DETERMINATION OF SOME PERSISTENT ORGANIC POLLUTANTS (POPs) IN SOME ENVIRONMENTAL COMPARTMENTS

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THESIS
Submitted in Partial Fulfillment of the Requirements for the Degree

Of
DOCTOR OF PHILOSOPHY

In
AGRICULTURAL SCIENCES
(Environment and Bio-Agric. –Agric. Environment)

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1441 A.H.
2020 A.D.

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Demands on the Rosetta Nile branch's water resources for irrigation, domestic water supply and industrial uses are continuously increasing due to population growth, expanding urbanization, industrialization and agriculture. Pollutants residues in river system not only pose threats to human health through water and fish consumption, but also pose threats to aquatic organisms.

Therefore, the objectives of this study were to (i) monitor for the first time the occurrence and spatiotemporal variations of 100 pesticide and 15 antibiotics in surface water, sediment and Nile tilapia collected at monthly intervals between July 2018 and June 2019 from 3 sampling sites (El-Rahawy, Sabal and Tala) situated along the Rosetta branch of the river Nile, Egypt, (ii) identify the potential non-carcinogenic health risks for the local population through the life time consumption of contaminated fish or drinking water, and (iii) perform an ecological risk assessment for aquatic organisms upon exposure to detected pollutants in surface water and sediment based on the risk quotients (RQs) method.

Sampling strategy was based on the presence of three drains (i.e., El-Rahawy, Sabal and Tala) that receive untreated, partially treated and/or treated wastewater from Wastewater Treatment

Plants (WWTP), that eventually discharge their effluents directly into the Rosetta branch of the river Nile. A monitoring study was carried out in 3 sampling points along the Rosetta branch and over 12 sampling periods from July 2018 to June 2019. For those 3 sampling sites, 144 surface water, 144 sediment and 72 Nile tilapia (*Oreochromis niloticus*) samples were obtained in duplicate as follows: 1 Km before (upstream) and after (downstream) the outlet of (1) El-Rahawy drain (Giza governorate; coordinates of 30°12'26.21"N and 31° 1'58.90"E), (2) Sabal drain (Minoufiya governorate; coordinates of 30°32'13.47"N and 30°51'07.09"E) and (3) Tala drain (Kafr El-Zayat, Gharbiya governorate; coordinates of 30°49'01.74"N and 30°48'47.77"E).

The results of the present work could be summarized as follows:

1. Occurrence and risk assessment of pesticides in surface water, sediment and Nile tilapia along the Rosetta branch of the river Nile:

1.1. Occurrence of pesticide residues in surface water:

Out of the 100 pesticides monitored, 22 belonging to thirteen chemical families were detected, and 76% of surface water samples were contaminated with pesticide residues. The most frequently detected pesticides were malathion (57%) followed by chlorpyrifos (54%), atrazine (23%) and carbendazim

(20%). The spatial distribution exhibited that El-Rahawy had the highest pesticide load (38.47 µg/L) among the studied sites, whereas Sabal the lowest (16.29 µg/L). The temporal variations revealed that the highest total pesticide concentrations were detected in summer season (27.98 µg/L) compared to spring (23.16 µg/L), winter (19.18 µg/L) and autumn (11.85 µg/L). Moreover, downstream surface water samples contained more pesticides, in terms of number and concentration, than those collected from upstream sampling sites.

1.1.1. Human health and ecotoxicological risk assessment of detected pesticides in surface water:

As regard to non-carcinogenic risks of the detected pesticides in surface water, target hazard quotient (THQ) values were lower than 1, implying no potential risk on human through drinking water exposure route in the studied sites. However, thirteen pesticides showed high risk quotient (RQ > 1), posing a potential ecological risk for aquatic organisms.

1.2. Occurrence of pesticide residues in sediments:

Out of the 100 pesticides monitored, 18 belonging to nine chemical families were detected and 55% of sediment samples were contaminated with pesticide residues. The mean concentration and detection frequency% of the four most frequently detected pesticides in sediment samples were: chlorpyrifos (0.18 mg/kg and 34%); *p,p′*-DDE (0.018 mg/kg and

30%); cypermethrin (0.03 mg/kg and 14%) and deltamethrin (0.026 mg/kg and 13%), respectively. The spatial distribution exhibited that El-Rahawy had the highest pesticide load (2.86 mg/kg) among the studied sites, whereas Tala the lowest (0.24 mg/kg). The temporal variations revealed that the highest total pesticide concentrations were detected in winter season (1.73 mg/kg) compared to autumn (0.92 mg/kg), summer (0.88 mg/kg) and spring (0.13 mg/kg). Moreover, downstream sediment samples contained more pesticides, in terms of number and concentration, than those collected from upstream sampling sites.

