (Younis, 2005; Mohamed, 2006 and Khalaf Allah, 2009).

The bottom of the bay consists mainly of five types of sediments; sand, silty sand, sand-slit-clay, clayey silt, and silty clay. In the western part of the bay, however, some rocky patches exist of which Nelson Island is obvious above the sea waters. The bay shores are covered with empty shells of gastropods, bivalves and dead plants (Frihy *et al*., 1994 and Radwan, 1996).

Mugilidae is the most interesting and numerically abundant group of fishes, distributed very widely in almost types of waters. They are generally filter feeders, feeding on algae, diatoms, small invertebrates especially crustaceans and decayed organic matters (Shehata, 1997a & b; Shapiro, 1998; Khalaf-Allah, 2001; Ghanem, 2006 and Ragab, 2017).

Variation of the biochemical composition of fish flesh may also occur within the same species depending upon the fishing ground, seasons, age and sex of the individual, spawning cycle and reproductive status (Love, 1970). Moreover, biochemical studies of fish tissues are of considerable interest for their specificity in relation to the food values of the fish and for the evaluation of their physiological needs at different periods of life (Weatherley and Gill, 1987). However, little pieces of information are available on the effect of a specific food on the nutritional values of these species. Hence, it was considered favorite to study food and feeding habits and the nutritional values of the mullet fish, *M. cephalus* commonly found in the water of the study period.

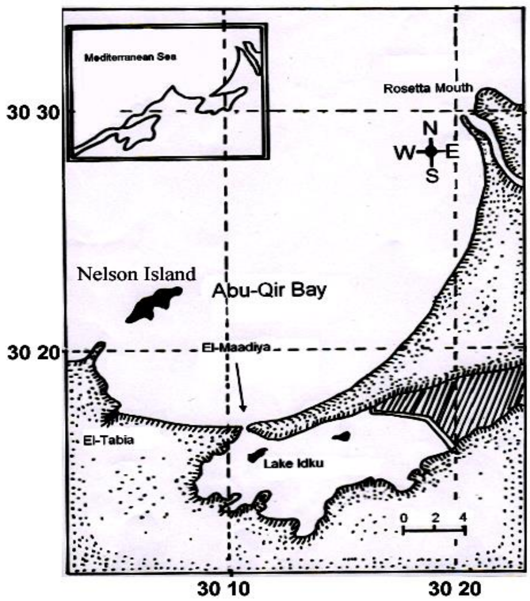

Fig (1): Map of Abu- Qir Bay showing the study area

MATERIALS AND METHODS

A total of 96 of golden grey mullet, *M. cephalus* (Fig., 2) were collected seasonally from the different localities of the study area, during the period from July, 2017 to June, 2018. Flathead Mullet Trammel net was the main fishing method used to collect the fish. After collection, fishes were divided into two length groups.

The species (*M. cephalus*) were selected carefully to cover two sized groups. One of these was a small-sized group (21.00-29.90 Cm), while, the large-sized group (30.00-43.5.00 Cm). After dissection, a known weight of the target organs (kidney, liver and muscles) was kept under the freezing condition at 4°C until the latter examinations.

Fig. (2): Lateral view of golden grey mullet, *Mugil cephalus*, collected from Abu-Qir Bay.

Food Analysis:

Feeding Activity: To study feeding activity, all the examined stomachs were firstly assessed. The assessment was based on the visual estimation of the distension of stomachs and the relative amount of food contained in them. The examined stomachs were classified into five groups, according to the following method utilized by Geevarghese (1976). Wherever fishes were examined fresh or preserved in 10% formalin solution for later examination. In the laboratory, fishes have identified stander and total length was measured to the nearest millimeters and recorded.

Fishes were separated into two length groups (small and large). The percentage occurrence of heavy, good and medium stomachs which was truly reflective of the well condition in each season was determined to assess the feeding activity.

Food Composition: To study food items, the point assessment method was carried out. After being dissection, each stomach was removed, washed with water, opened and its contents were flushed into a Petri dish and examined under a low power binocular microscope. Food items were taxonomically identified, as far as possible up to genera and classified into two main groups; animal food and plant food. The percentage occurrence of each category was estimated.

Biochemical Studies:

The biochemical analysis considered here were; total proteins, total lipids and total carbohydrates.

Preparation of Samples:

To study biochemical parameters, a known weight of each organ was homogenized by using the electric homogenizer for 2 min and centrifuged at 4000 r.p.m. for 15 min. at 2 °C in a refrigerator centrifuge. The supernatant solution was used directly or stored at 4 °C until the latter analysis.

Determination of Total Proteins:

Total proteins content in the different organs were determined according to Doumas (I975) using a kit of Bioadwic Company.

Determination of Total Lipids:

Total lipids contents in the different organs were determined according to the method of Knight *et al*. (I972), using a kit of Bioadwic Company.

Determination of Total Carbohydrates:

Total carbohydrates content in the different organs were determined according to the method suggested by Singh and Sinha (1977).

Statistical Analysis: Results were expressed in tables as mean ±S.D. Data were analyzed by using analysis of variance (ANOVA) according to Bailey (1981).

RESULTS AND DISCUSSION

The present study aimed to provide ecological and physiological studies on the commercial fish, *Mugil cephalus* collected from Abu-Qir Bay during the period from June, 2017 to May, 2018. On the bases of quantitative and qualitative analysis, the stomach contents, biochemical analysis (total protein, total lipids, and total carbohydrates) in the target organs (kidney, liver and muscles) of this fish were determined. Such investigation may lead to a better understanding of some biological aspects such as slow growth, mortality and metabolic process of *M. cephalus* inhabiting this area.

Food and Feeding Habits:

In the wild aquatic life, there is a wide diversity of microscopic organisms and macrophytes which fish species generally feed on (Pfenning *et al.*, 2011 and Ragab, 2017).

Seasonal Variations in the Feeding Intensity According To Sized Groups:

The present study (Table, 1) showed a considerable variation of the feeding intensity in the different sized groups and different seasons. The maximum values of feeding activity were recorded in the large fishes during summer (42.5%) and autumn (36.73%), while, the minimum values occurred during winter; being 13.44% in the small fish and 3.46 % in the large.

The highest values of poor stomachs were recorded in the lager fish during winter (89.32%) and spring (85.67%), while, the lowest values were observed in the smaller fish during winter and large one during summer; being 46.53% in the first and 39.75% in the second.

Table (1): Seasonal variations in the feeding intensity in different sized groups of the mullet fish, *Mugil cephalus* collected from Abu-Qir Bay, during the year, 2017 - 2018.

