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Microbial and Physico-Chemical Assessment of Water Quality of the River Nile at Assiut Governorate (Upper Egypt)

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Abstract: The Nile River quality being the problem concerned with everyone's health in Egypt. The Nile River is currently facing tremendous pressure due to encroachments, discharge of untreated domestic and industrial waste, dumping of solid waste and illegal diversion of water. The present study aimed to examine the bacterial quality of River Nile water at Assiut region. The current work was done in nine sampling locations distributed over about 120 km stretch at Assiut Governorate around the Nile River, for monitoring the microbial pollution by determination of total bacterial counts as well as bacterial indicators (total Coliform, fecal Coliform, and fecal Streptococci) for river Nile water. Moreover study of some physicochemical parameters during the period from September 2013 to August 2014, in order to evaluate its suitability for the intended purpose. The results showed that all of samples were contaminated with (total Coliforms, fecal Coliforms and fecal streptococci). The physicochemical parameters of the water samples of the most studied locations were in permissible limits of the Egyptian standards for drinking water. The present study observed that the overall water quality of the Nile River in the study area was ranged from marginal to good according to Egyptian lows of the Nile River protection agency.

Keywords: Total Coliform, Fecal Coliform, Fecal Streptococci, and physicochemical parameters.

1. Introduction

When color photographs of the earth as it appears from space were first published, it was a revelation: they showed our planet to be astonishingly beautiful. We were taken by surprise. What makes the earth so beautiful is its abundant water. The great expanses of vivid Blue Ocean with swirling, sunlit clouds above them should not have caused surprise, but the reality exceeded everybody's expectations. The pictures must have brought home to all who saw them the importance of water to our planet.

Water is a blessing of Allah and it is a very precious resource on this planet where it is an established source of life [1]. The amount of fresh water on the planet is constant, and yet the demand for this water is continually growing, thus leading to the inevitably increasing scarcity of clean drinking water worldwide [2].

The quality of drinking water has been decreased during this century due to the discharging of wastewater into water resources as well as environmental pollutants. One of the greatest challenges facing Egypt today is the growing number of rural and urban households who need access to basic infrastructure, mainly water supply and sewage.

One of the most important factors of water pollution is the microbial contamination especially with pathogenic microorganisms. The dangers of pathogenic microbes in surface drinking water supplies were recognized. Microorganisms threat the safety of drinking water that is growing in industrialized nations that have long regarded themselves as immune to wide spread waterborne illness and carries so common in developing countries [3].

Presence of pathogens is usually accompanied by the presence of the classic indicators of contamination such an *Escherichia coli*, Enterococci and other aerobic bacteria.

Coliform bacteria have long been used to indicate fecal contamination of water and thus a health hazard. The fecal streptococci are considered to be alternative indicators of fecal health hazards. Furthermore, classic indicators can be

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considered as efficient detectors of pathogens in most cases [4].

Enteric pathogens are typically responsible for waterborne sickness [5]. Also Using of indicator bacteria, such as fecal Coliforms (FC) and fecal streptococci (FS) for assessment of fecal pollution and possible water quality deterioration in fresh water sources is widely used [6].

In a previous study for the biological characteristics of the River Nile water to evaluate the traffic and the autotrophic state of the River, it is revealed the presence of fecal bacterial indicator, high number of pathogenic bacteria and yeasts because the River body receiving big quantities of domestic, industrial and agricultural wastes [7].

2. Materials and Methods

2.1 Study area

Assiut Governorate has a total gross area of 25,926 km², Minya Governorate is located north of it, and Red Sea Governorate to the east, and to the west, there is a New Valley Governorate and to the south Sohag Governorate figure (1).

Figure 1: Study area (Assiut Governorate) pointed in Egypt map

Figure 2: Sites position and sites code for collection of the Nile water samples distributed on Assiut Governorate map.

2.2 Sampling techniques and analysis

For this purpose nine locations (Figure 2) were chosen along the Nile River at Assiut Governorate during September 2013 to August 2014. Sampling locations and respective sampling codes are shown in **Table (1)**.

Physicochemical parameters were selected and estimated quantitatively and details of the analysis methods are summarized in **Table (2)**. Nile water samples examined for bacteriological purpose were collected in 100 ml sterile brown glass bottles and transferred into laboratory within 6 hours.