1.2.1. Ecotoxicological risk assessment of detected pesticides in sediments:

Thirteen pesticides showed high risk quotient (RQ > 1), posing a potential ecological risk for aquatic organisms living and feeding on these sediments.

1.3. Occurrence of pesticide residues in Nile tilapia:

Of the 72 analyzed fish muscle samples; 86% were contaminated with pesticides. Chlorpyrifos (ranging from BQL to 0.08 mg/kg) was the most frequently detected pesticide followed by *p,p′*-DDE (ranging from BQL to 0.04 mg/kg) in 83 and 45% of the fish muscle samples, respectively. The spatial distribution of the detected pesticides in fish samples along the Rosetta branch showed that the highest mean concentrations were found in the Sabal area, followed by samples from Tala and El-Rahawy. An

investigation into seasonal variations revealed that the highest mean concentrations of pesticides in fish samples were detected in winter.

1.3.1. Human health risk assessment of detected pesticides in Nile tilapia:

According to target hazard quotient (THQ) calculations for the detected pesticides in Nile tilapia muscle, all pesticides gave THQ values lower than 1, indicating that the consumption of this fish from the study sites is unlikely to cause any detrimental effects to consumers.

2. Occurrence and spatiotemporal variations of antibiotics in surface water, sediment and Nile tilapia along the Rosetta branch of the river Nile:

2.1. Occurrence of antibiotics residues in surface water:

Chloramphenicol was the only detected antibiotic in 1% of surface water at concentrations ranged from below quantification limit (BQL) to 0.09 µg/L. Spatiotemporal variations revealed that El-Rahawy was the most contaminated site. Samples collected from Sabal area were totally free of any antibiotic residues, whereas spring season samples were free from any antibiotics' residues.

2.2. Occurrence of antibiotics residues in sediments:

Nitrofurazone, oxytetracycline and chloramphenicol were detected in 18, 2 and 2% of the Rosetta branch's collected

sediment samples, respectively. The data showed also that samples from El-Rahawy area were the most contaminated with antibiotics followed by samples from Tala then Sabal with total mean concentration 104.32, 1.4 and 1.15 µg/kg, respectively. Regarding temporal distribution of antibiotics, sediment samples collected during winter were the most contaminated with total mean concentration (104.35 µg/kg) followed by summer (1.3 µg/kg), and autumn (1.1 µg/kg). On the other hand, samples collected during spring were free from any antibiotics' residues.

2.3. Occurrence of antibiotics residues in Nile tilapia:

Of the 72 analyzed fish muscle samples; 21% were contaminated with antibiotics. Nitrofurazone (ranging from 8.6 to 52 µg/kg) was the most frequently detected antibiotic, followed by nitrofurantoin (ranging from 1.1 to 2 µg/kg) and chloramphenicol (ranging from <LOQ to 0.17 µg/kg). These antibiotics were found in 12, 6 and 5% of the fish muscle samples, respectively. The spatial distribution of the detected antibiotics in fish samples along the Rosetta branch showed that the highest mean concentrations were found in the Sabal area, followed by samples from Tala and El-Rahawy. An investigation into seasonal variations revealed that the highest mean concentrations of antibiotics in fish samples were detected spring.

2.3.1. Human health risk assessment of detected antibiotics in Nile tilapia:

According to target hazard quotient (THQ) calculations for the detected antibiotics in Nile tilapia muscle, all antibiotics gave THQ values lower than 1, indicating that the consumption of this fish from the study sites is unlikely to cause any detrimental effects to consumers.

In light of the aforementioned results, it can be concluded that the presence of pesticides and antibiotics residues in the abovementioned compartments along the Rosetta branch means that the existing laws should be enforced. It is also important to increase inspection of discharged municipal, agricultural and industrial wastewaters into surface water and to review the requirements related to treatment efficiency in Wastewater Treatment Plants (WWTP). Regular surveillance and monitoring are recommended to assess the pollution status of the river Nile.