

## Monitoring of some disinfection by-products in drinking water treatment plants at El-Beheira Governorate, Egypt

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### ABSTRACT

Two water treatment plants (Edfina and Kom-Hamada) in EL-Beheira Governorate were selected to monitor disinfection by-products (DBPs) concentrations. A twelve month monitoring program from October 2011 to September 2012 was established for measuring of some DBPs and some water quality parameters such as temperature, pH, turbidity, total organic carbon (TOC), ammonia and bromide. The concentrations of DBPs were determined by gas chromatography with electron capture detector (GC-ECD). For Edfina plant (plant 1), the mean pH values ranged from 7.5 to 7.72 and from 7.0 to 7.22 for raw and treated water. The mean turbidity values ranged from 2.3 to 3.71 NTU and from 0.6 to 0.8 NTU for raw and treated water. The mean TOC values ranged from 5.3 to 6.6 mg/l and from 3.6 to 4.6 mg/l for raw and treated water. The mean ammonia values ranged from 0.6 to 3.1 mg/l for raw water and was not found in treated water. For Kom-Hamada plant (plant 2), the mean pH values ranged from 7.8 to 8.1 and from 7.2 to 7.6 for raw and treated water. The mean turbidity values ranged from 7.4 to 12 NTU and from 0.6 to 0.8 NTU for raw and treated water. The mean TOC values ranged from 5.8 to 8.5 mg/l and from 3.8 to 6.1 mg/l for raw and treated water. The mean ammonia value was 0.4 mg/l and found only in winter. It was not found in treated water. Bromide was below limit of quantification (LOQ) in all samples. Trihalomethanes (THMs) and chloral hydrate (CH) were commonly seen in all samples collected from plant 1 and plant 2. THMs mean concentrations were ranged from 34.5 to 64.6 µg/l and from 28.2 to 52.8 µg/l for plant 1 and plant 2. CH mean concentrations were ranged from 3.3 to 6.76 µg/l and from 2.8 to 3.9 µg/l for plant 1 and plant 2. Dichloroacetonitrile (DCAN) mean concentrations were ranged from 1.1 to 2.0 µg/l and from 1.2 to 2.1 µg/l for plant 1 and plant 2. Chloropicrin (CP) detected in plant 1 only with mean concentration ranged from 0.91 to 1.1 µg/L. Trichloroacetonitrile (TCAN) and dibromoacetonitrile (DBAN) were below LOQ in all samples. Higher concentrations of THMs were measured in the summer and spring compared to winter. DBPs concentrations were higher in plant 1 than in plant 2. The DBPs levels in all samples collected from Edfina and kom-Hamada were generally below the guideline values set by the Egyptian health minister in 2007.

**Key words:** Disinfection by-products, drinking water, water quality, treatment plant.

### INTRODUCTION

Chlorine is one of the most commonly used disinfectants in water treatment due to its low cost, easy operation and especially its high efficiency in killing pathogenic microorganisms but have been reported to form disinfection by-products (DBPs) which are suspected to be human carcinogens (Woo *et al.*, 2002; Hu *et al.*, 2010).

THMs consist of several methane derivative compounds and the four chemical species, comprise chloroform (CF), bromodichloromethane

(BDCM), dibromochloromethane (DBCM) and bromoform (BF). THMs were suspected to cause not only cancer but also liver and kidney damage, retarded fetus growth, birth defects and possibly miscarriage (Wright *et al.* 2004). The US Department of Health and Human Services has determined that chloroform may be anticipated to be a carcinogen. Also, it has been shown that dibromochloromethane and bromoform could damage the nervous system (USEPA, 2001). Though the reported concentrations of halonitromethanes (HNMs) were much lower than THMs and haloacetic acids (HAAs) and have not been regulated, cytotoxicity and genotoxicity posed by HNMs are comparable or even higher as compared to THMs and HAAs (Richardson *et al.*, 2007). To minimize the risk of cancer, the United States Environmental Protection Agency (USEPA) and the World Health Organization (WHO) have introduced regulations for levels of some DBPs in drinking water. USEPA regulation for THMs concentrations was set at 80 µg/l (USEPA, 2001). WHO has suggested a provisional guideline value of 20 µg/l for DCAN, while DBAN guideline value was set at 70 µg/l (WHO, 2008). The maximum contaminant level (MCL) for THMs compounds in Egypt was set at 100 µg/l, while CH, TCAN, DCAN and DBAN were set at 10, 1, 20 and 70 µg/l, respectively (Ministry of Health, 2007).

