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Organochlorine pesticides in two fish species from the southern Caspian Sea

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ABSTRACT

In the present research, we aimed to investigate organochlorine toxins accumulated in both *Rutilus frisii kutum* and *Liza aurata* captured at the southern Caspian Sea. At six sampling stations, organochlorine toxins were measured in fish tissues by the gas chromatography–electron capture detector (GC-ECD) method. Total organochlorine toxins ranged from 2.102 ppb to 9.033 ppb in *L. aurata* at the study area. The highest content of total organochlorine toxins was obtained at station 5, whereas the lowest content was achieved at station 4.

In *L. aurata*, lindane showed the highest level among the measured components (1.642 ppb), whereas α-lindane showed the highest mean level of the measured components (0.57 ppb). In this investigation, the total amount of organochlorine compounds in *R. frisii kutum* was more than that in *L. aurata*, but these compounds indicated no significant difference between the two types of fishes ($p > 0.05$). Moreover, the measured components in both types of fishes were lesser than the allowable limit.

Southern Caspian Sea is regarded as an important center for agriculture, and because of different dense cultures, the use of agricultural pesticides and fungicides in farms is very high. After sometime of application, these toxins are often discharged into rivers through soil washing induced by rain in farms, leak of agricultural wastes, and wind blows, and these lead to marine pollution (Ballschmiter et al., 1983).

Considering the life cycle of commercial fishes such as whitefish, Mugil, bleak, and carp in the coasts, these toxins are accumulated in fish tissues. Hence, damages of these toxins to human health through contaminated fish consumption are not lesser than their direct damages on the aqueous ecosystem and environment. Therefore, the focus of the harmful effects induced by overconsumption of these toxins is primarily on humans who are affected by various diseases every day (Francour et al., 1994; Gerber et al., 2016).

Among all man-made contaminants, the main concern is permanent organic pollutants (POPs). POPs are carbon-based compounds with a mixture of industrial chemicals such as polychlorinated biphenyls (PCB), pesticides, and by-products of combustion such as dioxins.

Risks of these pollutants are pertained to their resistance against photolysis, biodegradation and chemical decomposition, high lipophilicity, and high durability for a long time in the environment. Owing to these properties, POPs can bioaccumulate in the lipid tissues of living organisms and consequently increase along the food chain. By this point, these pollutants can have a harsh effect on the health of ecosystem, wildlife, and human beings (Pinet, 2006).

Fish and fishery products form < 10% of our food regimes, but they are the major ways through which these pollutants enter the human body. High consumption of fish in food regimes would result in increased absorption of these compounds. According to previous studies, there is a high correlation between the concentration of chlorine organic pollutants in the blood, milk, and human tissues with the consumption of contaminated fish (Judd et al., 2004).

Fish is concerned as a proper indicator for the assessment of pollution in aqueous systems, as they receive the pollutants both directly through water and indirectly through food, thereby resulting in accumulation of toxins in their tissues. Hence, fish is suitable for the examination of pollutant transfer and biomagnification process through food webs (Zhou et al., 2007).

In other words, fish is used as an indicator for monitoring water quality, as they directly receive the pollutants from surrounding environment and food, thereby resulting in accumulation of toxins in their tissues. Fishes have poor metabolization of organic organochlorine compounds, thus reflecting the pollution level of their environment (Pastor et al., 1996).

Distribution and accumulation of these pollutants in fish tissues indicate the pollution level in sediments and its aqueous environment. The aim of this trail was to determine organochlorine levels in Mugil and whitefish captured from the southern Caspian Sea.

In this research, organochlorine pollutants were investigated in *L. aurata* (10 fish in each site) and *R. frisii kutum* (10 fish in each site) in

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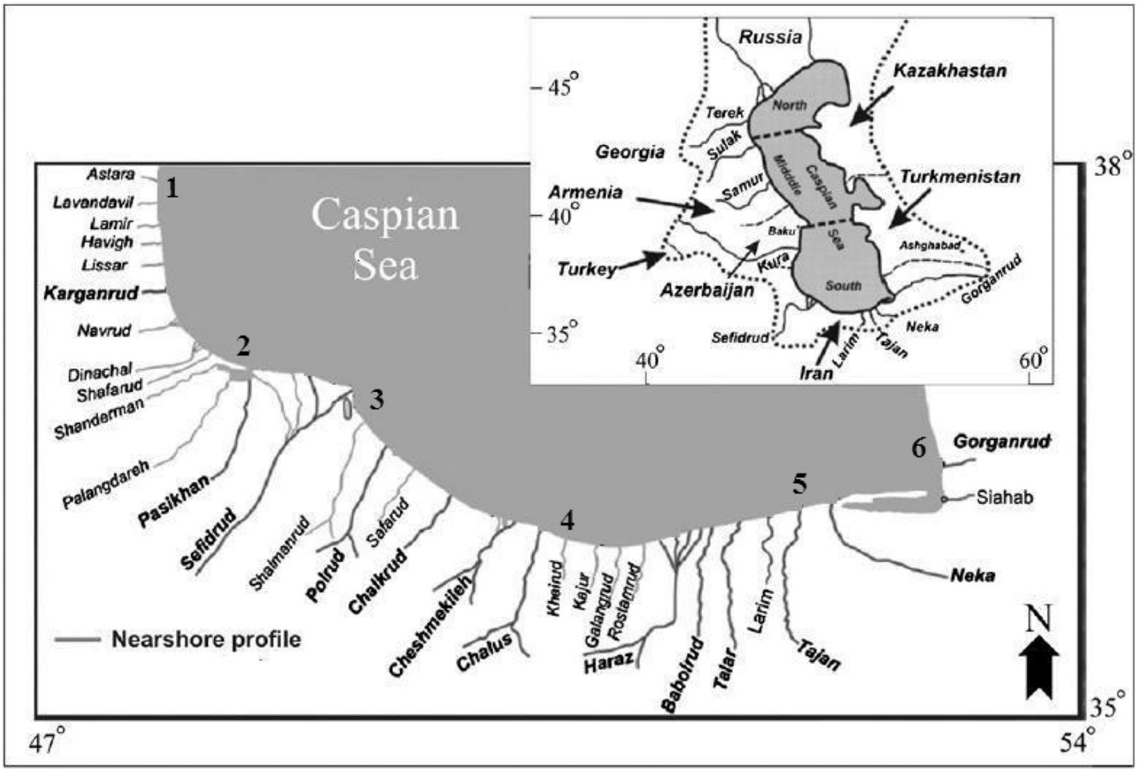

