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Bacteriological, Physical and Chemical Characteristics of the Drinking Water in Different Cities of Egypt

Aida H. Afify*; F. I. A. Hauka; M. A. E. Selim and Mai G. Abd-elhameed

Microbiology Dept., Fac. of Agric., Mansoura Univ., Mansoura, Egypt .

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ABSTRACT

It is will know that drinking water is very important and essential for human life. If water is not good or polluted, human health will be affected and it will cause many diseases. This study was conducted to evaluate the quality (bacteriological and chemical) of the drinking water which collected from tab water , ground water , River Nile water and bottled water from different cities in El-Dakahlia and Damietta Governorates , Egypt during four season , summer , autumn , winter and spring . Five bacterial isolates (*Escherichia coli*, *Kleibsila pneumoniae, Staphylococcus aureus, Staphylococcus epidermidis* and *Streptococcus* sp. were choosed and identified by morphologically, biochemically and molecularly as well as tested for antibiotics sensitivity. Results showed that there are difference between bacterial isolates sensitivity and different groups of antibiotics. Also, the water samples were physically and chemically analyzed for temperature, pH, electrical conductivity(EC), turbidity, total dissolved solids (TDS), total alkalinity, total hardness, ammonia, nitrate, nitrite, chloride, sulfate, phosphate, calcium hardness and magnesium hardness. High values as shown of Damietta for turbidity, pH, total alkalinity, total hardness and sulfate in tab water. In ground water, most significant high values of TDS in all water sources in El-Dakahlia . On other hand, the total alkalinity and total hardness of Damietta River Nile water recorded highest values compare with El-Dakahlia Governorate. In bottled water, the lowest values were observed compared with other sources of water especially in physical properties for water samples.

Keywords: Bacteriological, Physico - Chemical characteristics, Drinking water, Antibiotics .

INTRODUCTION

Water is considered the most important factor for life . So, it must be offered in a good state and to be sure that it free from any pollutants. Microbiological aspects are the most important indices for potable water whereas living microorganisms survive in potable water (such as bacteria, algae, fungi and protozoa) produce an unpleasant taste and odor . Moreover, the carry significant infections diseases or produce harmful toxins especially in the developing countries (WHO 2003) .

As a matter of fact, there is no drinking water approximately, free from microorganisms and microelements (Van dr Kooij , 1982). Therefore, bacteriological examination is the most important and useful parameter, which has been established for evaluating the quality of potable water. *Escherichia coli* is commonly used as an indication for water supplies contamination with domestic sewage (Allen and Gerldrich 1978 and USEPA, 2004) . *E. coli* is sub – group of fecal coliform (Office of Drinking Water System Management, 2004) . Staphylococci can be used as a useful indicator of pollution, where they had significant correlation with classical bacterial indicators, physic – chemical characters and phytoplankton biomass (Ali *et al*., 2000). Also, Sabae *et al*., (2006) reported that the pathogenic bacterial isolates included : *Escherichia coli* (16%) , *Klebsiella pneumoniae* (14%) and others bacteria (70%). Levy (1998) found that *Staphylococcus aureus* responded poorly to a once reliable antidote the antibiotic vancomycin . Fortunately in those patients, *Staph. aureus* remained susceptible to other drugs and

was eradicated. But the appearance of *Staph. aureus* not readily cleared by vancomycin for esh adows trouble . Lin *et al.,* (2005) studied the *in vitro* activities of 18 antibiotics against *K. pneumoniae* isolates. All isolates were susceptibility to imipenem and cefmetazole but, they were resistant to 11 antibiotics from 18 antibiotics. At the same time (Niumsup *et al*., 2008) found that fifty clinical isolates of *K. pneumonae* and *E.coli* with reduced susceptibility to third generation cephalospores collected from hospitals in Thailand.

Lu *et al.,* (2003) reported that total dissolved solids (TDS) are including organic and inorganic matters. Narouze (1991) mentioned that high level of TDS has physiological effects such as laxative mainly from both Na_2SO_4 and $MgSO_4$ salts.

