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RESEARCH ARTICLE

Evaluation of the Accumulation of Ethidium, Malathion, Trifluralin, Dichlorodiphenyltrichloroethane, and Dichlorodiphenyldichloroethylene in the Muscle of Anzali Wetland Fish

Mina Seifzadeh

National Fish Processing Research Center, Inland Water Aquaculture Institute, Iranian Fisheries Science Research Institute, Agricultural Research, Education and Extension Organization (AREEO), Anzali, Iran

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ABSTRACT

This study aimed to investigate the accumulation and comparison of ethidium, malathion, trifluralin, P, P-dichlorodiphenyltrichloroethane (P-DDT), and P, P-dichlorodiphenyldichloroethylene (P-DDE) in the tissue of Common carp, Common Pike, Crucian carp, Tench, and catfish of the central, western, and eastern wetland of Anzali wetland and comparison with the World Health Organization (WHO). The level of organochlorine pesticides in fish meat was measured by gas chromatography equipped with an electron capture detector and organophosphate toxin with gas chromatography–mass spectrometry. P, P-DDE, P, P, DDT, ethidium, and trifluralin did not show significant differences at the stations west, east, and central ($P > 0.05$). Ethidium, malathion, and trifluralin most were amounts in fish. Ethidium and malathion have no significant differences ($P > 0.05$). Ethidium, malathion, trifluralin, P, P-DDE, and P, P DDT decreased significantly compared to the WHO ($P > 0.05$). The results showed that according to the standards set by the WHO, the accumulation of these toxins in the fish of the Enrolled wetland does not pose a danger to consumers.

Key words: Chemical pesticides, economic fishes, edible muscle, organochlorine pesticides

INTRODUCTION

Population growth and shortage of food, especially high-quality protein, have led to special attention to seafood in the past two decades. Aquatic has long been one of the most important foods in terms of nutritional value (high-quality protein, unsaturated fats, vitamins, and minerals) and medicine. Fish is an important part of the human diet and therefore research in the field of health and hygiene is of particular importance.[1] Anzali Wetland is one of the most valuable natural ecosystems that have economic value in terms of biodiversity, ecotourism, aquaculture, and the location of the main spawning centers and newborns of migratory and economic fish of the Caspian Sea such as perch, whitefish, and wire is important.[2] Unfortunately, population growth, urban development, industry, and agriculture in recent years for various reasons such as increasing and unlimited discharge of industrial and urban effluents and runoff from agricultural activities, brings different compounds of metals that directly or through rivers leading to Wetlands are flooded, and the entry of organochlorine toxins such as dichlorodiphenyltrichloroethane (DDT), diatomaceous earth, and pesticides, including trifluoride nitrogen and organophosphates, such as malathion and ethion, disrupts the natural system of the wetland.[3,4]

Fish and other aquatic animals absorb pesticides from their food as well as from the water that passes through their gills. Absorption of toxins often depends on the

Address for correspondence:
Mina Seifzadeh
E-mail: M_seifzadeh_ld@yahoo.com

amount eaten and the amount of organochlorine and organophosphate toxins in food or hunting. It has been shown that marine areas with high phytoplankton densities, it leads to high concentrations of these toxins in larger and older fish than in areas with lower phytoplankton levels. Accumulation of organochlorine and organophosphate toxins takes a long time, and as a result, large amounts of these toxins accumulate in large fish.[5] Some species of fish, especially predatory species, which usually have a longer lifespan, accumulate higher amounts of toxins in their various translations. The lethal and acute levels of these toxins are usually in the range of 0.1–1 mg/L, depending on the duration of exposure and the chemical properties of the water. These toxins are present in small amounts in natural waters (surface or groundwater) and dissolve in pools after dewatering. One of the potentially harmful properties of toxins is their ability to accumulate in the blood and water flora (bioaccumulation). This property is quantitatively described by the coefficient of accumulation and its values can be hundreds to thousands.[6,7]

For many years, humans have used a variety of chemicals to repel pests. These substances have caused severe and irreparable damage to nature, environmental health, the balance and stability of ecosystems, and the health of living things. Among these, organochlorine pesticides have received more attention due to their carcinogenic effects and the potential for delayed onset of neurotoxicity.[8] Organochlorine toxins that enter the water are insoluble in water and lipophilic. These properties make it easier for microorganisms to enter the body as a result of access to the upper levels of the food chain pyramid and the accumulation of these toxins in aquatic life. In particular, stable organochlorine compounds have a great impact on aquatic health and ecosystem activity, as well as being one of the most important causes of death in aquatic mammals.[9]

Due to the density of different crops, the use of agricultural pesticides, fungicides, and herbicides in farms is very high. Often after use, toxins enter rivers through several ways such as washing farm soils due to rain and leakage of agricultural effluents and wind, resulting in pollution of seawater.[10]

Due to the life cycle of economically valuable fish, these toxins accumulate in the tissues of these fish, and thus the damage that these toxins cause to human communities through the consumption or presence of contaminated fish is not less than the damage directly to the aquatic environment. Therefore, the harms of excessive consumption of these toxins are primarily noticed by humans and various diseases afflict people every day.[11] In particular, organochlorine toxins, which have a long half-life and remain in the environment for several years (e.g., their half-life is 20 years and subsequently accumulate in the body of aquatic organisms. Pesticides affect the nervous system, mainly the brain. Gentle contact causes headaches, confusion, numbness, and weakness of the extremities. Severe contact leads to spasms of all muscles and eventually leads to seizures.[12] These substances are suspected of being carcinogenic. 25% of the pesticide in Iran is used in rice production alone. Due to the high solubility of organochlorine pesticides, the fat intake of these substances is not easily excreted from the body. The transfer of pesticides along the food chain is associated with bioaccumulation and biomagnification. Pesticides have been observed in high concentrations in the body of mammals (including humans). Due to their small chemical interactions, are resistant to oxidation and other degradation processes remain in the environment for a long time.[13] The present study was conducted assuming the possible contamination of economic fish of Anzali wetland with hepatochlorine, chlordane, and endosulfan agricultural pesticides. This study aimed to investigate the accumulation and comparison of hepatochlorine, chlordane, and endosulfan agricultural pesticides in the tissues of common carp (*Cyprinus carpio*), common Pike (*Esox lucius*), crucian carp (*Carassius carassius*), Tench (*Tinca tinca*), and mullets (*Silurus glanis*) of the west, central and east stations from Anzali wetland and their compare with the World Health Organization (WHO).