THMs concentrations were investigated in Egypt. Hassan *et al.* (1996) determined the range of THMs in Alexandria city in Egypt. The detected range of THMs was 49.6-67.3 µg/l. Chloroform and dichlorobromomethane constitute the major fraction of THMs (36.86% and 35.14%, respectively). Chlorodibromomethane was detected in lower concentration (25.09%) while bromoform was found only in trace amounts (2.91%). Geriash *et al.* (2008) studied the concentration of the THMs in eight water treatment plants along Ismailia Canal. THMs concentration was ranged from 52-112 µg/L. It is noticed that the concentrations of THMs are remarkably increased during winter season in all of the examined treatment units, which may be attributed to the flourishing of microbiological life during this low stage of the canal water and increasing of the effluent income to its course.

In Egypt, the main focus of the disinfection by-products is THMs. Only limited researches are conducted on other DBPs such as haloacetonitriles, haloketones, chloropicrin and chloral hydrate. The objective of this study was to monitor the levels of disinfection by-products (DBPs) and other water quality parameters such as pH, turbidity, alkalinity, TOC, bromide and ammonia in raw and treated water from two treatment plants in Beheira Governorate, Egypt and compared with the maximum contaminant level (MCL).

## **MATERIALS AND METHODS**

### **Sampling**

Sampling was conducted monthly between 10<sup>th</sup> and 20<sup>th</sup> each sampling day from October 2011 to September 2012 from two selected treatment plants in Beheira Governorate, Egypt. Monthly results expressed as an average for three replicates of samples. These plants are Edfina plant (Plant 1) and Kom-Hamada plant (plant 2). These treatment plants were selected to cover different points of surface water in Beheira Governorate. Chlorine disinfection and conventional treatment processes used in both plants. Conventional treatment processes phases were prechlorination, flocculation, sedimentation, filtration and postchlorination.

The sampling period was chosen to cover the seasonal variations during one year and all operational changes. Raw water samples were collected from the entrance of surface water to the plant, while the treated samples were collected from the finished treated water tank.

Samples were collected in 1 liter plastic bottle for measurement of water quality parameters such as pH, turbidity, alkalinity, ammonia and bromide. 60 ml amber glass vials were used to collect samples for DBPs analysis. Temperature, residual chlorine and pH were measured in the field immediately.

### **Analytical procedures**

All measurements were carried out according to the Standard Methods for the Examination of Water and Waste Water (APHA, AWWA, WEF, 2005). All chemicals and reagents were purchased from HACH, Sigma-Aldrich, Chemlab, Merck, Scharlau and Panreac.

Temperature and pH were measured for surface and treated water using portable HACH multi-parameter. Residual chlorine was measured for treated water by photometric method (S.M. 4500-Cl G) (APHA, AWWA, WEF, 2005) using HACH colorimetric.

Turbidity was measured for surface and treated water using HACH 2100N turbidity meter (S.M.2130B) (APHA, AWWA, WEF, 2005). Ammonia and bromide were determined by Dionex-600 ion chromatography equipped with electrochemical detector (ECD-50), isocratic pump (IP25) using instrument manual. Ammonia and bromide were determined for surface and treated water.

### **Analysis of Total Organic Carbon (TOC)**

TOC analysis was performed according to (S.M. 5310B) (APHA, AWWA, WEF, 2005) for raw and treated water samples. TOC was analyzed with TOC Analyzer (Tekmar-Dohrmann Apollo 9000).

### **Analysis of DBPs**

Trihalomethanes (chloroform, bromodichloromethane, chlorodibromomethane, and bromoform), haloacetonitriles (HANs) (trichloroacetonitrile, dichloroacetonitrile, dibromoacetonitrile), chloropicrin,

1,1,1-trichloropropanone and chloral hydrate were analyzed as described in USEPA method 551.1 (USEPA Method 551.1, 1995).

