EFFICIENCY OF TRADITIONAL WATER TREATMENT PLANT AND COMPACT UNITS IN REMOVING VIRUSES

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Abstract

The fecal bacteria have been taken as the gold standard for water industry. However, the spread of viral gastroenteritis due to drinking water have given a momentum to a recent push by microbiologists to consider viruses as important pollution indicator as fecal bacteria. Therefore, we designed a study to evaluate the efficiency of two types of water purification systems: the traditional water treatment plant and two types compact units. Both systems produced drinking waters free of bacteria, chemical contaminants and mostly viruses free. However, recent advances in molecular biology techniques, such as RT-PCR have detected Rotaviruses in chlorinated drinking waters resulted from all systems. The frequency of Rotaviruses since October 2010 till September 2012 in Shark El-Mansoura WTP in drinking water samples was 12.5% similar to raw water. While the compact unit at Depo Awam (American design) the frequency of Rotavirus was 16.6% in both raw and drinking water samples. On the other hand the virus frequency in the raw and drinking water sample in El-Danabik unit (Egyptian design) were 12.5% and 4.16% respectively. Signifying failure of the chlorination process in removing viruses completely. However, detection of Rotavirus genome in the drinking water samples does not means the presence of its infectivity. The infectious ability of the rotaviruses was confirmed by CC-RT-PCR in all positive samples, where viral RNA was not detected in the collected drinking water samples. In conclusion RT-PCR and CC-RT-PCR techniques high lightened the need to include viruses as mandatory pollution indicator in water treatment plants.

Keywords: Viral gastroenteritis; Drinking water; Rotaviruses; Pollution; Water purification systems; RT-PCR

Introduction

Many health risks are associated with drinking water include infectious diseases caused by bacteria, protozoa, viruses and intestinal helminthes (Ress et al., 2000 and Gibson et al., 2011). This is dramatized in the 842,000 deaths and billions of cases of diarrheal disease were reported annually due to the inadequate access to either sufficient and/or safe drinking water (Clasen et al., 2014). The dependence of water treatment and manufacturing industry on bacterial indicators such as total coliform, fecal coliform (Escherichia coli), Streptococci and Salmonella) was not enough (Leclerc et al., 2002 and Carducci et al., 2013). Since the bacterial indicators do not always reflect the risks associated with other important pathogenic bacteria, protozoan parasites (Cryptosporidium, Giardia) and enteric viruses (Griffin et al., 2001, Jiang et al., 2001 and Noble and Fuhrman, 2001).

Waterborne illness is complicated due to the presence of about 140 different serological types of viruses, found in water via sewage contamination. These viruses are capable of causing illnesses to humans such as acute gastroenteritis (AGE) diseases (Taylor et al., 2001, Hamza et al., 2009, Enserink et al., 2015 and Patil et al., 2015). These viruses are transmitted from person to person or through contaminated drinking water, food and bathing or recreational water (Rodriguez-Lazaro et al., 2012). The poor correlation of bacterial indicators with viruses is of particular concern because it cannot be used as reliable indicators of faecal pollution and viral particles in water (Jurzik et al., 2010, Chigor and Okoh, 2012 and Carducci et al., 2013). Furthermore, enteric viruses were detected in raw, surface water, ground water and treated drinking water despite meeting quality standards for coliform bacteria (Cho et al., 2000 and Pusch et al., 2005).

Considering the following virus attributes: low infectious doses, linkage with both acute and chronic disease and frequent implication in swimmer-associated illnesses (Fong and Lipp, 2005). Moreover, Chigor and Okoh (2012) have shown that bacteriological indicators, some human viruses and coliphages may beneficially serve as an index in determining viral contamination and the presence of human fecal waster. Generally, viruses are more resistant to extreme environmental conditions and treatment processes, such as chlorination, UV radiation and filtration compared...
to fecal bacterial indicators and other pathogens (Ahmed et al., 2010). While, enteric viruses are relatively resistant to heat, disinfectants and pH changes despite the absence of viral envelope (Koopmans et al., 2002). Most of the enteric viruses are host specific and thus allow screening of the species which is the source of fecal contamination (Silva et al., 2011 and Wu et al., 2011). Enteric viruses are shed in extremely high numbers in the feces of infected individuals, 10^9 to 10^13 virus particles per gram of stool (Hamza et al., 2009 and Schultz et al., 2011).