2.3 Microbial analysis

2.3.1 Total Viable Bacterial Count.

Plate count agar (PCA) medium was used for estimation of heterotrophic bacteria by spread plate method (SP) in water samples in 48 h at 35.0 °C on the basis of culturing in non-selective nutrient agar medium. Spread plate method was used for enumeration of total bacterial counts using plate count agar medium.

The Nile water samples were shacked well and further serial tenfold dilution were prepared, one drop (0.01 ml) of each dilution was spread with sterile glass spreader on agar plates having dry surfaces. Plate count agar were incubated, at 35 ºC for 48 h then counted.

2.3.2 Estimation of total Coliforms (TC) and fecal Coliforms (FC) using (MPN) Technique.

a) Presumptive Phase

Lauryl Tryptose Broth, (LTB) was used in the presumptive phase of the Standard Total Coliform Fermentation Technique in the examination of water [8].

Scope: the procedure below is for estimation of Coliforms by Multiple-Tube Fermentation Technique (MTF), also called Most Probable Number (MPN) procedure, in 96 hours, or less, in water samples on the basis of the production of gas and acid from fermentation of lactose. Formation of gas in any amount, in Durham tube, of the LTB tubes, at any time, within 48 ± 3 h transfer to confirmer test.

b) Confirmer Phase:

Using Brilliant Green Bile Broth, 2% is formulated according to AOAC and APHA [9] specifications for use in the confirmation of presumptive tests for Coliforms. The formation of gas in any amount, in Durham tube, of the brilliant green tubes, at any time, within 48 ± 3 h constitutes a positive confirmed result.

Using EC medium was developed by Hajna and Perry [10] in an effort to improve the methods for the detection of the fecal Coliform group and *E. coli*. This medium consists of a buffered lactose broth with the addition of 0.15% bile salt mixture. EC medium was used for the detection of fecal

Coliform bacteria (*Escherichia coli*) at 44.5°C.

The formation of gas in any amount, in Durham tube, of the EC tubes, at any time, within 24 ± 2 h constitutes a positive confirmed result.

Table 1: Sampling locations on the Nile River at Assiut Governorate.

Code	Town	Location	Latitude	longitude
DI	Dairut	In front of Dirut drinking water station	27°33'17.80"N	30°50'28.10"E
QO	Qosiya	In front of Qosiya drinking water station	27°26'9.21"N	30°51'36.65"E
MA	Manfalut	In front of Manfalut drinking water station	27°19'51.02"N	30°58'24.11"E
TW	Abnub and Al Fateh	In front of Al Tawabiyya drinking water station	27°12'33.01"N	31° 7'27.08"E
CZ	Assiut	In front of Czech drinking water station- Helaly street	27°11'8.24"N	31°11'42.35"E
NA	Assiut	In front of Nazlet Abed-Allah drinkingwater station	27°10'32.84"N	31°12'12.42"E
AT	Abu Tig	In front of Abu Tig drinking water station	27° 2'42.35"N	31°19'49.61"E
BS	Badari and Sahel Selim	In front of Badari drinking water station	26°58'0.65"N	31°24'4.01"E
SG	Sedfa and Elghanayem	In front of Sedfa drinking water station	26°58'13.23"N	31°23'27.09"E

Table 2: Parameters and methods employed in the physicochemical examination of water samples

No.	Parameters of water analysis	Method employed
1	Temperature ºC	Thermometric
2	pH	Potentiometric
3	Turbidity	Nephelometric
4	Conductivity (µS/cm)	Potentiometric
5	Total Alkalinity	Titrimetric
6	Total hardness	Titrimetric
7	Ca, Hardness	Titrimetric
8	Mg Hardness	Titrimetric
9	Nitrate (as NO_3^-)	Spectrophotometric
10	Ammonia (as NH_3)	Spectrophotometric
11	Total dissolved solids (TDS)	Gravimetric
12	Chlorides as (Cl^{-1})	Titrimetric
16	Chemical Oxygen Demand	Titrimetric
17	Biochemical Oxygen Demand	Titrimetric

c) Complete phase

The completed test for *E. coli* was performed on all samples that showed a positive result for fecal Coliforms by plating a loopful of broth from the appositive EC tube into an Asian Methylene Blue agar (EMB),[11]. Then Petri plates were incubated at 44 ºC for 24 to 48 hours.

The positive sample for MPN tubes plated on Eosin Methylene Blue (EMB) agar showed a green metallic sheen, which confirmed the presence of *E. coli*. Coliforms colonies were further identified by Gram staining.

d) Calculations:

According to MPN Index and 95% confidence limits for various combinations of positive results dilution [12].