This work was designed to collect some information about the microbiological aspects of potable water in different cities from El- Dakahlia and Damietta Governorates. This research aims to evaluate the bacteriological and physicochemical properties of drinking water to confirm and identify bacterial isolates which isolated from different sources of potable water in El-Dakahlia and Damietta Governorates.

MATERIALS AND METHODS

Source of water samples:

Four different types of water namely: tap water, ground water, River Nile water and bottled water were used . 320 water samples and eighty samples for each source were used for microbiological and physico-chemical analysis.

The samples were collected from four different cities (Sherbin, Mansoura, Meet-khamis and Damietta) from two Governorates (El-Dakhlia and Damietta) during four seasons (summer, autumn, winter and spring) at 2017 and 2018 years . Samples were collected in 100 ml sterile glass bottles, preserved in ice-box and examined within 8 hours. One ml of sodium thiosulphate (12.41g/L distilled water) was added to the bottle samples of chlorinated drinking water in order to eliminate chlorine residual .

Bacteriological examinations :

Total bacterial counts were determined by two methods (pour plate method and membrane filter technique) to isolate pathogenic bacteria from different sources of water, described by Abd-elhameed *et al.,* (2021).

Cultures purification were essential for accurate and bacterial isolates were identified on the basis of their morphological and biochemical properties according to Bergey's Manual of Determinative Bacteriology (2005).

Different bacterial isolates from shape were sent to identify by Molecular characterization using 16S rRNA (Boy, *et al.,*1999). This technique was performed by Sigma Scientific Services Company, Cairo, Egypt and amplified by polymerase chain reaction (PCR) using universal eubacteria specific primers.

Antibiotics sensitivity assay

The effect of antibiotics on the bacterial strains using the discs diffusion method. The cultural strains are spreading and incubated for 18 hr. with different antibiotic discs after that antibiotic zone inhibition were measured by millimeter(mm). Ten antibiotics from different groups of antibiotics were used to determin the sensitivity of each bacterial species. For all antibiotics three replicated were maintained (Araujo, *et al.,* 2003). The antibiotics and their, concentration (µg/mL) and mode of action were used as follows:

Antibiotics used	Antibiotic group	Mode of action	Concentration (µg/mL)
Cefoxitin	Cephalosporin	Cell wall synthesis	30
Vancomycin	Glycopeptide	Protein synthesis	30
Erythromycin	Macrolides	Protein synthesis	15
Ceftriaxone	Cephalosporin	Protein synthesis	30
Ampicillin	Beta-lactam	Cell wall synthesis	10
Cefaclor	Cephalosporin	Cell wall synthesis	30
Chloramphenicol	Macrolides	Protein synthesis	30
Levofloxacin	Quinolones	DNA synthesis	5
Ciprofloxacin	Quinolones	DNA synthesis	5
Neomycin	Aminoglycoside	Protein synthesis	30

Physical and chemical analysis:

Temperature, pH values, electrical conductivity (EC), turbidity, total dissolved salts (TDS), total alkalinity (mg $CaCO_3$/ L), total hardness, ammonia, nitrate, nitrite, chloride, sulfate, phosphate, calcium and magnesium were determined according to the method of APHA (2011).

Statistical analysis:

Using SAS (2001) numerical data collected was statistcally analyzed for analysis of variance (ANOVA) and Least significant difference (LSD) was used to compare treatment means at propability (P) level of < 0.01.

RESULTS AND DISCUSSION

Identification of bacterial isolated from water samples
Identification of bacterial isolates by standard tests

In this study, five bacterial isolates from different sources of water samples were purified as following : isolate No. (1) from tap water, isolate No. (2) from ground water, isolate No. (3,4 and 5) from River Nile water. Morphological and biochemical characterization by Abd-elhameed (2021) suggested that the five isolates may belong to the rods and cocci and vary in shape according to Bergy's Manual of Determinative of Bacteriology (2005) as shown in (Table 1).