MATERIALS AND METHODS

For this research, three stations including West (Abkenar), Central (Sarkhan Kol), and East (Shijan) of Bandar Anzali Wetland were considered. The studied fish were 5 species of wetland economic fish including common carp (*C. carpio*), Common

Pike (*E. lucius*), Crucian carp (*C. carassius*), Tench (*T. tinca*), and catfish (*S. glanis*). Organochlorine and phosphorus toxins were measured in these fish and the studied stations of Anzali wetland with three replications in the autumn of 2020. At each station, 15 pieces of studied fish were caught. The accumulation of DDT, DIA, and pesticides including trifluoroaline nitrogen in fish meat was measured by a gas chromatography device equipped with Cape Cher electron detector and malathion and ethion toxins by gas chromatography mass spectrometry (GC-MS) (Alignment GC7890 mass model 5975N) gas chromatography. The amount of 20–30 g of muscle per month (edible tissue) in the freezer dryer model CHRIST-LCG (121550-PMMA, Germany) was dried. Petroleum compounds were extracted from the dried samples during the Soxhlet steps with a Soxhlet device (BehrotestET, Behrlaber-Technick, Germany), soap, and separation. The analyzed samples (dried samples) were inserted into the column by the sample injection system. The components were separated during movement along the column, then the components were washed and detected by a cap-electron detector. Therefore, the device was concentrated with Rotavapor R-114, Buchi, and nitrogen gas.[14] Concentrated fish samples were injected into GC-MS. Then, the concentration of organochlorine and organophosphate toxins was calculated by reference standard (certified reference material) with three replications. Data analysis was performed after averaging, homogenization, and calculation of standard deviation using one-way analysis of variance. Then, TOUKY and DUNKAN tests were used to determine the significance.

RESULTS

According to the WHO, the permissible limit of the P, P-dichlorodiphenyldichloroethylene (P-DDE) toxin in food is 100 μg/g. As shown in Table 1, P, P-DDE toxins in carp of western, eastern, and central stations and also carp of the western station showed a significant difference compared to other studied fish in the sampled stations ($P < 0.05$). This metal did not show significant differences in carp in western, eastern, and central stations ($P > 0.05$). No significant difference was observed in other fish and studied stations ($P > 0.05$). The lowest amount

Table 1: Comparison of P, *P* - DDE toxin results in the edible tissue of economic fish of Anzali wetland (μg/gdw)

Species	Catfish			Tench			Crucian carp			Common Pike			Common carp		
Station	West station	East station	Central station	West station	East station	Central station	West station	East station	Central station	West station	East station	Central station	West station	East station	Central station
1	1.24±0.14^{aA}	1.39±0.76	1.05±0.49^{aA}	1.15±0.48^{aA}	1.19±0.54^{aA}	1.27±0.42^{aA}	2.32±0.39^{aA}	1.21±0.72^{aA}	1.63±0.38^{aA}	1.33±0.34^{aA}	1.25±0.82^{aA}	1.15±0.51^{aA}	2.55±0.95^{aA}	2.17±0.59^{aA}	2.31±0.80^{aA}
2	1.35±0.14^{aA}	1.28±0.71^{aA}	1.09±0.31^{aA}	1.11±0.81^{aA}	1.28±0.51^{aA}	1.32±0.50^{aA}	2.21±0.38^{aA}	1.33±0.83^{aA}	1.60±0.74	1.42±0.30^{aA}	1.08±0.93^{aA}	1.12±0.89^{aA}	2.52±0.86^{aA}	2.49±0.34^{aA}	2.14±0.91^{aA}
3	1.21±0.17^{aA}	1.44±0.16^{aA}	1.11±0.66^{aA}	1.95±0.30^{aA}	1.73±0.47^{aA}	1.35±0.89^{aA}	2.79±0.1^{aA} 3	1.25±0.64^{aA}	1.54±0.66^{aA}	1.51±0.46^{aA}	1.05±0.85^{aA}	1.27±0.83^{aA}	2.38±0.61^{aA}	2.43±0.36^{aA}	2.29±0.99^{aA}
4	1.27±0.34^{aA}	1.49±0.33^{aA}	1.14±0.27^{aA}	1.92±0.33^{aA}	1.89±0.32^{aA}	1.39±0.92^{aA}	2.28±0.23^{aA}	1.78±0.43^{aA}	1.65±0.65^{aA}	1.76±0.57^{aA}	1.11±0.81^{aA}	1.32±0.91^{aA}	2.39±0.31^{aA}	2.47±0.25^{aA}	2.34±0.86^{aA}
5	1.32±0.52^{aA}	1.58±0.24^{aA}	1.25±0.39^{aA}	1.84±0.79^{aA}	1.81±0.46^{aA}	1.41±0.93^{aA}	2.25±0.67^{aA}	1.79±0.39^{aA}	1.84±0.69^{aA}	1.83±0.62^{aA}	1.32±074^{aA}	1.38±0.21^{aA}	2.48±0.60^{aA}	2.54±0.90^{aA}	2.72±0.81^{aA}
6	137±0.41	1.69±0.89^{aA}	1.31±0.53^{aA}	1.73±0.88^{aA}	1.75±0.17^{aA}	1.42±0.88^{aA}	2.39±0.64^{aA}	1.66±0.20^{aA}	1.87±0.80^{aA}	1.53±0.76^{aA}	1.35±0.73^{aA}	1.39±0.11^{aA}	2.63±0.55^{aA}	2.51±0.91^{aA}	2.45±0.93^{aA}
7	1.44±0.19^{aA}	1.78±0.39^{aA}	1.36±0.12^{aA}	1.71±0.87^{aA}	1.39±0.24^{aA}	1.31±0.78^{aA}	2.57±0.22^{aA}	1.58±0.58^{aA}	1.89±0.82^{aA}	1.23±0.88^{aA}	1.24±0.51^{aA}	1.43±0.25^{aA}	2.37±0.43^{aA}	2.63±0.89^{aA}	2.51±0.35^{aA}
8	1.56±0.28^{aA}	1.52±0.34^{aA}	1.47±0.42^{aA}	1.86±0.21^{aA}	1.40±0.30^{aA}	1.20±0.49^{aA}	2.68±0.27^{aA}	1.46±0.63^{aA}	1.94±0.44^{aA}	1.38±0.93^{aA}	1.21±0.49^{aA}	1.48±0.32^{aA}	2.49±0.58^{aA}	2.65±0.71^{aA}	2.56±0.31^{aA}
9	1.54±0.35^{aA}	1.41±0.31^{aA}	1.01±0.48^{aA}	1.85±0.22^{aA}	1.51±0.65^{aA}	1.29±0.55^{aA}	2.73±0.60^{aA}	1.67±0.57^{aA}	1.92±0.23^{aA}	1.43±0.98^{aA}	1.29±0.52^{aA}	1.47±0.36^{aA}	2.51±0.98^{aA}	2.57±0.73^{aA}	2.59±0.90^{aA}
10	1.37±0.27^{aA}	1.53±0.73^{aA}	1.03±0.56^{aA}	1.19±0.23^{aA}	1.55±0.82^{aA}	1.57±0.57^{aA}	2.71±0.68^{aA}	1.69±0.43^{aA}	1.90±0.14^{aA}	1.49±0.22^{aA}	1.25±0.60^{aA}	1.41±0.64^{aA}	2.58±0.91^{aA}	2.68±0.28^{aA}	2.74±0.38^{aA}
11	1.43±0.28^{aA}	1.57±0.72^{aA}	1.09±0.29^{aA}	1.21±0.63^{aA}	1.63±0.86^{aA}	1.25±0.63^{aA}	2.82±0.72^{aA}	1.71±0.36^{aA}	1.85±0.94^{aA}	1.57±0.40^{aA}	1.36±0.71^{aA}	1.33±0.55^{aA}	2.79±0.59^{aA}	2.51±0.19^{aA}	2.46±0.24^{aA}
12	1.25±0.45^{aA}	1.50±0.64^{aA}	1.12±0.52^{aA}	1.35±0.71^{aA}	1.95±0.85^{aA}	1.21±0.68^{aA}	2.84±0.69^{aA}	1.38±0.35^{aA}	1.82±0.89^{aA}	1.64±0.43^{aA}	1.45±0.72^{aA}	1.56±0.58^{aA}	2.83±0.38^{aA}	2.32±0.24^{aA}	2.79±0.71^{aA}
13	1.21±0.23	1.56±0.42^{aA}	1.17±0.47^{aA}	1.50±0.36^{aA}	1.99±0.73^{aA}	1.28±0.64^{aA}	2.87±0.57^{aA}	1.49±0.29^{aA}	1.76±0.87^{aA}	1.95±0.56^{aA}	1.55±0.67^{aA}	1.67±0.41^{aA}	2.81±0.46^{aA}	2.95±0.17^{aA}	2.80±0.25^{aA}
14	1.29±0.12^{aA}	1.40±0.62^{aA}	1.23±0.26^{aA}	1.55±0.64^{aA}	1.94±0.37^{aA}	1.43±0.54^{aA}	2.73±0.49^{aA}	1.51±0.13^{aA}	1.88±0.64^{aA}	1.93±0.27^{aA}	1.32±0.53^{aA}	1.69±0.52^{aA}	2.95±0.44^{aA}	2.73±0.35^{aA}	2.81±0.46^{aA}
15	1.49±0.32^{aA}	1.71±0.64^{aA}	1.37±0.11^{aA}	1.81±0.51^{aA}	187±0.16^{aA}	1.46±0.49^{aA}	2.70±0.43^{aA}	1.53±0.25^{aA}	1.82±0.45^{aA}	1.73±0.29	1.30±0.34^{aA}	1.72±0.57^{aA}	2.90±0.57^{aA}	2.52±0.30^{aA}	2.97±0.77^{aA}

