



Impact of industrial wastewater on water and fish quality of Nile River in Kafr El-Zayat, Egypt

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ABSTRACT

In Egypt, Rosetta branch of the Nile River is impacted by several industrial effluents at Kafr El-Zayat City, which potentially affect and deteriorate its quality. To study the impact of these effluents on aquatic environment of the Rosetta branch, a total of 108 water samples and 36 fish samples were collected during the spring and autumn 2010 from 9 different regions along the branch at Kafr El-Zayat industrial area. Chemical analyses of water samples showed seasonal variation of pH, Pb, Cd, and NH₃ values. Cu concentrations in the water were below the maximum permissible limit, however, Pb, Cd, Hg, P, NH₃, and S exceeded the permissible limit. The distribution of these parameters at the area under investigations are strongly affected by the industrial effluents produced from *El-Mobidat*, *El-Malyia* and *Salt and Soda* companies which directly discharge industrial effluents at this area without any treatment. The presence of high levels of Pb, Hg, NH₃, and S in the fish muscles were in relation to water pollution in the studied area. The bacteriological analyses showed that TBC ranged from 1.9×10^3 to 5×10^5 cfu/ml for water and from 3×10^5 to 5×10^5 cfu/g for fish flesh. Importantly, the water and fish samples tested were positive for *Salmonella* and negative for *E. Coli*. In conclusion, the results demonstrate that the Nile River at Kafr El- Zayat industrial area is heavily polluted and consequently harmful effects to the aquatic environment and to the quality of the water are established. So, treatment and safe disposal of different industrial wastes is recommended.

Keywords: Water quality, Fish quality, Pollutants, River Nile, Kafr El-Zayat

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1. INTRODUCTION

The Nile River considers the longest river in the world. The main River Nile when reaches to the Delta is divided into two branches Rosetta and Damietta branches. The Rosetta branch water serves for a wide range of functions including agricultural, industrial and domestic water supply, fisheries and recreation. However, unfortunately the Rosetta Branch is impacted by several industrial companies at Kafr El-Zayat City. These industrial outfalls are *El-Mobidat* (Pesticides and chemical company, KZ, produced more than 40 kinds of chemical products, including agricultural pesticides and household pesticides in addition to

fertilizer); *El-Malyia* (pesticide production company, IFIC, produced superphosphate, different types of sulphuric acid, sodium fluosilicate, ferrous sulphates); and *Salt and Soda* (produced oil, soap, wax, animal fodder, liquid and solid sodium silicates) companies which are discharging directly at the east bank of the branch. There were several studies concerned with the environmental status of the Nile River through the analysis of water and fish (Massoud and Mahdi, 1985; Elewa, 1991; Gomaa, 1995 and Abdo, 2002). However, information about the quality of other components of the eco-system is lacking. The continual anthropogenic input of

heavy metals in aquatic habitats constitutes a potential threat to ecosystem by direct toxication of these metals to aquatic organisms (Nuzzi, 1972; Bella and Mccauley 1972). Moreover, heavy metals and other trace elements have been considered as dangerous substances causing serious health progressive irreversible accumulation in humans as a result of a repeated consumption of small amounts of these elements (Wheaton and Lawson, 1985). On the other hand, the fish acts as a vehicle for many microorganisms from its natural contaminated aquatic environment, sewage, soil and harvesting areas (Shewan, 1971 and National Academy of Science, 1985). The bacterial load of fish is a reflection of the water status in which they were caught and fish can acquire pathogenic microorganisms from the natural aquatic environment (National Academy of Science, 1985; Goosney et al., 2001). Therefore, current study was conducted to assess the pollution and contamination of Rosetta branch of Nile River at Kafr El-Zayat industrial area during spring and autumn 2010 to assess the risk of water pollution with chemicals and pathogenic microorganisms, which affect the humans and veterinary public health.

2. MATERIALS AND METHODS

2.1. Sample collection

The water and fish samples were collected during the spring and autumn 2010 from 9 different regions of Rosetta branch of Nile River at Kafr El-Zayat industrial area as follows:

- Point 1: about 2 kilo meters north the drainage of Salt and Soda Company.
- Point 2: at the drainage of Salt and Soda Company.
- Point 3: at the drainage of El-Malyia Company.
- Point 4: at the drainage of El-Mobidat Company.
- Point 5: at the other side of Nile River, opposite the drainage of El-Malyia Company.
- Point 6: at the other side of Nile River, opposite the drainage of Salt and Soda Company.
- Point 7: beside animal carcass.
- Point 8: at the other side of Nile River, opposite the drainage of El-Mobidat Company.
- Point 9: about 2 kilo meters south the drainage of El-Mobidat Company.