2.3.3 Detection and Enumeration of Fecal Streptococci.

Determination of Fecal Streptococci using the Most Probable Number Method [12] through the presumptive test, confirmation test and complete test using various selective media.

a) Presumptive test procedure

Samples shacked vigorously before inoculation. A series of 10, 1.0, 0.1 and 0.01 ml volumes of water were inoculated for fecal streptococcus test using test tubes containing azide dextrose broth, double-strength broth for 10 ml inoculants.

Tested samples were carried out using 3 decimal dilutions (1, 0.1 and 0.01 ml) for each water sample tube containing azide dextrose broth [12], inoculated tubes incubated at 35 ± 0.5°C. Each tube was examined at the end of 24 ± 2 h for turbidity or button of sediment at the bottom of culture tube. If no definite turbidity is present, re-incubated, and investigated again at the end of 48 ± 3 h.

b) Confirmed test procedure:

Confirmation of the presence of fecal streptococci in the sample is done by sub culturing in Pfizer selective Enterococcus (PSE) agar.

All azide dextrose broth tubes showing turbidity after 24 or 48 h. incubation subjected to the confirmed test. A portion of growth from each positive azide dextrose broth tube was streaked on PSE agar, then incubated at 35 ± 0.5°C for 24 ± 2 h. Brownish-black colonies with brown halos confirm the presence of fecal streptococci in the culture.

c) Completed test:

A completed test is conducted by performing a catalase test, before performing the catalase test, the brownish-black colonies are sub cultured on a non-selective nutrient agar to avoid (PSE) agar interfering with the catalase test. A growth on the nutrient agar was transferred to a clean glass slide and a drop of hydrogen peroxide (3%) was added. The absence of bubbles (catalase-negative result) demonstrates the presence of fecal streptococci.

The MPN values, for a variety of positive and negative tubes combinations, are given in appendix A.1. [12].The samples volumes indicated in indexes A.1 illustrates MPN values for combinations of positive results when five tubes from each dilution of sample portion volumes are test.

3. Result and discussion

3.1 Bacteriological indictors (Table 3)

In the present study, all of the samples were contaminated with the bacterial indicators. Results showed that samples taken from some sites were highly contaminated, so that giving an indication of contamination right from the beginning of the main water source.

Table (3): Average of all bacteriological indicators of river Nile samples at Assiut Governorate during the period from autumn 2013 to summer 2014.

parameter	T.B.C.s (1mlX10^3)			T.C.F.s (MPN/100ml)			F.C.s(MPN/100ml)			F.S.s (MPN/100ml)		
code	Mean	± S.D.	Log Mean	Mean	± S.D.	Log Mean	Mean	± S.D.	Log Mean	Mean	± S.D.	Log Mean
NA	19	5.03	4.28	930	202.67	2.968	517	181.05	2.713	468	257.4	2.67
CZ	20	5.08	4.291	844	204.6	2.926	440	164.83	2.643	401	146.27	2.603
MA	26	8.95	4.412	923	413.05	2.965	469	289.55	2.671	543	134.37	2.734
DI	28	17.71	4.45	713	172.5	2.853	379	241.85	2.579	439	46.78	2.643
QO	32	17.46	4.5	951	234.34	2.978	580	269.33	2.763	451	180.66	2.654
BS	41	15.03	4.614	799	110.67	2.903	395	91.47	2.597	524	116.95	2.719
TW	82	45.18	4.915	1426	532.24	3.154	703	373.24	2.847	888	190.68	2.948
AT	46	32.66	4.66	1048	203.53	3.02	618	380.38	2.791	545	70.05	2.736
SG	38	15.92	4.576	861	73.76	2.935	430	185.49	2.633	365	131.47	2.562

From the bacteriological view, regions showed higher counts of total viable bacterial counts as well as presence of bacterial indicators (total Coliforms, fecal Coliforms and fecal streptococci), which means the presence of fecal pollution source around these sites.

Especially in (TW) site which located in the opposite side of Al-Zenar canal, and in Abo Tig (AT) site around of Decran canal. The total viable bacterial count is used to estimate the total amount of bacteria in water and indicates the overall microbial status of the water [13]. Total Coliforms, thermotolerant Coliforms, *E. coli* and Enterococcus spp. are bacteria whose presence indicates that the water may be contaminated by human or animal wastes [14]. Disease-causing microbes (pathogens) in these wastes can cause diarrhea, cramps, nausea, headaches, or other symptoms. These pathogens may pose a special health risk for infants, young children, and people with severely compromised immune systems [15].