The different signs in the same column indicate significant differences ($P<0.05$).

of this metal was observed in Central Station catfish and East Station Common Pike and the highest amount of this metal was observed in East Station carp. The amount of this metal in fish and studied stations showed a significant decrease compared to the WHO ($P < 0.05$). The results obtained were lower than the standard.

According to the WHO, the permissible limit of the P, P DDT toxin in food is 100 µg/g. Based on Table 2, the amount of P, P DDT toxin was the highest in East Station catfish and the lowest in the common Pike of East Station. This toxin did not show a significant difference in fish and studied stations ($P > 0.05$). Measured data had a significant decrease compared to the WHO standard ($P < 0.05$). The results obtained were lower than the standard.

Based on the WHO, the permissible limit of the Malathion toxin in food is 300 µg/g. According to the Table 3, the amount of malathion toxin was the highest in Central Station catfish and the lowest in West Station carp. The amount of this toxin did not show a significant difference in catfish, sludge, and Common Pike of western, eastern, and central stations. This toxin showed a significant increase in central station carp compared to western and eastern station carp ($P < 0.05$). Furthermore, in carp, the eastern station showed a significant increase compared to the central station ($P < 0.05$). The overall measured results were significantly lower than the WHO standard ($P < 0.05$) and lower than the standard.

According to the WHO, the permissible limit of the trifluralin toxin in food is 100 µg/g. According to Table 4, the amount of trifluorine toxin in the studied fish in the western, eastern, and central stations did not show a significant difference ($P > 0.05$). It was highest in East Station catfish and lowest in West Station carp and Crucian carp common and Central Station Common Pike. The overall measured results were significantly lower than the WHO standard ($P < 0.05$) and lower than the standard.

According to the WHO, the permissible limit of the ethion toxin in food is 300 µg/g. According to the Table 5, the amount of ethion toxin was the highest in East Station catfish and common carp and the lowest in West Station Tench and East Station Common Pike. The amount of this toxin in the studied fish of western, eastern, and central stations did not show a significant difference ($P > 0.05$). The

Table 2: Comparison of P, P DDT toxin results in the edible tissue of economic fish of Anzali wetland (µg/gdw)