An Agilent 7890A Gas Chromatograph with an electron capture detector (ECD) with DB-1 30m×0.25mm×1.00µm capillary column was used for identification and quantification of DBPs. GC conditions, injection temperature was 220° C. ECD temperature was 300° C. Column temperature program was 35° C held for 9 minutes, then a 1° C per minute increase to 40° C which was maintained for 3 minutes, and finally a 6° C per minute increase until a temperature of 150° C was reached, which was held for 1 minute. The injection was splitless with a set time for 0.5 minutes. Flow was set to 23 cm/sec linear velocity.

#### Method validation and uncertainty.

The validation procedure including limit of quantification (LOQ), recovery (%R) and relative standard deviation (% RSD) based on EURACHEM Guide for method validation (EURACHEM Guide, 1998). All results are shown in Table 1. The mean recovery ranged from 82-120%. The mean RSD ranged from 4-9%.

**Table 1:** LOQ, RSD%, Recovery and MU for DBPs analysis.

Compound	LOQ <sup>a</sup>	RSD% <sup>b</sup>	Recovery%	MU <sup>c</sup>
Chloroform	1	5	85-117	
Bromodichloromethane	0.5	6	82-116	
Dibromochloromethane	0.5	6	88-114	
Bromoform	0.2	7	84-116	
Trichloroacetonitrile	0.1	5	84-120	
Dichloroacetonitrile	1	8	83-114	15%
Dibromoacetonitrile	1	9	85-117	
Chloral hydrate	0.2	7	85-115	
Chloropicrin	0.5	4	84-116	
1,1,1-Trichloropropanone	0.5	6	82-116	

a: LOQ=Limit of quantification. b:RSD% relative standard deviation, c:MU= Method Uncertainty.

#### Calibration and quality control

- Blank sample analyzed with every sequence.
- A calibration curve was set at five calibration standard levels.
- Two calibration standards at different concentration levels analyzed at the beginning and the end of sample set.
- Surrogate standard (decafluorobiphenyl) injected in each sample to measure extraction efficiency with accepted recovery up to 20%.

## RESULTS AND DISCUSSION

### Water quality characteristics

Raw water pH ranged from 7.32 to 8.1 and from 7.5 to 8.25 for plant 1 and plant 2, respectively. For plant 1, the maximum average value of pH (7.72) for raw water found in winter, while minimum average value (7.5) was in spring. For plant 2, the maximum average value (8.1) for raw water reported in autumn, while minimum average value (7.53) was in spring. Treated water pH ranged from 6.83 to 7.4 and from 7.5 to 8.25 for plant 1 and plant 2, respectively. For plant 1, the maximum average value (7.22) for treated water reported in summer, while minimum average value (7.0) was in spring. There was no definite variation between seasons. For plant 2, the maximum average value (7.6) for treated water was reported in autumn, while minimum average value (7.2) was in winter.

Raw water turbidity results were ranged from 2.1 to 3.9 NTU and from 2.2 to 15.3 NTU for plant 1 and plant 2, respectively. For plant 1, the maximum average value (3.71 NTU) was reported in spring, while the minimum average value (2.3 NTU) was in autumn. For plant 2, the maximum average value (12 NTU) reported in autumn, while the minimum average value (7.4 NTU) was in spring. All results of treated water turbidity were below 1 NTU.

Free chlorine residual results in treated water ranged from 0.89 to 1.8 mg/l and from 1.3 to 1.7 mg/l for plant 1 and plant 2, respectively. For plant 1, the maximum average value was 1.6 mg/l and reported in winter, while the minimum average value was 1.2 mg/l and reported in summer. For plant 2, the maximum average value was 1.6 mg/l and reported in autumn, while the minimum average value was 1.37 and reported in summer.

The raw water TOC results ranged from 4.8 to 7.9 mg/l and from 4.8 to 9 mg/l for plant 1 and plant 2, respectively. For plant 1, the maximum average value (6.6 mg/l) reported in winter. The minimum average value (5.3 mg/l) reported in spring. For plant 2, the maximum average value (8.5 mg/l) reported in winter, while the minimum average value (5.6 mg/l) was in spring. These ranges of TOC are higher than range reported by Geriash *et al.* (2008). They reported a range varied between 2.4 and 5.3 mg/l in Ismailia Canal in Egypt. They noticed also that the maximum result reported in winter due to the low stage level of the canal during this season (effluent conditions). The treated water TOC results were ranged from 2.9 to 5.7 mg/l and from 3 to 6.3 mg/l for plant 1 and plant 2, respectively.

