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Bacterial and Chemical Evaluation of Drinking Water Quality at El-Gharbia Governorate, Egypt

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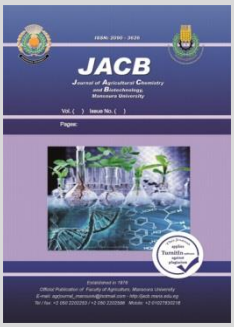

ABSTRACT

This study was conducted at El- Gharbia Governorate to evaluate the quality of water for domestic purposes. The samples of water were collected from different sites during 2012 /2013 in order to determine and identify the bacterial isolates. In addition, certain physical and chemical parameters like temperature, pH, turbidity, electrical conductivity, total of some chemicals (hardness, partial hardness, calcium, magnesium, calcium hardness, magnesium hardness, SO_4, silica, iron, manganese, aluminum, phosphoras, ammonia), Nitrite, Nitrate and Chlorides were determined to evaluate quality of Nile, ground and tap water at five sites namely: Tanta, Elmehala-Elkobra, Mehalt Abo Ali, Samanod and Mehalt-Roh. In a previous study at 2016 about 60 bacterial isolates were detected on selective media after isolation from the three sources of drinking water. These bacterial isolates were belonging to genera: *Staphylococcus, Aeromonas, Proteus, Serratia* and *Pantoea.* In this study, the Vitek Microbial system was used for identified the bacterial genera speices as: *Staphylococcus aureus, Aeromonas hydrophila, Proteus mirabilis, Serratia plymythica* and *Pantoea agglomerans*. The physical and chemical analyses showed that water qualities of three water sources are convenient for both aquatic life and domestic purposes as the normal range within a River Nile and tap water but in ground water are different.

Keywords: Bacterial identification, physico-chemical, drinking water

INTRODUCTION

On the earth, water is very important vital liquid for maintating the life. For human use, little portion of 0.3% is available as a surface and ground water. About 97% of the water is not suitable for drinking because exists in occeans and only 3% is fresh water wherein 2.97% is comprised by glaciers and ice caps (Miller, 1997). Water contamination due to pathogenic agents such as bacteria and fungi, chemicals, pesticides, water disinfectants and their by-products of industrial and agricultural activities, leaching from soil, rocks and atmospheric deposition and other human activities in different regions of the world. Through the dissolution of moneral/ores, different chemicals are being introduced into water of leaching from soil, rock or via atmospheric deposition, industrial and agricultural run off. Due to effect on groundwater quality during indiscriminate withdrawal of ground water causes deterioration (Klimas and Gregorauskas, 2002). Ali *et al*., (2000) studied the characteristics of the Nile water to evaluate the microbial nutrition state of the Nile. They reported that there are faecal bacteria, pathogenic bacteria and fungi because the Nile media receiving huge amounts of several wastes. This main reasons of the contamination of ground water are different bacteria including pathogens. There is a common misconception among people that groundwater is generally safe for human. However, it is not correct to presume that ground water is generally safe owing to qualitative changes in ground water, especially in the high-density residential areas where sewage disposal practices are not proper (Krishnan *et al*., 2007). Chemical characterization of water quality were tested tap water parameter value as follow pH 7.5 total hardness (mg/l). As $CaCO_3$ 160 calcium hardness (mg/l) as $CaCO_3$ 80 total alkalinity (mg/l) 124 chloride (mg/l) 30 Sulfate (mg/l) 36 Lead (pb) (mg/l) 0.01 and Iron (Fe) (mg/l) 0.03 (Lasheen *et al* ., 2008). This study was designed to study the microbiological , physical and chemical properties of Nile, ground and tap water samples collected from different sites at El Gharbia Governonrate Egypt to evaluate their suitability for aquatic life and domestic purposes

MATERIALS AND METHODS

Water samples

Nile, tap and ground water samples were collected from some sites at El- Gharbia Governorate, Egypt according to Afify, *et al.* (2016).