Acute gastroenteritis, mainly diarrhea, is one of the most common diseases in human, and remains a leading cause of morbidity and mortality worldwide. It is reported that about 3–5 billion cases of acute gastroenteritis occur each year in children under 5 years, resulting in nearly 2 million deaths (Parashar et al., 2003, Mulholland, 2004 and Elliott, 2007). In developing countries, the incidence rate of acute gastroenteritis is 2.1 to 3.8 diarrhea episodes per child between 11 and 48 months of age per year (Kosek, 2003).

This has posed the challenge of finding a suitable indicator of viral contamination of drinking water. In 2008, the World Health Organization has estimated that rotavirus alone caused 453, 000 deaths, accounting for 5% of all deaths in children younger than 5 years old (WHO, 2012). Therefore, we have taken rotaviruses as good indicators production good quality drinking waters. In this study, we detected Rotavirus in raw Nile water and after each step of treatment in Shark El-Mansoura Water Treatment Plant (WTP) and the two compacts units of Depo Awam and El-Danabik villages.

Materials and Methods

Sites of the water treatment plant and compact units

Two types of water treatment plants distributed in three sites were involved in this study. The conventional Shark El-Mansoura water treatment plant (WTP) which supplies residents of Mansoura City, Egypt, with drinking water. While, the two compact units of Depo Awam (American design) and El-Danabik (Egyptian design) supplies drinking water to residents of respective villages. The WTP is supplied by the raw water from El-Mansoria canal and the water treatment in this plant goes through the traditional steps of flocculation, sedimentation, sand filtration and final chlorination. The Depo Awam unit is supplied by fresh waters from Bahr Tnab and El-Danabik unit is supplied by raw water from a small fresh water canal branched from El-Bahr El-Sageer canal.

Water Samples Collection

A total of 192 water samples (20 litters each) were collected from the three sites in the period of October 2010 to September 2012. A total of 96 samples were collected from the different steps of water purification in WTP as follow: 24 samples from raw water (inlet), 24 samples after sedimentation step, 24 samples after sand filtration step and 24 samples from outlet water (drinking). While, 48 water samples were collected from each compact unit: 24 samples from inlet raw water and 24 samples from outlet water. The chlorinated water samples were treated with sodium thiosulfate (0.5% wt/v) to inactivate chlorine followed by 6N aluminum chloride, to increase the stability of the viruses in the concentrated water samples (APHA, 2005).

Physicochemical Analysis of Water Samples

The physicochemical properties of raw water samples: like temperature, pH, turbidity, alkalinity, electrical conductivity, hardness, chloride, dissolved oxygen and consumed oxygen were measured by the standard procedure detailed in the Egyptian standard methods (EMH, 2007) and the American standard methods (APHA, 2005).

Bacteriological Analysis of Water Samples

Fecal contamination analysis of water samples were performed according to the universally accepted standard methods for bacteriological examination of waters. In these methods we estimated the number of live heterotrophic bacteria on R2A (low nutrient media), total coliform bacteria using membrane filter technique within 24 h at 35°C on an Endo-type medium containing lactose, the fecal coliform using M-FC media at 44.5 ± 0.2°C and detection of fecal Streptococcus group on m-enterococci media grown for 48 hr at 35 ± 0.5°C (APHA, 2005).

Virus Isolation

Primary and secondary water samples concentrations were performed by adsorption/elution technique (APHA, 2005). Primarily, the water samples were acidified (pH 3.5) before filtration, to enhance the adsorption of virus particles to the negatively charged nitrocellulose membrane filters. Viruses were eluted from the nitrocellulose membranes by a 70 ml of 0.05 M glycine buffer containing 3% beef extract, pH ~9.5 (Smith and Gerba, 1982 and Rose et al., 1984). In the secondary concentration, the eluate from primary concentrate is again acidified (pH 3.5) to help viruses to be trapped in the flocks of proteins and organic components before being harvested by centrifugation at 3,000 rpm. Each of the harvested pellets was dissolved in 1 ml Na2HPO4 (0.14N, pH 9) and kept at -70°C until used for detection of viruses (Katznelson et al., 1976).

Extraction of Total RNA from Rotaviruses

The Rotaviruses RNA was extracted by the TRIzol method (BIOZOL Total RNA Extraction reagent, BioFlux, Japan) according to the manufacturer’s instructions as detailed by Steyer et al (2008). The RNA pellet was dissolved in 50-100µl of RNase-free water and stored at -70 °C for further use.