Raw water ammonia (NH<sub>3</sub>) results ranged from 0.55 to 5.1 mg/l and from 0.3 to 0.45 mg/l for plant 1 and plant 2, respectively. For plant 1, the maximum average value (3.1 mg/l) reported in winter, while the minimum average value (0.6 mg/l) reported in summer. For plant 2, it was detected only in autumn. These ranges were higher than range reported by Othman, *et al.* (2012) in Ismailia Canal in Egypt (0.07–1.49mg/l). It was not present in all treated water samples.

In comparison, plant 2 has a higher maximum average pH and turbidity than plant 1. Plant 1 and Plant 2 have the same trend of TOC results, where the maximum average values were found in winter and the minimum were found in summer. But plant 2 has higher results than plant 1. The higher results of raw water in plant 2 than plant 1 may be due to plant 2 supplied from smaller canal than plant 1.

Raw water ammonia (NH<sub>3</sub>) results were much higher in plant 1 than in plant 2 especially in winter and autumn. This is due to low stage of water and increasing discharge of sewage in Rosetta branch.

### Occurrence and speciation of DBPs

THMs were detected in all samples of plant 1 and plant 2 (Tables 1 and 2). THMs concentrations ranged from 19.9 to 81.4 µg/l and from 18.5 to 59.5 µg/l for plant 1 and plant 2, respectively. The maximum average value for plant 1 was 64.6 µg/l. It was reported in spring, while its minimum average value was 34.5 µg/l. It was reported in winter (Figure 1). The maximum average value for plant 2 was 52.8 µg/L. It was reported in summer, while the minimum average value was 28.2 µg/L. It was reported in winter (Figure 1). Increasing in THMs concentration in spring and summer related to increasing of temperature. This trend is in agreement with what reported in many researches (Golfinopoulos and Nikolaou, 2005; El Shehawy and Awad, 2012). El Shehawy and Awad (2012) reported lower maximum value for THMs (61.4 µg/l) in Fayoum, Egypt. They reported that the highest THMs formation occurred in spring and summer while the lowest in winter.

Chloroform was the most abundant THMs species followed by BDCM and DBCM which represent about 54%, 33% and 13% in plant 1 and 55%, 32% and 13% in plant 2, respectively. Bromoform concentrations were below the LOQ in all samples. The percentages of chloroform were lower than those of Ates *et al.* (2007). They reported that chloroform was found to be the major THMs compound (77.9%), followed by BDCM (16.4%), DBCM (4.9%), and bromoform (0.9%).

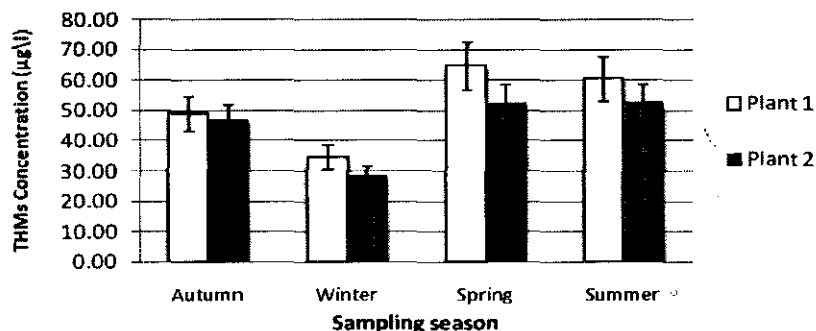


Figure 1: Seasonal variation of THMs concentrations in plant 1 and plant 2.

Other DBPs including halogenated acetonitriles (HANs), 1,1,1-trichloropropanone (TCP), chloral hydrate (CH) and chloropicrin (CP) were usually detected in treated water samples but at lower concentrations from THMs (Table 1, Table 2).

CH is the most abundant compound after THMs. CH was detected in all samples of the two plants. CH ranged from 1.2 to 8.2 µg/l and from 1.8 to 5.2 µg/l for plant 1 and plant 2, respectively. The maximum average result in plant 1 was 6.76 µg/l, it was reported in summer. Its minimum average result was 3.3 µg/l, it was reported in autumn (Figure 2). The maximum average result in plant 2 was 3.9 µg/l, it was reported in spring. Its minimum average result was 2.8 µg/l, it was reported in winter (Figure 3). These ranges are in agreement with results reported by Lebel *et al.* (1997), and Wei *et al.* (2010). CH/THMs ratios were calculated to compare CH to THMs. This ratio ranged from 6% to 16% and from 3% to 10% for plant 1 and plant 2 respectively. The highest ratio was reported in winter while the lowest one was reported in summer. These ranges are in agreement with Koudjonou *et al.* (2008).