Microbiological analyses

Three types of water samples were collected in bottles, maintained in ice box and tested within 8 hours. The all analyses were carried out in the microbiological laboratory of Microbiol. Dept., Fac. of Agric., Mansoura Univ., Egypt. In this study bacterial isolates were obtained as genera identified on selective media, after that by using standerd method of identification according to Bergy's Manual 2005 and by Vitek Microbial identification (AbdAllah 2016) the biomerieux vitek® 2 system david h. Pincus bioMerieux, Inc Hazelwood, MO, USA.

Physicochemical analyses

The collected water samples were analysed for their physicochemical properties according to Rawway *et al.*

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(2016) & Afify and Abdallah (2022) using the methods mentioned in Table (1).

Table 1. The methods used to study the physicochemical properties of the collected water samples

No.	Parameters		Method
1	Temperature (ºC)		Thermometric
2	pH		Potentiometric
3	Turbidity (NTU)		Nephelometric
4	Electrical Conductivity (EC)		Potentiometric
5	Total hardness	mgL^{-1}	Titrimetric
6	Partial hardness	mgL^{-1}	Titrimetric
7	Total calcium	mgL^{-1}	Spectrophotometric
8	Total magnesium	mgL^{-1}	Spectrophotometric
9	Total calcium hardness	mgL^{-1}	Spectrophotometric
10	Total magnesium hardness	mgL^{-1}	Spectrophotometric
11	Total SO_4	mgL^{-1}	Titrimetric
12	Total silica	mgL^{-1}	Spectrophotometric
13	Total iron	mgL^{-1}	Spectrophotometric
14	Total manganese	mgL^{-1}	Spectrophotometric
15	Total aluminum	mgL^{-1}	Spectrophotometric
16	Total phosphoras	mgL^{-1}	Spectrophotometric
17	Total ammonia	mgL^{-1}	Spectrophotometric
18	Nitrite	mgL^{-1}	Spectrophotometric
19	Nitrate	mgL^{-1}	Spectrophotometric
20	Chlorides	mgL^{-1}	Titrimetric

RESULTS AND DISCUSSION

Data in Table (2) showed the bacterial genera which were found in the collected water samples based on their morphological characteristics according to Bergys Manual of Systmatic Bacteriology (2005) and Abd-elhameed *et al.* (2021). Similarly, Afify *et al.* (2016) previously isolated and identified five bacterial genera using selective media in collected drinking water samples. These genera were *Aeromonas, Staphylococcus, Proteus, Serratia* and *Pantoea*.

Table 2. Characteristics of bacterial genera isolated from drinking water

Bacterial genera	Cell size µm	Cell shape	Gram stain	Capsulation	Endospore formation	Motility
Aeromonas	0.3 x 1.0	Rod	-	-	-	+
Staphylococcus	0.5 – 1.0	Cocci	+	-	-	-
Proteus	0.3 x 1.5	Rod	-	-	-	+
Serratia	0.4 x 1.0	Rod	-	-	-	+
Pantoea	0.8 x 0.4	Rod	-	-	-	+

Biochemical characteristics and antibiotic sensitivity

Several biochemical tests and antibiotics sensitivity of the isolated bacteria were carried out as described by Afify *et al.* (2021) using biomerieux VITEK® 2 System David H. Pincus bioMerieux, Inc Hazelwood, MO, USA (Barnett *et al.*, 2000). The obtained results indicated that:

Genus *Aeromonas* was found to be positive with catalase, indole, citrate, acetate, V.P., gelatin, and lipase. While, was negative with urea, malanate and not produce acid from cellobiose, inositol, melibiose, raffinose and sorbitol. The antibiotics sensitivity test indicated that, genus *Aeromonas* is sensitive to Piperacillin, Ertapenem, Amikacin, Gentamicin, Tobramycin, Ciprofloxacin, Minocycline, Trimethoprim and Pefloxacin. While, genus *Aeromonas* is resistant to Tetracycline, Cefepime, Ceftazidime, Aztreonam and Colistin. The scientific name of genus is *Aeromonas hydrophila*. Similar reports were noted by Schubert, (1991) which confirmed these speices in water with other entric pathogens act as indicator for contamination of the enviroment.