Reverse Transcriptase-PCR (RT-PCR)

Rotavirus viral protein 6 (VP6), is the gold standard for detection and diagnosis of all Retroviruses. Two pairs of oligonucleotide primers were used to amplify a 379-b region of the VP6 gene: VP6-F: 5'-

This paper can be downloaded online at [http://ijasbt.org](http://ijasbt.org) & [http://nepjol.info/index.php/IJASBT](http://nepjol.info/index.php/IJASBT)
GACGGNCNACTACATGGT-3' and VP6-R: 5'-GTCCAA TTCTNCCCTGGTG-3'. A second pair of primers, VP6-NF: 5'-GCTAGAA ATTTTGATACA-3' and VP6-NR: 5'-TCTGCAATTTGTAATC-3', were used to amplify a 155 b fragment. Extracted water samples (5 µl) were heated to 99°C for 5 min and immediately placed on ice. Salts, nucleotides, primers and 100 U of reverse transcriptase (Fermentas-EU) were added in 10 µl final volume to give a working concentration of 50 mM Tris-HCl, pH 8.3, 40 mM KCl, 5 mM MgCl₂, 5 mM DTT, 0.5 mM Tween 20, 0.2 mM of each dNTPs (Fermentas-EU) and 1 µM of both VP6-F and VP6-R primers. The samples were incubated for 60 min. at 50°C for the RT reaction. Five µl of the RT product were added to a final volume of 50 µl of the PCR reaction mix containing 5 µl of the PCR buffer (Fermentas-EU), 2 mM MgCl₂, 0.2 mM of each dNTPs, 1 µM of each primer and 2.5 U of the Taq DNA polymerase enzyme (Fermentas-EU). After a denaturation step of 95°C for 3 min, 40 cycles of amplification at 94°C for 1 min, 50°C for 1 min, and 72°C for 1 min. were performed with a final extension of 72°C for 10 min. The nested PCR involved adding 2 µl of first-round PCR product to a 48 µl PCR mix containing 10 mM Tris (pH 8.0), 50 mM HCl, 2.5 mM MgCl₂, 0.2 mM of each dNTPs (Fermentas-EU), 1 µM of VP6NF and VP6NR primers, and 2.5 U of Taq DNA polymerase (Fermentas-EU). Cycling conditions for VP6NF/VP6NR were 35 cycles of 94°C for 1 min, 42°C for 1 min, and 72°C for 1 min. PCR products (10 µl) were analyzed by electrophoresis on 3% agarose gels (Iturriza-Gomara et al., 2002 and Gallimore et al., 2006).

**Results and Discussion**

International and local standards were set and established worldwide for drinking water purifications processes which included minimum and maximum limits for contaminants. Water purification processes are intended to remove all sorts of contaminants from natural waters (rivers, canals and/or reservoirs) which are loaded with undesirable chemicals and biological contaminants, that can cause human illness such as bacteria, viruses, fungi, protozoa and some algae.

Two types of water purifications systems do exist in Egypt and worldwide. The traditional methods of water purification (includes physical processes such as flocculation, sedimentation, sand filtration and chlorination) and the pre-packed compact smaller units used for quick water purification mainly in rural areas. The two systems examined in Mansoura and its surroundings proved to be highly efficient in removing all sorts of chemicals and microbial contaminants from raw waters and produced drinking waters meeting all national and international standards. However, their abilities to remove the viral causative agents of human illnesses, such as Rotavirus. Since Rotaviruses was detected in some drinking water samples from both systems. While seasonal detection of Rotaviruses in winter and autumn was observed.

Water quality through the presence of pathogenic enteric microorganisms may negatively affect human health. Where, coliform bacteria, such as Escherichia coli, and coliphages are normally used as indicators of water quality. However, the presence of above-mentioned indicators do not always suggest the presence of human enteric viruses which may be more resistance than the bacterial indicators. Therefore, Lin and Ganesh, (2013) concluded that it is highly important to study human enteric viruses in water to avoid their pathogenic action on children and immune-compromised people. While the current study demonstrated the efficiency and efficacy of the two water treatment systems in removing all microbial and undesired chemical contaminants. It failed to completely remove causative agents of gastroenteritis viruses such as Rotaviruses (Tables 1, 2 and Fig 1).