Table 1. Morphological and biochemical properties of the water isolated bacteria

| Bacterial isolates No.	Source of water	G-Stain	Cell shape	Motility	Catalase	Oxidase	Lactose	Indole	M R	VP	Urease	Citrate
1	Tap water	-	Straight Rods	+	+	-	+	+	+	-	-	-
2	Ground water	-	Bacilli	-	+	-	+	-	-	+	+	+
3	River Nile	+	Cocci	-	+	+	+	-	-	-	+	-
4	River Nile	+	Coccus in clusters	-	+	-	+	-	+	-	+	-
5	River Nile	+	Cocci	-	-	-	+	-	+	-	+	-

(+)= positive reaction ; (-)= negative reaction

Molecular identification of the bacterial isolates

The phylogentic tree (Fig.1) showed high genetic relationship between the isolate No.2 and the strain of *Klebsiella pneumoniae* which strongly prove that the isolate No.2 can be identified moleularly as *K. pneumoniae*, based on the 16S rRNA nucleotide sequence and the phylo-tree analysis . Also, the phylogentic tree (Fig.2) showed high genetic relationship between the isolates No.3 &No.4 and the strains of *Staphylococcus epidermidis* , *Staph. aureus* , respectivily which strongly prove that the isolates No.3 &No.4 can be identified moleularly as *Staph. epidermidis* and *Staph. aureus*, based on the 16S rRNA nucleotide sequence and the phylo-tree analysis .

The three bacterial isolates (Nos. 2,3 & 4) were identified analyzing the sequence of 16S rRNA gene and phylogentic tree as following :
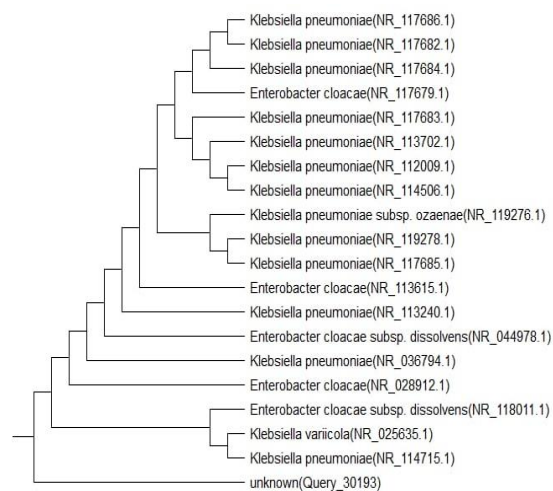
Fig. 1. Phylogentic tree of *Klebsiella pneumoniae* (isolate No. 2)
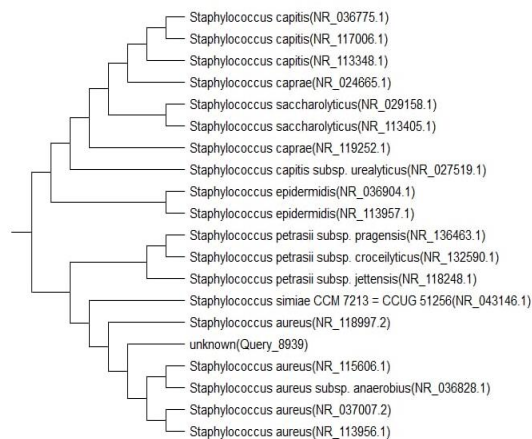
Fig. 2. Phylogentic tree of *Staphylococcus epidermidis* (isolate No. 3) and *Staphylococcus aureus* (isolate No. 4).

The PCR sequencing results of three isolated bacteria tree recorded:

Isolate No. 2 : *Klebsiella pneumoniae* strain ATCC 13883 16S ribosomal RNA

Isolate No. 3 : *Staphylococcus epidermidis* strain Fussel 16S ribosomal RNA

Isolate No. 4 : *Staphylococcus aureus* strain ATCC 12600 16S ribosomal RNA

Sensitivity of the isolated bacteria for different antibiotics :

The results from different antibiotics (Cefoxitin, Vancomycin, Erythromycin, Ceftriaxone , Ampicillin , Cefaclor , Chloramphenicol , Levofloxacin, Ciprofloxacin, Neomycin) against five isolated pathogenic species that isolated from different sources of water were tested *in vitro* using inhibition zone diameter measuring (mm)are shown in figures (3,4,5,6 & 7). The results showed difference in sensitivity to tested antibiotics against bacteria. All bacteria were sensitive to Chloramphenicol, Levofloxacin, Ciprofloxacin and Neomycin except *Streptococcus* sp. showed resistance to Neomycin, and Cefoxitin and Cefaclor.