Length in Cm / Feeding intensity	Small fish	Large fish	Small fish	Large fish	Small fish	Large fish	Small fish	Large fish
Heavy stomachs	-	-	-	-	-	-	18.53%	-
Good stomachs	-	-	-	36.73%	-	-	-	-
Medium stomachs	23.15%	42.50%	14.15%	-	13.44%	3.46%	13.72%	14.33%
Poor stomachs	58.34%	39.75%	64.35%	63.27%	46.53%	89.32%	67.75%	85.67%
Empty stomachs	18.51%	17.75%	21.50%	-	40.03%	7.22%	-	-
Actively fed	**23.15%**	**42.50%**	**14.15%**	**36.73%**	**13.44%**	**3.46%**	**32.25%**	**14.33**
Non actively fed	**76.85%**	**57.50%**	**85.85%**	**63.27%**	**86.56%**	**96.54%**	**67.75%**	**85.67%**
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Seasonal Variations in the Food Items According To Sized Groups:

Results (Table, 2) revealed that the diet of this fish showed considerable variations in different sizes during different seasons. Data showed no qualitative differences in the diet of different sized fishes; even though for the individual items there is a quantitative difference. The same twenty items namely plant tissue, unidentified food, green algae, blue-green algae, red algae, diatoms, seeds, dinoflagellate, phytoplankton, Mollusca, Crustacea, foraminifera, hydrozoa, insects, Polychaeta, fishes, Spirotrichea, Protozoa, Acantharia and sand granules are most sought after by both the two length groups.

The quantitative differences of any article of food between smaller and larger fishes are not of a regular pattern in all seasons; in some seasons if an item of food is consumed by the smaller fish in a greater quantity than in the larger fish, the same article is consumed in a lesser quantity than in the larger one in some other seasons. The maximum amount of plant food was recorded in the stomachs of small-sized groups (90.86%) during spring and the minimum amount occurred in the same size during autumn (9.87%). The highest value of animal food was recorded in the stomachs of small fish during autumn (85.87%) and the lowest value occurred in the same sized group during spring (0.14%). However, the maximum values of sand granules were recorded in the stomachs of small fish during winter (54.84%) and summer (44.11%), while the minimum values (4.26% and 9%) occurred in the same sized group during autumn and spring, respectively (Table, 2).

Table (2): Percentage occurrence of various categories of food items in the stomachs of different sized groups of the mullet fish, *M. cephalus*, collected from Abu-Qir Bay, during the year, 2017-2018.

Seasons / Food items	Summer		Autumn		Winter		spring	
	small	large	Small	large	small	large	small	large
Plant foods	**52.43%**	**64.23%**	**9.87%**	**36.22%**	**43.47%**	**45.26%**	**90.86%**	**36.84%**
Plant tissues	34.44%	53.11%	8.46%	33.56%	0.33%	-	90.21%	22.84%
Green algae	5.43%	5.90%	0.53%	2.14%	7.01%	6.73%	0.51%	3.61%
Blue green algae	4.64%	0.36%	0.11%	0.09%	0.54%	0.86%	0.06%	0.37%
Red algae	0.43%	0.82%	0.15%	0.14%	2.09%	1.19%	0.08%	0.43%
Diatoms	2.75%	0.08%	0.04%	0.16%	0.30%	0.06%	-	2.16%
Seeds	-	-	0.24%	-	-	-	-	-
Dinoflagellats	-	-	-	-	0.02%	-	-	-
Phytoplankton	0.009%	-	-	-	-	-	-	-
Unidentified	4.73%	3.96%	0.34%	0.13%	33.18%	36.42%	-	7.43%
Animal foods	**3.47%**	**0.37%**	**85.87%**	**51.71%**	**1.69%**	**25.5%**	**0.14%**	**38.28%**
Mollusca	-	-	84.67%	-	0.41%	-	-	37.96%
Crustacea	-	-	-	51.33%	-	-	0.03%	0.03%
Foraminifera	3.34%	0.13%	1.20%	0.31%	-	-	0.002%	0.29%
Hydrozoa	0.12%	-	-	-	0.06%	25.32%	-	-
Insecta	-	-	-	-	1.17%	-	0.11%	-
Small fishes	-	0.24%	0.004%	0.004%	-	0.07%	0.0002%	-
Polychete larvea	-	-	-	0.07%	-	-	-	-
Spirotrichea	-	-	-	-	0.05%	0.08%	-	-
Protozoa	0.01%	-	-	-	-	-	-	-
Acantharia	-	-	-	-	-	0.03%	0.0004%	-
Sand granules	**44.11%**	**35.40%**	**4.26%**	**12.07%**	**54.84%**	**29.24%**	**9%**	**24.88%**
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Mugilidae is one of the large families within the order of Perciforms. Mullets are fresh, brackish and salt-water fishes (Wheeler, 1975). Most are generalized herbivorous fishes. Their teeth and jaws can be adapted for their diets (Mohamed, 1995; Shapiro, 1998; Khalaf Allah, 2001 and Ragab, 2017). Feeding intensity refers to the degree of feeding as indicated by the relative fullness of the stomach. It varies considerably according to the availability of preferred food, maturity stages and spawning season of this species (Jaya and Saksena, 2013).

The fish is essentially herbivorous and consumed a wide range of plants and a low range of animal food. The major plant foods include plant tissue, unidentified food and green algae. Mollusca and crustacea were the main animal food ingested by the fish. Sand granules constituted a considerable percentage in the diet of this fish. The relative importance of plant food increases with the increasing length of the fish except for the spring season. The percentages of sand granules decrease with the increasing length of the fish during summer and winter. Results were in agreement with Shapiro (1998); Khalaf-Allah (2001) and Ragab (2017) and differ with Contreras- Balderas, and Escalante (1984) who found that *M. cephalus* alter their trophic mode from being primarily planktonivorous or carnivorous feeders to be primarily benthic feeders.

Results revealed that the highest value of feeding activity of *Mugil cephalus* was recorded during summer and the lowest value was detected during winter. High feeding intensity may be due to the abundance of food items during the worm season. Similar observations agree with Spataru (1978); Khalaf-Allah (2001); Ragab (2017) and Shehata *et al*. (2017). The rate of feeding activity of *M. cephalus* was peaked during summer and declined during winter. The maximum value of feeding activity was recorded in the larger fish during summer and autumn and the minimum values occurred in the smaller one during autumn and winter. The lowest rate of feeding activity during winter might be due to the effect of turbidity, low water temperature and abundance of food in nature. A similar observation was recorded by Shehata (1994); Allam (1995); Kiran & Puttaiah (2004); Argyris (2005) and Oliveira *et al*. (2007). However, Spataru (1978); Ragab (2017) and Shehata *et al*. (2017) referred that, the reason for the abundance of food items during the dry season could be autotrophic nature of the phytoplankton using light as their energy input for their growth. Furthermore, Shehata and Zaki (1994); Khalaf Allah (2001 and 2009); Argyris (2005) and Oliveira *et al*. (2007) and Shehata *et al*. (2017) reported the feeding activity increases with the increasing length of fishes.

In the present study, the changes in feeding activity appear to be correlated with water temperature and the availability of food in nature. The mullet fish, *M. cephalus* appeared to diurnal feeders as most of the fishes collected during the day were found to be more or less with empty stomachs. These results are agreed with Khalaf Allah (2001) and Ragab (2017).

Results revealed that the examined fish species changed their feeding habits with the changes of season. It seems that this is mainly dependent on the relative abundance of different items of food in nature. Thus, the material in the gut of fishes maybe reflects the relative density of food items in the different seasons and the ability of fish to consume the available items according to their needs. Similar observations were detected by many authors (Abdel-Backy, 1997; Khalaf-Allah, 2009 and Ragab, 2017).