Arafah, in his study around Nile river in all of Egypt reported that the total bacterial count of at 37ºC as an average log of total bacterial count (CFU/ ml) ranged from 4.9 to 5.2 (CFU/ml) and at 22°C it ranged from 5.1 to 5.5 (CFU/ml) [16].

Also his results around my study area at Assiut Governorate at 37°C in Sedfa district were 4.8 ,3.5 ,4.5 and 4.5 (CFU/ml) during autumn 2009,winter 2010 , spring 2010 and summer 2010 respectively, while in Nazlet Abed-Allah (NA) site were 4.1, 5.6, 5.4 and 5.3 (CFU/ml) during autumn 2009, winter 2010, spring 2010 and summer 2010 respectively. On other hand at 22°C his results which reported in Sedfa district (SG) were 4.8, 4.4, 4.7 and 4.5 (CFU/ml) during autumn 2009, winter 2010, spring 2010 and summer 2010 respectively and in Nazlet Abed-Allah (NA) site were 4.8, 5.2, 5.3 and 4.97 (CFU/ml) during autumn 2009, winter 2010, spring 2010 and summer 2010 respectively.

Osman, et al., reported that the total bacterial count at 37ºC and 22ºC as an average log of total bacterial count (CFU/100 ml) in all Nile water samples in his study at different sites, the highest average log count of Nile water at 37ºC reached 6.4 CFU/100 ml in El-Giza district, followed by Helwan, Shubbra El-Khema and lastly Embaba being 5.8, 5.63 and 6.4 CFU/100 ml, respectively. On the other hand, the highest average log count of Nile water at 22ºC reached 6.2 CFU/100 ml in both Helwan and El-Giza regions, while Shubbra El-Khema and Embaba regions recorded lower count, being 5.42 and 2.9 CFU / 100 ml [17].

El-Taweel and Shaban, reported that the log total bacterial count of Nile water ranged from 4.1, to 7.4 CFU/100 ml at 22ºC, while it reached from 4.1 to 7.3 CFU/100 ml at 37 ºC [18].

Ali, et al., reported that the log total bacterial counts at 22ºC and 37 ºC in Nile at El-Giza region reached 5.8 and

5.5 CFU/100 ml, respectively[19] and Rifaat, found that the log total bacterial count of Nile water at Greater Cairo was 5 CFU /100 ml[20].

Concerning bacterial indicators of pollution, Arafah, reported that the average most probable number of total Coliform bacteria in some of Assiut Governorate sits was 3.32, 3.26, and 3.26 MPN-index/100ml for total Coliform, fecal Coliform and fecal Streptococci, respectively during his study [16].

Osman, et al., reported that the highest average log numbers in Nile water were found in El-Giza region being 4.8, 3.1 and 2.5 MPN-index/100ml for total Coliform, fecal Coliform and fecal Streptococci, respectively. In contrast, the lowest average log numbers of bacterial indicators were recorded in Embaba region being 2.2, 1.1 and 1.1 MPN-index/100ml for total Coliform, fecal Coliform and fecal Streptococci, respectively [17]. These results were in accordance with those obtained by Ali et al. [19], they found that the log counts of total Coliform, fecal Coliform and fecal Streptococci were 4.1, 2.3 and 2.5 MPN-index/100 ml, respectively, in Nile water samples at El-Giza Drinking Water Treatment Plant.

Other workers found that the log count of total Coliform in Nile water reached 4-6 MPN-index/100 ml. These relatively high counts might be due to pollution by 34 industrial facilities discharging to the Nile water between Aswan and Cairo [21].

These observations suggest Coliform bacteria may enter the environment as a result of fecal contamination from humans, domestic animals and wildlife and from agricultural land, These results indicate that the water reservoirs need to be treated regularly. Furthermore, public health authorities should make the public aware of the potential danger of the surface water supply, and encourage in house treatment of the water before consumption. So all the sources of water i.e., main reservoir, distribution lines and consumers should be properly monitored in order to provide contamination free water to public. Also concerned authorities must follow WHO [22], standards about limits of contamination. This type of study should be updated from time to time to monitoring quality of surface water in Egypt as source of drinking water because environmental pollution problems are the most serious national problems which requires great efforts at all levels; individual, group, national and international. So data collection, analysis, and interpretation are required to overcome heavy pollution.