![Fig. 1: Agarose gel electrophoresis (3%) in TBE buffer stained with ethidium bromide showing RT-PCR product profile of VP6 gene characteristic of Rotaviruses in examined water samples, lane 1: raw water of Shark El Mansoura (Jan.2011), lane 2: after sedimentation water of Shark El Mansoura (Jan.2011), lane 3: after sand filtration of Shark El Mansoura (Jan.2011), lane 4: chlorinated effluents of Shark El Mansoura (Jan.2011), lane 5: raw water of DepoAwam CU (Nov.2011), lane 6: chlorinated effluents of Depo Awam CU (Nov.2011), lane 7: raw water of El-Dnabik CU (Nov.2011), 8: chlorinated effluents of El-Dnabik CU (Nov.2011), all bands of positive samples were appeared with a size about155b. Marker: OX 174 / HaeIII (Bio labs).](http://nepjol.info/index.php/IJASBT)
(3/24), and 4.16% (1/24) in raw water and Chlorinated effluents, respectively. Only water samples collected in the months of January 2011 and September 2011 showed positive results for the existence of Rotaviruses. While, RT-PCR positive Rotavirus were detected in raw and drinking water samples collected from the compact units of Depo Awam and Danabik in the months of November 2010 and September 2011, suggesting a failure in the systems in the mentioned months only.

Table 1: Rotavirus in water samples collected from Water treatment plants.

| Year | WTPs | Shark El Mansoura¹ | Depo Awam² | El Dnabik³ |
|------|------|---------------------|------------|------------|
|      | Months | Raw water | After Sedimentation | After Sand Filtration | Tap water | Raw water | Tap water | Raw water | Tap water |
| 2010 | October | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
|      | November | - | - | - | - | + | + | - | - | - | - | - | - | - | - | - | - | - | - | - |
|      | December | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
|      | January | + | - | + | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
|      | February | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
|      | March | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
|      | April | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
|      | May | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
|      | June | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
|      | July | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
|      | August | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
|      | September | + | - | - | + | - | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| 2011 | October | - | + | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
|      | November | - | + | - | - | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
|      | December | + | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
|      | January | - | - | - | - | + | + | - | - | - | - | - | - | - | - | - | - | - | - | - |
|      | February | - | + | - | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
|      | March | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
|      | April | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
|      | May | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
|      | June | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
|      | July | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
|      | August | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
|      | September | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

1: Traditional water treatment plant  
2: American design compact unit  
3: Egyptian design compact unit  
+: Presence  
-: Absence
Table 2: Total coliforms, fecal coliforms and fecal streptococci of selected raw water and drinking samples

| Water Treatment System | Type of Water | Bacterial Colony Forming Unit (CFU) / 100 ml |
|------------------------|--------------|--------------------------------------------|
|                        |              | Total coliforms | Fecal coliforms | Fecal streptococci |
|                        | Month/year   | Oct 2010 | Jan 2011 | Apr 2011 | Jul 2011 | Sep 2011 | Oct 2010 | Jan 2011 | Apr 2011 | Jul 2011 | Sep 2011 | Oct 2010 | Jan 2011 | Apr 2011 | Jul 2011 | Sep 2011 |
| Shark El-Mansoura¹     | Raw water    | <5x10³   | 30x10³  | 53x10³  | 73x10³  | 56x10³  | 69x10²  | 55x10²  | 12x10²  | 25x10²  | 45x10²  | 44x10    | 35x10    | 22x10    | 35x10    | 19x10    |
|                        | Drinking     |          |         |         |         |         |         |         |         |         |         |          |          |          |          |          |          |
|                        | water        | nil      | nil      | nil      | nil      | nil      | nil      | nil      | nil      | nil      | nil      | nil       | nil       | nil       | nil       | nil       | nil       |
| Depo Awam²             | Raw water    | <5x10³   | 29x10³  | 41x10³  | 70x10³  | 45x10³  | 77x10²  | 34x10²  | 10x10²  | 19x10²  | 26x10²  | 57x10    | 39x10    | 37x10    | 37x10    | 29x10    |
|                        | Drinking     |          |         |         |         |         |         |         |         |         |         |          |          |          |          |          |          |          |
|                        | water        | nil      | nil      | nil      | nil      | nil      | nil      | nil      | nil      | nil      | nil      | nil       | nil       | nil       | nil       | nil       | nil       |
| Danabik³               | Raw water    | <5x10³   | 26x10³  | 43x10³  | 68x10³  | 47x10³  | 76x10²  | 30x10²  | 9x10²   | 17x10²  | 29x10²  | 58x10    | 37x10    | 33x10    | 39x10    | 21x10    |
|                        | Drinking     |          |         |         |         |         |         |         |         |         |         |          |          |          |          |          |          |          |
|                        | water        | nil      | nil      | nil      | nil      | nil      | nil      | nil      | nil      | nil      | nil      | nil       | nil       | nil       | nil       | nil       | nil       |