**Table 1:** Seasonal variation of DBPs for plant 1.

DPBs	Autumn <sup>a</sup>		Winter		Spring		Summer	
	Range	Mean ± SD <sup>b</sup>	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD
THMs <sup>c</sup>	27.4-72.1	48.8±16.5	19.9-45.1	34.5±9.0	50.7-81.4	64.6±10.5	54.9-65.9	60.2±5.5
TCAN	ND	NA	ND	NA	ND	NA	ND	NA
DCAN	1.7-2.5	2.0±0.44	1.4-1.8	1.6±0.2	ND-1.3	1.1±0.1	1.7-2.1	1.9±0.3
DBAN	ND	NA	ND	NA	ND	NA	ND	NA
CH	1.2-4.5	3.3±1.8	4.8-6.1	5.4±0.67	5.7-8.2	6.7±1.3	6.2-7.3	6.7±0.6
CP	ND	NA	0.71-1.1	0.91±0.2	ND-1.3	1.1±0.09	ND	NA
TCP	1.9-2.4	2.1±0.45	2.1-2.3	2.2±0.1	1.8-2.1	1.9±0.15	1.6-2.2	1.9±0.3

a: Autumn (Oct to Dec2011), Winter (Jan to March2012), Spring( Apr to Jun2012) Summer ( Jul to Sep 2012) b: Mean± Standard deviation, c: THMs = CF+DCBM+DBCM+BF, d-ND: Not detected, e- NA: no assigned value

**Table 2:** Seasonal variation of DBPs for plant 2.

DBPs	Autumn <sup>a</sup>		Winter		Spring		Summer	
	Range	Mean $\pm$ SD <sup>b</sup>	Range	Mean $\pm$ SD	Range	Mean $\pm$ SD	Range	Mean $\pm$ SD
THMs <sup>c</sup>	33.9-56.3	46.4 $\pm$ 11.4	18.5-40.1	28.2 $\pm$ 10.9	47.7-57.4	52 $\pm$ 6.4	44.3-59.5	52.8 $\pm$ 6.9
TCAN	ND	NA	ND	NA	ND	NA	ND	NA
DCAN	ND-1.7	1.4 $\pm$ 0.2	ND-1.4	1.2 $\pm$ 0.1	1.8-2.3	2.0 $\pm$ 0.25	1.7-2.4	2.1 $\pm$ 0.4
DBAN	ND	NA	ND	NA	ND	NA	ND	NA
CH	2.5-4.5	3.4 $\pm$ 1.0	2.5-3.1	2.8 $\pm$ 0.3	2.6-5.2	3.9 $\pm$ 1.3	1.8-4.2	2.9 $\pm$ 1.2
CP	ND	NA	ND	NA	ND	NA	ND	NA
TCP	1.8-4.2	2.1 $\pm$ 0.3	1.6-1.9	1.8 $\pm$ 0.2	1.7-2.2	2.0 $\pm$ 0.3	1.7-2.6	2.2 $\pm$ 0.5

a: Autumn (Oct to Dec2011), Winter (Jan to March2012), Spring( Apr to Jun2012) Summer ( Jul to Sep 2012) b: Mean $\pm$  Standard deviation, c: THMs = CF+DCBM+DBCM+BF, d-ND: Not detected, e- NA: no assigned value

For HANs, TCAN and DBAN were below LOQ in all samples in plant 1 and plant 2. DCAN was found in 75% and 67% from samples of plant 1 and plant 2, respectively. The concentration range was from ND to 2.5  $\mu\text{g/l}$  and from ND to 2.4  $\mu\text{g/l}$  for plant 1 and plant 2, respectively. These ranges are in agreement with Wei *et al.* (2010), they found the range was from ND to 3.43  $\mu\text{g/l}$ .