Species	Catfish			Tench			Crucian carp			Common Pike			Common carp		
Station	West station	East station	Central station	West station	East station	Central station	West station	East station	Central station	West station	East station	Central station	West station	East station	Central station
1	1.12±0.76^{aA}	1.45±0.56^{aA}	1.00±0.39^{aA}	1.05±0.82^{aA}	1.35±0.91^{aA}	1.25±0.82^{aA}	1.19±0.79^{aA}	1.15±0.81^{aA}	1.28±0.93^{aA}	1.34±0.72^{aA}	0.95±0.74^{aA}	1.29±0.71^{aA}	1.05±0.89^{aA}	1.25±0.88^{aA}	1.25±0.72^{aA}
2	1.51±0.31^{aA}	1.67±0.53^{aA}	1.41±0.51^{aA}	1.80±0.49^{aA}	1.88±0.18^{aA}	1.45±0.48^{aA}	2.19±0.28^{aA}	1.59±0.21^{aA}	1.93±0.24^{aA}	1.82±0.47^{aA}	1.37±0.33^{aA}	1.79±0.61^{aA}	2.84±0.34^{aA}	2.50±0.31^{aA}	2.84±0.81^{aA}
3	1.53±0.38^{aA}	1.39±0.26^{aA}	1.32±0.24^{aA}	1.89±0.3 8	1.86±0.29^{aA}	1.44±0.52^{aA}	2.38±0.19^{aA}	1.61±0.23^{aA}	1.52±0.81^{aA}	1.70±0.48^{aA}	1.42±0.28^{aA}	1.80±0.66^{aA}	2.82±0.30^{aA}	2.49±0.34^{aA}	2.33±0.69^{aA}
4	1.59±0.25^{aA}	1.57±0.37^{aA}	1.27±0.32^{aA}	1.25±0.28^{aA}	1.90±0.25^{aA}	1.59±0.32^{aA}	2.13±0.30^{aA}	1.60±0.33^{aA}	1.51±0.80^{aA}	1.65±0.50^{aA}	1.49±0.71^{aA}	1.83±0.50^{aA}	2.92±0.94^{aA}	2.58±0.89^{aA}	2.70±0.52^{aA}
5	1.42±0.22^{aA}	1.57±0.95^{aA}	1.13±0.83^{aA}	1.38±0.18^{aA}	1.77±0.86^{aA}	1.50±0.31^{aA}	2.98±0.31^{aA}	1.78±0.63^{aA}	1.64±0.84^{aA}	1.63±0.37^{aA}	1.51±0.78^{aA}	1.82±0.49^{aA}	2.45±0.85^{aA}	2.59±0.81^{aA}	2.53±0.49^{aA}
6	1.31±0.26^{aA}	1.62±0.23^{aA}	1.38±0.91^{aA}	1.46±0.41^{aA}	1.65±0.69^{aA}	1.53±0.40^{aA}	2.99±0.37^{aA}	1.76±0.71^{aA}	1.64±0.84^{aA}	1.41±0.50^{aA}	1.58±0.84^{aA}	1.89±0.74^{aA}	2.26±0.71^{aA}	2.65±0.37^{aA}	2.37±0.99^{aA}
7	1.84±0.43^{aA}	1.31±0.15^{aA}	1.22±0.31^{aA}	1.86±0.23^{aA}	1.41±0.32^{aA}	1.17±0.50^{aA}	2.21±0.49^{aA}	1.28±0.13^{aA}	1.37±0.24^{aA}	1.55±0.31^{aA}	1.45±0.61^{aA}	1.16±0.35^{aA}	2.35±0.70^{aA}	2.49±0.21^{aA}	2.27±0.55^{aA}
8	1.63±0.32^{aA}	1.65±0.36^{aA}	1.34±0.25^{aA}	1.46±0.31^{aA}	1.57±0.15^{aA}	1.26±0.62^{aA}	2.29±0.44^{aA}	1.38±0.59^{aA}	1.57±0.34^{aA}	1.69±0.35^{aA}	1.01±0.83^{aA}	1.12±0.48^{aA}	2.39±0.75^{aA}	2.40±0.19^{aA}	2.21±0.25^{aA}
9	1.79±0.41^{aA}	1.69±0.75^{aA}	1.56±0.76^{aA}	1.97±0.38^{aA}	1.65±0.25^{aA}	1.34±0.72^{aA}	2.19±0.47^{aA}	1.44±0.31^{aA}	1.58±0.89^{aA}	1.72±0.46^{aA}	1.09±0.74^{aA}	1.17±0.52^{aA}	2.31±0.76^{aA}	2.15±0.37^{aA}	2.20±0.53^{aA}
10	1.74±0.45^{aA}	1.73±0.91^{aA}	1.55±0.78^{aA}	1.84±0.49^{aA}	1.27±0.93^{aA}	1.30±0.11^{aA}	2.38±0.12^{aA}	1.47±0.53^{aA}	1.90±0.85^{aA}	1.83±0.70^{aA}	1.15±0.68^{aA}	1.18±0.47^{aA}	2.30±0.88^{aA}	2.35±0.26^{aA}	2.19±0.56^{aA}
11	1.93±0.11^{aA}	1.68±0.73^{aA}	1.47±0.73^{aA}	1.81±0.55^{aA}	1.35±0.54^{aA}	1.61±0.21^{aA}	2.37±0.22^{aA}	1.48±0.75^{aA}	1.94±0.81^{aA}	1.46±0.66^{aA}	1.13±0.72^{aA}	1.21±0.36^{aA}	2.33±0.90^{aA}	2.24±0.17^{aA}	2.14±0.47^{aA}
12	1.48±0.13^{aA}	1.70±0.26^{aA}	1.61±0.76^{aA}	1.91±0.82^{aA}	1.21±0.68^{aA}	1.60±0.31^{aA}	2.25±0.39^{aA}	1.23±0.33^{aA}	1.58±0.74^{aA}	1.33±0.26^{aA}	1.28±0.90^{aA}	1.11±0.24^{aA}	2.37±0.91^{aA}	2.44±0.36^{aA}	2.34±0.34^{aA}
13	1.39±0.51^{aA}	1.88±0.55^{aA}	1.52±0.85^{aA}	1.28±0.73^{aA}	1.36±0.37^{aA}	1.52±0.36^{aA}	2.28±0.38^{aA}	1.37±0.63^{aA}	1.44±0.70^{aA}	1.23±0.75^{aA}	1.25±0.95^{aA}	1.13±0.27^{aA}	2.45±0.29^{aA}	2.47±0.27^{aA}	2.36±0.33^{aA}
14	1.47±0.46^{aA}	1.94±0.72^{aA}	1.35±0.82^{aA}	1.21±0.88^{aA}	1.80±0.27^{aA}	1.74±0.29^{aA}	2.20±0.49^{aA}	1.56±0.76^{aA}	1.21±0.83	1.10±0.88^{aA}	1.08±0.87^{aA}	1.21±0.31^{aA}	2.44±0.58^{aA}	2.75±0.82^{aA}	2.48±0.15^{aA}
15	1.82±0.41^{aA}	1.97±0.77^{aA}	1.39±0.91^{aA}	1.78±0.98^{aA}	1.90±0.20^{aA}	1.76±0.11^{aA}	2.22±0.29^{aA}	1.58±0.70^{aA}	1.24±0.71^{aA}	1.12±0.22^{aA}	1.11±0.82^{aA}	1.29±0.59^{aA}	2.48±0.37^{aA}	2.85±0.80^{aA}	2.54±0.85^{aA}

The different signs in the same column indicate significant differences ($P<0.05$).

Table 3: Comparison of the results of Malathion toxin in the edible tissue of economic fish of Anzali wetland (μg/gdw)