The water samples were obtained from all 9 points during spring and autumn of 2010; 3 samples were collected from each point in clean plastic bottles for chemical analysis, and another 3 samples (a total of 108 water samples) were also collected in sterilized glass bottle for bacteriological analysis (Rabeh, 2007). The fish samples were obtained only from points 1, 3 and 9 during the same periods; similarly 6 samples were collected from each point (a total of 36 fish samples), 3 for chemical analysis, and another 3 samples for bacteriological analysis (Ragab, 2001).

2.2. Determination of pH

pH values of water was measured by using chromatography HPLC digital pH meter (Ragab, 2001).

2.3. Chemical Analysis:

Ammonia (APHA, 1998), Phosphorus (Ragab, 2001), Sulphur (Grondelle et. al., 1977) and heavy metals (APHA, 1998) of Lead, Mercury, Copper and Cadmium were determined in the examined samples.

2.3. Bacteriological examination

All samples were analyzed for total aerobic count, isolation and identification of *Salmonella* and *Escherichia coli* according to APHA (1998), ICMSF (1978) and Mari'a et al., (2007) respectively.

3. RESULTS

3.1 Chemical Analysis of water

The mean concentrations of the tested parameters in the water of the Nile River at Kafr EL-Zayat are presented in Table 1, 2 & 3. Metal concentrations followed an abundance of Hg > Pb > Cu > Cd., in spring and they were in the following order: Hg > Cu > Pb > Cd in autumn. Seasonal variation of pH Pb, Cd, and NH₃ water values were observed.

3.2 Bacteriological analysis of water

TBCs of the analyzed water samples ranged from 6×10^3 to 5×10^5 cfu/ml and from 1.9×10^3 to 3.7×10^5 cfu/ml in spring and autumn, respectively (Table 4). *Salmonella* were identified in points 1, 5, 6, 7, 8, 9; meanwhile *Escherichia coli* were not detected in any water sample.

3.3 Chemical Analysis of fish muscles

Table 5 shows the concentrations of the tested parameters in fish flesh. The accumulation of the measured heavy metals increases in the following order, Cd < Cu < Pb < Hg.

3.4 Bacteriological analysis of fish muscles

TBCs of the analyzed fish muscles ranged from 4×10^5 to 5×10^5 cfu/g in spring and from 3×10^5 to 5×10^5 cfu/g in autumn (Table 5). The entire fish samples tested were positive for *Salmonella* and negative for *E. Coli*.

Table (1): pH, Copper, and Lead values (N=3) in water of Nile River at Kafr EL-Zayat industrial area during spring and autumn 2010. (Mean± SE).

Season	Spring			Autumn		
	Location	pH	Cu	Pb	pH	Cu
Point 1	7.11±0.038	0.30±0.032	0.51±0.018	7.05±0.029	0.07±0.005	0.02±0.005
Point 2	7.05±0.0284	0.19±0.015	0.34±0.012	7.16±0.029	0.04±0.008	0.03±0.005
Point 3	7.74±0.055	0.27±0.017	0.34±0.009	7.14±0.021	0.05±0.014	0.03±0.005
Point 4	7.3±0.088	0.27±0.024	0.34±0.009	7.15±0.023	0.05±0.014	0.03±0.006
Point 5	7.6±0.052	0.27±0.026	0.55±0.017	8.01±0.029	0.06±0.015	0.04±0.005
Point 6	7.2±0.120	0.25±0.020	0.55±0.017	7.30±0.014	0.06±0.017	0.04±0.012
Point 7	6.5±0.088	0.27±0.017	0.37±0.005	6.7±0.080	0.06±0.018	0.03±0.005
Point 8	6.5±0.057	0.29±0.014	0.18±0.002	7.16±0.031	0.06±0.018	0.02±0.005
Point 9	7.4±0.059	0.30±0.008	0.18±0.003	6.76±0.059	0.07±0.017	0.03±0.008

Table (2): Concentrations of Cadmium, Mercury, and Phosphorus (N=3) in water of Nile River at Kafr EL-Zayat industrial area during spring and autumn 2010. (Mean± SE).