TCP was detected in all water samples of plant 1 and plant 2. Results ranged from 1.5 to 2.4  $\mu\text{g/l}$  and from 1.6 to 2.6  $\mu\text{g/l}$  for plant 1 and plant 2, respectively. These values are in agreement with Wei *et al.* (2010), but lower than values found in turkey by Baytak *et al.* (2008), which reached up to 7.81  $\mu\text{g/l}$ .

CP was found in about 30% of the total samples of plant 1, while was not present in all plant 2 samples. Plant 1 results were ranged from ND to 1.3 $\mu\text{g/l}$ . These values are lower than values found in Beijing City, China by Wei *et al.* (2010), which reached up to 2.08  $\mu\text{g/l}$ . It is noticed that CP detected only from January 2012 to April 2012 in which level of ammonia in raw water was higher than 1.5 mg/l.

In comparison, plant 1 has generally higher DBPs concentration than plant 2. This is due to plant 1 has larger reservoir than plant 2 which mean higher contact time leading to higher DBPs formation. Maximum average value of plant 1 is higher than plant 2 maximum average value. But about seasonal variation, THMs concentration increase in summer and spring, while they decrease in winter. The percentages of each compound in THMs value are very close in the two plants. Plant 1 results show higher CH concentration and CH/THMs ratio than plant 2. In the two plants, CH/THMs ratios have the highest value in winter and the lowest value in summer. DCAN and TCP results of both plants are in agreement with each other. There is no observed seasonal variation for these compounds. CP



was not found in plant 2 while found in 30% of samples of plant 1 due to high level of ammonia in plant 1 raw water in winter season.

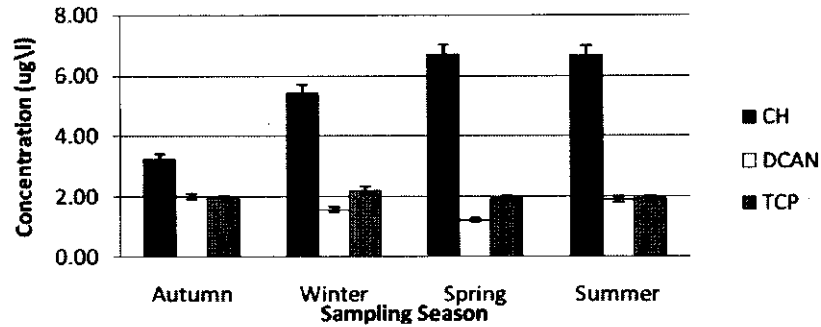


Figure 2: Seasonal variation of CH, DCAN and TCP in plant 1

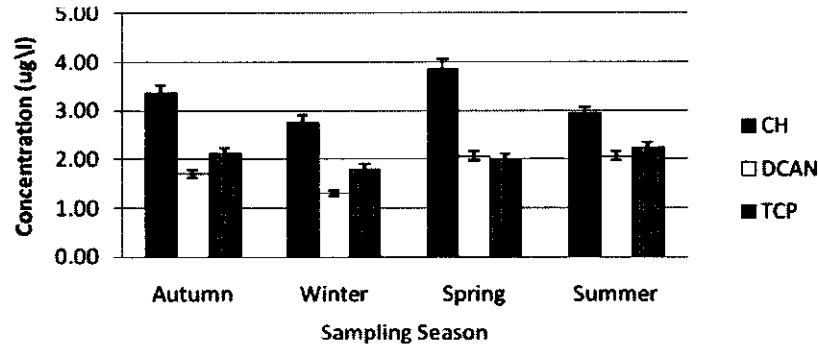


Figure 3: Seasonal variation of CH, DCAN and TCP in plant 2

## CONCLUSION

- Samples of drinking water from the two plants, Edfina and Kom-Hamada, were analyzed for water quality parameters and Disinfection by-products (DBPs). The results indicated that the DBPs levels in all samples collected from October 2011 to September 2012 were generally below MCL set for these compounds in drinking water guidelines.
- Higher DBPs results were detected in spring and summer, while the lowest results detected in winter.
- Plant 1 show higher DBPs concentrations than plant 2 due to larger reservoir of plant 1.
- Chloroform was the most abundant THMs species with a percentage up to 55%.
- CH/THMs ratios were ranged from ratio increase during winter and decrease in summer.
- CP detected only in the presence of high level of ammonia in raw water.