Niumsup *et al., (*2008) reported that *E. coli* bacteria was more sensitive to Chloramphenicol, Levofloxacin and Ciprofloxacin antibiotics also, *K. pneumonia*e was more sensitive to Levofloxacin and Ciprofloxacin but with less sensitivity to Chloramphenicol antibiotic. On the other hand, *Staph. aureus* was more sensitive to Levofloxacin antibiotic other than Chloramphenicol or Ciprofloxacin.Chloramphenicol, Ciprofloxacin and Levofloxacin antibiotics had the same effect on the *Staph . epidermidis*, but Ceftriaxone had the most effective efficiency on *Streptococcus* sp. With the same sensitivity to Ciprofloxacin, Chloramphenicol and Levofloxacin antibiotics (CLSI , 2020).
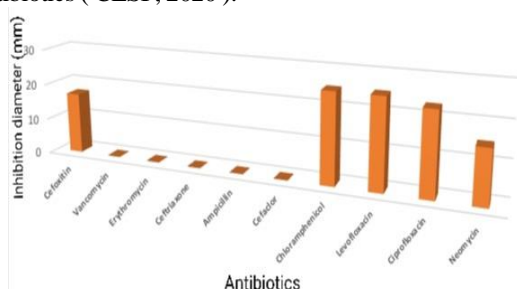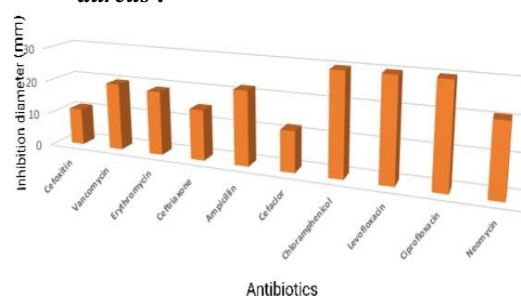

Fig. 3. Effect of different antibiotics against *E.coli*.
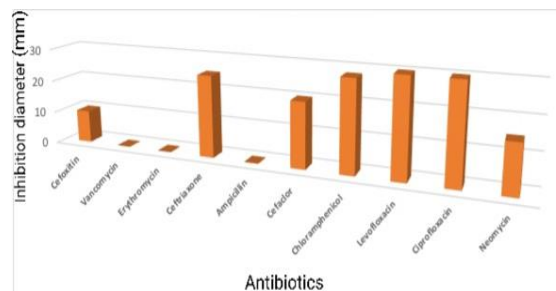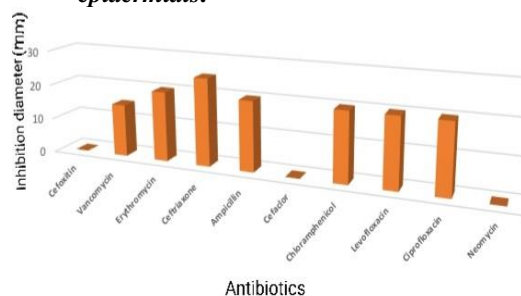

Fig. 4. Effect of different antibiotics against *K. pneumoniae* .
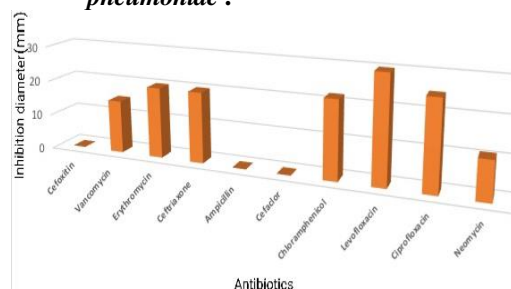
Fig. 5 . Effect of different antibiotics against *Staph. aureus* .