1- Traditional water treatment plant  
2- American design compact unit  
3- Egyptian design compact unit
### Table 3: The physico-chemical parameters of selected water samples in different seasons

| Seasons  | Autumn 2010 |  |  | Winter 2011 |  |  | Spring 2011 |  |  | Summer 2011 |  |  |
|----------|-------------|--|--|-------------|--|--|-------------|--|--|-------------|--|--|
| WTPs     | Shark¹      | Depo²     | ElDnabik³ | Shark¹      | Depo²     | ElDnabik³ | Shark¹      | Depo²     | ElDnabik³ | Shark¹      | Depo²     | ElDnabik³ |
| Water types | Raw | Tap | Raw | Tap | Raw | Tap | Raw | Tap | Raw | Tap | Raw | Tap | Raw | Tap | Raw | Tap | Raw | Tap | Raw | Tap |
| Raw      | 23.2        | 24.7      | 23   | 23.5   | 23   | 23.4  | 18     | 18   | 18.6  | 18.4  | 18   | 18.7  | 24   | 24.5  | 24.4  | 24.4  | 24   | 31.7 | 31.5 | 30.3 | 30   | 30.4 |
| Tap      | 7.68        | 7.32      | 7.63 | 7.34   | 7.7   | 7.37  | 7.74   | 7.25  | 7.78  | 7.32  | 7.75 | 7.38  | 7.7  | 7.3   | 7.75  | 7.75  | 7.25 | 7.75 | 7.3  | 7.72 | 7.38 | 7.4 |
| PH       | 267         | 277       | 265  | 273    | 265  | 287   | 295    | 316   | 276   | 289   | 373  | 319   | 237  | 240   | 231   | 236   | 235 | 251  | 207  | 211  | 209  | 212  | 195 | 200 |
| T.D.S    | 146         | 132       | 144  | 138    | 148  | 132   | 148    | 132   | 142   | 136   | 148  | 132   | 126  | 118   | 128   | 118   | 128 | 124  | 134  | 114  | 138  | 128  | 116 | 116 |
| Alk       | 142         | 140       | 138  | 138    | 140  | 142   | 144    | 138   | 146   | 140   | 138  | 148   | 118  | 114   | 114   | 118   | 112 | 130  | 120  | 114  | 124  | 124  | 120 | 120 |
| Ca Hardnes | 88          | 88        | 88   | 88     | 86   | 82    | 86     | 82   | 88    | 80    | 82   | 88    | 82   | 80    | 78    | 78    | 82   | 64   | 66   | 82   | 82   | 80   | 76 |
| Mg Hardnes | 54          | 52        | 50   | 50     | 54   | 60    | 58     | 56   | 58    | 60    | 56   | 60    | 36   | 34    | 36    | 34    | 34   | 48   | 46   | 48   | 42   | 42   | 40   | 44 |
| Sulphate  | 20          | 25        | 20   | 25     | 20   | 24    | 38     | 42   | 28    | 34    | 37   | 34    | 27   | 36    | 23    | 32    | 28   | 31   | 24   | 30   | 30   | 33   | 28   | 34 |
| Chlorides | 30          | 38        | 28   | 38     | 26   | 32    | 38     | 46   | 30    | 38    | 36   | 48    | 26   | 30    | 22    | 30    | 24   | 30   | 18   | 26   | 20   | 30   | 18   | 24 |
| Amonia    | 0.13        | 0.13      | 0    | 0.2    | 0.15 | 0     | 0.15   | 0    | 0.15  | 0     | 0.15 | 0     | 0.12 | 0     | 0.15  | 0    | 0.16 | 0    | 0.16 | 0    | 0.19 | 0    | 0.18 | 0 |
| Nitrite   | 1.7         | 2.7       | 2.1  | 3.8    | 2.3  | 3.8   | 3.7    | 5    | 2.8   | 3.9   | 2.4  | 3.2   | 3.81 | 4.4   | 2.5   | 5.3   | 3.4  | 5.5  | 3.9  | 5.7  | 2.8  | 5.3  | 5.1  | 5.5 |
| Nitrate   | 0.017       | 0.006     | 0    | 0.008  | 0    | 0.031 | 0.015  | 0    | 0.08  | 0     | 0.015| 0     | 0.021| 0     | 0.021 | 0    | 0.022| 0    | 0.005| 0    | 0.023| 0    | 0.021| 0 |
| Iron      | 0.05        | 0.02      | 0.01 | 0.01   | 0.01 | 0.01  | 0.01   | 0    | 0.01  | 0     | 0.002| 0.01  | 0.04 | 0.01  | 0.01  | 0     | 0.02 | 0    | 0.02 | 0    | 0.01 | 0    | 0    | 0 |
| Manganese | 0           | 0         | 0    | 0      | 0    | 0     | 0      | 0    | 0     | 0     | 0    | 0     | 0    | 0     | 0     | 0     | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| Almonium  | 0.038       | 0.065     | 0.038| 0.078  | 0.044| 0.069 | 0.014  | 0.021| 0.01  | 0.08  | 0.017| 0.061 | 0.008| 0.014 | 0.02  | 0.034| 0.006| 0.019| 0.009| 0.022| 0.021| 0.51| 0.02| 0.04|
| (DO)      | 6.4         | 7.9       | 6.2  | 8.2    | 5.6  | 7.9   | 5.7    | 8    | 6.4   | 7.8   | 5.6  | 5.3   | 6    | 8     | 6    | 7.4   | 6    | 7.4  | 5.2  | 6.5  | 5.6  | 7.2  | 6.2  | 7.5 |
| (COD)     | 3.9         | 4         | 0    | 3.9    | 0    | 4     | 3.9    | 0    | 4     | 0     | 3.9  | 0     | 3.9  | 0     | 3.5  | 0     | 3.9  | 0    | 4.6  | 0    | 3.2  | 0    | 4    | 0 |