Species	Catfish			Tench			Crucian carp			Common Pike			Common carp		
Station	West station	East station	Central station	West station	East station	Central station7	West station	East station	Central station	West station	East station	Central station	West station	East station	Central station
1	20.55±0.35^{aA}	20.95±0.76^{aA}	21.05±1.93^{aA}	20.15±0.57^{aA}	20.45±0.50^{aA}	20.49±0.73^{aA}	20.17±1.15^{aA}	20.05±0.1.17^{aA}	21.00±0.82^{aA}	19.45±0.24^{aA}	20.00±0.97^{aA}	20.05±0.52^{aA}	19.80±0.96^{aA}	20.15±0.89^{aA}	19.11±0.48^{aA}
2	20.26±0.13^{aA}	20.39±0.66^{aA}	21.37±0.91^{aA}	20.19±0.49^{aA}	20.33±0.56^{aA}	2016±0.55^{aA}	20.29±0.39^{aA}	20.12±0.73^{aA}	21.14±0.84^{aA}	19.13±0.35^{aA}	20.15±0.52^{aA}	20.19±0.51^{aA}	19.85±0.92^{aA}	20.92±0.18^{aA}	19.21±0.68^{aA}
3	20.29±0.17^{aA}	20.38±0.77^{aA}	21.35±0.92^{aA}	21.16±0.43^{aA}	20.54±0.57^{aA}	20.78±0.59^{aA}	20.47±0.51^{aA}	20.11±0.16^{aA}	21.16±0.32^{aA}	19.37±0.39^{aA}	20.22±0.90^{aA}	20.11±0.71^{aA}	19.80±0.35^{aA}	20.83±0.36^{aA}	19.30±0.69^{aA}
4	20.34±0.24^{aA}	20.46±0.68^{aA}	21.94±0.73^{aA}	21.13±0.47^{aA}	20.36±0.90^{aA}	20.82±0.71^{aA}	20.21±0.48^{aA}	20.19±0.23^{aA}	21.31±0.37^{aA}	19.23±0.26^{aA}	20.27±0.98^{aA}	20.09±0.51^{aA}	19.37±0.22^{aA}	20.71±0.72^{aA}	19.45±0.31^{aA}
5	20.63±0.16^{aA}	20.73±0.39^{aA}	21.75±0.83^{aA}	21.36±0.51^{aA}	20.54±0.73^{aA}	20.54±0.81^{aA}	20.13±0.53^{aA}	20.33±0.30^{aA}	21.59±0.44^{aA}	19.37±0.15^{aA}	20.25±0.79^{aA}	20.11±0.91^{aA}	19.81±0.17^{aA}	20.64±0.21^{aA}	19.47±0.49^{aA}
6	20.72±0.49^{aA}	201.7±0.80^{aA}	21.15±0.84^{aA}	21.27±0.40^{aA}	20.19±0.24^{aA}	20.92±0.62^{aA}	20.14±0.74^{aA}	20.42±0.98^{aA}	21.34±0.51^{aA}	19.53±0.21^{aA}	20.11±0.65^{aA}	20.17±0.76^{aA}	19.73±0.47^{aA}	20.68±0.49^{aA}	19.49±0.21^{aA}
7	20.25±0.57^{aA}	20.54±0.85	21.76±0.87^{aA}	21.25±0.52^{aA}	20.53±0.67^{aA}	20.87±0.33^{aA}	20.37±0.67^{aA}	20.46±0.80^{aA}	21.74±0.57^{aA}	19.61±0.23^{aA}	20.81±0.41^{aA}	20.07±0.36^{aA}	19.18±0.81^{aA}	20.15±0.24^{aA}	19.51±0.23^{aA}
8	20.36±0.43	20.18±0.92^{aA}	21.99±0.90^{aA}	20.98±0.35^{aA}	20.49±0.59^{aA}	20.85±0.71^{aA}	20.55±0.64^{aA}	20.51±0.61^{aA}	21.22±0.66^{aA}	19.65±0.40^{aA}	20.86±0.46^{aA}	20.03±0.34^{aA}	19.28±0.36^{aA}	20.76±0.88^{aA}	19.66±0.36^{aA}
9	20.39±0.78^{aA}	20.99±0.94^{aA}	21.47±0.81^{aA}	20.86±0.93^{aA}	20.21±0.39^{aA}	20.56±0.34^{aA}	20.62±0.59^{aA}	20.78±0.32^{aA}	21.75±0.92^{aA}	19.27±0.50^{aA}	20.35±0.34^{aA}	20.21±0.39^{aA}	19.44±0.26^{aA}	20.35±0.37^{aA}	19.14±0.77^{aA}
10	20.41±0.94	20.94±0.83	21.77±0.71^{aA}	20.75±0.84^{aA}	20.28±0.42^{aA}	20.24±0.32^{aA}	20.71±0.71^{aA}	20.77±0.29^{aA}	21.68±0.90^{aA}	19.29±0.75^{aA}	20.24±0.37^{aA}	20.26±0.48^{aA}	19.71±0.19^{aA}	20.15±0.19^{aA}	19.29±0.80^{aA}
11	20.52±0.85	20.56±0.79	21.65±0.43^{aA}	20.83±0.73^{aA}	20.37±0.81^{aA}	20.69±0.11^{aA}	20.54±0.70^{aA}	20.39±0.21^{aA}	21.62±0.91^{aA}	19.38±0.69^{aA}	20.18±0.68^{aA}	20.32±0.58^{aA}	19.78±0.33^{aA}	20.67±0.73^{aA}	19.33±0.57^{aA}
12	20.67±0.93	20.74±0.78	21.25±0.73^{aA}	20.91±0.27^{aA}	20.53±0.74^{aA}	20.58±0.30^{aA}	20.37±0.81^{aA}	20.35±0.18^{aA}	21.79±0.81^{aA}	19.72±0.70^{aA}	20.16±0.77^{aA}	20.48±0.67^{aA}	19.65±0.29^{aA}	20.33±0.20^{aA}	19.54±0.42^{aA}
13	20.28±0.81	20.86±0.49	21.13±0.62^{aA}	21.11±0.15^{aA}	20.55±0.69^{aA}	20.18±0.38^{aA}	20.28±0.85^{aA}	20.76±0.95^{aA}	21.80±0.86^{aA}	19.84±0.74^{aA}	20.91±0.44^{aA}	20.22±0.74^{aA}	19.63±0.15^{aA}	20.21±0.26^{aA}	19.37±0.39^{aA}
14	20.44±0.72	20.91±0.55	21.61±0.59^{aA}	20.87±0.91^{aA}	20.19±0.66^{aA}	20.94±0.42^{aA}	20.25±0.90^{aA}	20.79±0.85^{aA}	21.88±0.72^{aA}	19.28±0.82^{aA}	20.99±0.31^{aA}	20.60±0.78^{aA}	19.68±0.83^{aA}	20.89±0.39^{aA}	19.41±0.53^{aA}
15	20.64±0.90	20.89±0.36	21.66±0.54^{aA}	20.65±0.56^{aA}	20.35±0.17^{aA}	20.89±0.51^{aA}	20.31±0.98^{aA}	20.81±0.33^{aA}	21.47±0.81^{aA}	19.43±0.61^{aA}	20.88±0.62^{aA}	20.08±0.38^{aA}	19.53±0.91^{aA}	20.39±0.97^{aA}	19.52±0.41

The different signs in the same column indicate significant differences 7 ($P<0.05$)

Table 4: Comparison of Trifluralin toxin results in the edible tissue of economic fish of Anzali wetland (μg/gdw)