Season	Spring			Autumn		
	Location	Cd	Hg	P	Cd	Hg
Point 1	ND	0.71±0.02	0.18±0.010	0.05±0.008	0.43±0.028	0.40±0.002
Point 2	ND	0.78±0.03	0.07±0.004	0.02±0.005	0.44±0.02	0.31±0.006
Point 3	ND	0.61±0.017	0.027±0.001	0.02±0.005	0.43±0.01	0.32±0.012
Point 4	ND	0.54±0.05	0.02±0.005	0.02±0.005	0.60±0.02	0.31±0.007
Point 5	ND	0.60±0.02	0.017±0.002	0.03±0.005	0.38±0.01	0.21±0.009
Point 6	ND	0.64±0.017	0.024±0.001	0.03±0.005	0.43±0.02	0.27±0.005
Point 7	ND	0.29±0.037	0.03±0.0005	0.02±0.005	0.43±0.02	0.31±0.006
Point 8	ND	0.57±0.05	0.525±0.012	0.01±0.003	0.36±0.01	0.26±0.004
Point 9	ND	0.76±0.05	0.029±0.004	0.02±0.005	0.39±0.014	0.31±0.004

ND: Not Detected

Table (3): Concentrations of Ammonia and Sulphur (N=3) in water of Nile River at Kafr EL-Zayat industrial area during spring and autumn 2010. (Mean± SE).

Season Location	Spring		Autumn	
	NH3	S	NH3	S
Point 1	0.32±0.024	14.4±0.28	3.2±0.12	11.38±0.42
Point 2	0.32±0.008	16.06±0.46	3.4±0.14	12.73±0.79
Point 3	0.37±0.02	19.28±0.2	7.2±0.24	14.66±0.29
Point 4	0.04±0.005	54.09±0.87	3.7±0.05	38.11±1.51
Point 5	0.04±0.008	15.51±0.23	2.9±0.008	12.36±0.43
Point 6	0.3±0.01	6.78±0.03	4.3±0.21	5.4±0.21
Point 7	0.04±0.005	13.64±0.16	5.2±0.2	12.4±0.43
Point 8	0.07±0.012	29.16±0.92	4.1±0.12	18.66±0.66
Point 9	0.06±0.008	14.6±0.18	5.1±0.21	10.99±0.26

Table (4): Bacteriological analysis (N=3) of water of Nile River at Kafr EL-Zayat industrial area during spring and autumn 2010. (Mean± SE).

Season Location	Spring			Autumn		
	TBCs	<i>Salmonella</i>	<i>E. Coli</i>	TBCs	<i>Salmonella</i>	<i>E. Coli</i>
Point 1	1.6×10 ⁴ ±5.7×10 ²	+ve	-ve	3.7×10 ⁵ ±6.5×10 ⁴	+ve	-ve
Point 2	5×10 ⁵ ±1.1×10 ⁵	-ve	-ve	2.1×10 ⁵ ±5.7×10 ³	-ve	-ve
Point 3	3.6×10 ⁴ ±8×10 ³	-ve	-ve	5.1×10 ³ ±4×10 ²	-ve	-ve
Point 4	9×10 ³ ±1.5×10 ³	-ve	-ve	4×10 ³ ±5.7×10 ²	-ve	-ve
Point 5	3×10 ⁴ ±1.2×10 ³	+ve	-ve	1.9×10 ³ ±1.2×10 ²	+ve	-ve
Point 6	3×10 ⁴ ±0.15×10 ⁴	+ve	-ve	6×10 ⁴ ±1.5×10 ⁴	+ve	-ve
Point 7	6×10 ³ ±1×10 ³	+ve	-ve	6×10 ³ ±1.4×10 ²	+ve	-ve
Point 8	4.6×10 ⁴ ±2.1×10 ⁴	+ve	-ve	3.6×10 ⁵ ±8×10 ⁴	+ve	-ve
Point 9	2×10 ⁴ ±1×10 ⁴	+ve	-ve	3.3×10 ⁵ ±1.8×10 ⁵	+ve	-ve

Table (5): Seasonal variations of chemical and bacteriological analysis (Mean± SE) of Nile River Fish muscles at Kafr El-Zayat industrial area during 2010.