Fig. 6 . Effect of different antibiotics against *Staph. epidermidis*.

Fig. 7. Effect of different antibiotics against *Streptococcus* sp.

Physical and chemical properties of water samples:
Tap water

The tap water collected from Sherbin, Mansoura, Met- Khamis and Damietta cities in El- Dakahlia and Damietta Governorates were evaluated for its chemical and physical properties (Table 2). The parameters of temperature, pH, EC, turbidity, TDS, total alkalinity, total hardness, NH_3-N, NO_3-N, NO_2-N , chloride, sulfate, phosphate, Ca hardness and Mg hardness were estimated.

As shown from the results the higher values were of city of Damietta, the highest turbidity, pH, total alkalinity, total hardness and sulphate, followed by the water collected from Mansoura city, then the water of Met- Khamis and finally the water collected from Sherbin city. The highest

TDS is the water from Mansoura city, NO_2-N, and also the highest Mg hardness. The highest chloride value was estimated from the water of Sherbin followed by Mansoura then Damietta and finally Met- Khamis city. The sulfate values of Sherbin, Mansoura, Met-Khamis and Damietta were 23, 37, 29 and 46 respectively with the highest value of Damietta.

WHO (2003) considers that drinking water should be suitable for human consumption and for all usual domestic purposes including personal hygiene. Drinking water should be suitable for consumption, washing/showering and domestic food preparation. In human health terms, exposure to water and its constituents can occur through ingestion, contact and aerosol inhalation. The drinking water should be safe for life time use, taking account of differing sensitivities that occur across life stages, but all are not necessarily suitable for people suffering from certain specific immunocompromising disorders. Piped drinking water supplies typically involve source abstraction, treatment and distribution. The latter may comprise ancillary devices at domestic or institutional levels, such as softeners, activated carbon treatment, vending machines, dispensers, etc. Drinking waters also comprise those obtained from non-piped sources, such as from springs and community wells, in bottles and as ice (WHO, 2020).

Table 2. Physical and chemical properties of tap water from different cities in two Governorates

Parameter	Unit	Sherbin	Mansoura	Met-khamis	Damietta
Temperature	C^0	24	25*	25*	23
pH		6.9	7.2	6.9	7.4*
EC	dsm^{-1}	297	304	320*	290
Turbidity	NTU	4.5	5.6	5.4	7.4*
TDS	mg L^{-1}	330	356*	208	289
Total alkalinity CaCO3	mgL^{-1}	230	219	226	253*
Total hardness	mg L^{-1}	214	231	222	267*
NH_3-N	mg L^{-1}	0.13	0.24	0.09	0.35*
NO_3-N	mg L^{-1}	2.31	2.61*	1.09	2.19
NO_2-N	mg L^{-1}	0.02	0.016	0.039	0.103*
Chloride	mg L^{-1}	220*	190	112	137
Sulfate	mg L^{-1}	23	37	29	46*
Phosphate	mg L^{-1}	0.01	0.04*	0.03	0.04*
Ca hardness	mg L^{-1}	49	44	47	50*
Mg hardness	mg L^{-1}	57	65*	49	38

*Significant at P= Value ≤0.001in each group of data
NTU = Nephelometric Turbidity Unit

Ground water

Also, the physical and chemical parameters of the ground water collected from Sherbin, Mansoura, Met- Khamis and Damietta cities in the two Governorates, as shown in Table 3 and as mentioned in the ground water, the highest values of all estimated parameters , pH, EC, turbidity, TDS, total alkalinity, total hardness, NH3-N, NO3-N, , chloride, sulfate, and Ca hardness were from Damietta ground water with 7.6, 363, 9.8, 294, 551, 221, 1.67, 4.24, 50, 22 respectively the most significant high value of TDS between all other water sources in El- Dakahlia 0 and 245 respectively, the TDS of Met-Khamis was 280 mgL-1, that followed the Damietta value, . On the other hand, NO2-N, phosphate and Mg hardness of Sherbin ground water has the highest value. The highest chloride number was the number of Met- Khamis ground water 53 mgL-1.Our results are agreement with (Makinde, *et al.*,2015) who repoerted that variation were observed in all the parameters.