Biochemical Studies:

The chemical composition of the different fish species shows variation from individual species to another, depending on seasons, availability of food, migratory behavior, sexual maturation, feeding cycles and environmental factors (Huss, 1995 and Ravichandran *et al*., 2011). However, little physiological information is available on the studied fish (Gad, 2003; Ghanem, 2006; Ragab, 2017 and Mohamed, 2019). The biochemical composition of fish organs is a good indicator of the fish quality, physiological condition and fish habitat. Fish of various species do not provide the same nutrient profile to their consumers and the nutritive value of a fish varies with season. So, biochemical evaluation is necessary to ensure the nutritional value of the fish (Mathana *et al*., 2012).

Total Proteins:

Proteins serve majorly in the building of cell structure and protection of the body against invaders to keep the immune system intact (Edori and Konne, 2015). The reduction of protein may be due to proteolysis and increased metabolism under toxicant stress (Remia *et al*., 2008; Ghanem, 2014; kola *et al*., 2015 and Ghanem, 2019). From another angel, Das (1978) suggested that protein content goes on increasing with the advancement in the maturity of *Mugil cephalus*.

Results (Table, 3) revealed that total proteins in the target organs of *Mugil cephalus* collected from the study area were affected with size and season. The maximum value of total proteins in the kidney of *M. cephalus* was recorded in the large size during winter, however, the minimum value was observed in the small size during the summer; being 5.79±0.73 and 3.38±0.53 g/100g wet wt, respectively. These findings were agreed with that obtained by Abbas (2015) and Sabrah *et al*. (2016) and differ with that obtained by Abdel- Tawwab *et al*. (2010).

Table (3): Seasonal variations of biochemical parameters (Mean ± S.D. g /100 g wet weight) in the target organs of *M. cephalus* collected from Abu-Qir Bay, during the year, 2017 - 2018, according to sized groups.

Organs	Parameters / Seasons	Total proteins		Total lipids		Total carbohydrates	
		Small	Large	Small	Large	Small	Large
Kidney	Summer	3.38 ±0.53	4.69 ±1.43	0.76 ±0.12	0.57 ±0.23	0.63 ±0.16	0.64 ±0.13
	Autumn	3.84 ±1.28	4.53 ±0.65	1.43 ±0.41	1.54 ±0.29	0.82 ±0.23	0.55 ±0.14
	Winter	5.21 ±1.36	5.79 ±0.73	0.86 ±0.27	0.75 ±0.31	0.79 ±0.09	0.80 ±0.11
	Spring	4.09 ±0.34	5.15 ±1.13	1.38 ±0.34	1.68 ±0.46	0.93 ±0.17	1.23 ±0.43
Liver	Summer	2.42 ±0.67	3.98 ±1.09	0.92 ±0.29	0.65 ±0.11	1.16 ±0.14	1.33 ±0.18
	Autumn	2.83 ±0.47	4.38 ±1.15	1.43 ±0.28	1.21 ±0.36	1.29 ±0.21	1.49 ±0.16
	Winter	3.16 ±0.22	5.38 ±1.40	1.19 ±0.31	1.32 ±0.14	1.13 ±0.37	1.27 ±0.31
	Spring	4.54 ±0.84	5.88 ±0.43	1.73 ±0.26	1.91 ±0.24	0.93 ±0.17	0.86 ±0.16
Muscles	Summer	4.64 ±1.04	5.29 ±1.45	0.53 ±0.09	0.77 ±0.18	0.89 ±0.15	1.20 ±0.11
	Autumn	4.25 ±0.76	4.62 ±1.11	0.76 ±0.23	1.08 ±0.28	1.38 ±0.23	1.12 ±0.31
	Winter	6.24 ±1.23	7.48 ±1.15	1.31 ±0.29	1.29 ±0.13	1.18 ±0.27	0.92 ±0.21
	Spring	5.35 ±1.28	7.76 ±1.03	1.44 ±0.34	1.64 ±0.35	1.43 ±0.34	0.78 ±0.36

The higher content of total proteins in the liver of mullet fish occurred in the large size during spring (5.88±0.43 g/100g wet wt.) and the lower value was recorded in the small fishes during summer (2.42±0.67 g/100g wet wt.).

The percentages of protein contents in the muscles of *M. cephalus* are usually affected by several factors including the type of food, fish size and seasons (Abbas, 2005; Tayel, 2007; Ghanem, 2011 and Ragab, 2017).

According to size, total protein in the muscles of *M. cephalus* was peaked in a large-sized group during spring and winter (7.76±1.03 and 7.48±1.15 g/100g wet wt.) and declined during autumn in the small one (4.25±0.76 g/100g wet wt.). This finding agrees with that obtained by Ghanem (2006) and Abbas (2015) and differ with Kaur and Saxena (2001); Abou El-Naga (2003); Abou El-Naga and El- Boray (2004); Abdel-Tawwab *et al*. (2010) and El-Desoky *et al*. (2016) whom concluded that the depletions in protein contents were observed in the muscles of large fishes, due to the protein utilization which decreases with the increasing length of the fish.

The elevation in total proteins during spring as a result of a suitable temperature and food availability, fish size and maturity stages. Total protein contents in the most examined fish were increased with the increasing length groups. Also, the liver considered a metabolic organ that contains a higher level because of its metabolic function in addition to it is the center for various metabolism. Similar observations were obtained by Shakweer & Abbas (2005) and Shah (2013) and differ with Hassanein (1991) and Sancho *et al.* (1998) who mentioned that total proteins in the different organs of immature and mature fish were nearly similar.

However, the highest level of proteins during winter and spring may be attributed to the combined effects of high food availability to storing material prior to spawning. These findings were agreed with Bgum (2004) and Tulgar & Berik (2012) and differ with Ghanem (2006) and El-Desoky *et al*. (2016) who found the lower temperature (onset of winter) may have affected feeding activity, this may depend on water temperature and their distribution is limited by their thermal tolerance. In addition to the changes in water quality by the action of heavy metals, that may critically influence the growth rate and quality of the fishes which feed on flora and plankton induced by bioaccumulation of metals.

The depletion in protein content during winter may be due to the lower activity depends on water temperature and their distribution is limited by their thermal tolerance. In addition to the changes in water quality by the action of pollutants especially heavy metals and humic matter, that may influence the rate of growth. These findings agreed with Ghanem (2006) and differ with Kaur & Saxena (2001) and Abdel-Tawwab *et al*. (2010) who concluded that the depletions in proteins content were observed in the muscles of the large-sized group, due to the protein utilization which decreases with the increasing age and dietary protein levels.

However, the lowered protein value in the target organs of studied fish during summer was suggested as a metabolic adaptation to the food shortage in the environment (White *et al*., 1986). From another side, Abdel-Moati (1992) found the increase in metal concentrations reduced the soluble protein in the different organs which reflects both a reduction in synthesis and an increase in its utilization under metals stressed conditions.