Protection of drinking water sources from pollution in Egypt as the Nile is the responsibility of everyone in the community where it is wrong to believe that the Government that bears all the burden in solving this problem but we have direct responsibility to protect this gift that God has given us.

3.2 Physical and chemical properties (Table 4)

Temperature

The quality of water with respect to temperature is usually left to the individual taste and preference and there are no set guidelines for drinking water temperature [23]. In the present study, temperatures varied from 16 to 33 °C. The variation in the Nile water temperature may be due to the different timing of collection and seasons influence.

Hydrogen ion (pH)

PH value has an effect on the biological, chemical reactions, as well as it controls the metal ion solubility and thus it affects the natural aquatic life. More specifically, it was reported that desirable pH for fresh-water is in the ranges of 6.5-9 and is 6.5-8.5 for aquatic life. Moreover pH could control the pathogenic microorganism growth [24]. In the present study, the pH values showed almost alkaline in all the sites. During the present investigation a pattern of pH change was noticed.

Total Alkalinity

The alkalinity of water is caused mainly due to OH, CO_3, HCO_3 ions. Alkalinity is an estimate of the ability of water to resist change in pH upon addition of acid. Alkalinity also important as an indicator of water body's ability to resist pH change with addition of acid from an accidental spill or acid preparation [25]. The desirable alkalinity limit range of water prescribed for drinking purpose by [26] is 30 -130 which indicate that our results of the studied samples occur in desirable limits.

The electrical conductivity (EC)

The ions in solution are formed by dissociation of inorganic compounds. For this reason, the measurement of conductivity gives a good indicator of the concentration of dissolved salts in water. In the present study EC values were ranged from 233 to 336 μs/cm during year of study. The variation in EC averages depends on the presence of the ions and their total conductivity, mobility, relative concentration and the temperature of measurement according to [27].

Turbidity

Turbidity is the reflection of the total suspended matter to which it is inversely related on one hand and it is an indication of clay and inert particles on the other hand [28]. Average of measured Turbidity NTU of river Nile samples at Assiut Governorate during the period from autumn 2013 to summer 2014 seasonally increased gradually during winter season (15 NTU recorded) this due to the level of surface water in the study area is generally decreasing at this time.

Total Dissolved solids (TDS), Total Suspended Solids (TSS) and Total Solids (TS).

A higher concentration of TDS usually serves as no health threat to humans until the values exceed 10,000 mgl^{-1} [29]. TDS are composed mainly of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium and manganese, organic matter, salt and other particles. The maximum allowable limit of TDS according to (Egyptian law no. 48/1982) [30] is 500 mg/l. The maximum average of TDS results seasonally in my study area is 193 mg/l. Generally the average TDS values in the present study increased during cold seasons may be due the impact of turbidity.

Table 4: Range values of River Nile water characters from September 2013 – August 2014.

Parameter	NA	CZ	MA	QO	DI	BS	TW	AT	GS	Low no.48/1982[(a)]
Temperature	17-28	16 -28	17-29	18 -31	18-29	17-28	16 -33	18-30	17-29	5ºC above normal
Turbidity	9.1-12.2	8.8-12.3	8.5-11.8	8.7-12	8.3-12.4	7.5-10.1	11.9-15	9.1-12.4	9.4-9.4	-
pH	7.7-8.6	7.9-8.6	7.7-8.5	7.6-8.7	7.9-8.7	7.9-8.5	7.8-8.6	8.1-8.6	7.9-8.5	6.5-8.5
T. Alk. ppm[(b)]	113-140	117-134	109-136	109-139	115-143	122-134	114-144	111-129	117-131	150 -20
E C µs/cm [(c)]	245-318	265-312	255-314	267-323	235-321	279-336	289-329	235-325	233-329	-
T D S ppm	164-186	159-186	166-189	166-182	167-192	169-192	169-191	162-191	169-190	500
T.H ppm [(d)]	106-127	103-130	111-134	113-126	110-142	119-141	109-132	121-144	119-137	500
Ca .H ppm	68-85	69-83	74-89	68-84	71-91	69-93	69-87	72-91	78-88	-
Mg H ppm	34-48	32-47	33-49	32-53	37-51	41-52	37-51	40-56	40-51	-
Nitrate ppm	0.23-1.11	0.091-0.87	0.36-0.81	0.39-0.78	0.42-0.91	0.039-1.1	0.44-2.55	0.061-0.95	0.079-1.1	2
NH_4 ppm	0.0033-0.079	0.0027-0.098	0.026-0.324	0.028-0.19	0.0037-0.312	0.0039-0.076	0.089-1.51	0.0022-0.44	0.0034-0.39	0.5
Cl^{-1} ppm	16-27	16-24	15-29	13-26	17-28	16-24	16-27	14-23	12-21	
COD ppm	7.8-18.7	6.6-19.2	4.9-16.8	5.1-19.3	7.2-21.2	7.4-19	9.25-19.9	9.1-19.1	9.1-18.2	10
BOD ppm	3.56-5.87	4.32-5.63	369-7	3.89-6.1	3.54-6.5	3.66-7	5.34-7.5	3.76-7	4.5-5.78	6