Table 3. Physical and chemical properties of ground water from different cities in two Governorates.

Parameter	Unit	Sherbin	Mansoura	Met_khamis	Damietta
Temperature	C^0	23	23	24*	23
pH		7.3	6.4	6.1	7.6*
EC	dsm^{-1}	320	300	349	363*
Turbidity	NTU	7.1	9.5	6.2	9.8*
TDS	mg Ll^{-1}	362*	329	280	294
Total alkalinity CaCO3	mgL^{-1}	365	350	361	551*
Total Hardness	mg L^{-1}	146	251*	168	221
NH_3-N	mg L^{-1}	1.57	1.41	1.55	1.67*
NO_3-N	mg L^{-1}	0.039	0.085	0.006	4.24*
NO_2-N	mg L^{-1}	3.26*	2.17	2.81	3.06
Chloride	mg L^{-1}	42	39	53*	50
Sulfate	mg L^{-1}	28	24	30	220*
Phosphate	mg L^{-1}	0.56*	0.44	0.28	0.50
Ca hardness	mg L^{-1}	167	149	170	245*
Mg hardness	mg L^1	80*	36	60	49

*Significant at P= Value ≤0.001in each group of data
NTU = Nephelometric Turbidity Unit

River Nile water

The chemical and physical parameters of River Nile water were estimated from four cities of the two Governorate**s**, Sherbin, Mansoura, Met- Khamis and Damietta, (Table 4). The River Nile water of Met- Khamis had the highest values of pH, EC, TDS and sulphate. On the other hand, the total alkalinity and total hardness of Damietta had recorded the highest values of 312 and 330 respectively, with the most significant high value of Ca hardness. The water collected from Mansoura city had the lowest estimated values of the parameters with 6.8, 299, 4.46, 227, 116, 256, 0.67, 2.16, 0.093, 37, 32, 1.86, 156 and 38 respectively. (Makinde, *et al.,* 2015) concluded that variation were observed with all paramerters evaluated showed higher concentration during the rainy season when water volume is increased to its maximum.

Table 4. Physical and chemical properties of River Nile water from different cities in two Governorates

Parameter	Unit	Sherbin	Mansoura	Met-khamis	Damietta
Temperature	C^0	24	24	24	24
pH		7.27*	6.8	7.01	6.32
EC	dsm^{-1}	370	299	477*	380
Turbidity	NTU	4.2	4.46	5.4	7.5*
TDS	mgL^{-1}	222	227	286*	280
Total alkalinity CaCO3	mgL^{-1}	120	116	128	312*
Total hardness	mg L^{-1}	260	256	312	330*
NH_3-N	mgL^{-1}	0.75*	0.67	0.31	0.73
NO_3-N	mg L^{-1}	2.27*	2.16	1.71	1.85
NO_2-N	mg L^{-1}	0.014	0.039	0.024	0.106*
Chloride	mg L^{-1}	30	37*	25	33
Sulfate	mgL^{-1}	26	32	34*	31
Phosphate	mg L^{-1}	1.27	1.86	1.03	2.51*
Ca hardness	mg L^{-1}	160	156	95	536*
Mg hardness	mgL^{-1}	50*	38	50*	49

*Significant at P= Value ≤0.001in each group of data ;
NTU = Nephelometric Turbidity Unit

Bottled water

Bottled water collected from market of El- Dakahlia Governorate stores were evaluated for chemical and physical properties (Table 5). The values were 24.0, 6.9, 199.0, 0.1, 119.4, 76.0, 312.0, 0.052, 1.06, 0.106, 14.02, 24.0, 0.04, 56.0 and 128.0 for , pH, EC, turbidity, TDS, total alkalinity, total hardness, NH_3-N, NO_3-N, NO_2-N , chloride, sulfate, phosphate, Ca hardness and Mg hardness, respectively.