Genus Staphylococcus: Colonies appear white, yellow, or orange in colour. Cells are spherical in shape and arranged in clusters positive for catalase, phosphatase, fermented sucrose, lactose, mannitol, mannose, maltose and trehalose. However, it is negative for ribose, raffinose, proline, xylose, lactose, urease, galactose and grows at 6.5% NaCl. The antibiotics sensitivity test of *Staphylococcus* indicated that it is sensitive to several antibiotics such as: Gentamicin, Levofloxacin, Moxifloxacin, Erythromycin, Clindamycin, Quinupristin, Linezolid, Vancomycin, Tetracycline, Tigecycline, Rifampicin, Trimethoprim and Nitrofurantion. But only resistant to Benzylpenicillin and Oxacillin. *Staphylococcus aureus* was detected in wastewater and drinking water because these cocci are found in the gastrointestinal tract and released into water by human contact (Anti, 1987).

Genus *Proteus* grows on different media, reduces nitrate and produces H_2S, positive with some enzymes: phosphtase, lipase, urease, catalase but not oxidase and fermented glucose, while negative with proline, sucrose, lactose, glycin, maltose, mannitol, trehalose, mannose, citrate, galactose, cellobiose and sorbitol. Supplementing medium with the above concentrations of bile salts lithium chloride, sodium thiosulfate and sodium citrate resulted in selective growth of *Proteus mirabilis*. Furthermore, *Proteus* was found to be sensitivite to many antibiotics such as: Ampicillin, Ampicillin/sulbactam, Cefazolin, Ceftriaxone, Cefepime, Aztreonam, Ertapenom, Imipenem, Meropenem, Amikacin, Gentamicin, Tobramycin, Ciprofloxacin, Moxifloxacin and Trimethoprim/sulfamethoxazle. On other side, Proteus is resistant for Tigecycline and Nitrofurantion. The genus was namely *Proteus mirabilis* (Janak, 2012). Ali *et al.*, (2008) documented that these bacteria are the most contaminants in water.

Genus *Serratia*: The biochemical tests of *Serratia* indicated that this genus is able to produce H_2S and positive for urease, phosphatase, lipase. Moreover, *Serratia* can use several carbon sources (*i.e.* glucose, sucrose, inositol and arabinose). In addition, *Serratia* can utilize citrate but it can not ferment proline, lactose, maltose, trehalose, mannose, cellobiose, lactose, sorbitol and galactose or raffinose. These results are in agreement with those obtained by Nieto *et al.* (1984) and Amos (1985). Using routine laboratory method for the evaluation of biochemical characteristics all tests showed correlations about 100% then identification as *S. plymuthica* strains (Jose *et al.*, 2000). The antibiotics sensitivity test showed that genus *Serratia* is resistant to only Aztreonam while sensitive to many antibiotics: Cefazolin, Ceftriaxone, Cefepime, Ertapenom, Imipenem, Meropenem, Amikacin, Gentamicin, Tobramycin, Ciprofloxacin, Moxifloxacin, Tigecycline, Nitrofurantion and Trimethoprim. From these results scientific name is *Serratia plymuthica*.