Season Location	Spring			Autumn		
	Point 1	Point 3	Point 9	Point 1	Point 3	Point 9
Cu	ND	ND	ND	0.02±0.008	0.03±0.001	0.03±0.005
Pb	0.02±0.005	0.02±0.008	0.08±0.008	0.06±0.005	0.04±0.008	0.25±0.008
Cd	ND	ND	ND	ND	ND	ND
Hg	4.55±0.17	9.1±0.09	4.24±0.19	1.9±0.23	1.7±0.1	2.4±0.25
P	0.36±0.022	0.35±0.01	0.45±0.01	0.36±0.012	0.33±0.002	0.26±0.011
NH3	17.2±0.16	19.2±0.31	16.9±0.69	24.5±0.14	27.8±0.44	26.6±0.10
S	46.1±0.40	43.3±0.36	40.83±0.04	30.87±0.36	34.28±0.47	32.6±0.23
TBCs	5×10 ⁵ ±2×10 ⁵	4×10 ⁵ ±1×10 ⁵	4×10 ⁵ ±2×10 ⁵	5×10 ⁵ ±2×10 ⁵	3×10 ⁵ ±1×10 ⁵	3×10 ⁵ ±1×10 ⁵
<i>Salmonella</i>	+ve	+ve	+ve	+ve	+ve	+ve
<i>E. Coli</i>	-ve	-ve	-ve	-ve	-ve	-ve

ND: Not Detected

4. DISCUSSION

The Nile River has been subjected to different sources of pollution and contamination through several and complicated routes. Industrial effluents constitute a real threat to The Nile River. Recently, the risk of water pollution with toxic chemicals not limited to the public health and veterinary public health only but extended and jointed as toxic chemicals causing zoonotic diseases as reported by El-Tras et al. (2011). The Nile River at Kafr El-Zayat, is impacted by several industrial outfalls from oil and soap, fertilizers pesticides and Sulfur industry (El-Malh and Soda, El-Malyia and El-Mobidat factories). There were other sources of pollution and contamination as agricultural drains, laying carcasses and sewage which discharged from several villages distributed along the two banks of the Rosetta Branch. The present study showed seasonal variation of pH water values (Table 1); the lowest acidic value (6.5) was recorded in spring at point 7 and at point 8. The highest alkaline value (8.01) was recorded in autumn at point 5. Presence of carcass pollution at point 7 and the drainage of acids from El-Mobidat company at point 8 may increase the acidity of Nile water. In general the pH values were always on alkaline side. Massoud and Mahdi (1985) found that the pH values showed seasonal changes and varied between 7.5 – 8.2. Ahmed (1988) reported that pH values in water of Nile River at Aswan, Egypt were fluctuated between 7.1 and 8.4. Generally, the pH values below 6.5 and higher than 9.0 is harmless to fish, although the toxicity of other poisons may be affected by the changes within this range (Alabester and Lioyed, 1980). The mean concentrations of the tested metals in the water of the Nile River at Kafr EL-Zayat in spring followed an abundance of $Hg > Pb > Cu > Cd.$, and in autumn they were in the following order: $Hg > Cu > Pb > Cd.$ In general, the

distribution of these metals at the area under investigations are strongly affected by the industrial effluents produced from El-Mobidat, El-Malyia and Salt and Soda companies which directly discharge industrial effluents at this area without any treatment. These results are in a good agreement with that reported by Issa et al, 1996. Seasonal variations of copper in water of Nile River at different selected locations were found to be within the range 0.19 - 0.30 mg/l in spring and 0.04 - 0.07mg/l in autumn (Table 1). According to the Egyptian General Authority of Standardization and Quality Control (2000), the permissible limit of the Copper value in water was 2 mg/l. Therefore, the Nile River at the examined area was not exceeding the permissible limit of Copper in both of spring and autumn. The values of Pb concentration (Table 1) were found to be in the range of 0.02 - 0.55 mg/l; the higher values were recorded in spring (0.18 - 0.55) and the lower values (0.02 - 0.04) were recorded in autumn (Table 1). The concentrations of Pb in the water of the studied area were higher than Egyptian maximum permissible level (0.01 mg/l.) recommended by Egyptian General Authority of Standardization and Quality Control (2000). Lead pollution could pose a threat to human health such as high pressure, anemia, kidney damage, impaired healing and mental retardation (Wagner, 1995). In addition, the mean values of cadmium concentration (Table 2) were varied in the range of ND - 0.05 mg/l. No cadmium values were recorded at any point in spring; while, in autumn the values ranged between 0.01-0.05 mg/l. These results indicate that cadmium concentration in autumn exceeded the permissible limit (0.003 mg/l). Cadmium toxicity may cause anemia, dry and scaly skin, emphysema, fatigue, hair loss, heart disease, depressed immune system response, hypertension, joint pain, kidney stones or damage, liver dysfunction or damage, loss of sense of smell, lung