1- Traditional water treatment plant (Shark El Mansoura)
2- American design compact unit (Depo Awam)
3- Egyptian design compact unit (El Dnabik)
These results were similar to the previously published reports on Rotaviruses in raw Nile water, treated drinking water and ground waters in Egypt (El-Senousy et al., 2004, El-Senousy and El-Mahdy, 2009, El-Senousy et al., 2013a&b and El-Senousy et al., 2014), Tunisia (Sdiri-Louliziz et al., 2008) and France (Gratcap-Cavallier et al., 2000). The French report emphasized that the winter epidemics of Rotavirus infections was associated with a high level of interhuman transmission, after they have analyzed drinking waters in homes of children suffering from Rotaviral gastroenteritis by RT-PCR. Moreover, they have detected in the children's feces rotavirus genome different from human Rotaviruses, three of them were of animal origin (porcine or bovine). On the other hand, Grassi, et al (2010) showed the widespread viral contamination in different water samples collected from Italy and Rotaviruses peaked in spring. On the contrary, Verheyen, et al (2009) have concluded that no seasonal pattern for viral contaminations was found after comparisons of water samples obtained during the dry and wet seasons from Benin, West Africa. The detection of genome in the drinking water samples did not mean the capability of the virus to cause diseases. It does not confirm the infectivity of the virus (He et al., 2009). Liu et al., (2006) attributed the higher frequency of detection of rotaviruses (for example) was due to an outbreak of diarrheal in Beijing 2006 where Rotavirus was detected in 60% of all diarrheal patients. The traditional water treatment is extensive process and involves several steps subjective to humans interferences, compact units do everything inside without such interference. Although the disinfecting power of chlorine is well documented in the literature against all types of microbes including viruses, the detection of Rotaviruses in the drinking water sample in Shark El-Mansoura WTP suggested a failure in the chlorination process which needs attention. Chlorination was reported denature the proteins and causes breakage in the nucleic acid molecules (Ogata, 2007). These should be sufficient to remove all forms of microbes and viruses. Moreover, the detection of viruses in drinking waters produced by the two compact units indicate an inherited problems with these units which requires more and thorough investigation.

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