Total Lipids:

The maximum value of total lipids in the kidney of *M. cephalus*, was observed in the large fish during spring (1.68 ± 0.46 g/100g wet wt.) and the minimum value (0.57 ± 0.23 g/100g wet wt.) was detected in the same group during summer. Total lipids content found to be a good indication of nutritional values. They are the best energy producers of the body next to carbohydrates (Chezhian *et al*., 2010). During starvation, the source of energy is lipids and carbohydrates. Higher fat was observed in ripe and gravid fish where a lower level of fat was recorded in the spent and young fish (Bhuyan *et al*., 1980 and Bhuyan *et al*., 2003). Furthermore, the lipid is affected by the spawning cycle, food availability, seasonal variations and biochemical activity of fish (Bayomy *et al*., 1993; Huss, 1988 and Tayel, 2007).

Results revealed that the maximum average values of total lipids in the kidney of *M. cephalus* were recorded in the large fishes during spring. Whereas, the minimum average values were detected in the large-sized groups during summer. This finding agrees with that obtained by El-Shebly (2002) and Abou El-Naga (2003), however, Ghanem (2011) reported that the smaller fish had a lower level of fat than the larger one. This may be due to the favorable climatic condition, the availability of more amount of food consumed by the fish and the increase of feeding intensity.

In the liver of *M. cephalus*, the maximum values of total lipids were observed in the large fish during spring (1.91 ± 0.24 g/100g wet wt.) and the minimum value occurred in the same size during summer (0.65 ± 0.11 g/100 g wet wt.). This finding agrees with that obtained by El-Shebly (2002); Abou El-Naga (2003) and Ghanem (2011) and differ with Jain & Singh (1987); Folmer *et al.* (1992) and Ghanem (2006) whom stated that, total lipids in the liver of the fish increases during summer and decreases during autumn. It may be attributed to the reproductive cycle and the feeding activity of this fish. The present study also differs from Wassef & Shehata (1991) and Ragab (2017) who reported that the percentage of fats in the liver of younger fish is relatively higher than the larger one.

Total lipids in the target organs especially metabolic organs (kidney and liver) were exhibited a higher peak during spring may be attributed to the combined effects of high food availability to storing material. These findings are in agreement with Bayomy *et al.* (1993); Tulgar & Berik (2012); Ragab (2017) and Mohamed (2019). Depletion in lipids contents in the metabolic organs may be due to the action of toxicity which suppresses the activity of enzymes (1) the secretion of catecholamine and corticosteroids in the bloodstream after the toxicant stress that produces an enhanced in metabolic rate which in turn reduces the metabolic reserves, (2) the use of energy-rich lipids for energy production during toxic stress. Results were in agreement with Sancho *et al*. (1998); Chandra *et al*. (2004) and Blaner *et al*. (2005) and Agrahari & Gopal (2009) and differ with Khan *et al.* (1992); Shakoori *et. al.* (1996) and Virk & Sharma (1999) who mentioned that lipid contents were decreased in the liver by the action of toxicity which suppresses the activity of enzymes responsible for lipid transformation ultimately causing disturbance in lipid metabolism and lead to the decreasing in values of cholesterol.

The total lipids in muscles of *M. cephalus*, was varied from 0.53 ± 0.09 g/100g wet wt. in the small fish during summer to 1.64 ± 0.35 g/100g wet wt. in the large size during spring. These findings are agreed with that obtained by Ghanem (2011) and Sabrah *et al*. (2016) and Ragab (2017) whom attributed that, the favorable climatic condition, the availability of more amount of food consumed by the fish and increase of feeding intensity during this period (optimum climatic seasons) and differ with Kandemir & Polat (2007); Tulgar & Berik (2012) and El- Desoky *et al*. (2016) whom mentioned that, the increasing of lipids in the fish muscles prior to reproduction and decreasing during the spawning period. There is an inverse relationship between lipids and water quality. Also, the present study not matching with Wassef & Shehata (1991) who reported that the percentage of fats in the muscles of the smaller fish is relatively higher than the larger one. A weak positive relationship was found between the lipid, length and weight of *Nemipetrus japonicus* and *Scomber japonicus* (Abou El-Naga, 2003).

The change in lipid content is probably due to the feeding behaviour and the energy requirement for gonadal development. This explanation agrees with Wassef and Abdel-Hady (1999) who reported that the lipid contents in the muscles of *Siganus canaliculatus* were dropped during gonadal development. Also, Abou-Hegab *et al*. (1994) reported that seasonal variations of lipid metabolites are mostly related to feeding and breeding activities.

Total Carbohydrate:

Results (Table, 3) exhibited the increasing level of total carbohydrates in the kidney of *M. cephalus*, during spring in large fishes (1.23 ± 0.43 g/100g wet wt.) and the decreasing value occurred in the same group during autumn (0.55 ± 0.14 g/100g wet wt.). Moreover, total carbohydrates in the liver of *M. cephalus*, showed seasonal variation with an increasing level in the large fishes during autumn (1.49 ± 0.16 g/100g wet wt.) and the decreasing level occurred in the same group (0.86 ± 0.16g/100g wet wt.) during spring. In general, total carbohydrates in the liver of these fishes were higher in the larger fishes than the smaller ones except spring. In the muscles, however, total carbohydrates were peaked in the small-sized group during autumn and spring (1.38 ± 0.23 and 1.43± 0.34 g/100g wet wt, respectively) and declined in the large one during spring (0.78 ± 0.36 g/100g wet wt.).

Carbohydrates are considered the first degraded under the stress condition of animals (Chezhian *et al*., 2010). Glycogen in many marine animals does not contribute much to the reserves in the body (Pilla *et al*., 2014). Moreover, carbohydrate content in the fish is affected by some environmental and physiological factors such as seasons, spawning and feed intake. Seasonal differences in the availability of food and changes in the reproductive cycle have considerable effects on the biochemistry of the fish tissue (Bumb, 1992).

Seasonal variation of total carbohydrates in the target organs indicated that the maximum values of total carbohydrates in the kidney of *M. cephalus* were recorded in the large-sized groups during spring. However, the minimum average value was observed in the kidney of small fishes during summer. The highest average values of total carbohydrates in the liver of *M. cephalus* were recorded during autumn in large fish and the lowest value was detected during spring in the same group.The present study indicated that total carbohydrates in the fish muscles affected with size, the maximum average values in the muscles were observed in the small size of *M. cephalus* during autumn and spring. Moreover, the minimum average value was measured in the larger size during spring. Similar observation agrees with Abou El-Naga and El- Boray (2004) and differs with Sivakami *et al*. (1986); Abbas (2015) and Sabrah *et al*. (2016) who found that the maximum values during the cold season and the minimum values were observed during the hot season.

Generally, the fall in the liver glycogen contents may be due to the breakdown of glycogen (glycogenolysis). The decrease of muscles glycogen may be due to an increasing rate of glycogenolysis (Srivastava & singh, 1981; Ghazaly, 1992; Ghanem, 2006 and Ghanem, 2019). This finding differ with Abou El-Ella (1996) who recorded the increasing in accumulation rate of heavy metals in pancreatic islets of the fish leads to damage of insulin producing (Beta cell) with decreasing carbohydrate content.