Fig. 1. Locations of sampling sites at the coastline of the southern Caspian Sea.

east, west, and central parts of the southern Caspian Sea (Fig. 1). Fish samples were captured from six stations using a beach seine net in winter 2018 and then transported to the laboratory in ice boxes.

Approximately 6 g of tissue was cut and put in a test tube. After weighing the tube, 8 ml of hexan solvent (32%) followed by acetone solvent (a ratio of 1:1) was added. Tubes were covered by aluminum and shaken well on a shaker for 5 min to mix the solvents with the sample. Afterwards, samples were placed in an ultrasonic device for 25 h to completely remove the organic matter and obtain a homogenate solution. Then the supernatant was separated with a syringe and simultaneously injected with helium gas into a gas chromatography device equipped by an electron capture detector (MOOPAM, 1999). Accuracy of the measurements was controlled by a standard reference for marine fish (NO. IAEA-406), and 1000 ppm of a standard solution with a mixture of chlorine toxin prepared by Dr. Ehrenstorfer Company was applied for calibration.

Results were classified in an online program of Microsoft database. The obtained peaks were then studied, and data were standardized and calibrated. The type and level of toxins in fish tissue at different stations were measured and reported in ppb.

Statistical analysis was performed using SPSS software. Data normality was analyzed by the Kolmogorov–Smirnov test. Moreover, comparison of fish pollution among different stations was done by one-way analysis of variance and Duncan's test when data showed normality. The *t*-test was applied to compare the pollution level between the two species.

The organochlorine toxin levels measured at each station in both *R. frisii kutum* and *L. aurata* are presented in Tables 1 and 2. According to the obtained results, the highest amount of DDT, DDD, DDE, aldrine, endrin aldehyde, endrin, dieldrin, lindane, α-lindane, β-lindane, endosulfan were detected at stations 4, 4, 4, 1, 4, 4, 4, 5, 5, 6, and 6, respectively. Moreover, endrin ketone, metoxychlor, and heptachlor were not at detectable levels at any station.

Lindane had the highest mean level measured in *L. aurata* (1.642 ppb) (Fig. 2). The total level of organochlorine toxins measured in Mugil ranged from 2.102 ppb to 9.033 ppb. Generally, the highest level of organochlorine was measured at station 4, while the lowest level was observed at station 2 (Fig. 3).

In *R. frisii kutum*, the maximum level of β-lindane was 0.398 ± 0.105 ppb at station 5, whereas those of the other components were at station 1 (Fig. 4). Furthermore, endrin ketone, endrin, endosulfan, metoxy chlor, and heptachlor were not measurable at any station. In this fish, α-lindane showed the highest mean level among the measured components (0.57 ppb). The total level of organochlorine toxins was the highest at station 5 (2.71 ppb) and the lowest at station 4 (1.40 ppb) (Fig. 5).

In the case of DDT isomers, it could be noted that DDT was converted into DDE during decomposition under aerobic conditions by microorganisms, whereas under anaerobic conditions, DDD was the main product (Aguilar, 1984). Therefore, aerobic condition of the surrounding environment can be a reason for the observed high level of DDE. DDE is the most important isomer of DDT decomposition, and it bioaccumulates at high levels. In living and nonliving components, DDE is regarded as the most stable isomer with high half-life (Connell et al., 1999; Walker, 2001; Andersen et al., 2001). Moreover, the high level of this compound can be attributed to its direct application along the coasts.

In *L. aurata*, the amount of aldrine was more than that of dieldrin, whereas it was vice versa in *R. frisii kutum*. Generally, aldrine is readily transformed into dieldrin, which is more toxic than the former form.

Generally, bioaccumulation and biomagnification processes have a key role in the content of toxins in the body tissues of the aquatic organisms placed in upper trophic levels of a food chain. Biomagnification is remarkably important in the accumulation of organic pollutants, particularly high hydrophobic pollutants. The process is affected by various biotic factors including feeding habit and habitat of the organism, its feeding condition, its fat content in the body tissue, age, gender, and season of sampling or spawning as well as nonbiotic factors such as chlorine grade of the pollutant, their hydrophobicity coefficient, water solubility degree, ionization degree, and toxin