Genus *Pantoea* was found to be positive to catalase, glucosidase, xylosidase, galactosidase, urease and it can ferment sucrose, maltose, mannitol, trehalose, mannose, sorbitol as well as cellobiose. Genus *Pantoea* can not

produce H_2S, lipase, oxiase, urease, lactate and phosphatase. It is beloning to family Enterobacteriaceae that inhabits plants, soil and water. Some species of this genus are pathogenic for animals and humans (Gavini *et al.*, 1989). The antibiotics sensitivity test indicated that, genus *Pantoea* is resistant to many antibiotics (Titracarcillin, Ceftazidime, Gentamicin, Tobramycin, Ciprofloxacin, Minocycline as well as Colistin) and sensitive to some antibiotics (Piperacillin, Piperacillin/ Tazobactam, Cefepime, Aztreonam, Pefloxacin, Imipenem, Meropenem, Amikacin and Trimethoprim). This genus was named according to USFDA (2002) as *Pantoea agglomerans.*

Physicochemical analyses

1. River Nile water

The River Nile water collected from Tanta, Elmehala-Elkobra, Mehalt Abo Ali, Samanod and Mehalt-Roh cities at El-Ghabia Governonrate were tested for their properties. The results in Table (3) represent the mean values of four seasons during 2012/2013. Results cleared that the higher values were at Elmehala-Elkobra city, follwed by Tanta city, then Mehalt-Roh, finally Mehalt Abo Ali and Samanod. Espcially most high mean was recorded at Elmehala-Elkobra, Tanta and Mehalt-Roh with the following parameters: temperature, pH, turbidity, electrical conductivity, partial hardness, total of: (hardness, calcium, magnesium, calcium hardness, magnesium hardness, SO_4, silica, iron, aluminum, phosphoras, ammonia), Nitrite, Nitrate and Chlorides. Generally, the higher conductivity values and high atmospheric temperatures resulting in high evapotranspiration rates (Nwadiaro 1989). There are slight variation with seasons and different sites. Caused by sewage effluent, fertilizers, pesticides and discharges from industries and these results are in agreement with those obtained by Asuquo and Etim (2012) who reported that high turbidity could result from the presence of colluded particles arising from clay and silt during rainfall or from industrial waste. Makinde *et al.* (2015) found that the concentrations of various water quality parameters showed higher concentrations when water volume is increased to its maximum during the rainy season. Sulphate and nitrate as agricultural fertilizers showed reduced concentrations in the Niger Delta. In addition, this study has shown that industry effluents discharged into Ekerekana creek resulted in the presence of high concentrations of pollutants in the water body.

Table 3. Physical and chemical parameters of River Nile water samples from some sites at El-Ghabia Governonrate

Parameter	Tanta	Elmehala-Elkobra	Mehalt Abo Ali	Samanod	Mehalt-Roh
Temperature ºC	24.5	24.5	23.5	23.5	24.5
pH	7.75	7.57	7.50	7.47	7.42
Turbidity NTU	6.50	9.80	4.10	6.10	5.70
Electrical Conductivity (EC) dsm^{-1}	347.5	387.5	291.0	295.5	330.0
Total hardness mgL^{-1}	268.5	295.0	137.25	156.25	282.5
Partial hardness mgL^{-1}	261.75	281.75	133.00	141.25	269.25
Total calcium mgL^{-1}	29.07	33.22	31.00	30.50	30.12
Total magnesium mgL^{-1}	18.25	17.55	19.57	18.97	19.85
Total calcium hardness mgL^{-1}	92.00	88.00	71.75	69.75	70.50
Total magnesium hardness mgL^{-1}	71.75	62.75	55.50	57.50	62.00
Total SO_4 mgL^{-1}	34.50	32.25	26.25	21.00	24.75
Total silica mgL^{-1}	2.18	2.17	2.12	2.10	2.36
Total iron mgL^{-1}	0.16	0.20	UDI	0.66	0.15
Total manganese mgL^{-1}	UDI	UDI	UDI	UDI	UDI
Total aluminum mgL^{-1}	0.23	0.27	0.23	0.24	0.14
Total phosphoras mgL^{-1}	2.60	2.50	2.10	2.50	2.70
Total ammonia mgL^{-1}	0.66	0.54	0.43	0.39	0.72
Nitrite mgL^{-1}	0.075	0.060	0.060	0.020	0.270
Nitrate mgL^{-1}	2.40	2.40	2.30	2.10	2.20
Chlorides mgL^{-1}	30.50	35.50	33.00	30.50	34.00