cancer, pain in the back and legs, and yellow teeth in humans. Additionally, the concentrations of Mercury (Table 2) were found to be in the range of 0.29 - 0.78 mg/l in spring; and 0.36 - 0.60 mg/l in autumn. Regarding to our results, the pollution with mercury exceeds the permissible limit (0.001 mg/l) in all examined samples. The presence of high values of heavy metals in this study indicated that the water quality deterioration is pronounced. This result is parallel to Daifullah et al. (2003) and Moustafa et al. (2010) who reported that analyzed water samples at Kafr El- Zayat indicated higher values of Fe, Mn, Zn, Cu, Pb, Hg and Cd than the permissible levels, due to discharges of industrial companies. In general, the distribution of these metals at the area under investigations are strongly affected by the industrial effluents produced from Soda & Salt and El-Malyia companies which directly discharge industrial effluents at this area without any treatment. These results are in a good agreement with that reported by Issa et al, (1996). In the present study, P concentrations fluctuated between 0.017- 0.525 mg/l in spring; the lowest value was recorded at point 5, while the highest value was detected at point 8. In autumn P values were ranged between 0.21 - 0.40 mg/l (Table 2). These values may be related to industrial effluents of fertilizers, pesticides, herbicides and detergent enriched by phosphorus. NH₃ fluctuated in wide range of seasonal variations and showed high concentrations (7.2 mg/l) affected by industrial effluents of El-Malyia company discharging into the aquatic environment of the branch at point 3. The ranges of NH₃ were found to be 0.04- 0.37 mg/l in spring, compared with 2.9 - 7.2 mg/l in autumn (Table 3); which showed noticeable increase of NH₃ during autumn season. The highest concentration values were recorded during cold season, which may be related to the low water levels and the leaching of fertilizer residues used on the agriculture into the aquatic

environment of the branch via drains. This result is coincident with that reported by Abdo (2013) on Rosetta Branch and Abdel-Satar (2008) on Lake Manzalah. Generally, the average values of ammonia concentrations during autumn season in the water of the studied area at Kafr El- Zayat showed higher levels than the chronic guidelines (1.46 mg/l) recommended by USEPA (1999) for the protection of aquatic life. This result agreed with that finding registered by Abdo (2002), and Abdo (2013) on the same area. The sulphur concentrations were varied in the ranges of 6.78 - 54.09 and 5.4 - 38.11 mg/l in spring and autumn seasons respectively (Table 3). The highest concentration values in both spring (54.09 mg/l) and autumn (38.11 mg/l) season were recorded at point 4. The increase in S of Rosetta branch at point 4 could be attributed to the industrial effluents of El-Mobidat Company discharged at these locations. The present results agreed with the findings of Abdel-Satar and Elewa (2001), Sayed (2003), Moustafa et al. (2010) and Abdo (2013). The bacteriological examination of water samples from Nile River at Kafr El- Zayat city showed that TBCs ranged from 6×10^3 to 5×10^5 cfu/ml and from 1.9×10^3 to 3.7×10^5 cfu/ml in spring and autumn, respectively (Table 4). Therefore, there were no significant seasonal changes of Total Bacterial Count in water of Nile River at Kafr EL-Zayat industrial area during spring and autumn 2010. This observation does not comply with previous studies where highest bacterial counts of the River Nile water at Damietta Branch were recorded during summer (Sabae and Rabeh, 2007). The foodborne pathogens that were examined in the present study were: *Salmonella* spp. and *Escherichia coli*. The use of these pathogens as indicator bacteria for assessment of faecal pollution and possible water quality deterioration in fresh water sources is widely used (APHA, 1998). Currently, *Salmonella* spp. and *E. coli* are of great