Species	Catfish			Tench			Crucian carp			Common Pike			Common carp		
Station	West station	East station	Central station	West station	East station	Central station	West station	East station	Central station	West station	East station	Central station	West station	East station	Central station
1	10.15±0.38^{aA}	10.42±0.97^{aA}	10.35±0.46^{aA}	10.27±0.31^{aA}	10.49±0.15^{aA}	10.25±0.90^{aA}	10.18±0.52^{aA}	10.12±0.37^{aA}	10.14±0.81^{aA}	10.26±0.39^{aA}	10.25±0.93^{aA}	10.13±0.84^{aA}	10.19±0.42^{aA}	10.21±0.64^{aA}	10.25±0.71^{aA}
2	10.22±0.36^{aA}	10.40±0.17^{aA}	10.31±0.45^{aA}	10.34±0.59^{aA}	10.45±0.46^{aA}	10.21±0.30^{aA}	10.26±0.50^{aA}	10.11±0.26	10.13±0.79^{aA}	10.25±0.31^{aA}	10.21±0.95^{aA}	10.17±0.73^{aA}	10.18±0.98^{aA}	10.31±0.79^{aA}	10.16±0.78^{aA}
3	10.25±0.38^{aA}	10.42±0.76^{aA}	10.33±0.46^{aA}	10.29±0.80^{aA}	10.41±0.58^{aA}	10.31±0.78^{aA}	10.49±0.33^{aA}	10.26±0.39^{aA}	10.19±0.67^{aA}	10.34±0.38^{aA}	10.27±0.83^{aA}	10.23±0.85^{aA}	10.11±0.83^{aA}	10.32±0.81^{aA}	10.12±0.40^{aA}
4	10.17±0.45^{aA}	10.44±0.89^{aA}	10.45±0.49^{aA}	10.36±0.79^{aA}	10.39±0.35^{aA}	10.28±0.61^{aA}	10.43±0.67^{aA}	10.16±0.31^{aA}	10.17±0.71^{aA}	10.19±0.59^{aA}	10.26±0.13^{aA}	10.31±0.37^{aA}	10.39±0.92^{aA}	10.22±0.78^{aA}	10.15±0.58^{aA}
5	10.19±0.49^{aA}	10.52±0.81^{aA}	10.39±0.75^{aA}	10.43±0.53^{aA}	10.48±0.76^{aA}	10.55±0.62^{aA}	10.23±0.73^{aA}	10.22±0.57^{aA}	10.24±0.93^{aA}	10.27±0.69^{aA}	10.20±0.43^{aA}	10.47±0.24^{aA}	10.12±0.89^{aA}	10.29±0.59^{aA}	10.21±0.99^{aA}
6	10.21±0.52^{aA}	10.63±0.95^{aA}	10.30±0.76^{aA}	10.45±0.51^{aA}	10.40±0.99^{aA}	10.62±0.73^{aA}	10.37±0.72^{aA}	10.29±0.27^{aA}	10.32±0.38^{aA}	10.28±0.67^{aA}	10.27±0.12^{aA}	10.39±0.96^{aA}	10.17±0.66^{aA}	10.32±0.61^{aA}	10.36±0.91^{aA}
7	10.32±0.53^{aA}	10.47±0.90^{aA}	10.46±0.88^{aA}	10.17±0.62^{aA}	10.52±0.65^{aA}	10.67±0.70^{aA}	10.29±0.36^{aA}	10.33±0.70^{aA}	10.18±0.42^{aA}	10.36±0.73^{aA}	10.35±0.33^{aA}	10.45±0.88^{aA}	10.21±0.58^{aA}	10.19±0.67^{aA}	10.24±0.59^{aA}
8	10.34±0.39^{aA}	10.49±0.99^{aA}	10.51±0.16^{aA}	10.30±0.68^{aA}	10.61±0.63^{aA}	10.15±0.71^{aA}	10.22±0.93^{aA}	10.47±0.50^{aA}	10.23±0.49^{aA}	10.24±0.19^{aA}	10.43±0.73^{aA}	10.48±0.74^{aA}	10.35±0.49^{aA}	10.36±0.84^{aA}	10.18±0.61^{aA}
9	10.11±0.47^{aA}	10.54±0.24^{aA}	10.45±0.39^{aA}	10.12±0.72^{aA}	10.57±0.41^{aA}	10.46±0.43^{aA}	10.51±0.53^{aA}	10.24±0.51^{aA}	10.34±0.50^{aA}	10.21±0.50^{aA}	10.59±0.28^{aA}	10.56±0.99^{aA}	10.38±0.35^{aA}	10.18±0.89^{aA}	10.27±0.67^{aA}
10	10.26±0.45^{aA}	10.32±0.37^{aA}	10.53±0.27^{aA}	10.39±0.74^{aA}	10.55±0.32^{aA}	10.73±0.25^{aA}	10.64±0.71^{aA}	10.37±0.40^{aA}	10.16±0.31^{aA}	10.31±0.52^{aA}	10.66±0.36^{aA}	10.67±0.59^{aA}	10.24±0.68^{aA}	10.20±0.69^{aA}	10.33±0.73^{aA}
11	10.29±0.40^{aA}	10.44±0.65^{aA}	10.49±0.71^{aA}	10.31±0.79^{aA}	10.19±0.81^{aA}	10.62±0.31^{aA}	10.66±0.78^{aA}	10.35±0.43^{aA}	10.28±0.52^{aA}	10.30±0.79^{aA}	10.69±0.42^{aA}	10.53±0.34^{aA}	10.31±0.74^{aA}	10.15±0.32^{aA}	10.40±0.88^{aA}
12	10.31±0.41^{aA}	10.43±0.77^{aA}	10.38±0.78^{aA}	10.46±0.80^{aA}	10.59±0.89^{aA}	10.45±0.87^{aA}	10.78±0.39^{aA}	10.19±0.40^{aA}	10.29±0.73^{aA}	10.35±0.88^{aA}	10.71±0.90^{aA}	10.58±0.72^{aA}	10.36±0.93^{aA}	10.37±0.14^{aA}	10.37±0.34^{aA}
13	10.43±0.47^{aA}	10.41±0.87^{aA}	10.32±0.86^{aA}	10.22±0.92^{aA}	10.63±0.95^{aA}	10.39±0.89^{aA}	10.98±0.88^{aA}	10.29±0.76^{aA}	10.33±0.83^{aA}	10.47±0.37^{aA}	10.15±0.85^{aA}	10.43±0.91^{aA}	10.37±0.82^{aA}	10.25±0.63^{aA}	10.32±0.89^{aA}
14	10.55±0.54^{aA}	10.39±0.92^{aA}	10.41±0.91^{aA}	10.23±0.81^{aA}	10.60±0.97^{aA}	10.56±0.93^{aA}	10.68±0.87^{aA}	10.31±0.44^{aA}	10.40±0.96^{aA}	10.37±0.92^{aA}	10.18±0.83^{aA}	10.52±0.58^{aA}	10.49±0.76^{aA}	10.16±0.74^{aA}	10.28±0.77^{aA}
15	10.18±0.23^{aA}	10.35±0.91^{aA}	10.37±0.99^{aA}	1.15±0.18^{aA}	10.46±0.77^{aA}	10.34±0.92^{aA}	10.40±0.29^{aA}	10.36±0.39^{aA}	10.39±0.95^{aA}	10.22±0.19^{aA}	10.19±0.98^{aA}	10.49±0.97^{aA}	10.27±0.45^{aA}	10.12±0.71^{aA}	10.29±0.70^{aA}

The different signs in the same column indicate significant differences ($P<0.05$).