Depletion in glycogen may be due to its utilization for supplying the energy to the fish under stress condition. This is confirmed by the fact that all stress conditions invariably lead to retardation of growth and alter the physiological mechanism. If the stressed condition continuous, long enough mortality ensues (Bhattacharya *et al*. 1987; Al-Akel *et al.*, 1988; Ghanem, 2006 and Mathana *et al.,* 2012).

The high level of carbohydrate contents were observed during autumn and spring; it may be due to the favourable temperature and high feeding activity. This finding agree with Bumb (1992) who recorded the variation of carbohydrate contents with feed intake and intensive of feeding in *Ambassis commersoni* coincides with the occurrence of high carbohydrate content in the fish muscle. This finding agree with Sabrah *et al*. (2016); Ragab (2017) and Ghanem (2019) who found the increasing in carbohydrate level attributed to the suitable condition for fish growth.

Statistical Analysis for Metabolic Parameters in the Fish:

Statistical analysis of metabolic parameters in the target organs at different sized groups of *M. cephalus* showed significant differences ($p<0.05$) at one way of ANOVA between the different organs and between different parameters, however, it showed non-significant differences between the different sized groups. On the other hand, it was non-significant differences at the interaction between organs and sized group, by using two ways of ANOVA. However, it showed highly significance ($p<0.01$) at the interaction between organs and parameters and between sized groups and parameters (Table, 4).

Table (4): Analysis of variance (ANOVA) of the metabolic parameters in the target organs and different sizes of *M. cephalus*.

Source of variance	**F-value**
Organs	5.96*
Sizes	1.56 n.s.
Parameters	3.11*
Organs * Sizes	0.44 n.s.
Organs * parameters	9.74**
Sizes* parameters	11.20**
Errors	--
Total	--

Although, the availability of food items during any season due to the optimum condition; it may reflect the lower level of nutritional values attributed to the changes in water quality by the action of pollutants, that may critically influence the growth rate and quality of the fishes which feed on flora and plankton induced by bioaccumulation of metals.

Such investigation may lead to a better understanding of some biological aspects like food chains, growth rates, productivity, mortality and nutritional values as well as their trophic levels.

REFERENCES

Abbas, H. K. (2005): Aflatoxin and Food Safety, Taylor and Francis Group, Philadelphia, PA, 587 pp.

Abbas, M. M. M. (2015): Accumulation of heavy metals in the water, sediment and some fish species inhabiting EL-Max Bay, Alexandria, Egypt. M. Sc. Thesis, Zool. Dept, Fac. Sci., Al-Azhar University, Egypt, 367 pp.

Abdel-Backy, T. E. (1997): Length-weight relationship, relative condition, gonad index and maturation of Sea bass, *Dicontrarchus labrax* (Linn.) in Lake Manzallah, Egypt. J. Egypt. Ger. Soc. Zool., 24 (B): 47-66.

Abdel-Moati, M. A. R. (1992): Biological and physiological responses of *Mytilus edulis* to Hg and Pb in the coastal water of Alexandria region. FAO Tech. Rep., 69: 61-72.

Abdel-Tawwab, M.; Ahmed, M. H.; Khattab, Y. A. E. and Shalaby, A. M. E. (2010): Effect of dietary protein level, initial body weight and their interaction on the growth, fed utilization and physiological alterations of nile tilapia, *Oreochromis niloticus*. Aquaculture. 298(3), 267-274.

Abou El-Naga, E. H. (2003): Seasonal variations in protein, lipids, ash and water contents in muscles of three fish species collected from the Gulf of Suez, Egypt, Egypt. J. Aquat. Boil. and Fish., 7 (2): 103-117.

Abou El-Naga, E. H. and El-Boray, K. F. (2004): Protein, lipids and glycogen contents in muscle, liver and gonad and their relation to reproductive cycle of *Rhabdosargus haffara*. J. Egypt Ger. Soc. Zool., 43: 265-277.

Abou-Hegab, S.; Ahmad, S. M. and Abou EL-Naga, E. H. (1994): Seasonal changes of some haematological and physiological parameters in teleosi, *Liza aurata*. J. Egypt. Ger. Soc. Zool. Comp. physiol., 13(A):333-344.

Agrahari, S. and Gopal, K. (2009): Fluctuations of certain biochemical constituents and markers enzymes as a consequence of monocrotophos toxicity in the edible fresh water fish, *Channa punctatus*. Pesticide Biochem. & Physiol., 94:5-9.

Al-Akel, A. S.; Shamsi, M. J. K.; Al-Kahem, H. F.; Chaudhary, M. A. and Ahmed, Z. (1988): Effect of cadmium on the cichlid fish, *Oreochromis niloticus*,: behavioural and physiological responses. J.Univ.Kuwait (Sci)., 15(2): 341-346.

Allam, S. M. (1995): Feeding habits of soles, *Solea vulgaris*, *Solea aegyptiaca*, *Solea impar* and *Solea kleini* from Abu-Qir Bay, Southeastern Mediterranean Sea, Egypt. Bull. Nat. Inst. Ocean. & Fish. A.R.E., 21 (2): 477-500.

Argyris, K. (2005): Age, growth, mortality, reproduction and feeding habits of the striped sea bream, *Lithognathus mormyrus* (Pisces: sparidae), in the coastal waters of the Thracian Sea, Greece. Scientia Marina., 69(3): 391- 404.

Bailey, N. T. J. (1981): Statistical methods in biology. 2nd Ed. (Biological Science Texts): 216pp.

Bayomy, M. F.; Khallaf, E. A. and Gaber, N. (1993): Studied on the fat content and their relation to the reproduction of *Clarias lazera* (CUV and VAL) In Bahr Shebeen Nile canal. J. Egypt, Ger. Soc. Zool., 10(B): 165-182.

Bgum, G. (2004): Cabofuran insecticide induced biochemical alterations in liver and muscle tissues of the fish *Clarias batrachus* (Linn.) and recovery response. Aquat. Toxicol., 66: 83-92.

Bhattacharya, T., Ray, A. K. and Bhattacharya, S. (1987): Blood glucose and hepatic glycogen interrelationship in Channa punctatus: a parameter of non-lethal toxicity bioassay with intestinal pollutants. Indian J. Exp. Biol., 25: 539-541.

Bhuyan, H.; Chowdhury, M. B.; Nath, K. K.; Seal, P. and Hag, M. A. (2003): Studies on the biochemical parameters of Cynoglossids in the Kutuboha Channel, Bangladesh. Bangladesh J. Sci. Ind. Res., 38: 91-96.

Bhuyan, B. K.; Constance L. B.; and Kathleen D. S. (1980): Lethality of nogalamycin, nogalamycin analogs, and Adriamycin to cells in different cell cycle phases." Cancer research 40(10): 3437-3442.

Blaner, C.; Curitis, M. and Chan, H. (2005): Growth, nutritional composition and hematology of Artic chair (*Salvelinus alpinus*) exposed to toxaphene and tapeworm (*Diphyllobothrium dendritiam*), Archive of Environmental Contamination and Toxicology, 48: 397-404.