NTU= Nephelometric Turbidity Unit ; UDI= Un Detected Ion

2.Ground water

The results in Table (4) represent the mean values of four seasons during 2012/2013. The results indicated that the most high mean values of temperature, pH, turbidity, electrical conductivity, total hardness, partial hardness, total calcium, total calcium hardness, total magnesium hardness, total SO_4, total silica, total iron, total aluminum, total phosphoras, total ammonia, nitrite, nitrate and chlorides were recorded in Tanta, followed by Elmehala-Elkobra then Samanod, finally Mehalt-Roh and Mehalt Abo Ali, respectively. The obtained results are in agreement with those obtained by Makinde *et al.* (2015) who reported that variations were noted in all the cities with the eexception of pH, waterhardness. Conversely, in dry season temperature, EC, nitrates were higher, while, in wet season the values of turbidity, sulphates and chlorides were elevated.

3. Tap water

The tap water collected from Tanta, Elmehala-Elkobra, Mehalt Abo Ali, Samanod and Mehalt-Roh cities at El-Ghabia Governonrate were tested for their parameters. Data in Table (5) represent the mean values of four seasons during 2012/2013. The obtained results indicated that in the collected tap water the most high mean values of all parameters were in Tanta, Elmehala-Elkobra cities with exception of total hardness, partial hardness and nitrite which were found at the lowest values in Elmehala-Elkobra. The lowest mean values of turbidity, total calcium, total calcium hardness, total magnesium hardness, total iron and chlorides were recorded in Samanod city. The lowest EC were recorded in Tanta and the highest in Mehalt-Roh. The results revealed that tap water is suitable for both domestic purposes and for aquatic life (WHO, 2003).

Table 4. Physical and chemical parameters of ground water collected from some sites at El-Ghabia Governonrate

Parameter	Tanta	Elmehala-Elkobra	Mehalt Abo Ali	Samanod	Mehalt-Roh
Temperature ºC	23.5	34	23	23	24
pH	7.85	7.69	7.52	7.97	7.82
Turbidity NTU	9.11	6.85	4.52	10.52	6.60
Electrical Conductivity (EC) dsm^{-1}	353	328.75	320	401	317.5
Total hardness mgL^{-1}	163.25	165	157	136.5	155.5
Partial hardness mgL^{-1}	157.25	159.25	148.25	130.25	142.5
Total calcium mgL^{-1}	28.8	29	28.5	28.8	29.7
Total magnesium mgL^{-1}	15.82	15.72	14.62	16.07	16.05
Total calcium hardness mgL^{-1}	81	90.5	70.7	71.7	72.5
Total magnesium hardness mgL^{-1}	70.25	61.5	62.25	62.5	69.5
Total SO_4 mgL^{-1}	49	62.37	34.25	29.5	29.5
Total silica mgL^{-1}	2.45	2.6	2.3	2.5	2.36
Total iron mgL^{-1}	0.45	0.73	0.19	0.31	0.19
Total manganese mgL^{-1}	0.03	0.01	UDI	UDI	UDI
Total aluminum mgL^{-1}	0.31	0.44	0.27	0.32	0.27
Total phosphoras mgL^{-1}	0.15	0.19	0.00	0.18	0.00
Total ammonia mgL^{-1}	0.41	0.50	0.26	0.20	0.08
Nitrite mgL^{-1}	0.09	0.05	0.23	0.03	0.09
Nitrate mgL^{-1}	3.07	2.80	3.31	2.87	0.07
Chlorides mgL^{-1}	33.75	28.25	23.25	38.75	29.25

NTU= Nephelometric Turbidity Unit ; UDI= Un Detected Ion

Table 5. Physical and chemical parameters of tap water samples collected from some sites at El-Ghabia Governonrate