Table 5: Comparison of the results of Ethion toxin in the edible tissue of economic fish of Anzali wetland (µg/gdw)

Species	Catfish			Tench			Crucial carp			Common Pike			Common carp		
Station	West station	East station	Central station	West station	East station	Central station	West station	East station	Central station	West station	East station	Central station	West station	East station	Central station
1	20.15±0.25^{aA}	20.38±0.67^{aA}	20.23±0.19^{aA}	20.05±0.98^{aA}	20.27±0.75^{aA}	20.24±0.19^{aA}	20.19±0.59^{aA}	20.15±0.27^{aA}	20.21±0.13^{aA}	10.12±0.89^{aA}	20.05±0.45^{aA}	20.16±0.99^{aA}	20.15±0.53^{aA}	20.39±0.74^{aA}	20.05±0.66^{aA}
2	20.24±0.14^{aA}	20.53±0.61^{aA}	20.21±0.76^{aA}	20.01±0.96^{aA}	20.23±0.77^{aA}	20.34±0.98^{aA}	20.29±0.69^{aA}	20.18±0.76^{aA}	20.28±0.23^{aA}	10.15±0.81^{aA}	20.01±0.41^{aA}	20.11±0.88^{aA}	20.12±0.51^{aA}	20.34±0.72^{aA}	20.01±0.67^{aA}
3	20.36±0.89^{aA}	20.39±0.60^{aA}	20.19±0.81^{aA}	20.15±0.91^{aA}	20.21±0.62^{aA}	20.27±0.81^{aA}	20.18±0.41^{aA}	20.32±0.78^{aA}	20.31±0.38^{aA}	10.13±0.88^{aA}	20.09±0.80^{aA}	20.17±0.92^{aA}	20.14±0.57^{aA}	20.31±0.64^{aA}	20.04±0.54^{aA}
4	20.27±0.34^{aA}	20.41±0.64^{aA}	20.66±0.72^{aA}	20.11±0.99^{aA}	20.22±0.79^{aA}	20.16±0.72^{aA}	20.42±0.57^{aA}	20.98±0.79^{aA}	20.39±0.43^{aA}	10.19±0.79^{aA}	20.06±0.81^{aA}	20.26±0.53^{aA}	20.16±0.63^{aA}	20.29±0.54^{aA}	20.09±0.71^{aA}
5	20.38±0.17^{aA}	20.78±0.79^{aA}	20.57±0.85^{aA}	20.08±0.64^{aA}	20.29±0.43^{aA}	20.25±0.83^{aA}	20.29±0.63^{aA}	20.17±0.83^{aA}	20.41±0.47^{aA}	10.18±0.33^{aA}	20.11±0.79^{aA}	20.31±0.77^{aA}	20.17±0.73^{aA}	20.48±0.97^{aA}	20.07±0.82^{aA}
6	20.52±0.94^{aA}	20.35±0.78^{aA}	20.66±0.71^{aA}	20.13±0.18^{aA}	20.18±0.76^{aA}	20.44±0.77^{aA}	20.29±0.32^{aA}	20.49±0.76^{aA}	20.38±0.53^{aA}	10.21±0.48^{aA}	20.15±0.73^{aA}	20.13±0.89^{aA}	20.18±0.83^{aA}	20.30±0.99^{aA}	20.08±0.84^{aA}
7	20.32±0.28^{aA}	20.31±0.63^{aA}	20.34±0.65^{aA}	20.06±0.29^{aA}	20.20±0.85^{aA}	20.35±0.92^{aA}	20.29±0.49^{aA}	20.14±0.67^{aA}	20.22±0.59^{aA}	10.17±0.59^{aA}	20.08±0.67^{aA}	20.12±0.69^{aA}	20.22±0.77^{aA}	20.42±0.91^{aA}	20.03±0.76^{aA}
8	20.67±0.43^{aA}	20.12±0.57^{aA}	20.75±0.82^{aA}	20.17±0.33^{aA}	20.29±0.83^{aA}	20.17±0.47^{aA}	20.29±0.57^{aA}	20.76±0.65^{aA}	20.27±0.41^{aA}	10.11±0.57^{aA}	20.02±0.52^{aA}	20.19±0.90^{aA}	20.19±0.79^{aA}	20.59±0.96^{aA}	20.01±0.59^{aA}
9	20.27±0.95^{aA}	20.18±0.42^{aA}	20.62±0.93^{aA}	20.14±0.97^{aA}	20.31±0.81^{aA}	20.89±0.52^{aA}	20.29±0.89^{aA}	20.13±0.59^{aA}	20.36±0.50^{aA}	10.25±0.31^{aA}	20.13±0.57^{aA}	20.24±0.59^{aA}	20.25±0.81^{aA}	20.36±0.84^{aA}	20.15±0.52^{aA}
10	20.59±0.46^{aA}	20.78±0.61^{aA}	20.13±0.95^{aA}	20.07±0.90^{aA}	20.17±0.91^{aA}	20.31±0.84^{aA}	20.29±0.79^{aA}	20.25±0.51^{aA}	20.15±0.73^{aA}	10.24±0.73^{aA}	20.16±0.55^{aA}	20.21±0.91^{aA}	20.29±0.70^{aA}	20.37±0.63^{aA}	20.17±0.68^{aA}
11	20.16±0.37^{aA}	20.63±0.97^{aA}	20.36±0.67^{aA}	20.09±0.88^{aA}	20.19±0.72^{aA}	20.18±0.89^{aA}	20.29±0.94^{aA}	20.23±0.62^{aA}	20.25±0.84^{aA}	10.22±0.87^{aA}	20.12±0.48^{aA}	20.18±0.92^{aA}	20.23±0.69^{aA}	20.44±0.53^{aA}	20.11±072^{aA}
12	20.56±0.29^{aA}	20.51±0.99^{aA}	20.25±0.49^{aA}	20.12±0.41^{aA}	20.26±0.55^{aA}	20.21±0.97^{aA}	20.29±0.99^{aA}	20.36±0.49^{aA}	20.17±0.98^{aA}	10.39±0.92^{aA}	20.04±0.95^{aA}	20.14±0.58^{aA}	20.35±0.67^{aA}	20.47±0.87^{aA}	20.10±0.83^{aA}
13	20.69±0.74^{aA}	20.49±0.59^{aA}	20.44±0.56^{aA}	20.18±0.48^{aA}	20.46±0.49^{aA}	20.36±0.43^{aA}	20.29±0.33^{aA}	20.26±0.88^{aA}	20.32±0.32^{aA}	10.33±0.82^{aA}	20.18±0.35^{aA}	20.15±0.68^{aA}	20.28±0.62^{aA}	20.35±0.59^{aA}	20.21±0.51^{aA}
14	20.71±0.85^{aA}	20.27±0.70^{aA}	20.49±0.88^{aA}	20.02±0.39^{aA}	20.37±0.37^{aA}	20.29±0.96^{aA}	20.29±0.38^{aA}	20.34±0.81^{aA}	20.11±0.49^{aA}	10.16±0.72^{aA}	20.15±0.40^{aA}	20.23±0.77^{aA}	20.24±0.85^{aA}	20.28±0.66^{aA}	20.12±0.49^{aA}
15	20.82±0.21^{aA}	20.73±0.67^{aA}	20.76±0.90^{aA}	20.03±0.52^{aA}	20.32±0.95^{aA}	20.23±0.39^{aA}	20.29±0.45^{aA}	20.21±0.82^{aA}	20.19±0.38^{aA}	10.24±0.63^{aA}	20.22±0.48^{aA}	20.26±0.52^{aA}	20.26±0.91^{aA}	20.50±0.75^{aA}	20.02±0.60^{aA}

The different signs in the same columns indicate significant differences ($P<0.05$)

overall measured results were significantly lower than the WHO standard ($P < 0.05$) and lower than the standard.