These results are in agreement with parameter of International Health Organization for Drinking water and World Health Organization (WHO), which reported that

drinking water are contains physical chemical and bacteriological characters. Also, WHO recommendations (WHO, 2011) regulated contaminants include metals, organic compounds and bacteria.

Table 5. Physical and chemical properties of bottled water.

Parameter	Unit	
Temperature	C^0	24
pH		6.9
EC	dsm^{-1}	199.0
Turbidity	NTU	
TDS	$mg\ L^{-1}$	119.4
Total alkalinity CaCO₃	$mg\ L^{-1}$	76.0
Total hardness	$mg\ L^{-1}$	312.0
NH₃-N	$mg\ L^{-1}$	0.052
NO₃-N	$mg\ L^{-1}$	1.06
NO₂-N	$mg\ L^{-1}$	0.106
Chloride	$mg\ L^{-1}$	14.02
Sulfate	$mg\ L^{-1}$	24.0
Phosphate	$mg\ L^{-1}$	0.04
Ca hardness	$mg\ L^{-1}$	56.0
Mg hardness	$mg\ L^1$	128.0

NTU = Nephelometric Turbidity Unit

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الخصائص البكتريولوجية و الفيزيائية والكيميائية لمياه الشرب لمدن مختلفة في مصر

عايدة حافظ عفيفى ، فتحى إسماعيل على حوقه ، محمد عبد الله العوضى سليم و مي جمال عبد الحميد

قسم الميكروبيولوجي ــ كلية الزراعة ــ جامعة المنصورة ــ المنصورة ــ مصر

من المعروف ان مياه الشرب هامة جدا وأساسية لحياة البشر، ولذا فإذا كانت المياة غير جيدة او ملوثة فإن صحة الإنسان سوف تتأثر و تتسبب المياة بالتالى فى العديد من الأمراض . ولذلك أجريت هذه الدراسة لتقييم جودة مياه الشرب بكتيريولوجيا وطبيعيا و كيميائيا حيث تم أخذ عينات المياه من الحنفية و الماء الجوفى (الأرضى) ونهر النيل و كذلك من زجاجات المياه المعدنية من مدن مختلفة فى محافظتى الدقهلية و دمياط خلال فصول السنة الأربعة الصيف و الخريف و الشتاء و الربيع خلال عامى 2017/2018 و ذلك لتعريف بعض العزلات البكتيرية الملوثة () هذه الملوثات البكتيرية المعرفة أختبرت حساسيتها للمضادات الحيوية وقد تم تعريف خمسة عزلات بكتيرية بواسطة الإختبارات المورفولوجية و البيوكيميائية بالإضافة إلى التعريف بالطرق الجزيئية و ذلك بتقدير 16SrRNA وعرفت العزلات على انها : .Streptococcus sp *and Staph.epidermidis , Staph.aureus , K.pneumoniae , E.coli* كما كان هناك إختلاف بين هذه العزلات فى حساسيتها لمجموعات المضادات الحيوية المختلفة. و فى نفس الوقت بتحليل عينات المياه طبيعيا و كيميائيا للمتغيرات التالية :الأس الهيدروجينى و درجة الحرارة و العكارة و درجة التوصيل الكهربى و الأس الهيدروجينى و القلوية و عسر الماء و القلوية و الكالسيوم و الكبريتات و الفوسفور و الكلوريد و النتريت و النترات و الأمونيا. وكانت اعلى القيم المتحصل عليها فى عينة ماء الحنفية فى مدينة دمياط فى العكارة و الأس الهيدروجينى و القلوية و عسر الماء الكلى و الكبريتات . وفى الماء الأرضى(المياه الجوفية) كانت المعنوية عالية فى درجة الأملاح الكلية فى جميع عينات المياه فى محافظة الدقهلية عموما . و من جهة أخرى كانت درجة القلوية الكلية و عسر الماء الكلى عالية فى مدينة دمياط و ذلك فى عينة مياه النيل .أما فى زجاجات المياه المعدنية سجلت أقل القيم فى الخواص الطبيعية بالمقارنة بمصادر عينات المياه الأخرى .