Bumb, S. (1992): Studies on the biology of Commersoni's Glassy perchlet, *Ambassis commersoni* (Cuvier). Ph.D Thesis Submitted To Goa University, 214 pp.

Chandra, S.; Ram, R. and Singh, I. (2004): First ovarian maturity and recovery response in common carp, *Cyprinus carpio* after exposure to carbofuran. Journal of Environmental. Biology 25:239-249.

Chezhian, A.; Kumar, N. K. and Senthamilselvan, D. (2010): Impact of chemical factory effluent on the structural changes in gills of estuarine fish, *Mugil cephalus*. World App. Sci. J., 9 (8): 922-927.

Contreras-Balderas, S. and Escalante-C, M. A. (1984): Distribution and known impacts of exotic fishes in Mexico. Johns Hopkins University Press, Baltimore, USA. 102-130.

Das, H. P. (1978): Maturity and spawning in *Mugil cephalus* Linnaeus in Goa waters. Ibid. 11: 63-71.

Doumas, B. T. (1975): Colourimetric determination of total protein in serum or plasma. Clin. Chem., 21(8): 1159-1166.

Edori, O. S. and Konne, J. L. (2015): Biochemical alterations in bay scallops (*placopecten magellanicus*) exposed to crude oil. World Journal of Pharmaceutical Research. 4 (8):2270-2285.

El-Desoky, M. A.; Gad N. S. and Mohammed A. S. (2016): Seasonal variations of antioxidant enzyme activities in *Tilapia zillii* fish caught from Lake Qarun, Int. J. Adv. Res., 4 (8): 216-222.

El-Shebly, A. A. (2002): Seasonal variations of some biochemical parameters in muscles of *Oreochromis niloticus*, reared in Lake Manzalah fish farms. Bull. Nat. Inst. Oceanogr. and Fish. A.R.E., 28: 201-215 .

Folmer, L. C.; Moody, T.; Bonomelli, T. and Gibson, J. (1992): Annual cycle of blood chemistry parameters in striped mullet, *Mugil cephalus* and pinfish, *Lagodon rhomboids*, from Gulf of Mexico. J. Fish. Biol., 41:999-1011.

Frihy, O.E.; Mousa, A.A. and Daniel,J.S. (1994): Abu-Qir Bay, a sediment sink of the northwestern Nile Delta, Egypt. Marine Geology, 121 (3): 199-211.

Gad, N. S. (2003): Effects of dimethoate on some aspects of protein and carbohydrate metabolism in the serum, muscle and liver of Nile Tilapia, *Oreochromis niloticus*. Egypt. J. Aquat. Boil. and Fish., 7 (1): 241-251 .

Geevarghese, C. (1976): Studies on some aspects of the biology of *Glossogobius giuris* with a taxonomic note on six goboid fishes occurring in and around Trivandrum. M. Phil. Dissertation, Univ. Kerala. PP: 1- 90.

Ghanem, M. H. M. (2006): Ecological, physiological and histopathological studies on the grey mullet, *Mugil cephalus*, at different Egyptian lakes. M.Sc. Thesis, Zool. Dept. Fac. Sci., Al-Azhar Univeristy, Egypt., 456 pp .

Ghanem, M. H. M. (2011): Seasonal variations of total proteins, lipids and carbohydrates in cultivated, brackish and salt-water fishes with special references to their nutrient values. Ph.D. Thesis, Zool. Dept. Fac. Sci., Al-Azhar Univeristy, Cairo., 395 pp.

Ghanem, M. H. M. (2014): Effect of heavy metals on some physiological responses in two fishspecies inhabiting Mediterranean Sea Coast; Damietta Governorate, Egypt. Al-Azhar Bull. Of Sci., 25(1):43-56.

Ghanem, M. H. M. (2019): Physiological responses influenced by certain heavy metals at themullet fish, *Mugil cephalus* inhabiting Mediterranean Sea Coast at Damietta Governorate, Egypt. Egypt. Acad. J. Biolog. Sci., 11(3): 97- 108.

Ghazaly, K. S. (1992): A comparative study of trace element accumulation in tissues of the teleost, *Tilapia zilliii*, from contaminated and clean areas. Bull. Nat. Inst. Oceanogr. and Fish. A.R.E., 18: 37-41.

Hassanein, H. M. A. (1991): Biological studies on the effect of some water pollutants (pesticide) on fresh water fish, *Gambusia affinis*. M. Sc. Thesis, Fac. Sci. (Sohag), Assiut Univ. Egypt, 367 pp.

Huss, H. H. (1995): Quality and quality changes in fresh fish. FAO Fisheries Technical Paper No. 348, Food and Agriculture Organization (FAO) of the United Nations, Rome, Italy.

Huss, H. H. (1988): Fresh fish. Quality and quality changes. FAO Fisheries, No. 29.

Jain, K. F. and Singh, C. P. (1987): Monthly variation in the fat content of a Carp, *Labeo gonius* (Ham). Comp. Phvsiol. Ecol., 12(2): 100-102.

Jaya, C. and Saksena, D. N. (2013): Diet composition, feeding intensity, gastrosomatic index and hepatosomatic index of a catfish, *mystus cavasius* from chambal river (near, rajghat) morena, madhya pradesh. International Journal of Recent Scientific Research 4 (9):1350- 1356.

Kandemir, S. and Polat, N. (2007): Seasonal variation of total lipid and total fatty acid in muscle and liver of Rainbow Trout (*Oncorhynchus mykiss* W, 1792) reared in derbent Dam Lake. Turkish Journal of Fisheries and Aquatic Sciences. 7 (1).

Kaur, T. and Saxena, P. K. (2001): Impact of pollution on the flesh of some fishes inhabiting river Satluj waters' a biochemical study, Indian J. Environ. Health, 44 (1): 58-64.

Khalaf-Allah, H. M. M. (2001): Ecological and biological studies on some fishes in Lake Qarun, Egypt. M.Sc. Thesis, Zool. Dept. Fac. Sci., Al-Azhar Univ., Egypt., 331 pp.

Khalaf-Allah, H. M. M. (2009): Biological studies on some Mediterranean Sea fish species with special reference to their feeding habits, growth and reproduction. Ph.D. Thesis, Zool. Dept. Fac. Sci., Al-Azhar Univ., Egypt., 432 pp.

Khan, E. A.; Sinha, M. P.; Saxena, N. and Mehrotra, P. N. (1992): Biochemical effect of cadmium toxicity on a hill stress Teleost Garramullya (sykes) during Egg maturation II. Cholesterol and Glycogen, Pollution Research. 11(3): 163-167.

Kiran, B. R. and Puttaiah, E. T. (2004): Food and feeding habits of *Salmostoma untrahi* from Bhadra Reservoir, Karnataka. Indian J. Fish., 51 (3): 335 – 344.

Knight, J. A.; Anderson, S. and Rawie, J. M. (1972): Chemical basic of the sulfophosphovanillin reaction for estimating total serum lipid. J. Clin. Chem., 18: 199-202.