DISCUSSION

Fish is one of the most important foods in the world, especially for people who live by the sea. To benefit from the health benefits, nutritionists recommend that people include fish in their food chain, but due to the ability of toxins to accumulate in the body tissues of fish, special considerations should be taken in their consumption.[15,16] The potential carcinogenicity of these toxins suggests that people should not only consume small amounts of contaminated foods but also consider the variety to prevent the consumption of toxins and unhealthy foods. Pollutant information on a wide range of commercial fish is not generally available to the public. Therefore, there is a need for more research into the levels of pollutants in fish and provide information on pollutant levels in fish.[17] Information on the exact identification of species, place of collection, and permissible levels of pollutants in fish in certain regions of the world can allow people to make informed decisions to remove the least amount of pollutants by consuming the right fish. Countries like the United States and organizations such as the Food and Drug Administration prevent many of the problems caused by contaminants in seafood by setting the right consumption pattern. Therefore, in addition to trying to increase the per capita share of fish consumption in Iran, it is necessary to pay special attention to seafood safety.[18] Carp is a floor-feeding fish, but due to the presence of plants in the diet of this fish, which is at the lower level of the food chain; Carp can be expected to show less contamination. Of course, carp are mollusks that are at the top of the food chain; they also feed and on the other hand, the habitat of carp in the estuaries of rivers increases the possibility of contamination of this fish. The Common Pike of Anzali Wetland is a carnivorous, fish-eating, and all kinds of food.[19] Fish with different diets show obvious differences in the accumulation of contaminants, which can be explained by differences in biological variables, environmental parameters, physiology, and habitat of fish. Sediments, as the final site of contaminants in aquatic environments, play a significant role in the accumulation of organochlorine and organophosphate toxins in benthic invertebrates and their transfer to higher nutrient levels.[20]

Based on Tables 1-5, the accumulation of Ethion, Malathion, Trifluralin, DDT, and DDE toxins in the edible muscle of economic fish of Anzali wetland was significantly reduced compared to the WHO. The results of the present study showed that there is no significant difference between the three sampled areas in terms of the amount of pollutants studied. According to the Agency for Toxic Substances and Diseases Registry (2017), 22,000 tons of pesticides are used annually in the country.[21] Unfortunately, some of these toxins are stored in the adipose tissue of mothers and damage the fetus. While Iran is required by the Stockholm Convention to remove some long-lasting chemicals such as DDT from the consumption cycle, and due to the high toxicity and stability of this compound, its amount in species such as white fish that have high economic value should be at least possible. Zarei-Choghan *et al*. (2022) studied the potential risks of Organophosphorus pesticides. These researchers determined the mean concentration of OPPS (Chlorpyrifos, Malathion, Ethion, Dichlorvos, Trifluralin, and Diazinon) in fish samples from 0.68 - 3.94 µg/kg.[22] Overall, the concentrations of pesticides in fish samples were below the maximum residue limit 30 µg/kg during the study period, according to the United States Environmental Protection Agency in 2022 and the WHO (1996).[23,24] Ghorbanzadeh Zafarani *et al* (2023) examined the pollution level of six pesticides-three organochlorines (aldrin, dieldrin, and endrin) and three organophosphates (OPPs: diazinon, malathion, and azinphosmethyl) in fish from the Miankaleh wetland (Iran). OCPs and OPPs were not detected in fish samples in the Miankaleh wetland.[25] Barnhoorn *et al*. (2015) examined the levels of organochlorine toxins in catfish muscle tissue at three major dams in Roodeplaat. The results showed that, except for lindane, the levels of other toxins were lower than those reported by the US EPA and were not carcinogenic to humans.[26] Yared *et al*. (2014) explored the accumulation of organochlorine toxins and their effect on fish Tilapia zillii (*Coptodon zillii*), *Carassius* spp, and *Clarias gariepinus* from Lake RiftValley in Ethiopia on human health. DDT was 8.63-1.41 Nanog/g. DDT was the predominant contaminant. The level of organochlorine contamination in all studied species is much less than the acceptable daily standard of toxin.[27] Hussein *et al*. (2022) indicated that hexachlorocyclohexane (lindane) in examined seafood ranged from 0.27 in N. pelagicus to 61.61 µg/kg in *Sardinella aurita*. Hexachlorobenzene (HCB) was found in five different species, with meanvalues of 2.03, 1.5.7, 0.94, 0.35, and 0.18 µg/kg in *Clupea harengus, S. aurita*, *Mugil cephalus, Oreochromis niloticus*, and *Sepia savigngi*. Moreover, the summation of Heptachlor was 10.19, 1.27, 2.58, 0.95, 0.21, and 0.32 µg/kg of wet weight in examined *C. harengus*, *M. cephlaus, S. aurita, O. niloticus, N. pelagicus*, and *S. savigngi*. Aldrin and dieldrin residues were 3.75 and 4.86 µg/kg in *C. harengu*, meanwhile, they were 1.61 and 0.78 µg/kg in *M. cephalus*. pp-DDE was dominant in all examined species within different concentrations 5.08, 0.98, 3.07, 0.93, 0.08, and 0.35 µg/kg in and *S. savigngi*, respectively. All of the examined seafood samples were lower than the recommended maximum residue limit.[28] Teklit (2016) conducted to assess the levels of organochlorine pesticides namely DDT, DDE, Lindane, Endosulfan, Heptachlor, and Chlordane residues in Lake TeKeze dam using fish (*Labeobarbus* spp., *Clariasgariepinus* and *O. niloticus*) samples. DDE was the predominant residue in all the samples, at the mean concentrations of 4.81 ppb in samples.[29] Thus, the use of these pesticides to control pests by farmers within the study area with little or no knowledge must be checked through adequate control of the trade and use of pesticides and the enforcement of appropriate sanctions. Morshdy *et al*. (2018) determined organochlorine pesticides (OCPs) in Tilapia nilotica (*Oreochomis niloticus*). The results revealed that tilapia collected from Damietta had the highest incidence of OCP contamination (75%), over that collected from Sohag (60%) compared to the control value (35%). All examined samples had OCP residues within the maximum permissible limits (MPLs) set by the WHO (1996).[24,30] Adeyemi and Abdulmalik (2017) determined the levels of Organochlorine pesticide residues (Lindane, Aldrin, Endosulfan, and DDT) in Mackerel, Sardine, and Shawa frozen. Residues were detected in some of the fish samples in concentration ranges of (1.053–5.77 µg/g) for Lindane, (0.468 µg/g) for

Aldrin, (ND) for Dichlorophenyltrichloroethane and (ND) for Endosulfan. All the pesticide residues determined have their mean concentrations above the permissible limit of 0.01 μg/g set by USEPA.[31] The results of these studies are similar to the results of the present study.

CONCLUSION

Based on the obtained results, the economic fish of Anzali Wetland including catfish, perch, carp, Common Pike, and carp in the western, eastern, and central stations of Anzali Wetland in terms of contamination with the agricultural organochlorine and organophosphate pesticides including ethion, malathion, trifluorine, D P, P-DDE are suitable for human consumption in terms of food hygiene.

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