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### المخلص العربي

رصد بعض نواتج عملية تعقيم المياه في محطات معالجة مياه الشرب بمحافظة

البحيرة، جمهورية مصر العربية

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<sup>2</sup>المعمل المركزي لمياه الشرب بشركة مياه الشرب و الصرف الصحي بالبحيرة

هذا البحث يستهدف رصد بعض مركبات نواتج تفاعل الكلور أثناء عمية تطهير المياه وبعض خصائص المياه في محطات معالجة الشرب بمحافظة البحيرة حيث تم رصد نتائج محطة ادفيبا ومحطة كوم حماده شهريا لمدة عام من أكتوبر ٢٠١١ إلى سبتمبر ٢٠١٢. وقد تم تقدير المركبات الناتجة عن عملية التطهير باستخدام جهاز الكروماتوجرافي الغازي GC-ECD

أوضحت نتائج محطة ادفيينا ان متوسط نتائج الرقم الهيدروجيني تراوحت بين ٧,٥ إلى ٧,٧٢ و من ٧ إلى ٧,٢٢ في المياه الخام و المياه المعالجة. وكان متوسط نتائج العكارة يتراوح بين ٢,٣ الى NTU٣.٧١ و ٠,٦ الى ٠,٨ في المياه الخام و المياه المعالجة. وتراوحت نتائج المواد العضوية الكلية بين ٥,٣ إلى ٦,٦ ملليجرام/لتر و ٣,٦ إلى ٤,٦ ملليجرام/لتر في المياه الخام و المياه المعالجة. وتراوح متوسط نتائج الأمونيا بين ٠,٦ إلى ٣,١ ملليجرام/لتر في المياه الخام ولم تكن موجودة في المياه المعالجة. وأوضحت نتائج محطة كوم حماده ان متوسط نتائج الرقم الهيدروجيني تراوحت بين ٧,٨ إلى ٨,١ و من ٧,٢ إلى ٧,٦ في المياه الخام و المياه المعالجة. وكان متوسط نتائج العكارة يتراوح بين ٧,٤ الى NTU١٢ و ٠,٦ الى ٠,٨ في المياه الخام و المياه المعالجة. وتراوح متوسط نتائج المواد العضوية الكلية بين ٥,٨ إلى ٨,٥ ملليجرام/لتر و ٣,٨ إلى ٦,١ ملليجرام/لتر في المياه الخام و المياه المعالجة. وكان متوسط نتائج الأمونيا ٠,٤ ملليجرام/لتر في المياه الخام وتم رصدها في فصل الشتاء فقط ولم تكن موجودة في المياه المعالجة. جاءت نتائج البروميديا اقل من حد التقدير الكمي في كل العينات. تم رصد مركبات التريال هالوميثان و مركب الكلورال هيدرات في جميع العينات في محطة ١ و محطة ٢. تراوح متوسط نتائج مركبات التريال هالوميثان من ٣٤,٥ إلى ٦٤,٦ ميكرو/لتر و من ٢٨,٢ إلى ٥٢,٨ ميكرو/لتر في محطة ١ ومحطة ٢. وتراوح متوسط نتائج الكلورال هيدرات من ٣٤,٥ إلى ٦٤,٦ ميكرو/لتر و من ٢٨,٢ إلى ٥٢,٨ ميكرو/لتر في محطة ١ ومحطة ٢. متوسط نتائج داي كلورواسيتونيتريل تراوح بين ١,١ إلى ٢ ميكرو/لتر و من ١,٢ إلى ٢,١ في محطة ١ ومحطة ٢. كلوروبيكريد وجد في محطة ١ فقط وتراوح متوسط النتائج بين ٠,٩١ إلى ١,١ ميكرو/لتر. جاءت نتائج تريال كلورواسيتونيتريل و داي برومواسيتونيتريل أقل من حد التقدير الكمي في كل العينات. كانت نتائج التريال هالوميثان اعلى في فصل الربيع و الصيف بالمقارنة مع فصل الشتاء. كما كانت نتائج المركبات في محطة ١ أعلى من محطة ٢. و إجمالاً كانت نتائج المركبات الناتجة عن عملية التطهير أقل من الحد الأقصى المسموح به في قرار وزير الصحة الخاص بمياه الشرب رقم ٤٥٨ لسنة ٢٠٠٧.