importance among bacterial indicators used in water quality definition and health risk (Giannoulis et al., 2005; McEgan et al., 2013). In the present study, the isolates of genus *Salmonella* were identified in all points except at points 2, 3 and 4 (Table 4). There were no seasonal changes of *Salmonella* occurrence in water of Nile River at Kafr EL-Zayat industrial area during spring and autumn 2010. *Salmonella* spp. previously constituted 11% of gram-negative bacteria from the examined water samples of Dameitta Branch (Sabae and Rabeh, 2007). Unexpectedly, *Escherichia coli* were not detected in any water sample in this study. This also indicated that the water of Rosetta Branch at Kafr EL-Zayat is not subjected to sewage pollution or the industrial effluents of water may affect on survival of *E. coli*. Recently, studies have shown that the combination of ozonated water and metal ions or the dissolution of ZnO nanoparticles in water may be useful as antimicrobial agents for *E. coli* (Kang et al., 2013; Li et al., 2013). However, *E. coli* (as the main indicator of fecal pollution) was detected in 16% of the identified gram-negative bacteria in the examined water samples of Dameitta Branch (Sabae and Rabeh, 2007). With regards to metal accumulation in tissues of fish, our results indicated that the accumulation of the measured heavy metals increases in the following order:- cadmium < copper < lead < mercury. This interpretation is closely agreed with that reported by Mohamed and Gad, (2008). As shown in Table 5, copper was not detected in fish muscles at any point during spring 2010, and cadmium was not detected during spring or autumn. The seasonal variations were found to be in the range of 0.02 - 0.03 µg/g in autumn for copper; 0.02- 0.08 in spring and 0.04- 0.25 µg/g in autumn for lead; 4.24 - 9.1 in spring and 1.7 - 2.4 µg/g in autumn for mercury. The concentration of Cu in the muscle of the studied fish are below the permissible level for Cu (30 mg/kg)

recommended by the National Health Medical Research Council (Marks et al, 1980). On contrary, the concentrations of Pb and Hg in the muscle of the studied fish were more than maximum permissible level for Pb (0.5 and 0.6 µg/g respectively) recommended by the WHO (WHO, 1986). Therefore, the accumulation of such pollutants in certain tissues of the fishes may cause several hazards or even may be fatal to the consumers. Additionally, seasonal variations of phosphorous in the fish flesh at different selected points were found in the range of 0.35 - 0.45 µg/g in spring and 0.26 - 0.36 µg/g in autumn; ammonia 16.9 - 19.2 µg/g in spring and 24.5 - 27.8 µg/g in autumn; sulphur 40.83 - 46.1 µg/g in spring and 30.87 - 34.28 µg/g in autumn (Table 5). The high values of phosphorus in muscle of Nile fish are in close agreement with values reported by Petenuci et al., (2008). Ammonia is extremely toxic and even relatively low levels pose a threat to fish health (El Gammal and El Shazely, 2008). However, certain fish species can accumulate high levels of ammonia in the brain or defense against ammonia toxicity by enhancing ammonia excretion (Ip and Chew, 2010). The bacteriological examination of fish samples from Nile River at Kafr El- Zayat city showed that TBCs ranged from 4×10^5 to 5×10^5 cfu/g in spring and from 3×10^5 to 5×10^5 cfu/g in autumn (Table 5). So, no seasonal variation of TBCs in muscle of fish was observed. Similar findings were also noticed in the present study regarding TBC of water samples (Table 4), indicating that TBC of fish in a certain season is related to the TBC of water in the same season. Importantly, the entire fish samples tested were positive for *Salmonella* and negative for *E. Coli*. This result is parallel to the results of bacteriological analysis of water samples in this study, proving that the Nile water is the main contamination source for fish in the same area. Egyptian General Authority of Standardization and Quality Control (2000) recommended 10^6

total bacterial counts per gram as a maximum permitted limit for fish, and added that fish must be free from *Salmonella* and *Shigella*. In addition, Goosney et al. (2001) reported that bacterial pathogens could survive and persist to exploit their host's cellular processes to mediate their effects extracellularly or intracellularly. In a zoonotic survey, *Salmonella* was isolated from the Nile tilapia fish as the most common pathogen (Onyango et al., 2009). The sources of salmonellae are poorly understood, and this study provides vital data that is critical in assessing and controlling the risk associated with the presence of salmonellae in the Nile environment. The presence of diverse enteric bacteria in the aquaculture environments suggests that strict hygiene procedures should be followed during the handling and processing of fish from the culture systems to prevent the transfer of potentially pathogenic bacteria to humans. In conclusion, the results demonstrate that the Nile River at Kafr El- Zayat industrial area is heavily polluted and consequently harmful effects to the aquatic environment and to the quality of the water are established. So, pretreatment of different wastes through chemical and microbiological unit before discharging to the River Nile stream is recommended.

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