(a) Egyptian low 48/198 after Decree no 92/2013 for article (49). (b) EC = electrical conductivity. (c) T.H = Total Hardness. (d) T.alk = Total Alkalinity.

Total Hardness (TH)

Hardness has no adverse effect on human health and water above hardness of 200 mgl^{-1} may cause scale deposition in the water distribution system and more soap consumption. Soft water below hardness less than 100 mgl^{-1} is more corrosive for water pipes [22], [31].Where TH is the total hardness of Ca and Mg are measured in ppm the ratio in formula (TH= 2.497 Ca 4.115 Mg) are in weights. The maximum allowable limit of TH according to [30] is 500 mg/l. In studied water samples the averages of TH values are at the standard limits.

Nitrate (NO_3^-)

The concentration of nitrogenous compounds indicates the occurrence of extensive anaerobic bacterial activities. Nitrates represent the final product of the biochemical oxidation of ammonia. Monitoring of nitrates in drinking water supply is very important because of health effects on humans and animals. The highly nitrate content was in (TW) and (AT) sites respectively might be due to leaching of nitrate from nearby agricultural fields. Maximum nitrate content was 2.55 ppm found In (TW) site than other sites which indicates that the water of this point is more pollutant. The upper limit of Nitrate concentration of in [30] is 2 ppm.

Ammonia

The ammonia ion is either released from proteinaceous organic matter and urea or is synthesized by industrial processes.

Throughout this study, Ammonia concentrations showed variations both regionally and seasonally. The recorded mean values violate the permissible limits of law 48/1982 (not to exceed 0.5 mg/l), but 1.5 ppm recorded in (TW) location. Increasing in ammonia concentrations could be attributed to organic pollution resulting from domestic sewage and fertilizers runoff.

Chloride (Cl^-)

In potable water, the salty taste is produced by the chloride concentrations is variable and dependent on the chemical composition. [32] High chloride content may harm metallic pipes and structures as well as growing plants [33].

Generally in the present study, Chloride average values increased from hot season to cold season and (29 ppm) value recorded as maximum value during a year of study on other hand all of present study results occur in allowable limit of [30] which conceders that 250 mg/l value as the maximum limit Chloride concentration.

Chemical Oxygen Demand (COD)

The minimum values of COD might be due to low organic matter, while the maximum value might be due to high concentration of pollutants and organic matter. In the present study, COD (ppm) value summarized as the average values seasonally were 14.2, 17.2, 10.6 and 15.4 ppm in autumn, winter, summer and spring; respectively. Allowable limit according to [30] is 10 ppm increasing of COD value may be due to concentrations of pollutants and organic matter.

BOD

BOD is a measure of the amount of dissolved oxygen removed from water by aerobic bacteria for their metabolic requirements during the breakdown of organic matter [34]. Measurement of BOD is used to determine the level of organic pollution of water. The maximum value measured in the present study area was 7.5 ppm. The allowable limit according to [30] is 6 ppm.

4. Conclusions

The microbiological quality of all the water samples in the present study was poor due to direct contamination by point, non-point sources and human activities. During our assessment, we investigated that the surface water in the examined area is generally contaminated and the sources of contamination are principally from population effects, fertilizers, electricity stations and agricultural drainage and sewage channels (Al-Zennar and Decran channels). So rapid and reliable monitoring of surface water is essential for keeping a close watch on water quality parameters.

The degree of contamination increase generally in (TW) location due to the proximity of the Al Zennar drainage channel from the sewage treatment plant, which acted directly on the River Nile, which shows that the treatment processes are not optimal. On the other hand it was also noted that the level of microbial contamination varies depending on the monitoring points and the proximity of the various sources of pollution.

Physicochemical characteristics of the Nile River in the study area ranged from marginal to good according to Egyptian lows of the Nile River protection agency.

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