Parameter	Tanta	Elmehala-Elkobra	Mehalt Abo Ali	Samanod	Mehalt-Roh
Temperature ºC	23	22	21	20.5	22
pH	7.0	7.0	6.9	6.5	6.3
Turbidity NTU	0.32	0.38	0.33	0.25	0.38
Electrical Conductivity (EC) dsm^{-1}	331	342	333	328	410
Total hardness mgL^{-1}	140	127	138	124	128
Partial hardness mgL^{-1}	131	120	134	119	124
Total calcium mgL^{-1}	30	31	27.5	26.5	29.6
Total magnesium mgL^{-1}	14.7	16.4	13.0	13.7	15.9
Total calcium hardness mgL^{-1}	70.5	81.0	64.5	61.0	70.2
Total magnesium hardness mgL^{-1}	65	56	57	54	64
Total SO_4 mgL^{-1}	38.5	37.7	31.2	33.0	26.0
Total silica mgL^{-1}	1.9	2.0	1.9	1.9	2.0
Total iron mgL^{-1}	0.0	0.36	0.0	UDI	UDI
Total manganese mgL^{-1}	UDI	UDI	UDI	UDI	UDI
Total aluminum mgL^{-1}	0.0	0.9	UDI	UDI	UDI
Total phosphoras mgL^{-1}	0.15	0.19	0.0	0.18	0.0
Total ammonia mgL^{-1}	0.41	0.50	0.26	0.32	0.08
Nitrite mgL^{-1}	0.08	0.05	0.23	0.03	0.09
Nitrate mgL^{-1}	3.0	2.8	3.3	2.7	0.07
Chlorides mgL^{-1}	17	19	16	16	18

NTU= Nephelometric Turbidity Unit
UDI= Un Detected Ion

CONCLUSION

Generally, on the basis of the obtained results the microbiological, physical and chemical properties of Nile, ground and tap water samples collected from five sites at El Gharbia Governonrate Egypt were evaluated. The results indicated that River Nile and tap water are in the normal range for both aquatic life and domestic purposes but in ground water are different.

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تقييم جودة مياه الشرب بكتيريا وكيميائيا فى محافظة الغربية بمصر

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[2] قسم النبات و الميكروبيولوجى – كلية العلوم – جامعة الأزهر – القاهره - مصر

الملخص

أجريت هذه الدراسة لتقييم مصادرمياه الشرب (مياه نهر النيل أو مياه جوفيه أو مياه الصنبور) لبعض المراكز والقرى (طنطا- المحله الكبرى- محلة أبو على- سمنود- محلة روح) بمحافظه الغربية بمصروذلك خلال عامى 2012 /2013 حيث تم تحليل عينات المياه ميكروبيولوجيا وكيميائيا . وقد سجلت نتائج التحليل الميكروبيولوجى على البيئات المتخصصه فى دراسة سابقه وجود مستعمرات بكتيريه تنتمى للأجناس البكتيريه Staphylococcus, Aeromonas, Proteus, Serratia and Pantoeaوفى هذه الدراسة تم تعريف أنواع هذه الأجناس البكتيريه بالطرق القياسيه لتعريف البكتيريا على أنها: *Staphylococcus aureus, Aeromonas sobria, P roteus mirabilis, Serratia plymuthica* and *Pantoea agglomerans* .وعند إجراء التحليلات الفيزيائيه والكيميائيه لعينات المياه الثلاثه طبقا للخصائص المختلفه أمكن إثبات أن هذه المصادر الثلاثه من مياه الشرب ذات جوده عاليه للإستخدام الأدمى وبالتالى للإستخدام المنزلى وأن نتائج التحليلات الكيميائيه فى الحدود المسموح بها دوليا وذلك فى عينات نهر النيل ومياه الصنبور ولكن هناك إختلاف فى المياه الجوفيه .