Kola, R. K.; Mohd, A. and Yalavarthy, P. D. (2015): Effect of triclosan on total protein content in fresh water fish, *channa punctatus*. International Journal of Recent Scientific Research 6 (6):4641-4643.

Love, R. M. (1970): The chemical biology of fishes. Academic Press, London and New York. 1-78.

Mathana, P.; Thiravia Raj, S.; Radha Krishnan Nair, C. and Selvamohan, T. (2012): Seasonal changes in the biochemical composition of four different tissues of red spotted emperor *Lethrinus Lentjan* (Family:Lethrinidae). Annals of Biological Research. 3 (11): 5078-5082.

Mohamed, A. Y. (2019): Effect of certain environmental pollutants on different fish species inhabiting Lake Qarun, Egypt. M. Sc. Thesis, Dept. of Environ. and Bio-Agric., Fac. Of Agric., Al-Azhar Univ., 275pp.

Mohamed, E. F. (1995): Biological and histological studies on family Mugilidae in Lake Qarun to recognize the probabilities of its spawning in the lake. M.Sc. Thesis, Fac. Sci., Cairo University, 320 pp.

Mohamed, M.A. (2006): Chemical studies of the interstitial water of Abu-Qir Bay of Alexandria, (Egypt). M.Sc. Thesis, Chem. Dep., Fac. Of Sci., Al-Azhar University, pp 279.

Oliveira, F.; Erzini, K. and Goncalves, M. S. (2007): Feeding habits of the deep-snouted pipefish, Syngnathus typhle in a temperate coastal lagoon. Estuarine Coastal and Shelf Science. 72: 337-347.

Pfenning, F., Kurth, T.; Meissner, S.; Standke, A.; Hoppe, M.; Zieschang, F.; Raitmayer, C.; Gobel, A.; Kretzschmar, G. and Gutzeit, H. O. (2011): The Social Station of the male nile Tilapia *Oreochromis niloticus* influence on testis structure and gene expresser Reprod., 143: 71-84.

Pilla, S.; Ratnakala M.; Vijaya L. M.; and Sree R. K. (2014): Biochemical compositions in muscle and liver of normal and infected fish of *Lutjanus johni* off Visakhapatnam Coast .Int. J. of Engin. and Sci., 4 (9): 38-42.

Radwan, A.M. (1996): Hydrographic structure and head budget of Abu – Qir Bay. M. Sc. Thesis, Fac. Sci., Alexandria University. 101pp.

Ragab, A. M. (2017): Biological studies on some bony fishes with special reference to their feeding habits and nutritional values. M.Sc. Thesis, Zool. Dept. Fac. Sci., Al-Azhar Univeristy, Egypt., 259 pp .

Ravichandran, S.; Kumaravel, K. and Pamela Florence, E. (2011): Nutritive composition of some edible finfishes, Int. J. of Zool. Res., 7 (3): 241-251.

Remia, K. M.; Logaswamy, S.; Logankumar, K., and Rajmohan, D. (2008): Effect of an insecticide (Monocrotophos) on some biochemical constituents of the fish *Tilapia Mossambica*. Poll. Res., 27 (3): 523-526.

Sabrah, M. M.; Mohamedein, L. I.; El-Sawy, M. A. and Abou El-Naga, E. H. (2016): Biological characteristics in approaching to biochemical and heavy metals of edible fish *Terapon puta*, Cuvier, 1829 from different fishing sites along the Suez Canal, Egypt, J. of Fisheries and Aquatic Sci., 11 (2): 147-162.

Said, M.M. (1979): Effect of oceanographical and meteorological factors on the transport of pollutants in Abu – Qir Bay, M.Sc. Thesis, Fac. Sci., Alexandria Univeristy, pp 95.

Sancho, E.; Ferrando, M. D.; Fernandez, C. and Andreu, E. (1998): Liver energy metabolism of *Anguilla anguilla*, after exposure to fenitrothion. Ecotoxicol. Environ. Saf., 41(2): 168-175.

Shah, S. (2013): Studies on seasonal variation in protein and lipid content of *Schizothorax labiatus* and *Schizothorax plagiostomus*. Ph.D. Thesis, Fac. Sci., department of zoology Faculty of Biological Sciences University of Kashmir, Kashmir, 235 pp.

Shakoori, A. R.; Mughal, A. L. and Iqbal, M. J. (1996): Effects of sublethal doses of fenvalerate (A. synthetic pyrethroid, Aadministered continuously for four weeks) on the blood, liver and muscle of a freshwater fish *Ctenopharyngodon idella*. Bulletin of Environmental Contamination Toxicology. 57:487-494.

Shakweer, L. M. and Abbas, M. M. (2005): Effect of ecological and biological factors on the uptake and concentration of trace elements by aquatic organisms at Lake Edku. Bull. Nat. Inst. Oceanogr. and Fish., 31 (1): 271-288.

Shapiro, J. (1998): Food of the thin-lipped grey mullet (*Liza ramada*) in Lake Kinneret, Israel. Israel J. Aquacul., 50 (1): 3-11.

Shehata, S. M. A. (1994): Food and feeding habits of yellow-tail emperor fish, *Lethrinus mahsena* (Forsskal) (Lethrinidae: Perciformes) Al-Azhar Bull. Sci., 5 (2): 647-663.

Shehata, S. M. A. and Zaki, Z. T. (1994): Food and feeding habits of the bluestripe snapper fish, *Lutjanus kasmira* (Forsskal) (Lutjanidae: Perciformes). Al-Azhar Bull. Sci., 5 (2): 665-681.

Shehata, S. M. A. (1997a): Anatomical and histochemical studies on the oesophagus and stomach of certain teleostean fishes with interference to their adaptational features. Al-Azhar Bull. Sci., 8 (2): 735-767.

Shehata, S. M. A. (1997b): The functional anatomy of the intestine in certain teleostean fishes with special reference to their adaptational features. Al-Azhar Bull. Sci., 8(2): 769-793.

Shehata, S. M.; Ghanem, M. H. and Ragab, A. M. (2017): Effect of some environmental factors on the food and feeding habits of the cichlid fish, *Tilapia zillii*, inhabiting Lake Qarun, Egypt. Egypt. Acad. J. Biol. Sci., 9(1): 55-77.

Singh, N. B. and Sinha, R. N. (1977): Carbohydrates, lipids and protein in the developmental stages of *Sitophilus oryzae* and *Sitophilus granaries*. J. Soc. Am., 70: 107-111.

Sivakami, S.; Ayyappan, S.; Rahman, M. F. and Govind, B. V. (1986): Biochemical composition of *Cyprinus carpio* (Linnaeus) cultured in cage in relation to maturity, Indian J. Fish, 33(2):180-187.

Spataru, P. (1978): Food and feeding habits of *Tilapia zillii* (Gerv.) in Lake Kinneret (Israel). Aquaculture. 14(4): 327-338.

Srivastava, A. K. and Singh, H. (1981): Effect of acute exposure to methyl parathion on carbohydrate metabolism of Indian catfish. Acta. Pharmacol. Toxicol., 48: 26-31.

Tayel, S. I. (2007): Histological and biochemical seasonal changes of *Oreochromis niloticus* muscles in relation to water quality at Zefta and El-Mansoura Cities, Damietta branch River Nile, Egypt. J. Egypt. Acad. Soc. Environ. and Develop., 8 (2): 81-92.

Tulgar, A. and Berik, N. (2012): Effect of Seasonal Changes on Proximate Composition of Red Mullet (*Mullus barbatus*) and Hake (*Merluccius merluccius*) were Catched from Saroz Bay. Res. J. of Biol., 02 (2): 45-50.

Virk S. and Sharma R. C. (1999): Biochemical changes induced by Nickel and Chromium in the liver of *cyprinus carpio* (L). *Pollution Research.* 18(3): 217-222.

Wassef, E. A. and Abdel-Hady, H. A. (1999): Amino acid and fatty acid profiles of peari spotted rabbitfish, *Siganus canaliculatus*, in the muscles. Bull. Nat. Inst. Of Oceanogr. and Fish., A. R. E., 57: 357-370.

Wassef, E. A. and Shehata, M. B. (1991): Biochemical composition of gilthead bream, *Sparus aurata* from Lake Bardawil, Egypt. J. king Abdul Aziz Univ., Mar. Sci., 2: 111-122.

Weatherley, A. H. and Gill, H. S. (1987): Tissue and growth In Biology of Fish Growth. St. Edmundsbury press; Great Britian, 147-173 .

Wheeler, A. C. (1975): The occurrence of the blue whiting in the Southern north Sea. Ann. Mag. Nat. Hist., 8: 155-159.

White, A.; Fletcher, T. C. and Pope, J. A. (1986): Seasonal changes in serum lipid composition of the Plice, *Pleuronectes pltessa* , L. J. Fish Biol., 28(5): 595-606.

Younis, A. E. M. (2005): Speciation of Organotin Compounds in Semi-closed Areas along the Mediterranean Coast of Alexandria. M. Sc. in Chemistry, Faculty of science; Al-Azhar University, Egypt.224pp.

ARABIC SUMMARY

تأثير وفرة الغذاء على بعض العوامل البيوكيميائية فى الأعضاء المستهدفة لأسماك البورى الأصيل القاطنة لخليج أبوقير، محافظة الإسكندرية, مصر.

محمد حامد محمد غانم
قسم علم الحيوان -كلية العلوم (بنين) -جامعة الأزهر

تهدف هذه الدراسة لتقييم المحتوى المعدى والنشاط الغذائى لسمكة البورى الأصيل المجمعة من خليج أبوقير خلال الفترة من يوليو، 2017 إلى يونيو، 2018م وتأثيرها على القيم الغذائية الممثلة فى البروتينات الكلية، الدهون الكلية وكذلك الكربوهيدرات الكلية فى الأعضاء المستهدفة مثل الكلى، الكبد والعضلات من أسماك البورى الأصيل، والذي قد يؤدي بدوره إلى الفهم الصحيح لمدى تأثير توافر الغذاء خلال المواسم المختلفة على وجودة هذه النوعية من الأسماك. وقد استخدمت دلائل عديدة في الوصف المعدي والمحتوى الغذائي بقصد التعرف على أصناف الغذاء، وعادات (سلوك) التغذية والدور الوظيفي لهذه النوعية من الأسماك في السلاسل الغذائية.

أوضحت النتائج إرتفاع معدل النشاط الغذائى لأسماك البورى أثناء فصل الصيف وإنخفاضه أثناء فصل الشتاء. كما أظهرت النتائج أعلى معدل للنشاط الغذائى فى مجاميع الأسماك الكبيرة خلال فصلى الصيف والخريف وأقل معدل فى مجاميع الأسماك الصغيرة خلال فصلى الخريف والشتاء. كما بينت النتائج إرتباط التغير فى النشاط الغذائى بدرجة حرارة المياة وكذلك وفرة الغذاء.

يعتبر التركيب البيوكيميائى للأعضاء المختلفة من الأسماك مؤشر جيد لجودة الأسماك وحالتها الفسيولوجية. كما بينت النتائج أن أدنى قيمة من البروتين الكلى فى كلى وأكباد هذه النوعية من الأسماك قد سجلت فى مجاميع الأسماك الصغيرة خلال فصل الصيف. كما أظهرت النتائج أن محتوى العضلات من البروتين قد تأثر بالعديد من العوامل (نوعية الغذاء، حجم الأسماك وكذلك المواسم المختلفة)، حيث أظهر إنخفاضاً ملحوظاً فى الأسماك الصغيرة أثناء فصل الخريف.

أوضحت النتائج أن أعلى قيمة للدهون الكلية فى كلى وأكباد أسماك البورى قد سجلت فى الأسماك الكبيرة خلال فصل الربيع، بينما سجلت أقل قيمة فى نفس الحجم من الأسماك خلال فصل الصيف. كما بينت الدراسة أن أقل معدل من الدهون الكلية فى عضلات هذه النوعية من الأسماك قد سجل فى الأسماك الصغيرة خلال فصل الصيف وأعلى معدل له قد سجل فى المجاميع كبيرة الحجم خلال فصل الربيع.

أظهرت الدراسة أن أعلى مستوى من الكربوهيدرات الكلية فى كلى أسماك البورى قد سجل خلال فصل الربيع فى الأحجام الكبيرة وأقل مستوى له فى فصل الخريف لنفس الحجم من الأسماك. ومن ناحية أخرى، فقد أوضحت التحاليل تغيرات موسمية فى مستوى الكربوهيدرات الكلية لأكباد الأسماك بزيادة ملحوظة فى الأسماك كبيرة الحجم خلال فصل الخريف، كما أظهرت مجاميع نفس الحجم أقل معدل خلال فصل الربيع. بينما سجل أعلى مستوى للكربوهيدرات فى عضلات الأسماك الصغيرة خلال فصلى الخريف والربيع وأقل مستوى فى عضلات الأسماك الكبيرة خلال فصل الربيع.

وعلى الرغم من وفرة الغذاء فى بعض المواسم بسبب توافر الظروف المثلى لذلك، فقد أظهرت النتائج إنخفاضاً ملحوظاً فى القيم الغذائية للأسماك بسبب العديد من العوامل منها إختلافات جودة المياة بفعل الملوثات المختلفة والتى تؤثر تأثيراً سلبياً على معدل النمو وجودة هذه الأسماك.

أوضحت التحاليل الإحصائية وجود فروق معنوية فى حالة تحليل التباين أحادى الإتجاه بين كلاً من الأعضاء المختلفة وكذلك العوامل البيوكيميائية المختلفة. بينما أظهر عدم وجود فروق معنوية فى حالة التداخل بين قيم العوامل البيوكيميائية فى الأعضاء المختلفة ومجاميع الأحجام.

تعمل مثل هذه الدراسات على زيادة الفهم الصحيح لبعض العوامل البيولوجية مثل معدلات النمو المرتبط بتوافر الغذاء من السلسلة الغذائية، إنتاجية وجودة هذه النوعية من أسماك الدراسة.